FOODBORNE OUTBREAK INVESTIGATIONS: How Epidemiology Contributes to Public Health Action

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Overview

- Overview of foodborne outbreak investigations in United States
- Examples of two recent foodborne outbreak investigations
- Preparing for the future
Foodborne Diseases: A Changing Landscape

Focal scenario

- Large number of cases in one jurisdiction
- Detected by affected group
- Local investigation
- Local solution
- Food handling error
Foodborne Diseases: A Changing Landscape

Focal scenario

- Path from farm to table was shorter
- Localized food distribution
Foodborne Diseases: A Changing Landscape

New dispersed scenario

- Fewer, but larger producers
- Wide distribution
- More imported food
- New techniques in food production and preparation
Foodborne Diseases: A Changing Landscape

New dispersed scenario
- Many affected communities
- Detected by lab-based subtype surveillance
- Response requires coordination among states and agencies
- Industrial contamination event
Public Health Infrastructure in the United States

- The county, city, state health department
- The federal agencies:
  - CDC, FDA, USDA, EPA
- "Tiered response" to emergencies
  - CDC provides back-up to states with epidemiologists, laboratory support, coordination of investigation
Federal Roles

- Disease surveillance
- Outbreak detection and investigation
- Education and training of public health staff
- Food safety policies
- Inspection and enforcement
- Product recall and traceback
- Investigation of production facilities
Cycle of Foodborne Disease Control and Prevention

- Surveillance
- Prevention Measures
- Epidemiologic Investigation
- Applied Research
What is PulseNet USA?

- National molecular subtyping network for foodborne disease
  - >80 public health and regulatory laboratories
- Perform molecular typing of foodborne disease-causing bacteria
  - Current method is pulsed-field gel electrophoresis (PFGE)
What is PulseNet USA?

- Share DNA “fingerprints” electronically
- DNA “fingerprints” are kept in national database at CDC
PulseNet Data Analysis: Searching for Clusters

- Monitors for similar patterns in past 2-4 months
- When cluster identified, PulseNet contacts epidemiologists

Cluster of indistinguishable patterns
87 labs in the PulseNet USA network

CDC PulseNet headquarters
★ Regional labs
▲ Local and secondary state labs
● Federal labs

December 2011
Clusters Reported to CDC by Source, 2008 (n=175)

<table>
<thead>
<tr>
<th>Source of Report</th>
<th>Percent of Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>PulseNet</td>
<td>75%</td>
</tr>
<tr>
<td>State</td>
<td>14%</td>
</tr>
<tr>
<td>Regulatory agency</td>
<td>3%</td>
</tr>
<tr>
<td>FBO Listserv</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
<tr>
<td>Lab</td>
<td>1%</td>
</tr>
<tr>
<td>Media</td>
<td>1%</td>
</tr>
<tr>
<td>Epi-X</td>
<td>0.6%</td>
</tr>
<tr>
<td>International agency</td>
<td>0.6%</td>
</tr>
</tbody>
</table>
Isolates Reported to PulseNet USA, 1996-2011

*Human*  *Food/Animal/Environment*

Entries are individual specimen patterns uploaded to PulseNet USA and include submissions to the Salmonella, Shiga toxin-producing E. coli O157 and non-O157, Shigella, Listeria, and Campylobacter databases.
Inherent Delays in Surveillance Timeline for Reporting Cases

1 – 3 days

Contact with health care system: 1 – 5 days

Patient Eats Contaminated Food

Stool Sample Collected

Diagnosis: 1 – 3 days

Public Health Lab Receives Sample

Shipping: 0 – 7 days

Patient Becomes Ill

Salmonella Identified

Serotyping & DNA fingerprinting: 2 – 10 days

Case Confirmed as Part of Outbreak
Cycle of Foodborne Disease Control and Prevention

Surveillance

Prevention Measures

Applied Research

Epidemiologic Investigation
CDC Outbreak Response Team

- Supports a national network of epidemiologists and public health officials who investigate foodborne outbreaks
- Collaboration between CDC and
  - State and local health departments
  - USDA
  - FDA
- Works in close partnership with PulseNet
- Comprehensive outbreak surveillance
- Rapid response to multi-state foodborne outbreaks
Steps in a Foodborne Outbreak Investigation

1. Detecting a possible outbreak
2. Defining and finding cases
3. Generating hypotheses
   - Hypothesis-generating interviews
   - Analytic studies
   - Laboratory testing of samples
4. Testing the hypotheses
5. Finding the point of contamination and source of the food
6. Controlling an outbreak
   - Recall product(s)
   - Remove source of contamination
   - Revise production process
7. Deciding an outbreak is over

If cases continue:
- Not finding associations between food & illness
- Finding associations between food & illness
- If cases stop: Unsolved mystery
- Cases stop
Some Features Considered in Triaging Clusters

• Pathogen
  – Severity (botulism v. *E. coli* O157 v. *Salmonella*)
    • Number of deaths or hospitalizations
    • Frequency of serotype or PFGE pattern
    • Distribution over time
    • Geographic distribution

• Person, place and time
  – “Momentum”: number of ill over time
  – Gender and age
  – Geographic distribution
<table>
<thead>
<tr>
<th>Year</th>
<th>Outbreak Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>E. coli O157 &amp; bagged spinach</td>
</tr>
<tr>
<td>2006</td>
<td>E. coli O157 &amp; shredded lettuce (restaurant chain A)</td>
</tr>
<tr>
<td>2006</td>
<td>E. coli O157 &amp; shredded lettuce (restaurant chain B)</td>
</tr>
<tr>
<td>2006</td>
<td>Botulism &amp; commercial pasteurized carrot juice</td>
</tr>
<tr>
<td>2006</td>
<td>Salmonella &amp; fresh tomatoes</td>
</tr>
<tr>
<td>2007</td>
<td>E. coli O157 &amp; frozen pizza</td>
</tr>
<tr>
<td>2007</td>
<td>Salmonella &amp; peanut butter</td>
</tr>
<tr>
<td>2007</td>
<td>Salmonella &amp; a vegetarian snack food</td>
</tr>
<tr>
<td>2007</td>
<td>Salmonella &amp; dry dog food</td>
</tr>
<tr>
<td>2007</td>
<td>Salmonella &amp; microwaveable pot pies</td>
</tr>
<tr>
<td>2007</td>
<td>Salmonella &amp; dry puffed breakfast cereal</td>
</tr>
<tr>
<td>2007</td>
<td>E. coli O157 &amp; ground beef</td>
</tr>
<tr>
<td>2007</td>
<td>Botulism &amp; canned chili sauce</td>
</tr>
<tr>
<td>2008</td>
<td>Salmonella &amp; cantaloupe</td>
</tr>
<tr>
<td>2008</td>
<td>E. coli O157 &amp; ground beef</td>
</tr>
<tr>
<td>2008</td>
<td>Salmonella &amp; fresh produce items containing foods</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; peanut butter</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; imported white and black pepper</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; alfalfa sprouts</td>
</tr>
<tr>
<td>2009</td>
<td>Multidrug resistant Salmonella &amp; ground beef (x2)</td>
</tr>
<tr>
<td>2009</td>
<td>E. coli O157 &amp; blade tenderized steaks</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; salami made with contaminated pepper</td>
</tr>
<tr>
<td>2009</td>
<td>E. coli O157 &amp; prepackaged cookie dough</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella Typhi &amp; frozen mamey fruit pulp</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; frozen meals</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; shell eggs</td>
</tr>
<tr>
<td>2009</td>
<td>Salmonella &amp; alfalfa sprouts</td>
</tr>
<tr>
<td>2010</td>
<td>E. coli O145 &amp; shredded romaine lettuce</td>
</tr>
<tr>
<td>2010</td>
<td>Salmonella &amp; alfalfa sprouts</td>
</tr>
<tr>
<td>2010</td>
<td>Salmonella Typhi &amp; frozen mamey fruit pulp</td>
</tr>
<tr>
<td>2010</td>
<td>Salmonella &amp; frozen meals</td>
</tr>
<tr>
<td>2010</td>
<td>Salmonella &amp; shell eggs</td>
</tr>
<tr>
<td>2010</td>
<td>Salmonella &amp; alfalfa sprouts</td>
</tr>
<tr>
<td>2010</td>
<td>E. coli O157 &amp; hazelnuts</td>
</tr>
<tr>
<td>2010</td>
<td>Multidrug resistant Salmonella &amp; turkey burgers</td>
</tr>
<tr>
<td>2010</td>
<td>Salmonella &amp; alfalfa/spicy sprouts</td>
</tr>
<tr>
<td>2011</td>
<td>Multidrug resistant Salmonella &amp; ground turkey</td>
</tr>
<tr>
<td>2011</td>
<td>Salmonella &amp; whole, fresh imported papayas</td>
</tr>
<tr>
<td>2011</td>
<td>Multidrug resistant Salmonella &amp; ground turkey</td>
</tr>
<tr>
<td>2011</td>
<td>Listeria &amp; cantaloupes</td>
</tr>
<tr>
<td>2011</td>
<td>Salmonella &amp; imported pine nuts</td>
</tr>
<tr>
<td>2011</td>
<td>Salmonella &amp; kosher broiled chicken livers</td>
</tr>
<tr>
<td>2011</td>
<td>E. coli O157 &amp; romaine lettuce</td>
</tr>
<tr>
<td>2011</td>
<td>Multidrug resistant Salmonella &amp; ground beef</td>
</tr>
</tbody>
</table>
OUTBREAK OF SALMONELLA HEIDELBERG INFECTIONS

May-November 2011
Outbreak Detection

- May 23, 2011: CDC PulseNet identified 30 *Salmonella* Heidelberg infections since March 1, 2011
- PFGE pattern was rare
  - Expect background of 2-4 uploads per month to PulseNet
- CDC Outbreak Response Team began coordinating a multistate investigation
Salmonella Heidelberg Outbreak PFGE Pattern
Uploads 2006–2011

- Human isolates only
- Cluster isolates highlighted

Uploads as of 08/15/2011
Salmonella

- Major bacterial cause of foodborne disease in U.S.
  - 1.2 million illnesses, ~400 deaths annually
- Many different sources
  - Meat, poultry, produce, animal contact
- >2,500 serotypes
  - Heidelberg is a common serotype
Salmonella Infections

- Incubation period 12 to 72 hours
- Illness duration 4 to 7 days
- Acute gastroenteritis: fever, diarrhea, abdominal cramps, vomiting, bloody stools
- Serious illness: meningitis, bloodstream infections, joint infections
  - Young children, immunocompromised, elderly
- Most do not require treatment other than oral fluids
  - May require rehydration with intravenous fluids
  - Antibiotics not usually indicated
Outbreak Case Definition

- Illness in a patient with *Salmonella* Heidelberg infection
- Illness onset after February 27, 2011
- Isolate matching PFGE pattern of the outbreak strain
Hypothesis Generation

- June–July, 2011: Hypothesis generating questionnaire
  - 35% (12/34) case-patients reported ground turkey
Hypothesis Testing

- Does 35% represent an elevated exposure rate?
  - Needed comparison group
  - Obtaining traditional control group is time consuming
  - Utilized FoodNet Population Survey - National food consumption survey
  - 11% of general population report ground turkey
  - 35% exposure rate in case patients was elevated.
  - Finding was statistically significant.
Identifying the Source

- July–August, 2011: Poultry Specific Questionnaire
  - 61% (17/28) case-patients reported eating ground turkey
- Outbreak strain isolated from retail ground turkey samples
Antibiotic Resistance Profiles

- Antibiotic resistance pattern between patient and retail poultry isolates matched
- Multi-drug resistant pattern
- Antibiotic resistance profile:
  - Ampicillin
  - Streptomycin
  - Gentamicin
  - Tetracycline
What Ground Turkey was Contaminated?

- Shopper card information from multiple patients showed specific brand of ground turkey products:
  - 3 national brands
  - 3 store brands

- USDA-FSIS traced brands back to a single production plant, Plant A, operated by Company A.
Epidemic Curve for *Salmonella* Heidelberg as of 8/3/2011 (n= 77)

Illnesses that began during this time may not have been reported.
Persons infected with *Salmonella* Heidelberg by state as of 8/3/2011 (n=77)
First Recall

- July 28, 2011: USDA’s Food Safety and Inspection Service (USDA-FSIS) informed Company A of potential link between ground turkey and Plant A
- August 3, 2011: Company A recalled ~36 million pounds of ground turkey products
- Largest USDA-FSIS Class I recall in U.S. history
The Outbreak Expands

- August 8, 2011: Second Heidelberg PFGE pattern matched retail sample
- CDC and states conducted new interviews
- 78% (7/9) of case-patients reported ground turkey consumption
- Case definition expanded to include this pattern
- 23 additional cases added to outbreak
Second Recall

- Samples collected from Plant A tested positive for outbreak strain after August recall
- September 11, 2011: Company A issued second recall of 185,000 pounds of ground turkey products
- Production of raw ground turkey products suspended at plant until corrective actions implemented
Infections with *Salmonella* Heidelberg by Week of Illness Onset, February–November, 2011 (n= 136)
Persons infected with *Salmonella* Heidelberg by state as of 11/15/2011 (n=136)
<table>
<thead>
<tr>
<th>Clinical Characteristics</th>
<th>n=136</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>63 (46 %)</td>
</tr>
<tr>
<td>Median age (range)</td>
<td>23 years (&lt; 1 – 90 years)</td>
</tr>
<tr>
<td>Hospitalized</td>
<td>35 (38%)</td>
</tr>
<tr>
<td>Death</td>
<td>1 (0.7%)</td>
</tr>
</tbody>
</table>
Outbreak Overview

- Epidemiologic investigation, laboratory evidence and traceback can solve an outbreak
- Critical collaboration between state and federal agencies
- Shopper card information aided product identification
- Company A acted quickly to eliminate contaminated product
August-November 2011

OUTBREAK OF *LISTERIA* INFECTIONS
Outbreak Detection

- September 2, 2011: Colorado contacted CDC
  - Expected Listeria baseline—2 cases per month
  - Past 5 days—7 cases reported
  - Monthly total—9 cases
- All 9 cases hospitalized
- 2 deaths
- Age: 30-90 years (median age 84 years)
- 89% female
Listeria monocytogenes (LM) in the United States

- **Annual public health impact**
  - 1,600 illnesses
  - 1,450 hospitalizations
  - 250 deaths

- **Foodborne pathogen**
  - <1% bacterial foodborne illnesses
  - 19% food-related deaths

- **94% hospitalization rate**
  - Highest among foodborne pathogens

- **15.9% overall case-fatality rate**
  - 25–50% among newborns

*Scallan E et. al., Emerging Infectious Diseases; 2011 Jan; 17(1); 7-15.*
Listeria: Epidemiology

- Ubiquitous in soil and water
- Animal reservoirs
- Typical food vehicles
  - Unpasteurized (raw) milk
  - Raw-milk cheeses
  - Hot dogs
  - Deli meats
  - Smoked seafood
- Growth during refrigeration
- Mostly sporadic illness
  - 2–3 U.S. outbreaks annually
Listeria: Clinical Manifestations

- Long incubation: 3–70 days (median: 21 days)
- “Healthy” individuals
  - Asymptomatic
  - Febrile gastroenteritis
- Invasive disease
  - Septicemia
  - Meningitis
- High-risk groups
  - Immunocompromised
  - Older adults (≥60 years)
  - Pregnant women
  - Newborns
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 8)

- September 2 —
  - 8 cases reported since August 15
- Expect 1–2 cases in August in Colorado
Investigation

- Case definition
  - Illness onset after July 31
  - Culture-confirmed *Listeria* clinical infection
  - PFGE Isolate indistinguishable from any of four outbreak strains
- Case Finding
  - PFGE Patterns in PulseNet
Hypothesis Generation

- Patient interviews
  - Conducted by Colorado Department of Public Health and Environment
  - Confirm course of illness
  - Determine food exposures
  - Generate hypotheses
- Initial analysis showed:
  - Cantaloupe
  - Ham
Hypothesis Testing

- Results needed control comparison
  - Controls needed to be matched on case patient’s age range and health status
  - Identifying and interviewing traditional control group time consuming
  - General population results of FoodNet Population Survey were not ideal
- Compared to sporadic cases in *Listeria* Initiative
Listeria Initiative

- Enhanced surveillance system (CDC)
- Implemented 2004
  - >40 states currently participating
- All *Listeria* isolates are fingerprinted in PulseNet
- Standard extended questionnaire
  - Individual, sporadic illnesses
  - Food consumption history
- Ready bank of data for ill controls
  - Speed public health interventions
Hypothesis Testing

- *Listeria* Initiative data on sporadic cases used as control group
  - Matched on age and time of year
  - Outbreak cases compared to similar group of sporadic cases to assess differences in food exposure
  - Case-control analysis → Case-case analysis
Case comparison to The *Listeria* Initiative*

<table>
<thead>
<tr>
<th>Date</th>
<th>Cantaloupe</th>
<th>Ham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept 9</td>
<td>OR (95% CI) = 8.54 (1.32-∞)</td>
<td>OR (95% CI) = 2.01 (0.51–9.44)</td>
</tr>
<tr>
<td></td>
<td>Cases: 11/11 (100%)</td>
<td>Cases: 7/11 (64%)</td>
</tr>
<tr>
<td></td>
<td>Controls: 54/85 (64%)</td>
<td>Controls: 360/774 (47%)</td>
</tr>
<tr>
<td></td>
<td>P=0.02</td>
<td>P=0.41</td>
</tr>
</tbody>
</table>

* In controls, cantaloupe exposures limited to those with isolation dates in August. Controls are non-pregnancy associated sporadic cases among persons 60 years or greater.

** Cases initially limited to PFGE patterns 1 and 2.
Traceback: Cantaloupes

- FDA and Colorado state partners initiate traceback of cantaloupes
  - Preliminary interview and traceback implicate cantaloupes marketed as “Rocky Ford”
- Farm A identified as supplier of “Rocky Ford” cantaloupes supplied to stores where case-patients shopped
Laboratory Findings: Cantaloupes

- Cantaloupe collected from patient’s home
  - Whole and cut cantaloupe both positive for Listeria
  - PFGE identified 3 of 4 outbreak strains
- Farm A cantaloupes collected at retail
  - 10/10 (100%) tested positive for Listeria
  - PFGE identified 3 of 4 outbreak strains
- Farm A cantaloupes collected at retail by FDA
  - 9/10 (90%) tested positive for Listeria
  - PFGE identified a single outbreak strain
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 8)

- **September 2** —
  - 8 cases reported since August 15
- **Expect 1–2 cases in August in Colorado**
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 15)

- CDC establishes statistically significant association
- Colorado announces cantaloupes are the likely cause of illness
- FDA collects cantaloupes from retail
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 15)

- Colorado health officials and FDA visit Rocky Ford Producers including Farm A
  - Collect environmental and product samples
  - Further harvest at Farm A ceases as a precautionary measure
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 28)

- September 14
  - Ongoing traceback investigations converge on Farm A
  - Farm A voluntarily recalls all cantaloupe
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 53)

- September 19
  - Samples collected at Farm A yield several outbreak strains of *Listeria*
  - Fourth outbreak strain of *Listeria* identified
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 131)

- October 19
  - FDA announces findings of Farm A root cause environmental assessment conducted September 22–23
Timeline of Events: Multistate Listeriosis Outbreak—July–October, 2011 (n = 146)

- October 31
  - Last day of the outbreak period determined by CDC
Number of Patients by Date of Illness Onset — All States, July–October, 2011 (n = 145)

Farm A recalls all cantaloupe

Colorado cases
Non-Colorado cases

Number of Illnesses

Date of Illness Onset

August
September
October
Persons Infected with Outbreak Strains of Listeria, by State*

* n= 146 for whom information was reported to CDC on December 2, 2011
### Characteristics — All Patients (n = 146)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median years (range)</td>
<td>77 (&lt;1–96)</td>
</tr>
<tr>
<td>≥ 60 years of age</td>
<td>126 (86)</td>
</tr>
<tr>
<td>Female</td>
<td>85 (58)</td>
</tr>
<tr>
<td>Hospitalized*</td>
<td>142 (99)</td>
</tr>
<tr>
<td>Died</td>
<td>30 (21)</td>
</tr>
</tbody>
</table>

* Among 144 patients with available data
Root Cause Environmental Assessment — Farm A, September 22–23

- Joint assessment
  - Food and Drug Administration (FDA)
  - Colorado Department of Public Health and Environment
  - Prowers County Public Health
  - Colorado Department of Agriculture
- Identify factors leading to introduction, growth and spread of Listeria
- Environmental assessment
- Review management and production practices
Root Cause Environmental Assessment — Packing Operations

- Contamination likely during packing operations
- Sanitation practices deficient due to
  - Floors allowed standing water and not easily cleanable
  - Equipment not easily cleaned and sanitized
- Introduction of used processing equipment
  - Potential source and reservoir of Listeria
- No pre-cooling of cantaloupes
  - Amplification of Listeria during cold storage
Root Cause Environmental Assessment — Packing Operations Equipment Design

- July 2011: equipment installed at packing facility
  - Replaced hydrocooling wash process
  - Refurbished equipment
  - Not easily disassembled, cleaned, or sanitized
- Two components
  - Brush rollers with spray wash
  - Felt rollers to dry
- First Listeria-positive swab collected from felt roller
- Potential role in contamination of cantaloupes
  - Listeria introduced with equipment
  - Design $\Rightarrow$ difficult to clean $\Rightarrow$ Listeria growth and spread
Root Cause Environmental Assessment — Packing Operations Equipment Design
Root Cause Environmental Assessment — Packing Operations Equipment Design
Root Cause Environmental Assessment — Packing Operations Equipment Design

Cantaloupes enter

Cantaloupes exit
Root Cause Environmental Assessment — Packing Operations Equipment Design

Cantaloupes enter

Brush rollers and spray wash

Felt rollers

Cantaloupes exit
Root Cause Environmental Assessment — Packing Operations Postharvest Practices

- No pre-cooling of cantaloupes to remove field heat
- Residual moisture on cantaloupe rind from wash step
- Contaminated felt rollers spread listeria to cantaloupes
- Warm Cantaloupes boxed in cool storage enabled condensation in packaging
Conclusions

- Whole cantaloupes produced and packed by Farm A caused outbreak
- First reported Listeriosis outbreak associated with whole cantaloupe
  - Ready-to-eat and processed foods previously
- Largest documented U.S. outbreak of Listeriosis
  - Deadliest U.S. foodborne outbreak in >90 years
- Rapid identification and action by Colorado state partners saved lives
Lessons Learned in Investigating Multistate Foodborne Disease Outbreaks

• Multistate outbreak detection enhanced by PFGE Fingerprinting and PulseNet
• Pre-existing control groups for comparison analysis speed vehicle identification
  – Help identify when foods are being consumed in an unusually high rate by ill persons
  – CDC FoodNet Population Survey- Surveys of food consumption in the general public
  – Listeria Initiative- sporadic cases food consumption
• Shopper/customer loyalty card information can provide critical clues
  – Quickly search purchase history for suspect products
  – Facilitate traceback
The Future of Foodborne Outbreak Detection

- New Dispersed Scenario for Foodborne Outbreaks will continue
- Current detection relies on PFGE patterns obtained through culture
- Cultures ordered by physicians to diagnose
- As new non-culture based diagnostics are developed, there will be less isolates to PFGE
  - Example: Point of Care Rapid Antigen Testing
- Existing system for multistate foodborne outbreak detection is in jeopardy
Future Solutions?

- How to continue wide surveillance without cultured isolates is being explored
- Currently no simple solution has been identified
- Continue to encourage stool culture for cases of suspected foodborne illness
- Optimistic that another system will be developed in the future, perhaps by an epidemiology student here today.
Acknowledgments

- State and Local Health Departments
- FDA
- USDA-FSIS
- CDC Colleagues
- Michigan Public Health Association
Thank you very much!

For more information please contact Centers for Disease Control and Prevention

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E-mail: cdcinfo@cdc.gov  Web: http://www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.