

Listeria monocytogenes

What You Should Know About This Rare But Serious Bacterial Foodborne Pathogen



Chip Manuel, Ph.D.
Food Safety Science Advisor
GOJO Industries, Inc.



Lily Yang, Ph.D.
Associate, Food Safety
The Acheson Group



Rolando González, Ph.D.
Vice President of Public Health
The Acheson Group

INTRODUCTION

Food Safety refers to a specific set of practices, guidelines, and procedures put in place by a food establishment to ensure production of food that poses little to no risk to the consumer. Ultimately, Food Safety seeks to prevent potentially dangerous organisms, called pathogens, from contaminating food. Pathogenic microorganisms can be viruses, spores, and bacteria, and may vary in their severity. *Listeria monocytogenes*, while relatively rare, is one of the more serious bacterial foodborne pathogens that poses a risk to both retail and foodservice establishments. In this technical bulletin, we first introduce *L. monocytogenes*, including its symptoms of infection and illness burden. We then discuss the factors leading to its proliferation in these environments. Finally, we close by discussing what specific action retailers and operators can take to minimize risk of *L. monocytogenes* contamination within their facilities.

WHAT IS LISTERIA MONOCYTOGENES?

The genus *Listeria* includes 26 species of bacteria that are widely distributed in nature.¹ *L. monocytogenes* is the only species of human health concern and considered a pathogen (disease-causing organism), with 3 out of 13 identified serovars causing about 95% of all infections.²

It is a Gram-positive, rod-shaped, non-spore forming, motile bacterium that can be found in moist environments, soil, water, decaying vegetation, animals, farm fields, vegetables, and ready-to-eat foods, and it has been found in other environments such as food processing facilities, retail stores and home kitchens.³ It is a facultative anaerobe (*i.e.*, does not require oxygen to survive and grow), which makes it a pathogen of concern in modified atmosphere packaged products.⁴ It has also been shown to grow at a minimum water activity level of 0.92 and over a pH range of 4.4–9.4.⁵

L. monocytogenes thrives in wet and cold areas of food handling facilities (e.g., drains, condensate, chillers, refrigerated products) and can survive and even grow under refrigeration temperatures. In fact, it has been shown that *L. monocytogenes* can multiply slowly at temperatures as low as 34°F and can tolerate other food preservation measures (e.g., high salt concentration, frozen storage for extended periods, and acidic conditions). It is also more resistant to heat than are many other bacterial foodborne pathogens.⁶ Ideal harborage sites include areas where food and water are present, especially in cracks and hard-to-clean areas. In these areas, *L. monocytogenes* can persist for many months and even years. It may also grow and form or become part of biofilms on processing equipment, making its removal with routine cleaning and sanitizing procedures more difficult and increasing the risk of potential cross-contamination of products.

SYMPTOMS OF ILLNESS AND BURDEN

Individuals who experience a mild infection with *L. monocytogenes* may experience symptoms such as fever and diarrhea, as with other foodborne pathogens. This mild type of *Listeria* infection is rarely diagnosed.⁷ Individuals who become ill with *L. monocytogenes* infection may develop a more severe disease called listeriosis.⁸ According to the CDC, listeriosis symptoms experienced by people other than pregnant women can

include headache, stiff neck, confusion, loss of balance, and convulsions in addition to fever and muscle aches. Pregnant women typically experience only fever and other flu-like symptoms, such as fatigue and muscle aches, but infections during pregnancy can lead to miscarriage, stillbirth, premature delivery, or life-threatening infection of the newborn. Susceptible individuals, such as those who are immunocompromised, neonates, young children, and the elderly, can suffer much more severe infections with complications including blood infections, meningitis, convulsions, miscarriage, and possibly death. While the incubation period ranges from 1–4 weeks after eating food contaminated with *Listeria*, some people have reported symptoms starting as late as 70 days after exposure or as early as the same day of exposure.

In the United States, approximately 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths occur each year due to consumption of contaminated food.⁹ Out of those, 9 million illnesses, 56,000 hospitalizations, and 1,300 deaths can be attributed to known pathogens,¹⁰ with *L. monocytogenes* being responsible for 19% of that mortality rate. While it does not cause the most cases of foodborne illness (the incidence of foodborne listeriosis in the United States alone is about 1,600 cases per year), it has one of the highest (>95%) hospitalization and death rates among susceptible populations, with an approximate 20–30% mortality rate from complications (compared to <1% for *Salmonella spp.* or *Escherichia coli* O157).

Based on a model using *L. monocytogenes* outbreak data that gives equal weight to each of the most recent five years of data (2014–2018), the Interagency Food Safety Analytics Collaboration (IFSAC) estimated that over 90% of illnesses were attributed to non-meat food categories, with over 75% of these being attributed to dairy and fruits.¹¹



HOW IS L. MONOCYTOGENES SPREAD?

Due to the ubiquitous presence of *L. monocytogenes* in the environment, cross-contamination can occur at multiple points throughout the chain when food is harvested, processed, prepared, packed, transported, or stored in environments contaminated with this organism.

Environmental surfaces and niches not naturally prone to harboring *Listeria* can be contaminated by raw materials, water, soil, incoming air, and human traffic patterns and activities. The level of vulnerability to *L. monocytogenes* contamination and entrenchment in equipment or a facility will depend on the type(s) of commodities handled and the nature of the handling.¹²

WHY SHOULD RETAIL FOOD AND FOODSERVICE ESTABLISHMENTS BE CONCERNED?

L. monocytogenes is a foodborne pathogen that can adapt, survive, and persist in food handling facilities. It presents a particular concern with respect to food handling because it can grow at refrigeration temperatures, which are commonly used to control pathogens in foods. In addition, given that it is such a ubiquitous organism, keeping it totally out of the food handling environment can be difficult.

In retail and foodservice establishments, there are multiple potential sources of *L. monocytogenes* contamination, including food products and ingredients, the facility environment itself, equipment, employees, and customers or vendors. Contamination with foodborne hazards can occur before food products are delivered to the retail store, primarily due to their growing conditions, inherent natural flora, or processing steps. For example, raw food items such as meat, poultry, seafood, some fruits and vegetables may naturally carry pathogenic microorganisms, including *L. monocytogenes*. Over time as these products move through the food chain, the amount of *L. monocytogenes* present on the surface may grow to levels that pose a risk of infection to the consumer. Additionally, many of these items may become incorporated into more complex food systems (e.g., fruits and vegetables that become ingredients in salads), exacerbating the problem and making traceback investigation difficult, if not impossible, in the event of an outbreak. *L. monocytogenes* contamination may also occur after the lethality step. For example, ready-to-eat meat products may encounter *L. monocytogenes* in the plant environment after the lethality step and before packaging.¹³ This emphasizes the critical nature of proper and frequent sanitation in these environments.



When food contaminated with *L. monocytogenes* enters a retail or foodservice establishment, the possibility that other foods may become contaminated increases. Once the pathogen is introduced into the food, it encounters conditions that are optimal for survival, spread, and possible growth, not only in the food but in the environment that is touched by that food. This highlights the importance of keeping *L. monocytogenes* out of the environment through all means possible.

L. monocytogenes has been shown to survive in food facilities for long periods of time, even years. Once established in a particular surface (e.g., a drain), it can find its way to a food-contact surface typically aided by human activity (e.g., drain cleaning with a high-pressure hose) and can continue to re-contaminate any food that touches that surface (e.g., contaminated hands, equipment, countertops) and consumers eventually exposed to it via consumption of the contaminated food.¹³

WHAT CAN RETAIL AND FOODSERVICE ESTABLISHMENTS DO TO HELP PREVENT LISTERIA MONOCYTOGENES OUTBREAKS IN THEIR FACILITIES?

There are five major factors related to food safety practices within the retail and foodservice industry that the CDC has identified as most often contributing to foodborne illness:

- 1 **Poor personal hygiene**
- 2 **Improper food holding/time and temperature**
- 3 **Contaminated equipment/protection from contamination**
- 4 **Inadequate cooking**
- 5 **Food obtained from unsafe sources**

Out of those, two key risk factors that contribute to *L. monocytogenes* contamination in retail environments are improper cleaning and sanitation of equipment, food-contact surfaces, and non-food-contact surfaces, and improper time and temperature control.¹⁴ Additionally, controlling cross-contamination can help reduce risks of *L. monocytogenes* in a facility.

Improper cleaning and sanitation

Improper cleaning and sanitation of equipment and food-contact and non-food-contact surfaces in retail and foodservice environments enhances the risk of harboring *L. monocytogenes*, and in turn, increases the opportunity for cross-contamination, particularly of RTE food. When cleaning and sanitation are neglected or their efficacy decreases, *L. monocytogenes* can grow to high levels and establish itself, including potentially forming biofilms on surfaces. Once *L. monocytogenes* biofilms are established, they can be extremely difficult to remove from the environment.

Time and temperature control

While refrigerated food should be kept at 41°F or colder, unlike other foodborne pathogens, *L. monocytogenes* can grow slowly at refrigeration temperatures. Ready-to-eat (RTE) foods can become contaminated with *L. monocytogenes* during processing, so even stored under refrigeration, they may allow *L. monocytogenes* to multiply to levels that can cause consumers to get sick. Federal food safety guidelines call for refrigerated RTE foods considered high risk for *L. monocytogenes* to be discarded 7 days after opening.



Cross-contamination

The transfer of microorganisms from one surface to another is known as cross-contamination and can occur between equipment, food, the environment, and even employees. Cross-contamination can occur in multiple ways, with some of the typical routes for spreading *L. monocytogenes* in the retail environment including:¹⁵

- Slicing and handling of RTE items
- Dirty fans in coolers and display cases
- Condensation water that drops onto RTE or other food products
- Drains serving as reservoirs of *L. monocytogenes* and spray from hose water during cleaning, which can spread the organism throughout surfaces and the environment
- Cracks in equipment, utensils, and preparation tables that hinder their proper cleaning and constitute an ideal niche for *L. monocytogenes*
- RTE foods encountering raw foods, contaminated RTE foods, or contaminated equipment during transport, storage, and display, including foot or vehicle traffic between raw and RTE areas
- Improper handwashing by employees performing multiple different tasks, or use of improper utensils to avoid direct contact with food
- Dirty clothing, especially footwear, which can become contaminated with *L. monocytogenes*

Other risk factors are associated with the contamination and growth of *L. monocytogenes* in retail establishments. As an example, the baseline results of a 10-year study conducted by the FDA to identify the least and most often occurring foodborne illness risk factors and food safety behaviors and practices in delis within the United States reflect that retail establishments are better at managing bare-hand contact with ready-to-eat foods and ensuring foods are cooked to required temperatures and reheated properly. However, they also need to gain better control over cooling, cold holding of foods requiring refrigeration, and employee handwashing.¹⁶

Addressing these factors by identifying and implementing effective control measures as part of a robust prevention and control program will mitigate the risk of *L. monocytogenes* in retail and foodservice operations.

WHAT SPECIFIC CONTROLS CAN BE PUT IN PLACE TO HELP REDUCE RISK?

There are specific actions that retailers and operators handling food can take to decrease the potential for *L. monocytogenes* growth or cross-contamination.

Effective cleaning and sanitation

Thorough and frequent cleaning is needed, and when coupled with a hygiene monitoring program, it can help detect and manage harborage sites and the overall cleanliness of the food handling environment more effectively. Typical sites that require attention include floors and drains, less frequently cleaned areas such as HVAC systems, walls, coolers and freezers, damaged equipment, cracks, crevices, and hollow areas. It is essential to avoid creation of aerosols especially when using high-pressure hoses to clean floors and drains in RTE preparation and storage areas, to avoid potential spread of *L. monocytogenes*.¹⁷



Addressing potential harborage sites with good sanitation and environmental controls is essential for preventing growth in food through time and temperature control, or through formulation barriers. The chances for cross-contamination directly in a food increase when the organism is allowed to persist in the environment.

Controlling cross-contamination

Several aspects of a retail and foodservice operation can be effectively managed to mitigate the risk of cross-contamination:



- Buying from known and reputable sources, using selection, approval, and regular evaluation criteria such as those operating under Hazard Analysis Critical Control Point (HACCP) plans, certificates of analysis for specific pathogens, and third-party and/or regulatory inspections
- Developing flow plans with proper physical separation and minimized traffic between raw and RTE food preparation areas, from receiving, to storage, through processing or preparation, storage, and sale at display case with proper segregation of raw and RTE products



• Since food or ingredients may be potentially contaminated with *L. monocytogenes*, it is important to control the spread of the organism to other foods, food-contact surfaces, and equipment, with the following approaches:

- If possible, use a central kitchen to ensure good processing controls – prepare large volumes of RTE foods and distribute smaller volumes of packaged foods to each store
- Minimize the number of times food is handled, repackaged, or reworked
- Break down and clean slicers and other frequently used foodservice equipment at least every 4 hours
- Use clean and sanitized utensils for each specific task and for each step in the process
- Train employees on proper personal hygiene techniques, including proper handwashing and gloving

Maintaining strict time and temperature control

Since *L. monocytogenes* is often ubiquitous in the environment, and since some foods may become contaminated with this pathogen at low levels, it is critical to maintain strict time and temperature controls on foods at high risk for *L. monocytogenes* contamination.



- If possible, receive foods at 41°F or colder, and store foods at this temperature as well. Ensure that all cold storage facilities and equipment are functioning properly in order to maintain this temperature.
- Rotate foods by date using the “first in first out” (FIFO) rule for RTE products. This helps to ensure that food does not sit for long periods of time, which may allow *L. monocytogenes* to grow to dangerous levels.

- Work with vendors to produce smaller portions of RTE products to minimize the time that any *L. monocytogenes* present has to grow during display and/or storage
- Maintain internal temperature of food products at 41°F or colder when stored for periods of time.
- Label all food items prepared or opened with a date that the product must be used by or discarded. Per the FDA, potentially hazardous foods (foods that must be refrigerated for safety) that are prepared or opened at the retail establishment and held at 41°F or below must be discarded within 7 days.
- Verify date labeling to ensure proper rotation. For products that have not been opened, do not exceed manufacturers' recommended shelf-life code dates or manufacturers' “use by” date.
- To ensure proper airflow and refrigeration, do not exceed the recommended capacity of the display case and refrain from overstocking food items. Ensure that display cases are functioning properly by checking the internal temperature of several food items with a probe-based thermometer. Ensure all cooling equipment is on a preventative maintenance schedule to ensure proper function and prolong service life.

CONCLUSION

Given its pervasive nature, *L. monocytogenes* can be difficult to control once established inside a facility. When allowed to persist, *L. monocytogenes* can linger for months, and in some instances, years. Having a solid food safety plan, one that focuses on frequent and proper sanitation along with ensuring proper time and temperature controls for food storage, can help reduce the risks associated with this pathogen.

Information brought to you by the PURELL® brand

1. <https://www.microbiologyresearch.org/docserver/fulltext/jsem/71/5/jsem004795.pdf?expires=1625570601&id=id&acname=guest&checksum=81F380AF1E5936575313D072344CD15> 2. <https://doi.org/10.1128/mBio.03126-20> 3. <https://www.ecolab.com/expertise-and-innovation/resources/microbial-risks/listeria> 4. <https://www.unitedfresh.org/content/uploads/2019/03/FINAL-UFPAL-Listeria-Guidance.pdf> 5. International Commission on Microbiological Specifications for Foods, Microorganisms in Foods 5, Microbiological Specifications of Food Pathogens, Blackie Academic and Professional, New York, 1996. 6. <https://www.fda.gov/media/102633/download> 7. <https://www.cdc.gov/listeria/symptoms.html> 8. <https://www.fda.gov/food/foodborne-pathogens/listeria-listeriosis> 9. Scallan, E., Griffin, P. M., Angulo, F. J., Tauxe, R. V., & Hoekstra, R. M. (2011). Foodborne Illness Acquired in the United States—Unspecified Agents, Emerging Infectious Diseases, 17(1), 16-22. 10. Scallan, E., Hoekstra, R. M., Angulo, F. J., Tauxe, R. V., Widdowson, M., Roy, S. L., Griffin, P. M. (2011). Foodborne Illness Acquired in the United States—Major Pathogens, Emerging Infectious Diseases, 17(1), 7-15. 11. Scallan, E., Griffin, P. M., Angulo, F. J., Tauxe, R. V., & Hoekstra, R. M. (2011). Foodborne Illness Acquired in the United States—Unspecified Agents, Emerging Infectious Diseases, 17(1), 16-22. 12. <https://www.unitedfresh.org/content/uploads/2019/03/FINAL-UFPAL-Listeria-Guidance.pdf> 13. https://foodsafety.cals.cornell.edu/sites/nyfoodsafety.cals.cornell.edu/files/shared/Listeria_Retail_520Guidance_final_5_29_2019.pdf 14. <https://extension.psu.edu/control-of-listeria-monocytogenes-in-retail-establishments> 15. <https://extension.psu.edu/control-of-listeria-monocytogenes-in-retail-establishments> 16. <https://www.fda.gov/media/148247/download> 17. <https://extension.psu.edu/control-of-listeria-monocytogenes-in-retail-establishments> ©2021 GOJO Industries, Inc. All rights reserved. 1 #32262 (09/2021)