Draft - Interagency *Listeria monocytogenes* in Retail Delicatessens Risk Assessment

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FMI Food Protection Committee

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Need for Virtual Deli Model of *L. monocytogenes* (Lm)

- **Lm**: a major cause of foodborne related death in the US
  - 255 deaths per year (Scallan et al. 2011)
- **Deli meat**: highest risk of ready-to-eat (RTE) food categories
  - FDA/FSIS, 2003
- **Lm prevalence and Lm levels are higher for in-store packaged than for manufacturer-packaged RTE food**
  - Gombas et al., 2003, NAFSS, 2008
- ~80% of all listeriosis cases attributed to deli meat are from deli meat sliced and packaged at retail
  - Endrikat et al., 2010, Pradhan et al. 2010

- **Hypothesis**: at retail
  - Additional cross-contamination?
  - Temperature abuse?

![Cumulative Fraction vs log10(Lm concentration, MPN/g)](Image)
Basic Processes to be Considered

Use Mass Balance Approach

Incoming Product (Chubs, Salad Bulks)

Deli Department (Cross contamination)

Niche or Environment

Growth

Contamination

Initial Contamination

Inactivation

Wiped, Washed, Disinfected

Trashed (Gloves, End of Chub)

Sold

Partitioning

To Risk

In a dynamic environment!
Definition of Baseline Conditions

#1: “**Multiple Niche 100W**” baseline condition
   - Stores with regular *L. monocytogenes* transfer from the environment and/or niches
   - Incoming *L. monocytogenes*: from incoming products and from the environment/niche

#2: “**No Niche**” baseline condition
   - Stores without transfer from the environment and/or niche
   - Incoming *L. monocytogenes*: from incoming products

#3: “**Incoming Growth Chub**” baseline condition
   - Stores with highly contaminated incoming product type that supports growth

#4: “**Incoming Non-Growth Chub**” baseline condition
   - Stores with highly contaminated incoming product type that does not support growth

#5: “**Temperature Control**” baseline condition
   - Stores without transfer from the environment and/or niche and with compliant temperature control (≤41°F)

#6: “**Niche & Temperature Control**” baseline condition
   - Stores with regular *L. monocytogenes* transfer from the environment and/or niches and with compliant temperature control (≤41°F)
Source of Lm Entering the Deli

- Baselines #2 and #4 (“no niche” and “temperature control”)
  - Product entering the store based on observed FSIS in plant monitoring

- Baselines #1 and #6 (“multiple niche” and “niche and temperature control”)
  - Product entering the store based on observed FSIS in plant monitoring
  - Additional environmental / niche contamination

- Baselines #3 and #4 (“incoming growth chub” and “incoming non-growth chub”)
  - Product entering the store based on observed FSIS in plant monitoring
  - One additional product (growth or non growth) contaminated at higher concentrations than FSIS observed (hypothetical)
Baseline Risks

Mean Susceptible Risk per Serving $\times 10^{-7}$

- Multiple Niche 100W
- No Niche
- Incoming Growth Chub
- Incoming Non growth Chub
- Temp. Control
- Niche & Temp. Control

Baselines
“What-If” Scenarios

• Sanitation Related Scenarios
  – Some NFCS cleaned FCS, Increase the effectiveness of cleaning, No sanitation, …

• Worker Behavior Related Scenarios
  – No glove, No contact glove-case, Preslice products in the morning, Do not slice product on gloves

• Growth Inhibitor Related Scenarios
  – All products with GI, No product with GI

• Cross contamination Related Scenarios
  – Separate slicers, No cross contamination

• Storage Temperature and Duration Related Scenarios
  – Temperature in compliance with FDA food code, Temperature set so that no growth can occur
Multiple Niche Baseline : Risk per serving

Mean Risk per Serving, Susceptible Population

Relative Susceptible Risk to Baseline (%)

Baseline Q50
Wash & Sanitize
Clean 8 Sporadic
No Sanitation
No Sporadic Cleaning
No Glove
Gloves Every Serving
NFCS As FCS
Transfers to 0
Transfers and Slicer to 0
No Contact Glove Case
Reduce Prevalence
Preslice
Separate Slicer
Separate Slicer Case
Lower Env Cont
Do Not Slice On Gloves
<table>
<thead>
<tr>
<th>Predicted risk per serving, susceptible population&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Multiple Niche 100W</th>
<th>No Niche</th>
<th>Incoming Growth Chub</th>
<th>Incoming Non-growth Chub</th>
<th>Temp. Control</th>
<th>Niche &amp; Temp. Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wash &amp; Sanitize: Increase the effectiveness of cleaning from simply washing to washing and sanitizing</td>
<td>1.7×10&lt;sup&gt;-7&lt;/sup&gt;</td>
<td>1.4×10&lt;sup&gt;-7&lt;/sup&gt;</td>
<td>16.6×10&lt;sup&gt;-7&lt;/sup&gt;</td>
<td>2.8×10&lt;sup&gt;-7&lt;/sup&gt;</td>
<td>1.2×10&lt;sup&gt;-7&lt;/sup&gt;</td>
<td>1.5×10&lt;sup&gt;-7&lt;/sup&gt;</td>
</tr>
<tr>
<td>Clean 8 Sporadic: Double the number of sites cleaned from 4 to 8</td>
<td>-1.6</td>
<td>1.7</td>
<td>-0.6</td>
<td>2.0</td>
<td>-1.3</td>
<td>-7.6&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>No Sanitation: No wiping, washing, or sanitizing</td>
<td>41.3&lt;sup&gt;*&lt;/sup&gt;</td>
<td>7.9&lt;sup&gt;*&lt;/sup&gt;</td>
<td>2.9&lt;sup&gt;*&lt;/sup&gt;</td>
<td>23.5&lt;sup&gt;*&lt;/sup&gt;</td>
<td>11.9&lt;sup&gt;*&lt;/sup&gt;</td>
<td>50.2&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>No Sporadic Cleaning: Clean as required by the 2009 FDA Food Code, but no additional sporadic cleanings</td>
<td>3.0</td>
<td>-3.0</td>
<td>-0.4</td>
<td>1.7</td>
<td>1.7</td>
<td>3.5</td>
</tr>
<tr>
<td>NFCS As FCS: Workers clean deli NFCSs at same rate as FCSs</td>
<td>-3.0</td>
<td>0.7</td>
<td>-0.6</td>
<td>0.3</td>
<td>-5.4&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Sanitation Related Scenarios:**

**Worker Behavior Related Scenarios:**

| No Glove: Workers do not use gloves when serving customers | 5.1<sup>*</sup> | 2.5 | 1.2 | 8.5<sup>*</sup> | 6.0<sup>*</sup> | 7.0<sup>*</sup> |
| Gloves Every Serving: Workers change gloves before every sale | 4.1 | 0.7 | 0.7 | 0.6 | -0.2 | 0.6 |
| No Contact Glove Case: Workers do not use their hands to open the deli case (e.g. if a floor switch is used) | -1.4 | -3.4 | -1.3 | 1.3 | 1.3 | -0.3 |
| Pre-slice: Workers pre-slice RTE products in the morning, after cleaning | 6.0<sup>*</sup> | 24.9<sup>*</sup> | 49.5<sup>*</sup> | -34.4<sup>*</sup> | 19.2<sup>*</sup> | 1.0 |
| Separate Slicer: Workers use a separate slicer for RTE products that support growth of L. monocytogenes | -6.3<sup>*</sup> | -0.6 | -1.7<sup>*</sup> | 22.7<sup>*</sup> | -0.8 | 4.6 |
| Do Not Slice On Gloves: Workers collect the slices of RTE products on tissue paper rather than on his/her gloved hand | 1.9 | 1.0 | 0.2 | 3.8 | -1.9 | 8.0<sup>*</sup> |

**Growth Inhibitor Related Scenarios:**

| All GI: Reformulate all RTE products sold at the retail deli that would otherwise support L. monocytogenes growth to include growth inhibitors | -96.0<sup>*</sup> | -95.2<sup>*</sup> | -97.5<sup>*</sup> | -94.5<sup>*</sup> | -94.4<sup>*</sup> | -94.8<sup>*</sup> |
| No GI: Reformulate all RTE products that support L. monocytogenes growth that are sold at the retail deli to not include GI to restrict L. monocytogenes growth | 184.1<sup>*</sup> | 191.5<sup>*</sup> | 35.1<sup>*</sup> | 190.5<sup>*</sup> | 187.7<sup>*</sup> | 188.9<sup>*</sup> |

**Cross Contamination Related Scenarios:**

| Transfers to 0: Cross contamination would only result from the deli slicer | -4.3 | 2.5 | 1.0 | 3.7 | 0.2 | -0.3 |
| Transfers and Slicer to 0: No cross contamination in the retail deli | -33.8<sup>*</sup> | -18.6<sup>*</sup> | -9.5<sup>*</sup> | -60.8<sup>*</sup> | -19.2<sup>*</sup> | -30.4<sup>*</sup> |
| Reduce Level: Mean incoming L. monocytogenes concentration in all RTE products lowered from -9.2 to -9.5 log<sub>10</sub> cfu/g | -21.6<sup>*</sup> | -24.2<sup>*</sup> | -1.1 | -9.8<sup>*</sup> | -22.5<sup>*</sup> | -15.6<sup>*</sup> |
| Separate Slicer Case: Workers use a separate slicer and a separate deli case for RTE products that support the growth of L. monocytogenes. | -2.5 | -1.6 | -1.2 | 21.0<sup>*</sup> | -0.9 | 7.5<sup>*</sup> |
| Lower Env Cont: Reduce transfer of L. monocytogenes among RTE products, FCSs, and NFCSs (i.e., reduce transfer coefficients by 50%) | -4.5 | -4.4<sup>*</sup> | -1.4 | 0.4 | 1.6 | 0.9 |

**Storage Temperature and Duration Control Related Scenarios:**

| Temp = 5°C: Set the retail deli case temperature to 5°C (41°F) (i.e., in compliance with the 2009 FDA Food Code) for all delis, instead of using the deli case temperatures reported by Ecosure | -4.8 | -14.3<sup>*</sup> | -8.1<sup>*</sup> | -2.8 | NA | NA |
| No Growth (T<sup>≤</sup>5°C): At this temperature, no L. monocytogenes growth will occur | -16.5<sup>*</sup> | -21.3<sup>*</sup> | -18.2<sup>*</sup> | -5.7<sup>*</sup> | NA | NA |
| Temp < 5°C: Use only the retail deli case temperatures observed in the Ecosure dataset at or below 5°C (41°F). | -9.0<sup>*</sup> | -16.3<sup>*</sup> | -12.3<sup>*</sup> | -8.2<sup>*</sup> | NA | NA |
| Shorten Time in Retail Delis: Reduce the length of time RTE products are held before they are sold or disposed from 7 to 4 days | -2.5 | 3.3 | -1.2 | 2.0 | -0.2 | 1.7 |
Risk Management Question: Sanitation

• Observed sanitation practices critical in reducing risk.
  – Stopping sanitation increased risk across all baselines.

• Additional sanitation (more effective cleaning, more frequent cleaning, …) generally not significant.
Glove changes observed ~65% of customers.

Never using gloves increased risk in 4 of 6 baselines.

Changing gloves for every customer led to no significant risk reduction.
Changes to worker behavior sometimes depended on the type of baseline store.

Risk Management Question: Worker behavior

- Multiple Niche 100W
- No Niche
- Temperature Control
- Incoming Growth Chub
- Incoming Non-Growth Chub
- Niche & Temperature Control

Relative Susceptible Risk to Baseline (%)

-60  -40  -20  0  20  40  60

Baseline

-60

a. Preslice
Risk Management Question: Growth Inhibitors

- Growth inhibitors prevented growth both at retail and at home.

- Broad growth inhibitor use led to dramatic reduction in risk.
Risk Management Question: Cross contamination, incoming levels

- Reducing incoming mean concentrations by factor of 2 reduced risk across all baselines except incoming growth chub.
Risk Management Question: Cross contamination

- Eliminating cross contamination reduced risk across all baselines, especially incoming non growth chub
- Slicer is primary nexus for cross contamination.
If retail delis simply followed the FDA recommended temperature versus current observed practice, an 8-16% reduction could be achieved.

- Reduces in-store growth
Key Findings

- To reduce predicted risks of listeriosis to consumers
  - Prevent Lm entering deli department
    - from incoming growth supporting product
    - from incoming non growth supporting product
    - from environment / niches
  - Increase growth inhibitor use (growth at retail and at home)
  - Improve temperature control (growth at retail)
  - Maintain adequate sanitation & glove use

No single intervention will eliminate listeriosis risk from food sold at retail delis. Instead, there are a host of steps that deli operators and suppliers can take to reduce the risk.
Discussion

• Pre-slicing
• Holding of product after slicing
• Separate slicer
• Sanitation
• Dose-response