What Should You Know About Foodborne Illnesses

Dubai International Food Safety Conference
Dubai, February 21-23, 2010

Ewen C. D. Todd
Professor
Advertising, Public Relations and Retailing
Michigan State University
East Lansing, Michigan

Overview of the Presentation

- The rationale for foodborne disease outbreak surveillance
- Seeking health and finding infectious DNA – the risk of produce
- Difficulty in identifying the origin of foodborne disease outbreaks and containing them
- Factors contributing to foodborne disease outbreaks – going more in depth
- Conclusions

The Rationale for Foodborne Disease Surveillance

How to Reduce Foodborne Disease?

- Many countries are starting to recognize they have major problems with foodborne disease that need to be solved effectively but with limited available resources
- However, it is not clear which issues are the most important to tackle for that particular country
- We find today that governments are wrestling with the process of generating appropriate science-based policies to reduce foodborne disease for a minimum cost

The Importance of Surveillance

- Need for foodborne disease surveillance systems to:
  - 1) determine the burden of foodborne disease (national, state/provincial, local) [social cost of the disease - getting on the political agenda]
  - 2) help determine factors such as food attribution to rank the riskiest food pathogen combinations [set priorities]
  - 3) determine the main factors contributing to outbreaks [education and training]
  - 4) measure the effectiveness of food control programs [auditing]
  - 5) identify new agents, spread of existing pathogens, and trends over time [anticipating future issues]
  - 6) establish meaningful monitoring programs [compliance and trend analysis for commodities and individual firms]

Rationale for Improved Surveillance by Governments

- Governments need to put resources into foodborne disease because:
  - 1) governments are expected to safeguard all foods for its citizens
  - 2) over many decades there has been no or minor decrease in outbreaks and recalls worldwide
  - 3) there are trade concerns with contaminated food
  - 4) foodborne disease is preventable though multiple interventions
  - Note: as surveillance systems become effective, it looks like to policy makers as if there are more not less outbreaks occurring because of better detection

Foodborne Disease Surveillance Systems - Limitations

- Even if many countries have surveillance systems for communicable diseases, their capacity to detect and investigate foodborne illness rapidly may be limited
- Passive surveillance systems result in underreporting of disease, because only a small fraction of ill people seek medical care or submit specimens for laboratory analysis
- Laboratories only test for a limited number of disease-causing agents and thus report only selected information to health officials
- The nature of outbreaks means the investigations are hampered by time to remove the contaminated food

Outbreak Investigation Difficulties (Selman and Green, 2008)

- **Those ill or exposed**:
  - Delay of notification of illnesses
  - Difficulty contacting patrons and lack of knowledge and cooperation when contacted
- **Implicated facility**:
  - Lack of cooperation by foodservice employees and management
- **Investigative agency**:
  - Lack of epidemiologic assistance or a team approach
  - Lack of staff, knowledge, training and experience in outbreak investigation
  - Lack of cooperation by physicians and other environmental/food control agencies

Foodborne Disease Outbreaks - United States, 2006

- 1,270 foodborne disease outbreaks (624, 49.1%, con**firmed**), 27,634 cases,11 deaths
- Norovirus: 337 (54%), of outbreaks and 11,879 cases
- *Salmonella*: 112 (18%) of outbreaks and 3,252 cases
- Histamine: 31 (5.0%) of outbreaks and 111 cases
- *E. coli* O157:H7: 29 (4.6%) of outbreaks and 592 cases
- *Campylobacter*: 22 (3.5) of outbreaks and 301 cases
- *Vibrio parahaemolyticus*: 6 (1.0%) of outbreaks and 322 cases
- 11 reported deaths: 6 *E. coli* O157:H7, 2 *Listeria monocytogenes*, 1 *Salmonella Enteritidis,* 1 *Clostridium botulinum*, 1 mushroom toxin
- **Most common implicated food commodities: poultry (21%), leafy vegetables (17%), and fruits/nuts (16%)**

Comparison of Foodborne Disease Outbreak Numbers by Country

Agent	EU 2007 5609	US 2006 624	Canada 1996-2005 293
Salmonella	**2201 (39%)**	**112 (18%)**	**76 (25.9%)**
Norovirus	**668 (12%)**	**337 (54%)**	14 (4.8%)
Campylobacter	**461 (8%)**	22 (4%)	**32 (10.9%)**
E. coli	65 (1%)	**29 (5%)**	**74 (25.3)**
Yersinia	22 (0.4%)	0 (0.0%)	2 (0.7%)
Bacillus cereus	102 (1.8%)	3 (0.5%)	26 (8.9%)
Histamine	69 (1%)	31 (5%)	ND
Shigella	12 (0.2%)	9 (1%)	10 (3.4%)
Vibrio	1 (0.02%)	6 (1%)	3 (1.0%)
C. botulinum	16 (0.3%)	4 (0.6%)	5 (1.7%)
C. perfringens	75 (1.3%)	16 (2.6%)	22 (7.5%)
S. aureus	182 (3.2%)	12 (1.9%)	10 (3.4%)
L. monocytogenes	1 (0.02%)	3 (0.5%)	4 (1.4%)
Trichinella	4 (0.1)	1 (0.2%)	7 (2.4%)

Seeking Health and Finding Infectious DNA – the Risk of Produce

Increased Demand for Fresh Products

- What are the risks vs. advantages?
  - Healthy food: Spinach as an example – rise from new industry in late 1980s in California to meet salad bar aficionados to national demand both in restaurants and retail stores
  - More imported fruits and vegetables for more choices and year-round availability for Canada/U.S.: cantaloupes and green onions from Mexico, raspberries from Guatemala/Chile, mangoes from Brazil; lettuce from Spain for northern Europe
  - Rapid transportation + cold chain from around the world means more opportunities for pathogen survival

Large Foodborne Outbreaks in the Europe (1997 - 2008)

- 1994 *Shigella* sp. — iceberg lettuce from Spain (110 in Norway and more in other EU countries)
- 2001/02 *Salmonella* Oranienburg — chocolate (>439, Germany and 6 other EU countries)
- 1999 Hepatitis A virus — wedge clams from Peru (188 in Spain)
- 2002 *E. coli* O157:H7 — fermented sausage (30 in Sweden)
- 2003 *Salmonella* Enteritidis — eggs from Spain (648 in UK)
- 2004 *Salmonella* Newport — lettuce (350 in UK)
- 2005 *E. coli* O157:H7 — lettuce (135, 11 with HUS in Sweden)
- 2005 Salmonella Hadar — pre-cooked chicken (2138 in Spain)
- 2006 *Salmonella* Montevideo — chocolate (53, mainly children in UK)
- 2006/07 Hepatitis A virus — shellfish and vegetables (22 in Ceuta)
- 2007 *Salmonella* Weltevreden — alfalfa sprouts from imported seeds (29 in Norway, Denmark, Sweden)

Examples of Large Foodborne Outbreaks in the U.S. (1990 - 2006)

• 1990	*Sal.* Poona	cantaloupes
• 1994	*Shigella flexneri*	onions
• 1994	*Listeria monocytogenes*	milk
• 1995	*Salmonella* Enteritidis	ice cream
• 1996	*Cyclospora* sp.	raspberries
• 1996	*E. coli* O157:H7	apple juice
• 1997	*Salmonella* Infantis	alfalfa sprouts
• 1997	*Cyclospora* sp.	lettuce, basil
• 1997	Hepatitis A virus	strawberries
• 1999	*Listeria monocytogenes*	hot dogs
• 2003	Hepatitis A virus	scallions
• 2006	Norovirus	salad?
• 2008	*Salmonella* Saintpaul	tomatoes/peppers

Illnesses from Lettuce (Ethelberg et al., 2010)

- 11 outbreaks of gastroenteritis with a total of 260 cases occurred in Denmark from mid January to early February, 2010, caused by norovirus and ETEC on imported French lettuce
- 480 potentially exposed persons (attack rate = 54.2%)
- NoV genogroup I was found in two patients, genogroup II in 12 patients, and mixed infections with these viruses in 9 patients
- ETEC *E. coli* O6:K15:H16 containing genes for LT and ST toxins
- Norovirus of genogroup II recovered from lettuce from one outbreak
- Lettuce recalled in Denmark on January 22 by order of the Danish Food and Veterinary Administration

Illnesses from Lettuce (Ethelberg et al., 2010)

- Two inquiries were released through the EU CDC's food- and waterborne diseases network, mentioning the norovirus outbreaks and the ETEC findings, and the information was also distributed through the norovirus network
- In response, Norway reported having three outbreaks caused by the lettuce from two imported batches which had caused disease in Denmark
- French exploring the cause of the contamination - human feces may have been the source of the contamination, possibly via contaminated water

Illnesses from Lettuce (Ethelberg et al., 2010)

- Neither norovirus nor ETEC are generally covered by routine analyses of stool samples from patients with gastroenteritis in Denmark and other European countries
- Surveillance for both agents is therefore incomplete and the extent of the infections may have been more widespread than what we describe here
- Furthermore, both disease agents can be extremely difficult to detect in food

Outbreaks from Carrots

- Baby or shredded carrots
  - *Cryptosporidium*
  - ETEC
  - Hepatitis A
  - *Shigella sonnei*
  - *Yersinia pseudotuberculosis*
  - One recall because of *Salmonella* contamination
- Bacteria survive well on carrots and are difficult to disinfect

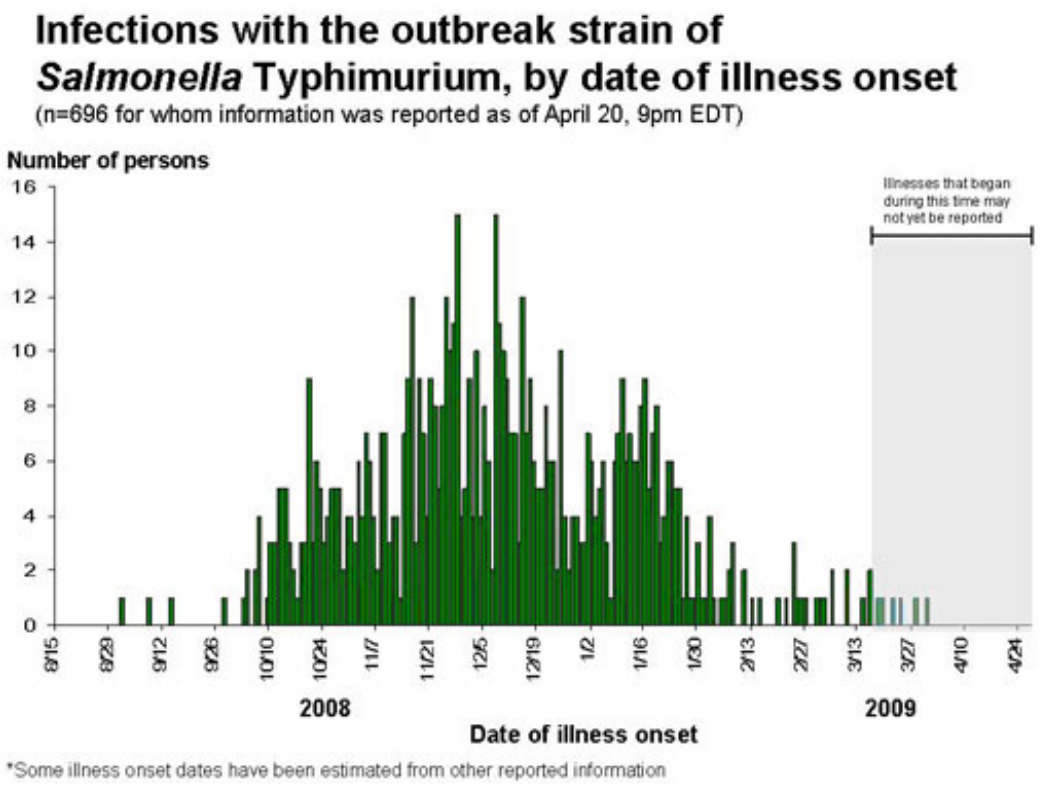
Key Events Linked to Produce

- Whether domestically produced or imported, five key events have brought focus and concern for the microbial food safety of fresh fruits, vegetables, nuts and other edible horticultural foods:
- 1. Recent **reoccurring outbreaks** linked to consumption of imported and domestic products [on-going issues]
- 2. **Positive detection and recovery of human pathogens** from random survey sampling of both imported and domestically produced produce [uncertain and multiple mean of exposure]
  - such as irrigation water, birds and wild animals, proximity of animal-raising farms, manure, dust, harvesting equipment, and human error
- 4. Recent reports from several researchers documenting the **difficulty of cleaning and disinfecting produce surfaces** [total decontamination currently not possible]
- 5. Recent reports from several researchers documenting the potential for **internalization of pathogens** during postharvest handling [not clear whether this is an issue in the field]

Difficulty in Identifying the Origin of Outbreaks and Containing Them

Peanut Butter/Peanut Containing Products Recall List, October, 2009

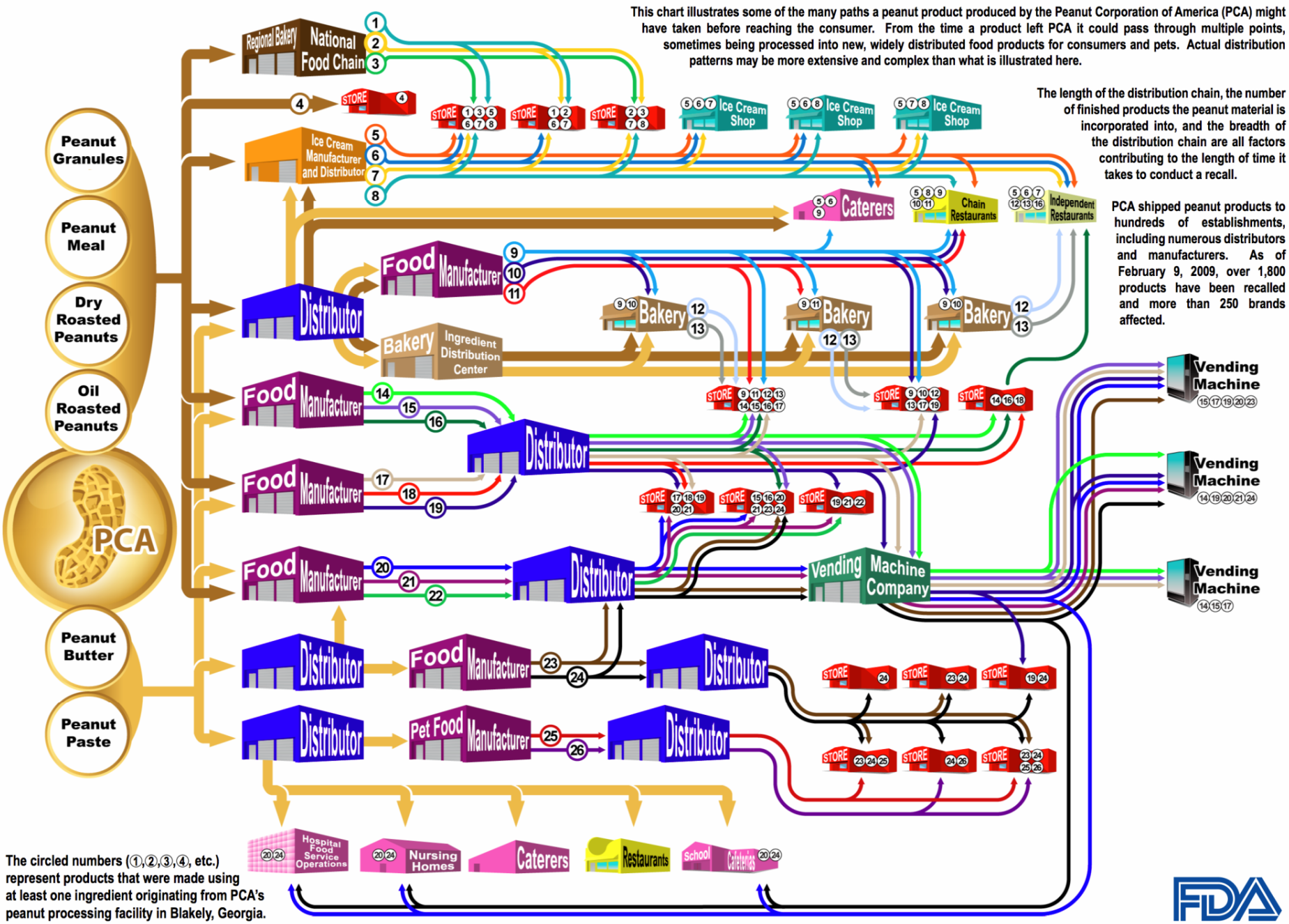
- 715 *Salmonella* Typhimurium cases in 46 states and Canada, **beginning Sept 6, 2008** with 3918 entries on the recall list: brownies, cakes and pies, candy, cereal, cookies, crackers, donuts, dressings and seasonings, fruit and vegetable products, ice creams, peanut butter/paste, pet food, prepackaged meals, snack bars, toppings



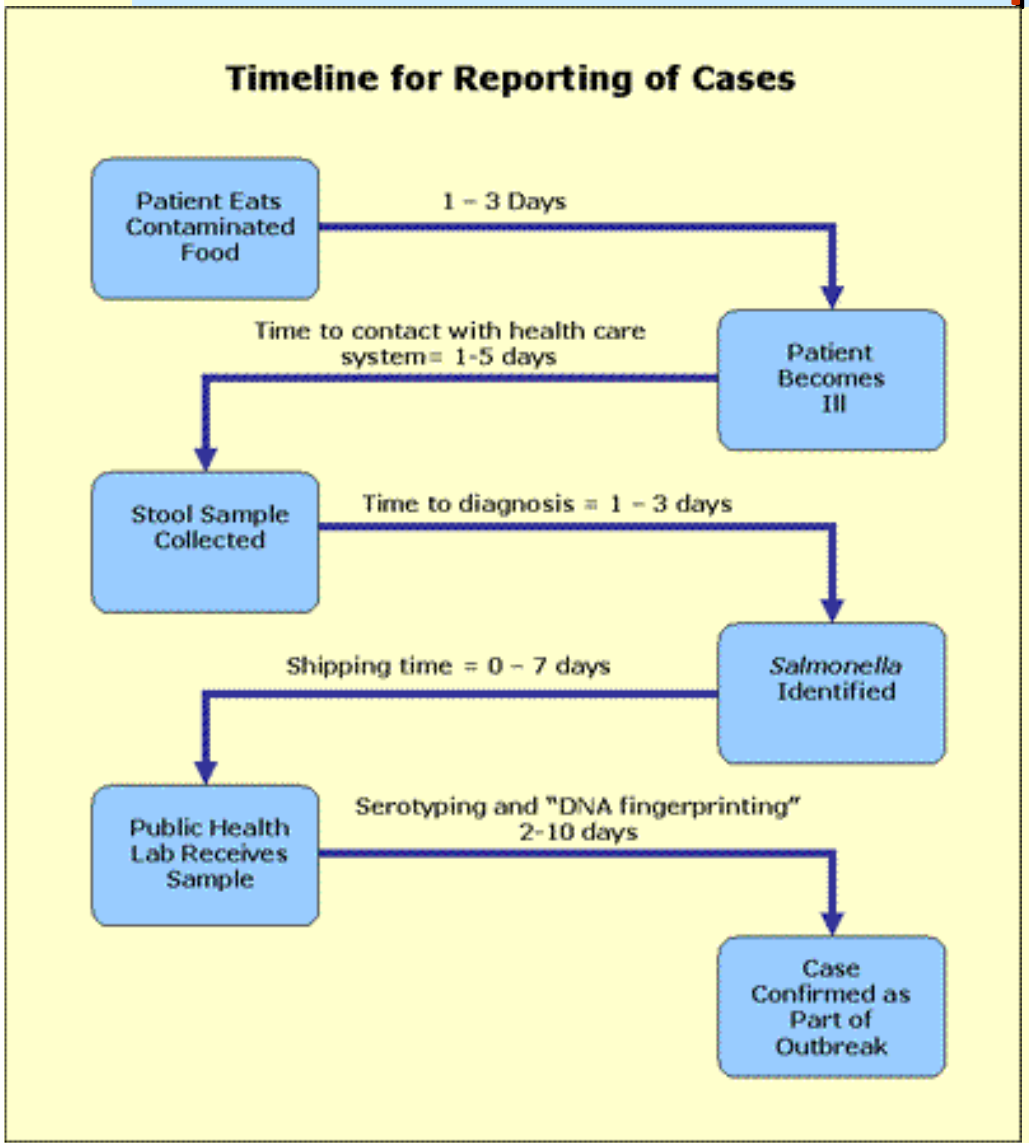
On **January 28, 2009**, PCA announced a voluntary recall of all peanuts and peanut products processed in its Georgia facility since January 1, 2007, and stopped production of all peanut products.

Illnesses were still being reported among people who ate the recalled brands of peanut butter crackers after the recall.

Simplified Peanut Product Distribution Pattern From Peanut Corporation of America (PCA) to Point of Sale



Salmonella Outbreak Investigations: Timeline for Reporting: CDC



The time required to ship the *Salmonella* strain from the laboratory to the state public health authorities that will perform serotyping and "DNA fingerprinting" takes 0-7 days

Diagnostic laboratories are not required by law to forward *Salmonella* isolates to the public health labs and not all diagnostic laboratories forward any isolates unless specifically requested

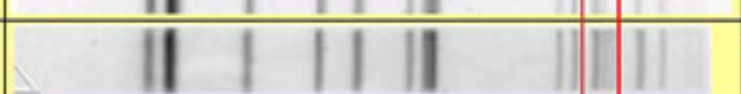
Peanut Butter Investigation

- November 10, 2008: CDC's PulseNet staff noted a small and highly dispersed cluster of 13 *Salmonella* Typhimurium isolates with an unusual PFGE pattern reported from 12 states
- November 25, 2008: CDC, working with state and local partners, began an epidemiologic assessment of that cluster, which had increased to 35 isolates
- December 2, 2008: CDC and state and local partners began an assessment of a second similar cluster of 41 *Salmonella* Typhimurium isolates
  - Neither of these patterns were seen previously in the PulseNet *Salmonella* Typhimurium database, and the clusters were similar epidemiologically, so the two patterns were grouped together as a single outbreak strain, and the investigations were merged

Peanut Butter Outbreak Investigation

- Preliminary analysis of the first national case-control study conducted by CDC and public health officials in multiple states on January 3 and 4, 2009, comparing foods eaten by ill and well persons indicates that peanut butter is a likely source of the infections
  - Minnesota Department of Health suggested King Nut brand creamy peanut butter as a likely source of *Salmonella* infections among many ill persons in MN, and the Minnesota Department of Agriculture Laboratory isolated the outbreak strain of *Salmonella* Typhimurium from an open 5-pound container of King Nut brand creamy peanut butter
  - Connecticut Department of Public Health Laboratory and the Georgia Department of Agriculture independently isolated *Salmonella* from unopened 5-pound containers of King Nut brand peanut butter

Identity of Strains Isolated (PFGE)

Location(s) of Sample	*Salmonella* Serotype	DNA Fingerprint ID (PFGE Pattern*)	PFGE Image	Source in Which Strain was Found
Multiple States	Typhimurium	JPXX01.1818		ill humans
Multiple States	Typhimurium	JPXX01.1825		ill humans
Multiple States	Typhimurium	JPXX01.0459		ill humans
Canada	Typhimurium	JPXX01.1818		Austin brand Toasty Peanut Butter Crackers purchased in the United States
Connecticut	Typhimurium	JPXX01.1825		Unopened container of King Nut brand creamy peanut butter
Connecticut	Typhimurium	JPXX01.0459		Unopened container of King Nut brand peanut butter
Georgia	Typhimurium	JPXX01.1818		King Nut brand crunchy peanut butter
Michigan	Typhimurium	JPXX01.0459		Closed container of King Nut brand peanut butter
Michigan	Typhimurium	JPXX01.0459		Unopened container of King Nut brand creamy peanut butter
Minnesota	Typhimurium	JPXX01.1818		Open container of King Nut brand creamy peanut butter
Minnesota	Typhimurium	JPXX01.1825		Open container of King Nut brand creamy peanut butter
North Carolina	Typhimurium	JPXX01.0459		Retained PCA peanut paste sample
Ohio	Typhimurium	JPXX01.1818		Opened container of King Nut brand creamy peanut butter

Peanut Butter Environmental Investigation

- ***Salmonella*** **strains of other serotypes than Typhimurium were found in food and in environmental samples during this outbreak investigation not associated with the illness.**

Location of Sample Orgination	Other *Salmonella* Serotypes	DNA Fingerprint ID (PFGE Pattern *)	PFGE Image	Source in Which Strain was Found
Georgia	Mbandaka	TDRX01.0011		PCA plant in Blakely, Georgia - Floor crack
Georgia	Senftenberg	JMPX01.0089		PCA plant in Blakely, Georgia - Floor crack
Georgia	Tennessee	JNXX01.0011		unopened container of King Nut brand peanut butter
Minnesota	Tennessee	JNXX01.0026		unopened container of King Nut brand peanut butter

PCA: "Testing into Compliance"

- A private lab occasionally tested samples for PCA and found *Salmonella* in a sample but PCA retested and got a negative result but did not stop sales
- At least 12 positive tests for *Salmonella* occurred between 2007 and 2008 at their Blakely, GA, plant
- Food producers in most states are not required to alert health regulators if internal tests show possible contamination at their plants
- Major peanut butter manufacturers stated they have stringent food safety and quality control standards but will not say how often their plants test the finished product

Peanut Product Recall Survey (Blendon et al., 2009)

- During the outbreak and recall
  - 67% of Americans expressed only some or very little confidence in food manufacturers to produce safe food
  - 62% expressed only some or very little confidence in the government inspections system to keep food safe
  - 52% have only some or very little confidence in grocery stores to keep food safe
  - 14% of those who were aware of the recall checked the FDA's online list of foods involved
  - 19% looked for more information about the recall

Factors Contributing to Foodborne Disease Outbreaks – Going More in Depth

Factors Contributing to Outbreaks, USA, 1997 (Olsen et al., 2000)

- Factors recorded in investigation reports: 266/504 (52.8%)
- Improper holding temperatures (30.6%)
- Inadequate cooking (9.5%)
- Contaminated equipment (8.5%)
- Unsafe source (3.8%)
- Poor personal hygiene (19.8%)
- Other factors (8.5%)

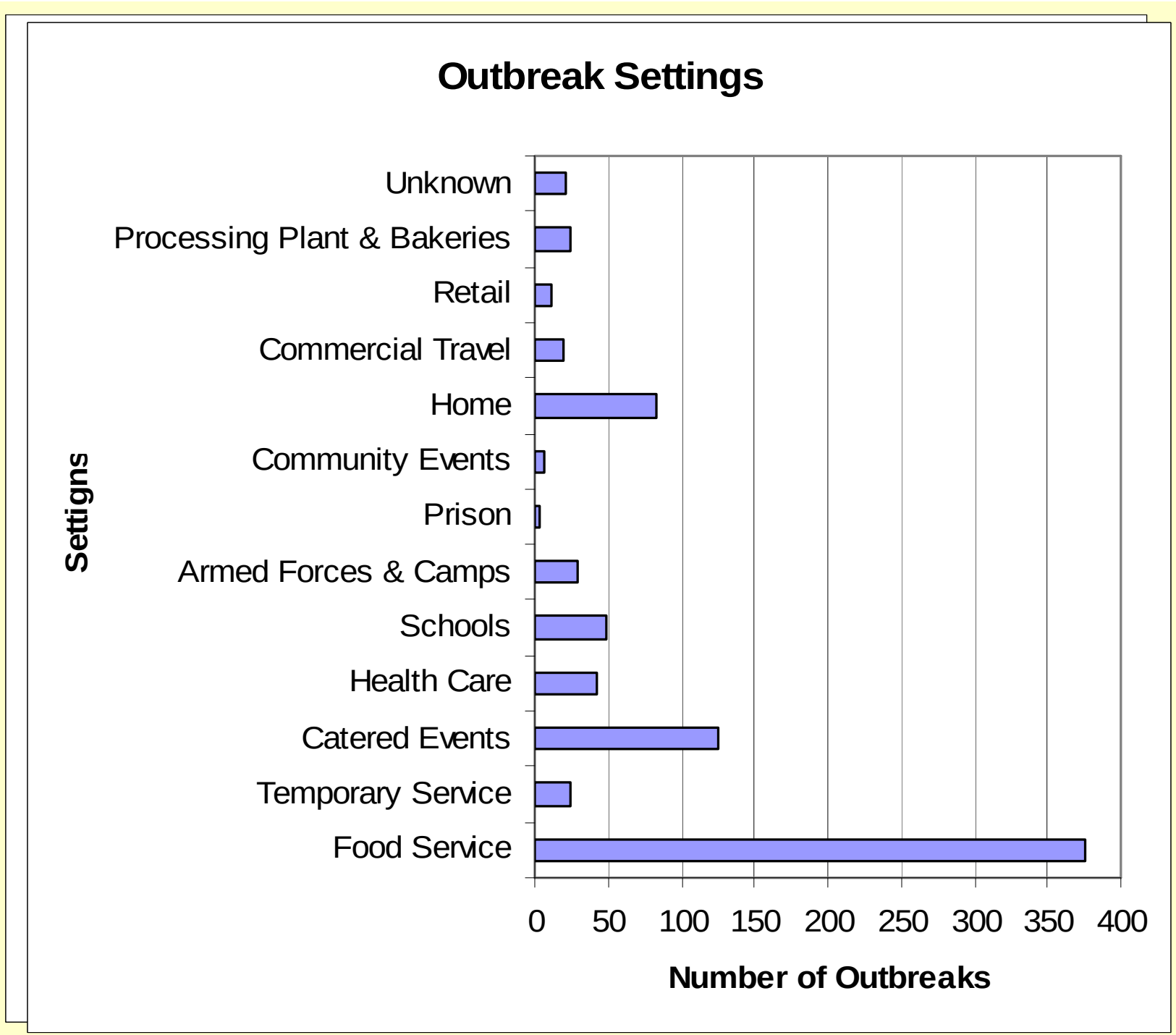
Outbreaks Where Food Workers Have Been Implicated in the Spread of Foodborne Disease [IAFP request to the CCFI]

- 6 papers: Greig et al., 2007; Todd et al., 2007a,b; Todd et al., 2008a, b; Todd et al., 2009
- 1) Description of the problem, methods, and agents involved
- 2) Description of outbreaks by size, severity, and settings
- 3) Factors contributing to outbreaks and description of outbreak categories
- 4) Infective doses and pathogen carriage
- 5) Sources of contamination and pathogen excretion from infected persons
- 6) Transmission and survival of pathogens in the food processing and preparation environment

Foods Associated with Outbreaks Where Food Workers Were Implicated

Multiple foods and multi-ingredient foods were noted most frequently

- Salads, including potato, pasta and coleslaw (92)
- Sandwiches (74)
- Chinese, Mexican food and pizza (19)
- Hors d'oeuvres and other RTE cold snacks with sauces and glazes (8)


Outbreak Settings
Settigns
Unknown
Processing Plant & Bakeries
Retail
Commercial Travel
Home
Community Events
Prison
Armed Forces & Camps
Schools
Health Care
Catered Events
Temporary Service
Food Service
0
50
100
150
200
250
300
350
400
Number of Outbreaks

Factors Contributing to Outbreaks Involving Food Workers

Pathogenic agent	Food worker error factors[a]:																		
	P1	P2	P3	P4	P6	P12	C6	C7	C9	C10	C11	C12	C13	C15	S1	S2	S3	S4	S5
Norovirus										105	1	232	6	32					
Probable norovirus										42		64	1						
HAV										32		83	1	10					
Rotavirus										4		12	1						
Unknown viral										25	1	54	2	10					
Salmonella (nontyphoidal)	4	8	21	4	10	1	5	3	15	40		129	6	6	13	3	1	2	1
Salmonella Typhi										7		21		3					
Staphylococcus aureus	7	3	15	2	4				1	27		53	1	1					
Shigella spp.	1		4							7		32	2	4	1				
Streptococcus groups A and G		3	5	1						7		17		1					
Vibrio cholerae	2		1							2		11		1	1	1			
Yersinia enterocolitica										4		7							
Campylobacter jejuni	1		1						1	2		5		1					
ETEC O157:H7 and O6: H16[b]									1			3							
Giardia lamblia/intestinalis										6		9		3					
Cryptosporidium spp.										1		3							
Cyclospora cayetanensis												11	1						
Unknown		1								14		21		1					
Total	15	16	48	7	14	1	5	3	18	325	2	767	21	73	15	4	1	2	1

Contributory Factors to Food Worker Outbreaks

Factors contributing to outbreaks are an invaluable resource, identifying situations resulting in contamination of food and the environment

- The most frequently reported factors were bare hand contact of food and/or improper washing of the hands
- Workers who care for an ill family member or change diapers easily become contaminated
- Fecal-oral route is the most frequent, but vomitus, sneezes, open cuts and sores can deliver large quantities of pathogens into the food or preparation environment
- Low infective dose and survival of pathogens in food preparation areas

Conclusions

Continuing Surveillance

- **Commitment**: foodborne disease surveillance is mainly a national endeavor depending on the national priorities
- **Developing countries**: need help to monitor for diseases that are a concern internationally
- **Challenge**: overall burden of foodborne illnesses (morbidity, mortality and economic losses) difficult to determine
- **Learn more on the issues**: Limited understanding of the types and proportions of foods in transmitting specific diseases
  - e.g., because of a better detection methodology today we find more produce outbreaks than meat and poultry
- **Increased trade and public demand for safety**: drive improved surveillance and avoid embarrassing recalls
- **Targeted national strategies**: help reduce specific diseases
- **Surveillance should stimulate research**: fill in the data gaps and contribute to the risk assessment process and control


Thank you for your attention