Listeria monocytogenes transmission at retail

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Collaborative effort between Cornell and New York State Department of Agriculture and Markets
(Dan Rice, Joe Corby)

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**L. monocytogenes** strain differentiation (subtyping/fingerprinting)

- Tools which allow sensitive differentiation of bacterial subtypes
  - Detection of contamination sources
- Strain differentiation methods commonly applied to *L. monocytogenes* include serotyping, ribotyping, Pulsed Field Gel Electrophoresis (PFGE), DNA sequencing
  - While serotyping differentiates only 13 subtypes (serotypes), molecular methods generally differentiate more than >100 *L. monocytogenes* subtypes
Ribotyping
Examples of different *L. monocytogenes* ribotypes

Listeria monocytogenes
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Pulsed Field Gel Electrophoresis
**L. monocytogenes prevalence**

- Pristine environments: 1.3% (n=900)
- Urban environments: 7.3% (n=900)
- Ruminant farms
  - Bovine farms with listeriosis cases: 24.35% (n=616)
  - Bovine farms without listeriosis cases: 20.06% (n=643)
  - Small ruminant farms with listeriosis: 32.92% (n=322)
  - Small ruminant farms without listeriosis: 5.89% (n=475)
- Raw foods
- Food processing environments: from <0.1% to 30% or more
- Ready-To-Eat foods: 0.17 – 4.7 % (Gombas et al., 2004)
L. monocytogenes in urban environments

- Albany, NY
  - 214 samples tested
  - 27 positive for LM
  - 10 isolates were ribotype DUP-1038B (over three samplings and >1 year)
The graphs show the percentage of LM (presumably Listeria monocytogenes) positive samples across different sample categories for two groups: bovine and small ruminants.

### Bovine
- **Control**
  - Fecal: n=163, Sample Category: 30% LM Positive
  - Soil: n=160, Sample Category: 25% LM Positive
  - Feed: n=158, Sample Category: 20% LM Positive
  - Water: n=162, Sample Category: 15% LM Positive

- **Case**
  - Fecal: n=160, Sample Category: 35% LM Positive
  - Soil: n=160, Sample Category: 20% LM Positive
  - Feed: n=162, Sample Category: 25% LM Positive
  - Water: n=162, Sample Category: 10% LM Positive

### Small Ruminants
- **Control**
  - Fecal: n=120, Sample Category: 10% LM Positive
  - Soil: n=85, Sample Category: 40% LM Positive
  - Feed: n=120, Sample Category: 25% LM Positive
  - Water: n=76, Sample Category: 15% LM Positive

- **Case**
  - Fecal: n=86, Sample Category: 15% LM Positive
  - Soil: n=120, Sample Category: 45% LM Positive
  - Feed: n=120, Sample Category: 30% LM Positive
  - Water: n=115, Sample Category: 5% LM Positive

The graphs indicate higher LM positive rates in cases compared to controls, with soil samples showing the highest positive rates across both bovine and small ruminant groups.
<table>
<thead>
<tr>
<th>Raw Product</th>
<th>3/1/01</th>
<th>3/21/01</th>
<th>4/18/01</th>
<th>5/15/01</th>
<th>6/13/01</th>
<th>7/9/01</th>
<th>8/7/01</th>
<th>10/2/01</th>
<th>11/1/01</th>
<th>12/4/01</th>
<th>2/14/02</th>
<th>2/11/02</th>
<th>4/9/02</th>
<th>5/7/02</th>
<th>6/5/02</th>
<th>7/1/02</th>
<th>8/1/02</th>
<th>8/28/02</th>
<th>9/24/02</th>
<th>12/2/02</th>
</tr>
</thead>
<tbody>
<tr>
<td>L spp</td>
<td>L spp</td>
<td>1052A</td>
<td>1042B</td>
<td>1039A</td>
<td>1039C</td>
<td>1039C</td>
<td>-</td>
<td>1038B</td>
<td>L spp</td>
<td>L spp</td>
<td>L spp</td>
<td>L spp</td>
<td>L spp</td>
<td>L spp</td>
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</tr>
<tr>
<td>1 of 6</td>
<td>3 of 6</td>
<td>2 of 6</td>
<td>1 of 6</td>
<td>1 of 6</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Raw Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>E3: Apron</td>
</tr>
<tr>
<td>Fillet knife</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Finished Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1: Drain</td>
</tr>
<tr>
<td>E3: Drain</td>
</tr>
<tr>
<td>E4: Cooler Floor</td>
</tr>
<tr>
<td>Floor</td>
</tr>
<tr>
<td>Floor mat</td>
</tr>
<tr>
<td>E6: Cart wheels</td>
</tr>
<tr>
<td>E7: Under Slicer</td>
</tr>
<tr>
<td>E9: Sliding Door</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Food Contact Surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>E7: Gloves</td>
</tr>
<tr>
<td>E10: Slicer</td>
</tr>
<tr>
<td>E11: Skinner</td>
</tr>
<tr>
<td>E12: DeBoner</td>
</tr>
<tr>
<td>E13: Hot Table</td>
</tr>
<tr>
<td>Tubs-dirty</td>
</tr>
<tr>
<td>Tubs-clean</td>
</tr>
<tr>
<td>New Mixer</td>
</tr>
<tr>
<td>New Table</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Finished Product</th>
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</thead>
</table>
**L. monocytogenes in retail environments**

- Subtyped 98 food and 40 environmental *L. monocytogenes* isolates collected from retail establishments in New York State between 1997 and 2002
  - Isolates collected from 50 different retail establishments were characterized.
- 16 retail establishments showed evidence for persistence of one or more specific *L. monocytogenes* strains as indicated by isolation of the same EcoRI ribotype from food and/or environmental samples collected in a given establishment on different days
- 17 ribotypes were found among human clinical isolates as well as among food and environmental isolates

Distribution of *Listeria monocytogenes* Molecular Subtypes among Human and Food Isolates from New York State Shows Persistence of Human Disease–Associated *Listeria monocytogenes* Strains in Retail Environments

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**ABSTRACT**
**L. monocytogenes in retail environments - example**

<table>
<thead>
<tr>
<th>Est. Code</th>
<th>Source</th>
<th>Sample Description</th>
<th>Date Collected</th>
<th>Ribotype</th>
<th>Persistent Ribotype (Lineage)</th>
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<tr>
<td>V</td>
<td>Food</td>
<td>Oven roasted turkey</td>
<td>08/17/00</td>
<td>DUP-1062A</td>
<td>DUP-1062A (II)</td>
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<tr>
<td></td>
<td>Food</td>
<td>Smoked turkey breast</td>
<td>08/25/00</td>
<td>DUP-1062A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>Swab; display cooler</td>
<td>08/29/00</td>
<td>DUP-1062A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>Swab</td>
<td>08/29/00</td>
<td>DUP-1062A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>Swab</td>
<td>08/29/00</td>
<td>DUP-1062A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>Swab; deli case</td>
<td>09/21/00</td>
<td>DUP-1062A</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Environment</td>
<td>Swab</td>
<td>10/27/00</td>
<td>DUP-1053A</td>
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<tr>
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<td>Swab</td>
<td>10/27/00</td>
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<tr>
<td>X</td>
<td>Food</td>
<td>Ham</td>
<td>11/07/00</td>
<td>DUP-1042C</td>
<td>DUP-1042C(I)</td>
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<td>11/20/00</td>
<td>DUP-1042C</td>
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<tr>
<td></td>
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<td>Swab</td>
<td>11/20/00</td>
<td>DUP-1042C</td>
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<tr>
<td></td>
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<td>Swab</td>
<td>12/04/00</td>
<td>DUP-1042C</td>
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<tr>
<td></td>
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<td>Swab</td>
<td>12/04/00</td>
<td>DUP-1042C</td>
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</tbody>
</table>
On-going prospective study on *L. monocytogenes* in retail

- The goal of this project is to collect and test for LM environmental sponge samples from 120 retail establishments over 12 months (10 establishments/month)
  - in each month sponge samples are collected from 5 establishments where NYS Ag & Mkts collected sliced deli meats and from 5 establishments where NYS Ag & Mkts collected store made salads
- Sampling visits are part of NYS Ag & Mkts regular routine surveillance, only change is that environmental sponges will be tested in addition to scheduled food sample
Environmental samples collected

- Slicer or bowl, spoon, cutting boards, tables (e.g., utensils used to prepare salads)
- Sponge from deli case
- Sponge from sink interior in deli/salad area
- Drain in deli area
- Drain in raw meat area
- Drain in raw seafood area
- Floor in a dry isle
- Sponge from dairy case
- One sponge sample from wheels of 4 grocery carts (if no carts are available sponge sample from floor near store entrance will be taken)
- Two optional sponge samples, including, if possible, one sponge sample from a drain in the produce preparation area and one from a drain in a restaurant/café located in the retail operation
Subtyping results (completed for 16 stores with >1 LM positive sample)

- 5 stores: all different subtypes
  - One store with positive RTE salad had different subtypes in product and environment (deli sink)
- One store: drains in produce, seafood, and bakery area all same subtype
- One store: drains in raw meat and produce area, dry isle floor, and sink in deli area all same subtype
- One store: drain in raw meat and produce area same subtype
- One store: drain in raw meat area and sink in deli area same subtype
More subtyping results......

• One store: floor in deli area and dairy case same subtype
• One store: shopping cart wheels and sink in meat area same subtype
• One store: shopping cart wheels and dry isle floor same subtype
• One store: shopping cart wheels produce prep area same subtype
• One store: floor drain in deli area and sink in deli area same subtype
• One store: deli salad utensils and sink in deli area same subtype
• One store: shopping cart wheels and sink in meat area same subtype
• 11 stores with same subtype in multiple sites
Human listeriosis?

- On-going subtyping of human listeriosis cases conducted in collaboration with NYS Department of Health and New York City Department of Health
Geographic Distribution of Human Listeriosis Cases

Number cases (rate/100,000)

Temporal Clusters: A, B, C, D, E, F, G, H, I
Spatial Clusters: B*, D, G*, H, I

*=Epidemiologically-linked cluster (outbreak)
Geographic Distribution of Human Listeriosis Cases

Example: Cluster G

- Single localized geographic cluster

Temporal Clusters: A, B, C, D, E, F, G, H, I

Spatial Clusters: B*, D, G*, H, I

*=Epidemiologically-linked cluster (outbreak)
Summary and conclusions

• *L. monocytogenes*, including subtypes that have been linked to human disease, can persist in natural and urban environments, on farms, in food processing plant and in retail environments
  • Persistence is likely to also occur in other environments (e.g., restaurants, consumer homes)
• More human listeriosis cases than previously assumed may represent small outbreaks
  • Persistence in food chain is likely to be critical for occurrence of listeriosis outbreaks
• Lm contamination in retail operations appears to be dominated by positives in drain samples and multiple sample sites often have appear to have the same subtype
  • Improved sanitation procedures and procedures to reduce cross contamination can likely reduce risk of RTE product contamination
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