Salmonellosis symptoms

- Fever
- Diarrhea (may be bloody)
- Nausea
- Vomiting
- Abdominal pain
- Reactive arthritis (long term)
- In severe cases, septicemia, endocarditis

Salmonellosis overview

- 40,000 laboratory-confirmed cases each year in the US
- Only an estimated 3% of Salmonella infections are laboratory-confirmed and reported to CDC

Salmonellosis outbreak: 2008-09

- As of February 22, 2009, 666 persons infected with the Salmonella Typhimurium outbreak strain have been reported in 45 states
- Illnesses began between September 1, 2008 and February 3, 2009
Salmonellosis victims

- Age range: <1 to 98 years
- Median age = 16, with 21% under age 5; 17% > 59
- 48% female
- 23% hospitalized
- Nine deaths (Idaho, 1; Minnesota, 3; North Carolina, 1; Ohio, 2; Virginia, 2)
- Rates of hospitalization and mortality are “typical” – strain does not appear to be unusually virulent

Anatomy of an outbreak

- On November 10, 2008, the CDC noted a small, highly dispersed cluster of 13 *Salmonella Typhimurium* isolates with an unusual “fingerprint” obtained from 12 states
- An epidemiological investigation was initiated on November 25
- On December 2, a second cluster of 41 *Salmonella Typhimurium* isolates was investigated

Anatomy of an outbreak...

- On January 4, CDC and public health officials determined that peanut butter was the likely source of the outbreak
- Minnesota Department of Health suggested King Nut brand creamy peanut butter as a source, based on an isolate obtained from an open 5-lb container obtained from a nursing home with three sick residents
- Connecticut, Michigan and Georgia also isolated *Salmonella* from unopened King Nut brand peanut butter
Further clarification….

• Between January 17 and 19, 2009 telephone interviews were conducted with 95 victims and 405 case-control well persons
• Data analysis revealed an association between illness and consumption of pre-packaged peanut butter crackers (Austin and Keebler, both made by Kellogg, using peanut paste from the Peanut Corporation of America)

The recalls start…

• On January 14, 2009, the Kellogg Company put a precautionary hold on Keebler and Austin crackers; the products were recalled on January 16
• On January 28, PCA announced a voluntary recall of all peanuts and peanut products processed in Blakely, GA since 1/1/07. All production stopped on 1/28
• On February 6, Oregon public health officials determined that the human outbreak strain can also affect pets, with a laboratory-confirmed illness in a dog
• Plainview, TX plant closed on February 23 after contamination was discovered there. All products manufactured there since March 2005 recalled.
• More than 3,490 peanut-containing products have been recalled by a variety of companies

• On February 20, PCA informed customers who received products from its Georgia or Texas plants not to distribute or further use those products and to contact the FDA regarding the proper disposition of recalled products and any other matters related to the recall via the FDA recall coordinators. FDA and the Texas Department of State Health Services are working together to implement the PCA recall.

PCAs filed for bankruptcy protection as of Friday, Feb. 13

• On February 20, PCA informed customers who received products from its Georgia or Texas plants not to distribute or further use those products and to contact the FDA regarding the proper disposition of recalled products and any other matters related to the recall via the FDA recall coordinators. FDA and the Texas Department of State Health Services are working together to implement the PCA recall.

Americans clueless about food recalls….

• Although recall of peanut products have been in the news, many Americans don’t understand that cakes, snack bars, brownies, cookies and ice cream may be contaminated and have also been recalled
• 93% of 1,283 surveyed adults knew, in general, about peanut product recalls, but only half or fewer knew that some snack bars and cakes had been recalled
• ~25% knew that some ice creams had been recalled; fewer knew that jars of dry-roasted peanuts had been recalled
• ~25% believed that major national brands of peanut butter should be avoided
• ~60% had only “some” or “very little” confidence that food manufacturers and government inspection systems can keep food safe

Outside of the US, products have been distributed to…

• Aruba, Australia, the Bahamas, Bermuda, Canada, the Cayman Islands, Haiti, Italy, Jamaica, Japan, Korea, Malaysia, Mexico, the Netherlands, New Zealand, Norway, Sr. Maarten, St. Vincent and the Grenadines, Singapore, Slovenia, Spain, Turks and Caicos, and the United Kingdom
What went wrong?

- Major discrepancies among inspector reports
  - Third party audits rated the plant as “superior”
  - Oct. 23, 2008 state inspection reported only mildew and dust in a storage room, as well as reuse of shipping bags
  - In January 2009, a federal team found many problems including the leaky roof and swab samples from the floor positive for Salmonella
- Processing line had not been decontaminated after Salmonella had been detected
- Product was shipped before the results of contamination tests were received
- PCA stopped using an outside lab when too many results came back positive

What went wrong?

- An e-mail from Mr. Parnell (PCA president) to Mr. Lightsey (plant manager): the positive Salmonella tests are “costing us huge $$$$ and causing obviously a huge lapse in time from the time we pick up peanuts until the time we can invoice”

What went wrong?

- Raw peanuts stored next to finished product
- Roaster not calibrated like a pasteurizer
- Both plants had rodents; bird feathers, rodent excrement detected in Texas plant
- Roof leaks allowed water into the Georgia plant
- Peanut industry not required to inform government of Salmonella contamination
- Manufacturers rely on the manufacturer to perform microbiological testing and divulge problems

What went wrong?

- Despite 12 tests in 2007 and 2008 that showed Salmonella contamination in company products, on January 12, 2009, Mr. Parnell (PCA president) wrote an e-mail to company employees that stated “We have never found any salmonella at all.”

What went wrong?

- An e-mail from Mr. Parnell (PCA president) to FDA officials, pleading to allow business to continue after their plant was linked to the outbreak: we “desperately at least need to turn raw peanuts on our floor into money”
Hey, Mr Parnell……….  

**Theater in Congress**

- Representative Greg Walden, Republican from Oregon, brought in a large jar wrapped in yellow crime-scene tape and filled with peanut butter-containing cookies and crackers and asked PCA executives "Would either of you be willing to take the lid off and eat any of these products?"
- Both Mr. Parnell and Mr. Lightsey evoked the Fifth Amendment during testimony to the Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce in the U.S. House of Representatives on February 11, 2009

**Consequences**

- Sales of peanut butter dropped by ~25% in January
- Major brands (Jif, Peter Pan) are buying advertisements to announce that their products are safe
- This tactic is generally avoided to prevent drawing more attention to the outbreak
- Peanut company is under criminal investigation, accused of knowingly shipping products that had tested positive

**Consequences**

- PCA CEO stripped of seat on a board that advises the government on peanut quality standards

**Consequences**

- FDA’s Dr. Stephen Sundlof is requesting new or enhanced authority in several areas:
  - Authority for FDA to issue preventive controls for high-risk foods;
  - Authority for enhanced access to food records during routine inspections to ensure that inspectors have access to all information that bears on product safety;
  - Authority for FDA to require food facilities to renew their registrations every two years, and allow FDA to modify the registration categories
  - Mandatory recall authority

**Peanut related outbreaks have been uncommon….**

- First outbreak in the US occurred in 2006-07, associated with Peter Pan peanut butter
- Only other reported outbreak occurred in Australia in 1996
Peanut butter factoids

- Peanut butter was developed by a St. Louis physician in 1890 as an easily digested protein source.
- Sold as a nutrition supplement for several years; big hit at 1904 World's Fair.
- George Washington Carver, Tuskegee University, developed more than 300 peanut byproducts in the early 20th century.
- Peanut butter and jelly became an "American standard" after PB&J found their way into Army K-rations during WWII.
- Today, the typical American eats three pounds of peanut butter each year.

What's going on?

- *Salmonella* persist nearly indefinitely in high-fat, low-water-activity foods like peanut butter.
- In such foods, *Salmonella* can withstand temperatures as high as 194 F (90 C) for 50 minutes.
- Peanuts are typically roasted at ~350 F (180 C), but post-roasting processing may not be at such high temperatures.

Take-home messages

- Before you hit the send button on your e-mail, try to imagine your text as a court document.
- This outbreak will have far-reaching consequences for the food industry:
  - Enhanced recall powers by the government?
  - Enhanced governmental access to records?
  - Mandatory reporting to government/customers of positive tests?
  - Enhanced requirement to verify "safety" of ingredients on the part of manufacturers (e.g., Kellogg's)?

- Consumers can use [FDA's online database](http://www.fda.gov/oc/opacom/hottopics/salmonellatyph.html) to see if foods are on the recall list. Those without Internet access may call 1-800-CDC-INFO (available 24 hours a day, seven days a week) for product recall information.

Salmonella Outbreak

- Schwan’s Ice Cream – 1994
  - External Contamination Issues

- Relates to the Dairy Industry
  - Internal Contamination Issues
    - Brine
    - Positive Air Pressure
    - Other Contamination Sources

Interestingly enough, PCA TX was also certified as Organic
- Organic doesn’t necessarily encompass ‘food safety’

How does this relate to the Dairy Industry???
Update on Fluid Milk Quality Research at Cornell University

2008-09 Projects
- Milk Quality Improvement Program: core Voluntary Shelf-Life program and dairy industry outreach
- Evaluation of raw milk bacteriological tests for effective prediction of processed fluid milk quality ("the PI Project")
- Feasibility of development of a single raw milk assay to predict shelf-life performance of pasteurized milk

NYS Milk Quality Improvement Program (MQIP)
- Objectives and Approach:
  - Monitor shelf life characteristics of commercially processed and packaged NYS fluid milk products
  - Monitor NYS raw milk quality
  - Assist NYS dairy plants in identifying and correcting handling and processing problems affecting dairy product quality
  - Visit HTST fluid milk processing plants two times a year to collect products and as necessary to solve targeted problems

NYS Milk Quality Improvement Program Shelf Life Studies
- Sample preparation & test days
  Hold milk at 43° F and test at initial day, day 7, day 10 and day 14 (day 17 for selected plants)
- Tests performed
  - Microbiological (standard plate count, coliform count)
  - Chemical (Freezing point, butter fat; initial day only)
  - Flavor analysis/Sensory Testing

Plant Status & Update

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<td>&lt; 12.0 d</td>
<td>12.5 d</td>
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<table>
<thead>
<tr>
<th>Day</th>
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<th>Day 10</th>
<th>Day 14</th>
<th>Day 17*</th>
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<tr>
<td>1990</td>
<td>--</td>
<td>15% (day 12)</td>
<td>17%</td>
<td>32%</td>
</tr>
<tr>
<td>2000</td>
<td>25%</td>
<td>--</td>
<td>32%</td>
<td>32%</td>
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<td>2003</td>
<td>50%</td>
<td>56%</td>
<td>--</td>
<td>33%</td>
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<tr>
<td>2008</td>
<td>58%</td>
<td>56%</td>
<td>36%</td>
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* Day 17 results apply to only 17 plants

Percentage of Processed Milk Samples with SPC ≤20,000/ml
Percent of Samples/Milk with SPC ≤ 20,000

2008 Data:
20 NY State Plants; Upstate Only, 18 Plants
Weighted averages adjusted based on individual plant milk sales in NYS, 2007

Average Processed Milk Flavor Scores

Year

0 20 40 60 80 100

I 7 10 14 I 7 10 14
All Plants Upstate Only
Un-Wgted Wgted

0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0


Day 1 Day 7 Day 10 Day 14

Percentage Processed Milk Samples by Sensory Quality Rating Categories - Day 14

Flavor Score Ranges

0 10 20 30 40 50 60 70


Year

% Flavor 

1999 = 67%
2008 = 83%
17% increase

NYS Dairy Product Quality

Day 14 - % SPC >1,000,000 cfu/ml vs. % Flavor >=6.0

% Flavor >=6.0:
1999 = 58%
2008 = 41%
16% decrease

% SPC >1,000,000:
1999 = 67%
2008 = 83%
17% decrease
“PI” Project Design

- Four New York State dairy processors sampled once a month for twelve months.
- Samples include raw silo milk and corresponding 2% milkfat pasteurized fluid milk.
- Raw milk analyzed before and after Preliminary Incubation (18 hours at 55°F)
  - Standard Plate Count
  - Lab Pasteurization Count
  - Various selective agars
    - Vogel-Johnson agar (Staph)
    - Crystal Violet Tetrazolium agar (Gram negatives including coliforms)
    - Modified Edwards Media (strep)
    - Coliform petrifilm.
- Raw milk also tested for Somatic Cell Count, Psychrotrophic Bacteria Count, Spore Count as well as Ropy milk test.

Preliminary Incubation Project Design, cont.

- Bacteria are selected from the raw and incubated raw SPC, PBC, Edwards, LP and Spore plates are identified using molecular tools.
- Pasteurized 2% samples as well as Lab Pasteurized raw and Spore treated raw held at 6°C and tested on days initial, 7, 10, 14, 17 and 21 for SPC and Coliforms.
- Sensory analysis of 2% finished product samples on days initial, 10, 14 and 17.
- Bacteria are collected for identification from samples held over shelf life on all samples that exceeded 20,000 cfu/mL as well as all samples on day 21.

Other Methods

<table>
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<th>Count Method (Raw Milk)</th>
<th>R2</th>
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<td>SCC</td>
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<tr>
<td>SPC</td>
<td>0.005</td>
</tr>
<tr>
<td>PBC</td>
<td>0.008</td>
</tr>
<tr>
<td>SPC</td>
<td>0.003</td>
</tr>
<tr>
<td>SPC Incubated</td>
<td>0.006</td>
</tr>
<tr>
<td>VJ</td>
<td>0.0036</td>
</tr>
<tr>
<td>VJ Incubated</td>
<td>0.0013</td>
</tr>
<tr>
<td>CVTA</td>
<td>0.0049</td>
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<tr>
<td>CVTA Incubated</td>
<td>0.0231</td>
</tr>
<tr>
<td>Edwards</td>
<td>0.0087</td>
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<tr>
<td>Edwards Incubated</td>
<td>0.0133</td>
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<tr>
<td>Cell</td>
<td>0.0383</td>
</tr>
<tr>
<td>Cell Incubated</td>
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</tr>
<tr>
<td>LP</td>
<td>0.0032</td>
</tr>
<tr>
<td>LP Incubulated</td>
<td>0.1253</td>
</tr>
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</table>

Not all bacteria are created equal in their ability to limit pasteurized milk shelf-life

PI Position Statement

- It is the position of the MQIP that there is no significant association of raw milk PIC with the shelf-life of pasteurized fluid milk. The use of the PIC test for this purpose is not supported by current science.

National Milk Survey

Pseudomonas growth is rapid, masking sporeform bacteria
Shelf Life of Fluid Milk Products

- Assuming that post-pasteurization contamination is controlled, the presence of **Gram positive spore-forming bacteria capable of surviving pasteurization** are the specific biological barrier limiting HTST-processed milk shelf life extension

(Durak et al. 2006. JFS, 71:M50-56.)

Feasibility of Development of a Single Raw Milk Assay to Predict Shelf Life Performance of Pasteurized Milk
Preliminary incubation does not correlate to shelf-life, nor to spoilage by gram-positive spore formers.

- Low numbers of *Paenibacillus* in raw milk mean that traditional methods for assessing raw milk quality will not predict processed product performance.
- Novel, high sensitivity techniques:
  - Polymerase Chain Reaction can find DNA in concentrations as low as $10^{-12}$ g mL$^{-1}$!

Can we design a new method that will identify and target genes that are specific to the bacteria that spoil milk?

### The MQIP Culture Collection

- The MQIP has collected over 2,000 isolates during our previous studies.
- Currently we have a total of 683 *Paenibacillus* isolates identified, corresponding to 133 unique types.
- The DNA sequence data from the *rpoB* genes of these allelic types were analyzed to identify groups.

### Optimizing Detection of *Paenibacillus* in Milk

Even if the probe works perfectly, other technical hurdles remain to be solved, notably sample preparation.

- Heat resistance of *Paenibacillus* allows us to:
  1. Inactivate other contaminants in milk samples using conventional spore-treatment (80°C/12min)
  2. Incubate samples to enrich *Paenibacillus* population

Goal: optimize an enrichment process while simultaneously developing the TaqMan® protocol

### Do *Paenibacillus* Share Unique Physiological Characteristics?

- Can *Bacillus* grow in milk at low temperature?
  - Most *Bacillus* isolates cannot grow below 7°C, but all *Paenibacillus* tested so far grow relatively well in milk even at 4°C.
- Do *Paenibacillus* have a common metabolic characteristic that can be measured directly on a petri plate?

Purified DNA of 2 representatives from each group will be used to test the robustness of the method.
**Do Paenibacillus Share Unique Physiological Characteristics?**

"X-test"

**National Milk Survey**

Pseudomonas growth is rapid, masking sporeformer bacteria

**Extending HTST Fluid Milk Shelf Life**

- Our challenge is to identify and eliminate entry points for these spoilage organisms into fluid milk production systems

**A New Project**

Identification of farm practices associated with the presence of psychrotolerant *Bacillus* spp. and related sporeformers in bulk tank milk

Collaborative project among:
- Ynte Schukken, Quality Milk Production Services, Vet College
- David Galton and Rick Watters, Animal Science Department
- Kathryn Boor and Rob Ralyea, Milk Quality Improvement Program

Will survey 100 farms for management practices in parallel with microbiological analyses

Funded by Federal Formula (Hatch) dollars

**Pasteurization Requirements & Current Recommendations**

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>Temperature</th>
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<tr>
<td>53.4</td>
<td>174°F</td>
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<tr>
<td>40.0</td>
<td>175°F</td>
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<tr>
<td>30.0</td>
<td>176°F</td>
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<tr>
<td>22.5</td>
<td>177°F</td>
</tr>
<tr>
<td>16.9</td>
<td>178°F</td>
</tr>
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</table>

- 161°F for 15 seconds are the minimum temperature & times for legal pasteurization
- Recently, fluid milk processors have been urged to use HTST conditions greater than minimum
- As plants increased HTST conditions, they noticed an increase in bacterial numbers over shelf-life

Previous industry minimum recommendation (06-17-07) was 177°F/22 sec or equivalents

**Microbial Numbers in Pasteurized Milk Over Shelf-Life at 43°F (6.0°C)**

- Bacterial numbers increased with pasteurization temperature (p<0.05)

- 185°F = 8,600,000 CFU/ml
- 167°F = 540,000 CFU/ml

- Day 1: 100,000 CFU/ml
- Day 14: 500,000 CFU/ml
- Day 21: 1,000,000 CFU/ml
Summary
• Pasteurized fluid milk processed in upstate NY plants is of “good” quality at 14 days post-pasteurization.
• Results from the PI test do not correlate with pasteurized fluid milk quality.
• Currently, no raw milk bacteriological test is predictive of pasteurized milk performance. The lack of correlation between test results and product performance is compounded by post-pasteurization contamination of milk in the processing plant.
• Psychrotolerant sporeformers (Paenibacillus spp.) are the bacteria that limit shelf-life extension in conventionally pasteurized milk. These microbes are present in very low numbers in raw milk.
• Even measurement of psychrotolerant sporeformers present in raw milk will not predict pasteurized milk performance with reliability as long as pasteurized milk is re-contaminated in the processing plant.

What do we need?
• Control of post-pasteurization contamination in the milk processing plant.
• An assay that will rapidly identify and quantify psychrotolerant gram positive spore-forming bacteria with spoilage potential in raw milk.
• A strategy for locating and eliminating these microbes in milk processing systems.
• An integrated partnership between producers and processors to target and eliminate these microbes in milk production/processing systems.
• Or an entirely new, “outside of the box” approach for processing fluid milk.

Food Processing and Development Laboratory
http://www.foodscience.cornell.edu/cals/foodsci/research/FPDL/index.cfm

Walker Cone Bottom Processor
• Capacity: 100 gallons
• Agitator Motor: 1 ½ h.p.
• 2 speed, 36 & 18 rpm, constant torque
• Range 30-220°F
• Recording chart 20-220°F

Butter Churn
• 50 gallon butter churn

Cheese Equipment
• Kusel A-Frame Cheese Press
  • 3 rows each side
  • 7—40#/Wilson Hoops Per Row
  • 42 Hoops—Total capacity
Cheese Vats

Kusel cheese Vat
- Capacity: 50 gallons

Kusel Model MX Vat

Microthermics HTST/UHT 25DH

Armfield FT 25 BA Scraped Surface Processing System

Emery Thompson Batch Ice Cream Freezer