# Final report

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# Listeria monocytogenes in ready-to eat meat products: Risks and management

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# Preface

This publication is the result of a project conducted for Meat & Livestock Australia by the University of Tasmania (project number PRMS.012). The complete project report is a comprehensive (over 300 pages) quantitative risk assessment conforming to international norms for risk assessment as defined by the Codex Alimentarius Commission. The full report may be cited as:

T.Ross, S. Rasmussen, J. Sumner, G. Paoli and A. Fazil (2004) Listeria monocytogenes in Australian processed meat products: *risks and their management. Unpublished report for Meat & Livestock Australia.*

This interpretive summary owes much to a summary document prepared by Dr. T. Ross for industry and discussed by an MLA expert panel during the course of the risk assessment.

This report was prepared by MLA.

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# Introduction

## About this risk assessment

Risk assessment of food is defined as "a process to scientifically evaluate the probability of occurrence and severity of known or potential adverse health effects resulting from human exposure to food-borne hazards".

There are basically two types of risk assessment – qualitative and quantitative. Qualitative risk assessments estimate the risk of illness or death from a particular hazard as Low, Medium or High. Quantitative Risk Assessments (QRAs) give numerical estimates of risk e.g. the hazard is likely to cause one death from every one billion servings. To give a realistic estimate QRAs require a tremendous amount of data gathering. Then the data need skilful handling by risk modellers plus inputs from industry experts.

Risk assessment is a team exercise which requires significant resources. The USA assessment team which delivered the QRA of *L. monocytogenes* in ready-to-eat foods, for example, lists more than 20 people, arranged in four teams and worked for more than four years.

While the present QRA of *L. monocytogenes* in processed meats had a much leaner team, all the major authors are members of the FAO/WHO roster of experts on risk assessment and on the team which drafted the FAO/WHO risk assessment on *L. monocytogenes* in RTE foods. The FAO/WHO and the Australian processed meats risk assessments overlapped and the latter benefited greatly from the work which the international team did for FAO/WHO. As well, the team received great input from the smallgoods industry which provided information on products, processes and contamination with *L. monocytogenes*.

The present QRA is therefore a state-of-the-art tool to help all stakeholders to understand:

- The risk of listeriosis from certain smallgoods
- Where the risks come from
- What can be done to reduce them

Properly used, QRAs can be used to measure industry improvement and it will be a straightforward task to follow the risk reduction strategies modelled in the present assessment.

This summary of the QRA is in three parts:

Part 1: Listeriosis and our exposure to it
Part 2: Estimates of the risk of contracting listeriosis from RTE meats
Part 3: Estimates of risk reductions strategies

# Part 1: Listeriosis and our exposure to it

## *Listeria monocytogenes*: the hazard and our exposure to it

Listeriosis is caused by *L. monocytogenes*. In Australia there are around 60 cases of listeriosis reported each year and probably an equal number go unreported. It is likely that some of those cases are due to ready-to-eat processed meat. There have been many serious outbreaks of listeriosis in recent years. Those involving processed meats are presented in Appendix 1 and include two outbreaks in Australia. Other RTE foods which have caused listeriosis in Australia include smoked sea foods, fermented dairy products, fruits and vegetables.

Listeriosis is not a common disease but, because it leads to death in 20-30% of the people who get it, is one of the most serious food borne diseases. One way to measure the burden imposed by a disease is to calculate how much "healthy" life is lost due to sickness or, in extreme cases, death. One measure is called Disability Adjusted Life Years (DALY) where one DALY is one year of lost healthy life. *Listeria* is highly ranked third behind *Campylobacter* and *Salmonella* as a cause of food-borne disease because of its high death rate and because of the abortions and deaths of new babies that listeriosis often causes.

> Listeriosis is not a common disease, but it has serious impact. The burden of the disease is high because of the high death rate, particularly abortions and deaths of foetuses and newborn babies

## How many *L. monocytogenes* does it take to make people sick?

There is no simple answer to this question. It's been estimated that a normal, healthy, adult can consume millions of *L. monocytogenes* in a meal without getting listeriosis. But some people - such as the very young, very old, pregnant and people whose immune systems are reduced (e.g. from AIDS, chemotherapy, organ transplants) - are much more likely to get listeriosis than others.

> Some people with particular medical conditions are much more likely to get sick from L. monocytogenes than other people.

You can read about Listeriosis and its occurrence in Australia in more detail in Appendix 1 of this report.

## Exposure to *L. monocytogenes*

When we talk about being exposed to *L. monocytogenes* it means the number of times that someone eats processed meats that have some of the bacterium in them and how many of the pathogen they end up eating.

If we're doing a risk assessment we need to know:

- How many times we eat RTE meats
- How often those products are contaminated with *L. monocytogenes*
- The actual number of *L. monocytogenes* we eat – this is a combination of the level of contamination and the size of the meal serving.

# Smallgoods production in Australia

The researchers used a number of surveys to estimate the volume of smallgoods consumed in Australia. The total, around 400,000t per year, includes products that will be cooked such as sausages and bacon as well as RTE products such as luncheon meats, pâtés, ham and salami. Only RTE products are a potential risk and about 263,000t of this category are manufactured each year (*Table 1*).

> Many studies have shown that *L. monocytogenes* can grow in cooked meat emulsions such as frankfurters, saveloys and cocktail sausage but cannot grow in salamis, slow-cured meats (e.g. prosciutto) and dried meats (e.g. biltong, jerky). In fact, *Listeria* germs die off slowly in some of the latter group of products. Not all smallgoods pose a risk of listeriosis to consumers

**Table 1: Estimated Volumes of Australian RTE products**

| Product type | Volume (t) |
|---|---|
| Ham – whole muscle and manufactured | 104,000 |
| Cooed sausages to be reheated | 42,000 |
| Deli meats and luncheon meats | 90,500 |
| *Pâté*s and terrines | 8,400 |
| Salami | 28,600 |
| Total | 263,500 |

# Contamination rates in Australian smallgoods

## *Contamination at the plant level*

The researchers obtained a large volume of information from two sources about the frequency with which RTE meats were contaminated by *L. monocytogenes*: testing carried out by government laboratories and by individual manufacturers. In all, more than 5,000 tests were carried out between 1997 and 2003 and give an estimate of the rate of contamination at the production stages.

Over this seven-year period, the prevalence of *L. monocytogenes* in RTE meats fell, reflecting implementation of food safety plans within the smallgoods industry. The mean prevalence over the period 1997-2003 is presented in *Table 2*.

**Table 2: Mean prevalence of RTE meats contaminated with *L. monocytogenes* over the period 1997-2003**

| Product type | Prevalence (%) |
|---|---|
| Luncheon and deli meats | 4.77 |
| *Pâté* | 1.20 |
| Cooked sausages | 2.8 |

## *Contamination at the retail level*

While contamination levels of Australian smallgoods at production are generally low the proportion of smallgoods contaminated with detectable levels of *L. monocytogenes* increases during storage and retailing when around 15% of the product is found to be contaminated with the pathogen. Of those products that are contaminated, about 1% contains levels of *L. monocytogenes* that are considered dangerous to susceptible consumers.

Part of this increase is because the bacterium grows in RTE meats during their shelf-life, even during proper storage, while some of the increase is due to contamination in retail stores.

# How do RTE meats become contaminated with *L. monocytogenes*?

Most cooking processes kill *L. monocytogenes*. Australian smallgoods manufacturers use what they call a 6D process to kill germs in their products which means that for every million *L. monocytogenes* germs in the product before cooking, there might be one left afterwards. Since the process is measured at the slowest heating point of the product, most of it will receive a process many times more lethal than 6D.

> Cooking is a Critical Control Point for *L. monocytogenes*

## *Post-processing contamination*

Studies have shown sliced products are much more likely to be contaminated than unsliced products indicating that *L. monocytogenes* enters the product *after* processing. *L. monocytogenes* is able to colonise factories, particularly in cool, wet areas and, if those areas also contain food particles, the pathogen will grow and multiply.

Sites of colonisation include hard to clean equipment such as slicers and packing machines, hollow rollers on production lines, rubber seals on cool room doors and floor drains. *L. monocytogenes* can move through a factory making plant layout and work practices vital to prevent potential for cross-contamination to post-cooking areas.

> *L. monocytogenes* contamination of cooked products is almost always caused by recontamination after processing.

## *Contamination at Retail*

Studies of Australian butcher shops showed that approximately 5% of surfaces and equipment that could come into contact with meat, including processed meats, were contaminated with *L. monocytogenes*. A similar study in UK found that 13% of retail meat slicers were contaminated with the pathogen and an Australian study showed cross contamination to RTE meats from cutting utensils and boards used for raw meat. In a NSW study of a supermarket delicatessen linked to an outbreak, *L. monocytogenes* was found in the ice-making machine, in ice used in a display, and on some unpackaged foods, including bulk pâtés.

These reports illustrate how contamination increases between production and retail. However, contamination at retail may pose less risk to the consumer because of the shorter time between the contamination and consumption.

# Shelf-life and the growth of *L. monocytogenes*

Because *L. monocytogenes* can grow during refrigerated storage there is no Critical Control Point (CCP) for it when RTE meats are transported, retailed and stored in the home fridge. Like all bacteria, when *L. monocytogenes* grows it does it by splitting into two and doubling its numbers. At 4°C in a typical cooked meat emulsion product *L. monocytogenes* will double in number every couple of days so, during a week of storage their numbers will increase 10-fold. Over a second week of storage there will be another ten-fold increase making the number 100x greater than at the start of the storage period. After 8 weeks of storage, even at proper refrigeration temperature, the increase in risk could be as much as ten million times.

> The time RTE meats are stored increases the risk of listeriosis.

The researchers carried out surveys in Melbourne and Hobart to estimate shelf-lives used by Australian manufacturers of RTE meats and also to determine the shelf life remaining on processed meats at their time of purchase. The surveys involved visits to retail outlets and examination of the labelling on the processed meats in stock. Almost all products included a use-by date on the package from which it was possible to estimate the shelf life remaining had the product been purchased on the day of the survey. Many labels also included date of manufacture information from which the researchers determined the nominal shelf life of the product specified by the manufacturer. This was calculated from the difference between date of manufacture and use-by date. A wide diversity of retail outlets and product types was visited and, in all, more than 500 shelf lives were determined for:

- Delicatessen meats (hams, luncheon meats, etc)
- Pâté
- Cooked RTE sausages (saveloys, frankfurters, viennas etc)

Typical shelf lives of Australian processed meat products are shown in *Table 3* and are in the range of 6-8 weeks for hams, luncheon meats and cooked sausages; pâtés have significantly longer shelf-lives.

**Table 3: Shelf-lives (days) of some Australian RTE meats**

| | Deli Meats | Pâtés | Cooked sausages |
|---|---|---|---|
| Minimum | 22 | 30 | 29 |
| Maximum | 119 | 184 | 78 |
| Mean | 63 | 70 | 56 |

The surveys found that the public purchases most smallgoods after about 20-30% of their shelf-life has expired and 80% of RTE meats have more than 50% shelf-life remaining at the time of purchase. The chances of finding a product at retail with more than 90% of its shelf-life remaining is low reflecting the time taken for distribution from production to retail display.

# Summary

From production data it's estimated that, on average, each Australian consumes a 50-100g serving of ready-to-eat smallgoods every one to two days. Australian RTE meats are occasionally contaminated with *L. monocytogenes*. Contamination can occur at the factory during processing and also at the retail level. Numbers of *L. monocytogenes* are low at the point of contamination and growth is needed before a serious hazard exists. The amount of growth increases exponentially with time so those products that support the growth of the pathogen and those that are stored for the longest time pose the greatest risk: deli meats, *pâté* and cooked sausages.

# Part 2: Estimates of the risk of contracting listeriosis from RTE meats

## Risk Assessment

Risk has two components:

- The chance of being exposed to a hazard
- The severity of the consequences when exposure occurs i.e. how ill you become

The risk of listeriosis from smallgoods depends on how often people eat foods contaminated with *L. monocytogenes* and the number of *L. monocytogenes* that those foods contain. To work out this risk, information was collected on how much RTE meats Australians eat, how often they eat them, how often they are contaminated with *L. monocytogenes* and the level of contamination at the point of consumption.

The researchers developed a mathematical model to estimate the range of concentrations of *L. monocytogenes* on servings of processed meats at the time of consumption and, from that estimate and the size of the servings, the range of doses that would be ingested by consumers. In the model up to 100 000 scenarios, called 'iterations' were run for each of the three products categories (deli meats, *pâté* and cooked sausages) and that process repeated ten times. The average risk estimate from each of the ten 100 000 iterations was calculated to give the risk estimate.

### *Risk estimates*

The researchers calculated the average probability of illness per serving and, by combining this with the total annual number of servings in each category it is possible to estimate of the number of cases of listeriosis associated with consumption of RTE meals (*Table 4*).

**Table 4: Predicted average risk of listeriosis per serving of Australian processed meats**

| | Deli meats | Pâté/liverwurst | Sausages |
|---|---|---|---|
| Average risk | $1.00 \times 10^{-8}$ | $2.28 \times 10^{-9}$ | $7.06 \times 10^{-9}$ |

The risk estimates in *Table 4* indicate that, for every 100 million servings of deli meats, one may cause the consumer to become ill with listeriosis. For every 1,000 million serves of *pâté*, two consumers are likely to become ill and 1,000 million serves of cooked sausages are likely to result in 7 illnesses (note that the researchers made an assumption that 95% of cooked sausages, such as saveloys, frankfurters would be heated before consumption). Almost all of the risk of listeriosis comes from the consumption of deli meats because the quantity of these meats is so much higher than the other two categories.

### *Uncertainty*

It is in the nature of QRAs that there are data gaps, so estimates need to be based on a number of assumptions. While the researchers believe that much of the data in the present QRA are very good compared with most other microbiological QRAs performed to date, they stress that the estimates include a high degree of uncertainty.

The identification of data gaps and assumptions is required by the Codex principles and Guidelines of microbiological risk assessment and is necessary for the QRA to be transparent. It also allows a QRA to be re-estimated if and when data gaps are resolved. For the Australian smallgoods industry the present estimates provide a baseline on which strategies for reducing risk can be based and the researchers were able to estimate the effect of such strategies.

# Part 3: Estimates of risk reductions strategies

## Using the model to assess risk reduction strategies

All the major researchers were members of the FAO/WHO team of experts from several countries who worked on a QRA of *L. monocytogenes* in RTE foods (meats, seafoods, dairy products, fruits and vegetables). Thus the Australian QRA has a model which is sound and which can be employed to assess the effect of alternative potential risk management strategies. And, while there are uncertainties in the risk estimates associated with this model, the model can be used with great confidence to compare the risk under one set of circumstances relative to that from another. The effectiveness of potential risk management options can be assessed by using the model to simulate different risk management options and to compare the predicted risk resulting from each of those strategies to that of the baseline risk described in Part 2.

Using that approach, several questions were explored using the model. These were:

-What is the effect of a reduction in prevalence of contamination at the manufacturing plant?

-What is the effect on predicted risk of a treatment that reduces bacterial growth rate on processed meats?

-What is the effect on predicted risk of a treatment that reduces *L. monocytogenes* levels 'in-pack' by several orders of magnitude?

-What is the contribution to listeriosis risk of in-store contamination with *L. monocytogenes* compared with contamination at the manufacturing plant?

### *Scenario 1: Reduction in prevalence of* **L. monocytogenes** *at manufacturing*

In this scenario, reduced prevalence of *L. monocytogenes* was assumed to result from more effective cleaning and sanitation operations that also reduced the number of spoilage organisms. Two scenarios were investigated. In the first, the prevalence of *L. monocytogenes* was reduced to 10% of the original frequency (90% reduction) and in the second, the prevalence of *L. monocytogenes* was reduced to 33% of the level in the baseline scenario (67% reduction). For both scenarios, 10 runs of 20,000 iterations for each product category were performed. The results are presented in *Table 5*.

Both 67% and 90% reductions are predicted to lead to significantly lower levels of listeriosis from processed meats - by approximately 54% and 75%, respectively.

**Table 5: Predicted reduction in risk associated with reducing prevalence of *L. monocytogenes* contamination at the manufacturing stage**

| | Reduction in number of cases (% reduction) | |
|---|---|---|
| Product category | 90% reduction in prevalence | 67% reduction in prevalence |
| Deli meats | 81.1 | 53.6 |
| Pâté/liverwurst | 75 | 50 |
| Sausages | 75 | 50 |
| Overall | 79 | 53.8 |

## *Scenario 2: Reduction in* L. monocytogenes *growth rate*

In this scenario the rate of growth of *L. monocytogenes* is reduced, as is caused by the addition of a compound such as salts of lactic acids. The researchers modelled reduction in growth rate of *L. monocytogenes* by 50% and 30% and, in addition, the lag times were also increased. The predicted risk under these scenarios is summarised in *Table 6* and compared with the baseline situation.

The results of these scenarios suggest that treatments that decrease microbial growth rate and increase lag times, even by relatively modest amounts, can have a large effect on the amount of growth of *L. monocytogenes* and hence on the risk of listeriosis from processed meats. As shown in *Table 6,* reductions in listeriosis cases by 86% and 54% with a 50% and 30% reduction in growth rate, respectively is predicted.

**Table 6: Predicted reduction in risk from addition to processed meats of compounds that reduce the growth rate of *L. monocytogenes***

| | Reduction in number of cases (% reduction) | |
|---|---|---|
| Product category | 50% reduction in growth rate | 30% reduction in growth rate plus extended relative lag time |
| Deli meats | 86 | 85 |
| Pâté/liverwurst | 75 | 75 |
| Sausages | 75 | 75 |
| Overall | 86 | 54 |

## *Scenario 3: Reduction in initial microbial load*

This scenario models the effect on risk of listeriosis that might occur if an in-pack listericidal treatment were applied, such as a heat treatment or high pressure processing (HPP). The effect of such treatments was modelled by reducing the initial level of contamination by various amounts.

In the first scenario, the initial level of contaminating *L. monocytogenes* was reduced by a variable amount from 1,000 to 10,000-fold (3 to 4 log reduction). This effect is similar to that demonstrated by Food Science Australia studies for processed meats which had undergone HPP treatment.

In the second scenario, the effects of a milder listericidal treatment were estimated such as might be expected from in-pack pasteurisation. Results of both scenarios are presented in (*Table 7*) and predict that listeriosis from processed meats retailed in packages would virtually be eliminated.

**Table 7: Predicted reduction in risk associated with implementation of an in-pack post-processing microbial decontamination treatment for processed meats**

| | Reduction in number of cases (% reduction) | |
|---|---|---|
| Product category | 3-4 log reduction in initial contamination | 1-2 log reduction in initial contamination |
| Deli meats | 99.8 | 99.3 |
| Pâté/liverwurst | 100 | 100 |
| Sausages | 100 | 100 |
| Overall | 99.8 | 99.2 |

## *Scenario 4: Contribution of 'in-store' contamination*

The researchers modelled the effect of contaminating processed meat at the point of sale in a delicatessen, probably as a result of cross contamination during slicing. Numbers of the pathogen also increased during home storage.

The model predicted no significant differences in risk from product contaminated at retail and product not contaminated at retail. The researchers believe that, due to the relatively short time available for *L. monocytogenes* growth between contamination at retail and consumption the effect of retail contamination is insignificant compared with the baseline risk when product contaminated at production may have several weeks storage in the retailing chain.

# Conclusions of the QRA

By constructing a robust model and inputting good quality data, the researchers were able produce a baseline level of listeriosis from processed meat consumed in Australia. The model demonstrated the fact that long refrigerated shelf-lives are at the basis of listeriosis cases from processed meats. The researchers then used the risk assessment model to explore and demonstrate different approaches to minimise *L. monocytogenes* on processed meats.

The results suggest that the most effective means of reducing the risk of listeriosis from Australian processed meats would be to reduce initial contamination levels, using technologies such as HPP and in-pack pasteurisation. Other effective strategies to reduce risk include use of agents such as lactate in the formulation coupled with enhanced cleaning and sanitation, well-constructed plants.

Taken together, these strategies could be expected to eliminate the risk of listeriosis from processed meats. However, the researchers emphasis that any further extension of shelf-life required for retailing would counter-act (or reduce?) the effect of these strategies.

# Appendix 1: Outbreaks of Listeriosis

**Reported outbreaks of listeriosis in which ready-to-eat meat products were implicated.**

| Date | Location | Food Implicated | Cases | Adult Deaths | Foetal/Neonatal Deaths | Product Recalled? (Volume) | Reference |
|---|---|---|---|---|---|---|---|
| 1987-89 | United Kingdom | pâté (esp. fish) | 366 | | | Yes, after 2 years | Ryser (1999); CFSAN/FSIS (2003) |
| 1990 | Perth, W. Australia | pâté (epidemiologically implicated but not proven by microbiological analysis) | 11 | | | pâté, pastrami | Watson *et al.* (1990) |
| 1992 | France (all) | jellied pork tongue | 279 | 56 | | | Ryser (1993) |
| 1993 | Western France | pork rilletes, pâté | 39 | | | | Ryser (1993); CFSAN/FSIS. (2003) |
| 1996 | South Australia | pre-diced chicken | 5 | 1 | | yes | Hall *et al.* (1996) |
| 1998/1999 | USA | hot dogs and "deli meats" | 101 | 15 | | Yes, 6800 tonnes | Anon (1999a), K. Wachsmuth, (*pers.comm*., 2000) |
| 2000/2001 | USA | turkey franks' | ≥29 | ≥4 | | Yes, 7600 tonnes | Hurd *et al.* (2000); Dix (2000) |
| 1999 | France | ham rilletes | ≥6 | 1 | | yes, from 8 nations | Anon. (1999b) |
| 1999/2000 | France | jellied pork tongue | 23 | 7 | | Yes | Anon. (2000a), Dorozynski (2000) |
| 1999 | USA | pâté | 11 | | | | CFSAN/FSIS (2003) |
| 2000 | New Zealand | corned beef | 2 | n/a | | 50 products from a single manufacturer | Anon. (2000b) |
| 2002 | USA | turkey and chicken based deli-meats | >50 | 8 | | Yes, ~12,500 tonnes processed chicken and turkey products | MMWR (2002) |

[§] centred numbers indicate that the report did not differentiate between adult and foetal/neonatal cases

# Appendix 2: Perspectives on risks of listeriosis

The maximum size of the risk from listeriosis in Australia can be inferred from nationally compiled statistics. About 60 cases of listeriosis are reported in Australia per year and the researchers estimate that there are an equal number of cases of listeriosis per year in Australia that go unreported...

It is helpful to place listeriosis statistics in perspective. The table below indicates rates of death in Australia from other diseases and reinforces that listeriosis is a comparatively rare cause of death.

**Rates of death in Australia from various causes**

| Disease | Deaths/year/100,000 population |
|---|---|
| Total foetal, neonatal and perinatal deaths | 23.8<br>(1840 per 100,000 ***births)*** |
| Cardio vascular disease | 270 |
| Cancers | 180 |
| Injuries and accidents | 50 |
| Mental illness | 30 |
| Acute respiratory infections | 25 |
| Diabetes | 15 |
| Suicides | 12 |
| Asthma | 7 |
| Homicide | 2 |
| Hepatitis B | 0.3 |
| Listeriosis | 0.1-0.2 |

It is evident that many diseases that are a far greater public health burden and risk involve an element of self-responsibility (life-style choices in terms of diet, exercise, smoking etc). Accidental death is far more likely than death by listeriosis. It could be argued that listeriosis is also accidental - food manufacturers generally do not intend to harm their customers - yet a death due to listeriosis might be expected to generate much more negative publicity and accusations of blame than other preventable causes of illness or death. One explanation for this lies in the study of risk perception which indicates that people are less tolerant of risks that they feel that they have no control over and also of situations where they consider that the benefits from accepting a particular level of risk are not equally shared by all stakeholders e.g. if a company is perceived to be making profits by taking shortcuts with food safety.

Listeriosis appears to be particularly emotive because it can cause the death of babies. The mother and baby are exposed to a risk over which they feel they have no control (they are unable to tell whether *L. monocytogenes* is present in foods or not) and, because they expect food to be completely safe, do not perceive the benefit inherent in foods (i.e. food that is affordable, palatable and nutritious because it has not been processed to sterility). The outrage associated with the death of babies and children also has a rational basis when interpreted in terms of the DALY concept because when an infant dies their entire potential life is lost. The outrage associated with the death by listeriosis of an elderly or critically ill person might be expected to be less because they are expected to have fewer years of life remaining.

It is also noteworthy that there are many causes of infant death and the researchers estimate that listeriosis is responsible for less than one-thousandth of those deaths. Again, the response to infant deaths by listeriosis compared with the far greater burden from other sources is that, if the listeriosis is shown to be food-borne, there is someone who can be blamed, whereas in other cases it may be considered as fate.

To further place the risk of listeriosis in Australia into perspective consider statistics for iatrogenic injury, caused by healthcare management. A report commissioned by the Australian Commonwealth Department of Health and Aged Care estimated that at least 10% of admissions to hospitals are associated with a potentially preventable adverse event and that such adverse events are associated with as many as 50,000 permanent disabilities and 10,000 deaths each year in Australia. Given the proportion of Australians that enter hospital each year and the thousands or tens of thousands of dollars associated with each admission to provide the level of health care that Australian expect it might be argued that the risk of listeriosis from the 20 billion meals, worth a few dollars each, that Australians consume annually is relatively insignificant. These statistics are cited as an example of how perception and acceptance of risk can be divorced from reality. Education of consumers as to relative risks (risk communication) can be an effective tool in risk management.