Listeriosis in Canada: Anatomy of an Outbreak, Lessons-Learned and Path Forward

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Health Canada
Pathogens: traditional and emerging bacteria, viruses and parasites in foods, and BSE/TSE issues

Bureau of Microbial Hazards (BMH)

Nutrients, infant formula formulations, fats and oils, vitamins

Bureau of Nutritional Sciences (BNS)
**BMH – Key Activities**

**Research**
- Research and method development
- Research in support of RA, policy
- Reference services
- Collaborative research activities with industry, academia, other government departments

**Evaluation**
- Risk assessments
- Policy development
- Establish guidelines/standards
- Novel food assessments
- Public education
- Compendium Methods

*BMH: Bureau of Microbial Hazards*
*BDM: Bureau des dangers microbiens*
Outline

• Listeriosis in Canada
• 2008 deli-meat listeriosis outbreak
• The culprit
• Government response
• Outbreak-lessons learned
• Control strategies
1981 - Coleslaw (41 cases, 17 deaths) - Halifax

1989 - Sporadic cases associated with contaminated Brie cheese and alfalfa tablets

1996 - (2 cases) Imitation crab meat - Ontario

2002 - (2 cases) Imitation crab meat - Ontario

2002 - (47 cases) Cheese from pasteurized milk - B.C

2002 - (86 cases) Cheese from pasteurized milk - B.C

2008 - National (57 cases, 23 deaths) RTE deli-meats

2008 - (38 cases, 2 deaths) Cheese - Quebec

2007 - (17 cases) Raw-milk cheese - Quebec
Listeriosis in Canada

- Surveillance methods for listeriosis in Canada have varied over the past few decades

- A national passive surveillance program was initiated in 1987

- By 1995, all provinces and territories, except Quebec, were participating

- Since 1995, listeriosis has remained a reportable disease in these provinces and territories and was added to the list of reportable diseases in Quebec in 2004

- Listeriosis was removed from the list of nationally notifiable diseases in 2000, and not officially reinstated until 2009
Incidence of Listeriosis in Canada (2000-2008)

PHAC unpublished data, cases/ $10^6$ population
Incidence of Listeriosis by Age Group, Years 1995-2004

*Based on Listeriosis Reference Service (LRS) data received from the provinces and territories
## Common *Listeria* Serotypes in Canada 1995-2004

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Blood (%)</th>
<th>CSF and brain tissue (%)</th>
<th>Specimens associated with pregnancy and miscarriage (%)</th>
<th>Stools (%)</th>
<th>Total by serotype (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2a</td>
<td>253 (45.8)</td>
<td>45 (52.3)</td>
<td>1 (12.5)</td>
<td>6 (21.4)</td>
<td>48</td>
</tr>
<tr>
<td>1/2b</td>
<td>82 (14.9)</td>
<td>11 (12.8)</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>1/2c</td>
<td>5 (0.9)</td>
<td>1 (1.2)</td>
<td>1 (12.5)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4b</td>
<td>160 (30.0)</td>
<td>22 (25.6)</td>
<td>6 (75)</td>
<td>22 (78.6)</td>
<td>32</td>
</tr>
<tr>
<td>Others</td>
<td>52 (9)</td>
<td>7 (8.1)</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>552</td>
<td>86</td>
<td>8</td>
<td>28</td>
<td>-</td>
</tr>
</tbody>
</table>

Clark et al., 2009
Surveillance for *Listeria monocytogenes* and listeriosis, 1995–2004

C. G. CLARK1,2,3,4, J. FABER3,4, F. PAGOTTO3,4, N. CIAMPA3,5, K. DORÉ3,5, C. NADON3,6, K. BERNARD1, L.-K. NG1,2,6 AND the CPHLN†

**SUMMARY**

Canadian cases and outbreaks of illness caused by *Listeria monocytogenes* between 1995 and 2004 were assessed. Isolates (722 total) were characterized by serotyping, and pulsed-field gel electrophoresis (PFGE) was performed to provide a means of detecting case clusters. Rates of listeriosis remained fairly consistent during the period of study, and patient characteristics were similar to those seen in studies of other populations. Most isolates were obtained from blood and cerebrospinal fluid, although during some outbreak investigations isolates were also obtained from stools. Serotype 1/2a predominated in isolates from patients in Canada, followed by serotypes 4b and 1/2b. Outbreaks caused by *L. monocytogenes* that occurred during the period of study were caused by isolates with serotypes 1/2a and 4b. A retrospective analysis of PFGE data uncovered several clusters that might have represented undetected outbreaks, suggesting that comprehensive prospective PFGE analysis coupled with prompt epidemiological investigations might lead to improved outbreak detection and control.

**Key words:** *Listeria monocytogenes*, listeriosis, PFGE, surveillance.
Summer 2008 Canadian Listeriosis Outbreak
In 2008, a national outbreak of foodborne listeriosis resulted in 57 confirmed cases in 7 provinces, with a total of 23 deaths.
Bacterial outbreak sparks deli meat recall

Ontario chief medical officer warns consumers to be vigilant after one person dies, dozens fall sick

By Linda Nguyen and Tiffany Crawford

A spreading bacterial outbreak has left one person dead and dozens more sick as the Canadian Food Inspection Agency and Maple Leaf Consumer Foods plan to expand its recall of ready-to-eat deli meats, including supplies to fast food outlets McDonald’s and Mr. Sub.

So far, there is no evidence of a link between the death and the meat recall, other than they both involve the potentially deadly bacteria Listeria monocytogenes.

The Toronto production plant has been temporarily shut down and a review has been launched into all food safety procedures at the facility. There have been 29 cases associated with the outbreak across 17 health units.

Of these, 13 are confirmed cases, and the rest are probable and suspect cases which are under investigation by the local health units. There are two cases of Listeriosis reported in British Columbia, one in Saskatchewan and one in Quebec.

Ontario’s chief medical officer of health yesterday warned residents to be vigilant about what meat products they consume.

“I strongly advise the public, especially those at high risk for Listeriosis, such as the elderly, pregnant women and those with weak immune systems, to make sure they avoid consuming these products,” said Dr. David C. Williams.

Spokesman for Ontario Health Mark Nesbitt said Ontario health officials were in the process of contacting all the long term care homes and hospitals to confirm that they are aware of the recall of the food products that may have been contaminated.

“There hasn’t been any confirmation and the testing is ongoing. It’s quite difficult because Listeria has an incubation period between two and 30 days and it has been up to 90 days,” he said.

“We’re all jumping in and trying to get to the bottom of it. (The investigation) is very complex and involved and it takes lot of old fashioned detective work.”

Yesterday, the recall was expanded to include 23 ready-to-eat deli meats. The suspect products were produced at Maple Leaf’s Toronto plant since June 2 and were distributed to fast-food restaurants, institutions, nursing homes, hospitals and supermarket delis across Canada.

To date, there have been no confirmed illnesses from eating the meats.

Coincidentally, there has been a report of one recent death from listeriosis, confirmed by the Public Health Agency of Canada (PHAC) yesterday, but it has not been linked to the current tainted meats recall and is being investigated to determine its origin.

The recall, which began Sunday in conjunction with the Canadian Food Inspection Agency (CFIA), initially only included two varieties of packaged meat after some of the products tested positive for low levels of Listeria monocytogenes, a bacterium found in the environment.

A majority of those who got sick across the country are believed to have eaten the same food in nursing homes and hospitals in July, PHAC said. The average age of those sick is 65 years old.

CanWest News Service
The 2008 listeriosis outbreak was identified following three weeks of higher than expected case reports of listeriosis in Ontario.

On August 6, 2008, the Toronto Public Health Unit informed CFIA of two listeriosis cases at a Toronto nursing home.

Following a food safety investigation led by CFIA, the source of the *Listeria* was linked to Establishment 97B (Maple Leaf Foods Canada) RTE meat products.

Eventually seven provinces were implicated in the outbreak.
### Geographic Distribution

<table>
<thead>
<tr>
<th>Province</th>
<th>Confirmed</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>British Columbia</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Manitoba</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ontario</td>
<td>41</td>
<td>16</td>
</tr>
<tr>
<td>Quebec</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57</strong></td>
<td><strong>23</strong></td>
</tr>
</tbody>
</table>

* PFGE results were not available for 2 cases

PHAC (2009/10)
### Descriptive Epidemiology

Prior health status was known for 31 of the 57 cases and all 31 cases had underlying conditions.

Residents, inpatients or outpatients of institutions in the 70 days prior to their illness.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>75</td>
</tr>
<tr>
<td>Median age</td>
<td>78</td>
</tr>
<tr>
<td>Age range</td>
<td>29-98</td>
</tr>
<tr>
<td>Female</td>
<td>67%</td>
</tr>
<tr>
<td>Immunocompromised*</td>
<td>100%</td>
</tr>
<tr>
<td>Institutional exposure**</td>
<td>84%</td>
</tr>
</tbody>
</table>

* Prior health status was known for 31 of the 57 cases and all 31 cases had underlying conditions.
** Residents, inpatients or outpatients of institutions in the 70 days prior to their illness.

PHAC (2009)
Figure 1. Number of confirmed outbreak cases by symptom onset date (or specimen collection if onset date unavailable), Canada, 2008 (n=57)
Public Health Actions

- **August 13, 2008**, open samples of deli-meat from 2 institutions in Ontario tested positive for Lm with the outbreak pattern PFGE

- **August 17, 2008** – Recall → CFIA and ML Foods warned the public not to serve or consume *Sure Slice Roast Beef and Corned Beef*, because these products may be contaminated with Lm

- **August 19, 2008** – Recall → CFIA and ML Foods warned the public not to serve or consume any *RTE deli meat products* produced at facility # 97B because they may be contaminated with Lm

- **August 24, 2008** – Recall → ML Foods voluntarily recalled all products manufactured at facility #97B in Toronto

- **August 24, 2008** – Facility Closure → Toronto ML facility #97B was shut down and disinfection of the entire plant commenced
Maple Leaf Foods Establishment 97B had several production lines that produced a variety of RTE meat products, including Sure Slice brand products which were distributed nationally.

The Sure Slice brand included 6 different types of deli-meats and was marketed primarily to hotels, restaurants and institutions including hospitals and homes for the aged.
Listeria Line Positive Samples

Dates

Number Positives
0 1 2 3 4 5 6 7 8

Line 7
Line 8
Lm Levels in Select RTE deli-meats

![Bar Chart]

- **Food Type**: Black Forest Ham, Corned Beef, Roast Beef, Turkey
- **CFU/gram**: Ranges from 10-100, 100-1000, 1000-10000, 10,000+

The chart shows the number of positives (CFU/gram) for different food types. Black Forest Ham has the highest number of positives, followed by Corned Beef and Turkey, with Roast Beef having the fewest.
The Culprit
The Strain

- Three distinct, but highly-related strains, may have been involved in the outbreak
- Two isolates were found to harbour a 50 kbp putative mobile genomic island encoding translocation and efflux functions, that have not been observed in other *Listeria* genomes

Gilmour et al., 2010; BMC Genomics
Reference Outbreak Strain

- Serotype 1/2a
- PFGE type (LMACI.0040, LMAAI.0001)
- Ribotype (DUP-1045)
- Lineage II
- Clonal complex 8; ST 120
- Related to ECIII
PFGE (Ascl) variation detected by PulseNet Canada

a) LMACI.0040
b) LMACI.0001
Government Response
Early Actions

Improved Federal Response to Foodborne Illness Outbreaks: Actions to improve the overall preparedness and response capacity of the food safety system

- Improved government coordination by updating FPT protocols
- Enhance leadership capacity for outbreak response
  - Consolidating Incident Command Structure
  - Pilot test surge capacity
- Improved risk communication during foodborne emergencies
- Target communication to vulnerable populations
- Develop GoC food safety website
Building on Action Already Taken

The Government of Canada has taken concrete actions to-date:

- Food and Consumer Safety Action Plan has invested money in increased inspection and monitoring, mostly focused on imported products.
- Ongoing FPT engagement on food safety and foodborne illness coordination.
- Special *Listeria* fund (MC).
Early Actions After the Outbreak

Lessons Learned: Public Health Agency of Canada's Response to the 2008 Listeriosis Outbreak

December 2008

The information in this report was obtained by the Centre for Excellence in Evaluation and Program Design (CEESP) through a review of relevant material and a series of interviews. This report does not offer conclusions or definitive conclusions on the causes or the outcome of the outbreak. Rather, the observations made in this report aim to provide a general overview to Public Health Agency management and are intended to identify areas for improvement in the agency’s response to future outbreaks.

[Introduction]

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5. Conclusion

Chairman,

I would like to thank the Sub Committee for inviting me to be here today.

3 me are Ms. Meena Ballantine, Assistant Deputy Minister of Health Canada’s Health Products and Food Branch, and Dr. Jeff, Director of the Bureau of Microbial Hazards, Food Directorate Products and Food Branch.

Here to outline the support that Health Canada provides to the Health Agency of Canada and the Canadian Food Agency during an outbreak of food-borne illness.

1. The health and
• All of the end products sampled by MLF during the first 6 months of 2008 were negative for Lm
• Industry environmental sampling program for Est. 97B had identified positive results for *Listeria* spp. between May - August
• MLF management advised the CFIA that the expert panel identified five sources of contamination, four being environmental
The CFIA was advised that the major probable cause of the listeriosis outbreak was a commercial meat slicer. This created a new risk that had not previously been identified in the Est. 97B HACCP plan.

Additional factors that may have contributed to contamination:

• Insufficient written disassembly and inspection procedures for slicers
• Potential for cross-contamination as a result of employee flow between different rooms
• Structural damage and poor maintenance in RTE rooms
• Several biological, chemical and physical hazards not properly identified or addressed in the company’s HACCP plan
Internal Reviews - Shared Recommendations

What worked well:
• Generally, CFIA, PHAC and HC managed the outbreak well
• Federal partners worked effectively together; effective coordination for sample testing and transfer; information sharing
• Good cooperation and coordination with provinces and territories

Areas for improvement:
• **Improve clarity of roles** - Need to revisit the Foodborne Illness Outbreak Response Protocol (FIORP) to guide a multi-jurisdictional response
• **Communications** – Need to improve communications internally in federal government and externally with key stakeholders, P/Ts and the public
• **Capacity** - Need to address capacity (surge and ongoing) issues, particularly demands on technical capacity
Changes to CFIA Meat and Poultry *Listeria* Directives

The CFIA is implementing major enhanced controls

- Under the new requirements, production facilities must implement food contact surface (FCS) testing for *Listeria* spp. and/or Lm
- In addition, the CFIA has increased the frequency of its own environmental and end-product monitoring
- The enhanced requirements focus on early detection and control of *Listeria* by introducing new testing and reporting requirements for industry, e.g., positive test results from all FCS must now be immediately reported to the CFIA
- Where applicable, operators must also implement the "Risk based verification sampling of RTE Meat and Poultry Products"
- Companies must perform **trend analysis** on their test results
# Risk-Based Verification Sampling of RTE Products

## Sampling based on risk: **Operator PRODUCT Sampling**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Control measures</th>
<th>Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1</td>
<td>Antimicrobial agent or process and post-lethality treatment after the primary lethality process</td>
<td>1 / year</td>
</tr>
<tr>
<td>Alternative 2A</td>
<td>Post-lethality treatment after the primary lethality process</td>
<td>3 / year</td>
</tr>
<tr>
<td>Alternative 2B</td>
<td>Antimicrobial agent or process</td>
<td>6 / year</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>Sanitation only</td>
<td>1 / month</td>
</tr>
</tbody>
</table>

**Lower risk**

**Higher risk**
Trend Analysis Can Inform Process Control

Swanson, 2009
Trend Analysis - General

- Need corporate and regulatory buy-in
- Have to track an organism that is present at low levels
- Need to have access to industry, as well as (independent) regulatory testing
- Need people to have some training in trend analysis
- Sanctions when non-compliant, and benefits for compliance

Surak (2010)
“It was a failure to analyze test data that we weren’t even obligated to collect—a failure on our part to analyze that data and look for root-cause analysis, investigate and follow-up on individual trends to look for patterns so that we could find the bacteria that we couldn’t see inside the facilities, and end up with a different result.”

Michael McCain
President and CEO, Maple Leaf Foods, INC.
-Weatherill Report
Before 2008 Outbreak –
Tracking the number of positive sites, and making sure that each one is sanitized

NOW: Daily, scientific analysis to look for repeat patterns and root causes, complete management oversight and quarantine procedures
Weatherill Report

Independent Investigator Report - Overview

Report focused on:

- Overview of Canadian food safety system
- Events surrounding the outbreak
- Response coordination among FPT partners
- Handling of communications to the public and medical community
- Progress made since the outbreak
- Federal and multi-jurisdictional governance of food safety

Contains 57 recommendations
HC Key Lessons-Learned

HC provided consistent and timely turnaround of sample testing and met all Health Risk Assessment deadlines.

Listeriosis Reference Service worked well.

HC operations and labs communicated well with federal partners.

However, there is a need to:

- Enhance understanding of HC’s roles and responsibilities across federal partners.
- Build surge capacity in laboratory facilities for emergency situations.
- Enable information technology to support transfer of food safety information.
- Improve coordination of internal communications among federal partners.
- Engage in more proactive and targeted communications to the public.
- Update the Health Canada *Listeria* policy.
Changes to HC’s *Listeria* Policy - Managing Risks

HC is currently reviewing its policy on “*Listeria monocytogenes* in Ready-to-Eat (RTE) Foods”:

- Applies to all high-risk RTE foods (i.e., dairy, produce, fish and seafood, meats); in both federally-registered and non-registered sectors
- Encourage industry to use approved post-processing treatments (e.g., heat) and/or *Listeria* inhibitors (e.g., lactate/diacetate)

**Specific policy changes include:**

- Updated operational and sampling guidelines to enhance the ability to detect *L. monocytogenes*
- Potential for new end-product compliance criteria consistent with Codex
New end-product compliance criteria have been developed to be in-line with the International Codex Alimentarius standards:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Action level for Lm</th>
<th>Nature of concern</th>
<th>Level of priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) RTE foods in which growth of Lm can occur until the end of shelf life</td>
<td>Detected in 125g (5 x 25g)</td>
<td>Health Risk 1</td>
<td>High</td>
</tr>
<tr>
<td>2A) RTE foods in which a limited potential for growth of Lm to levels not greater than 100 CFU/g can occur until the end of shelf life</td>
<td>&gt;100 CFU/g</td>
<td>Health Risk 2</td>
<td>Medium-Low</td>
</tr>
<tr>
<td>2B) RTE foods in which growth of LM cannot occur until the end of shelf life</td>
<td></td>
<td></td>
<td>Low</td>
</tr>
</tbody>
</table>
IF I WERE YOU, MISTER, I'D FORGET ABOUT FINISHING THAT COLD MEAT SANDWICH...
The Good
Weight of Evidence: Factors to Consider for Appropriate and Timely Action in a Foodborne Illness Outbreak Investigation

April, 2010

Contributors:
Health Canada
Public Health Agency of Canada
Canadian Food Inspection Agency

Not for Distribution
The simplified process of decision-making is, as follows:

Microbiology → Weight of Evidence → Health Risk Assessment → Action
Industry Best Practices For Control of 
*Listeria monocytogenes*

Meat Industry *Listeria monocytogenes* Working Group
July 2009

(Logos of participating industry associations to be added here)
Meat Industry Best Practices Document

Meat Industry Best Practices for the Control of *L. monocytogenes*

The document is intended to provide guidance to establishment operators on the best practices to apply in order to achieve effective control of *Listeria* in the processing environment and prevent contamination of finished RTE meat products.

**The guidance encompasses:**

i) good manufacturing practices (GMPs) and their incorporation into the establishment’s HACCP system

ii) effective sanitation measures

iii) comprehensive testing programs to verify the effectiveness of sanitation and other measures being implemented, as well as advice on how to respond to any finding of positive test results
The Council of Chief Medical Officers of Health (CCMOH) convened a working group on listeriosis to:

- identify priorities and gaps in public health messages on listeriosis
- articulate clear and easily understood information on the causes and prevention of listeriosis that can be used to develop public health messages for the general population, vulnerable groups, and health care foodservice providers
Have shortened our HC gold-standard reference method MFHPB-30

- The new method is now more specific and can distinguish *L. monocytogenes* from non-pathogenic *Listeria* that often outcompete *L. monocytogenes*
- Method was developed based on in-house data and a collaborative project with PHAC (C-EnterNet); now takes 3-4 days from start to finish
- New method seems equivalent to MFHPB-30 based on work done to date (full validation not yet complete)
- Methodology for testing and recovering *Listeria* spp. from stainless steel

Pagotto et al., 2010
Goal:

Follow up to the listeriosis outbreak of August 2008: Address recommendations from SCAF and Weatherill Report / Enhance Surveillance and Early Detection

Corneau et al., 2010
Corneau et al., 2010
Control Strategies

- Clean
- Separate
- Cook
- Chill
- Throw Away
- Check
Overview of Risk Assessments: Risks of listeriosis

Five factors contribute to the risk of listeriosis:

- Amount and frequency that a food is eaten
- Frequency and extent of contamination
- Ability to support growth of *Lm*
- Time and temperature of refrigerated storage
- Susceptibility of consumers
Results of *Listeria* Risk Assessments

Confirmed what was already known:

- Higher levels of $Lm$ = higher risk of listeriosis
- A small portion of RTE foods has high levels of $Lm$
- Foods supporting growth should be the target of risk management efforts
Barriers and Challenges to the Control of *Listeria*

- The microorganism is commonly found in the environment including food processing, distribution, retail environments and in the home.
- Because *L. monocytogenes* is widespread, it can easily enter processing plants via raw foods, humans, equipment, vehicles, shoes, etc.
- Once inside a processing plant, *L. monocytogenes* can establish itself and persist for long periods of time.
- It can grow in many foods during refrigerated storage.
Reducing the Risk of Listeriosis

• Avoiding cross-contamination (sanitation)
• Processes that inhibit growth during shelf life, e.g., low moisture, high acidity, freezing
• Ingredients that inactivate listeriae (e.g., nisin, growth inhibitor packaging, dipping products)
• Processes that can inactivate listeriae (e.g., cooking steam heat, UHP)
• Incorporating ingredients that inhibit the growth of Listeria (e.g., lactate and diacetate)
Transient vs. Resident Pathogens

Transient:
- Removed by cleaning and sanitizing
- Limited amount of food is exposed

Resident:
- Become established in one or more sites, multiply and persist over time (e.g., months, years)
- Numerous lots of food can be exposed
A site(s) where food and water accumulate and microorganisms multiply.

- Serve as reservoirs from which microorganisms are dispersed during production
- Typically cannot be cleaned
Harborage Site or Niche

- May not be readily accessible for cleaning
- Equipment appears clean (i.e., passes visual inspection)
- Serves as a reservoir from which *Listeria* spp. are dispersed during production
- Sampling is necessary to detect a harborage site
Factors Influencing the Presence of Pathogens in a Niche

- Temperature
- Moisture/water activity
- Nutrients
- pH
- Competitive flora
1. Prevent harborage sites
2. Establish sampling programs to assess control
3. Respond to each positive product contact sample as rapidly and effectively as possible
4. Verify the problem has been corrected
5. Provide a short term assessment (e.g., weekly)
6. Provide trend analysis summaries
Strategies for Control

1. **Eliminate biofilms and niches that can lead to unacceptable microbial contamination**
Biofilm

- Microorganisms are embedded in a matrix of organic polymers produced by the cells.

- Biofilms provide favorable conditions for growth and survival (e.g., resistance to disinfectants).

- Bacterial cells in biofilms may be up to 500 times more resistant to sanitizers than free flowing cells of the same species.
2. Use a sampling program that can assess in a timely manner whether the environment is under control:

- **Goal**: to detect a problem, if one exists
Example of a Sampling Program

Sample from areas where RTE foods are exposed:

- Weekly from established sites
- Sample during production
- Number and location of samples will vary with complexity of the system
- Use sponges, mops, floor sweepings or whatever is appropriate for the food operation
- Size of samples should be as large as possible
3. Respond to each positive product contact surface sample as rapidly and effectively as possible

- A written corrective action plan should be developed and implemented before re-starting the packaging line
4. **Verify the problem has been corrected**

- Sample the packaging line daily until 3 consecutive sets of negatives are obtained
- A positive necessitates repeating step 3
5. **Provide a short-term assessment**

- Weekly reporting
- Include results for the past, e.g., 7 weeks
Randomizing sample sites in a food operation is not effective for assessing control

- Sample more frequently during construction
- Encourage aggressive sampling beyond the basic sampling program
- Treat each positive sample as a “success”
6. Provide quarterly or annual summaries

Examine for:

- Environmental sites of higher frequency
- Trend Analysis
Investigational Sampling to Find the Source

- Collect samples during production
- Analyze individually, not as composites
- Sample more sites than normal
- Sample more frequently (e.g., every 4 h)
Factors Determining Success of a Control Program

1. Strength of the environmental testing program

2. Response to a positive sample
Sampling Product vs. Equipment

Product

• Results offer no clue as to how contamination occurs and how to correct the problem

Equipment

• Results reveal how contamination occurs and problem can be solved sooner
Sampling tidbits

Sample from areas where RTE products are exposed:

- At least weekly from established sites
- No sooner than 3 h after the start of operation
- Collect 2 - 10 samples from each packaging line
- Sample floors of chill rooms and near packaging lines
- Use sponges or gauze eye pads
- Sample LARGE areas
- Test for *Listeria* spp.
Sampling Sites

- Sites should be selected based on experience, not random samples.
- Randomizing sample sites in a food operation is **not** effective for assessing control.
- Include the final step in the process where exposed product is packaged.
- Zone concept.
Zone 1
Product contact surfaces:
Conveyors, tables, racks, vats, tanks, utensils, filling and packaging machines

Zone 2
Non-product contact surfaces in close proximity to product:
Exterior of equipment, refrigeration units, floors

Zone 3
Telephones, forklifts, walls, drains

Zone 4
Locker rooms, cafeteria, hallways
**Environmental sampling:**
- is more sensitive for assessing control than product testing
- provides the information needed to prevent identify the source
- Finished product testing offers no clue about how contamination occurred
- Testing for *Listeria* spp. is more conservative and leads to greater assurance of controlling *Lm*
The ML outbreak was our first meatborne and largest outbreak of foodborne listeriosis in terms of mortality.

The outbreak has led to a number of significant changes in terms of *Listeria* control, both from a government and industry standpoint.

Definite wake-up call for RTE food industry in Canada.

Lots of good has resulted in terms of internal communications, capacity, lab activities, trend analysis and educational-type initiatives.

We feel that we are now better prepared, in the event that another large foodborne outbreak occurs.

An integrated strategy approach is needed for the control of *Listeria*.
Acknowledgments

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Thank you for listening!