

Control of *Listeria monocytogenes* in Retail Establishments



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Background

Many hazards cause **foodborne illness**. When contaminated food is eaten, hazards such as bacteria, viruses, chemicals, or foreign objects can make people ill.

Let's look at each one of these hazards more closely.

- **Biological hazards** are caused by **microorganisms** that cannot be seen with the naked eye. Types of microorganisms found in food include bacteria, viruses, parasites, molds, and yeasts. In some cases, the presence of microorganisms in food is good and necessary to produce desired flavors and textures. Examples of foods that require the presence of certain microorganisms include bread, fermented dairy products such as yogurt, and fermented beverages such as cider or beer. Sometimes microorganisms present in food cause spoilage. Although spoilage microorganisms rarely cause foodborne illness, they cause the food to be inedible. The microorganisms that cause foodborne illness are called pathogens. Examples of commonly known pathogens include *E. coli* O157:H7, *Salmonella*, Hepatitis A, and *Listeria monocytogenes*. If eaten, pathogens can make people sick and even cause death. These microorganisms cause the majority of foodborne illness.
- **Chemical hazards** can range from natural toxins and drug residues to unapproved additives or chemicals. Some chemicals, such as detergents and sanitizers, are approved for use with food-contact surfaces. However, other chemicals are poisonous and should never be used around food (for example, pesticides, toxic metals, medications, and certain caustic cleaning and sanitizing compounds). If food becomes contaminated with chemical hazards, illness or death can result.
- **Physical hazards** are objects that, if eaten, can harm a person. Items such as glass, wood, stones, and metal shards, if swallowed, can choke or injure a person. Improperly maintained equipment, jewelry, and packaging materials also can be sources of physical hazards that contaminate foods.

In the past two decades, serious outbreaks of foodborne illness have been caused by a bacterial **hazard** known as *Listeria monocytogenes*. Many of the foods linked to the outbreaks can be found in the deli section of retail establishments. Some examples of food associated with the outbreaks include luncheon meat, hot dogs, deli salads, smoked fish, unpasteurized or soft cheeses, and fresh cut vegetables.

By identifying the sources and factors contributing to *Listeria monocytogenes* in the retail environment, steps can be taken to prevent and control outbreak opportunities.

This booklet will

- 1) provide an overview of foodborne illness and the disease caused by *Listeria monocytogenes*;
- 2) identify the general sources of foodborne hazards as well as the specific sources of *Listeria monocytogenes* in the retail environment;
- 3) explain factors that contribute to foodborne illness and to *Listeria monocytogenes* in retail establishments;
- 4) describe general food safety prevention and control techniques, specifically for *Listeria monocytogenes* in the retail environment;
- 5) demonstrate methods to verify that control programs for *Listeria monocytogenes* are adequate; and
- 6) provide suggestions for maintaining an effective food safety program for *Listeria monocytogenes*.

Certain terms in this booklet appear in bold face. These items are defined in the Glossary on page 23.

Note: While the information in this publication is aimed at retail establishments (e.g., food stores, delicatessens, grocers, supermarkets), the principles may be applicable to other entities such as food service, restaurants, and so forth.

Overview of Foodborne Illness and *Listeria monocytogenes*

Food goes through a long journey before arriving in a retail store. Although the United States has one of the safest food supplies in the world, foodborne illness may still result because of hazards in the production, processing, distribution, storage, or preparation of foods.

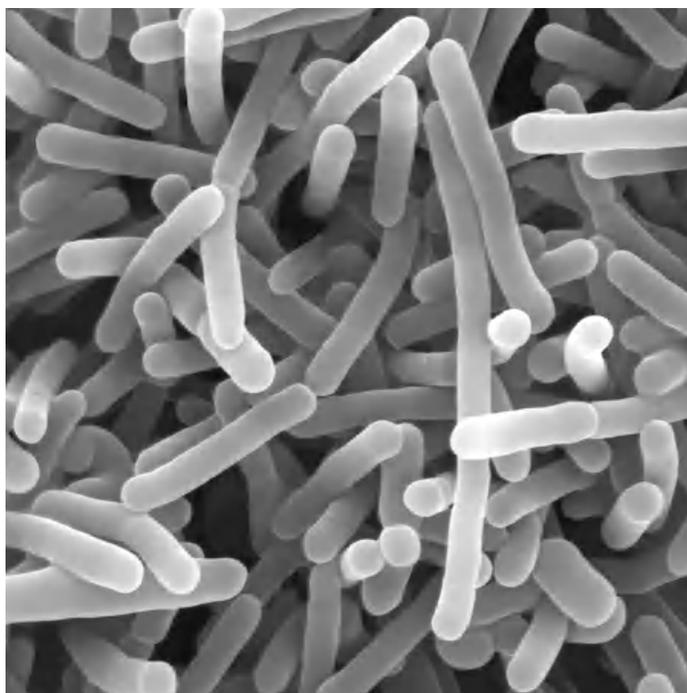
From 1983 to 2003, more than 300,000 cases of foodborne illness were reported to the Centers for Disease Control and Prevention (CDC). Even though this is a large number of illnesses, the CDC suspects that the actual number of illnesses is extremely underreported. The CDC estimates that 76 million people contract, and 5,000 die, as a result of foodborne illness each year in the United States. Of all of the causes of foodborne illness, *Listeria monocytogenes* (Figure 1) is particularly dangerous.

Factors that Make *Listeria monocytogenes* Particularly Dangerous in Retail Environments

Listeria monocytogenes Can Cause Foodborne Illness

Listeria monocytogenes is a bacterium, which is a living organism that cannot be seen with the naked eye. When eaten, this bacterium may cause the foodborne illness known as listeriosis.

Figure 1. Scanning electron micrograph of the bacterium *Listeria monocytogenes*.



Listeriosis Has a High Death Rate

Although it doesn't cause the most cases of foodborne illness, *Listeria monocytogenes* does have one of the highest hospitalization and death rates among populations susceptible to this **pathogen**. An estimated 20 percent of those who develop listeriosis die from complications.

Listeria monocytogenes Can Affect Highly Susceptible Populations

Not everyone reacts the same way when contracting listeriosis. Healthy adults generally may experience only mild symptoms, such as fever, nausea, headaches, muscle aches, or diarrhea, which may disappear quickly.

For people in highly susceptible populations, listeriosis can be particularly dangerous. Neonates, young children, seniors over the age of 65, pregnant women, or people with compromised immune systems are more likely to develop listeriosis and have more severe complications such as blood infections, meningitis, convulsions, miscarriage, and possibly death.

There Is a Zero-Tolerance Policy for *Listeria monocytogenes* in Ready-to-Eat (RTE) Foods in the United States

In the past 20 years, a link between *Listeria monocytogenes* and RTE, or processed foods, was identified. During the process of foods, the pathogen is killed by proper cooking. However, the organism may contaminate cooked RTE products before packaging, during transportation, or during post-cooking handling. Contamination is considered a serious problem for these foods since they usually receive little or no further cooking by food service, retail establishments, or consumers. If *Listeria monocytogenes* is associated with these products and is not destroyed through cooking, it may survive and cause a foodborne illness if eaten. It is important to note that most of the listeriosis outbreaks associated with RTE foods come from products manufactured in processing establishments. Some products that have been associated with *Listeria monocytogenes* include hot dogs, luncheon meat, deli salads, smoked fish, unpasteurized or soft cheeses, and fresh cut fruits and vegetables. Since 1989, the U.S. Department of Agriculture Food Safety Inspection Service (USDA-FSIS) has had a zero-tolerance policy for *Listeria monocytogenes* in RTE meat and poultry. All RTE foods regulated by the Food and Drug Administration (FDA) are also under the zero-tolerance policy for *Listeria monocytogenes*. The zero-tolerance policy states that the organism must not be detectable in a 25-gram food sample. If *Listeria monocytogenes* is found, the food is considered adulterated and may not be sold. If the contaminated food has entered commerce, it must be recalled.

Listeria monocytogenes Is Ubiquitous

Listeria monocytogenes is a ubiquitous organism, meaning that it is found all around us—in the air, soil, water, plant material, and animals. Therefore, keeping this organism out of food production can be difficult.

Foods grown in soil can easily be contaminated by *Listeria monocytogenes*. Fruits and vegetables that are not properly washed can contaminate foods to which they are added, such as salads. RTE foods, such as hot dogs and luncheon meats, can become contaminated after the product has been cooked and before it is packaged. Once *Listeria monocytogenes* is introduced into the food, it usually has food, moisture, time, and the right temperature—everything it needs to survive and possibly grow.

Listeria monocytogenes Grows at Refrigeration Temperatures

Another characteristic of *Listeria monocytogenes* is that it can survive and even grow at refrigeration temperatures. Even though it grows only slowly at refrigeration temperatures, the long shelf life of some RTE foods may give the organism the opportunity to grow to dangerously high levels. Therefore, to minimize any potential hazard from *L. monocytogenes*, retail establishments should store refrigerated foods at 41°F or colder, mind expiration dates, and use date marking to ensure prompt use of products once sealed packages are opened and product is exposed to possible cross-contamination.

Listeria monocytogenes May Be Found in a Retail Environment

Food processing plants are relatively closed environments and have many controls in place to prevent *Listeria monocytogenes* from contaminating the plant's environment and RTE products. These may include footbaths, sanitizer misters, clean rooms, protective clothing, and rigorous personal hygiene standards. However, retail environments are much more open with many people coming and going. These open retail environments may allow for the introduction of *Listeria monocytogenes* at various points and times of the day, potentially making control of *Listeria monocytogenes* in the retail environment more difficult.

Sources of *Listeria monocytogenes* in Retail Environments

How do foodborne hazards such as *Listeria monocytogenes* make their way into the retail environment? There are a number of sources of contamination, including the following:

- food products
- environment
- equipment
- employees
- customers or vendors

Let's look a little more closely at these sources of contamination in retail establishments.

Food Products

Some items sold in a retail establishment may be contaminated with foodborne hazards before they are delivered to the retail store. Raw items such as meats, poultry, seafood, and some fruits and vegetables may carry microorganisms such as *Listeria monocytogenes* (Figure 2). Although processing methods such as heat or chemical treatments can destroy *Listeria monocytogenes*, some processed foods may be contaminated with pathogens when inadequately treated or when they come in contact with other contaminated foods. If food contaminated with *Listeria monocytogenes* enters a retail establishment, the possibility that other foods may become contaminated increases.

Environment

Microorganisms are a natural part of water, air, and soil. Cleaning, sanitizing, and air filtration are some ways in

Figure 2. Raw meat and other raw food products commonly found in the retail environment may be contaminated with pathogens, including *Listeria monocytogenes*.



which retail establishments can prevent microorganisms from entering or growing in the retail environment. Chemicals such as cleaners, sanitizers, and even pesticides are common in retail environments. However, steps must be taken to ensure that chemicals are separated from food preparation, storage, and service areas. Physical hazards such as metal, wood, and plastic are also found in retail establishments and steps must be taken to ensure they do not contaminate foods inadvertently.

Equipment

Dirty or contaminated equipment can contaminate otherwise safe food (Figure 3). Improperly cleaned equipment can be a source of *Listeria monocytogenes* contamination. Preventative maintenance and care of equipment is necessary to prevent equipment from transferring pathogens to otherwise safe food.

Figure 3. Soiled and improperly cleaned and sanitized equipment can be a source of contamination for otherwise safe foods that may come in contact with the equipment.



Figure 4. Employees that handle foods, such as raw chicken, may spread pathogens and need to be aware of proper food handling procedures to minimize contamination of otherwise safe foods.



Employees

Employees can contaminate food with *Listeria monocytogenes* if proper personal hygiene policies are not followed or if employees do not take the proper steps to safely receive, store, prepare, and serve food (Figure 4).

Customers and Vendors

Anyone entering a retail establishment has the potential to introduce foodborne hazards into the store. For example, customers and vendors may carry microorganisms on their shoes, clothing, and hands and may transfer them to carts and foods during their shopping visits (Figure 5). Then employees can pick up the microorganisms during the course of their normal routines and transfer them to the foods they are handling.

Potential Sources of Hazards in Retail Establishments

While all three types of hazards should be evaluated and addressed in retail establishments, microorganisms present the greatest risk for illness and injury from foods. *Listeria monocytogenes* is one such microorganism that can contaminate food and cause foodborne illness, or even death. It has been well documented that *Listeria monocytogenes* has the ability to survive and replicate well in food processing establishments. The pathogen can set up residence in difficult-to-clean or dirty places, known as **harborage sites**. These sites may contaminate RTE foods if not completely cleaned. However, very little is known about the harborage sites of the pathogen in retail establishments. So, we can only speculate on the specific sources of *Listeria monocytogenes* in a retail environment. Let's consider the following information.

Figure 5. Customers can harbor microorganisms on their shoes, clothing, and hands that may be transferred to carts and foods during shopping.



Food Products

RTE foods sold at meat counters, seafood counters, the deli, or even the salad bar may be a source of *Listeria monocytogenes*. Raw foods such as meats, seafood, vegetables, and fruits may also be potential sources for the pathogen. Because many retail establishments produce rotisserie chicken, cooked seafood, and meat salads, the potential for **cross-contamination** from the raw products to other RTE foods and equipment is possible.

A study conducted in 2000 and 2001 measured the prevalence of *Listeria monocytogenes* in RTE foods. The results demonstrated that the pathogen was most commonly found in seafood salads, smoked seafood, and deli salads.

Product	Prevalence of <i>Listeria monocytogenes</i> (%) (No. of positive samples/no. of samples x 100)
Fresh soft cheeses	0.17
Bagged salads	0.74
Blue-veined cheeses	1.42
Mold-ripened cheeses	1.04
Seafood salads	4.70
Smoked seafood	4.31
Luncheon meats	0.89
Deli salads	2.36

Gombas, D. E., Y. Chen, R. S. Clavero, and V.N. Scott. 2003. Survey of *Listeria monocytogenes* in Ready-to-Eat Foods. *Journal of Food Protection* 66:559–69.

Environment

Listeria monocytogenes harborage sites in retail facilities are likely to be similar to those found in processing facilities. These sites include, but are not limited to, the following:

- drains (Figure 6)
- grease traps
- floors
- walls
- air vents
- areas where rodents or insects may enter the establishment

Equipment

Listeria monocytogenes may also be found on equipment used to transport, store, or prepare food. Without definitive information, we should consider that any type of equipment may become a source for the pathogen. Keep in mind that the pathogen can hide in difficult-to-clean equipment such as the following:

Figure 6. Drains and other high-moisture areas are known sources of *Listeria monocytogenes*. Special care should be taken when cleaning to reduce the possibility of spreading contamination to other areas in the retail environment.

Figure 7. Employees should be trained in proper handwashing techniques and personal hygiene to prevent the contamination of food and equipment with *Listeria monocytogenes*.



- slicers
- wheels of carts that transport food
- refrigerated storage units such as display cases and coolers
- cracks in preparation tables
- cooling fans in display cases

Also, any **food-contact surface** such as knives, cutting boards, gloves, or bamboo mats may be a potential source of *Listeria monocytogenes*.

Employees

Employees also may be a source for *Listeria monocytogenes* since some humans are known to carry the pathogen in their gastrointestinal tracts. Poor personal hygiene practices, such as improper handwashing or dirty uniforms, can lead to the contamination of food and equipment with *Listeria monocytogenes* (Figure 7).

Customers and Vendors

Hands, shoes, and clothes of employees, customers, and outside vendors also may be contaminated with the pathogen, thereby allowing the bacteria to contaminate floors and any items used by employees.

Understanding the sources of *Listeria monocytogenes* is an important step to develop and implement a proper control program.

Factors that May Contribute to Foodborne Hazards and *Listeria monocytogenes* in Retail Establishments

Now that we know that *Listeria monocytogenes* causes foodborne illness and we have identified some potential sources of the organism in the retail environment, it is important to understand the factors that can cause the pathogen to contaminate, grow, and spread.

Based on FDA reports and **foodborne outbreak** reports provided to the CDC, three risk factors have been identified most frequently as contributing to the contamination, spread, and growth of foodborne pathogens, including *Listeria monocytogenes*, in processing or retail environments. They are

- cross-contamination;
- improper cleaning and sanitation; or
- improper time and temperature control.

Let's look at these factors more closely.

In 1998 and 2003, the FDA conducted a study to observe and document the occurrence of risk factors that contribute to foodborne illness in foodservice and retail establishments. These scenarios included:

- food from unsafe sources
- improper holding/time and temperature
- inadequate cooking
- poor personal hygiene
- contaminated equipment/prevention of contamination

This study compared observed practices to procedures in the FDA Food Code for addressing these risk factors and found the following rates of noncompliance in retail environments:

Foodborne Illness Risk Factor	Percent of Observations Out of Compliance
Improper holding/time and temperature	64.4
Poor personal hygiene	23.5
Contaminated equipment/protection from contamination	23.4
Other/chemical	21.9
Inadequate cooking	9.2
Food from unsafe sources	5.0

FDA Report on the Occurrence of Foodborne Illness Risk Factors in Selected Institutional Foodservice, Restaurant, and Retail Food Store Facility Types (2004), <http://www.cfsan.fda.gov/~dms/retrsk2.html>.

Improper Time and Temperature Control

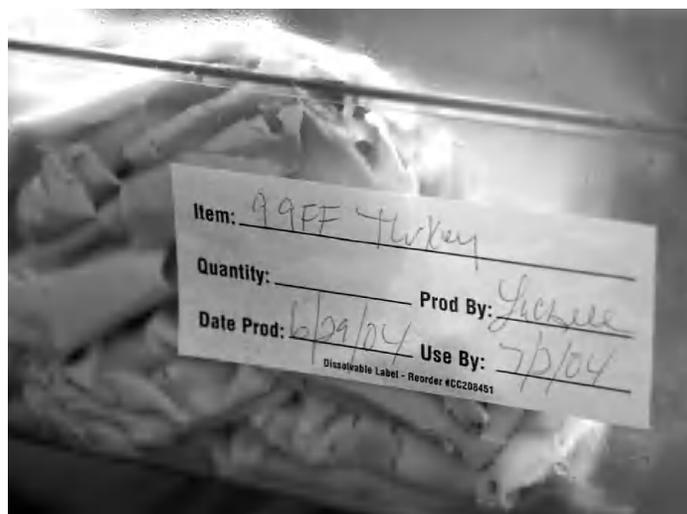
The first risk factor that contributes to *Listeria monocytogenes* contamination in retail environments is improper time and temperature control.

Federal guidelines recommend that refrigerated food be kept at 41°F or colder. These guidelines are in place because most foodborne pathogens do not grow well when kept at 41°F or below. Unfortunately, *Listeria monocytogenes* can grow slowly at refrigeration temperatures. RTE foods such as luncheon meat, fresh fruits and vegetables, and cooked seafood can become contaminated with *Listeria monocytogenes* during processing. If these products are stored at refrigeration temperatures for long periods of time, *Listeria monocytogenes* may grow to levels that can cause foodborne illness. While refrigeration is important to control *Listeria monocytogenes* at temperatures higher than 41°F, the pathogen may grow at a much faster rate. For this reason, federal guidelines recommend that RTE foods considered high risk for *Listeria monocytogenes* be held at 41°F. These foods should be discarded 7 days after opening (Figure 8). Check with your state or local government inspection agency for the recommended disposal times.

Cross-Contamination

Cross-contamination occurs when microorganisms are transferred from one surface to another, possibly leading to contamination of otherwise safe food or **clean** equipment. Cross-contamination can occur between equipment, food, the environment, and even employees.

Figure 8. Federal guidelines recommend that high-risk, ready-to-eat foods be labeled with the date they are opened or prepared. Under federal guidelines, certain products must be used or discarded after holding for 7 days at 41°F. Check your state or local regulations for more specific information.



Cross-contamination can occur in many ways. The following are some common examples of cross-contamination in a retail environment:

- **Slicing RTE items.** If a slicer is contaminated with product that contains microorganisms, then other foods that come into contact with that slicer can become contaminated (Figure 9).
- **Display cases and coolers.** Dirty fans in coolers and display cases can spread *Listeria monocytogenes* onto foods. As the fans circulate air, the microorganisms on the fans can be spread throughout the case or cooler, thereby increasing the incidence of cross-contamination in these pieces of equipment (Figure 10).

Figure 9. After a slicer has become contaminated, foods that subsequently come in contact with it can become contaminated.

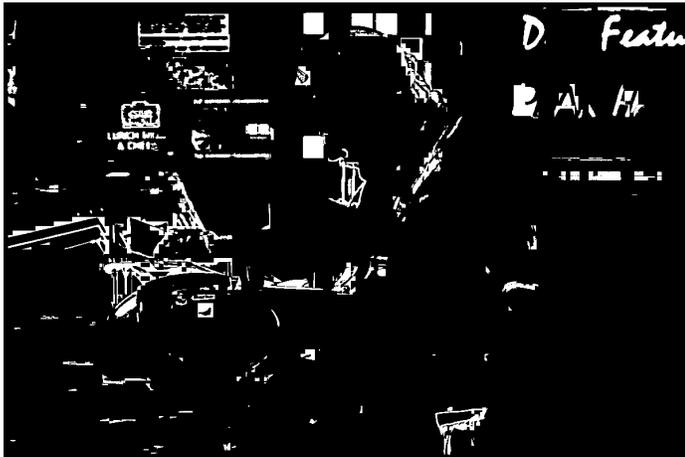
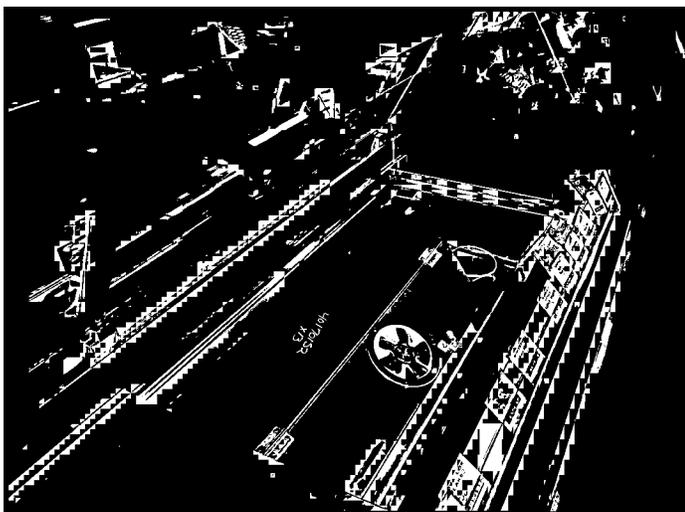


Figure 10. Contaminated fans in display cases and coolers can spread pathogens, such as *Listeria monocytogenes*, through circulating air and onto the foods in the case.



Condensation that forms in the case also may create another cross-contamination problem. Water that drops onto a RTE product is another way food may become contaminated.

- **Drains.** Data have demonstrated that drains are potential **reservoirs** of *Listeria monocytogenes*. During floor and drain cleaning, food and equipment may become contaminated if spray from hoses splashes the organism onto surfaces or into the environment. Since water droplets can carry *Listeria monocytogenes* from the drain and into the air, high-pressure hoses should be used very carefully in RTE preparation and storage areas.
- **Cracks in equipment and utensils.** *Listeria monocytogenes* may hide in cracks in equipment, utensils, and preparation tables, making them difficult to clean. If these surfaces are not cleaned properly, food that comes in contact with them could become contaminated. This scenario may be a common cause of cross-contamination in the retail environment (Figure 11).

Figure 11. Utensils and other equipment used in the retail environment can be sources of contamination when not cleaned and sanitized properly. Extra attention should be taken in difficult-to-clean areas of equipment and utensils. See circled area below.



- **Contamination during transport, storage, and display.**

Foods may become contaminated by improper handling during transport from receiving to the counters, and during storage or display. If RTE foods come in contact with raw foods, contaminated RTE foods, or contaminated equipment, the potential for cross-contamination can increase. Foot traffic from raw product areas, such as meats and seafood, can also introduce *Listeria monocytogenes* into the RTE environment.

- **Employees.** Dirty or unwashed hands can contaminate food and equipment. Employees who perform many different tasks in retail establishments without proper handwashing in between or fail to use appropriate utensils, such as tongs or clean gloves, may contaminate food and equipment. Soiled clothing also can contribute to contamination of food. Therefore, a proper dress code should be part of the hygiene regimen. To reduce the chance of cross-contamination, aprons should be changed when soiled and removed when leaving the work area.

Improper Cleaning and Sanitation

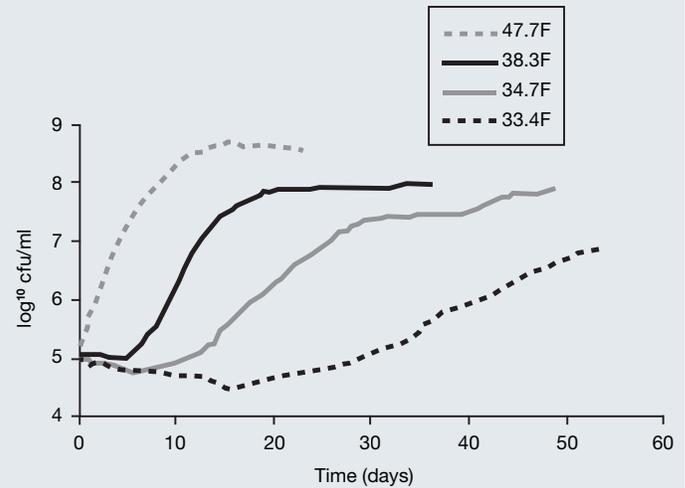
The second risk factor that may contribute to *Listeria monocytogenes* in retail environments is improper cleaning and sanitation of equipment, food-contact surfaces, and nonfood-contact surfaces.

Improper or infrequent cleaning and sanitation may allow *Listeria monocytogenes* to grow to high levels on equipment and the environment. If *Listeria monocytogenes* remains on equipment and environmental surfaces for long periods of time, the risk for contamination of RTE food increases.

This approach is especially important since *Listeria monocytogenes* can produce **biofilms**, or an invisible slime layer, on surfaces.

In summary, numerous risk factors are associated with the contamination and growth of *Listeria monocytogenes* in retail establishments. These factors need to be addressed to identify control measures for an effective *Listeria monocytogenes* prevention/control program.

A study conducted in 1990 examined the growth of *Listeria monocytogenes* at refrigeration temperatures. The study demonstrated that *Listeria monocytogenes* can grow at temperatures used for refrigerated storage, but with decreasing temperatures, the growth was slowed. The study also demonstrated that *Listeria monocytogenes* could grow at temperatures as low as 31.3°F.



Growth of *Listeria monocytogenes* CFA 433 in chicken broth when incubated at 47.7°F, 38.3°F, 34.7°F, and 33.4°F.

Walker, S. J., P. Archer, J. G. Banks. 1990 Growth of *Listeria monocytogenes* at refrigeration temperatures. *Journal of Applied Bacteriology*. 68:157–162.

Control of *Listeria monocytogenes* in Retail Establishments

Now that the risk factors that contribute to the contamination, growth, and spread of the pathogen have been identified, steps must be taken to control them. The following are three essential ways to control *Listeria monocytogenes* in retail establishments:

- Prevent cross-contamination.
- Practice proper sanitation.
- Control time and temperature.

Let's look at each one of these ways more closely.

Controlling Cross-Contamination

Controlling *Listeria monocytogenes* in retail environments first begins with preventing cross-contamination. To prevent the contamination of food prior to delivery, it is recommended that establishments:

- work with reputable vendors who operate under Hazard Analysis and Critical Control Point or HACCP systems and/or are inspected by federal, state, or local agencies;
- require vendors to provide letters of guarantee (LOG) and/or certificates of analysis (COA) that indicate products have been tested and are free of pathogens, if possible.

To prevent *Listeria monocytogenes* cross-contamination within the retail establishment, especially between raw and RTE food preparation areas, develop flow plans for foods from receiving, to storage, through processing or preparation, and finally to sale. As part of the flow, establishments should make an effort to take the following precautions in designing flow plans:

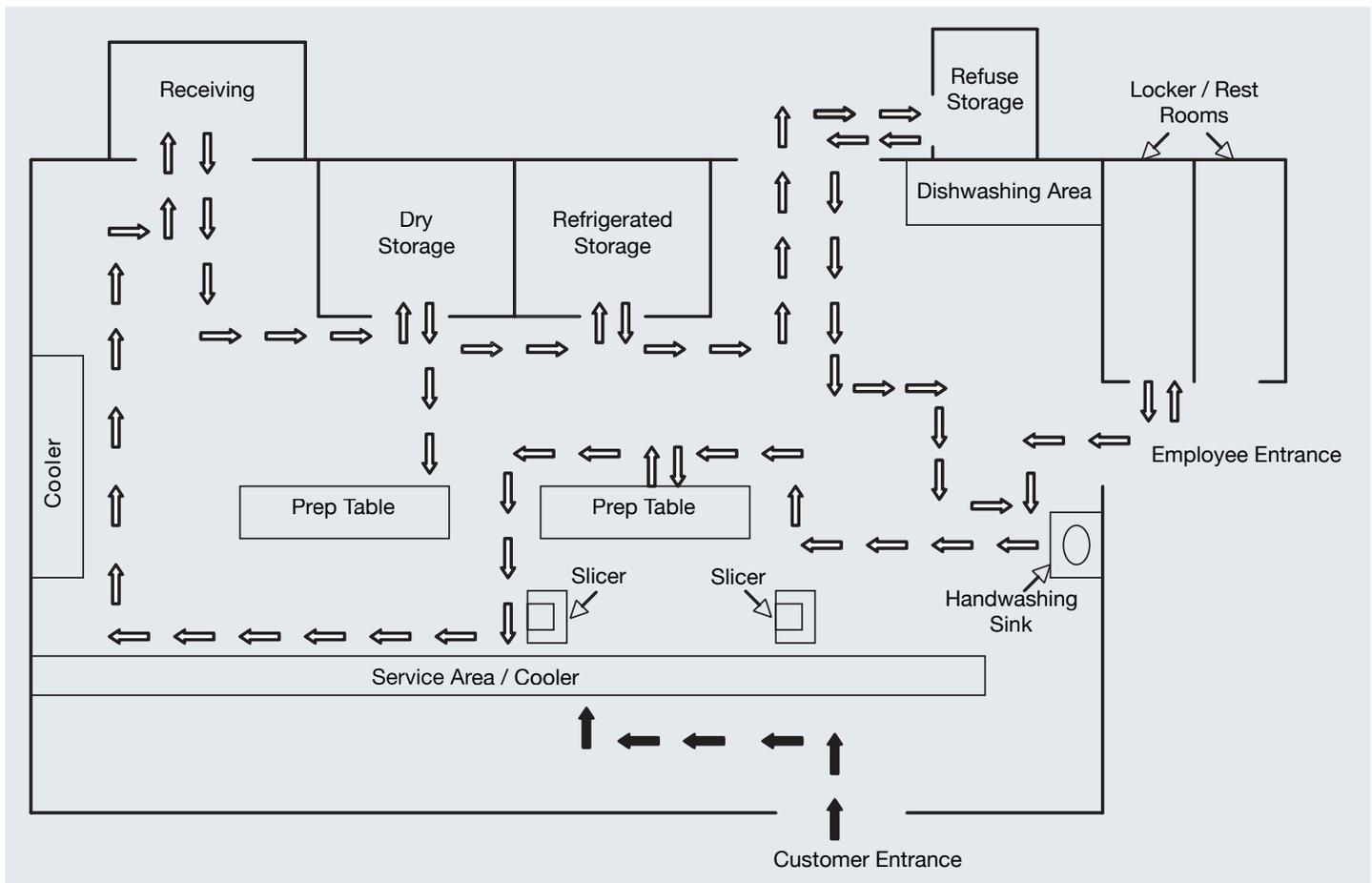
- Separate raw and RTE preparation areas. Raw meats should not be prepared or processed in the deli preparation areas. Preparation of raw chicken for the rotisserie or raw fish for frying should be done in an area separate from the deli and/or RTE food preparation area.
- Minimize traffic between raw and RTE areas (Figure 12). Raw foods such as raw meats, poultry, and seafood should not be transported through RTE food areas such as the deli. This approach is essential since there is a potential for cross-contamination between the raw and RTE product. Raw meats, poultry, and seafood also should be displayed in a separate case, preferably away from the deli area or physically separated by sturdy and cleanable dividers within cases.

Figure 12. Minimize traffic between raw and RTE areas by implementing procedures that take into account the flow of food during preparation.



- Physically separate raw and RTE products in refrigerated display cases and refrigerated storage areas. Ideally, raw and RTE foods should be displayed in separate cases. When this is difficult, due to facility restraints, an effort should be made to physically separate raw and RTE foods with plastic barriers or containers.

Figure 13. Example of workflow patterns through a simplified foodservice floor plan.



Properly designed establishment controls will minimize the number of times food is handled, the length of time food spends in the **temperature danger zone**, and the potential for cross-contamination. Flow patterns that can affect food safety include flow of employees, flow of food, and even airflow through the establishment (Figure 13).

Another consideration in control programs is that food or ingredients may be potentially contaminated with *Listeria monocytogenes*. Therefore, it is important to control the spread of the organism to other foods, food-contact surfaces, and equipment. Consider the following recommendations:

- If possible, prepare large volumes of RTE foods, such as salads, in a central kitchen and distribute smaller volumes of packaged salads to each store.
- Minimize the number of times food is handled, repackaged, or reworked. Consider using a central kitchen to ensure good processing controls when the same RTE product is sold at multiple outlets.
- Breakdown and clean slicers and other frequently used equipment at least every 4 hours.
- Use clean utensils for each specific task and for each step in the process.
- Train employees on proper personal hygiene techniques, including proper handwashing and gloving. See table for proper handwashing and gloving techniques on page 12.
- Keep raw meats, poultry, and seafood away from areas where RTE food preparation or storage occurs.

Handwashing Table



1) Rinse hands with warm water.

1



5) Dry hands with an individual, disposable towel.

5



2) Apply a generous amount of soap. Work soap into a lather.

2



6) If hand sanitizer is used, it only should be applied after hands have been properly washed and dried.

6



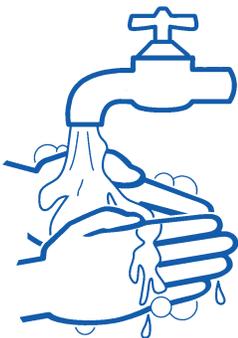
3) Vigorously scrub lathered hands and wrists for 20 seconds, paying particular attention to fingertips, areas between fingers, and backs of hands.

3



7) To avoid recontaminating hands, use disposable paper towels when touching surfaces (i.e., faucet handles, sink, door handle).

7



4) Thoroughly rinse under clean, running, warm water.

4



8) If gloves are used, they should be applied after hands have been properly washed and dried.

8

Controlling Time and Temperature

The third critical control for preventing contamination of foods by *Listeria monocytogenes* in foods is time and temperature control. Some examples of time and temperature control measures include the following:

- Receive foods at 41°F or colder (Figure 14).
- Rotate foods: use the “first in first out” (FIFO) rule for RTE products.
- To minimize contamination at the retail level, work with vendors to produce smaller portions of RTE products. The quicker the product is used, the less time *Listeria monocytogenes* has to grow during display and/or storage.
- Maintain the internal temperature of products at 41°F or colder. To maintain product temperature, keep refrigerated cases at 39°F or colder.
- Label all food items prepared or opened with a date that the product must be used by or discarded. According to FDA guidelines, 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.
- For products that have not been opened, do not exceed manufacturers’ recommended shelf life code dates or manufacturers’ “use by” date.

- Maintain controls to ensure RTE products are kept at the proper temperatures at all times. To ensure proper airflow and refrigeration, do not exceed the recommended capacity of your display case.
- Take temperature of open foods as often as necessary to ensure that refrigeration equipment is working and food is maintained at safe temperatures. To ensure documentation, make sure these temperatures are recorded accurately by properly trained employees.

Figure 14. *Listeria monocytogenes* can grow at refrigeration temperatures, but the pathogen can grow faster when temperatures are higher than 41°F.



Practicing Proper Sanitation

Proper sanitation is a crucial part of the plan to control *Listeria monocytogenes* in retail establishments. A proper sanitation plan is necessary to eliminate *Listeria monocytogenes* from food-contact surfaces, equipment, and the environment, and to prevent the buildup of biofilms on these surfaces.

See Biofilms table on page 15.

To eliminate *Listeria monocytogenes* from the retail environment and to prevent the formation or build up of biofilms, institute an effective sanitation program. See Sanitation table on page 16 for the proper way to clean and sanitize. The following are recommendations for an effective sanitation program:

- Train employees in proper sanitation and record keeping.
- Develop and implement an appropriate cleaning and sanitizing schedule with adequate record keeping.
- Use cleaning compounds and sanitizers at proper concentrations, proper temperatures, and application times.
- Clean first with a cleaning compound specific for the type of equipment (such as stainless steel or plastic) or type of residue (such as fat or protein).
- Rinse surface thoroughly and check for residue.
- Sanitize only visibly clean surfaces since sanitizers won't work effectively on dirty surfaces.
- Identify and purchase equipment that is easily cleaned.

Establishments may want to work with a reputable sanitation vendor to design the best sanitation program for the establishment, including the best cleaners and sanitizers for eliminating *Listeria monocytogenes*.

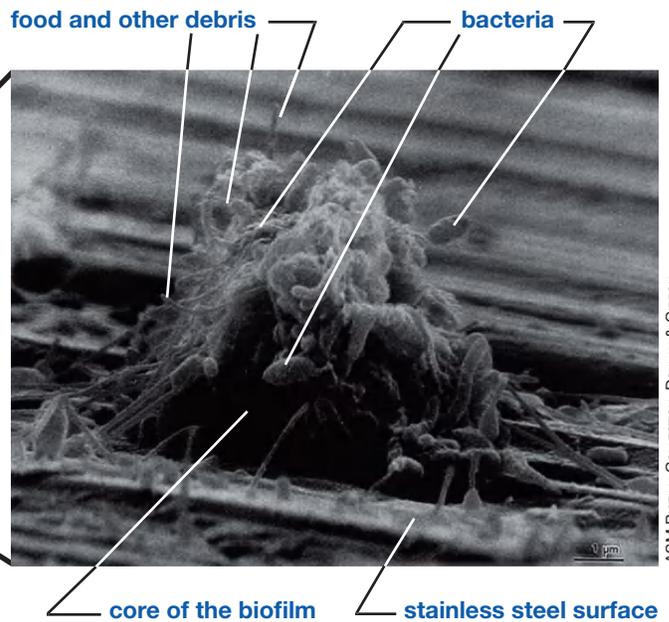
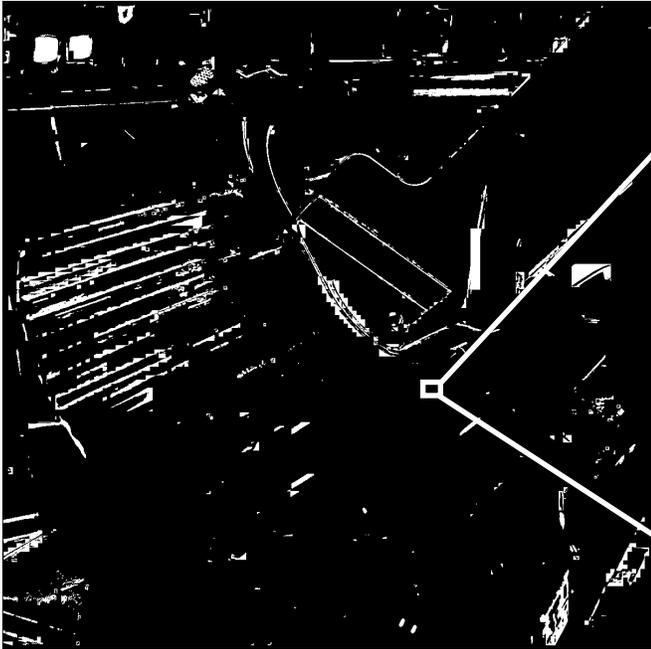
Next, it is important to determine if all of the equipment used in the processing areas is intact and cleanable. Some considerations include the following:

- Replace equipment that is scratched, rusted, or damaged in a way that makes it difficult to clean. Keep in mind that pitted, rusted, or riveted equipment provides great places for bacteria to hide.
- Make sure all areas of equipment parts and facility surfaces in need of cleaning are accessible to employees and receive adequate attention (Figure 15).

Figure 15. Improperly maintained and designed equipment can have areas that are difficult to clean, allowing bacteria to survive and multiply.



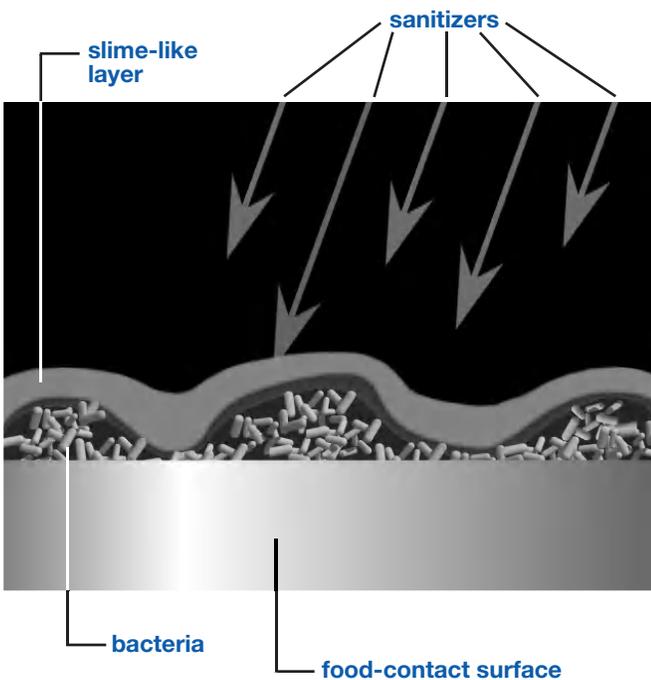
Biofilms Table



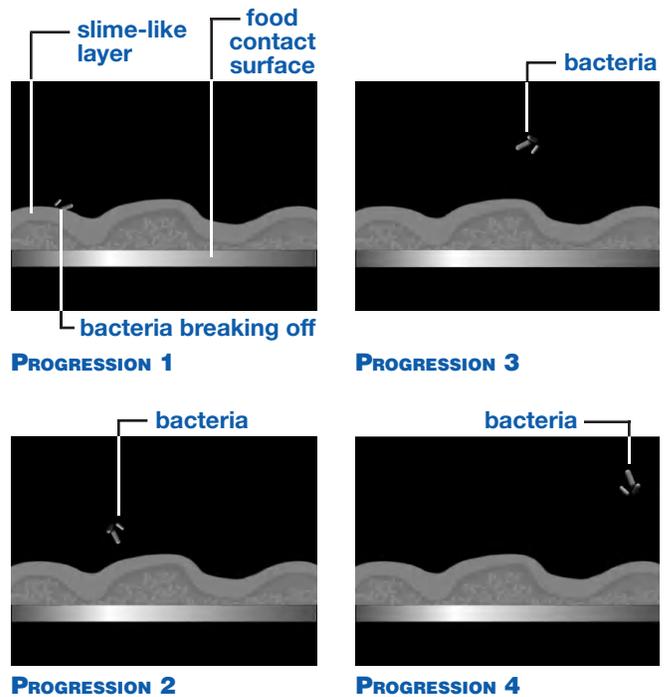
ASM BIOFILM COLLECTION: DONLAN & GIBBON

Biofilms can cling very tightly to surfaces, such as stainless steel, plastic, and wood, especially if in contact with food products for a long period of time. They also can be found inside equipment and on gaskets, food-contact surfaces, and hard-to-clean surfaces—basically in any “nook or cranny.”

Biofilms occur when a thin layer of food particles and bacteria build up on surfaces and a slime-like layer is formed, especially in hard-to-clean areas. Biofilms are so thin that they cannot be seen with the naked eye and can occur in places that appear to be completely clean.



The slime-like layer can prevent the organism from being detected, and it can prevent sanitizers from reaching the bacteria.



The danger from biofilms is that bacteria in them can break off and be transferred to food or food-contact surfaces.

Sanitation of Equipment in Three-Compartment Sink



Step 1a Three-compartment sink: warm, soapy water; clean rinse water; and sanitizing solution.



Step 1b Make sure sanitizing solution is at the proper temperature, concentration, and/or pH.



Step 2 Scrub equipment with warm, soapy water in the first compartment.



Step 3 Rinse equipment in clean rinse water in the second compartment to remove traces of detergent.

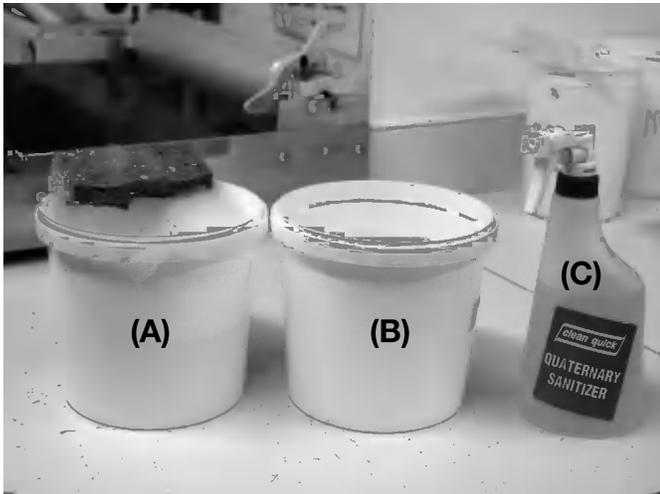


Step 4 Rinse equipment with sanitizing solution in the third compartment. Sanitizing solutions may include chlorine, iodine, or quaternary ammonium compounds.

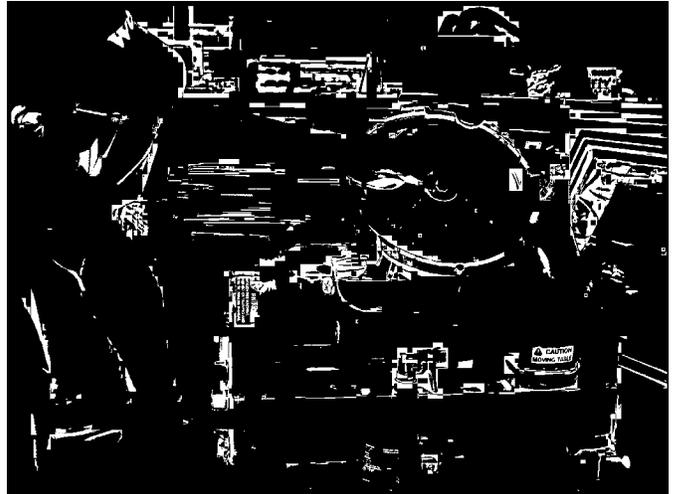


Step 5 Air-dry all equipment and utensils.

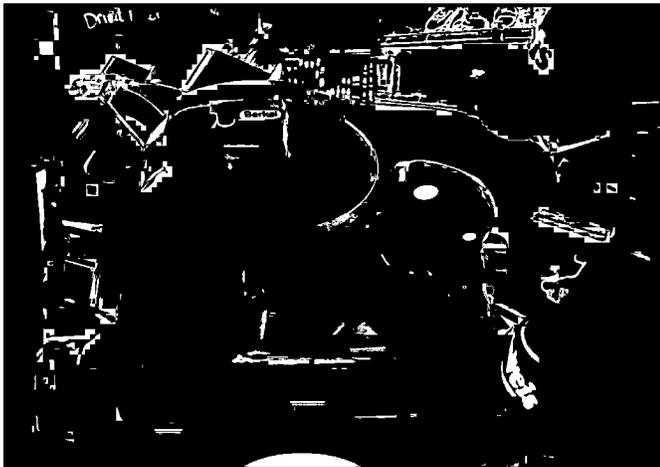
Sanitation of Clean-in-Place Equipment



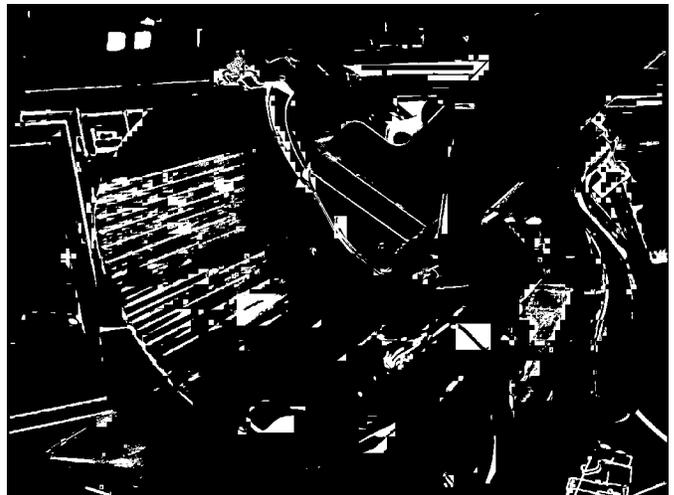
Step 1 Prepare bucket of warm, soapy water (A), a bucket of clean rinse water (B), and sanitizing solution (C). Follow directions on the product label for proper mixing.



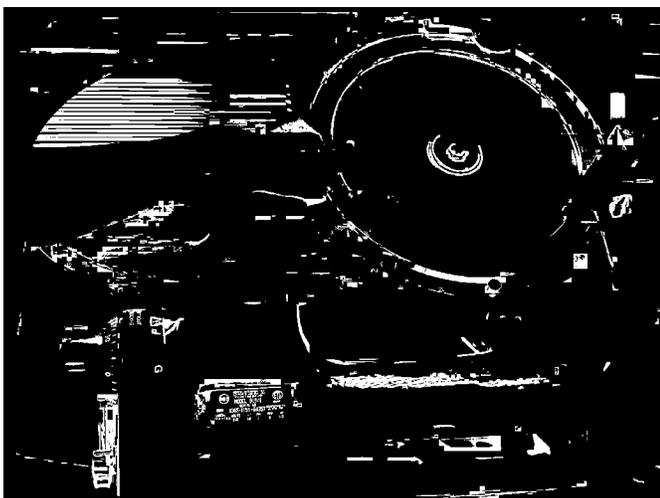
Step 4 Sanitize clean-in-place equipment with sanitizing solution from spray bottle. Sanitizing solutions may include chlorine, iodine, or quaternary ammonium compounds.



Step 2 Take equipment apart and scrub clean-in-place equipment with warm, soapy water.



Step 5 Clean-in-place equipment that has been properly cleaned and sanitized.



Step 3 Rinse clean-in-place equipment with clean rinse water to remove all traces of detergent.

Once proper sanitation materials are determined, it is critical to design a cleaning and sanitation schedule that assures the timely removal of food, organic matter, and possible bacterial contamination from both food-contact and non-food-contact surfaces. Consider the following recommendations:

- Clean and sanitize equipment and utensils that are in frequent contact with food at least every 4 hours (Figure 16).
- Make sure to develop a cleaning and sanitation schedule for the places that *Listeria monocytogenes* may hide such as drains; the inside of display cases including fans, grates, dividers, and other items inside the case; slicers; utensils; preparation surfaces; and packaging equipment.
- Train all employees on the appropriate times, methods, and records to keep for cleaning and sanitizing in RTE

Figure 16. Slicers and other equipment in frequent contact with food should be cleaned and sanitized at least every 4 hours. Cleaning will remove filth and residues and sanitizing will eliminate harmful levels of foodborne pathogens.



areas. Consider providing as much information to the employee to assure that cleaning and sanitizing is done in a proper and timely manner.

Implementing these controls will help to decrease the likelihood that *Listeria monocytogenes* enters, grows, and spreads within the retail environment.

Verification of Control Programs

Once systems are in place to control *Listeria monocytogenes*, verify that the systems are working.

Consider the following five verification strategies:

- record keeping
- regular examination of critical controls to maintain a safe environment
- third-party audits
- microbiological testing
- evaluating employee performance

Record Keeping

Keeping records of factors critical to the control of *Listeria monocytogenes* is important so that they can be reviewed to verify that

- jobs are completed and done correctly; and
- critical factors such as time and temperatures do not exceed critical limits.

In order to set up an effective record keeping system, consider

- developing a log book;
- training employees on when and how to complete logs (Figure 17); and
- maintaining logs as required.

Examples of record keeping can include:

- a receiving log in which receiving temperatures of product are recorded;
- time and temperature logs in which the temperatures of products are recorded during hot or cold holding; or
- sanitation logs in which days and times cleaning and sanitation jobs are completed.

Figure 17. Proper record keeping is an essential component in a *Listeria monocytogenes* control program. Employees need to be trained on proper record-keeping procedures.



Check records frequently to assure critical tasks are being done and to detect any trends that may allow for the contamination by or growth of *Listeria monocytogenes*.

Examination of Critical Controls

Another verification strategy is to regularly check those controls that are critical to reducing and eliminating *Listeria monocytogenes*. Listed below are some ways to examine critical controls:

- Review regulatory inspection reports to identify areas in which the establishment is doing well and areas where food safety strategies may need to be improved or need to be added.
- Visually observe critical tasks such as cleaning and sanitation procedures, equipment maintenance and operation, temperatures, the flow of food through the establishment, and checking of code dates.

- Regularly inspect records for any trends that show problems with the food safety system, such as malfunctioning equipment, incomplete or missed sanitation procedures, or other critical problems.

Consider Third-Party Audits

In addition to in-house audits, arrange for third-party or outside audits to evaluate if a food safety program is effective. The advantage of a third-party audit is that the outside auditor can give an unbiased opinion as to how the food safety program is working.

Consider Microbiological Testing

Experience in food processing facilities has shown that environmental microbiological testing is a good, cost-effective way to evaluate how well food safety systems are controlling the entry, spread, and growth of foodborne pathogens such as *Listeria monocytogenes*. Establishments may want to consider microbiological testing of the retail environment, food-contact surfaces, or even food products in the RTE areas of the retail establishment.

See Microbiological Testing Chart on page 20.

Consider conducting a preliminary set of tests for environmental or nonfood-contact surfaces and food-contact surfaces. After food safety systems are in place, establishments can conduct microbiological tests regularly and monitor the results to see how well the food safety program is working.

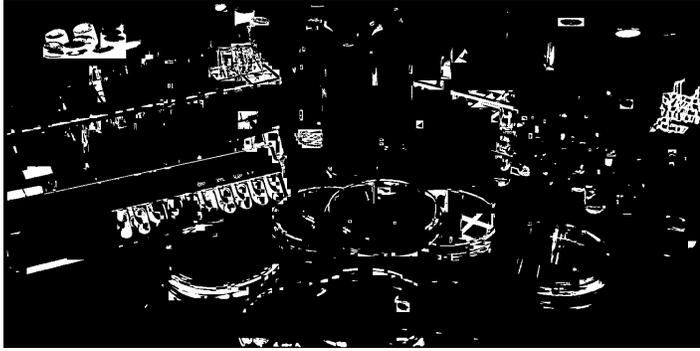
In order to keep costs for microbiological testing down, establishments may sample only for indicator organisms, such as total plate counts or even generic *Listeria*, rather than testing for the pathogen *Listeria monocytogenes*. If, for example, regular microbiological tests demonstrate a decrease in the prevalence of total plate counts, then it would suggest that the implemented food safety systems are working.

Evaluate Employee Performance

Because the safety of food is primarily dependent on employees, it is necessary to ensure that employees understand the control strategies and can perform them easily in their job responsibilities. When evaluating employees, supervisors should consider the following:

- Conduct regular in-house audits. Observe if employees are following the designated controls and good personal hygiene practices.
- If environmental testing indicates problem areas, work with employees to design control measures and assign tasks that will address the problem.
- Verify that employees are maintaining records, such as temperature charts, receiving records, or other important records. Employees should initial each entry they make on these records.

Microbiological Testing Chart



WHAT IS MICROBIOLOGICAL TESTING?

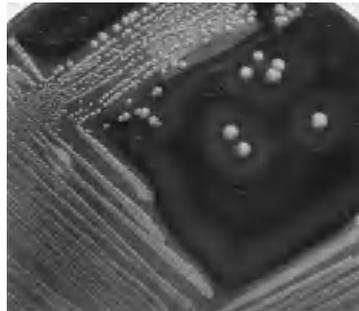
Samples from the environment, food, or food-contact surfaces are taken and then analyzed in a laboratory to determine types and levels of the microorganisms present in the sample.



WHICH AREAS SHOULD BE TESTED FOR MICROORGANISMS?

- Establishments can begin a testing program by sampling the retail environment. Possible testing areas could include floors, walls, drains, wheels on transport carts, vents, and air-handling units.
- If environmental testing indicates problem areas, it may be necessary to test food-contact surfaces such as food preparation surfaces, slicers, utensils, display cases and fans, packaging equipment, and other equipment located in the deli.
- Testing of food products may be necessary if food-contact surface testing indicates contamination.

Listeria monocytogenes ▶
grown on blood agar



WHICH TESTS SHOULD BE CONDUCTED FOR WHICH ORGANISMS?

In order to keep costs for microbiological testing down, establishments may only sample for indicator organisms, such as total plate counts or even generic *Listeria*, rather than testing for the pathogen *Listeria monocytogenes*. If, for example, microbiological tests demonstrate a decrease in the prevalence of total plate counts over time, then it would appear that the implemented food safety systems are working.

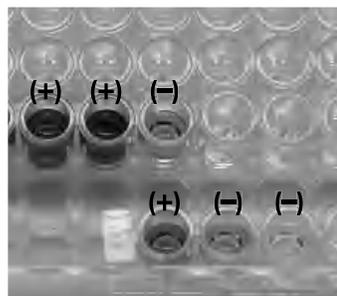


◀ Environmental sampling
with sterile cotton swabs

WHEN SHOULD MICROBIOLOGICAL TESTS BE CONDUCTED?

Consider collecting a preliminary set of tests for non-food-contact surfaces. After food safety systems are in place, establishments can conduct the tests regularly and compare the preliminary results to see how well the food safety program is working. If tests for non-food-contact surfaces show an increase in microbiological contamination, conducting further testing on food-contact surfaces and even food products may be necessary.

Antibody tests for *Listeria* spp. ▶
(+) = positive for *Listeria* spp.
(-) = negative for *Listeria* spp.



WHAT SHOULD BE DONE IF TESTS INDICATE POSSIBLE MICROBIAL CONTAMINATION?

If tests show an increase in indicator organisms or the presence of generic *Listeria*, step up cleaning and sanitizing procedures. In some cases, additional testing may be necessary to determine if *Listeria monocytogenes* is present. Establishments also will need to redesign food safety strategies, reevaluate critical factors such as cross-contamination, sanitation, and employee training to reduce and eliminate the microorganisms from those areas.

- Don't forget to encourage and reward employees for a job well done. Some examples of rewards programs can include:
 - monetary rewards or promotions for satisfactory implementation of food safety programs
 - recognition programs such as Food Safety Employee of the Month programs
 - if possible, offer paid time off or bonuses

The use of verification procedures is an essential element of an effective *Listeria monocytogenes* control program. Record keeping, inspections, audits, microbial testing, and evaluations of employee performance are essential for verification that the control measures are working effectively.

Maintaining a *Listeria monocytogenes* Control Program

While it is important to design and implement a *Listeria monocytogenes* control program for retail establishments, maintaining the program on a daily basis is crucial. The following are suggestions for maintaining an effective control program:

- **Maintain a record-keeping system** to record all important parts of the control program—information such as temperature logs, vendor receipts, and sanitation logs. Review these logs on a regular basis to identify any problems with the system.
- **Conduct internal and third-party audits** to determine if there is anything missing from the program. Having another outside opinion is important for food safety programs. Also talk with your local, state, or federal inspector to determine if there are any strategies that can help to maintain and improve your food safety system.
- **Dedicate a portion of employees' duties to maintaining the food safety system.** Having employees involved in creating, implementing, and maintaining the food safety program is necessary for the program's success. Consider allowing an employee to spend several hours each week acting as a food safety monitor. The employee could spend his/her time monitoring critical components of the program, talking to other employees to determine needed improvements to the program, and auditing the program to ensure that the program is working properly.

- **Consider routine microbiological testing** to monitor the effectiveness of the controls (Figure 18). If testing uncovers problem areas, work with the proper people to reduce or eliminate the problem. This approach may mean asking employees for more practical ways to carry out their food safety responsibilities, investigate different cleaning chemicals or processes with a sanitation vendor, or change food suppliers.
- **Have a recall plan ready** that details each step the establishment will take if pathogens, such as *Listeria monocytogenes*, are found. Carry out mock recalls periodically to see if the recall plan works effectively.

Figure 18. Microbiological testing can be used to evaluate how food safety systems are controlling entry, growth, and spread of foodborne pathogens such as *Listeria monocytogenes*. Microbiological testing also may uncover issues in sanitation and working habits of employees that may need to be addressed.



RECALL PLANS

A recall is a process by which food that has been identified by a manufacturer or government agency as adulterated or misbranded is removed from commerce to protect the public from potential foodborne illness. To develop a recall plan:

1. Form a recall team.
 - The membership of this team will vary depending on the size and type of retail establishment, but it may consist of corporate managers, store managers, quality assurance managers, logistics or receiving specialists, company attorneys, public relations personnel, accountants, scientific advisers, and/or administrative support.
 - All contact information (phone, e-mail, etc.) for the team should be written down and all members of the team should have a copy of the contact sheet.
2. Develop a recall plan.
 - Develop criteria for determining if/when a recall will occur.
 - Develop procedures to identify suspect products. This approach usually requires that establishments keep thorough records in order to identify and locate suspect products.
 - Develop procedures for removing suspect products from commerce.
 - Develop procedures for removing suspect products from the retail establishment.
 - Develop cleaning and sanitation procedures for areas potentially contaminated by suspect products.
3. Develop a communications strategy.
 - Develop sample press releases.
 - Assign a team member to act as a spokesperson.
 - Determine how the establishment will communicate the recall to its customers.
 - Determine how the establishment will answer consumer questions regarding the recall.
4. Consult the government agency (local, state, or federal) that inspects the retail establishment in order to determine what procedures or information they may require during a recall.
5. Develop procedures to monitor the recall, including development of a recall log book to record all actions taken during the recall.
6. Conduct mock recalls to test if the recall plan works. Take the following steps to carry out a mock recall:
 - Assemble the recall team.
 - Choose an item in the deli (for example, a chub of luncheon meat with a particular code).
 - Run through the recall plan to see if the developed procedures are operating successfully.
 - Record all actions taken during the mock recall to assess if the recall plan works as written.
 - Make changes to the plan if necessary.

In order for establishments to maintain an effective *Listeria monocytogenes* control program, it is important to remember to:

- revise programs if there are major process, product, structural, equipment, personnel, or vendor changes;
- provide regular ongoing training for employees with regard to equipment, sanitation, good personal hygiene practices, good retail practices, preventing cross-contamination, and record keeping.

To maintain a *Listeria monocytogenes* control program, a retail establishment should periodically revise and review the plan, especially when there is a change in the operations within the establishment. Regular reviews of record keeping, testing, training, and recall procedures will ensure that the control program is up to date and working properly.

Conclusion

Listeria monocytogenes should be considered a serious hazard in retail establishments. To protect customers and to protect the business, operators of retail establishments should implement a program to control *Listeria monocytogenes*. Understanding the sources of the pathogen and factors that contribute to the risk of contamination, growth and spread of the pathogen are important building blocks to an effective control program. The implementation of proper prevention and control measures, verification and monitoring procedures, and a maintenance program will help to ensure that *Listeria monocytogenes* does not contaminate your product. An effective control program is the best defense against this pathogen.

Glossary

Definitions

Biofilm—An invisible accumulation of bacteria, slime, and/or food on environmental or food-contact surfaces.

Clean—Free of visible soil.

Cross-contamination—Occurs when a hazard that causes foodborne illness is transferred from one surface to another, possibly contaminating otherwise safe food.

Food-contact surface—A surface of equipment or a utensil with which food normally comes into contact; or a surface of equipment or a utensil from which food may drain, drip, or splash either into a food or onto a surface normally in contact with food.

Foodborne illness—Illness caused by eating a food contaminated with a foodborne pathogen or its toxin.

Foodborne outbreak—Two or more cases of a similar illness resulting from eating a common food.

Food processing plant—A commercial operation that manufactures, packages, labels, or stores food for human consumption and does not provide food directly to a consumer.

Harborage site—A location in the environment where microorganisms can live or multiply. These locations may be difficult to clean.

Hazard—A biological, chemical, or physical property that may cause an unacceptable consumer health risk.

Microorganism—A living organism that cannot be seen by the naked eye; different types of microorganisms include bacteria, viruses, parasites, fungi, and mold. *Listeria monocytogenes* is a bacterium.

Pathogen—A microorganism that is capable of causing illness. A person cannot see, smell, or taste pathogenic microorganisms. *Listeria monocytogenes* is a foodborne pathogen.

Reservoir—An object or area where harmful microorganisms can live and grow.

RTE (ready-to-eat) foods—Food that is served to a consumer without any further processing or cook step to eliminate foodborne pathogens. Examples of RTE deli products can include luncheon meats and cheeses, deli salads, fresh fruit and vegetables, sandwiches, items from salad bar, and rotisserie chicken.

Sanitize—To make a surface free from harmful levels of foodborne pathogens.

Temperature danger zone—Range of temperature (41–135°F) in which bacterial pathogens can grow in foods, given sufficient time.

Resources

Food Safety Contacts for Pennsylvania Retail Establishments

Federal Government Agencies

<http://www.foodsafety.gov/~fsg/fsggov.html>

United States Department of Agriculture, Food Safety and Inspection Service

<http://www.fsis.usda.gov/>

<http://www.fsis.usda.gov/Businesses/index.asp>

State Government Agencies

Pennsylvania Department of Agriculture, Bureau of Food Safety and Laboratory Services

<http://www.agriculture.state.pa.us/agriculture/site/default.asp>

717-787-4315

Pennsylvania Department of Health

<http://www.dsf.health.state.pa.us/health/site/default.asp>

717-787-6436

Other State and Local Agencies

<http://www.statelocalgov.net/index.cfm>

Regulations and Guidelines

Food and Drug Administration Food Code

<http://www.cfsan.fda.gov/~dms/foodcode.html>

Pennsylvania Food Code

http://www.agriculture.state.pa.us/agriculture/lib/agriculture/legalreference/007_0046.pdf

Other State Food Safety Regulations

<http://www.nasda-hq.org/nasda/nasda/Foundation/food-safety/index.html>

Record-Keeping Forms

<http://peaches.nal.usda.gov/FSTEA/resources/tooltime/forms.asp>

United States Department of Agriculture, Food Safety and Inspection Service Regulations and Policies

http://www.fsis.usda.gov/Regulations_&Policies/Regulations_Directives_&Notices/index.asp

Recalls

Association of Food and Drug Officials Food Recall Manual

<http://www.afdo.org/afdo/upload/FoodRecallManual11-09-2004.pdf>

List of Recalled Food Products

<http://www.recalls.gov/food.html>

United States Department of Agriculture, Food Safety and Inspection Service

http://www.fsis.usda.gov/Fsis_Recalls/index.asp

Microbiology/*Listeria monocytogenes*

Listeria monocytogenes

United States Department of Agriculture, Food Safety and Inspection Service

http://www.fsis.usda.gov/fact_sheets/listeria_monocytogenes/index.asp

Microbiological Testing

<http://www.foodhaccp.com/>

Small and Very Small Plant Outreach

United States Department of Agriculture, Food Safety and Inspection Service Workshop: Control of *Listeria monocytogenes* in Ready-to-Eat Meat and Poultry Products

http://www.fsis.usda.gov/Science/Workshop_SmallPlants_Lm/index.asp

Food Safety Web Sites

Penn State Food Safety Web Site

<http://foodsafety.cas.psu.edu/>

FDA Retail Food Protection

<http://www.cfsan.fda.gov/~ear/retail.html>

Gateway to Government Food Safety Information

<http://www.foodsafety.gov/>

Food Safety Training and Education Alliance

<http://www.fstea.org/>

USDA/FDA Foodborne Illness Education Information Center

<http://www.nal.usda.gov/fnic/foodborne/index.html>

The Bad Bug Book

<http://vm.cfsan.fda.gov/~mow/intro.html>

Food Safety Educational Tools

Food Safety Posters and Brochures

Author: Penn State

Summary: Four food safety posters that emphasize the importance of handwashing, preventing cross-contamination, controlling food temperatures, and cooling foods quickly

UK061 Food Safety Poster: Wash Hands After . . . (2000)

UK062 Food Safety Poster: Prevent Cross-Contamination (2000)

UK063 Food Safety Poster: Control Food Temperatures (2000)

UK064 Food Safety Poster: Cool Foods Quickly (2000)

Cost: Free

Ordering information:

Penn State College of Agricultural Sciences Publications Distribution Center

Telephone: 814-865-6713

Fax: 814-863-5560

Signs, Fact Sheets, Brochures, Logs, and Checklists

<http://www.fstea.org/resources/tools.html>

Training Manuals and Programs Online

<http://peaches.nal.usda.gov/FSTEA/resources/tooltime/manuals.asp>

Graphics and Clip Art

<http://peaches.nal.usda.gov/foodborne/fbindex/Graphics.asp>

Slide Shows and Videos on the Web

http://peaches.nal.usda.gov/foodborne/fbindex/Slides_Videos.asp

Multilingual Resources

<http://peaches.nal.usda.gov/FSTEA/resources/multilingual.asp>

Additional Training Resources

<http://www.fstea.org/resources/tooltime/moreresources.html>

Food Marketing Institute. 2006. Guidance for the control of *Listeria monocytogenes* risks in retail food stores.

http://www.fmi.org/forms/store/ProductFormPublic/search?action=1&Product_productNumber=2137

Food Safety Education

United States Department of Agriculture, Food Safety and Inspection Service

http://www.fsis.usda.gov/Food_Safety_Education/index.asp



Prepared by Catherine Cutter, associate professor and food safety extension specialist, and Dana McElroy and Stephanie Penn, food safety extension associates.

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Scanning electron micrograph of the bacterium *Listeria monocytogenes* used in Figure 1 and on front and back covers copyrighted by Dennis Kunkel Microscopy, Inc.

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