RANKING FOOD SAFETY RISKS
DEVELOPMENT OF NZFSA POLICY 2004-2005

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Peter Cressey
Dr Rob Lake

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Institute of Environmental Science & Research Limited
Christchurch Science Centre
Location address: 27 Creyke Road, Ilam, Christchurch
Postal address: P O Box 29 181, Christchurch, New Zealand
Website: www.esr.cri.nz

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Kevin Taylor
Food Safety Programme Manager

Dr Rob Lake
Project Leader

Dr Andrew Hudson
Peer Reviewer

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SUMMARY

This project is intended to develop a scientifically-based process for ranking food safety risks that has broad application, is user friendly, and has wide acceptance by stakeholders.

A risk ranking process usually includes the following steps:

1. Define and categorise the risk to be ranked;
2. Identify the risk attributes (criteria) that should be considered;
3. Describe the risks in terms of the attributes in risk summary sheets;
4. Select participants and perform the risk ranking; and,
5. Describe the issues identified and the resulting rankings.

The categorisation of risks is covered by the food/hazard combinations used for Risk Profiles.

At a consultation meeting held in July 2004 it was decided that the criteria for ranking would be:

- Public health (incidence of illness apportioned to the food of interest);
- Severity (morbidity, mortality);
- Uncertainty about the risk (quality of data);

Due to uncertainty in describing the food/hazard combinations in terms of these criteria (particularly apportionment), the July 2004 meeting also decided to make Step 3 in the process above the subject of an expert consultation. This was held in May 2005, and discussed:

- Apportionment of total incidence due to transmission in foods in general;
- Apportionment of total incidence due to transmission in the specific foods considered in Risk Profiles;
- Severity; and,
- Associated issues, such as the definition of "foodborne".

The results of this consultation are presented in this report, together with quantitative data from surveillance and other sources.

The final step in the risk ranking process is to combine the apportionment and severity estimates. A suggested final ranking is presented.

A final risk ranking process for the NZFSA is suggested as an amended version of the above:

1. Define and categorise the food/hazard combinations whose risks are to be ranked;
2. Assemble available scientific data related to the attributes incidence and severity.
3. Describe the risks in terms of the attributes on the basis of an expert consultation;
4. Combine scientific data and expert consultation to produce the risk ranking; and,
5. Describe the issues identified and the resulting rankings.

1 INTRODUCTION

1.1 The NZFSA's Risk Management Framework for Food Safety

The New Zealand Food Safety Authority (NZFSA) has adopted a structured approach to food safety risk management. Details of the generic approach have been published in the document "Food Administration in New Zealand: A Risk Management Framework for Food Safety" (Ministry of Health/Ministry of Agriculture and Forestry, 2000). The NZFSA's risk management framework adopts the following definitions:

- A **hazard** is a biological, chemical or physical agent in food that has the potential to cause an adverse health effect in consumers.
- **Risk** is a function of the probability of adverse health effects and the severity of those effects in the population consuming that food.
- **Risk management** is the process, distinct from risk assessment, of weighing policy alternatives, in consultation with all interested parties, considering risk assessment and other factors relevant to health protection of consumers and promotion of fair trade practices, and, if needed, selecting appropriate prevention and control options.

The four-step framework for food safety risk management is shown in Figure 1.

Figure 1: Risk Management Framework

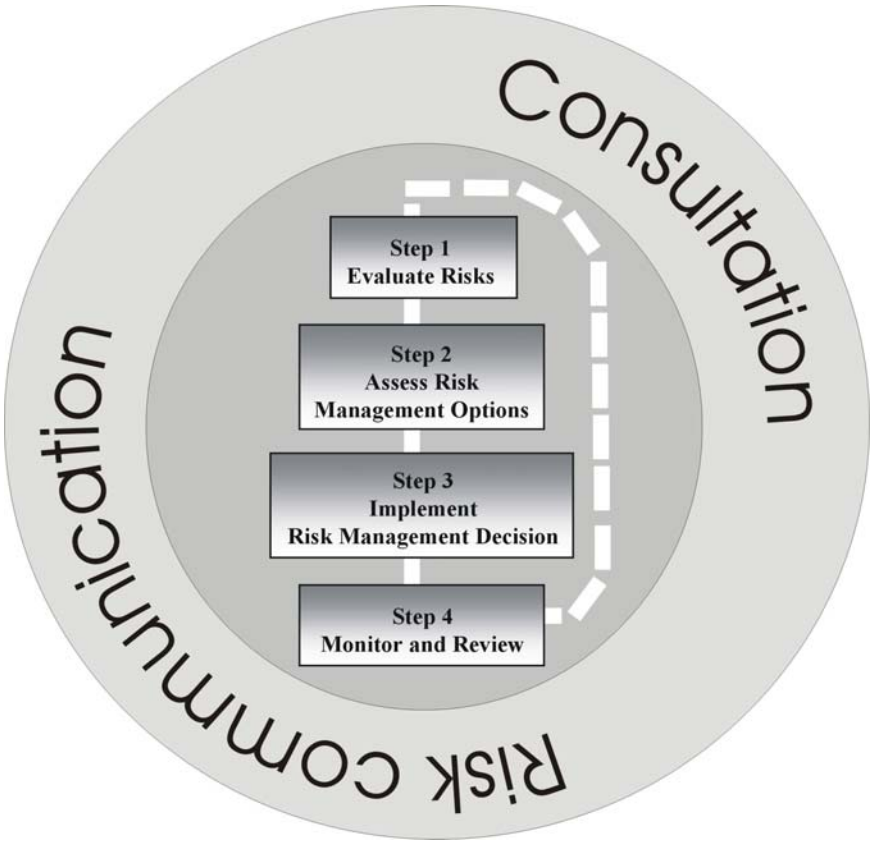

Figure reproduced from "Food Administration in New Zealand. A risk management framework for food safety" (Ministry of Health/Ministry of Agriculture and Forestry, 2000).

In more detail, the four-step process is:

1. Preliminary risk management activity

- identification of the food safety issue
- establishment of a risk profile
- **ranking of the food safety issue for risk management**
- establishment of risk assessment policy
- commissioning of a risk assessment
- consideration of the results of risk assessment

2. Risk management option assessment

- identification of available risk management options
- selection of preferred risk management option
- final risk management decision

3. Implementation of the risk management decision

4. Monitoring and review.

Since 2000 ESR has produced Risk Profiles for microbiological hazards in particular foods ('food safety issues') as part of Step 1 above. This process is now well established and attention moves to the next step in the process – the ranking of the food safety issue for risk management.

During 2002-2003 a discussion document was prepared to consider issues and review existing approaches to the ranking of food safety risks (Cressey and Lake, 2003). While a number of similar discussion documents have been produced by other organisations, particularly related to environmental risks, there are far fewer examples of cases where theoretical risk ranking methodologies have been applied to actual risk scenarios.

During 2003-2004 the risk ranking project aimed to:

- Develop a prototype risk ranking methodology (including risk categories and criteria) suitable for food safety issues appropriate to the NZFSA.
- Develop risk summary sheets based on existing food/(microbiological) hazard Risk Profiles and demonstrate their use to create a risk ranking using the methodology.
- Make suggestions on how the methodology could be extended to cover non-microbiological risks.
- Make suggestions for a communication process to achieve stakeholder acceptance of the risk ranking methodology.
- Supply the methodology, microbiological risk ranking, and communication suggestions to NZFSA in the form of a draft risk ranking policy.
- Provide risk communication material for use in stakeholder consultations with respect to microbiological risk ranking.

A report from the 2003-2004 project addressing these issues was provided to NZFSA in March 2004 (Cressey and Lake, 2004). This document was then used as the subject of a

stakeholder consultation meeting in July 2004, including representatives from NZFSA, ESR, consumers, the food industry, Ministry of Health, and the Ministry of Agriculture and Forestry. A number of revisions to the risk ranking process were decided at this meeting, principally:

- Restricting criteria to severity and incidence measures;
- Convening an expert consultation to address the difficult question of attribution of disease incidence to foodborne transmission, in general, and to the foods that have been the subjects of Risk Profiles, in particular.

The Expert Consultation was held on 24 May 2005. This report consolidates the results of that meeting, together with scientific information from surveillance and other sources.

2 INCIDENCE OF FOODBORNE DISEASES IN NEW ZEALAND

Part of the process of ranking the risks associated with specific food-hazard combinations requires an estimate of the amount of disease in New Zealand due to transmission of the particular hazard in the specific food. Such an estimate requires four pieces of information:

1. The notified rate of disease due to a particular hazard, or an estimate from other sources (for non-notifiable diseases);
2. An estimate of the difference between the reported rate of disease and the actual rate of disease in the community. This estimate is sometimes known as the rate of under-reporting. This may not be applicable for non-notifiable diseases, where the estimate may be for the total rate.
3. An estimate of the proportion of that total disease rate due to transmission via food (apportionment to food);
4. An estimate of the proportion of that foodborne disease rate due to transmission in the specific food (apportionment to a specific food).

Due to uncertainty in each of these pieces of information, a modelling approach was taken to estimate the incidence of disease due to a specific hazard and a specific food. Notification data and other sources of information have been brought together in this report to provide the first two pieces of information. Estimates for apportionment were supplied from an expert consultation. These estimates were used to create Pert distributions (Vose, 1996) in a model that combined them with the distributions for estimated total rates of disease. The output from this model is a numerical distribution for the rate of disease due to a particular hazard in a specific food.

The Pert distribution utilises the same parameters as the triangular distribution (minimum, most likely, maximum) but is less sensitive to the minima and maxima, and so is less likely to be affected by extreme values. This makes it more suited to the modeling of expert opinion.

2.1 Estimated Rate of Disease

2.1.1 *Bacillus* Intoxication

No New Zealand estimates for the incidence of *Bacillus* intoxication are available. Lake *et al*. (2000), using the data of Wheeler *et al*. (1999), estimated approximately 15,000 toxin-related cases of illness in New Zealand (equivalent to a crude rate of approximately 375 cases/100,000). 'Toxin-related' includes cases due to *Clostridium perfringens*, *Staphylococcus aureus* and *Bacillus* spp. On the basis of outbreak data, there are more cases due to *Clostridium perfringens* and *Staphylococcus aureus*, than *Bacillus* spp. Based on outbreak cases for 2001-2003, approximately 20% of toxin-related cases were due to *Bacillus* spp., equating to a crude rate of approximately 75 cases/100,000.

Estimates for *Bacillus* intoxication cases in Australia (Martyn Kirk, personal communication) gave a median of 6900 cases (credible interval; low = 0, high = 16000). Based on an Australian population of approximately 20 million this equates to a crude rate of 35 cases/100,000 population (Credible interval 0 – 80). These figures are consistent with those derived from Lake *et al*. (2000). In the absence of New Zealand specific data, the Australian

rate and the associated credible interval will be used for the current risk ranking exercise. As these estimates are for total cases no further factor will be included for under-reporting.

2.1.2 Campylobacteriosis

Campylobacteriosis is notifiable in New Zealand. The notified rate for the 2004 year was 326.8. To define parameters for the Pert distribution, the lowest and highest notified rates over the past five years in New Zealand were taken as values for the minimum and maximum (233 and 395.6).

In a UK study Wheeler *et al*. (1999) estimated that there were 7.6 community cases of campylobacteriosis for every reported case. A median estimate for the number of campylobacteriosis cases in Australia during 2001-2002 (Martyn Kirk, personal communication) was 12.3 times the notified rate for the same period. The Australian study also defined a credible interval for the number of Australian campylobacteriosis cases, which ranged from 4.0 to 20.6 times the notified rate. For the purpose of the current exercise, a most likely under-reporting rate of 7.6, derived from the UK study, will be used, with a minimum of 4.0 and a maximum of 20.6. The UK figure for the degree of under-reporting has been preferred as it comes from a prospective study of actual cases, while the Australian estimate has been inferred from a combination of expert opinion and notification data.

2.1.3 Listeriosis

The rate of listeriosis in New Zealand in 2004 was 0.7 cases/100,000 of population. During the last five years the rate has been within a very narrow range 0.5-0.7 cases/100,000. These rates are for the invasive form of the disease, rather than the mild gastroenteritis that has been reported.

Although no New Zealand estimates have been made, given the severe nature of invasive listeriosis, there are likely to be very few cases that go unreported. An *ad hoc* assumption will be made that all cases of invasive listeriosis in New Zealand are notified (no under-reporting).

2.1.4 Tuberculosis disease due to *Mycobacterium bovis*

The current (2004) rate of tuberculosis disease in New Zealand is 10.0 cases/100,000. The lowest and highest rates reported during the last five years were 9.8 and 11.2 cases/100,000 respectively.

Of the cases in which a causative organism was identified, during 2004 1.6% of cases were due to *Mycobacterium bovis*. During the last five years this percentage has varied in the range 1.5 to 3.2%.

It appears that national surveillance does not capture all cases of tuberculosis disease. In 2002, 333 hospital discharge records reported tuberculosis disease as the reason for hospitalisation, while national surveillance only reported 193 cases of tuberculosis disease for which hospitalisation was reported. It may be assumed that this ratio (1.7) is indicative of the most likely level of under-reporting of tuberculosis disease and represents the most likely level of under-reporting. However, it is also possible that the hospital discharge data may

reflect multiple admissions for cases during the year or readmission of cases reported during a pervious year. A lower bound for under-reporting may thus be 1.0 (no under-reporting). For the purpose of the current exercise we will assume a symmetric upper-bound to the under-reporting ratio (2.4).

2.1.5 Norovirus infection

Norovirus is the aetiological agent most commonly identified as causing outbreaks of enteric disease in New Zealand, with approximately 1,300 outbreak-associated cases identified in New Zealand during each of 2002 and 2003.

Lake *et al*. (2000) estimated approximately 53,000 cases of norovirus infection in New Zealand per annum, equating to a crude rate of approximately 1,300 cases/100,000. This was based on the rate of detection of "small round structured virus" in the UK study (Wheeler *et al.*, 1999). An estimate of calicivirus cases in Australia (norovirus is a calicivirus) was an order of magnitude greater, equating to a crude rate of approximately 11,000 cases/100,000, with a 'credible interval' ranging from 9,000 to 14,000 cases/100,000 (Martyn Kirk, personal communication). It is uncertain what proportion of calicivirus cases would be expected to be due to norovirus, as the group caliciviruses includes other viruses, such as hepatitis E.

It is clear that there is considerable uncertainty associated with the incidence of norovirus infections in New Zealand (and Australia). For the purpose of the current exercise, it can be said that the number of cases are at least as many as are observed from outbreaks (crude rate 32.5 cases/100,000), but may be as high as the Australian upper credible limit (14,000 cases/100,000). The previous New Zealand estimate of approximately 1,300 cases/100,000 will be used as the most likely estimate.

2.1.6 Salmonellosis

Salmonellosis is notifiable in New Zealand. The notified rate for the 2004 year was 28.9 cases/100,000. To define parameters for the Pert distribution, the lowest and highest notified rates over the past five years in New Zealand were taken as values for the minimum and maximum (28.9 and 64.7).

In a UK study Wheeler *et al*. (1999) estimated that there were 3.2 community cases of salmonellosis for every reported case. A median estimate for the number of salmonellosis cases in Australia during 2001-2002 (Martyn Kirk, personal communication) was 11.6 times the notified rate for the same period. The Australian study also defined a credible interval for the number of Australian salmonellosis cases, which ranged from 3.0 to 20.0 times the notified rate for the same period. For the purpose of the current exercise, a most likely under-reporting rate of 3.2 will be used, with a minimum of 3.0 and a maximum of 20.0. The UK figure for the degree of under-reporting has been preferred as it comes from a prospective study of actual cases, while the Australian estimate has been inferred from a combination of expert opinion and notification data.

2.1.7 STEC

STEC infection is notifiable in New Zealand. The notified rate for the 2004 year was 2.4 cases/100,000. To define parameters for the Pert distribution, the lowest and highest notified

rates over the past five years in New Zealand were taken as values for the minimum and maximum (1.9 and 2.8).

STEC infection results in serious conditions in a proportion of cases. The most common of these is haemolytic uraemic syndrome (HUS), which mainly affects children and infants (Baker *et al*., 1999). Based on studies in Canada, it has been estimated that in New Zealand 10-12 cases of STEC infection occur for each reported case of HUS (Baker *et al.*, 1999). Table 1 shows historical case numbers for STEC infection in New Zealand, case numbers under the age of 5 years and case numbers for HUS as reported by the New Zealand Paediatric Surveillance Unit (NZPSU).

Table 1: Case numbers for STEC infection and HUS, 1998-2004

Year	1998	1999	2000	2001	2002	2003	2004
Total STEC notifications	48	64	68	76	73	105	89
STEC notifications (<5 years)	31	37	38	49	39	66	46
HUS cases	14	2	3	6	5	4	3
Fatalities	1	0	0	0	0	0	0

While HUS case numbers in 1998 suggest that there was under-reporting of STEC infection case numbers in the under five age group, this does not appear to be the case in subsequent years, with the ratio of under-five STEC notification to HUS cases being in the range 8 to 19. These figures would suggest that there are few unreported cases of STEC in the under five age group. An analysis of national surveillance data (Episurv) since 1999 demonstrated that the rate of hospitalisation due to STEC infection, where information was recorded, was no higher amongst cases under 5-years than for older cases. This suggests that STEC infection is a generally serious disease, rather than just being severe for children. On this basis the ratio of total STEC infections to notifications would not be expected to be large and for the purpose of the current study will be given bounds of 1 and 2, with a most likely value of 1.5.

It is recognised that the STEC serotypes differ significantly in their pathogenicity and the preceding discussion relates mainly to STEC serotypes capable of causing a relatively high proportion of serious outcomes. Mead *et al.* (1999) estimated that there may half as many infections due to non-O157 STECs as infections due to O157 STECs in the USA. In New Zealand approximately 90% of notification are due to O157 STECs. Based on the analysis of Mead *et al.* this would suggest a rate 1.35 times that currently notified. This falls within the envelope proposed to account for under-reporting.

A median estimate for the number of STEC cases in Australia during 2001-2002 (Martyn Kirk, personal communication) was 50 times the notified rate for the same period. The Australian study also defined a credible interval for the number of Australian STEC cases, which ranged from 0 to 108 times the notified rate for the same period.

While it is possible that there are large numbers of cases of mild gastroenteritis caused by other STEC serotypes, there are currently no data to estimate to magnitude of this problem for New Zealand. At this stage its occurrence remains speculative and will not be considered in this analysis.

2.1.8 Toxoplasmosis

Little information is available on the incidence of toxoplasmosis in New Zealand (Lake *et al*., 2002). A high proportion of the population carries antibodies to *Toxoplasma gondii* (45% of females, 48% of males; Metcalfe *et al.*, 1981), indicating prior infection. However, infection is often asymptomatic and development of clinical toxoplasmosis is rare. Toxoplasmosis was notifiable in New Zealand from 1987 to 1996. However, only one case of congenital toxoplasmosis was notified during that period.

Although an area of major concern is transmission of the parasite to the developing foetus, diagnosis is rare (10 cases of toxoplasmosis in preganancy diagnosed in the Wellington region from 1989 to 1997). Other New Zealand information is often difficult to interpret. For example, in 2000/2001 15 cases were reported as being hospitalized due to toxoplasmosis, but all were males.

It has been estimated that 0.6% (600 cases/100,000) of the US population experience an acute infection due to *Toxoplasma gondii* each year (Mead *et al.*, 1999).

Considering the fragmented and sometimes contradictory nature of New Zealand information on toxoplasmosis, no estimate will be made of the incidence in New Zealand.

2.1.9 *Vibrio parahaemolyticus* infection

Vibrio parahaemolyticus infection is not notifiable in New Zealand, although some cases get notified under the category of 'acute gastroenteritis'. Rates have been estimated, from retrospective analysis of the communicable disease database (Episurv) or from case series, at approximately 1.6 cases/100,000.

A median estimate for the number of *Vibrio parahaemolyticus* infection cases in Australia during 2001-2002 (Martyn Kirk, personal communication) equated to a crude rate of 5 cases/100,000. The Australian study also defined a credible interval for the number of Australian *Vibrio parahaemolyticus* infection cases, which ranged from 0 to 13 cases/100,000. Due to the similarity between the New Zealand and the Australian median rate estimates and given that the New Zealand estimate will not have been corrected for under-reporting, the Australian mean and limits will be adopted for the current exercise with no further correction for under-reporting.

2.1.9 Yersiniosis

Yersiniosis is notifiable in New Zealand. The notified rate for the 2004 year was 11.2 cases/100,000. To define parameters for the Pert distribution, the lowest and highest notified rates over the past five years in New Zealand were taken as values for the minimum and maximum (11.0 and 12.7).

Lake *et al*. (2000) used an estimate of five for the ratio of total cases to reported cases. In the absence of other data, this estimate for under-reporting was derived as the mean of the under-reporting rates for salmonellosis and campylobacteriosis. A median estimate for the number of yersiniosis cases in Australia during 2001-2002 (Martyn Kirk, personal communication) was 9.2 times the notified rate for the same period. The Australian study also defined a

credible interval for the number of Australian yersiniosis cases, which ranged from 0 to 18.8 times the notified rate for the same period. For the current exercise the Australian estimate and range of under-reporting factors will be used, with the adjustment that the lower limit will be raised to one, representing the notified rate of yersiniosis.

3 THE PROPORTION OF DISEASE CASES THAT ARE FOODBORNE

As part of the expert consultation organised by the NZFSA during May 2005, the expert panel were asked to estimate the proportion of cases of the diseases, listed in section 2 of this report, that they believed were due to transmission via food. The expert panel were also asked to nominate lower and upper bound estimates for the proportion of each disease that may be due to foodborne transmission. After a facilitated round-table discussion experts were asked to repeat the exercise. Table 2 summarises the results of this questionnaire.

Table 2: Proportion of disease due to foodborne transmission – summary of expert opinion, May 2005

Disease	**Most Likely (%)**			**Minimum (%)**			**Maximum (%)**		
	Min	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**
Bacillus intoxication	90	97.4	100	50	90.0	100	90	98.9	100
Campyobacteriosis	30	57.5	80	10	37.1	60	40	69.6	90
Listeriosis	50	84.9	100	40	78.4	100	60	92.1	100
Tuberculosis disease (*M.bovis*)	5	27.9	95	0	22.2	90	5	34.9	99
Norovirus infection	10	39.6	60	5	27.9	50	15	48.9	80
Salmonellosis	20	60.7	80	10	45.4	70	30	68.9	90
STEC infection	5	39.6	95	5	27.0	80	15	51.4	99
Toxoplasmosis	3	31.5	80	1	20.1	50	5	41.7	95
Vibrio parahaemolyticus infection	70	89.2	100	50	80.0	100	80	95.4	100
Yersiniosis	40	56.2	90	20	41.5	80	50	70.8	100

Min = minimum expert opinion, Mean = average expert opinion, Max = maximum expert opinion

The expert responses were particularly variable for tuberculosis disease and toxoplasmosis. This perhaps reflects the fact that the expert panel were selected to obtain the widest possible expertise in foodborne illness investigation, but that specific expertise in these illnesses was lacking.

In the modeling of risk criteria, the responses from each expert were represented by a Pert distribution and the opinions of each expert were equally weighted.

4 THE PROPORTION OF DISEASE TRANSMITTED VIA FOOD THAT IS TRANSMITTED VIA A SPECIFIC FOOD

After being asked to estimate the proportion of each disease that was due to foodborne transmission, the expert panel were presented with a specific food or foods for each disease and asked to estimate what proportion of the foodborne transmission was due to this particular food. Results are summarised in Table 3.

Table 3: Proportion of disease due to foodborne transmission that is due to specific foods – summary of expert opinion, May 2005

Disease	Food	Most Likely (%)			Minimum (%)			Maximum (%)		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bacillus intoxication	Rice	40	61.4	80	20	47.9	80	60	73.6	100
Campyobacteriosis	Poultry	15	52.9	75	5	37.9	75	15	63.6	80
Listeriosis	RTE meats	15	53.9	80	5	39.6	80	20	66.4	85
Listeriosis	Ice cream	0	6.6	25	0	4.3	20	0	10	40
Tuberculosis disease (*M.bovis*)	Milk	2	24.0	50	0	3.9	10	2	39.3	100
Norovirus infection	Shellfish	10	40.0	75	5	29.3	60	15	49.6	90
Salmonellosis	Poultry	15	35.7	70	10	25.0	60	25	47.5	90
STEC infection	Red meat	3	30.6	60	1	18.6	60	5	42.9	90
STEC infection	UCFM	2	20.7	50	0	11.6	50	4	31.0	90
Toxoplasmosis	Red meat	20	54.1	95	10	41.8	80	30	63.5	99
Vibrio parahaemolyticus infection	Seafood	70	89.2	100	20	76.2	100	80	97.6	100
Yersiniosis	Pork	35	52.9	75	20	38.6	70	40	63.6	90

Min = minimum expert opinion, Mean = average expert opinion, Max = maximum expert opinion

In the modeling of risk criteria, the responses from each expert were represented by a Pert distribution and the opinions of each expert were equally weighted.

5 THE INCIDENCE OF FOODBORNE DISEASE DUE TO SPECIFIC FOOD-HAZARD COMBINATIONS

The Pert distributed data for; the incidence of disease, under-reporting (if applicable), apportionment to food and apportionment to the specific food were combined by computer simulation using @RISK software (Palisades Asia-Pacific Pty Ltd).

Table 4 gives the mean and 5th and 95th percentile estimates for the incidence of the disease due to the specific food.

Table 4: Output of simulation modeling of disease incidence rates in New Zealand due to exposure via specific foods

Disease	**Food**	**Incidence (cases/100,000)**		
		5th	**Mean**	**95th**
Bacillus intoxication	Rice	5.6	19.2	38.1
Campyobacteriosis	Poultry	213.7	820.8	1637
Listeriosis	RTE meats	0.09	0.30	0.48
Listeriosis	Ice cream	0	0.04	0.15
Tuberculosis disease (*M.bovis*)	Milk	0.0004	0.02	0.12
Norovirus infection	Shellfish	25.7	399.1	1311
Salmonellosis	Poultry	10.5	42.4	105.6
STEC infection	Red meat	0.04	0.43	1.2
STEC infection	UCFM	0.02	0.30	0.93
Toxoplasmosis	Red meat	NC	NC	NC
Vibrio parahaemolyticus infection	Seafood	1.3	4.2	7.7
Yersiniosis	Pork	9.1	28.6	59.1

UCFM = uncooked, comminuted, fermented meat
NC = Not calculated (no data on which to base an estimate)

As well as contributing expert opinion to the quantitative analysis presented here, the expert consultation held during May 2005 also elicited qualitative opinions on:

- The most likely food sources for a range of organisms,
- The probability of occurrence of infectious gastrointestinal disease due to each organism,
- The activity representing the most likely route of transmission for each organism and the most likely source within that activity.

The quantitative ranking from the current study (1 – 10) and relevant qualitative outputs from the expert consultation are summarised in Table 5.

Table 5 demonstrates a very high correlation between the ranking based on quantitative apportionment of the disease incidence to the food of particular interest (after correction for under-reporting) and the qualitative estimates of occurrence of the disease, in general. The process of apportionment does add additional value where two or more foods have been

linked to a single organism, in supporting decisions as to which food may be a higher priority for risk management activities.

In most cases eating was identified as the major transmission route for the organisms considered in this study, with the exceptions being Norovirus and STEC infection, for which contact with infected humans and animals, respectively, were considered to be the most important transmission routes. For transmission of tuberculosis disease due to *M. bovis*, hunting and drinking raw milk were both considered to be important transmission routes.

In all cases the food-hazard combination selected for the establishment of risk profiles and subsequent risk ranking were in good agreement with the expert panels assessment of the most important food source for each infectious gastrointestinal disease.

5.1 Issues that Needed to be Clarified

During the expert consultation there were a number of issues that needed to be clarified. They are summarised here in order to improve consistency in future such exercises.

1. Definition of "foodborne". Some transmission of pathogens occurs from an infected food handler to the food, followed by consumption. Although the source of contamination is more immediate than for most foods, the consultation decided that this did indeed represent foodborne transmission.
2. It was important that everyone understood the percentages that were being estimated. There was some confusion about estimating the percentage of the total incidence or the foodborne incidence attributable to a specific food.
3. For some pathogens (e.g. *Bacillus*) it was important to be clear about the specific species/strains being included.
4. This consultation was limited to infectious gastrointestinal disease; however, during the consultation a number of pathogens and chemicals were discussed that cause other illnesses. The inclusion/exclusion of these needed to be clarified.
5. There was also some discussion about whether there were differing epidemiologies for outbreaks and sporadic cases, and what effect this had on the scientific information available.
6. The status of water needed to be clarified. For this consultation, it was decided that drinking water was excluded, but water used for food preparation and processing was a legitimate vehicle for transmission.

Table 5: Summary of incidence ranking information

Disease	Food	Ranking (this study)*	Most likely food source	Probability of disease occurrence	Most likely activity/source
Bacillus intoxication	Rice	5	Starchy foods, milk powder, dairy	Medium	Eating – Starchy food
Campyobacteriosis	Poultry	1	Poultry, red meat, water used in food production, processing or preparation	High	Eating – Chicken/poultry
Listeriosis	RTE meats	8=	Long shelf life RTE foods	Low	Eating – RTE meat
Listeriosis	Ice cream	10	Long shelf life RTE foods	Low	Eating – RTE meat
Tuberculosis disease (*M.bovis*)	Milk	11	Raw milk, wild foods	Low	Hunting – Feral Meat Drinking – Raw milk
Norovirus infection	Shellfish	2	Food handling, mollusca	High	Contact - Human
Salmonellosis	Poultry	3	Raw meats, sesame, spices, food handling	High	Eating – Meat Eating - Poultry
STEC infection	Red meat	7	Raw meats, raw milk, water used in food production, processing or preparation	Low-medium	Contact – Animals/animal faeces
STEC infection	UCFM	8=	Raw meats, raw milk, water used in food production, processing or preparation	Low-medium	Contact – Animals/animal faeces
Toxoplasmosis	Red meat	NC	Meat, venison	Low-medium	Eating – Red meat
Vibrio parahaemolyticus infection	Seafood	6	Personally imported seafood	Low	Eating - Shellfish
Yersiniosis	Pork	4	Pork, venison, sheep meat	Medium	Eating - Pork

* 1 = high incidence, 10 = low incidence

6 SEVERITY OF FOODBORNE DISEASE

For the purpose of the current risk ranking exercise the severity of the disease was assessed in terms of:

- The proportion of cases hospitalised (% hospitalisation)
- The proportion of cases that died (% mortality)

Wherever possible data were taken from the national surveillance system (Episurv). No attempt was made to scale hospitalisation or mortality rates for the effects of under-reporting, as no information could be found concerning the relative rates of morbidity and mortality in notified as against non-notified cases. Where the disease was not notifiable, data from outbreak surveillance was used. Numbers of cases hospitalised or dying tend to rise and fall with the total number of cases, however, when expressed as a percentage of cases (i.e. as rates) these measures are more or less independent of the incidence of the disease. This is demonstrated for campylobacteriosis in Table 6.

Table 6: Incidence, hospitalisation rate and fatality rate for campylobacteriosis in New Zealand, 200-2004

	2000	2001	2002	2003	2004
Incidence (cases/100,000)	233	271.5	334.3	395.6	326.8
Hospitalisation rate (% of cases)	6.3	6.2	6.7	7.6	7.6
Fatality rate (% of cases)	0.04	0.01	0.008	0	0

As hospitalisation and fatality rates (as a proportion of total cases) are less likely to follow temporal trends than incidence rates the most likely rates were taken as the mean of the last five years of available data. Minimum and maximum estimates were taken as the minimum and maximum reported rates during that period.

6.1 *Bacillus* Intoxication

Bacillus intoxications are not notifiable. The annual summary of outbreaks usually reports approximately 4-12 outbreaks due to *Bacillus cereus*. However, no hospitalisations or fatalities have been reported, except in 2000, when 14.8% of outbreak related cases were reported to have been hospitalised. Outbreak data from the 2000 year are generally unusual in reporting a very high proportion of cases being hospitalised.

Hospital discharge data report one hospitalised case of *Bacillus cereus* intoxication in each of 2002 and 2003. If we accept the Australian estimates for the extent of *Bacillus* intoxication (see section 3.1.1), scaled for New Zealand, this would indicate a hospitalisation rate of less than 0.1% of total cases.

6.2 Campylobacteriosis

The mean hospitalisation rate from notified cases over the last five years is 6.9% (range 6.2 to 7.6%). The mean fatality rate during the same period was 0.012% (range 0 to 0.04%). Hospitalisation rates from outbreak analyses are far more variable, with no additional fatalities being reported.

6.3 Listeriosis

The hospitalisation rate for invasive listeriosis is rarely less than 100%, as the disease is often only diagnosed after admission to hospital. The average hospitalisation rate over the last five years was 98.9% (range 94.4 to 100%), while the mean fatality rate was 18.0% (range 11.1 to 27.3%).

6.4 Tuberculosis Disease due to *M. bovis*

According to national surveillance data, the mean hospitalisation rate during the last five years was 60.6% (range 55.5 to 63.8%), while the mean fatality rate was 1.5% (range 0.5 to 2.3%).

6.5 Norovirus Infection

Norovirus is not a notifiable disease.

Percent hospitalisation figures are reported from analyses of outbreaks. Hospitalisation status was not reported in all cases and the percentages reported here use total outbreak cases as the denominator, not total outbreak cases for which hospitalisation status was reported. The mean for the last five years is 2.0% (range 0.5 to 3.6%).

Hospital discharge statistics include hospitalisations due to 'acute gastroenteropathy due to Norwalk agent'. Figures under this category are lower than those from national surveillance of outbreaks (e.g. in 2003, 12 hospitalisations were reported from hospital discharge and 31 were reported from national surveillance).

Percent mortality figures are reported from analyses of outbreaks, with a mean for the last five years of 0.11% (0 to 0.16%). New Zealand mortality data supplied by the New Zealand Health Information Service do not report any fatalities due to 'Norwalk agents'.

6.6 Salmonellosis

The average hospitalisation rate over the last five years is 13.9% of notified cases (range 12.5 to 14.9%), while the mean fatality rate is 0.11% (range 0 to 0.4%).

6.7 STEC Infection

The average hospitalisation rate over the last five years is 24.0% of notified cases (range 16.9 to 32.1%), while no fatalities have been reported in the last five years. STEC infection in New Zealand is statistically unusual in having a very high rate of hospitalisation, but without recent fatalities.

6.8 Toxoplasmosis

Toxoplasmosis is not notifiable in New Zealand and no estimates of the incidence have been made.

Hospital discharge statistics for 2000/2001 report 15 cases of hospitalisation due to toxoplasmosis. All 15 cases hospitalised were male.

New Zealand mortality data supplied by the New Zealand Health Information Service reported no fatalities due to toxoplasmosis during the 2000 year.

6.9 *Vibrio parahaemolyticus* Infection

Vibrio parahaemolyticus infection is not notifiable in New Zealand, although some cases get notified under the category of 'acute gastroenteritis'. Based on retrospective analysis of the communicable disease database (Episurv) or from case series, an estimate of hospitalisation rates was made of 12-15%.

Hospital discharge statistics report only 0-2 people per year hospitalised due to 'Food-borne intoxication due to *Vibrio parahaemolyticus*'. No fatalities were attributed to this pathogen in NZHIS statistics.

6.10 Yersiniosis

The average hospitalisation rate over the last five years was 9.9% (range 6.1 to 11.6%), while the mean fatality rate is 0.05% (range 0 to 0.23%).

6.11 Summary: Severity

Table 7 summarises the parameters for the severity of the potentially foodborne diseases discussed above.

Based on these measures each disease can be ranked from 1 (most severe) to 10 (least severe). In addition, the expert consultation panel convened by NZFSA were asked to provide a qualitative ranking (low, medium, high) of the severity of outcomes due to the organisms causing these diseases. Table 8 summarises the severity rankings based on hospitalisation and fatality rates and the qualitative ranking provided by the expert consultation.

Table 7: Hospitalisation and fatality rate parameters for potentially foodborne diseases

Disease	Hospitalisation (%)			Fatalities (%)		
	Min	Mean	Max	Min	Mean	Max
Bacillus intoxication		<0.1			0	
Campyobacteriosis	6.2	6.9	7.6	0	0.012	0.04
Listeriosis	94.4	98.9	100	11.1	18.0	27.3
Tuberculosis disease (*M.bovis*)	55.5	60.6	63.8	0.5	1.5	2.3
Norovirus infection	0.5	2.0	3.6	0	0.11	0.16
Salmonellosis	12.5	13.9	14.9	0	0.11	0.4
STEC infection	16.9	24.0	32.1	0	0	0
Toxoplasmosis						
Vibrio parahaemolyticus infection	12.0	13.5	15.0		0	
Yersiniosis	6.1	9.9	11.6	0	0.05	0.23

Min = Minimum, Max = Maximum

Table 8: Ranking of potentially foodborne diseases by severity

Disease	Hospitalisation ranking (1 = most severe, 10 = least severe)	Fatalities ranking (1 = most severe, 10 = least severe)	Qualitative ranking
Bacillus intoxication	9	7=	Low
Campyobacteriosis	7	6	Medium
Listeriosis	1	1	High
Tuberculosis disease (*M.bovis*)	2	2	High
Norovirus infection	8	3=	Low
Salmonellosis	4	3=	Medium
STEC infection	3	7=	High
Toxoplasmosis	NC	NC	Low
Vibrio parahaemolyticus infection	5	7=	Medium-High
Yersiniosis	6	5	Medium

NC Not able to be classified, due to lack of data

Rankings are remarkably consistent across the three measures, with two exceptions:

- Norovirus infection was classified as low severity by the expert panel and the low proportion of cases hospitalised supports this classification. However, based on outbreak data, norovirus appears to have a disproportionately high case fatality rate.
- STEC infection was classified as high severity by the expert consultation and on the basis of case hospitalisation rates. However, the lack of any reported fatalities within the

five-year timeframe used for data collection means that this disease is not classified as particularly severe on the basis of case fatalities.

The correlation between rankings based on hospitalisation and the qualitative rankings of the expert panel is excellent.

7 CONCLUSIONS: RANKING AND PROCESS

The determination of rankings for incidence and severity has been based on a combination of scientific data and expert opinion. The final step is to combine these into a risk ranking. This presents a challenge as the general trend is for high severity illnesses to be combined with low ranking for incidence, and vice versa. Table 9 classifies each of the food hazard combinations into a low, medium or high category for apportioned incidence and for severity. For the purpose of the categorisation exercise high incidence was taken as >100/100,000, medium as 1-100/100,000, and low as <1/100,000. For severity the qualitative judgments of the expert panel were used.

Table 9: Categorisation of food-hazard combinations on the basis of apportioned incidence and severity

		Severity		
		Low	**Medium**	**High**
Incidence	**High**	Norovirus/Shellfish	Campylobacteriosis/Poultry	
	Medium	*Bacillus* intoxication/Rice	Salmonellosis/Poultry *Vibrio parahaemolyticus* infection/Seafood Yersiniosis/Pork	
	Low			Listeriosis/RTE meats Listeriosis, Ice cream Tuberculosis disease (*M. bovis)*/Milk STEC infection/Red meat STEC infection/UCFM

As discussed previously, the majority of food hazard combinations lie on the axis of high/low, medium/medium, low/high. The only exceptions, based on the categorisation in Table 8 are campylobacteriosis from poultry, that lies above this axis, and *Bacillus* intoxication from rice, that lies below this axis.

During the preparation of Risk Profiles for these food-hazard combinations (see; http://www.nzfsa.govt.nz/science-technology/risk-profiles/index.htm) an initial categorisation of combinations on the basis of incidence and severity was made. Incidence was categorised on a four point scale (1 = >100/100,000, 2 = 10-100/100,000, 3 = 1-10/100,000, 4 = <1/100,000) and severity on a three point scale (1 = >5% severe outcomes, 2 = 0.5-5% severe outcomes, 3 = <0.5% severe outcomes). Comparison of tentative categorisations from Risk Profiles with the results in Table 9 show a high level of congruence. Differences were:

- Yersiniosis was considered to be of medium severity in the current analysis, while it was classified as of low severity in the Risk Profile
- Campylobacteriosis was considered to be of medium severity in the current analysis, while it was classified as of low severity in the Risk Profile
- The incidence of norovirus infection due to shellfish consumption was estimated to be high (>100/100,000) in the current analysis, while the Risk Profile estimated an incidence in the range 10-100/100,000.

This document describes a process for risk ranking that has amended the generic ranking processes taken from the literature. It is likely that the risk ranking will need to be updated from time to time, as new issues are identified, or new information is assembled (e.g. new completed Risk Profiles). The stepwise risk ranking process for the NZFSA can be described as:

1. Define and categorise the food/hazard combinations whose risk is to be ranked;
2. Assemble available scientific data related to the attributes: incidence and severity.
3. Describe the risks in terms of the attributes on the basis of an expert consultation;
4. Combine scientific data and expert consultation to produce the risk ranking; and,
5. Describe the issues identified and the resulting rankings.

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