Enteric Disease Surveillance and Outbreak Investigation

Bill Keene
Oregon Public Health Division
What happens when you google “76 million”?
What happens when you google "76 million"?

Food Safety, Home | CDC Bacterial, Mycotic Diseases
While the food supply in the United States is one of the safest in the world, CDC estimates that 76 million people get sick, more than 300000 are ...
www.cdc.gov/foodsafety/ - 30k - Cached - Similar pages

Food and diseases, disease information, NCID, CDC
CDC estimates that 76 million Americans get sick, more than 300000 are hospitalized, and 5000 people die from foodborne illnesses each year. ...
www.cdc.gov/ncidod/diseases/food/ - 32k - Cached - Similar pages
More results from www.cdc.gov »
Range of Foodborne Illnesses

- gastroenteritis ........................................ many
- birth defects ........................................... toxoplasmosis
- abortion/stillbirth ...................................... listeriosis
- septicemia ............................................... V. vulnificus
- respiratory failure ..................................... botulism
- kidney failure ........................................... E. coli O157
- amnesia ................................................... domoic acid
- paralysis .................................................. campylobacteriosis
- seizures .................................................. taeniasis
- dementia ................................................... nvCJD/TSE
# Common Agents of Enteric Illness

**Bacterial**
- Shigella
- Salmonella
- Bacillus cereus
- Campylobacter
- Yersinia
- Clostridium perfringens
- Staphylococcus aureus
- Vibrio
- *Escherichia coli* O157:H7
- other STEC
- ETEC, EIEC, EPEC, EAEC
- *Listeria*

**Parasitic**
- *Giardia*
- *Cryptosporidium*
- *Cyclospora*

**Viral**
- norovirus
- sapovirus
- adenoviruses
- astroviruses
- rotavirus
- hepatitis A
Incidence Trends Since 1996–98, FoodNet

[Graph showing the relative incidence of Vibrio, Salmonella, Campylobacter, and E. coli O157 over the years 1999 to 2007.]
Disease Reporting

- Rules are state-specific

- Requirements for specific diseases, outbreaks, and “unusual diseases” in general

- Some isolates go to PHL for subtyping
Reporting is Incomplete

- Infected
- Symptomatic
- See MD
- Specimen
- Lab result/report

Days after exposure:
0 5 10 15

Proportion (%):
0 100
Sporadic Case Investigation Questions

- Basic demographics
- Basis of diagnosis
- Hot-button exposure(s)
- Identify others at risk
- Health education and individual control measures (e.g., child care, school, food handler restrictions)
Review Data to Detect Anomalies

- Monitor frequency of reports
- Assess demographic and exposure factors
- Integrate with lab subtyping (e.g., serotype, PFGE) both locally and nationally
What Starts Outbreak Investigations?

- Citizen and health care worker reports
- Noteworthy spikes in crude case counts
- Subtyping clusters
- Notification from other agencies

Epidemic Curve
Jack-in-the-Box outbreak
Washington State, 1992–93
Etiology of Reported Outbreaks

Norovirus
Salmonella
O157
other
unknown
unknown
unknown

“Epilinks” of FoodNet Cases, 2004–06

Salmonella
N = 19,658

E. coli O157
N = 1,465
Why Investigate Outbreaks?

- Stop ongoing transmission
- Facilitate diagnosis, proper treatment, and prophylaxis
- Identify risk factors
- Stimulate research
- Develop sensible prevention strategies

*Brand X ice cream caused 1994 salmonellosis outbreak—200,000+ cases nationwide*
Who Does the Epidemiology Work?

- State/local health departments conduct >95% of all enteric disease investigations
- CDC participates in a *small* proportion of total
- CDC is primary agency on a *tiny* proportion
- States do not work for the feds
- Coordination is good, but so is speed
- 1 or 2 states often set the pace on multi-state investigations
Stages of Outbreak Investigations

- **Recognition**

- **Initial Investigation**
  - find additional cases
  - identify the vehicle
  - circumscribe the problem

- **Later Investigation**
  - trace-backs and trace-forwards
  - identify root causes

- **Action**
  - recalls, media and public contact
  - supplemental research
Stages of Investigations (cont’d)

- Reaction
  - improve production and QA procedures
  - educate
  - regulate
  - litigate
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<td>OR</td>
<td>Human</td>
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<td>OR</td>
<td>Human</td>
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Review of Basic Data

- No obvious connections or “hot-button” exposures reported in routine interviews

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<td>Marion</td>
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<tr>
<td>37</td>
<td>M</td>
<td>8/25/06</td>
<td>Cowlitz (WA)</td>
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<tr>
<td>17</td>
<td>F</td>
<td>8/30/06</td>
<td>Benton</td>
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<tr>
<td>62</td>
<td>F</td>
<td>8/31/06</td>
<td>Linn</td>
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Follow-up “Shotgun” Interviews

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<tr>
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<td>A</td>
<td>☐</td>
<td>white or yellow onions</td>
</tr>
<tr>
<td>B</td>
<td>☐</td>
<td>green onions (scallions)</td>
</tr>
<tr>
<td>C</td>
<td>☐</td>
<td>leeks</td>
</tr>
<tr>
<td>D</td>
<td>☐</td>
<td>eggplant</td>
</tr>
<tr>
<td>E</td>
<td>☐</td>
<td>commercially made guacamole</td>
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<tr>
<td>F</td>
<td>☐</td>
<td>other avocado</td>
</tr>
<tr>
<td>G</td>
<td>☐</td>
<td>cabbage</td>
</tr>
<tr>
<td>H</td>
<td>☐</td>
<td>bean sprouts</td>
</tr>
<tr>
<td>I</td>
<td>☐</td>
<td>any stir-fry that might have included bean sprouts</td>
</tr>
<tr>
<td>J</td>
<td>☐</td>
<td>alfalfa sprouts</td>
</tr>
<tr>
<td>K</td>
<td>☐</td>
<td>any other sprouts (clover, mixed, broccoli, daikon radish, …)</td>
</tr>
<tr>
<td>L</td>
<td>☐</td>
<td>Did you handle any sprouts, even if you didn’t eat them?</td>
</tr>
<tr>
<td>M</td>
<td>☐</td>
<td>any bagged, pre-washed lettuce or salad mix</td>
</tr>
<tr>
<td>N</td>
<td>☐</td>
<td>any other iceberg lettuce</td>
</tr>
<tr>
<td>O</td>
<td>☐</td>
<td>any romaine lettuce</td>
</tr>
<tr>
<td>P</td>
<td>☐</td>
<td>any other leafy lettuce (red, green, butter, radicchio …)</td>
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<tr>
<td>Q</td>
<td>☐</td>
<td>any mesclun, “spring mix”, or “baby” salad items</td>
</tr>
<tr>
<td>R</td>
<td>☐</td>
<td>any lettuce on sandwiches or burgers</td>
</tr>
<tr>
<td>S</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>T</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>U</td>
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<td>☐</td>
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<tr>
<td>Z</td>
<td>☐</td>
<td>☐</td>
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</table>
Assessing Shotgun Surveys

How likely are we to find \( x \) or more out of \( n \) people eating a given product?

\[
\sum_{y=x}^{n} \left( \frac{n!}{y!(n-y)!} \right) p^y(1-p)^{n-y}
\]

- \( n = \text{number of cases} \)
- \( x = \text{number of cases with exposure} \)
- \( p = \text{background exposure rate} \)
Binomial Calculations

- 5 of first 6 Oregon/Washington cases reported eating bagged spinach
- Known spinach consumption rate ~17%

<table>
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<th>If background is...</th>
<th>Probability of 5/6</th>
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<tr>
<td>10%</td>
<td>0.00006</td>
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<tr>
<td>15%</td>
<td>0.0004</td>
</tr>
<tr>
<td>20%</td>
<td>0.002</td>
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<tr>
<td>25%</td>
<td>0.005</td>
</tr>
<tr>
<td>30%</td>
<td>0.01</td>
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</table>
Combining initial Oregon and Wisconsin cases: 13 of 14 reported bagged spinach

<table>
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<tr>
<th>Background</th>
<th>Probability of 13/14</th>
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<td>10%</td>
<td>&lt;0.000000001</td>
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<tr>
<td>15%</td>
<td>&lt;0.000000001</td>
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<tr>
<td>20%</td>
<td>0.000000009</td>
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<tr>
<td>25%</td>
<td>0.000000016</td>
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<tr>
<td>30%</td>
<td>0.00000016</td>
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</table>
Summary of Successful Investigations

- Lab, epi, and environmental help work together
- Statistics often *are* the smoking gun
- Food cultures are nice, but rarely necessary
- Tracebacks critical to pinpoint problem
- Public notification is usually rapid once a source is identified
- Many agencies get involved as investigation progresses
- Public/media reaction is unpredictable
Cautionary Notes

- Epi and lab capacity varies from state to state
- Many clusters elude solution
- Methods are improving, so expect to hear about more outbreaks
Puffed Rice and Puffed Wheat Cereals