Interagency Risk Assessment for *L. monocytogenes* in Retail Delis

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Focus on Retail Food Safety

- *L. monocytogenes (Lm)*: 2nd-3rd cause of foodborne-disease related death in the US
  - 1450 hospitalizations, 255 deaths per year (Scallan et al. 2011)
- Deli meat: 1st ready-to-eat (RTE) food vehicle of Lm
  - ca. 1,600 cases per year (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
- ca. 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-contaminations?
  - Temperature abuses?
Objective: Ascertain the impact on public health of current practices and potential interventions that reduce or prevent *Listeria monocytogenes* contamination in ready-to-eat food sliced, prepared and/or packaged in retail facilities.
What’s So Special About This Project?

- **Partnership**
  - USDA/FSIS & FDA/CFSAN

- **Collaboration**
  - Univ. of Maryland, Cornell Univ., VA Tech

- **Engagement**
  - Stakeholders early and throughout; > 56 meetings

- **Innovation**
  - 1st QMRA to quantitatively link retail practices to public health outcomes
Risk Management Questions

• “What is the exposure to *Listeria monocytogenes* from consuming ready-to-foods prepared in retail facilities?”

• “What are the key processes that increase ready-to-foods contamination at retails?”

• “How much is the relative risk per serving reduced according to specific risk management options?”
Risk Management Questions

Further refined; a list of proposed ‘what if’ scenarios to evaluate:

- Sanitation
- Worker behavior
- Growth inhibition
- Cross contamination
- Storage temperature & duration

Examples

- What is the public health impact of temperature abuse in deli cases?
- What would be the impact of separated slicers/counters for growth versus non-growth products?
- What is the impact of the use of gloves in the retail environment?
Outline

- Design
- Data Sources
- Implementation
- Modeling Approach
- Key Findings
Design: The Retail Deli Area

Food workers
Behavior → Events

Food
Meat
Cheese
Salad

Sites
Slicers
Cases
Food Contact Surfaces
Non Food Contact Surfaces
Utensils
...

Listeria

Niches
Slicers
Cases
...

June 18, 2013
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Washington, DC
Example Serve Customer Event
Example: Serve Customer Event

Wipe Slicer

Removes some bacteria from the slicer (if any)
Example: Serve Customer Event

Wipe Slicer

Wash hands & change gloves

Removes some bacteria from hands (if any).
No bacteria on the gloves
Example: Serve Customer Event

- Wipe Slicer
- Wash hands & change gloves
- Open case, remove chub, close case

Potential cross contamination between gloves and case

June 18, 2013
Wipe Slicer

Wash hands & change gloves

Open case, remove chub, close case

Slice on gloves

Potential cross contamination among gloves, slicer, chub and potential contamination of the product sold
Example: Serve Customer Event

- Wipe Slicer
- Wash hands & change gloves
- Open case, remove chub, close case
- Slice on gloves
- Touch scale

Potential cross contamination between gloves and scale
Example: Serve Customer Event

- Wipe Slicer
- Wash hands & change gloves
- Open case, remove chub, close case
- Slice on gloves
- Touch scale
- Rewrap chub

Potential cross contamination between the chub and the food contact surface
Example: Serve Customer Event

Wipe Slicer
Wash hands & change gloves
Open case, remove chub, close case
Slice on gloves
Touch scale
Rewrap chub
Open case, replace chub, close case

Potential cross contamination between the gloves and the case

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Example: Non Deli Time Event

Bacterial growth on products
From Retail to Risk

Dose Response Model

Contamination when sold

Home Storage (bacterial growth)

Contamination when eaten

Serving Size

Number of $Lm$ ingested

Dose Response Model

Probability of Illness

(FAO/WHO, 2004)
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Data Sources

- **Food worker behavior**

- **Transfer coefficients and Slicer**

- **Risk mapping**

- **Persistent strains in deli departments**
  - Oliver R. et al. (Cornell Univ./Purdue Univ.) (expected Summer 2013 )

- **Potential transfer during specific events**

- **Growth model**
  - Mejholm and Dalgaard, 2009 J Food Prot, 72(10), 2132-2143

- **Temperature in deli case**
  - Ecosure 2007 (www.FoodRisk .org)

- **Time/ temperature during transport and at home**
  - Ecosure 2007 (www.FoodRisk .org)

- **Consumption data**
  - NHANES study, WWEIA data, 1999-2006

- **Dose response model**
  - FAO/WHO 2004
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A Technical Challenge

- Discrete Event model + Few bacteria in the system = Slow convergence
- Each simulation: 100 Stores; 1,000,000 Servings
- Currently: 22 Scenarios tested, for 6 Baseline Conditions

Parameters
Excel Data File

model

Parallel computing

CSV Outputs

"Blue Meadow" cluster
2,016 cores, 21 TFlops

Available through the Office of Science and Engineering Laboratories,
CDRH - FDA
Outline

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Modeling Approach

- We evaluated a range of retail delicatessens conditions

**Approach**

- Define some *baseline conditions*
  - Baseline #1: regular environmental contaminations occur in the stores
  - Baseline #2: no environmental contamination occurs in stores
  - ...
- Evaluate various *scenarios within* these *baseline conditions*
Step 1: 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)
Step 2: Evaluation of the impact of various mitigation strategies in these contexts

- Within each of the 6 Baseline conditions
  - 22 Scenarios

- Answer the question (example):
  - Given that there is a niche in a retail deli, what are the best mitigation strategies?
  - and not
  - What is the probability that there is a niche in the store?
Approach to Risk Management Questions

- Separate slicers / counters for growth versus non-growth products?
  - Model more than one slicer. Select slicer to use each time customer is served based on product type.

- What is the impact of the use of “gloves” in the retail environment?
  - Set probability of wearing gloves to 100%

- Consider frequently touched non-food contact surfaces (e.g. case handles, scale touch pads) as food contact surfaces (i.e., required to be cleaned and sanitized every four hours)?
  - Change site classification to FCS

➢ Flexibility of the Discrete Event Model
“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
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This is a “Virtual Deli” model.

What can we learn from the model about the retail deli environment?
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Percentage Change Relative to Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sanitation Related Scenarios:</strong></td>
<td></td>
</tr>
<tr>
<td>Wash &amp; Sanitize: Increase the effectiveness of cleaning from simply washing to washing and sanitizing</td>
<td>-1.6</td>
</tr>
<tr>
<td>Clean 8 Sporadic: Double the number of sites cleaned from 4 to 8</td>
<td>-4.2</td>
</tr>
<tr>
<td>No Sanitation: No wiping, washing, or sanitizing</td>
<td>41.3*</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>
</tr>
<tr>
<td>NFCS As FCS: Workers clean deli NFCSs at same rate as FCSs</td>
<td>-3.0</td>
</tr>
<tr>
<td><strong>Worker Behavior Related Scenarios:</strong></td>
<td></td>
</tr>
<tr>
<td>No Glove: Workers do not use gloves when serving customers</td>
<td>5.1*</td>
</tr>
<tr>
<td>Gloves Every Serving: Workers change gloves before every sale</td>
<td>4.1</td>
</tr>
<tr>
<td>No Contact Glove Case: Workers do not use their hands to open the deli case (e.g. if a floor switch is used)</td>
<td>-1.4</td>
</tr>
<tr>
<td>Pre-slice: Workers pre-slice RTE products in the morning, after cleaning</td>
<td>6.0*</td>
</tr>
<tr>
<td>Separate Slicer: Workers use a separate slicer for RTE products that support growth of L. monocytogenes</td>
<td>-6.3*</td>
</tr>
<tr>
<td>Do Not Slice On Gloves: Workers collect the slices of RTE products on tissue paper rather than on his/her gloved hand</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Growth Inhibitor Related Scenarios:</strong></td>
<td></td>
</tr>
<tr>
<td>All GI: Reformulate all RTE products sold at the retail deli that would otherwise support L. monocytogenes growth to include growth inhibitors</td>
<td>-96.0*</td>
</tr>
<tr>
<td>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</td>
<td>184.1*</td>
</tr>
<tr>
<td><strong>Cross Contamination Related Scenarios:</strong></td>
<td></td>
</tr>
<tr>
<td>Transfers to 0: Cross contamination would only result from the deli slicer</td>
<td>-4.3</td>
</tr>
<tr>
<td>Transfers and Slicer to 0: No cross contamination in the retail deli</td>
<td>-33.8*</td>
</tr>
<tr>
<td>Reduce Level: Mean incoming L. monocytogenes concentration in all RTE products lowered from -9.2 to -9.5 log_{10} cfu/g</td>
<td>-21.6*</td>
</tr>
<tr>
<td>Separate Slicer Case: Workers use a separate slicer and a separate deli case for RTE products that support the growth of L. monocytogenes.</td>
<td>-2.5</td>
</tr>
<tr>
<td>Lower Env Cont: Reduce transfer of L. monocytogenes among RTE products, FCSs, and NFCs (i.e., reduce transfer coefficients by 50%)</td>
<td>-4.5</td>
</tr>
<tr>
<td><strong>Storage Temperature and Duration Control Related Scenarios:</strong></td>
<td></td>
</tr>
<tr>
<td>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</td>
<td>-4.8</td>
</tr>
<tr>
<td>No Growth (T=5°C): At this temperature, no L. monocytogenes growth will occur</td>
<td>-16.5*</td>
</tr>
<tr>
<td>Temp ≤ 5°C: Use only the retail deli case temperatures observed in the Ecosure dataset at or below 5°C (41°F).</td>
<td>-9.0*</td>
</tr>
<tr>
<td>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</td>
<td>-2.5</td>
</tr>
</tbody>
</table>
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.

![Risk Management Question: Sanitation Diagram]

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Risk Management Question: Worker behavior, glove use

- 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: 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 (prevent growth at retail/home)
◦ Improve temperature control (deli case <41°F))
◦ Maintain adequate sanitation & glove use
◦ Pre-slicing increases the risk of listeriosis

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.
Draft Interagency Risk Assessment—*Listeria monocytogenes* in Retail Delicatessens (May 2013)

