Anatomy of Multistate Foodborne Outbreaks -- Focus on Produce-Associated Outbreaks

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Burden of Foodborne Illness

- Estimated 48 million illnesses annually
  - 1 out of 6 Americans get a foodborne illness
  - 128,000 hospitalizations
  - 3,000 deaths

- Certain populations are more susceptible
  - Children, older persons, immune-compromised

- Typically causes diarrhea and fever
  - Can cause life-threatening complications

- Many sources
  - Meat, poultry, produce, animal contact
Number of Salmonellosis Outbreaks by Food Commodity Category of Single Implicated Food, 1998-2005

The chart shows the number of salmonellosis outbreaks by food commodity category from 1998 to 2005. The categories include Beef, Dairy, Eggs, Game, Pork, Poultry, Grains, Botanicals, Produce, Crustacean, Finfish, and Mollusk. The highest number of outbreaks is associated with Grains, followed by Produce and Crustacean.
Some Recent Large US Multi-State Outbreaks of Foodborne Infections 2006-2010 (n=28)

2006 - *E. coli* O157 and bagged spinach
2006 - *E. coli* O157 and shredded lettuce (restaurant chain A)
2006 - *E. coli* O157 and shredded lettuce (restaurant chain B)
2006 - Botulism and commercial pasteurized carrot juice
2006 - *Salmonella* and fresh tomatoes
2007 - *E. coli* O157 and frozen pizza
2007 - *Salmonella* and peanut butter
2007 - *Salmonella* and a vegetarian snack food
2007 - *Salmonella* and dry dog food
2007 - *Salmonella* and microwaveable pot pies
2007 - *Salmonella* and dry puffed breakfast cereal
2007 - *E. coli* O157 and ground beef
2007 - Botulism and canned chili sauce
2008 - *Salmonella* and cantaloupe
2008 - *E. coli* O157 and ground beef
2008 - *Salmonella* and raw produce (peppers)
2009 - *Salmonella* and peanut butter containing foods
2009 - *Salmonella* and imported white and black pepper
2009 - *Salmonella* and alfalfa sprouts
2009 - *E. coli* O157 and prepackaged cookie dough
2009 - Multidrug resistant *Salmonella* and ground beef (x2)
2009 - *E. coli* O157 and blade tenderized steaks
2009 - *Salmonella* and salami made with contaminated pepper
2010 - *E. coli* O145 and romaine lettuce
2010 - *Salmonella* and alfalfa sprouts
2010 - *Salmonella* and frozen meals
2010 - *Salmonella* and shell eggs
2010 - *Salmonella* and alfalfa sprouts
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“Produce” Outbreaks (n=11)
Challenge: A Broad Range of Foods Can Be Contaminated

10 new food vehicles identified in multistate outbreaks since 2006:

• bagged spinach
• carrot juice
• peanut butter
• broccoli powder on a snack food
• dog food
• pot pies
• canned chili sauce
• hot peppers
• white pepper
• raw cookie dough

National Foodborne Outbreak Surveillance System
Challenge: A Broad Range of Foods Can Be Contaminated

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National Foodborne Outbreak Surveillance System
Produce-associated outbreaks on the rise

- Proportion of all foodborne outbreaks associated with produce increasing over last 30 years
  - From < 1% to 6% of all outbreaks
  - From < 1% to 12% of outbreak associated cases

- Some produce items predominantly associated with particular pathogen
  - *Salmonella*: Almonds, melons, sprouts, tomatoes
  - *E. coli* O157:H7: leafy greens
Contaminated Food
What is a foodborne outbreak?

- When 2 or more people get the same illness from the same contaminated food or drink

- Illnesses not part of a recognized outbreak are “sporadic”
Who investigates foodborne outbreaks?

- Multidisciplinary teams
  - Epidemiologists
  - Microbiologists
  - Environmental health specialists or sanitarians
  - Regulatory officials and inspectors

- Other professionals added as investigation proceeds
  - Food industry can play important role
What agencies are involved?

- State and local health departments
- State regulatory agencies
- CDC
  - Non-regulatory, public health agency
  - Focus on problem identification and source implication
  - Usually lead multistate outbreak investigations
- FDA and USDA-FSIS
  - Regulatory agencies
  - Focus on risk management and source assessment
  - Trace foods to origin, test foods, assess food safety measures in restaurants and food processing facilities, lead farm investigations, announce food recalls
Cycle of Foodborne Outbreak Control & Prevention

- Surveillance
- Epidemiologic Investigation
- Prevention Measures
- Applied Research
Foodborne Disease Outbreak Investigations

• Goals of investigations
  – Immediate control of outbreak and prevention of illnesses
  – Provide opportunities to identify gaps in food safety systems

• Outbreak epidemiology changing
  – Globalization, centralization, industrialization
  – Number of possible outbreaks detected has grown substantially

• Effective investigations key to reducing burden of foodborne disease
  – Identify food vehicles and factors which lead to outbreaks
Cycle of Foodborne Outbreak Control & Prevention

Surveillance

Applied Research

Epidemiologic Investigation

Prevention Measures
Cycle of Foodborne Outbreak Control & Prevention: Stages of an Investigation

Stage 1: Detecting a cluster (increase # of infections above baseline for time period)
National Surveillance for Bacterial Foodborne Infections

- Reports to CDC of suspected outbreaks by state and local health departments
- Laboratory-based surveillance of clinical isolates
  - Serotype results
  - PulseNet
What is PulseNet?

- National molecular subtyping network for foodborne disease surveillance
- Network of >75 public health & regulatory laboratories
- Current method is pulsed-field gel electrophoresis (PFGE)
  - Creates DNA “fingerprints”
- Share DNA “fingerprints” electronically
- DNA “fingerprints” kept in dynamic database at CDC

Cluster of indistinguishable patterns as “outbreak strain”
Outbreak Epidemiology Changes

Past

• Food distribution localized
• Local outbreaks, large numbers ill
• Identified by affected group
• Improper food handling in single restaurant or event
• Local control measures
Cluster Identification in the Past
Outbreak Epidemiology Changes

**Past**
- Food distribution localized
- Local outbreaks, large numbers ill
- Identified by affected group
- Improper food handling in single restaurant or event
- Local control measures

**Present**
- Food products widely distributed
- Many affected communities with few cases
- PulseNet detects and connects dispersed cases
  - Communication, coordination critical
- Industrial contamination
  - Large-scale control measures
Cluster Identification Today
Burden of Foodborne Diseases

Population exposures

Person becomes ill

Person seeks care

Specimen obtained

Laboratory tests for organism

Culture-confirmed case

Reported to Health Department
Timeline for Reporting *Salmonella* Cases

1. **Person Eats Contaminated Food**  
   Time to contact with health care system = 1 to 5 days

2. **Person Becomes Ill**  
   Time to Diagnosis = 1 to 3 days

3. **Stool Sample Collected**  
   Shipping Time = 0 to 7 days

4. **Public Health Laboratory Receives Sample**  
   Serotyping and “DNA fingerprinting” = 2 to 10 days

5. **Salmonella Identified**

6. **Case Confirmed as Part of Outbreak**

Typically 2-3 weeks for *Salmonella* infections
Cycle of Foodborne Outbreak Control & Prevention

- Surveillance
- Epidemiologic Investigation
- Prevention Measures
- Applied Research
ORPB’s Outbreak Response Team

- Supports national network of epidemiologists and other public health officials who investigate outbreaks of foodborne, waterborne, and other enteric illnesses in the United States
- Collaboration between CDC and
  - State and local health departments, USDA, FDA
- Close partnership with PulseNet
- Helps ensure
  - Rapid, coordinated detection & response to multi-state enteric disease outbreaks
  - Promotes comprehensive outbreak surveillance
Cycle of Foodborne Outbreak Control & Prevention: Stages of an Investigation

Stage 1: Detecting a cluster of illnesses

Stage 2: Generating hypotheses

Stage 3: Testing hypotheses

Stage 4: Tracebacks

Stage 5: Laboratory assessments
Generating Hypothesis

• **Strategies include**
  – Interviews with structured questionnaire
  – Intensive open-ended interviews
  – In-depth interview with people in their homes, including refrigerator, pantry

• Some combination of all

• Attempt to standardize interviews

• Review interview data for common exposures
  – Food items, restaurants, stores
  – Collect shopper card numbers
Looking for early clues…

- Age distribution
- Gender
- Geography
Cycle of Foodborne Outbreak Control & Prevention: Stages of an Investigation

- **Stage 1:** Detecting a cluster of illnesses
- **Stage 2:** Generating hypotheses
- **Stage 3:** Testing hypotheses
- **Stage 4:** Tracebacks
- **Stage 5:** Laboratory assessments
Case-Control Study

- Study that compares two groups of people:
  - **Cases**: persons diagnosed with illness
  - **Controls**: similar group of people without disease

- Study medical and lifestyle histories to determine what risk factors may be associated with illness

- Look for statistical and epidemiologic association with food or other exposure
Cycle of Foodborne Outbreak Control & Prevention: Stages of an Investigation

- **Stage 1:** Detecting a cluster of illnesses
- **Stage 2:** Generating hypotheses
- **Stage 3:** Testing hypotheses
- **Stage 4:** Tracebacks
- **Stage 5:** Laboratory assessments (product testing)
Cycle of Foodborne Outbreak Control & Prevention

- Surveillance
- Epidemiologic Investigation
- Prevention Measures
- Applied Research
Preventing Future Outbreaks

• Outbreak investigations play key role in preventing foodborne diseases
  – New pathogens, new vehicles, gaps in food safety system

• Offer opportunities for different authorities and professionals to work together

• Raise questions that need research to better understand, prevent, reduce contamination
Preventing Future Outbreaks

• Outbreak investigations and additional research lead to
  – Better industry practices
  – Regulations and enforcement by regulatory agencies
  – Consumer understanding

• All should reduce number of foodborne illnesses
Steps in a Foodborne Outbreak Investigation

1. Detecting a possible outbreak
2. Defining and finding cases
3. Generating hypotheses (Hypothesis-generating interviews)
4. Testing the hypotheses (Analytic studies, Laboratory testing of samples)
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

If cases stop

- Unsolved mystery

Cases stop
Gaps in Multistate Outbreak Investigation Methods

- Need to decrease time to get subtyping results, enhance detection
- Limited resources for health departments to conduct interviews
- Individual illnesses may appear “sporadic”
  - Patients not routinely interviewed
- Cluster and outbreak investigations
  - Delays in
    - Patient interviews due to other priorities
    - Lag time from illness to interview, affects recall of foods eaten
    - Re-interviewing to collect product information
  - Initial questionnaires often not standardized between states
  - Lack of a standard database for states to enter interview data
    - No electronic transmission of exposure information to CDC
  - Rely on hundreds of volunteers to conduct multistate case-control studies
Lessons Learned from Past Outbreak Investigations

- Continually assess how we can better pinpoint cause and source of outbreaks more quickly
  - Apply lessons to future investigations
- Powerful role of investigating clusters in restaurants or events during multistate outbreaks
  - Aided by menus and recipes
  - Makes tracking specific ingredients easier
- Importance of considering potential “stealth” vehicles that may not be initially reported or considered by ill people
Lessons Learned from Past Outbreak Investigations

• Importance of working with industry as soon as possible to correct and identify potential sources of contamination

• Importance of rapid traceback that converges on a single product, producer or manufacturer
Improving Outbreak Response

• Improvements in laboratory infrastructure
  – Make it easier to identify foodborne disease outbreaks
  – Increased number and scope of outbreaks

• Enhancing capacity and implementing standard approaches at state, local, and federal levels
  – Make outbreak detection, investigation, and control even faster

• Accelerated ability to identify cases and interview people faster
  – Tracebacks to start sooner once food is suspected
2010 OutbreakNet Sentinel Sites
OutbreakNet Sentinel Sites (OSS)

- Facilitate collection of exposure data to more rapidly develop hypotheses and implicate vehicles
- Facilitate collection of specific product information for traceback investigations
- More rapidly collate and analyze epidemiologic and product information from multiple states
- Routinely join epidemiologic and PulseNet data
- Improve quality and speed of product data provided to regulatory agencies for traceback
- Share information in real time with regulatory agencies

Decrease time to identify how and where contamination occurred
Final Thoughts

- Produce is increasingly recognized as a source of foodborne outbreaks, causing more and larger outbreaks.
- We are continually working to improve foodborne outbreak investigation and response.
- Food industry can play an important role in outbreak investigations.
- New science and detection methods for foodborne disease outbreaks are driving our understanding of risks and consequences.
- Increasing consumer awareness is driving the demand for food safety improvements.
Public Health Impact

Salmonella Outbreak Fuels Food-Safety Efforts

THE WALL STREET JOURNAL.
Feb. 7, 2009

Peanut Case Shows Holes in Safety Net

The New York Times
Feb. 8, 2009

Obama Seeks to Improve Food Safety

The Washington Post
Mar. 14, 2009

The White House Blog Weekly Address:
Reversing a Troubling Trend in Food Safety
Mar. 14, 2009
Thank you