

# *Listeria monocytogenes* in Ready-to-Eat Foods

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December 2023

# Outline

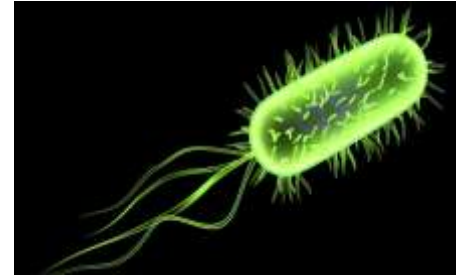
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- About *Listeria monocytogenes*
  - The organism
  - Illness
  - Epidemiology
- Standards and controls
- Outbreak case studies
- Specific lessons for control

# The Organism

# *Listeria monocytogenes*

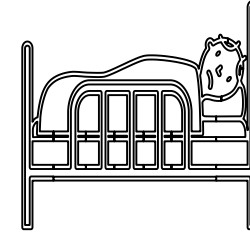
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- Ubiquitous organism
- Can survive and grow at low temperatures
- Difficult to eliminate from food processing environments
  - Niches and resistance to (sub-lethal concentrations) disinfectants
- May form biofilms
- Intracellular pathogen affecting a range of mammals including humans

# Listeriosis infection

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- Mild flu-like symptoms
- Gastroenteritis
  - Vomiting/diarrhoea
  - Usually self-limiting but can progress to bacteraemia
- Infection during pregnancy
  - Neonatal infection – abortion, stillbirth, premature delivery
- Invasive listeriosis
  - Infection of immuno-compromised and/or elderly
  - Severe – bacteraemia and meningitis
  - High mortality rate; average 20%, higher in some sub-groups

# Epidemiology

# Listeriosis epidemiology

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- Evidence for increased rates, particularly outbreaks, globally
- Responsible for 19% of known causes of foodborne-related deaths in United States
  - 90% of those affected in vulnerable groups; 20% mortality
  - In 2023, 21% US population over 65 years and growing
- In France, disease incidence studies show over 70% cases in persons with underlying diseases such as liver disease, cancer and diabetes
  - Account for 43% of cases and 55% of deaths
  - 65% had an underlying disease; 41% had immunosuppressive therapy
  - Highest rates seen in some blood cancers, solid tumours
- 17% of cases pregnancy-related, an annual rate of 5.6 cases per 100,000 population

# Invasive Listeriosis surveillance in Australia

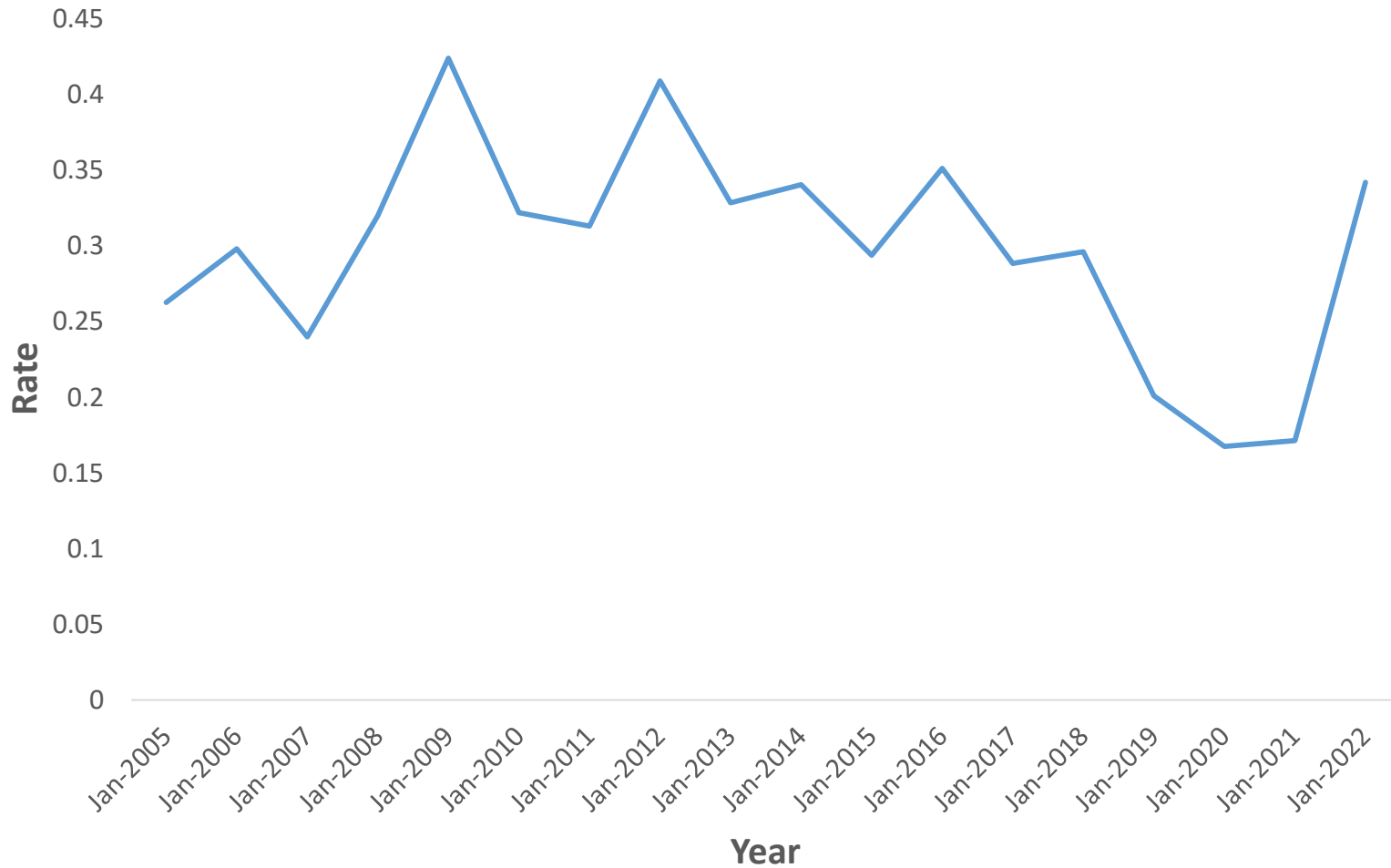
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- Generally sporadic illness with an average of 70 – 80 cases per year (0.3 cases per 100,000 population)
  - Worldwide ranges from 0.1% to 1%
- Case definition
- National surveillance plan
- Laboratory testing of *Listeria monocytogenes*
  - Mostly now whole genome sequencing (WGS)
  - WGS brings greater capacity to detect common source outbreaks and understand spread in environment



# Listeriosis in Australia 2005 – 2022

Listeriosis case rate per 100,000 population

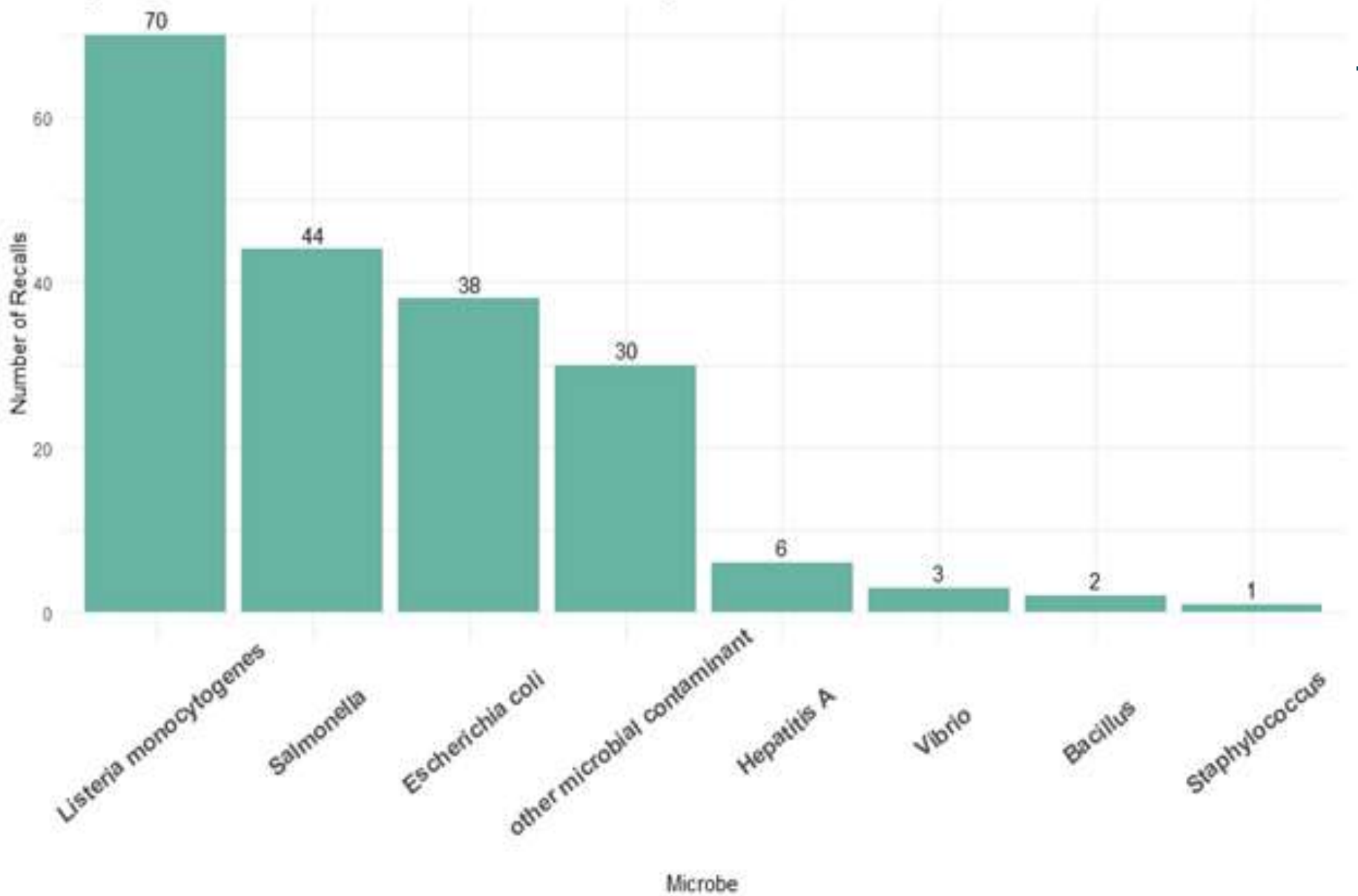


# Contamination of foods with *Listeria*

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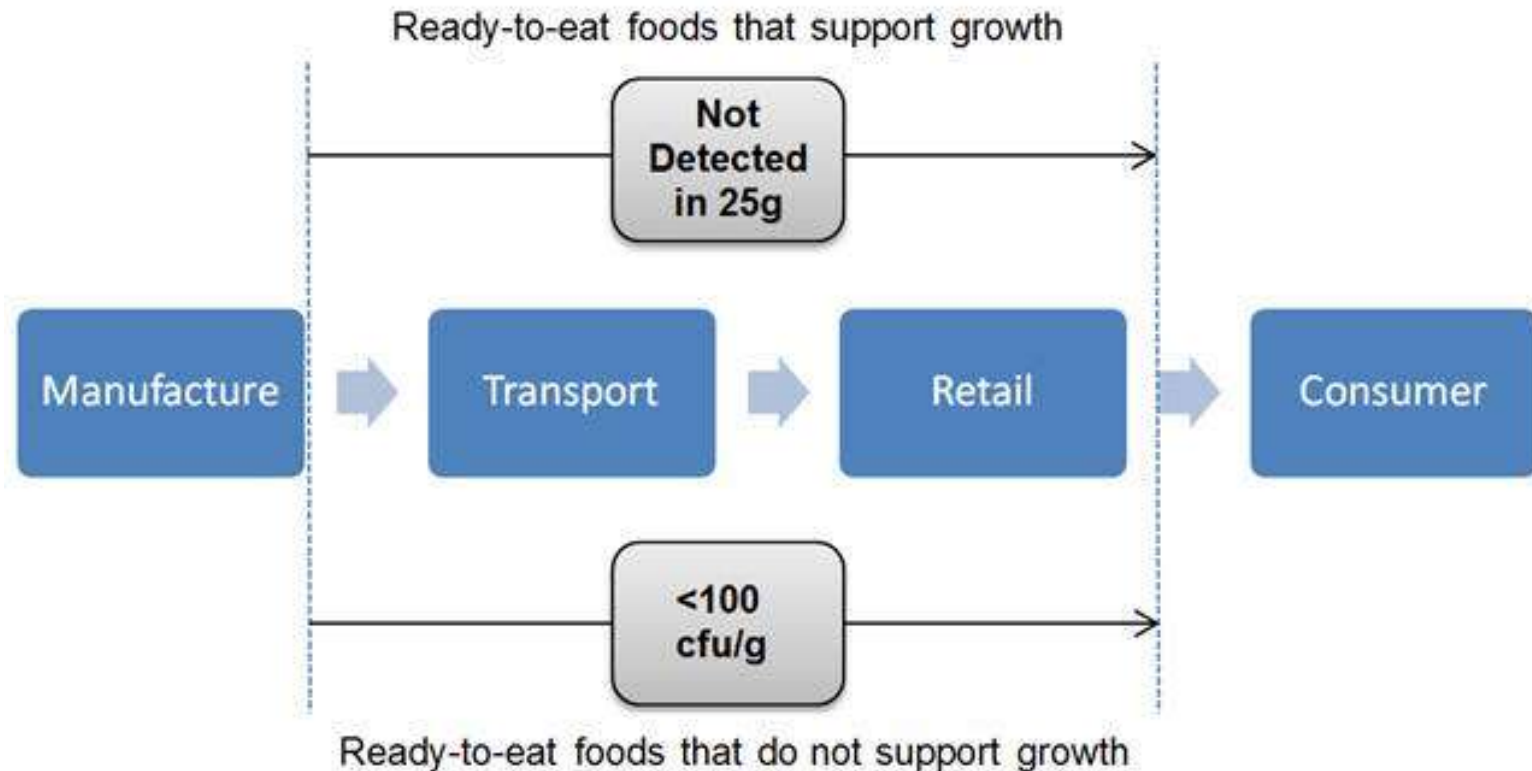
- Relatively low prevalence in most products ~1.5%
- Low levels detected in most surveys
  - Higher rates in targeted investigative surveillance
- Greater problem in products that support the growth of the organism
  - Typically, cold RTE meats, RTE seafood, soft cheese, fruit salad
  - Emerging vehicles – sprouts, rock melons, apples, frozen berries/vegetables
  - pH and water activity of the product
  - Shelf life
- Moist processing environments
- High risk operations such as slicing, dicing, shredding can lead to sporadic contamination – difficult to detect through end-product testing

Figure 7. Food recalls due to microbial contamination by microbe 2013-2022



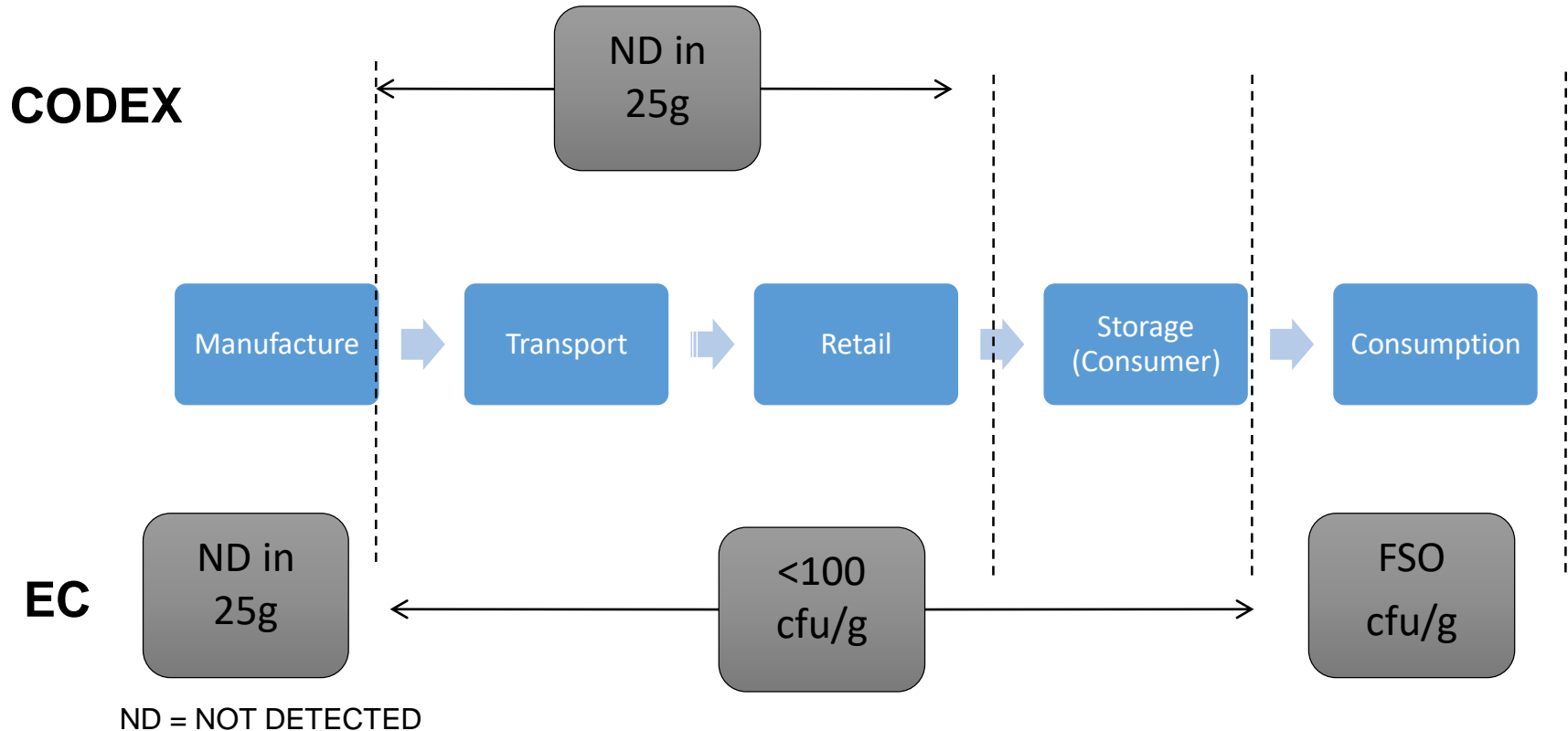
# Standards and Controls

# LM criteria – Australia/NZ Food Standards Code



# RTE products that support growth of LM

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# Risk assessment for LM Standard

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- Relying on international risk assessments
  - Most listeriosis due to high contamination
  - Potential for growth strongly influences risk
  - A limit of 100 CFU/g in non-growth foods with good compliance not predicted to affect disease rate

# Foods where *Listeria* tolerance may apply

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- For a food to be truly considered as not allowing the growth of *Listeria monocytogenes*, it would have to be:
  - held below  $-1^{\circ}\text{C}$ ; or
  - have a pH less than 4.5; or
  - a water activity of 0.92; or
  - be demonstrated through reliable scientific evidence:
    - challenge tests
    - changed formulations to inhibit growth
    - organic acids or other chemicals that exhibit inhibitory activity (e.g. nisin)
    - predictive modelling

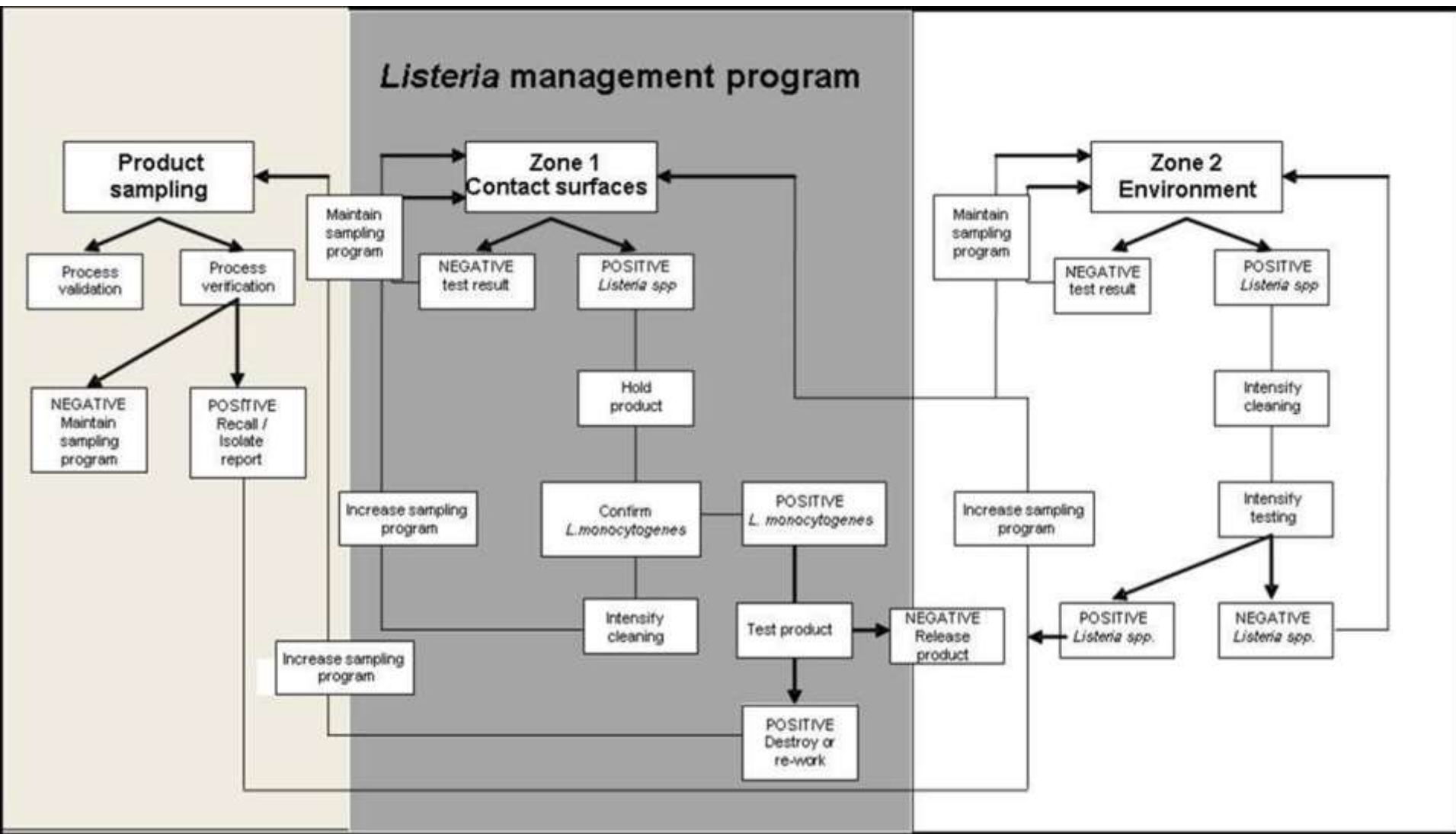


# Listeria Control

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- Control of Listeria will only be achieved through integrated and preventative food safety programs
  - HACCP plan
  - Prevent Listeria contamination of food product
  - Include many elements such as good process design, ongoing monitoring, effective cleaning and sanitation
  - Good culture within food manufacturer/business
- Compliance with Standard
  - Definition of “ready-to-eat”
  - Establishing whether a food can or cannot support growth – international guidance available
  - Analytical methods, including quantification
- Awareness and education of consumers
  - Aimed at vulnerable subgroups
  - Needs to be continually updated due to changing epidemiology

# Environmental monitoring program - 'seek and destroy'

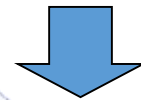
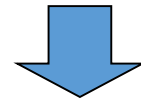


# Outbreak Case Studies

# Listeriosis Outbreak 1

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- Business A in NSW produced cooked chicken – diced and subject to post-cook “pasteurisation” in bag
- Supplied to Business B in QLD who made chicken wraps
- Supplied chicken wraps to catering companies, including company that supplied to airlines and conferences



# Investigation

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- Inspection of Business A premises
  - 5/16 environmental swabs from different areas of the premises positive for *Listeria* species
  - Sliced chicken products
    - 9/15 positive for *Listeria innocua*
    - 1/15 not detected
    - 5/15 positive for *Listeria monocytogenes*
  - Diced chicken products
    - 2/20 positive for *Listeria innocua*
    - 14/20 positive for *Listeria monocytogenes* at levels up to **2,600 cfu/g, 3,700 cfu/g and 73,000 cfu/g**, respectively

➔ Prohibition order placed on Business A

# 36 Outbreak-Associated Cases

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- 13 cases of invasive listeriosis
  - 8/13 pregnant women – 3 foetal deaths
  - 8 cases reported consumption of chicken wraps on national airline
- 23 cases with gastroenteritis symptoms
  - 17 cases reported consumption of chicken wraps on national airline
  - 6 cases reported consumption of chicken wraps at conference
- Investigations found issues around:
  - Environmental contamination
  - Product flow
  - Cooking controls
  - Temperature controls, cooling of product

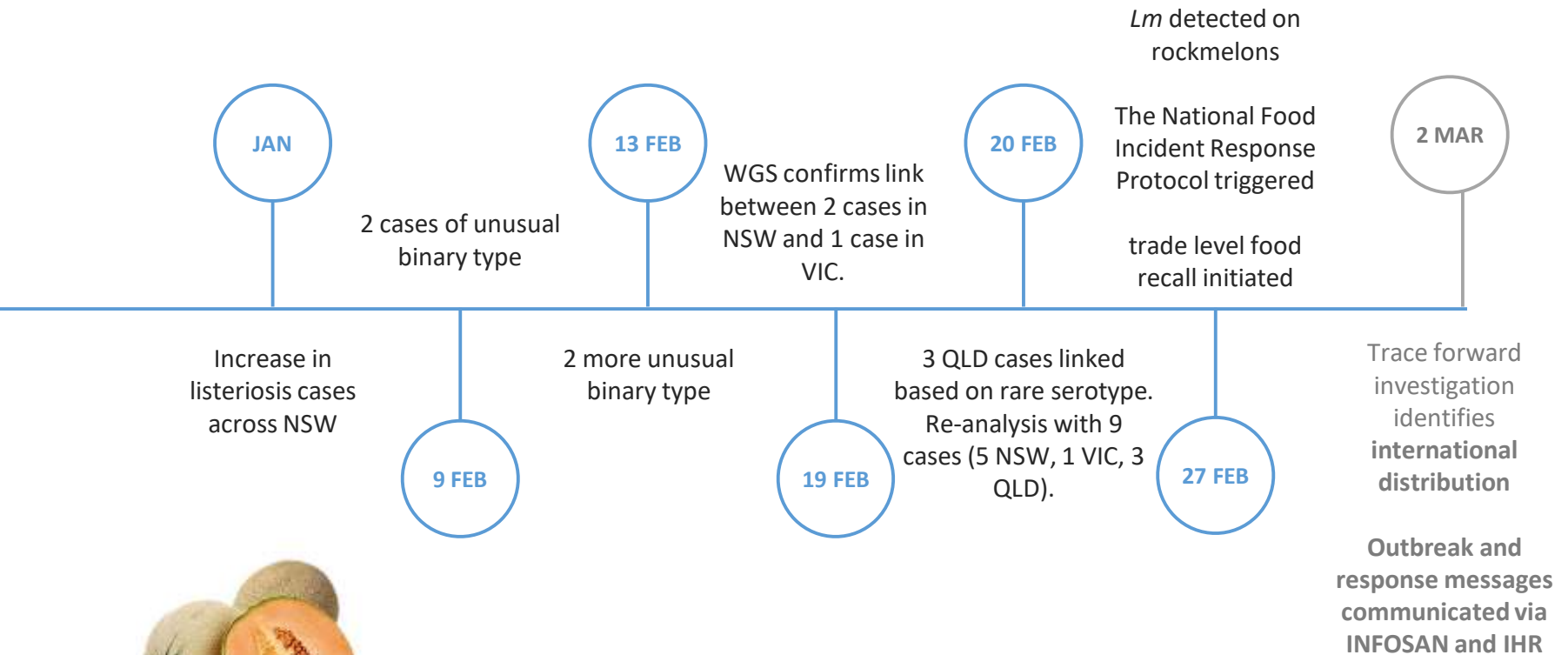
# Listeriosis Outbreak 2

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Listeriosis associated with rockmelon  
(cantaloupe)



# Food Incident Timeline





# Environmental investigation

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## Rockmelons identified as a common food item during epi investigation

- One predominant grower in NSW identified based on traceback, supply chain analysis, and other evidence
- Affected business voluntarily ceased production as further evidence gathered
- WGS of listeriosis cases eventually showed NSW increase linked to 3 separate clusters, with one cluster linked to cases interstate
- Environmental analysis confirmed *L. monocytogenes* on NSW grower from product tested at wholesale level (boxed), outbreak WGS on a rockmelon tested in Victoria (a different state)
- **Response:**
  - Recall and media release
  - Ongoing education for growers and consumers at risk of listeriosis

**Timeline: 2-3 weeks from epi investigation to risk management action**

# Environmental investigation

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## Rockmelon production investigation – Issues

- No major issues found with hygiene nor sanitation practices of the packing facility and farming operations

### **Adverse weather events (heavy rainfall prior to harvest, followed by dust storms)**

- Netted skin of rockmelons makes this fruit particularly hard to clean and sanitise
- Potential for very low levels of *L. monocytogenes* but these levels still resulted in illness when rockmelons were consumed by immunocompromised individuals

***• This outbreak highlights the need for improved control measures and awareness of external threats to food safety in the rockmelon industry (such as adverse environmental conditions) and possible impacts on the efficacy of established control measures and sanitising of fruit***

# Investigation Summary

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- 22 human cases of listeriosis in Australia January – April 2018
- Strain of *Listeria monocytogenes* causing infections related by whole genome sequencing (phylogenetic analysis) to isolates recovered from rockmelons sourced from Farm and environment of Farm
- Testing information, combined with epidemiological analysis, purchase history and product trace back, indicated rockmelon produced at Farm was source of infection

# Response

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## **Improved control measures and awareness of external threats to food safety in the rockmelon industry:**

- Industry education:
  - Corrective action by affected grower
  - Training provided for rockmelon growers in affected state
    - face-to-face workshops
    - provision of individual on-site food safety advice
    - best practice food safety guide developed for growers covering all aspects of farm management and washing and packing of melons
- Food Standards Australia New Zealand asked to review potential regulatory and non-regulatory measures to improve rockmelon food safety
  - Now a primary product standard for melons
- Targeted consumer education and awareness campaign

# Lessons around Control

# Lessons to be learnt – food safety program

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- A food safety program isn't just a piece of paper to impress the auditor – it is the tool to prevent product from becoming contaminated and causing an outbreak
- Design product flow to minimise potential for cross contamination
- Be prepared – do environmental testing to trace the organism to see if (or where) it is in the factory environment and act when positives are found
  - New Zealand seafood production example of pulling up and replacing factory floor to remove source of contamination

# Lessons - process control

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- Sliced, diced and shredded meat and poultry products continue to be over-represented in the recall and food poisoning outbreak statistics
- Contamination during handling by slicing/dicing/shredding of the RTE meat and poultry products is a large risk factor
  - Implement a comprehensive Food safety program
  - Maintain hygiene and sanitation standards (verify cleaning)
  - Ensure food handlers have skills and knowledge
  - Maintain records of RTE meat and poultry processing
  - Comply with Listeria Management Program

# Lessons – skills and knowledge

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- Ensure staff understand the *Listeria Management Program*
- Ensure staff have the skills and knowledge to recognise that if processes are changed, flow on effects can occur
- When changing a process – ALWAYS check the food safety implications!
  
- Learn to recognise the warning signs!
  - Repeated detections of *Listeria* in environmental samples
  - Take swift, effective action on environmental positives
  - Monitor trends



# Lessons – cooking temperatures

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- Initial cooking temperatures for RTE products to ensure a 6D reduction in *Listeria*
- Very high levels in product suggests multiple processing failures leading to survival and growth of the organism in the product
  - Insufficient temperatures reached while cooking
  - High contamination load
  - Improper cooling
  - Temperature abuse
  - All the above



# Lessons - cleaning and sanitation

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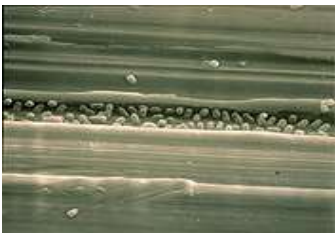
- Cleaning and sanitation of equipment vitally important for small, medium and large manufacturers
- Particular attention to cleaning & sanitation programs (don't cut corners)
- Control must be directed at preventing establishment and growth and keeping the organism off food contact surfaces - elimination of niches
- Pay particular attention to meat slicing equipment: these should be disassembled and aggressively cleaned and sanitised, including internal parts, on a regular basis

# Equipment Design

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- Install equipment that is easy to clean
- Avoidance of poor seals, cracks, crevices, poor welds, hollow tubes, dead spaces – allow biofilm formation
- Equipment must be accessible to cleaning, or be able to be dismantled for cleaning and sanitation
  - Slicers, dicers etc
- Cover insulation and lagging
  - Prevent getting wet



# Summary

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- High impact of listeriosis globally
- Continuing issues around Lm control
  - Standards on own will not fix problems
  - Need to ensure correct processing and minimise environmental contamination
  - Effectively implement food safety programs
  - Actively anticipate and respond to Listeria contamination issues
  - External contamination threats to primary products
- At risk populations an issue
  - Increasing number of aged population with co-morbidities
  - Exposure to high numbers of Lm still occurring
  - Random testing of products on market will not detect issues
  - Continued and revised consumer education needed due to new and novel food vehicles