Listeria: Surveillance and Public Health Response

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Centers for Disease Control and Prevention

Collaborative Food Safety Forum
November 3, 2011
Listeria monocytogenes

- A highly virulent bacterial pathogen
- Found in soil and water
- Grows in refrigeration temperatures
- Transmitted to people by food
Estimated Annual U.S. Number of Selected Diseases Transmitted Commonly by Food

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Illnesses</th>
<th>Deaths</th>
<th>Case-fatality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Campylobacter</em></td>
<td>1,300,000</td>
<td>120</td>
<td>0.1%</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>1,230,000</td>
<td>450</td>
<td>0.5%</td>
</tr>
<tr>
<td><em>STEC O157</em></td>
<td>96,000</td>
<td>30</td>
<td>0.5%</td>
</tr>
<tr>
<td><em>Listeria</em></td>
<td>1,600</td>
<td>260</td>
<td>16%</td>
</tr>
</tbody>
</table>

Scallan E, et al, *Emerging Infectious Diseases*, 2011
### Listeria Infection by Risk Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Typical illness</th>
<th>Surveillance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant women</td>
<td>Asymptomatic infection or “flu-like” illness with fever, then fetal loss (miscarriage or stillbirth)</td>
<td>Yes</td>
</tr>
<tr>
<td>Newborn infants (≤ 31 days old)</td>
<td>Bloodstream infection, meningitis</td>
<td>Yes</td>
</tr>
<tr>
<td>Persons with immunocompromising conditions and the elderly</td>
<td>Bloodstream infection, meningitis</td>
<td>Yes</td>
</tr>
<tr>
<td>Healthy children and adults</td>
<td>Diarrhea with fever</td>
<td>No</td>
</tr>
</tbody>
</table>

*Remainder of talk is about illness in first 3 groups*
Listeria Wake-up Call

- 1985: Large outbreak in California
  - 142 cases, 40 deaths
  - traced to Mexican-style soft cheese (queso fresco)
- Began surveillance
Incidence of Listeriosis, 1986-2010

1989: turkey hot dog outbreak; New regulatory policies, industry efforts

Cases per million population

Year

Data from sentinel site surveillance (FoodNet since 1996)
Incidence of Listeriosis, 1986-2010

1989: turkey hot dog outbreak; New regulatory policies, industry efforts

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Incidence of Listeriosis, 1986-2010

- 1989: turkey hot dog outbreak; New regulatory policies, industry efforts
- 1998: PulseNet began subtyping
- 2000: made nationally notifiable
- 2004: Listeria Initiative

Data from sentinel site surveillance (FoodNet since 1996)
Current Surveillance for Listeriosis
Developed: 1995

Because: After the 1993 hamburger outbreak, UDA's Food Safety Inspection Service began a modern meat inspection system. They needed to tell Congress if *E. coli* O157 infections were being prevented. They gave funds to CDC.

Now: Conducts surveillance for 9 infections and hemolytic uremic syndrome (HUS), working closely with 10 state health departments and other federal agencies.

Illnesses per 100,000 pop

Pregnancy-associated cases

Nonpregnancy-associated cases in patients ≥65 years old

Illnesses per 100,000 pop.

Pregnancy-associated cases in Hispanic patients

Pregnancy-associated cases in non-Hispanic patients

2004 2005 2006 2007 2008 2009
Current Surveillance for Listeriosis

CDC Enteric Disease Surveillance

- PulseNet
- FoodNet
- Listeria Initiative
- FDOSS
Developed: 1996

Because: After the 1993 *E. coli* O157 outbreak in hamburgers made 726 people sick and killed 4 children, more clinical labs began testing for *E. coli*, and health departments were flooded with reports of illness.

Now: National network of public health and food regulatory agency laboratories that perform standardized molecular subtyping ("fingerprinting") of foodborne disease-causing bacteria.

PulseNet

Connects cases of illness nationwide to identify outbreaks that would otherwise go undetected.

National Molecular Subtyping Network for Foodborne Disease Surveillance
In 1998, when states began submitting *Listeria* isolate PFGE patterns to PulseNet, we began linking illnesses in different states....
Hot Dog Outbreak, 1998-1999

- 108 cases
  - 95 not pregnancy-related
  - 13 pregnancy-related
- 14 deaths (all adults), 4 miscarriages
- Ill persons in 24 states
- Hot dogs from one processing plant
- Outcome: industry efforts to make hot dogs safer

# of patients

- Recall
- Death or miscarriage
- Survived

Plant Construction

Date

Mead et al
Queso Fresco Outbreak, 2000-2001

- 13 cases, all in North Carolina
  - 2 not pregnancy-related (no deaths)
  - 11 pregnancy-related (5 stillbirths)

- All Hispanic

- Queso fresco
  - Purchased from door-to-door vendors
  - Homemade using raw milk

- Outcome: State banned sale of raw milk, launched education program

MMWR: 50(26);560-2.
Turkey Deli Meat Outbreak, 2002

- 54 patients
  - 42 not pregnancy-related
  - 12 pregnancy-related
- 8 deaths, 3 miscarriages/stillbirths
- Ill persons in 9 states
- Deli turkey meat was contaminated in the plant after cooking

Outcome
  - USDA tightened regulations
  - Industry probably added growth inhibitors

Challenges of Listeriosis Outbreaks

- **Cases are often geographically dispersed**
  - Detection difficult

- **Getting food history difficult**
  - Incubation periods up to one month or even longer
  - Population affected often has other illness
  - Ill persons may die before interview

- **Primarily affects high risk populations**
  - Finding appropriate controls is difficult
Current Surveillance for Listeriosis

CDC Enteric Disease Surveillance

- PulseNet
- FoodNet
- Listeria Initiative
- FDOSS
Developed: 2004

Because: To quickly generate hypotheses for *Listeria* clusters and outbreaks and obtain appropriate controls for rapid case-control analyses.

Now: CDC asks participating states to interview all cases with a standard form that asks about foods. When PulseNet detects a cluster, CDC compares food exposures among *Listeria* patients in the cluster and not in the cluster to identify suspect foods.
To Respond to Challenges, CDC started *Listeria* Initiative in 2004

- CDC requests that states interview all cases with a standard form that asks about foods
- CDC requests that all *Listeria* isolates are rapidly fingerprinted in PulseNet
  - to monitor for clusters
- When cluster detected, CDC compares food exposures of
  - cases in the cluster with
  - *Listeria* patients with non-matching isolates
  - to generate hypotheses about food source
### II. FOOD CONSUMPTION HISTORY

**INSTRUCTIONS FOR INTERVIEWER:** Please read all options to case-patient in each category. For the names of purchase sites, it is preferable to use codes from Section I above, e.g. AI for first grocery store, AS for third grocery store, CS for fifth restaurant. A DELI COUNTER serves portions or helpings of salads, cheeses, and meats sliced ON-SITE at a specified counter within a grocery store, food market, or delicatessen. Foods sliced and packaged AT THE FACTORY or as pre-packaged containers in self-serve refrigerated display cases are NOT considered to be from a deli counter.

**INSTRUCTIONS TO READ TO CASE-PATIENT (OR SURROGATE):**

Now I’d like to ask you about the foods that you ate between / / (date 4 weeks before) through / / (specimen collection/delivery date). For each food item, please give me your best guess as to whether you ATE the food, you’re not sure but you LIKELY ATE the food, you’re not sure but you LIKELY DID NOT EAT the food, or you DID NOT EAT the food.

#### MEATS:

In the 4 week period, did you eat any of the following COLD CUT, DELI MEAT, OR LUNCHEON MEAT items?

<table>
<thead>
<tr>
<th><strong>Meat</strong></th>
<th>Ate (1)</th>
<th>Likely ate (2)</th>
<th>Likely did NOT eat (3)</th>
<th>Did NOT eat (4)</th>
<th>If ate or likely ate, How often?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ham</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>1-2 x/month</td>
</tr>
<tr>
<td>Bologna</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>~1-2 x/month</td>
</tr>
<tr>
<td>Turkey breast</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>~1-2 x/month</td>
</tr>
<tr>
<td>Other turkey deli meat (e.g. turkey ham)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>~1-2 x/month</td>
</tr>
</tbody>
</table>

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**If ate or likely ate, Where was it purchased?**

- Grocery store
- Deli/small market
- Restaurant
- Other venue
- Don’t know

**Was this item purchased from a deli counter at any of the sites?**

- Yes
- No
- Don’t know

---

Please send completed
Malistop A-38, Atlanta, GA 30333 (404) 639-3500
Reporting to the *Listeria* Initiative (LI)

<table>
<thead>
<tr>
<th>Year</th>
<th>Percent of cases</th>
<th>Number of states</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2005</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2006</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2007</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>2008</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>2009</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>2010</td>
<td>60</td>
<td>30</td>
</tr>
</tbody>
</table>

- Yellow bars: % of Listeria cases
- Green line: # states reporting to LI
- Green squares: # states reporting to LI form
States Reporting to the *Listeria* Initiative, 2004

At least one case reported

n=10
States Reporting to the *Listeria* Initiative, 2005

n=14

At least one case reported
States Reporting to the *Listeria* Initiative, 2006

n=20

At least one case reported
States Reporting to the *Listeria* Initiative, 2007

n=22

At least one case reported
States Reporting to the *Listeria* Initiative, 2008

$n=27$

At least one case reported
States Reporting to the *Listeria* Initiative, 2009

n=40

At least one case reported

[Map showing states reporting to the Listeria Initiative, 2009]
States Reporting to the *Listeria* Initiative, 2010

n=42

At least one case reported
Current Surveillance for Listeriosis

CDC Enteric Disease Surveillance

PulseNet
FoodNet
Listeria Initiative
FDOSS
Foodborne Disease Outbreak Surveillance System

**FD OSS**

Captures outbreak data on agents, foods, and settings responsible for illness

**Developed:** 1973

**Because:** Outbreaks are the major way we learn what foods are causing illness and how to prevent it.

**Now:** States report hundreds of outbreaks each year through the National Outbreak Reporting System (NORS). The data is used to determine pathogen-food combinations to target for prevention.
Listeria Outbreaks, 1978-2010
(from Foodborne Disease Outbreak Surveillance System)

- **Single state outbreak**
- **Multistate outbreak**

### Before PulseNet (20 years)
- **1978-1997**
- 5 outbreaks (0 multistate)
- Average 54 cases/outbreak

### Era of PulseNet (7 years)
- **1998-2004**
- 13 outbreaks (4 multistate)
- Average 21 cases/outbreak

### Era of Listeria Initiative (7 years)
- **2004-2010**
- 19 outbreaks (4 multistate)
- Average 18 cases/outbreak
Incidence and Outbreaks of *Listeria*, 1978-2010
(from FoodNet and Foodborne Disease Outbreak Surveillance System)

Incidence data from active surveillance systems (FoodNet)
Outbreaks of confirmed *Listeria monocytogenes* reported to CDC (FDOSS)
# Food Vehicles for *Listeria* Outbreaks, 1998-2008 (n=20 outbreaks)

<table>
<thead>
<tr>
<th>Food Vehicle</th>
<th># of Outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deli meat (usually turkey)</td>
<td>6</td>
</tr>
<tr>
<td>Cheese (usually Mexican-style)</td>
<td>5</td>
</tr>
<tr>
<td>Hot dogs</td>
<td>2</td>
</tr>
<tr>
<td>Deli meats and hot dogs</td>
<td>1</td>
</tr>
<tr>
<td>Other (1 outbreak each)</td>
<td>6</td>
</tr>
</tbody>
</table>

Data from Foodborne Disease Outbreak Surveillance System
Listeria Incidence, Outbreaks, and Food Sources -- Status Before 2011

- **Incidence**
  - Marked decline in incidence in 1990s, no further decline in 10 years

- **Outbreaks**
  - Increase in detected outbreaks shows improved surveillance from PulseNet and Listeria Initiative

- **Food vehicles**
  - Previous major food vehicles may be safer
    - Last multistate outbreak from hot dogs in 1999
    - Last multistate outbreak from deli meat in 2005
  - Possible sources: FoodNet sporadic case-control study in 2000-2003 found associations with hummus and melons
Multistate Outbreak of Listeriosis Associated with Jensen Farms Cantaloupe — United States, August–September 2011

Listeriosis is caused by *Listeria monocytogenes*, a Gram-positive rod that is a natural component of the environment. The organism can contaminate food, primarily through consumption of contaminated food. Listeriosis can cause a spectrum of illness, ranging from febrile gastroenteritis to invasive disease, including sepsis and meningitis. Invasive listeriosis occurs predominantly in older persons with impaired immune systems. Listeriosis in women is typically a mild “flu-like” illness, but it can be associated with spontaneous abortion.

Listeriosis (Listeria infection)

Listeriosis, a serious infection usually caused by eating food contaminated with *Listeria monocytogenes*, is an important public health problem in the United States. The disease primarily affects older adults, pregnant women, newborns, and adults with weakened immune systems. However, rarely, persons without these risk factors can also be affected. The risk may be reduced by recommendations for safe food preparation, consumption, and storage.

Multistate Outbreak of Listeriosis, September 2011

The Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration (FDA) are investigating a multistate outbreak of listeriosis in coordination with state and local health departments, including the Colorado Department of Public Health and Environment. The outbreak started in the late summer; Collaborative investigations by local, state, and federal public health and regulatory agencies indicate the source of the outbreak is whole cantaloupe grown at Jensen Farms' production fields in Granada, Colorado.
Listeria Outbreak from Cantaloupe, July – October, 2011

Information as of November 1, 2011

- Detected by Colorado health department
- 139 ill
  - 134 not pregnancy-related
    - most >60 years old
    - 29 died (48-96 years old)
  - 5 pregnancy-related
    - 1 miscarriage
- 56% female
- Illness began July 31 - October 21
- Ill persons live in 28 states
  - 39 in Colorado
  - 18 in Texas
- Outbreak caused by 4 strains of Listeria
- Cantaloupe from Jensen Farms in Colorado
Persons Infected with an Outbreak Strain of *Listeria*, by date of onset, 2011

* n= 139 for whom information was reported to CDC by 11am EDT on November 2, 2011
Locations of *Listeria* Cases and Distribution of Cantaloupe from Jensen Farms

* n= 139 for whom information was reported to CDC by 11am EDT on November 2, 2011
The Power of Good Surveillance and Public Health Response

Cases reported as of October 11, 2011. For cases with missing onset information, onset was estimated as two days before culture.

Epi Curve as of Oct. 11 Showing Residents of Colorado vs Other States
Timeliness of Colorado vs Other States

- **Time from illness onset to PulseNet upload of isolate PFGE pattern**
  - Colorado: median 10 days (range, 4-16 days)
  - Other states: median 18 days (range, 6-52 days)

- **Time from state receipt of case report to patient interview**
  - Colorado: median 1 day (range, 0-6 days)
  - Other states: median 1 day (range, 0-17 days)

• Time interval calculated for a subset of cases in Colorado (n=36 cases) and other states (n=25) due to missing date data.
• PFGE = pulsed-field gel electrophoresis pattern
## Cantaloupe Association
Quickly Found Using Data from the *Listeria* Initiative

<table>
<thead>
<tr>
<th>Date when data on cases available</th>
<th>Ate Cantaloupe</th>
<th>Ate Ham</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>54 (64%) of 85 controls</td>
<td>360 (47%) of 774 controls</td>
</tr>
<tr>
<td>Sept 9</td>
<td>All 11 cases Odds ratio 8.5 P=0.02</td>
<td>7 (64%) of 11 cases Odds ratio 2.0 P=0.41</td>
</tr>
<tr>
<td>Sept 12</td>
<td>All 13 cases Odds Ratio 10.1 P=0.01</td>
<td>9 (69%) of 13 cases Odds ratio 2.6 P=0.18</td>
</tr>
<tr>
<td>Sept 14</td>
<td>All 19 cases Odds ratio 14.9 P=0.001</td>
<td>10 (56%) of 18 cases Odds ratio 1.4 P=0.60</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.
Listeria—Apps and Gaps

- **Current surveillance systems accomplish the following**
  - Very good detection of outbreaks
  - Fairly rapid investigation of outbreaks, with
    - identification of risky foods, that forms the basis for
    - regulatory and industry changes to improve food safety
  - Document long-term decrease in incidence, recent stalling of progress, and highest incidence in pregnancy, esp in Hispanics

- **Opportunities to improve surveillance**
  - PulseNet: more patients’ isolates could be subtyped—and faster
  - Listeria Initiative: more patients could be interviewed—and faster
  - Outbreaks: patient interviews could be faster
    - including follow-up interviews for information on product labels and source
Cycle of Foodborne Disease Control & Prevention

Surveillance

Prevention Measures

Epidemiologic Investigation

Applied Research
The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention.

The Farm (2000) by Alexis Rockman