The annual cost of foodborne illness in Australia

March 2006

Australian Government Department of Health and Ageing

Prepared for the
Australian Government Department of Health and Ageing
by Applied Economics Pty Ltd

March 2006

ISBN: 0 642 82906 3

Online ISBN: 0 642 82907 1

Publications Approval Number: 3827

Authors

Dr Peter Abelson, Managing Director, Applied Economics Pty Ltd

Ms Mary Potter Forbes, Research Manager, NSW Injury Risk Management Research Centre, The University of New South Wales

Dr Gillian Hall, National Centre for Epidemiology and Population Health, The Australian National University

Front cover photographs

Dr John Marshall from the Victorian Infectious Diseases Reference Laboratory supplied the electron micrograph of norovirus particles in faeces.

Other photographs by Ann Parkinson.

Contents

Acknowledgments

I wish to acknowledge the essential contribution to this report by Dr Gillian Hall, National Centre for Epidemiology and Population Health, The Australian National University, Canberra. Drawing on the Centre's work, Dr Hall provided the epidemiological and health care utilisation estimates that are fundamental to this report. In particular, Dr Hall prepared Chapter 3 and Appendix A.

Mr Martyn Kirk and Ms Donna Cassoni, Australian Government Department of Health and Ageing, provided assistance with references and general advice throughout this study. Mr Kirk also provided the estimates of the costs to government of operating foodborne disease surveillance units, which are reported in Chapter 4. I also wish to thank Dr Scott Crerar, Food Standards Australia New Zealand, for providing data on the costs of food recalls.

Dr Peter Abelson
Applied Economics Pty Ltd, Sydney

Executive summary

Reliable estimates of both the incidence of foodborne illness and its financial impact are essential for informing policy decisions on food safety. Knowing the size of the problem also helps in assessing the effectiveness of any changes to food safety standards and regulations.

A recently published report, *Foodborne illness in Australia: annual incidence circa 2000* (Hall & Kirk 2005), provides the most comprehensive assessment of Australia's annual incidence of foodborne illness. That report showed that contaminated food caused approximately 5.4 million cases of gastroenteritis per year, along with 6,000 non-gastrointestinal illnesses and 42,000 episodes of long-term effects (chronic sequelae). Foodborne illness also led to 1.2 million visits to medical practitioners, over 300,000 prescriptions for antibiotics and 2.1 million days of work lost each year.

This current study uses the information in the 'incidence' report to estimate the annual cost of foodborne illness to Australia. Where possible, costs are based on 2004 prices, although costs of hospital services draw on 2002 cost estimates. The five areas where costs have been estimated are presented in Table 1.

Table 1 **Annual costs of foodborne illness in Australia**

Area to which costs apply	Cost ($ million)
Individuals and business: all productivity and lifestyle	771.6
Individuals: premature mortality	231.5
Health care services	221.9
Business: food safety recalls	14.0
Governments: foodborne illness surveillance and investigation, and maintaining food safety systems	10.0
Total	**1,249.0**

The total cost of foodborne illness in Australia is estimated at $1,249 million per annum. All productivity and lifestyle costs amount to $771.6 million (62% of the total). The next highest cost is due to premature mortality ($231.5 million; 19% of the total). Health care services amount to $221.9 million (18% of the total), of which emergency care and general practitioner and specialist services account for two-thirds.

Foodborne gastroenteritis accounts for approximately $811 million annually (81% of all productivity, lifestyle and premature mortality costs). Seven other foodborne illnesses account for the balance of 19% and, of these, listeriosis and reactive arthritis are the major contributors to costs.

Of the costs to health care services, foodborne gastroenteritis accounts for an estimated $200 million (90%). The seven other illnesses account for the remaining $22 million (10%), with irritable bowel syndrome being the most expensive of this group.

The costs to governments of public health actions (foodborne illness surveillance and investigation, and maintaining food safety systems) and the non-productivity costs to business are significant, but minor relative to the other costs of foodborne illness. The estimated cost of public health actions is in the order of $10 million annually (0.8%). Excluding the occasional exceptional cases, the estimated cost of business disruption due to recalls of a food safety nature is in the order of $14 million a year (1.1%).

Although this report is based on carefully considered research, much of the data are subject to some uncertainty. In general, the incidence of foodborne illness may vary by 25% above or below the estimates, thereby affecting the certainty of the cost estimates.

Nevertheless, the estimates in the report show that foodborne illness represents a significant continuing cost to the Australian community, and that efforts by governments, business and consumers to reduce the number of failures in food safety should continue to be encouraged.

This report provides the best available estimates of the costs of foodborne illness, circa 2000. However, the incidence of foodborne illness is unlikely to be static as it is influenced by a range of factors such as new regulations, emerging pathogens, changing agricultural and manufacturing practices, and changing trends in consumers' food choices and eating patterns.

Similarly, the effects of foodborne illness on Australian society are unlikely to remain the same. Australia has an ageing population and foodborne illness is known to affect vulnerable populations, including the aged, more severely. Consequently, there is a risk that the effects of foodborne illnesses on the economy may increase, unless interventions can reduce the incidence of these illnesses.

1 Introduction

This report provides estimates of the annual cost of endemic and epidemic foodborne illness in Australia.[1]

Costs are based on the estimated incidence of foodborne illness due to the following acute illnesses:

- gastroenteritis
- non-gastroenteritis illnesses (invasive listeriosis, toxoplasmosis, hepatitis A)
- sequelae (haemolytic uraemic syndrome, irritable bowel syndrome, Guillain-Barré syndrome and reactive arthritis).

The estimated costs relate to the incidence of foodborne illness in a typical year. Most costs are incurred and borne in the same year. However, in a few cases longer term effects (sequelae) may persist for more than a year. This report includes estimates of the costs of sequelae that are experienced in the study year but are due to infections occurring in earlier years. It does not estimate the costs of sequelae due to infections in the study year.

Gastroenteritis accounts for a high proportion of the total cost. The estimates for foodborne gastroenteritis are based on morbidity data collected by the National Centre for Epidemiology and Population Health (NCEPH) over a 12-month period in 2001–02. Experts in foodborne illnesses believe that this period may be regarded as representative. There was no major foodborne epidemic during this period, and the number of outbreaks in the year was not unusually high or low.

Epidemiological data for the other illnesses are drawn from various sources, as described in Chapter 3. In most cases, the costing data relate to 2003 or 2004.

The report estimates the major costs of foodborne illness. These include the costs of:

- health care services
- foodborne disease surveillance and control units
- lost productivity borne by businesses
- lost productivity, lifestyle and mortality costs borne by individuals, inclusive of the costs of caring for ill family members
- business disruption associated with food recalls.

Where possible, costs are based on 2004 prices, though costs of hospital services draw on 2002 cost estimates (the latest available data).

Accordingly, the estimates of the typical annual costs of foodborne illness are given in approximately 2004 prices. Given the low rate of inflation between 2002 and 2004, the costs of health care that were based on 2002 data have not been adjusted.

1 This report does not discuss or estimate the costs associated with ciguatera or scombroid poisoning. These morbidities are discussed in Hall and Kirk (2005).

2 Valuation methodology

2.1 Costs of health care services

For each type of illness, the report gives estimates of six main sets of health care costs:

- hospitalisations
- visits to emergency departments
- visits to general practitioners (GPs)
- specialist services
- diagnostic testing
- pharmaceutical expenses.

In each case, costs are the product of the **quantity** of services associated with each form of foodborne illness and the **unit cost** of these services.

Estimates of the incidence of disease and the quantity of services required for each of the six health care service categories shown above are given in Chapter 3 and Appendix A. The unit cost for each service and the total health care cost for each illness are reported in Chapter 4, with some further unit cost data in Appendix B.

2.2 Public foodborne illness surveillance and control costs

Government agencies across Australia:

- carry out foodborne illness surveillance
- conduct diagnostic testing
- conduct surveillance of specific infections
- investigate outbreaks of foodborne illness
- monitor food recalls.

In the absence of special survey work it is not easy to determine the specific costs incurred by government agencies as a result of outbreaks of foodborne illness.

Chapter 5 describes surveillance and control costs based on the regular staffing of surveillance units.

2.3 Health costs borne by businesses and individuals

In a few instances, individuals die as a result of foodborne illness. More generally they experience four main costs due to the illness:

- loss of workplace productivity (also borne by employers)
- loss of household productivity and disruption to household activities

- the cost of employing carers
- lifestyle disruption, for example pain and suffering, that is not included in the above.

The valuation procedures for premature mortality and the costs of illness are described below. More detail is given in Chapter 6.

Loss of life

Appendix A shows the estimated age ranges at which people died from foodborne illness, for most of the illnesses in this study. For hepatitis A and irritable bowel syndrome the estimates of early death are not age-specific.

When the data are not age-specific, the study adopts a value of life lost of $2.5 million. This figure is based on Abelson (2003b), which provides a comprehensive survey of methods and results for valuing life. Traditionally Australian authorities put a value on life of about $1.0 million (for example NSW Roads and Traffic Authority 2004). This figure is based on a human capital valuation in that it represents the present value of future earnings foregone.

However, as shown in Abelson (2003b), this approach is not consistent with economic valuation (willingness-to-pay or WTP) principles. The value of something, including life and health, is what individuals are willing to pay for it. In the case of life, the value of a life is derived from what individuals are willing to pay to reduce the risk of death. If people are willing to pay $2,000 on average to reduce the risk of death by 1 in 1,000, the value of one life is $2.0 million (that is, $2,000 x 1,000). Drawing on WTP studies, most estimates of WTP values for life fall in the range of $2.5 million to $7.0 million.

When there are data on deaths by age group, we estimate the present annual value of the number of years lost. To do this, we need estimates of the value of life over a year, the number of years lost and a discount rate.

To obtain an annual value of life, we convert the life value of $2.5 million to an annual figure. Assuming that 40 years of life are foregone and that an individual's real rate of time discount is 3%[2], a capital value of $2.5 million equates to the $108,000 per annum used in this report.[3] The average numbers of years lost for each

2 The timing of costs and consequences that do not occur in the present must be taken into account. A dollar received in the present is worth more than a dollar that is to be received some time in the future. This is known as the 'time preference for money'. Discount rates are applied to reflect this time preference, and costs and consequences that occur in the future are 'discounted' back to present-day values. A 3% discount rate was adopted as this was considered to best reflect the individuals' time preference rates.

The choice of discount rate has been much debated, centring on the choice between a marginal return on capital measure and the marginal rate at which individuals discount future consumption (an individual rate of time preference). The estimated risk-free marginal real return on capital for major projects is usually about 7–8%. However, because tax creates a wedge between the return on investment to society (including tax) and the return that private individuals receive, the real rate at which individuals discount future marginal consumption is generally in the order of 3–4% per annum.

type of foodborne illness is estimated using life tables. We adopt a 3% discount rate in this case because individual time preference rates are generally lower than the opportunity cost of capital due to the tax wedge (see Chapter 7, Abelson 2003a).

Loss of workplace productivity

The loss of workplace productivity is the product of the amount of work time lost and the unit value of work time. Appendix A provides estimates of the amount of work time lost for each illness. Time off work is valued at $175 per day based on average daily earnings. Note that this cost may be borne by the employer or the employee (depending on the nature of the employment or contract) or by a self-employed person. Chapter 6 describes our assumptions about the bearing of these costs.

Loss or disruption to household activity

Loss of household activity is the product of the amount of time lost or disrupted by people experiencing foodborne illness or people caring for those with foodborne illness, in activities other than paid work, and the unit value of household time. For gastroenteritis, Appendix A provides estimates of the amount of household activity time lost for each illness. We estimate the cost of the days lost or disrupted at 50% of average daily earnings (that is, at $87.50 per day).

As noted in Appendix A, the concept of household activity lost or disrupted is not a precise one and this is a potential source of error in estimating costs. Similarly, our assumption that such a day lost or disrupted has a cost of $87.50 reflects a judgment rather than a survey-based estimate. However, because of the valuation methodology we adopt in this report and describe below, possible errors in the estimates of lost or disrupted time and in the value per day assumption have a small effect on the estimated total cost of foodborne illness.

Costs of carers

The cost of carers is the product of the amount of time required for carers and the unit cost of carer time. However, the figures in Appendix A do not distinguish between carer and other time. Both work time lost and household time disrupted include carer time. Accordingly, when carer time is included in work time, it is valued at $175 per day. When included in household time, it is valued at $87.50 per day.

Lifestyle pain and suffering

Lifestyle pain and suffering is an all-inclusive set of costs borne by individuals, other than those costs included in loss of workplace productivity, loss of household productivity and disrupted household activities, and costs of carers.

3 $2.5 million = $108,000/1.03 + $108,000/$(1.03)^2$ + ...$108,000/$(1.03)^{40}$.

We estimate this **residual lifestyle cost** by (i) estimating the amount that individuals are willing to pay to avoid an illness, and (ii) by subtracting household-borne costs that have already been estimated. Thus:

$$LFC = WTP - (WPC + HDC) \qquad \text{(Equation 2.1)}$$

where LFC = lifestyle (residual) costs

WTP = total willingness to pay to avoid the illness

WPC = workplace costs (including carer costs) borne by the individual, not by the employer or business

HDC = household productivity and disruption costs.

Clearly, the estimate of LFC depends crucially on estimates of willingness to pay to avoid illness. This is estimated as follows:

$$WTP_i = SW_i \times D_i \times VDH \qquad \text{(Equation 2.2)}$$

where SW = the severity weight

D = days with illness

VDH = the value of a day of good health

subscript i denotes the type of illness.

The **severity weight** is a measure of the loss of quality of life. To represent this weight we use disability adjusted life year (DALY) weights. DALY weights are the disutility for a year not lived in perfect health. They are obverses of quality of life (QoL) indices, which identify the utility value of particular health states: QoL = (1 – DALY). For example, a severity weight for a case of food poisoning of medium severity that requires a visit to a GP is 0.094 (based on the relevant DALY in AIHW: Mathers et al. 1999). This indicates that an individual is losing 9.06% of the value of full health for a given period (in this case a number of days).

The **value of a day of good health** is valued in this study as the value of a year in good health divided by 365 days ($108,000/365 days = $296).

Assuming that a case of food poisoning of medium severity lasts for four days, an individual would be willing to pay $111 to avoid this illness (0.094 x 4 x $296 = $111).

Now it may be noted that the total costs (TC) borne by individuals are:

$$TC = WPC + HDC + LFC \qquad \text{(Equation 2.3)}$$

where the terms are as before, and WPC includes loss of carer time.

If we substitute in Equation 2.1 we obtain:

$$TC = WPC + HDC + WTP - WPC - HDC = WTP. \qquad \text{(Equation 2.4)}$$

In effect, the total cost of illness borne by individuals equals what individuals are willing to pay to avoid the illness.

This being the case, it might be asked: is it necessary to estimate the value of lost workplace and household activity? Why not simply estimate the total WTP figure?

The answer is that the dual approach, estimating both total cost and the main components, provides an important validation process.

In some cases household disruption costs are so high that there is no residual lifestyle cost. Most likely this means that household disruption costs have been overestimated, and the pain and suffering component of the costs has been underestimated. However, this dual process helps to validate the overall cost of illness, which is the figure of most interest.

2.4 Business costs in provision of safe food

There are two main business costs related to the provision of safe food. These are:

- the costs of complying with regulations
- the costs of disruption when food contamination occurs.

Business faces a trade-off. It may incur high costs of compliance and suffer few disruption incidents, or incur high costs of disruption because it has undertaken less compliance activity. Thus the food industry incurs high costs to ensure that export markets are protected (see Department of Agriculture, Fisheries and Forestry 2003).

The Allen Consulting Group estimated in 2002 that the costs of compliance with food regulations fell in a broad range of $200 million to $600 million, depending on assumptions about how much activity was attributable to food regulations and how much to standard business practice. But the Allen Consulting Group did not discuss the industry costs of dealing with food contamination. In this report, we focus on the costs of disruption.

Foodborne illness incidents may involve a number of costs to business, including:

- recall costs
- remedial costs (where applicable)
- information costs
- replacement costs
- litigation costs
- temporary or even permanent closure costs.

Of these, the most common are recall and replacement costs. The economic loss is the resource cost of replacing those products (since those resources could otherwise have produced some other goods), plus the resources involved in managing the recall process. Severe outbreaks can result in business closure.

Estimation of the cost to society is complicated because costs to one business may be offset by gains to a competitor. In this case the net loss to business is less than the gross cost to the initially affected business(es). Note also that the results of litigation may simply transfer costs borne by individuals to the business(es) responsible for the incident.

Empirically, the issue is complicated by the lack of documentation about foodborne incidents. Minter Ellison (2002) describes five significant foodborne incidents and outlines some industry effects, but does not quantify the monetary value of other costs. Applied Economics (2003) provides more data for one of these incidents—the cost of the outbreak of hepatitis A due to contamination of oysters in Wallis Lake, New South Wales.

Chapter 6 draws on these available data sources to show the kinds of costs borne by industry. Food Standards Australia New Zealand (FSANZ) also provided some data on food recall costs.[4]

2.5 Sensitivity tests

Many data in the report are uncertain. As discussed in Chapter 3, the incidence of foodborne illness is necessarily an estimate and Dr Hall has provided a range of incidence estimates around the mean. For many cost and valuation parameters, and especially for the value of a healthy year or day, there is also a plausible range of values. The report provides a range of results that allow for uncertainties in the data.

4 In a supplementary report, Applied Economics (2005) provides an analytical basis for estimating the cost of foodborne illness incidents to business, and a template for examining these costs when outbreaks occur.

3 Incidence of foodborne illness, health care and lost productivity

3.1 Introduction

Contaminated food can cause a range of illnesses, including:

- acute illnesses (gastroenteritis, invasive listeriosis, toxoplasmosis and hepatitis A)
- long-term sequelae (haemolytic uraemic syndrome, irritable bowel syndrome, Guillain-Barré syndrome and reactive arthritis).

Clinical information on these illnesses is given in Appendix A.

The incidence of both acute illness and sequelae were estimated in a study published in 2005 (Hall & Kirk, *Foodborne illness in Australia: annual incidence circa 2000*). This information was used extensively in estimating the costs of foodborne illness in Australia.

3.2 Data sources

Data for each illness are derived from different sources, because there is no single data source for each disease that covers the number of cases in the population, health care use and time off normal activities. Australian data are used when they are available.

Data sources include:

- National Gastroenteritis Survey 2001–02, conducted by OzFoodNet and NCEPH
- National Hospital Morbidity Database, held by the Australian Institute of Health and Welfare (AIHW)
- registered deaths data (mortality data), held by the Australian Bureau of Statistics
- National Notifiable Diseases Surveillance System, managed by the Australian Government Department of Health and Ageing (DoHA)
- notifiable diseases surveillance systems, held by state and territory health agencies
- Bettering the Evaluation and Care of Health (BEACH), held by AIHW and The University of Sydney
- various published studies, which are shown in Appendix A.

Where information was not available from these sources we obtained opinions from clinicians and other experts. Tests and treatment regimes were based on those suggested by the Royal College of Pathologists of Australasia and other clinical experts.

Several sources were used for estimates related to each disease. While the best available data are used, the quality of the data varies. This leads to a degree of uncertainty in the estimates of the amount of illness, treatments and lost time. An indication of the degree of uncertainty in the estimates of incidence (number of

cases in the Australian population per year) is given in Table 3.1 through use of the concept of a 'plausible range' and '95% credible interval (CrI)'[5] (see Hall & the OzFoodNet Working Group 2004 for more details).

Where data were obtained from formal, statistically sound studies, the credible interval is based on the 95% confidence interval (CI). Where definitive, statistically sound data were not available, a reasonable interpretation of available data informed the estimate of the credible interval of values. This means that the parameters of the credible interval are not necessarily based on a statistically derived value, but on interpretation of the best available data. The credible intervals were estimated using simulation of the uncertainty in each of the components of information used to calculate the incidence. Hall and colleagues (2005) describe the method.

Proportion of illnesses that are foodborne

Estimates of the proportion of illnesses that are foodborne were based on information from relevant literature, data from outbreaks, and collation of opinions from foodborne disease experts in Australia. A Delphi process involved ten experts who gave their opinions on gastroenteritis (Hall & the OzFoodNet Working Group 2004), and nine experts for each of the other acute diseases. Estimates for the proportions of sequelae due to foodborne causes were based on information in the literature and opinions from specialist physicians.

3.3 Infectious gastroenteritis

A national survey of the incidence of gastroenteritis in Australia and associated health-seeking behaviour, and to collect other information, was conducted for 12 months over 2001–02. The study was a representative, retrospective, cross-sectional survey across all states.

Data were collected by computer-assisted telephone interviews. The sample frame was all people living in residential households with a land telephone line. Households were selected by random-digit dialling.

The person in the household with the most recent birthday was interviewed. If the selected respondent was not at home, nine further attempts were made to contact the person at different times of the day before moving on to the next randomly selected respondent. The response rate was 67% of contacted households.

All respondents were asked about vomiting and diarrhoea, chronic illness, food safety perceptions, demographics and socioeconomic status. Respondents reporting diarrhoea or vomiting were asked for more details on symptoms and timing, health care use, investigation and treatment practices, and the effect of their illness on work and activities.

5 Credible interval (CrI): a concept used where data are scarce. Available data are used to simulate a plausible distribution. The middle 95% of the distribution is the credible interval, which describes the uncertainty in the estimates. A 95% credible interval means there is a 95% probability that the true value is contained in the interval. A wider interval indicates a higher level of uncertainty.

Case definition of gastroenteritis

The definition of gastroenteritis used in this study includes cases of moderate to severe illness (at least three loose stools or two vomits in 24 hours). Although there is no internationally agreed standard definition, this is consistent with most definitions of gastroenteritis that are based on a severity of three or more loose stools in 24 hours. Cases where persons identified a non-infectious cause of their symptoms (such as pregnancy, alcohol or chronic illness) were excluded. To minimise the influence of respiratory infections that might have concomitant gastrointestinal symptoms, a higher level of gastrointestinal symptoms, of at least four loose stools or three vomits, was required if respiratory symptoms were reported.

The data from the gastroenteritis study were weighted to the Australian population by age, sex and household size, and extrapolated to the whole population. The results of the survey gave an estimated 17.2 million cases (95% CI: 14.5–19.9 million cases) of moderate to more serious gastroenteritis in one year in Australia.

It is important to recognise that a stricter case definition would include only more severe cases, while a less strict definition would include more cases with a lesser level of illness. The survey showed that health care behaviour and time off work are related to the severity of the illness, with the more severe cases seeking health care and experiencing interruptions to work and activity. This means that regardless of the strictness of the definition used, the total population costs associated with gastroenteritis remain basically steady. It is the average cost per case that will change according to the definition, as this influences the total number of cases. Data presented as 'cost per case' should be interpreted with this in mind.

Proportion of gastroenteritis that is foodborne

The proportion of gastroenteritis due to contaminated food was estimated at 32% (95% CrI: 24–40%). This gives an estimated 5.4 million cases of foodborne gastroenteritis, including moderate and more serious cases in Australia each year (95% CrI: 4.0–6.9 million cases). Hall and colleagues (2005) show how this estimate was derived.

Visits for health care and treatment

The community survey gave estimates for visits to GPs and emergency departments, and for medications taken. There were so few admissions to hospital in the survey that the estimates for hospital admissions were not robust (with a large standard error). This means that even one more or less person attending hospital in the community survey could have significantly influenced the estimate of the number of hospital admissions. Accordingly, the National Hospital Morbidity Database was used for estimating hospitalisations as being a more reliable data source for this item.

The number of stool tests reported in the survey was also low, with resultant wider standard errors. The estimate was validated by comparison with Health Insurance Commission data that indicate a similar number of stool tests for the same period, 2001–02.

Time lost

Time lost due to the illness, for both paid work and other activities, was estimated from the survey. This included time lost by either the person with gastroenteritis or another person looking after the ill person.

Mortality

Death due to foodborne illness is a rare event in Australia. The National Hospital Morbidity Database 1993 to 1999 was used to estimate the number of deaths per year due to gastroenteritis. All hospital admissions where infectious gastroenteritis was either the main reason for hospital admission or a contributing reason (principal or one of nine additional diagnoses) were examined. Of those people who died, gastroenteritis was likely to have contributed to death, although it was not necessarily the only or main reason.

A summary of estimates for gastroenteritis is shown in Table 3.1. Details are in Appendix A.

Table 3.1 **Estimates of illnesses due to foodborne transmission in Australia in one year. Estimated numbers of cases, deaths, health care visits, treatments and time lost**

Foodborne illness	Percentage of cases in population due to foodborne transmission (95% CrI)[a]	No. cases due to foodborne illness/year (95% CrI)[b]	Deaths/ year	Hospital-isations/ year	Mean days in hospital/ patient	Visits to GPs/ year	No. of days lost paid work and activities/ year[c]
Gastroenteritis	32 (24–40)	5.4 million (4.0–6.9)	80	15,000	2	1.4 million	5.8 million
Listeriosis	98 (92–100)	120 (100–130)	26	120	23	180	3,000
Toxoplasmosis	35 (0–71)	5,900 (0–13,900)	0	21	8	1,200	9,020
Hepatitis A	10 (0–24)	150 (0–1,000)	1	24	4	540	6,020
Haemolytic uraemic syndrome	50 (0–100)	20 (0–40)	3	30	9	45	290
Irritable bowel syndrome	30 (10–60)	20,200 (6,400–35,800)	3	2,700	2	91,700	49,500[d]
Guillain-Barré syndrome	20 (15–25)	120 (90–160)	12	120	13	770	9,900
Reactive arthritis	30 (20–40)	21,000 (6,400–36,000)	0	20	5	17,100	61,050

(a) The proportion of cases due to foodborne transmission varies with different illnesses.

(b) The numbers in brackets indicate the credible interval—see text for details.

(c) Includes lost work days and household activity days.

(d) New and old cases of irritable bowel syndrome.

Sources: See Appendix A.

3.4 Invasive listeriosis, toxoplasmosis, hepatitis A and haemolytic uraemic syndrome

Invasive listeriosis, toxoplasmosis, hepatitis A and haemolytic uraemic syndrome are much less common than gastroenteritis, but each can lead to clinically serious illness (although there is a range from mild to serious for most of them). Information on the clinical characteristics of each of the illnesses and details of estimates are given in Appendix A. A summary of estimates of incidence, health service use and time off from activities and work is shown in Table 3.1.

Basic incidence data for invasive listeriosis, hepatitis A and haemolytic uraemic syndrome were obtained from notifiable disease data. We assumed that the notified numbers of invasive listeriosis were half those that actually occur, and adjusted under-reporting by a factor of 2.[6] For listeriosis there is a significant danger to the unborn foetus if the mother is infected, even if the mother is not very unwell. Each materno-foetal pair is counted as one illness.

Incidence data for toxoplasmosis was not available for Australia and was based on data from the United States of America (Mead et al. 1999).

For hepatitis A, under-reporting was assumed to be a factor, as in previous studies overseas (Mead et al. 1999). The National Notifiable Diseases Surveillance System collects data on both laboratory-confirmed cases and GP notifications for 'probable cases' of hepatitis A, but it is likely that a significant number of cases are not reported. People with mild illness are unlikely to present to a doctor. In addition, some people may not have a definitive diagnosis because hepatitis A antibodies were not detected. The number of notifications was therefore doubled[6] before adjusting for a fraction 'due to foodborne transmission'.

Haemolytic uraemic syndrome estimates were derived from notified data and the Australian Paediatric Surveillance Unit (APSU).

Proportion of illnesses that are foodborne

There are few data on the proportion of these illnesses due to foodborne transmission. Nine foodborne disease experts were asked for their opinion (May 2004) and, for haemolytic uraemic syndrome, supplementary data were obtained from the APSU (2004) and the Victorian surveillance system (J Gregory, OzFoodNet, DHS, 2004, pers. comm.). The results are summarised in Table 3.2. There was considerable variation in opinion for toxoplasmosis, hepatitis A and especially haemolytic uraemic syndrome. Data available for haemolytic uraemic syndrome from the APSU and outbreaks in Victoria lend support to the estimate of around 50%.

6 Not all infections causing hospitalisations are correctly diagnosed or reported. To account for this under-reporting we doubled the number of cases, as in Mead and others 1999.

Table 3.2 **Proportion foodborne: Delphi results**

Disease	Mean	Standard deviation	95% CrI
Listeriosis, materno-foetal	98	3	92–100
Listeriosis, others	98	3	92–100
Toxoplasmosis	35	18	0–71
Hepatitis A	10	7	0–24
Haemolytic uraemic syndrome, children 0–15 years	50	26	0–100
Haemolytic uraemic syndrome, adults 15 years or over	56	29	0–100

3.5 Irritable bowel syndrome, Guillain-Barré syndrome and reactive arthritis

These illnesses develop in a small number of people as a consequence of a gastroenteritis infection. Irritable bowel syndrome causes ongoing disturbance of bowel function with varying degrees of severity. Guillain-Barré syndrome is a progressive paralysis that can be fatal. Patients often require intensive support, including respiratory assistance for days to weeks, until the paralysis passes. Reactive arthritis is characterised by pain in large joints and general debilitation, and usually lasts weeks to months.

While the features of these illnesses differ markedly, they are all caused by a reaction that occurs some time after the original infection. However, these illnesses can sometimes be a sequel to infections other than gastroenteritis. A summary of estimates of the numbers relating to these illnesses due to foodborne transmission is shown in Table 3.1. More information about the characteristics of the illnesses and details of the estimates are shown in Appendix A.

Estimates of the number of foodborne cases of the three sequel illnesses are based on a combination of Australian data and overseas studies that have followed large cohorts of people who had gastroenteritis caused by a confirmed pathogen. The studies documented the development of illnesses at a later date in a certain proportion of these people (see Appendix A).

Calculation of the number of cases of irritable bowel syndrome and reactive arthritis include incorporation of data on the incidence of certain types of bacterial gastroenteritis in Australia (Hall & the OzFoodNet Working Group 2004). The incidence of irritable bowel syndrome and reactive arthritis are derived by applying the relevant proportions of foodborne cases found in the overseas studies to the estimate of the total number of foodborne gastroenteritis cases caused by certain bacterial pathogens in Australia. There is a degree of uncertainty inherent in these estimates, due particularly to the paucity of data used to derive the estimates of bacterial gastroenteritis. This uncertainty is indicated in the 95% credible interval range given for each illness.

The estimate of the incidence of Guillain-Barré syndrome was based on the assumption that all cases would be admitted to hospital. Data from the National Hospital

Morbidity Database gave the estimate of all cases of Guillain-Barré syndrome in Australia each year. The proportion of cases due to foodborne gastroenteritis estimated in the overseas studies was then applied to this.

4 Health care service costs

4.1 Introduction

The health care service costs estimated in this study are for hospitalisations; visits to hospital emergency departments, GPs and specialists where applicable; pharmaceutical consumption; and pathology or laboratory tests. Medical imaging is included when it is a significant component in the management of an illness.

Appendix A describes the quantity of health care services used in treating foodborne illness. More data on health care services are available for gastroenteritis than for the other illnesses. For gastroenteritis, data are available by male and female groups and the four age groups of 0–4 years, 5–14 years, 15–64 years and 65 years or over. For the other illnesses, data on services are not usually sex- or age-specific.

This chapter describes the main unit costs for each service and provides estimates of total costs of health care services. Appendix B provides further details on unit costs.

4.2 Main unit cost components

Hospitalisation

Our estimates of hospital costs are based on the national average cost of the most relevant diagnosis related group (DRG). This involved determining the most appropriate DRG and applying the relevant costing. The costs are those of 2002.

To find the relevant DRG, we first identified the Major Diagnostic Category (of which there are 23) into which the disease would be classified, and then identified the associated DRG category. DoHA's website provides a search facility for this process. Gastrointestinal diseases are generally found within Major Diagnostic Category Chapter XI (Digestive System). Non-gastrointestinal infections can be found in Chapter VI (Nervous System) and Chapter XIV (Genito-Urinary System). Where a number of DRG groups and costs could apply to a particular illness, a judgment was made as to the most appropriate classification according to disease severity.

The DRGs relevant to gastroenteritis are presented in Table 4.1. Of the five DRGs, four are differentiated by age, level of complexity and average length of stay (ALOS) in hospital. The latter was a helpful indicator as the epidemiological data also provides length of stay estimates for foodborne illnesses. ALOS was about two days for the three age groups under 65 years and five days for persons over 65.

Table 4.1 **Gastrointestinal DRGs and costs** (2002 prices)

DRG	Description	ALOS	Cost ($)
G67A	Oesophageal, gastroenteritis, and misc. Age over 9. With complications.	5.66	3,522
G67B	Oesophageal, gastroenteritis, and misc. Age over 9. No complications.	2.02	1,254
G68A	Gastroenteritis. Age under 10. With complications.	3.61	2,673
G68B	Gastroenteritis. Age under 10. No complications.	1.63	1,358
G69Z	Oesophageal and misc. digestive system problems. Age under 10.	1.94	1,510

Source: http://www.health.gov.au/casemix/costing/graph_table/round6/Public_National_Cost_Weights_Round_6_estim.xls.

Table 4.2 shows the DRG values and related costs selected for this report. DRG G68B was considered the most appropriate category for children under five years of age. For children aged 5–14 years, we adopted the average of the child with complications (G68A) and the adult with no complications (G67B), to account for the two DRGs that are covered by the 5–14 years age grouping ($2,673 and $1,254, for an average of $1,964). For adults, DRG G67B was considered the most relevant measure. For people over 65 years of age, we adopted DRG G67A.

Table 4.2 **DRGs and hospital costs for gastroenteritis, by age categories**

Age group	ALOS	DRG	Cost ($)
0–4 years	2	G68B	1,358
5–14 years	2	Av. G68A + G67B	1,964
15–64 years	2	G67B	1,254
65 years or over	5	G67A	3,522

Table 4.3 shows the DRGs adopted for the seven non-gastrointestinal illnesses in this report. Again, ALOS was a guide to the appropriate DRG. Listeriosis cases were hospitalised for an average of 23 days so it was assumed that all cases involved complications and we adopted DRG T01A with a cost of $19,541. ALOS for toxoplasmosis cases was eight days, so DRG T01C ($4,991) was adopted for these cases. Hepatitis A had an ALOS of four days, giving a cost of $8,134. Haemolytic uraemic syndrome was valued to the operative procedure for dialysis at $10,939. All cases of irritable bowel syndrome were costed at $1,254. Guillain-Barré syndrome was valued at the highest non-procedural rate of $5,098 and reactive arthritis was valued at the highest rate of $3,339, given the comparable ALOS between the epidemiological data and the DRG.

Table 4.3 **Non-gastrointestinal DRGs and costs** (2002 prices)

Disease	ALOS	DRG	DRG ALOS	Cost ($)	Description
Listeriosis	23	T01A	21.34	19,541	Operative procedures for complicated infectious or parasitic diseases
Toxoplasmosis	8	T01C	7.15	4,991	Other complicated infectious and parasitic diseases
Hepatitis A	4	H63A	8.26	8,134	Complicated disorders of the liver
Haemolytic uraemic syndrome	9	L02Z	11.04	10,939	Operative insertion of peritoneal catheter for dialysis
Irritable bowel syndrome	2	G67B	2.02	1,254	Oesophageal, gastric and miscellaneous digestive disorders in ages over nine years
Guillain-Barré syndrome	13	B71A	7.42	5,098	Complicated cranial and peripheral nerve disorders
Reactive arthritis	5	I66B	5.31	$3,339	Inflammatory musculoskeletal disorders

Source: http://www.health.gov.au/casemix/costing/graph_table/round6/Public_National_Cost_Weights_Round_6_estim.xls.

Emergency department visits

For gastrointestinal illness, estimated average cost per emergency department visit is $212, as estimated in the National Hospital Cost Database Collection. Average costs are available for four triage levels for presentations that are admitted, and for four levels for those that are not admitted. However, we adopted an overall average cost per emergency department visit as there were no data on the probability of admission or level of severity of admitted cases.

The only other foodborne illnesses that were costed for presenting to an emergency department were listeriosis and hepatitis A. Visits for listeriosis were costed at admitted triage level two at $393, while visits for hepatitis A were costed at the average cost of $212 (Appendix B).

Visits to general practitioners and specialists[7]

For visits to GPs and specialists, we adopted an average cost of $60 for an initial long GP consultation, $40 for a repeat GP visit, $90 for a specialist visit and $75 for a repeat specialist visit. These costs are calculated using the Medicare Benefits Schedule (MBS) payments, plus an estimate of the average copayments.

These costs are higher than those in the MBS, where the rebate for a long GP visit (Item 36 consultation), in which a detailed history is taken, investigations organised and a management plan implemented, is $48.75. Shorter visits are set at the Item 23 standard consultation rate of $25.70, or the brief consultation rate of $11.75 for a known problem. The MBS rebate for specialist consultations outside hospital is $60.45 for the initial consultation (Item 104) and $30.35 (Item 105) for subsequent

7 The estimated costs are based on the MBS for 2004. The costs do not include the rebate amounts.

visits. However, these MBS figures do not reflect real and full economic costs of providing GP and specialist services.

Laboratory (pathology) costs

The only test identified for gastroenteritis cases was a stool test. We allowed for this test as an Item 69345 (three stool culture test), with a cost of $51.65.

A variety of tests are required to diagnose and monitor non-gastroenteritis diseases and those that were included in the model are given in Appendix B.

Pharmaceutical costs

Various medications are used for each of the symptoms of gastroenteritis, such as diarrhoea or vomiting, and we applied the weighted average cost within each category. We obtained the prices of medications for gastroenteritis from the Pharmaceutical Benefits Scheme schedule. The medications and prices are provided in Appendix B. The relevant costs for treating non-gastroenteritis diseases are also included in Appendix B.

4.3 Summary of health care service costs

Tables 4.4 and 4.5 provide estimates of total health care service costs for foodborne gastroenteritis and non-gastroenteritis illnesses respectively.

Total health care costs for gastroenteritis are estimated at $200 million per annum in 2002 prices. Visits to GPs and emergency departments account for about two-thirds of these costs.

Total health care costs for other non-gastroenteritis illnesses are estimated at $22.3 million. Irritable bowel syndrome accounts for about three-quarters of these costs.

Table 4.4 **Health care costs of foodborne gastroenteritis** ($ million, based on 2002 data and prices)

	Hospital	ED visits	GP visits	Laboratory costs	Pharmacy costs	Total
Males						
0–4 years	5.8	2.0	5.6	—[a]	2.1	15.6
5–14 years	2.2	0.4	6.1	—[a]	2.5	11.2
15–64 years	2.1	10.6	16.4	3.4	5.8	38.7
65 years or over	1.6	n.a.	4.0	1.3	0.1	7.0
Total	11.7	13.0	32.1	4.8	10.6	72.1
Females						
0–4 years	5.2	13.1	11.4	0.13	1.5	31.4
5–14 years	2.0	9.5	15.1	—[a]	2.2	28.8
15–64 years	2.8	13.8	23.2	3.8	10.9	54.4
65 years or over	3.5	3.8	4.7	—[a]	1.1	13.1
Total	13.5	40.2	54.3	3.9	15.8	127.8
Total	**25.2**	**53.2**	**86.4**	**8.7**	**26.3**	**199.8**

(a) No stool tests were reported for these sex/age groups.

Table 4.5 **Health care costs of foodborne non-gastroenteritis illness** ($'000, based on 2002 data and prices)

Illness	Hospital	ED/GP visits	Specialist visits	Laboratory costs	Pharmacy costs	Total
Listeriosis	2,345	44	15	3	1	2,408
Toxoplasmosis	105	125	3	1	1	235
Hepatitis A	195	31	2	14	4	246
Haemolytic uraemic syndrome	328	2	1	10	n.a.	341
Irritable bowel syndrome	3,386	4,072	2,339	5,350	505	15,652
Guillain-Barré syndrome	612	33	26	59	n.a.	730
Reactive arthritis	71	768	231	1,544	113	2,727
Total	**7,042**	**5,075**	**2,617**	**6,981**	**624**	**22,339**

5 Cost of surveillance and control of foodborne illness[8]

The surveillance and control of foodborne illness in Australia is a cooperative effort between Australian government agencies, state and territory governments, laboratories and local government (see Kirk 2004). The tasks of preventing foodborne illness include laboratory testing of clinical specimens, surveillance of specific infections, surveillance of food and water hazards, investigation of outbreaks and regulation of food businesses. Surveillance is the ongoing systematic collection of data for the purposes of informing public health action. Following Thacker and colleagues (1996), surveillance may be characterised as 'outcome surveillance', where the outcome or disease is monitored, or as 'hazard surveillance', where the occurrence of hazards in the environment is monitored.

The organisation of communicable disease control in Australia is complex. In general, the states and territories are responsible for surveillance, investigation and management of control activities in their jurisdictions. State and territory governments have different organisational models (Deeble et al. 1999). Some states, such as Victoria and South Australia, are more centralised in their administration of foodborne disease surveillance and food safety regulation. In other states, such as New South Wales and Queensland, there is a mixture of regional and central administration of these activities. The activities of federal departments and agencies (such as FSANZ, the Department of Agriculture, Fisheries and Forestry, and DoHA (including OzFoodNet)) are superimposed on these state and territory systems.

5.1 Laboratory testing

The costs of primary testing for pathogens that are potentially transmitted from contaminated food are largely borne by Medicare, which is publicly funded. These costs are considered in Chapter 4. However, only about three in 100 people experiencing gastroenteritis submit a faecal specimen for testing. Where laboratories identify pathogens of public health importance they may need to forward the organisms isolated from specimens to nominated reference laboratories for further characterisation. Examples of this type of advanced testing include serotyping of *Salmonella* and biotyping of *Shigella*. The costs of these reference functions are not borne evenly by states and territories (Deeble et al. 1999).

Deeble (2002) reviewed the expenditure for public health laboratory functions in Australia. The review was complicated by the range of different funding structures and laboratory functions in different jurisdictions. However, it found that approximately $19 million was spent on medical microbiology covering all communicable diseases, many of which were not foodborne. The review also found that $11 million was spent each year on food and water testing, although this function was not consistent between laboratories in different jurisdictions.

8 This section was provided by DoHA.

5.2 Surveillance of specific infections

Each state and territory health department in Australia is responsible, under their public health legislation, for conducting disease surveillance in their jurisdiction. In 2002, gastrointestinal and foodborne diseases comprised 27% (26,708/100,278) of all notifications to the National Notifiable Disease Surveillance System (Yohannes et al. 2004). This is despite the most common enteric infection—*Campylobacter*—not being notifiable in New South Wales (Dalton 2004a).

To conduct surveillance of these diseases, these health agencies employ staff to record details of cases on databases, summarise epidemiological information, follow up individual patients and conduct investigations. The exact staffing levels and resources required for these activities are difficult to estimate. This is particularly true for systems that organise surveillance in regional units, where the resources are spread across many public health units. Examples of these regional systems include Queensland and New South Wales (Dalton 2004b).

To estimate the costs associated with maintaining surveillance for foodborne disease, Victoria was taken as a representative example of the state and territory health agencies that conduct surveillance, and then costs were extrapolated to national levels. In 2003, the Victorian Department of Human Services recorded approximately 7,000 gastrointestinal and foodborne infections, and investigated 150 outbreaks of gastroenteritis (Gregory & Lalor 2004). In 2002, resources for maintaining the enteric disease surveillance system were estimated to be $570,000 per annum (J Gregory, OzFoodNet, DHS, April 2002, pers. comm.). This includes costs for investigative staff, database maintenance, data entry and checking, and reporting. Extrapolating this nationally gives a total of $2.3 million spent by state and territory health departments on enteric disease surveillance each year. This is consistent with estimates for states with centralised surveillance, such as South Australia where the estimated yearly cost is $170,000.

In addition, two surveillance systems focus solely on foodborne illness and its prevention. These are OzFoodNet and the National Enteric Pathogens Surveillance Scheme (NEPSS). Both have different, but complementary, aims to determine the burden and causes of foodborne illness in Australia. OzFoodNet provides the capacity to investigate foodborne illness by employing epidemiologists in state and territory health departments, whose activities are coordinated nationally. NEPSS collects laboratory data on specific foodborne infections for analysis of trends and detection of clustering. The costs to maintain OzFoodNet and NEPSS annually are $2.1 million and $200,000 respectively (DoHA unpublished data).

5.3 Outbreak investigation

The costs of investigating outbreaks are inherent in the costs of maintaining foodborne disease surveillance systems. The societal benefits of government investigations and control of outbreaks are clear. In 2001, an investigation into *Salmonella* Stanley infections associated with imported peanuts allowed regulatory authorities to intervene and hold the remaining 18% of the total shipment (Outbreak

Investigation Team, Australia 2002). This would have prevented a further five notified cases, and over 75 cases in the community. In Australia, *Salmonella* infections cost an estimated $1,387 per notified infection (Yohannes 2002). The intervention in this outbreak may have saved the community $84,953.[9] The outbreak alert was vital for Canada and the United Kingdom to identify the source of identical outbreaks in a timely fashion and also prevent substantial illness by recalling contaminated product in those countries (Kirk et al. 2004).

In recent years, there have also been investigations into Japanese oysters contaminated with norovirus, lettuce contaminated with *S.* Bovismorbificans 32 served at fast-food restaurants, and multi-drug resistant *S.* Typhimurium 104 contaminating halva from Turkey (see OzFoodNet Working Group 2003 and Stafford et al. 2002). It is difficult to identify the resulting improvements in food safety and savings in reduced illness and mortality from these investigations, but it is important to recognise the role that they play in averting disease and societal costs. The investigation into the outbreak of *S.* Bovismorbificans 32 caused the implicated product to be withdrawn from sale, and major changes to procedures in the company preparing the product.

The investigation of the *S.* Typhimurium 104 outbreak indicated a high rate of hospitalisation with 33% (8/24) of notified cases requiring admission. In Australia, this outbreak investigation prevented an estimated 87.3% of the total consignment of halva reaching consumers (Kaldor et al. 2002). This investigation may have prevented 79 notified cases and a further 1,185 infections in the community, saving as much as $1.3 million. It is likely that all of these investigations prevented further importation or production of contaminated product, and mitigated current outbreaks and prevented potential outbreaks.

5.4 Food regulatory system

The food regulatory system in Australia relies on the different levels of government managing policy, developing standards, monitoring food safety and enforcing legislation. The aim of this system is to prevent illness and death from contaminated food.

KPMG (1998) estimated that, in 1997, the net costs to state, territory and local governments of administration and enforcement of food regulation was $24 million each year. These costs were estimated to increase to $47 million per annum with the Australia-wide implementation of risk-based food hygiene standards, which are still being implemented in many jurisdictions (KPMG 1999).

As well, several federal government agencies deal specifically with foodborne disease prevention. These include FSANZ, DoHA, the Australian Quarantine and Inspection Service, and the Department of Agriculture, Fisheries and Forestry. The costs of maintaining these agencies are not detailed here, although they are important to

9 This assumes that for each notified case of salmonellosis there were 15 community cases and that non-notified cases cost 75% of notified cases, due to lesser severity of illness.

the overall system for preventing and controlling foodborne illness. There is also a substantial compliance cost imposed on businesses through meeting regulations, which is not considered here.

5.5 Summary

The component costs for surveillance of foodborne illness and the other government actions directed at maintaining a safe food supply are difficult to quantify. Nevertheless, this chapter has provided indicative annual costs for the following activities:

- laboratory testing of food and water ($11 million)
- enteric disease surveillance ($2.3 million)
- maintaining OzFoodNet ($2.1 million)
- administering and enforcing food regulations, which include a food safety component ($24 million, 1997 estimate).

Indicative annual costs for responding to foodborne illness outbreaks are not given owing to the absence of particular survey work on this activity.

Aggregated costs for maintaining foodborne illness surveillance (including OzFoodNet), investigating outbreaks and maintaining food safety systems are estimated elsewhere in this report to be in the order of $10 million.

6 Health costs borne by businesses and households

6.1 Introduction

Chapter 2 outlines the methodology for estimating the costs of illness and death for individuals and businesses, which are based on:

- costs of early death
- lost workplace productivity
- costs of carers
- lost household productivity and disruption of household activity
- lifestyle (residual) costs not included in the above costs.

Appendix A shows estimates of lost workplace and household activity time, inclusive of carer time in both cases. We estimate lost workplace time at $175 per day, and lost or disrupted household time at $87.50 per day.

Estimates of total willingness to pay to avoid illnesses are needed in order to estimate residual lifestyle costs. Section 6.2 describes our estimates of these costs. The remaining sections describe estimates for gastroenteritis and the other illnesses.

6.2 Willingness-to-pay values to avoid illnesses

As described in Section 2.4, willingness to pay to avoid an illness is estimated as:

$$WTP_i = SW_i \times D_i \times VDH \qquad \text{(Equation 6.1)}$$

where SW = severity weight

D = days with illness

VDH = value of a day of good health ($296)

subscript i denotes the type of illness.

Table 6.1 shows our assumptions for severity weights and days in hospital for each condition. For gastroenteritis, we distinguish between three levels of severity: cases requiring hospitalisation, those requiring a visit to an emergency department or GP, and self-care cases. For toxoplasmosis, hepatitis A, irritable bowel syndrome and reactive arthritis, cases are divided into 'hospitalised' and 'others'. Because of the severity of the symptoms for listeriosis, haemolytic uraemic syndrome and Guillain-Barré syndrome, there are only hospitalised cases. The table also shows the estimated WTP amounts to avoid these conditions.

As an example, a hospitalised case of acute gastroenteritis involves an average time of two days in hospital with a severity weight of 0.402 and seven days of illness after hospital, with a severity weight of 0.056. These assumptions produce a willingness to pay of $238 to avoid the time in hospital and $116 to avoid the discomfort afterwards,

for a total WTP figure of $354. WTP amounts to avoid other acute illnesses such as listeriosis and toxoplasmosis are higher. Individuals are assumed to be willing to pay much higher amounts to avoid chronic sequelae such as irritable bowel syndrome and Guillain-Barré syndrome.

Table 6.1 **Estimated willingness to pay to avoid an illness** (average all ages)

Illness	Severity weight (SW)	Av. no of days in hospital (L)	Willingness-to-pay amount ($) (SW x L x $296)	Notes
Gastroenteritis				
Hospitalised	0.402	2	238	Weight and time in hospital
	0.056	7	116	Weight and time after hospital
Total hospitalised cases		9	354	
Emergency department/GP	0.094	4	111	GBD weight[a] and AIHW duration
Self-care	0.056	3	50	Dutch weight[a] and AIHW duration
Listeriosis				
Hospitalised	0.747	23	5,085	Weight and time in hospital
	0.094	21	584	Weight and time after hospital
Total hospitalised cases		42	5,669	
Toxoplasmosis				
Hospitalised	0.747	8	1,768	Weight and time in hospital
	0.094	28	779	Weight and time after hospital
Total hospitalised cases		36	2,547	
Other cases	0.094	7	195	
Hepatitis A				
Hospitalised	0.747	4	884	Weight and time in hospital
	0.042	37	460	Weight and time after hospital
Plus sequelae	0.140	182/10	754	Allows depression in 10% of cases for 6 months (AIHW estimate)
Total hospitalised cases		41 + seq.	2,098	
Other cases			1,214	= hospital case – hospital costs
Haemolytic uraemic syndrome				
Hospitalised	0.420	9	1,119	Weight and time in hospital
	0.094	14	390	Weight and time after hospital
Total hospitalised cases		23	1,509	
Irritable bowel syndrome				
Hospitalised	0.402	2	238	Weight and time in hospital
	0.094	7	195	Weight and time after hospital
Plus sequelae	0.056	100	1,657	
Total hospitalised cases		109	2,090	
Other cases		107	1,852	= hospital case – hospital costs

continued

Illness	Severity weight (SW)	Av. no of days in hospital (L)	Willingness-to-pay amount ($) (SW x L x $296)	Notes
Guillain-Barré syndrome				
Hospitalised	0.747	13	2,847	Weight and time in hospital
	0.257	90	6,846	Weight and time after hospital
Total hospitalised cases		103	9,693	
Reactive arthritis				
Hospitalised	0.402	5	594	Weight and time in hospital
Emergency department/GP	0.094	3	63	Weight and time after hospital
Plus sequelae	0.056	100	1,657	
Total hospitalised cases		148	2,314	
Other cases		100	1,720	= hospital case – hospital costs

(a) Gross Burden of Disease study weight and Dutch study weight quoted in AIHW: Mathers et al. (1999).

Sources:

1 AIHW: Mathers et al. 1999.

2 Australian Institute of Health and Welfare (AIHW 2004) <www.aihw.gov.au/bod/bod_yld_by_disease/a_infectious/a4_diarrhoea.xls>; <www.aihw.gov.au/bod/bod_yld_by_disease/a_infectious/a9a_hepa.xls>.

3 NCEPH survey (see Appendix A).

6.3 Cost of gastroenteritis

Table 6.2 shows our estimates of the costs of illness due to gastroenteritis. The first part of the table shows the cost of lost work time and lost or disrupted household activities. The incidence data are drawn from Table A1 in Appendix A. The value parameters are as discussed. It is assumed that businesses bear 80% of work time and carer time lost due to gastroenteritis, and that households bear the other 20% (that is, businesses are assumed to bear most of the cost of employees who are sick). Households bear the cost when work is self-employed or casual, and they also bear the cost of carers.

The middle part of the table shows estimated WTP amounts to avoid hospital, GP visits and self-care events respectively. The incidence estimates are based on Table A1. The number of cases with a severity of 0.094 is assumed to equal the number of visits to GPs. It is recognised that some people may visit a GP more than once. On the other hand, the number of cases with a severity of 0.056 is assumed to equal the number of self-care cases, although some of these might warrant a GP visit and fall into the category of medium-severity gastroenteritis. The WTP amounts are drawn from Table 6.1.

Table 6.2 **Costs of illness due to gastroenteritis borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work days lost	No.	2.1 million	Source: Appendix Table A1
Value of all work lost	$m	367.5	@ $175 per day
Value of 80% work lost	$m	294.0	Loss borne by businesses
Value of 20% work lost	$m	73.5	Loss borne by households
Household days lost	No.	3.7 million	Source: Appendix Table A1
Value household time lost	$m	323.7	@ $87.50 per day
Total cost for households	$m	397.2	20% work + household loss
Household WTP values			
Hospital cases	No.	15,000	Source: Appendix Table A1
WTP to avoid hospital cases	$m	5.3	@ $354 per case
GP visit cases	No.	1.4 million	Source: Appendix Table A1[(a)]
WTP to avoid GP cases	$m	155.4	@ $111 per case
Self-care cases	No.	4.0 million	Source: Appendix Table A1
WTP to avoid self-care cases	$m	200.0	@ $50 per case
Total	$m	360.7	
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	–36.5	WTP – (household work + activity costs)
Total no. of cases	No.	5.4 million	Source: Appendix Table A1
Average residual value/case	$	0.0	

(a) See text above.

Residual lifestyle cost is the difference between the sum of the WTP amounts and the work time, carer time and disrupted household activities borne by households. It turns out that the difference for all gastroenteritis cases is a negative number and hence not applicable. This implies either that (i) the WTP values are underestimated, or (ii) the quantity, or value, of work time or household activity disruption time is overestimated.

Both (i) and (ii) are possible sources of error. First, WTP values may be underestimated. For example, if households are willing to pay an average amount of $60 (instead of $50) to avoid a minor gastroenteritis event, the WTP value to avoid minor events would rise by $40 million from $200 million to $240 million. Residual lifestyle costs would rise from –$36.5 million to +$3.5 million (still a small number). Turning to error type (ii), as Dr Hall notes in Appendix A, there is a possibility of overestimation in the self-reporting of work time lost and household time disrupted. Also, a day of disrupted activity may not be a major cost to a household, in which case the value parameter of $87.50 per disrupted day may be too high for a self-care gastroenteritis effect.

Table 6.3 summarises the total cost of gastroenteritis borne by households and businesses, including mortality costs. The number of deaths (80) is taken from Table A1. The estimated cost of mortality is based on the estimated years of life lost by different age groups. The average value per death in this case turns out to be $1.5 million. This reflects the estimate that 49 of the 80 deaths are of persons over 65 years of age and thus the estimated years of life lost are fewer for this group. For the lifestyle residual lost, we allow a zero value. This implies that the estimated value of household time lost implicitly includes an allowance for pain and suffering.

As discussed in Chapter 2, in principle the WTP value is the most important one because this controls the estimate of total household cost. However, the division between disrupted household activity and residual lifestyle cost is an arbitrary one, especially for gastroenteritis.

Table 6.3 **Total costs of gastroenteritis borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Base case estimate			
Work time lost	2.1 million days	175	367.5
Household time lost	3.7 million days	87.50	323.7
Lifestyle residual lost	5.4 million cases	n.a.	0.0
Mortality	80 deaths	PV of $108,000 p.a.	119.5
Total			**810.7**

PV: present value.

6.4 Cost of listeriosis

Table 6.4 shows the estimated costs of illness due to listeriosis. All cases are hospital cases (see Table A2 in Appendix A). Also, estimated lost days in Table A2 do not distinguish between loss of work time and disruption of other activities. There is no separate estimate for disrupted household activities. Accordingly, we use a lower weighted value of $125 per day lost, being about halfway between the $175 and $87.50 unit values. We also assume that 67% of these costs will be borne by businesses and 33% by households (in contrast with the 80:20 split for gastroenteritis, where it is assumed that more of the costs will be borne by employers). This reflects the fact that listeriosis presents more frequently in certain population subgroups (the aged, the very young and the immunocompromised).

Table 6.4 **Costs of illness due to listeriosis borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/others days lost	No.	3,000	Source: Appendix Table A2
Value of all days lost	$m	0.360	@ $125 per day
Value of 67% days lost	$m	0.241	Loss borne by businesses
Value of 33% days lost	$m	0.119	Loss borne by households
Household WTP values			
Hospital cases excl. deaths	No.	94	Source: Appendix Table A.1
WTP to avoid hospital cases	$m	0.533	@ $5,669 per case
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	0.414	WTP – other household costs
Total cases minus deaths	No.	94	Source: Appendix Table A2
Average residual value/case	$	4,404	

Table 6.5 summarises listeriosis costs, including mortality costs. Mortality costs dominate the results—the estimated 26 deaths per annum have an estimated present value of $82.3 million.

Table 6.5 **Total costs of listeriosis borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	3,000 days	125	0.36
Lifestyle residual lost	94 days	4,553	0.41
Mortality	26 deaths	PV of $108,000 p.a.	82.30
Total			**83.07**

PV: present value.

6.5 Cost of toxoplasmosis

Table 6.6 shows the estimated costs of illness due to toxoplasmosis. Estimated days lost again include paid work and loss and disruption of other activities. Accordingly we use a value of $125 per day lost. Because of the large number of non-GP visit cases, we assume that these costs will be borne evenly by businesses and households, that is, a 50:50 split.

Table 6.7 provides a summary of toxoplasmosis costs. In this case, there are no deaths. Most costs are captured in estimated work and other days lost. This value is close to total WTP value so that there is only a small residual.

Table 6.6 **Costs of illness due to toxoplasmosis borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/other days lost	No.	9,020	Source: Appendix Table A3
Value of all days lost	$m	1.13	@ $125 per day
Value of 50% days lost	$m	0.56	Loss borne by businesses
Value of 50% days lost	$m	0.57	Loss borne by households
Household WTP values			
Hospital cases	No.	21	Source: Appendix Table A3
WTP to avoid hospital cases	$m	0.05	@ $2,547 per case
Other cases	No.	5,879	Source: Appendix Table A3
WTP to avoid other cases	$m	1.15	@ $195 per case
Total	$m	1.20	
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	0.58	WTP – other household costs
Total cases minus deaths	No.	5,900	Source: Appendix Table A3
Average residual value/case	$	98.30	

Table 6.7 **Total costs of toxoplasmosis borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	9,020 days	125	1.13
Lifestyle residual lost	5,900 days	98.30	0.58
Mortality	0 deaths	2.5 million	0.00
Total			**1.71**

6.6 Cost of hepatitis A

Table 6.8 shows the estimated costs of illness due to hepatitis A. Days lost include loss of work time, and loss and disruption of other household activities. Accordingly, we again allow $125 per day and in this case assume that businesses bear 67% of the costs and households bear 33%.

Table 6.8 **Costs of illness due to hepatitis A borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/other days lost	No.	6,020	Source: Appendix Table A.4
Value of all days lost	$m	0.75	@ $125 per day
Value of 67% days lost	$m	0.50	Loss borne by businesses
Value of 33% days lost	$m	0.25	Loss borne by households
Household WTP values			
Hospital cases	No.	24	Source: Appendix Table A.4
WTP to avoid hospital cases	$m	0.05	@ $2,098 per case
Other cases	No.	126	Source: Appendix Table A.4
WTP to avoid other cases	$m	0.15	@ $1,214 per case
Total	$m	0.20	
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	Negative value	WTP – other household costs
Total cases minus deaths	No.	150	Source: Appendix Table A.1
Average residual value/case	$	n.a.	See text.

It can be seen that the estimated cost to households of all work days lost and other activities forgone exceeds the estimated amount that they are willing to pay to avoid the illness. A possible reason is that our estimated severity weight for time outside hospital (0.042) is too low. Accordingly, in this case we adopt the estimated cost of lost and disrupted household days as the full cost and allow no residual lifestyle cost.

Table 6.9 provides a summary for hepatitis A. In this case, most costs are captured in estimated work and other days lost.

Table 6.9 **Total costs of hepatitis A borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	6,020 days	125	0.75
Lifestyle residual lost	5,900 days	n.a.	n.a.
Mortality	1 death	2.5 million	2.50
Total			**3.25**

6.7 Cost of haemolytic uraemic syndrome

A similar valuation process is adopted for haemolytic uraemic syndrome and the results are shown in tables 6.10 and 6.11 below. However, as with listeriosis, all cases are hospital cases (or deaths). A small proportion of cases will require ongoing treatment, including dialysis and kidney transplantation. These costs are not captured here.

Table 6.10 **Costs of illness due to haemolytic uraemic syndrome borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/other days lost	No.	290	Source: Appendix Table A5
Value of all days lost	$m	0.04	@ $125 per day
Value of 67% days lost	$m	0.03	Loss borne by businesses
Value of 33% days lost	$m	0.01	Loss borne by households
Household WTP values			
Hospital cases (persons)	No.	17	Source: Appendix Table A5
WTP to avoid hospital case	$m	0.03	@ $1,509 per case
Total	$m	0.03	
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	0.0	WTP – other household costs
Total cases minus deaths	No.	17	Source: Appendix Table A5
Average residual value/case	$	0.0	

Table 6.11 **Total costs of haemolytic uraemic syndrome borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	290 days	125	0.04
Lifestyle residual lost	n.a.	n.a.	n.a.
Mortality	3 deaths	PV of $108,000 p.a.	6.70
Total			**6.74**

PV: present value.

6.8 Cost of irritable bowel syndrome

Tables 6.12 and 6.13 show our assumptions, sources and estimated costs associated with irritable bowel syndrome. GP and self-care cases are combined because the data do not readily allow a distinction to be made, and an average WTP value is estimated for these cases (from Table 6.1). Businesses are assumed to bear 50% of estimated work time and disrupted household costs for irritable bowel syndrome, with households bearing the other half.

The cost of days lost to work or significant household disruption is a small part of the estimated total cost. This reflects the chronic nature of the illness.

Table 6.12 **Costs of illness due to irritable bowel syndrome borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/other days lost	No.	49,500	Source: Appendix Table A6
Value of all days lost	$m	6.2	@ $125 per day
Value of 50% days lost	$m	3.1	Loss borne by businesses
Value of 50% days lost	$m	3.1	Loss borne by households
Household WTP values			
Hospital cases	No.	2,700	Source: Appendix Table A6
WTP to avoid hospital cases	$m	5.6	@ $2,090 per case
Other cases	No.	17,500	Source: Appendix Table A6
WTP to avoid other cases	$m	52.5	@ $1,852 per case
Total	$m	32.4	
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	29.3	WTP – other household costs
Total cases minus deaths	No.	20,200	Source: Appendix Table A6
Average residual value/case	$	1,450	

Table 6.13 **Total costs of irritable bowel syndrome borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	49,500 days	125	6.2
Lifestyle residual lost	20,200 days	1,430	29.3
Mortality	3 deaths	PV of $108,000 p.a.	1.0
Total			**36.5**

PV: present value.

6.9 Cost of Guillain-Barré syndrome

Tables 6.14 and 6.15 show our assumptions, sources and estimated costs associated with Guillain-Barré syndrome. Based on Table A7 in Appendix A, all cases are assumed to be hospital cases. WTP values are high because of the severity and chronic nature of the disability.

Table 6.14 **Costs of illness due to Guillain-Barré syndrome borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/other days lost	No.	9,900	Source: Appendix Table A7
Value of all days lost	$m	1.24	@ $125 per day
Value of 50% work lost	$m	0.62	Loss borne by businesses
Value of 50% work lost	$m	0.62	Loss borne by households
Household WTP values			
Hospital cases excluding deaths	No.	108	Source: Appendix Table A7
WTP to avoid hospital cases	$m	1.05	@ $9,693 per case
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	0.43	WTP – other household costs
Total cases minus deaths	No.	108	Source: Appendix Table A7
Average residual value/case	$	3,981	

Table 6.15 **Total costs of Guillain-Barré syndrome borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	9,900 days	125	1.24
Lifestyle residual lost	108 days	3,981	0.43
Mortality	12 deaths	PV of $108,000 p.a.	23.70
Total			**25.37**

PV: present value.

6.10 Cost of reactive arthritis

Tables 6.16 and 6.17 show the assumptions, sources and estimated costs for reactive arthritis. GP and self-care cases are combined as the data do not readily allow a distinction to be made. Also, in estimating an average WTP to avoid these cases (Table 6.1), we do not distinguish between GP visits and self-care cases, as again the data did not provide such a distinction.

Table 6.16 **Costs of illness due to reactive arthritis borne by households and businesses**

	Unit	All persons	Notes/sources
Worktime/household costs			
Work/other days lost	No.	61,050	Source: Appendix Table A8
Value of all days lost	$m	7.6	@ $125 per day
Value of 50% work lost	$m	3.8	Loss borne by businesses
Value of 50% work lost	$m	3.8	Loss borne by households
Household WTP values			
Hospital cases	No.	20	Source: Appendix Table A8
WTP to avoid hospital cases	$m	0.04	@ $2,314 per case
GP visit/other cases	No.	21,000	Source: Appendix Table A8
WTP to avoid GP cases	$m	36.12	@ $1,720 per case
Total	$m	36.16	
Lifestyle (residual) costs			
Lifestyle (residual) costs	$m	32.4	WTP – other household costs
Total cases minus deaths	No.	21,000	Source: Appendix Table A8
Average lifestyle value/case	$	1,542	

Table 6.17 **Total costs of reactive arthritis borne by households and businesses**

	Incidence	Unit value ($)	Total value ($ million)
Work/other days lost	61,050 days	125	7.6
Lifestyle residual lost	21,000 days	1,542	32.4
Mortality	0 deaths	2.5 million	0.0
Total			**40.0**

6.11 Total cost to businesses and individuals

Table 6.18 provides a summary of estimated costs of all foodborne illness to businesses and households. The estimated total cost is $1,003 million, with gastroenteritis responsible for about $811 million of this. Listeriosis, irritable bowel syndrome, Guillain-Barré syndrome and reactive arthritis account for a high proportion of the residual cost.

The table also shows a breakdown of these costs between work/other days lost and disrupted, residual lifestyle costs, and mortality. Except for gastroenteritis, no distinction is made between workdays lost and household activity days disrupted. Also, as has been emphasised, estimates of household activity days disrupted in Appendix A are a large part of lifestyle effects; indeed, often they reflect the whole of them.

We estimate the 'residual lifestyle' lost because in principle this includes all other lifestyle effects, including pain and suffering, not elsewhere measured. However, the distinction between household days disrupted and residual lifestyle lost is an arbitrary one. Accordingly, while the estimated mortality costs (total $231.5 million) are a meaningful estimate, little weight should be attached to the breakdown between the costs of work and other days lost, and the residual lifestyle cost shown in the other column. The sum of the two effects is meaningful, but not the distinction between them.

Table 6.18 **Summary of costs to businesses and individuals** ($ million, 2004 prices)

Illness	Work/other days lost	Lifestyle residual lost	Mortality	Total cost
Gastroenteritis	691.2	0.0	119.5	810.7
Listeriosis	0.4	0.4	82.3	83.1
Toxoplasmosis	1.1	0.6	0.0[(a)]	1.7
Hepatitis A	0.8	0.0[(a)]	2.5	3.3
Haemolytic uraemic syndrome	0.0[(a)]	0.0[(a)]	2.5	2.5
Irritable bowel syndrome	6.2	29.3	1.0	36.5
Guillain-Barré syndrome	1.2	0.4	23.7	25.3
Reactive arthritis	7.6	32.4	0.0	40.0
Total	**708.5**	**63.1**	**231.5**	**1,003.1**

(a) Under $50,000.

7 Industry costs

7.1 Introduction

Chapter 7 reviews industry costs associated with food contamination and food recalls. In all, we report on ten studies. Drawing on Applied Economics (2003) we provide a detailed report on the industry costs of the outbreak of hepatitis A due to contaminated oysters from Wallis Lake, New South Wales. We draw on Minter Ellison (2002) to report briefly on the effects on industry of four other foodborne illness outbreaks. Finally, using data provided by FSANZ, we report estimates of the costs of five food recalls. The final section provides indicative costs.

7.2 Industry costs of contaminated oysters in Wallis Lake

In the first quarter of 1997, consumption of oysters from Wallis Lake was responsible for an estimated 444 cases of hepatitis A across Australia, including 274 cases in New South Wales (Conaty et al. 2000). Nearly one in seven cases was hospitalised. One 77-year-old person died two weeks after the onset of symptoms.

The NSW Department of Health notified the Great Lakes Shire Council of the outbreak on 11 February 1997. Oyster production in Wallis Lake was closed down on 14 February. Between 26 March and 4 April 1997, 20,000 oysters were tested and no hepatitis A virus was found, nor was any virus detected in samples of lake sediment. On 18 April, Wallis Lake was reopened to oyster production, with increased controls on production and testing amounting to an extra cost of nearly $100,000 per annum.

This outbreak had substantial economic effects on the oyster industry in Wallis Lake, and possibly more widely across New South Wales. The outbreak also affected local tourism and may have affected the local fishing industry.

Impact on oyster farmers

Estimates of impact on the net income of oyster farmers vary (that is, the loss of income less any savings in costs). Major oyster farmers in Wallis Lake reported in 2001 that production was still 20% below pre-1997 levels and that employment had fallen by about 60 workers because of the 'loss' of the Wallis Lake brand name and investor and consumer confidence (Applied Economics 2003).

Table 7.1 shows data for oyster production from Wallis Lake and New South Wales from 1994–95 to 1999–2000. These figures show:

- In the two financial years before the outbreak, oyster farmers from Wallis Lake produced 2.85 million dozen oysters, or about 33% of oyster production in New South Wales.
- In 1996–97, the year of the incident, production in Wallis Lake fell to 2.11 million dozen oysters and accounted for only 27% of oyster production in New South Wales.

- In 1997–98, oyster production increased to 2.70 million dozen oysters, assisted by a carryover from the previous year and excellent growing conditions.
- However, in 1998–99 and 1999–2000, oyster production in Wallis Lake averaged only 2.02 million dozen oysters and 25.6% of production in New South Wales.

Table 7.1 **Oyster production** (dozens of oysters)

Financial year	Wallis Lake	Rest of NSW	Total NSW	Wallis Lake (%)
1994–95	2,847,094	6,219,932	9,067,026	31.5
1995–96	2,886,528	5,627,325	8,513,853	33.9
1996–97	2,115,502	5,693,946	7,809,448	27.1
1997–98	2,703,000	6,344,881	9,047,881	29.9
1998–99	1,808,038	6,072,196	7,880,234	22.9
1999–00	2,236,870	5,662,584	7,899,454	28.3

Source: NSW Fisheries.

Before assessing the implications of these figures, two other issues should be discussed, namely whether the hepatitis incident may have affected (a) production of oysters across New South Wales, and (b) the premium price that could be charged for Wallis Lake oysters.

Table 7.1 shows that oyster production in the rest of New South Wales averaged 5.92 million dozen oysters over the two years 1994–95 to 1995–96, fell to 5.69 million dozen oysters in 1996–97, and averaged 6.21 million dozen oysters over 1997–98 to 1998–99. This suggests that New South Wales oyster output may have fallen in 1996–97, but that there was no subsequent decline in production. However, the 1996–97 figures are similar to those for 1995–96 and 1998–99. Therefore, even the short-term impact of the incident on oyster output from the rest of New South Wales is unclear.

In value terms, Wallis Lake oysters accounted for 31.3% and 33.6% of the New South Wales market in 1994–95 and 1995–96 respectively. This was similar to the lake's physical share of the New South Wales market (see Table 7.1). It appears that there was no significant brand premium for Wallis Lake oysters.

It is hard to draw firm conclusions from these data. It appears that oyster output from Wallis Lake may have fallen by the small amount of 5–10%, or by about 200,000 dozen oysters per annum, as a result of the hepatitis A outbreak. Oysters produced a gross revenue of $4 per dozen and provided a net income of $2 per dozen to oyster farmers and their employees. Thus oyster producers around Wallis Lake may have borne a loss of net income of $0.4 million per annum (200,000 dozen oysters x $2) for some years, plus the extra cost of control and testing ($0.1 million per annum).

Impact on fishing

Official fish catch data for Wallis Lake and New South Wales are shown in Table 7.2. The Wallis Lake catch was 9% lower in 1996–97 than the average for the previous four years.

In February 1997, the Sydney Fish Market asked the Wallis Lake Fishermen's Co-operative to stop sending fish for a short period, until NSW Health announced that the fish would not be a health risk once they were cooked. However, the Market declined to accept crabs for a further period. Brooker (1997) reported that when fish sales to the markets were resumed the fish sold at 30% below the market value. He estimated that local production fell by 75% ($1,000 a day) initially and was still 30% down in May 1997. Some commentators have suggested that the whole fishing industry in New South Wales lost sales due to the health concerns.

This suggests that local commercial fisheries may have lost $150,000–$200,000 in sales in the first half of 1997, which is consistent with Brooker's estimate. Given that the number of fishing trips and costs were more or less fixed, most of this loss of income would be loss of profit.

However, little reliance can be placed on the data after 1996–97. The data are based on the mandatory catch forms submitted to NSW Fisheries, which are only partially validated and do not include late forms. The data for Wallis Lake are low compared with data provided by the Wallis Lake Fishermen's Co-operative to Applied Economics. The halving of the New South Wales fish catch in the 1990s is not credible. This limits the inferences that may be drawn.

Table 7.2 **Commercial fish catch from Wallis Lake and New South Wales**

	Wallis Lake		New South Wales		Wallis Lake percentage of NSW catch	
Year	'000 kg	$'000	'000 kg	$'000	weight	value
1992–93	523	2,004	28,448	96,262	1.84	2.08
1993–94	499	1,949	29,989	107,524	1.66	1.81
1994–95	501	2,255	26,248	92,854	1.91	2.45
1995–96	533	2,274	26,114	92,030	2.04	2.47
1996–97	470	2,091	25,938	90,579	1.81	2.31
1997–98	439	2,057	18,637	66,491	2.36	3.0
1998–99	466	2,201	15,418	63,787	3.02	3.45
1999–2000	439	2,110	14,451	67,375	3.04	3.13

Source: NSW Fisheries Commercial Fishing Database.

Impact on tourism

Table 7.3 shows tourist activity in the Great Lakes area for 1996 and 1997. Data for guest nights and turnover for these years suggest that the outbreak in February 1997 had little impact on visitors in the first quarter of 1997. However, it apparently had a large impact in the second quarter and a small impact in the third quarter. There appears to have been no effect in the fourth quarter.

No comparable dips in visitors to Port Macquarie or Coffs Harbour occurred in the second and third quarters in 1997. Comparable data are not available for later years because of boundary changes from 1998.

As shown in Table 7.3, accommodation revenue in the Great Lakes region fell by over $1.1 million in the second and third quarters of 1997. However, capacity is fixed and employment scarcely fell. Allowing for small savings in labour costs associated with the preparation and cleaning of the rooms, the accommodation sector in the area lost an estimated net income of some $1.0 million in 1997.

However, any such loss may have increased income to tourist accommodation in other areas. A similar point applies to other expenditures by visitors on meals, refreshments, petrol and so on. A loss to tourist businesses in the Great Lakes area may have been a gain to businesses in other areas.

Table 7.3 **Visitors to the Great Lakes region**

Year (quarter)	**Employees**	**Guest nights** ('000)	**Turnover** ($'000)[(a)]
1996 (1)	186	69.2	1,953
1996 (2)	185	43.0	1,229
1996 (3)	174	43.8	1,228
1996 (4)	185	56.4	1,634
1997 (1)	195	68.6	2,023
1997 (2)	191	8.1	364
1997 (3)	189	38.1	1,061
1997 (4)	197	61.8	1,788

(a) Income from accommodation.

Source: Tourist Accommodation Small Area Data NSW, ABS, Cat. No. 8635.1.

Conclusions

Oyster producers around Wallis Lake most likely bore a loss of net income of $0.5 million per annum in 1997 and for a few years afterwards. The local fishing industry may have lost about $0.2 million in 1997. Further, the accommodation sector in the area lost an estimated net income of some $1.0 million in 1997. However, some of these losses would have been partially offset by increased sales of oysters, fish and tourist services in other areas.

7.3 Four more case studies

Listeriosis associated with consumption of fruit salad in the Hunter Valley, New South Wales, in 1998

Between January 1998 and January 1999, six cases of listeriosis occurred in the Hunter Valley, of which five were fatal. All were residents of aged care facilities that were serviced from a central catering facility.

Following the outbreak, the catering business recalled the fruit salad it had supplied, and ceased production until control measures had been instituted. The business

spent $75,000 on a variety of control measures such as improved staff training, changed product formulations and regular product testing. This expense was to prevent future outbreaks rather than being a cost of disruption due to the 1998 outbreak. Overall, the industry costs of dealing with the 1998 outbreak seem to have been small, although not necessarily small for the businesses incurring the costs.

Salmonella Heidelberg PT 16 in airline food in Cairns, Queensland, in 1996

Between 3 and 7 November 1996, a reported 488 passengers on about 20 flights from Cairns to Japan suffered food poisoning, with 56 passengers requiring hospital treatment. The cause was salmonella poisoning due to *Salmonella* Heidelberg PT 16. To put these numbers in perspective, there are about 7,000 reports of salmonellosis each year in Australia.

In its review, Minter Ellison was unable to establish any significant industry costs. Most media attention focused on the airlines. Despite extensive media coverage at the time, the outbreak had little effect on tourism or on airline revenue. Nor was there any effect on the egg industry, although cracked eggs were the cause of the illness. It was not possible to determine the impacts on the producer or distributor, who were not named in the media.

Hepatitis A virus in a yum cha restaurant in Sydney, New South Wales, in 1997

In May and June 1997, 21 people were diagnosed with hepatitis A, following consumption of contaminated prawns at a yum cha restaurant in Sydney. Court cases followed, between five plaintiffs and the restaurant, and between the restaurant and its suppliers. The district court found that the restaurant was guilty of breaching the *Sale of Goods Act 1923*, and no liabilities were found against the importer.

The restaurant suffered considerable losses, due to temporary voluntary closure, adverse media coverage and finally business closure. The restaurant employed about 20 staff and had an annual turnover of $1.3 million.

As is usual in these cases, most customers will have switched to alternative sources. There may have been some temporary employment loss but most of the retrenched workers would have found other employment. The social loss is the temporary loss of use of the facility and the cost of conversion to another use. Most other resources would have been re-employed quite rapidly.

Escherichia coli O111 outbreak in contaminated mettwurst in South Australia in 1995

In South Australia in 1995 about 190 people experienced illnesses linked to eating mettwurst contaminated with *E. coli* O111. Twenty-three children were hospitalised, five children suffered long-term health consequences and one child died.

The outbreak was traced to a batch of mettwurst produced by a South Australian smallgoods company. The company had been in operation for over 20 years; it had

a turnover of $13 million a year and employed 120 people. It was out of business in two months.

According to media reports, the smallgoods industry in South Australia consisted of 85 manufacturers and employed about 1,500 people. It suffered a 50% fall in sales of certain lines of processed meat. One family business (Wintulich) producing gourmet meat products, including mettwurst, had been operating since the early 1900s. At the start of 1995 it employed 50 people and had an annual turnover of $3 million. It lost a large proportion of its business in 1995 and did not survive as a family business.

Minter Ellison report various sources to the effect that the outbreak reduced Australian sales of mettwurst by more than 20% for several years after the incident and that 400–500 smallgoods producers across Australia went out of business. In addition, meat sales are also thought to have dropped significantly. The Australia New Zealand Food Authority (1999) estimated that the downturn in trade caused by this outbreak cost Australian industry $400 million.

Unlike the other examples, the effects of this event spread well beyond the affected company. However, as the Minter Ellison report notes, notwithstanding these wide industry effects and providing the spending did not get diverted into imports, there would be only a minor net effect on the economy as a whole. The real costs to the economy would have been a fraction of the $400 million.

7.4 Costs of food recalls: data from Food Standards Australia New Zealand

All food recalls are different and their costs vary significantly.[10] However, some general costs occur in most cases. The five main costs that a business incurs are:

- newspaper advertisements
- stock value
- stock recovery
- additional company testing
- stock destruction.

Newspaper advertisements

A business conducting a recall is required to place an advertisement in the major daily newspaper in each state or territory where the affected product is sold. The cost depends on the size of the advertisement and the day of the week that the advertisement is placed. A recall that affects only one product in one state or territory may require a small advertisement while a recall that involves a number of products may be substantially larger. While most businesses place advertisements in only one paper in each affected state or territory, some businesses place advertisements in several newspapers.

10 Dr Scott Crerar, FSANZ, provided the data and much of the text in this section.

In general terms, a small recall advertisement (that is, minimum size is two columns wide and 12 cm tall) for one product being recalled, in one state or territory, costs between $500 and $1,000. At the other end of the scale, a national multiple-product recall costs between $15,000 and $20,000. A business that places this type of advertisement in multiple newspapers in each state and territory could spend over $50,000 on advertisements.

Stock value

The loss of stock varies for every recall.

Stock recovery

The cost of stock recovery can also vary significantly. Smaller businesses that distribute products to a small area may pick up the goods in person. The sponsor of the recall may request that retailers destroy product at store level, therefore incurring no stock recovery costs. Other businesses may elect to have stock transported back to a central collection point for destruction or collection and transport back to the manufacturer for further processing. Product being recalled in Western Australia and returned to New South Wales for processing or destruction may incur large costs.

Additional company testing

The cost of testing varies depending on the type of testing being performed.

Destruction of stock

This varies depending on the volume of stock and the type of destruction required. The methods generally used are:

- normal trade waste
- deep burial
- destroy at store level (for example opening packets and pouring contents down drain)
- incineration.

FSANZ provided the following examples of the cost of conducting a recall:

1 Major retailer conducting recall of 17,280 cartons of instant noodles, 85 g, in New South Wales and the Australian Capital Territory:
   - press advertisements $9,800
   - stock costs $250,000
   - cost recovery $8,800.

   Total cost of recall $268,600.

2 Major retailer conducting national recall of 17,680 cartons of frozen processed chicken:
   - press advertisements $51,521
   - stock costs $75,709
   - cost recovery $119,425
   - labour costs $4,000
   - other associated costs $7,217.

   Total cost of recall $257,872.

3 Small retailer conducting a recall of processed meat in Queensland:
   - press advertisements $150
   - stock costs $33
   - cost recovery $0.

   Total cost of recall $183.

4 National retailer conducting recall of fruit cake in Victoria, New South Wales, Queensland and Western Australia:
   - press advertisements $7,000
   - stock costs $30,712
   - cost recovery $7,525
   - labour costs $500
   - other associated costs $8,000.

   Total cost of recall $53,737.

5 An international manufacturer–distributor conducting a recall of 11 varieties of pasta sauce distributed nationally and exported to two other countries reported to FSANZ that the recall cost $996,866.

The above examples come from recalls conducted between 2000 and 2003. Prices may have increased since then. FSANZ may not receive exact details of all the costs involved in a recall, as the businesses are not legally obliged to provide any information.

FSANZ is not notified of food withdrawals and therefore does not have any data on actual withdrawal costs. However, the costs to withdraw stock from sale would be similar to a recall, but without the cost of press advertisements and possibly laboratory testing.

7.5 Conclusions

It is not possible to generalise or to draw firm quantitative conclusions on the costs to industry of disruption due to major food outbreaks, including net loss of profits due to disruption.

In several of the incidents described above, the disruption costs, including loss of profits, would have been one or two million dollars. These would have been very significant to the businesses bearing the costs, but not to the economy. In the case of the *E. coli* O111 outbreak, the costs to industry may have run into tens of millions of dollars and possibly more.

A specific cost to industry is the cost of preventing or minimising contaminated product from reaching consumers as a result of recalls and destruction of contaminated stock.

The costs of recalls vary greatly with the circumstances. In the six years 1998–2003, there were, on average, 55 recalls per year. Allowing $250,000 per recall, the costs would amount to $13.75 million a year. This figure would not allow for other indirect costs of disruption, or for exceptional events.

8 Total annual cost of foodborne illness

In this report we identify the following five main types of costs due to foodborne illness:

- public foodborne illness surveillance and control activities
- industry disruption associated with food poisoning outbreaks
- health care services
- lost productivity borne by businesses
- lost productivity, lifestyle and mortality costs borne by individuals.

In Chapter 6, we attempt to distinguish between the loss of productivity borne by businesses and the costs borne by households, and also between productivity and lifestyle losses. These efforts are useful as a means of validating the estimated overall costs. However, the distinctions are not based on robust data. Accordingly, summary costs of estimated productivity and lifestyle losses are reported below. These totals are more reliable estimates than breakdowns of the components.

8.1 Government actions to maintain a safe food supply

In the absence of special survey work, it is not easy to separate out costs incurred by government agencies due to outbreaks of foodborne illness. However, the costs of surveillance, investigating outbreaks and maintaining food safety systems appears to be in the order of $10 million per annum.

8.2 Industry disruption due to foodborne illness outbreaks

The costs of recalls vary with circumstances. Excluding exceptional cases, the costs of industry disruption appear to be in the order of $14.0 million a year. Further research would be required to validate or amend this figure.

8.3 Cost of health care services

Table 8.1 summarises the major costs of health care services. The estimated total is $221.9 million. Of this total, gastroenteritis accounts for an estimated $199.8 million (90.0%).

The other seven diseases account for the remaining $22.1 million (10.0%), with irritable bowel syndrome contributing most to the costs. Visits to emergency departments, GPs and specialists account for two-thirds of all costs.

Table 8.1 **Estimated health care costs per annum** ($ million)

Illness	Hospital	ED/GP/ specialist visits	Other costs	Total costs
Gastroenteritis	25.2	139.6	35.0	199.8
Listeriosis	2.3	0.1	0.0	2.4
Toxoplasmosis	0.1	0.1	0.0	0.2
Hepatitis A	0.2	0.0	0.0	0.2
Haemolytic uraemic syndrome	0.3	0.0	0.0	0.3
Irritable bowel syndrome	3.4	4.1	8.2	15.7
Guillain-Barré syndrome	0.6	0.0	0.0	0.7
Reactive arthritis	0.1	1.0	1.6	2.7
Total	**32.2**	**144.9**	**44.8**	**221.9**

8.4 Costs of losses in productivity, lifestyle and mortality

Table 8.2 provides a summary of estimates of the costs of illness (losses of productivity and lifestyle) and of mortality costs. The estimated total cost is $1,003 million, of which illness-related costs account for an estimated 77.8% and premature mortality costs account for 22.2%.

In terms of diseases, gastroenteritis accounts for an estimated $811 million (81%) and the other seven diseases account for the balance of 19%. Of these seven diseases, listeriosis and reactive arthritis are the major contributors to the costs.

Table 8.2 **Estimated productivity, lifestyle and mortality costs** ($ million)

Illness	All productivity and lifestyle costs	Mortality	Total cost
Gastroenteritis	691.2	119.5	810.7
Listeriosis	0.8	82.3	83.1
Reactive arthritis	40.0	0.0	40.0
Irritable bowel syndrome	35.5	1.0	36.5
Guillain-Barré syndrome	1.6	23.7	25.3
Hepatitis A	0.8	2.5	3.3
Haemolytic uraemic syndrome	0.0[(a)]	2.5	2.5
Toxoplasmosis	1.7	0.0[(a)]	1.7
Total	**771.6**	**231.5**	**1,003.1**

(a) Under $50,000.

8.5 Major uncertainties and their effects

There is uncertainty about many of the figures used, even though they are based on considerable research. Hall and the OzFoodNet Working Group (2004) point out that, by adopting a credible interval with interpretation akin to that for a 95% confidence interval, there is approximately 25% variation up and down in the estimates of foodborne gastroenteritis cases per annum. There would be a similar level of uncertainty about days of activity lost per annum, which are estimated to be 5.8 million for gastroenteritis. Also, estimates of individual costs based on willingness to pay to avoid illness are sensitive to estimates of severity weights.

A detailed exploration of all possible effects of these uncertainties would be a complex and lengthy task. Reflecting the uncertainties simply in the estimates of cases, the estimated costs could be 25% lower or higher than the estimates shown in tables 8.1 and 8.2. With respect to other uncertainties, as discussed in Appendix A, it seems more likely that the days off work and activity are overestimates rather than underestimates. On the other hand, if these were reliable estimates, it would then be necessary to add costs for residual pain and suffering.

On balance, the estimates shown in tables 8.1 and 8.2 appear plausible central estimates. However, for the reasons stated, the actual costs could be 25% lower or higher than the costs shown in these tables.

Appendix A **Epidemiological data**

A1–A8 Detailed tables of estimates relating to foodborne illnesses included in costing:

- A1 Gastroenteritis
- A2 Listeriosis
- A3 Toxoplasmosis
- A4 Hepatitis A
- A5 Haemolytic uraemic syndrome
- A6 Irritable bowel syndrome
- A7 Guillain-Barré syndrome
- A8 Reactive arthritis

A9 Brief description of clinical features of non-gastroenteritis foodborne illnesses:

Listeriosis, toxoplasmosis, hepatitis A, haemolytic uraemic syndrome, irritable bowel syndrome, Guillain-Barré syndrome, reactive arthritis

A10 Some data issues and limitations

Access to data

Estimation of the proportion of illnesses that are foodborne

A11 Data sources for infectious gastroenteritis, listeriosis, toxoplasmosis, hepatitis A, haemolytic uraemic syndrome, irritable bowel syndrome, Guillain-Barré syndrome and reactive arthritis

A1 Gastroenteritis

Table A1 **Gastroenteritis due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, investigations, treatments and time lost**

Age group	No. cases/ year (millions)	No. deaths/ year[b]	No. hospital-isations/ year[c]	Mean days in hospital/ patient	No. visits to GPs/ year[d]	No. visits to ED/ year	No. stool tests outside hospital/ year	No. cases taking medications outside hospital/ year	No. days lost activities/ year	No. days lost paid work/ year
Female										
0–4 years	0.26	3	3,855	2	189,705	61,809	2,436	152,696	238,699	23,473
5–14 years	0.45	1	1,027	2	250,767	44,934	0	181,676	525,328	72,143
15–64 years	2.19	6	2,199	2	386,733	65,074	73,885	973,972	1,099,636	1,101,957
65 years or over	0.17	27	983	5	78,262	17,765	0	77,685	—	61,022
Total	3.06	37	8,063	2	905,468	189,583	76,320	1,386,029	1,946,033	1,258,597
Male										
0–4 years	0.32	4	4,293	2	92,585	9,338	0	226,374	651,772	52,367
5–14 years	0.44	0	1,130	2	101,537	1,730	0	239,180	686,582	330,465
15–64 years	1.50	13	1,657	3	273,920	50,138	66591	398,031	381,560	441,035
65 years or over	0.15	22	453	5	67,040	0	25465	40,015	62,130	0
Total	2.41	39	7,532	2	535,082	61,205	92,056	903,599	1,782,045	823,867
Total[e] rounded (CrI)[f]	**5.4 million (4.0–6.9)**	**80**	**15,000**	**2 days**	**1.4 million**	**250,000**	**168,000**	**2.3 million**	**3.7 million**	**2.1 million**
Source of data	National Gastro-enteritis Survey 2001–02.	Hospital morbidity data 1993–94 to 1998–99. Principal and additional diagnoses.	Hospital morbidity data 1998–2002. Adjusted principal diagno-ses.[c]	Hospital morbidity data 1998–2002.	National Gastro-enteritis Survey 2001–02.	National Gastro-enteritis Survey 2001–02.	National Gastro-enteritis Survey 2001–02.	National Gastro-enteritis Survey 2001–02. Details in tables A1.1 and A1.2.	National Gastro-enteritis Survey 2001–02. Self or carer.	National Gastro-enteritis Survey 2001–02. Self or carer.

(a) The proportion of cases due to foodborne transmission was estimated at 32% (95% CrI: 24–40%) of all gastroenteritis.

(b) Where infectious gastroenteritis was a contributing reason for hospital admission, and the patient died.

(c) Adjusted for additional diagnoses by increase of 38% on principal diagnoses. See Chapter 3.

(d) Cases may have more than one visit.

(e) Totals may not add due to rounding.

(f) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

Details of medications for gastroenteritis

Table A1.1 **Number of medications[a] taken by symptom groups for gastroenteritis due to foodborne transmission**

Age group	Diarrhoea	Pain relief	Antibiotics	Cramps	Nausea
Female					
0–4 years	1,218	129,223	51,858	0	0
5–14 years	62,045	106,578	3,361	0	86,526
15–64 years	195,936	730,087	117,044	39,329	181,817
65 years or over	74,251	23,766	21,637	0	11,037
Total	333,450	989,654	193,900	39,329	279,380
Male					
0–4 years	38,058	186,192	25,818	0	1,442
5–14 years	64,563	239,180	0	0	0
15–64 years	192,361	248,198	85,777	8,915	137,824
65 years or over	5,686	3,070	3,070	0	0
Total	300,669	676,640	114,665	8,915	139,265
Total	**634,119**	**1,666,294**	**308,565**	**48,245**	**418,645**

(a) More than one medication was taken by some people. Total number of medications taken = 3.1 million. Total number of people taking medication = 2.3 million.

Table A1.2 **Types of different medications and days taken in each symptom group**

Medication	% of group	Average no. days taken
Antibiotics		
Amoxycillin	44	
Bactrim	4	
Cloxacillin	22	
Doxycycline	4	
Erythromycin	9	
Metronidazole	13	
Penicillin	4	
Total	*100*	*7.5*
Diarrhoea		
Charcoal	7	
Electrolyte	23	
Imodium	49	
Lomotil	21	
Total	*100*	*2.3*
Cramps		
Buscopan	75	
Valium	25	
Total	*100*	*3.1*

Medication	% of group	Average no. days taken
Pain		
Aspirin	12	
Paracetamol + codeine	14	
Dymadon	1.5	
Mersyndol	1	
Nonsteroidal	4	
Paracetamol	66.5	
Tramal	0.5	
Morphine	0.5	
Total	*100*	*2.4*
Nausea		
Antacid	15	
Antihistamine	4	
Herbal	2	
'Antinausea'	79	
Total	*100*	*2.0*

A2 Listerosis

Table A2 **Listeriosis due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, treatments and time lost**

Age group	No. cases/ year	No. deaths/ year	No. hospital admissions/ year[b]	No. survivors	Mean days in hospital/ patient	No. visits to GPs/ year	No. visits to ED/ year	No. cases treated outside hospital/ year	No. days lost paid work and activities/ year
Male and female									
Materno-foetal pairs									
0–4 years	26	8	26	18	26	36	26	18	846
Others									
5–14 years	0	0	0	0	..	0	0	0	0
15–64 years	28	6	28	22	24	44	28	22	990
65 years or over	62	12	62	50	21	100	62	50	2,100
Total	90	18	90	72	22	144	90	72	2,200
Total[c] rounded (CrI)[d]	**120 (100–130)**	**26**	**120**	**90**	**23**	**180**	**120**	**90**	**3,000**
Source of data	State NDSSs 1998–2000.[e]	State NDSSs 1998–2000.[e]	Assume all cases admitted.[b] No. cases from state NDSSs 1998–2000.[e]		NHMD 1999–2002.	Assumed 2 follow-up visits for survivors post-hospital.	Assumed 1 visit before admission.	Assumed surviving hospitalised patients have ongoing medications outside hospital. Details Table A2.1.	Assumed time in hospital + 21 days.

(a) The proportion of cases due to foodborne transmission was estimated at 98% (95% CrI: 92–100%).

(b) Only 31 admissions noted in hospital morbidity dataset as principal diagnosis for same period as state notifications. It is likely that listeriosis may be coded as an additional diagnosis for people with another serious condition, such as cancer.

(c) Totals may not add due to rounding.

(d) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

(e) Under-reporting factor taken as 2.

Table A2.1 **Details of treatment in community for listeriosis after hospitalisation[a]**

Item	Minimum expected
Treatment after discharge from hospital	Four weeks amoxycillin
Visits for health care after discharge	Two visits to GPs, two visits to specialist physician
Tests	FBC, ESR
Days lost to paid work and activities	Three weeks for uncomplicated cases of bacteraemia
Disability—not considered in costing	A small number of patients with meningitis may have ongoing lifelong neurological damage and disability

(a) Opinion from infectious disease specialist, pers. comm.

A3 Toxoplasmosis

Table A3 **Toxoplasmosis due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, investigations, treatments and time lost**

Age group	No. symptomatic cases/ year	No. deaths/ year[b]	No. hospital admissions/ year[b]	Mean days in hospital/ patient	No. visits to GPs/ year	No. visits to ED/ year	Hospitalised patients: no. cases with tests outside hospital/ year	Hospitalised patients: no. cases treated outside hospital with medication/ year	Hospitalised patients: no. days lost paid work and activities/ year	Not hospitalised patients: no. days lost paid work and activities/ year
Female										
0–4 years			0	..			0	0	3	
5–14 years			1	3			1	1	24	
15–64 years			7	2			7	7	375	
65 years or over			0	..			0	0	5	
Total			8	2			8	8	407	
Male										
0–4 years			0	..			0	0	7	
5–14 years			1	3			1	1	32	
15–64 years			13	12			13	13	273	
65 years or over			0	..			0	0	4	
Total			14	12			14	14	315	
Total[c] rounded (CrI)[d]	**5,900 (0–13,900)**	**0**	**21**	**8**	**1,200**	**0**	**21**	**21**	**720**	**8,300**
Source of data	Overseas prevalence study, US (cited in Mead et al. 1999).	Mortality dataset 1999–2002.	NHMD 1998–99 to 2001–02. Principal diagnosis. Details in Table A3.1.	NHMD 1998–99 to 2001–02. Principal diagnosis.	Assumed 1 visit on average in 20% of symptomatic cases.	Assumed nil.	Assumed tests required after hospital. See details in tables A3.1 and A3.2 (tests for non-hospitalised patients not considered).	Assumed ongoing medications required after hospital. See details in tables A3.1 and A3.2.	Assumed hospital stay + 28 days. Males 40 days, females 30 days.	Assumed 7 days of illness in 20% of symptomatic cases, when activities are affected.

(a) The proportion of cases due to foodborne transmission was estimated at 35% (95% CrI: 0–71%).

(b) Where toxoplasmosis was the principal reason for hospital admission.

(c) Totals may not add due to rounding.

(d) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

Categories of toxoplasmosis

Table A3.1 **Clinical features of foodborne toxoplasmosis in hospitalised patients[a], 1998–2002**

Principal diagnosis	ICD-10-AM code	Cases/year due to foodborne[a]
Ocular	B58.0	3
Hepatitis	B58.1	0
Meningoencephalitis	B58.2	2
Pulmonary	B58.3	0
Other	B58.8	9
Unspecified	B58.9	8
Total		**22**
Congenital	P37.1	0

(a) 35% of all toxoplasmosis cases are estimated to be due to foodborne transmission.

Treatment

Treatment in the community for toxoplasmosis in cases not hospitalised

Tests and treatments for patients that were not hospitalised are not considered in the costing.

Some patients who present to GPs would be investigated (such as serology tests for anti-toxoplasmosis antibody titres, lymph node biopsy, full blood count (FBC), erythrocyte sedimentation rate (ESR)). It is important to note that many tests for toxoplasmosis involve screening of pregnant women who are not sick.

Treatment in the community for hospitalised cases of toxoplasmosis after discharge

Table A3.2 **Details of community treatment for toxoplasmosis after hospitalisation[a]**

Item	Minimum expected
Treatment after discharge from hospital[b]	Resolving case: eight weeks high-dose medications Ongoing case: eight weeks high-dose, and possibly years of low-dose medications (depending on category of toxoplasmosis infection and patient).
Visits for health care after discharge	Resolving case: expect two visits to GP and two to specialist Ongoing case: assume six visits to GP yearly, two visits to specialist physician yearly.
Tests	Ongoing case: serology and others as needed (e.g. FBC, ESR; tissue biopsy as needed).
Days lost to paid work and activities	Resolving case: three weeks for uncomplicated cases of bacteraemia Ongoing case: years.
Disability—not considered in costing	A small number of patients with encephalitis may have ongoing lifelong neurological damage and disability. Prognosis is shortened lifespan.

(a) Opinion from Australian infectious disease specialist, pers. comm.

(b) For serious cystic disease in hospitalised patients, recommended minimum treatment (Wu & Garcia 2003):
Pyrimethamine 75 mg at four per day for four weeks; Sulfadiazine 1 g at four per day for four weeks; Prednisone 100 mg daily for two weeks.

A4 Hepatitis A

Table A4 **Hepatitis A due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, investigations, treatments and time lost**

Age group	No. cases/ year[b]	No. deaths/ year[c]	No. hospital admissions/ year	Mean days in hospital/ patient	No. visits to GPs/ year	No. visits to specialists/ year	No. visits to ED/ year	No. tests outside hospital/ year	No. contacts of cases treated/ year	No. days lost paid work and activities/ year
Female										
0–4 years	4		0	..	16	0.7	1	8	8	177
5–14 years	12		2	3	43	2.0	2	24	24	474
15–64 years	40		11	4	149	6.8	8	80	80	1,648
65 years or over	3		1	8	12	0.6	1	6	6	134
Total	59		13	4	220	10.1	11	118	118	2,434
Male										
0–4 years	6		0	..	22	1.0	1	12	12	243
5–14 years	13		1	3	49	2.2	3	26	26	541
15–64 years	66		8	3	244	11.2	13	132	132	2,699
65 years or over	3		1	17	9	0.4	0	6	6	103
Total	87		11	4	0	0.0	0	174	174	0
Total[d] rounded (CrI)[e]	**150 (0–1,000)**	**1**	**24**	**4**	**540**	**25**	**28**	**290**	**290**	**6,020**
Source of data	NNDSS	Case fatality 0.005 (McLaughlin et al. 2004) + mortality data 1999–2002.	NHMD 1998–99 to 2001–02.	NHMD 1998–99 to 2001–02.	Mean visits/ case = 3.7 (McLaughlin et al. 2004).	Mean visits/ case = 0.17 (McLaughlin et al. 2004).	Mean visits/ case = 0.19 (McLaughlin et al. 2004).	Assume serology and tests done twice per case. See details in Table A4.1.	Assume 2 contacts/ case immunised as per recommended. (DHS 1997).	Mean duration 41 days (McLaughlin et al. 2004).

(a) The proportion of cases due to foodborne transmission was estimated at 10% (95% CrI: 0–24%).

(b) Under-reporting factor estimated as 2, that is, double the number of cases reported to NNDSS before taking foodborne proportion.

(c) Where hepatitis A was the principal reason for hospital admission.

(d) Totals may not add due to rounding.

(e) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

Details of tests and treatment for hepatitis A outside hospital

Appropriate tests include:

- hepatitis A virus antibodies
- urinalysis
- liver function tests (LFTs—AST, ALT, ALP, bilirubin)
- full blood count (FBC) (RCPA 2004b).

Assumed each case has each test twice.

Table A4.1 **Number of tests and treatments[a] per year for hepatitis A due to foodborne transmission**

Age group	Hepatitis A antibodies	Urinalysis	LFTs	FBC	IgG treatment for contacts[b]
Female					
0–4 years	9	9	9	9	9
5–14 years	23	23	23	23	23
15–64 years	80	80	80	80	80
65 years or over	7	7	7	7	7
Total	119	119	119	119	119
Male					
0–4 years	12	12	12	12	12
5–14 years	26	26	26	26	26
15–64 years	132	132	132	132	132
65 years or over	5	5	5	5	5
Total	175	175	175	175	175
Total	**294**	**294**	**294**	**294**	**294**

(a) Cases have more than one test.

(b) IgG for household and sexual contacts of the cases. Dose varies from 0.5 ml (child) to 2–5 ml (adult) (DHS 1997). Assume average of two contacts per case (based on average household size in Australia of 2.7).

A5 Haemolytic uraemic syndrome

Table A5 **Haemolytic uraemic syndrome due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, investigations, treatments and time lost**

Age group	No. cases/ year	No. deaths/ year[b]	No. hospital admissions/ year[b][c]	Mean days in hospital/ patient[b]	No. visits to GPs/ year[d]	No. visits to specialists/ year	No. cases with tests outside hospital /year[e]	No. days lost paid work and activities/ year
Males and females								
0–4 years	7	1	8		19	7	6	84
5–14 years	4	0	4		12	4	4	50
15–64 years	5	1	18		13	5	4	168
65 years or over	1	1	2		1	1	0	32
Total[f] rounded (CrI)[g]	**20 (0–40)**	**3**	**30**	**9**	**45**	**17**	**14**	**290**
Source of data	APSU for <15 years 1994–2000 (APSU 2004).	APSU 1994–2000 (APSU 2004); state NDSSs for >15 years 1999–2003.	NHMD 1998–99 to 2000–01. Principal diagnosis.	NHMD 1998–99 to 2000–01.	Assumed 3 per case.	Assumed 1 per case.	Assumed 2 per case. See details in text.	Assumed hospital stay + 14 days.

(a) The proportion of cases due to foodborne transmission was estimated at 50% (95% CrI: 0–100%).

(b) Where HUS was the principal reason for hospital admission. Does not include HUS coded as an additional diagnosis.

(c) Cases can have more than one admission due to hospital transfer.

(d) Assume one visit before admission (although could be a visit to a hospital emergency department) and two after discharge.

(e) Possible ongoing cases with significant renal or other problems are not considered.

(f) Totals may not add due to rounding.

(g) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

Follow-up management of HUS after hospitalisation

The following tests were assumed to have been done twice after discharge: blood urea, creatinine, electrolytes, full blood count, erythrocyte sedimentation rate, microbiological testing and culture of urine.

A few patients may have ongoing complications such as renal impairment and would need ongoing specialist care and possibly significant intervention. This has not been costed.

A6 Irritable bowel syndrome

Table A6 Irritable bowel syndrome following foodborne *Campylobacter*, *Salmonella* and *Shigella* infections[a] in Australia in one year. Estimated number of cases, deaths, health care visits, investigations, treatments and time lost

Age group	No. new cases/ year	No. deaths/ year (new and old cases)[b]	No. hospital admissions/ year (new and old cases)	Mean days in hospital (new and old cases)	No. visits to GPs/ year (new and old cases)	No. visits to ED/ year (new and old cases)	No. tests/ year (new and old cases)[c]	No. medications/ year (new and old cases)[c]	No. days lost paid work and activities/ year (new and old cases)[d]
Female									
0–4 years	0		0	1	0	0			0
5–14 years	0		9	2	1,228	0		626	626
15–64 years	11,521		1,699	1	45,440	0		25,098	25,098
65 years or over	2,033		183	2	14,737	0		7,625	7,625
Total	13,554	2	1,891	1	61,406	0		33,350	33,350
Male									
0–4 years	0		1	2	0	0			0
5–14 years	0		5	2	605	0		169	308
15–64 years	5,675		781	1	22,381	0		6,267	12,128
65 years or over	1001		83	8	7,259	0		2,032	3,729
Total	6,676	1	870	2	30,245	0		8,468	16,166
Total[e] rounded	**20,200**	**3**	**2,700**	**2**	**91,700**	**0**		**25,700**	**49,500**
(CrI)[f]	**(6,400–35,800)**								
Source of data	7% of estimate of foodborne *Salmonella/ Campylobacter/ Shigella* gastroenteritis (Hall & the OzFoodNet Working Group 2004).	Mortality dataset 1999–2002. Contributing cause of death.	NHMD 1998–99 to 2001–02. Principal diagnosis.	NHMD 1998–99 to 2001–02. Principal diagnosis.	BEACH data 1998–2003.	Assumed nil.	BEACH data 1998–2003. Details in Table A6.1.	BEACH data 1998–2003. Details in Table A6.2.	Assumed same as days in hospital + time visiting GP (0.5 day).

(a) The estimated proportion of irritable bowel syndrome following foodborne gastroenteritis was 30% (95% CrI: 10–60%).

(b) Where irritable bowel syndrome was a contributing reason for death.

(c) Case can have more than one test or treatment each. See tables A6.1 and A6.2.

(d) Assumes number of days lost apart from seeking health care. Based on episodes of care for all cases, new or ongoing.

(e) Totals may not add due to rounding.

(f) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

Details of GP investigations for irritable bowel syndrome

Table A6.1 **Number of investigations per year for irritable bowel syndrome following foodborne *Campylobacter*, *Salmonella* and *Shigella* infections**[a]

Age group	Micro-biological testing of stool	Stool culture	FBC	ESR	LFT	X-ray barium enema	Abdominal X-ray	Abdominal ultrasound	Specialist/ endoscopy/ colonoscopy
Female									
0–4 years	0	0	0	0	0	0	0	0	0
5–14 years	12	5	19	6	8	3	4	6	53
15–64 years	448	198	708	219	281	125	135	208	1,957
65 years or over	145	64	230	71	91	41	44	68	635
Total	605	267	957	295	380	169	183	281	2,645
Male									
0–4 years	0	0	0	0	0	0	0	0	0
5–14 years	6	3	9	3	4	2	2	3	26
15–64 years	221	97	349	108	138	62	67	103	964
65 years or over	72	32	113	35	45	20	22	33	313
Total	298	132	471	146	187	83	90	139	1,303
Total	**903**	**399**	**1,428**	**441**	**567**	**252**	**273**	**420**	**3,948**

(a) Based on the estimate that 30% of irritable bowel syndrome is a sequel to foodborne infection. Includes data from 30% of all consultations for irritable bowel syndrome (includes cases that are ongoing as well as new).

Source: BEACH data 1998–2003 (BEACH 2004), adjusted for proportional distribution by age and sex (see text).

Details of medications given by GPs for irritable bowel syndrome

Table A6.2 **Number of medications prescribed per year for irritable bowel syndrome following foodborne *Campylobacter*, *Salmonella* and *Shigella* infections**[a]

Age group	Stemetil 6% of visits	Buscopan 3% of visits	Colofac 14% of visits	Loperamide 4% of visits	Metamucil 1% of visits
Female					
0–4 years	0	0	0	0	0
5–14 years	74	37	172	49	12
15–64 years	2,726	1,363	6,362	1,818	454
65 years or over	884	442	2,063	589	147
Total	3,684	1,842	8,597	2,456	614
Male					
0–4 years	0	0	0	0	0
5–14 years	36	18	85	24	6
15–64 years	1,343	671	3,133	895	224
65 years or over	436	218	1,016	290	73
Total	1,815	907	4,234	1,210	302
Total	**5,499**	**2,750**	**12,831**	**3,666**	**917**

(a) Based on the estimate that 30% of irritable bowel syndrome is sequel to foodborne infection.

Source: BEACH data 1998–2003 (BEACH 2004).

A7 Guillain-Barré syndrome

Table A7 **Guillain-Barré syndrome due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, treatments and time lost[b]**

Age group	No. cases/ year[c]	No. deaths/ year[d]	No. survivors/ year	No. hospital admissions/ year	Mean days in hospital/ patient	No. visits to GPs/ year	No. visits to specialists/ year	No. treatments rehab/ physio-therapy/ year[e]	No. days lost paid work and activities/ year
Female									
0–4 years	1	0	1	1	7	7	3	6	87
5–14 years	2	0	2	2	18	15	6	13	190
15–64 years	33	3	30	33	10	209	89	179	2,684
65 years or over	16	2	14	16	19	100	43	86	1,283
Total	52	5	47	52	13	330	141	283	4,245
Male									
0–4 years	2	0	2	2	8	13	6	11	171
5–14 years	3	0	3	3	9	20	9	17	262
15–64 years	48	5	43	48	11	301	129	258	3,873
65 years or over	17	2	15	17	15	107	46	92	1,374
Total	70	7	63	70	12	442	189	379	5,680
Total[f] rounded (CrI)[g]	**120 (90–160)**	**12**	**110**	**120**	**13**	**770**	**330**	**660**	**9,900**
Source of data	NHMD 1998–99 to 2001–02. Principal diagnosis. all cases hospitalised.[c] Estimated 20% due to foodborne *Campylobacter*.	10% of cases[d] die (Hahn 1998; Kuwabara 2004).		NHMD 1998–99 to 2001–02. Principal diagnosis.	NHMD 1998–99 to 2001–02. Principal diagnosis.	Assume pre-hospital-isation = 1 visit to GP and post-hospital = 6 visits.	Assume post-hospital = 3 visits.	Assume 6 sessions rehab/ physio post-hospital.	Mean duration estimated 90 days for survivors.

(a) The proportion of Guillain-Barré syndrome cases due to foodborne *Campylobacter* was estimated at 20% (95% CrI: 15–25%).

(b) Cases with ongoing disability not accounted for. 20% have severe disability still at one year after onset of illness. Of these, 22% can't run, 8% walk aided and 10% have ongoing lifelong disability (Hahn 1998).

(c) There could be transfers of cases between hospitals, which would decrease the estimated number of cases.

(d) Age distribution assumed 10% cases each age group. Validation against mortality dataset 1999–2002 shows 23 per year for all Guillain-Barré syndrome. Taking 20% as foodborne gives five per year.

(e) Each case can have more than one test or treatment.

(f) Totals may not add due to rounding.

(g) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

A8 Reactive arthritis

Table A8 **Reactive arthritis due to foodborne transmission[a] in Australia in one year. Estimated number of cases, deaths, health care visits, investigations, treatments and time lost**

Age group	No. cases/ year[b]	No. deaths/ year	No. hospital admissions/ year[c]	Mean days in hospital/ patient	No. visits to GPs/ year	No. visits to ED/ year	No. tests/ year[d]	No. treatments/ medication/ year[d]	No. days lost paid work and activities/ year
Female									
0–4 years	0	0	0	1	0	0	0	0	0
5–14 years	1,281	0	1	3	1,025	0	256	256	3,663
15–64 years	10,247	0	4	5	8,197	0	2,049	2,049	29,302
65 years or over	1,281	0	1	7	1,025	0	256	256	3,663
Total	12,808	0	6	5	10,247	0	2,561	2,561	36,628
Male									
0–4 years	0	0	1	3	0	0	0	0	0
5–14 years	854	0	1	4	683	0	171	171	2,442
15–64 years	6,831	0	10	5	5,465	0	1,366	1,366	19,535
65 years or over	854	0	1	5	683	0	171	171	2,442
Total	8,539	0	13	5	6,831	0	1,708	1,708	24,419
Total[e] rounded (CrI)[f]	**21,000 (6,400–36,000)**	**0**	**20**	**5**	**17,100**	**0**	**4,300**	**4,300**	**61,052**
Source of data	Estimated 7% of *Salmonella/ Campylobacter/ Yersinia* gastroenteritis (Hannu et al. 2002b).	Mortality data 1999–2002.	NHMD 1998–99 to 2001–02.		20% of cases see a GP (Hannu et al. 2002b). Of these, assume 4 visits.		Assumed. See details Table A8.1.	Assumed. See details Table A8.2.	Among those visiting a doctor, 10% days. Mean duration 143 days (Hannu & Leirisalo-Repo 1988).

(a) The proportion of cases due to foodborne transmission was estimated at 30% (95% CrI: 20–40%) (Stoilov et al. 1990).

(b) Female sex is a risk factor (Hannu et al. 2002b). 60% of cases assumed female. Age groups allocated by same proportions as gastroenteritis (excluding 0–4 years): 5–14 years, 10%; 15–64 years, 80%; 65 years or over, 10%.

(c) Where reactive arthritis was the principal reason for hospital admission. It is likely that the illness may be coded as an additional diagnosis and such cases are not included.

(d) Each case can have more than one test or treatment.

(e) Totals may not add due to rounding.

(f) The numbers in brackets indicate the credible interval based on the 2.5 and 97.5 percentiles of the plausible range. Interpretation is akin to 95% CI (see text).

Details of investigations by GPs for reactive arthritis

Table A8.1 **Number of tests prescribed per year for reactive arthritis following foodborne *Campylobacter*, *Salmonella* and *Yersinia* infections**[a]

Age group	Microbiological testing of stool	Stool culture	Blood HLA-B27	FBC, ESR	Rheumatoid factor	Lumbosacral X-ray	Ultrasound lower limb	Referral to rheumatologist	Specialist visits/year
Female									
0–4 years	0	0	0	0	0	0	0	0	0
5–14 years	256	256	256	256	256	51	51	51	102
15–64 years	2,049	2,049	2,049	2,049	2,049	410	410	410	820
65 years or over	256	256	256	256	256	51	51	51	102
Total	2,561	2,561	2,561	2,561	2,561	512	512	512	1,025
Male									
0–4 years	0	0	0	0	0	0	0	0	0
5–14 years	171	171	171	171	171	34	34	34	68
15–64 years	1,366	1,366	1,366	1,366	1,366	273	273	273	546
65 years or over	171	171	171	171	171	34	34	34	68
Total	1,708	1,708	1,708	1,708	1,708	342	342	342	683
Total	**4,269**	**4,269**	**4,269**	**4,269**	**4,269**	**854**	**854**	**854**	**1,708**

(a) Data assumed based on the number of cases and investigations documented as carried out in studies in Finland (Hannu et al. 2002b). 20% of cases see a GP. Assume that all cases seeing a GP will have stool test, HLA-B27, FBC, ESR, RF. Of those seeing a GP, assume 20% will have a lumbosacral X-ray, ultrasound of lower limbs and a referral to a specialist rheumatologist. Assume two visits to the specialist.

Table A8.2 **Number of treatments prescribed per year for reactive arthritis following foodborne *Campylobacter*, *Salmonella* and *Yersinia* infections**[a]

Age group	Antibiotics e.g. Erythromycin one course to eliminate bacterial infection	NSAID e.g. Naprosyn 250 mg × two per day for 143 days	Eye drops e.g. Murine eye drops × three per day for 143 days
Female			
0–4 years	0	0	0
5–14 years	256	256	256
15–64 years	2,049	2,049	2,049
65 years or over	256	256	256
Total	2,561	2,561	2,561
Male			
0–4 years	0	0	0
5–14 years	171	171	171
15–64 years	1,366	1,366	1,366
65 years or over	171	171	171
Total	1,708	1,708	1,708
Total	**4,269**	**4,269**	**4,269**

(a) Data assumed, based on the number of cases and treatments recommended (Phelps 2002).

A9 Brief description of clinical features of non-gastroenteritis foodborne illnesses

Listeriosis

Listeriosis is caused by *Listeria monocytogenes*. This widespread organism is found in animals and is a common cause of stillbirth in domestic animals. It is a common foodborne contaminant, although most healthy people are not affected by it.

It is now thought that *Listeria* can cause a mild gastroenteritis illness in healthy people as well as invasive listeriosis. Invasive disease is a serious illness: the bloodstream is infected causing septicaemia and sometimes meningitis. General symptoms include fever, headache, tiredness, aches and pains, and sometimes diarrhoea, nausea and cramps. Infection of the nervous system can lead to stiff neck, confusion, loss of balance and convulsions. There is sometimes residual neurological damage. Mortality is high.

Immunocompromised people are especially vulnerable, as well as pregnant women. The organism crosses the placenta and infection in early pregnancy often leads to spontaneous abortion. About half the infants of mothers infected near term will be stillborn even if the mother is not very ill. Incubation is 7–28 days after ingestion. People with underlying cancers and HIV/AIDS are at much higher risk of invasive listeriosis, especially during periods when they are being treated with chemotherapy (DHS 2000; CDC 2004).

Toxoplasmosis

Most people infected with *Toxoplasmosis gondii* are asymptomatic. It is estimated that only about 15% of infections lead to symptoms that can range from mild to serious. If symptoms do develop, then there is generally a flu-like illness, swollen lymph glands, and aches and pains that last for a month or more.

Immunocompromised people (including HIV/AIDS patients, those on chemotherapy or those with a recent organ transplant) are prone to severe disease. The parasites form cysts most commonly in skeletal muscle, the heart and the brain, and the cysts can remain lifelong. Severe disease leads to damage to a number of organs.

Toxoplasmosis can be spread by contact with infected cat faeces or ingestion of raw infected meat or water (CDC 2003). The cat intestine is an essential part of the life cycle of the parasite as reproduction takes place there.

Toxoplasmosis is one of the most common infections worldwide, especially in warmer climates, but there is regional variation. Serology studies have indicated infection at some time in people 40–50 years of age in a number of countries. In France 90% are positive, in Japan 12.5% and in Holland 60% are positive (Wu & Garcia 2003). 40% of people 60 years of age are positive in the United States (Mead et al. 1999).

Congenital toxoplasmosis is acquired by cross-placental infection and causes retino-chorioditis (eye disease), cerebral calcifications and convulsions (Wu & Garcia 2003).

Hepatitis A

Hepatitis A is an infection of the liver with the hepatitis A virus. Patients feel generally unwell, and have aches and pains, fever, nausea, lack of appetite and abdominal discomfort. Urine becomes dark and faeces light-coloured. Skin and eyeballs become yellow with jaundice due to raised bilirubin in the blood.

Incubation is usually 28–30 days and the illness usually lasts for about three weeks. A feeling of lethargy can persist for some time after the other symptoms have gone. The clinical spectrum is from no symptoms at all to severe illness. Adults tend to be more seriously affected.

The disease is spread by the human faecal–oral route, which can involve food contamination, especially by an infected food handler. The infectious period lasts from two weeks before clinical symptoms to one week after jaundice starts.

The virus can survive at room temperature for several weeks (Queensland Health 2004).

Haemolytic uraemic syndrome (HUS)

HUS is a rare disease affecting the blood cells and kidneys. It is caused by a reaction in some people to stimuli of varying kinds, leading to the disintegration of the blood cells and renal failure. One of the more common reasons for developing HUS is infection with certain strains of *E. coli*, which can be ingested in contaminated food. The *E. coli* produce a toxin called 'verotoxin' that causes the reaction leading to the syndrome.

The illness begins about three days after eating contaminated food, with abdominal pains and bloody diarrhoea that lasts for about a week. Urine decreases as the kidneys become affected and the patient becomes lethargic and unresponsive. The illness can be extremely serious and is treated in hospital with support for the essential body functions until the reaction passes. Children under five years of age are more vulnerable to serious disease than adults.

Contamination of food is probably more likely in undercooked beef. Contamination can also be spread from one food to another before consumption, which may be more likely to lead to a problem when the second food is not cooked, such as salads. It is possible that contamination can also be spread directly from animals to humans (DHS 1998).

Irritable bowel syndrome (IBS)

IBS is characterised by abdominal pain and irregular bowel movements. Attacks can last for days to months. Diarrhoea can alternate with constipation. Other symptoms include a feeling of incomplete evacuation, bloating and wind. There may be mucus in the bowel motion. The bowel is thought to be oversensitive. IBS can be triggered by stress, diet or infection. Psychological disturbances are frequently associated with IBS (Gwee et al. 1996). Medications can produce similar symptoms (Australian Gastroenterology Institute 2001).

IBS is generally a lifelong illness but has a pattern of 'coming and going', with exacerbations of symptoms and periods of remission.

Guillain-Barré syndrome

This is an autoimmune disease that affects the nervous system. There are different triggers for this to happen and one of them is an infection of the gut with *Campylobacter*. First symptoms include weakness or tingling in the legs, which spreads to the upper body, usually over a number of days. Paralysis of respiratory muscles can occur and this can lead to an inability to breathe and death if the patient is not supported in hospital. The disease is more common in older people.

Most often the illness lasts from a few weeks to months, but in some cases residual weakness of some muscles can remain as a permanent disability (Brain Foundation 2003).

Reactive arthritis (ReA)

ReA is a non-purulent joint inflammation that can be triggered by gastrointestinal or urethral infections. *Salmonella*, *Yersinia* and *Campylobacter* have been implicated to varying degrees as the cause of the preceding infection, with the symptoms of reactive arthritis occurring some time after the infection. People who have a particular genetic disposition identified by a positive blood test for HLA-B27 are more likely to get ReA.

The classic triad of symptoms is arthritis, urethritis and conjunctivitis following infection. Joint pains and low back pain are common, and occur within the first weeks after infection (Hannu et al. 2002a, 2002b). Fever and weight loss can also occur. The arthritis is fairly mild in most cases but can range from mild to severe. The illness lasts weeks to months and is most common in middle age (Hannu & Leirisalo-Repo 1988; Hannu et al. 2002a, 2002b).

A10 Some data issues and limitations

This section describes in some detail the sources, validation, cross-checks and assessments of uncertainty associated with the data for each of the illnesses. This process was to ensure that the best available data were used for the costing study.

Access to data

One limitation was not having access to hospital unit record data of both principal and additional diagnoses for the period 1998–99 to 2002–03. Principal diagnosis of separations in the National Hospital Morbidity Database is available on the internet and this was analysed for the years 1998–99 to 2002–03. The full hospital separation data for gastroenteritis was obtained previously by NCEPH–OzFoodNet for an

earlier project that leads into this costing project ('Analysis of hospital separations of infectious gastroenteritis', conducted by MAE student Nola Tomaska). Some information on additional diagnoses for gastroenteritis came from this earlier project.

Estimation of the proportion of illnesses that are foodborne

As there are little data on how much of the illnesses are due to foodborne transmission, foodborne disease experts were asked for their opinion, to supplement opinion in the literature as most literature is not based in strong evidence. For gastroenteritis, ten experts were asked in the previous study in 2002 (Hall & the OzFoodNet Working Group 2004) and nine foodborne disease experts were asked for their opinion on the other diseases in May 2004.

Experts asked about pathogens causing foodborne gastroenteritis, 2002

Dr Craig Dalton, Director, Hunter Public Health Unit, New South Wales

Martyn Kirk, Co-ordinating Epidemiologist, OzFoodNet

Dr Scott Crerar, Food Standards Australia New Zealand

Geoff Milard, OzFoodNet Epidemiologist, Australian Capital Territory

Dr Mark Veitch, Public Health Physician, Microbiological Diagnostic Unit, Victoria

Dr Rod Givney, Epidemiologist Communicable Diseases, South Australia

Russell Stafford, OzFoodNet Epidemiologist, Queensland

Leanne Unicomb, OzFoodNet Epidemiologist, Hunter Region, New South Wales

Joy Gregory, OzFoodNet Epidemiologist, Victoria

Dr Scott Cameron, Associate Professor, National Centre for Epidemiology and Population Health.

Experts asked about other foodborne acute illnesses, 2004

Jenny Musto, Epidemiologist Communicable Diseases, New South Wales

Martyn Kirk, Co-ordinating Epidemiologist, OzFoodNet

Dr Scott Crerar, Food Standards Australia New Zealand

Dr Geetha Isaac-Toua, OzFoodNet Epidemiologist, Australian Capital Territory

Dr Mark Veitch, Public Health Physician, Microbiological Diagnostic Unit, Victoria

Karen Dempsey, Epidemiologist Communicable Diseases, Northern Territory

Russell Stafford, OzFoodNet Epidemiologist, Queensland

Joy Gregory, OzFoodNet Epidemiologist, Victoria

Dr Scott Cameron, Associate Professor, National Centre for Epidemiology and Population Health.

Details about the proportion of gastroenteritis that is foodborne are given elsewhere (Hall & the OzFoodNet Working Group 2004). For the other diseases, there was reasonable agreement among experts about the foodborne proportion, except for variable answers regarding HUS.

Some information on HUS was available from APSU and the Victorian surveillance system.

APSU data 1994–2000 (6.5 years) showed that 137 children had HUS. Of these, 115 children had a diarrhoeal prodrome, suggesting that gastroenteritis had an aetiological role. 87 stool samples were examined, and STEC was identified in 44 (55%). Information from the Victorian surveillance system 1999–2003 showed 19 cases of HUS, with VTEC found in nine of these. Of the 19 cases, 11 had been to a farm recently, suggesting possible environmental transmission (J Gregory, OzFoodNet, DHS, pers. comm.). This suggests that the estimate of 50% HUS being due to foodborne VTEC is reasonable.

A11 Data sources for infectious gastroenteritis, listeriosis, toxoplasmosis, hepatitis A, haemolytic uraemic syndrome, irritable bowel syndrome, Guillain-Barré syndrome and reactive arthritis

Infectious gastroenteritis

Most of the data for gastroenteritis were from the National Gastroenteritis Survey 2001–02 conducted by OzFoodNet and NCEPH. The full methods are described in detail elsewhere (Hall & the OzFoodNet Working Group 2004). Some areas of particular importance to costing include days of work and activities lost, visits to GPs, hospital admissions and mortality. These are discussed below.

Days of work and activities lost

Since this item was important for driving the costs, some issues are discussed here. Cases were asked in the survey whether they or anyone else had missed any days from work or any days from other activities as a result of their gastroenteritis. The number of lost days is high. Possibilities to consider include:

- The number of lost days reflects the real impact of gastroenteritis because questions were asked about a number of different ways of losing time. They are higher than found in some other studies because previous work has not differentiated between the various possible scenarios.
- The estimate of the number of people missing paid work due to foodborne gastroenteritis in Australia in one year was 715,000 (CrI: 478,000–952,000). The number of carers missing work to look after someone else was 466,000 (CrI: 151,000–780,000). The average number of days lost among those taking time off was over two. There is uncertainty in the estimates reflecting extrapolation of survey results to the whole country, and uncertainty in the estimate of the

proportion foodborne, as shown by the credible intervals. This needs to be taken into account when interpreting the results. The number of lost days due to interruption to 'other activities' is especially high.

- Since separate questions were asked in the survey rather than just one simple question about 'days missed', it is possible that asking more than one question may be related to people overestimating the amount of time, or that there is double-counting by respondents if they misunderstood the question. For example, missing one day of work, and on the same day missing other activities, may have been reported as a total of two days instead of two half-days. On the other hand, asking more than one question may result in people stating a negative answer in order to get over the questions quickly leading to underestimation. On balance, it seems more likely that overestimation would be possible rather than underestimation. A validation study may help resolve this issue.
- The high number of days of interrupted 'other activities' may reflect a reality where respondents may have thought about the difference between 'paid' and 'other activities', and time lost may have depended on a different level of illness for the two measures. To take a day off work is probably a more significant decision for many people than missing a number of other activities. In this respect, the days lost may well be real, but the same costing value attached to paid work and unpaid activities leads to an overestimate of cost. The missed other activities may be a minor inconvenience only, not meriting a full value compared with missed paid work.
- The Water Quality and Treatment study in Melbourne collected data on the number of days of missed paid work (Hellard et al. 2003). To account for others (apart from those with paid work), the same rate of lost time was applied to people not working. This means that the same level of illness is applied to lost paid work and lost activities, even though in reality a different level may be needed to interrupt the different use of time. There was also no allowance for interruption to 'other activities' by those in paid work, in addition to interruption to their paid work. Time lost to carers was minimal.

Visits to GPs for gastroenteritis: comparison between survey data and other data

The gastroenteritis survey gave an estimate of 3.4 million cases (95% CI: 2.4–4.5 million cases) visiting a GP, some people visiting more than once (4.5 million visits). The data were collected from the patient, not from the GP. About 25% of cases also had respiratory symptoms. The raw number of cases of all gastroenteritis visiting a GP was 100 out of 450 cases. This is very similar to the proportion of cases of gastroenteritis where the person visited a GP in similar surveys in Ireland, Canada and the United States (Scallan et al. 2005).

BEACH data is collected from a rolling random sample of GPs around Australia. Data are collected on reasons for encounter (the reasons the doctor says the patient presented for the visit) and on problems managed (the diagnoses from the GP), as well as treatment and management information. More than one reason for encounter and more than one problem managed can be recorded. The range for diarrhoea/

vomiting as a reason to visit a GP is approximately 1.8 to 3 million per year, while the problem of gastroenteritis is diagnosed in approximately 1.3 million encounters per year.[11]

While there is some overlap across the interval estimates from the survey and BEACH data, the survey data gives a higher estimate. This is likely to be partly due to the person, either the patient or the GP, giving the reason for going to the GP. Although more than one reason for encounter can be recorded by the GP, it is possible that if a patient has a collection of symptoms including respiratory and diarrhoea and/or vomiting, the reason for encounter could be recorded as respiratory or generalised virus or other, while the patient reports their symptoms as diarrhoea/vomiting in the survey.

The Water Quality and Treatment Study was conducted in 1998–99; the study measured gastroenteritis in a sample of families over 15 months in a suburb of Melbourne (Hellard et al. 2003). The extrapolated estimate from this study was for just over 1 million visits to GPs per year in Australia for all gastroenteritis. The restricted locality is the major limitation to this data.

The survey data has been used in this costing study, recognising that this is recall of incidents around gastroenteritis as defined by self-report, and that this may be an overestimate. Strong support for the data comes from three recent overseas studies with very similar estimates, although a similar methodological bias could possibly be affecting all studies.

Hospital separations for gastroenteritis: comparison of the gastroenteritis survey data with hospital morbidity data

The gastroenteritis survey gave an estimate of 430,000 admissions (95% CI: 66,000–790,000 admissions) to hospital. The number of admissions in the survey was only 12 out of 450 cases. The data were collected from the patient's point of view, not from the doctor's diagnosis that forms the basis of the hospital morbidity data. Because the numbers are so small, the data are not robust. The relative standard error was 0.41.

Hospital morbidity data is collected by every hospital and forwarded to the AIHW for collation at a national level. Data is recorded from medical records by trained coders using ICD-10-AM codes for gastroenteritis of specified aetiology and codes

11 Reason for encounter: This is the reason given by the doctor for the patient's attendance. More than one reason is allowed (Table 6.3, p. 28).

The reason is diarrhoea in 1.6 per 100 encounters, and vomiting in 1.1 per 100 encounters.

If diarrhoea and vomiting are from separate encounters, the maximum possible is 2.7 per 100 encounters. MBS funds 0.9 of encounters and there are about 100 million GP encounters from MBS per year, so this gives 2.97 million encounters per year. If all encounters are for diarrhoea and vomiting together, the minimum possible is 1.6 per 100 encounters = 1.76 million encounters per year. The range is therefore approximately 1.8 to 3 million per year.

Problems managed (doctor's diagnosis): This is the problem identified by the GP (Table 7.2, p. 39). Gastroenteritis, presumed infectious, is found in 1.2 per 100 encounters = approximately 1.32 million encounters per year.

Source: Britt et al. 2003.

for gastroenteritis 'presumed infectious'. There are multiple diagnoses allowed so gastroenteritis could be coded as the main (principal) reason for admission, or as an additional reason.

Unit record data were examined for the period 1993–94 to 1998–99, which showed approximately 27,000 admissions for a principal diagnosis of infectious gastroenteritis, and 37,000 if additional diagnoses are included, a 38% increase. As unit record data were not available for more recent years 1999–2000 to 2001–02, the number of principal diagnoses in this period (approximately 35,000 per year) were increased by 38% to approximately 49,000. The proportion of admissions that were due to foodborne illness was estimated as 32% (Hall & the OzFoodNet Working Group 2004).

Given the small number of admissions in Australia identified in the community survey, the estimate of hospital admissions is subject to wide fluctuations if even one extra or one less case were identified in the survey. The National Hospital Morbidity Database is likely to represent a more robust estimate and this was used in the costing. It may represent a conservative estimate in that serious chronic comorbidity may get precedence in coding over gastroenteritis.

Transfers between hospitals

It is worth noting that there were also 2,548 cases of gastroenteritis transferred to another acute care hospital in the six years' data 1993–99. These episodes are probably inflating the number of cases but not the number of admissions or days in hospital used for costing.

Comparison with United States estimates

The rate of Australian admissions in the population based on the hospital separations data are about twice the estimated admissions rate in the United States, as described by Mead and colleagues in 1999. This lends credence to the use of the National Hospital Morbidity Database rather than the survey data. (It is worth noting that the United States rate was based on a sample of hospitals, unlike the Australian situation where the data includes all hospitals, with a few exceptions.)

Mortality from gastroenteritis: comparison of the national hospital morbidity data 1993–94 to 1998–99 with mortality data 1999–2002

The National Hospital Morbidity Database 1993–94 to 1998–99 (six years) showed 287 deaths in patients with a code for a principal diagnosis of infectious gastroenteritis in the six years. When additional diagnoses (diagnoses 2–10) for infectious gastroenteritis were also included, there were 1,302 deaths. These give figures of 48 deaths per year in patients when gastroenteritis was the main reason for hospital admission, and 217 when gastroenteritis was either the main or contributing reason.

The mortality dataset 1999–2002 (four years) showed 177 deaths where infectious gastroenteritis was the main cause of death and 337 when additional causes (cause 2 and cause 3) were included. This gives an average of 27 deaths per year when

infectious gastroenteritis is the main cause of death, and 84 when gastroenteritis was either the main or contributing reason.

It would be worthwhile to examine the data on deaths from the two sources more closely. In either case, the estimate of the number of deaths is not large and does not have a major effect on the costing.

Comparison with the Mead estimate (Mead et al. 1999) in the United States of 5,000 deaths per year in a population of approximately 200 million suggests an equivalent in Australia would be 475 deaths per year, considerably higher than either of these data sources suggest for Australia.

The data on hospitalisation and deaths used in the study were based on principal and additional diagnosis in the hospital data.

Listeriosis

Incidence of invasive listeriosis and deaths

A special study examining notification of listeriosis in Australia was the source of data used (Kirk et al. 2002). This showed more cases in state NDSSs than in the national NDSS. In three years 1998–2000 there were 172 recorded cases of listeriosis in Australia on state surveillance systems. This equates to three cases per million people.

There were 37 materno-foetal pairs in the three years, giving an average of 13 each year. Of the 37 there were 13 stillbirths, nine infants were alive and 15 were unknown. There were 135 other cases, giving an average of 45 each year. Of these there were 27 deaths, 56 alive and 52 unknown.

An under-reporting factor of 2 was assumed for this costing study. That is, the number of identified cases was doubled, based on expert advice about reporting practices. This gave an incidence of six cases per million people, with eight foetal deaths and 18 deaths in others.

Age distribution of cases

The age distribution of cases on the NNDSS was used to allocate proportions to the 'other' cases from the study on state notifications. The age distribution was 31% aged 5–14 years, and the rest over 65 years of age.

Comparison with other data

A study in the United Kingdom showed a similar level of overall incidence of 4 per million population; and a United States study showed 7.1 cases per million (Kirk et al. 2002). Other data on mortality is in agreement with the figures noted above for Australia. Three outbreaks of a total of 232 cases in the United States in 1981, 1983 and 1985 had a case fatality rate of 36% (DHS 2000). The United States Centers for Disease Control and Prevention has estimated a case fatality rate of 20% each year (CDC 2004).

Uncertainty

The proportion of foodborne listeriosis was taken as 98%, with a 95% credible interval of 92–100%. The variation around three years of total cases notified to NNDSS was used to simulate a distribution of yearly values, mean 58, SD 3.1. The under-reporting factor of 2 then gave 120 cases (95% CrI: 100–130 cases) of foodborne listeriosis per year.

Health care

Discussion with an infectious diseases physician confirmed that all cases of invasive listeriosis would be hospitalised. After discharge from hospital, follow-up treatment by GP and specialist could be expected. Oral amoxycillin is given for four to six weeks after two weeks of intravenous antibiotics in hospital. Patients who recover could expect at least a month off work and activities. Some may be disabled for up to six months, and a few have ongoing residual neurological disability.

The National Hospital Morbidity Database was examined for 1998–2002 for ICD-10-AM codes A32 (listeriosis) and P37.2 (listeriosis congenital/foetal) for principal diagnosis only. There were fewer hospitalisations on average each year (31) than the average number of cases each year on state surveillance systems (45) for the slightly different time period 1998–2000. As patients who get listeriosis generally have an underlying immunocompromising illness, it is likely that a number of cases would be coded with the underlying condition as principal diagnosis and listeriosis as an additional diagnosis. An examination of state NDSS data and hospital data, including additional diagnoses, for exactly the same time periods, would be a useful cross-validation check. No separations were found under principal diagnosis for perinatal listeriosis. These may be coded under 'Additional diagnoses', with the birth being the principal diagnosis.

Hospitalisations were therefore taken to be the same as the number of cases, that is, 120 (95% CrI: 100–130).

Toxoplasmosis

Incidence and foodborne component

Due to the lack of Australian data, values were extrapolated from the United States of America. The estimate in the United States is 0.6% of the population infected each year, of whom 15% will have symptoms (from Mead et al. 1999, citing CDC unpublished data from 1994 in the United States). This gives approximately 19,000,000 × 0.006 × 0.15 = 17,100 new symptomatic cases in Australia in one year.

Uncertainty

The seroprevalence level in the United States is about 60% in those around 60 years (Mead et al. 1999), but there is wide regional variability. In people 40–50 years of age in France, 90% have positive serology, in Japan 12.5% and in Holland 60% (Wu & Garcia 2003). A distribution of variability of the estimate of seroprevalence

in Australia was taken as a 'plausible range' of about 12% to 90%, with a central estimate of 60%. The rate was based on this as 0.6% (95% CrI: 0.12–0.9%) of the population were infected each year. This was applied to the Australian population and 15% were assumed to be symptomatic cases. The distribution of the estimate of the proportion of foodborne toxoplasmosis was based on the Delphi results, with mean 35% and SD 0.18. The resultant uncertainty in the estimate of incidence of symptomatic cases in Australia is high, with a central estimate of 5,862 new cases per year.

Health care

Of the symptomatic cases, 20% were assumed to visit a GP and, of these, 20% were assumed to have investigations and tests. There were only a few hospitalisations on the National Hospital Morbidity Database for principal diagnosis 1998–99 to 2002–03. For people with HIV/AIDS or other serious underlying illnesses, toxoplasmosis may have been coded as an additional diagnosis. For patients hospitalised with eye or other cystic disease, long-term oral therapy is indicated (infectious diseases physician, pers. comm.).

Time off work and activities

Clinical systemic disease can last from one to 12 weeks. For generalised symptomatic unwell patients, three weeks was assumed to be an average time off activities. For serious illness, for example ocular or brain, the time lost was assumed to be the period in hospital plus four weeks.

Mortality

There were cases in Australia on the mortality dataset for 1999–2002, as causes 2–10. There were none coded as first cause of death. There were no cases of congenital toxoplasmosis recorded.

Hepatitis A

Incidence and foodborne component

The NNDSS provided the raw data for estimating the number of new cases each year. Between 1999 and 2003 there was a range of 385 to 1,545 notifications each year, with median 517 and SD 484. This was used to simulate a plausible distribution of yearly values. Because of the likely under-reporting of mild disease, an under-notification factor was considered likely (Mead et al. 1999) and a factor of 2 was simulated as a normal distribution with SD 0.5. The proportion foodborne was simulated with mean 10% and SD 0.07.

Health care

Data were largely taken from a Western Australian study of hepatitis A, where about 70 patients were followed through the course of their illness (McLaughlin et al. 2004). This study gave estimates of the number of visits to GPs, tests, visits to specialists and time off work.

The National Hospital Morbidity Database 1998–99 to 2002–03 was examined for hepatitis A coded as principal diagnosis; with coma B15.0 and without coma B15.9. There were two males and six females in the four years 1998–99 to 2001–02 with coma, to give estimates of 20% and 40% due to foodborne illness respectively.

The average length of hospital stay was 8.5 days in those with coma and 4.2 in those without.

The average yearly number of foodborne cases from the NNDSS 1998–2003 (147), compared with the average number in hospital coded as principal diagnosis (24), gives a ratio of about 20% of cases hospitalised. The McLaughlin study found 20 out of 69 cases in the community were hospitalised, equal to 29% of cases.

The longitudinal study showed an average of 3.7 visits to a GP per case, 0.17 visits to a specialist and 0.19 to hospital emergency departments (McLaughlin et al. 2004).

Mortality

Mortality data 1999–2002 had no deaths for causes 1–5. A case fatality rate of 0.02–1.5% had been found in previous studies (McLaughlin et al. 2004). A case fatality rate of 0.05% was based on this, to give 0.5 deaths per year in cases due to food.

Time lost

The mean length of illness in the longitudinal study was 41 days, with a range of three days to 4.5 months (McLaughlin et al. 2004). Of the adult cases, 10–15% may have recurrent or prolonged disease (McLaughlin et al. 2004).

Haemolytic uraemic syndrome (HUS)

Incidence and foodborne component

The estimates were based on data from NNDSS, hospital separations and the APSU dataset (APSU 2004). APSU has data for children aged under 15 years only, and in this age group APSU had approximately twice as many cases as NNDSS. Hospital separations were considerably more than the number of cases on the other two data sources. It seems more likely that the number of cases is less than hospital admissions as there are a number of transfers of patients between hospitals. A validation study across data sets would be useful.

HUS is a syndrome and can be due to different aetiologies. (*E. coli*) VTEC gastroenteritis is one cause. It was estimated that about 50% of cases of HUS is due to foodborne *E. coli* gastroenteritis (Delphi opinion).

Uncertainty

The plausible distribution of the yearly number of all cases was based on the APSU data for children under 15 years, and on the NNDSS for those over 15 years. For children, there were twice as many cases on the APSU as on NNDSS, so an under-reporting factor of 2 was used for the adults. The distribution based on APSU

data over the seven years 1994–2000 was simulated, with mean 21 and SD 8. The distribution for adults based on the NNDSS was mean 12 and SD 7. The distribution for all cases of HUS was mean 34 and SD 7. The plausible distribution of the proportion foodborne was simulated, with mean 50% and SD 0.25.

Health care

It was assumed that there would be at least one visit for health care before hospital admission, and these were counted as GP visits although visits to emergency departments could be an alternative. The National Hospital Morbidity Database was examined for separations due to HUS. The range was from 47 to 86 each year. Transfers between acute care hospitals were noted, which would at least partly account for the discrepancy between hospital and other data sources.

Appropriate tests in hospital include investigation of microangiopathic haemolysis, thrombocytopenia, renal impairment and diarrhoea. Tests include blood tests (FBC, blood film, platelet count, creatinine, urea, electrolytes), faeces tests (microscopy, culture and antigen detection) and molecular genetics (microbial for Shiga toxin) (RCPA 2004a). Other tests may include serum albumin, C3, C4, urine tests of microscopy, osmolality, sodium, culture and sensitivities (Westmead Children's Hospital 1994).

Fluid management, electrolyte balance, blood transfusion, and sometimes plasma exchange and treatment of other complications are necessary. Treatment can be complex and dialysis may be needed. Atypical HUS (that is, not due to enteric illness) is generally more severe. Cases requiring plasma exchange often belong to this group, which is not likely to be due to foodborne causes (Westmead Children's Hospital 1994). Mean length of stay was nine days (National Hospital Morbidity Database).

Two GP visits and a specialist visit were assumed as follow-up after discharge of a patient without residual effects, with tests including FBC and ESR, creatinine, electrolytes at this time. Some patients would have ongoing complications such as renal impairment and would need ongoing specialist care and possibly even dialysis or a renal transplant.

Mortality

The illness can be fatal, and case fatality is estimated at 2.8% for children under 15 years in Australia (APSU 2004). In 108 cases <15 years, from 1994 up to 1999, there were three deaths. In the registered deaths data 1999–2002, there was a mean of six cases per year recorded as causes 1–10.

The estimate of deaths due to foodborne disease used in the costing study was three (95% CrI: 0–7) per year.

Time off work and activities

For the majority of patients who recover, it was assumed that there would be another two weeks off work or school after the hospitalisation was over.

Irritable bowel syndrome (IBS)

Incidence of IBS and preceding bacterial gastroenteritis

Studies in the United Kingdom have identified IBS in 10% of the population (Parry et al. 2003a, 2003b) to 25% (Jones & Lydeard 1992). IBS is thought to be present in about 14% of the Australian population (although no evidence based in data is given) (Australian Gastroenterology Institute 2001).

Bacterial gastroenteritis is implicated as a trigger for IBS, notably *Salmonella* (McKendrick 1996) but also other bacteria (Neal et al. 1997; Parry et al. 2003a, 2003b). No difference was observed in development of IBS by bacterial species in one study (Neal et al. 1997), while another identified that IBS is more common after *Campylobacter* (Thornley 2001).

One United Kingdom study identified that, following an initial bacterial gastroenteritis, 7% developed IBS (Neal et al. 1997). Another study identified that IBS developed in 17% of those who had had a recent bacterial gastroenteritis and in 3% of controls (Parry et al. 2003a, 2003b). It was also found that pre-existing IBS is more common in those presenting with bacterial gastroenteritis and that studies need to exclude this group when calculating incidence (Parry et al. 2003a, 2003b).

The main age group affected is 15–65 years. People over 65 years account for about 15% of all cases; people aged 15–65 years account for about 85% of cases (Neal et al. 1997; Rodriguez & Ruigomez 1999). Another study found a similar pattern by age for altered bowel habit after gastroenteritis (not necessarily IBS) (Neal et al. 1997). Age over 60 years appears to be protective. It may occur rarely in children but in this study children under 15 years are considered to have zero IBS. Female sex is a risk factor (RR 3.4; 95% CI: 1.2–9.8) (Neal et al. 1997). Duration of diarrhoea over 15 days in the initial bout of gastroenteritis is also a risk factor (RR 6.5; 95% CI: 1.3–34).

Uncertainty

The overseas literature suggests that about 7% (95% CrI: 4–17%) of bacterial cases of gastroenteritis go on to IBS (Neal et al. 1997; Rodriguez & Ruigomez 1999; Parry et al. 2003b). This range was used to simulate a distribution of the plausible proportion of bacterial gastroenteritis cases that cause this sequel, which was then applied to the plausible distribution of estimates for the number of cases of acute gastroenteritis due to *Salmonella*, *Campylobacter* and *Shigella* (Hall & the OzFoodNet Working Group 2004). The resultant estimate was 20,000 new cases (CrI: 6,000–36,000 new cases) of IBS as a sequel to bacterial gastroenteritis.

To estimate the number of cases in each age range, the proportion of all gastroenteritis that occurred in each age group in the national gastroenteritis survey was applied to the total number of approximately 20,000 cases due to a foodborne sequel. This assumes that the age distribution for all gastroenteritis is similar to the age distribution for specific bacterial gastroenteritis. Children under five years accounted for 11% of all gastroenteritis, children 5–14 years for 16%, adults 15–64

for 67% and older people over 65 years accounted for 6%. This was overlaid with information about the age distribution of all IBS, with no cases in children under five years.

Proportion of IBS that is foodborne

There were no data on the proportion of IBS that is considered due to foodborne gastroenteritis. This was not necessary for the calculation of all new cases of IBS as a sequel to foodborne gastroenteritis, but was needed for application to hospitalisations and visits to GPs for all IBS.

In one study in the United Kingdom, incidence of IBS was found to be about 0.27 per 100 per year in the general population (Rodriguez & Ruigomez 1999). When applied to Australia, this equates to about 53,000 new cases of IBS in Australia per year. The estimate of the number of cases of IBS secondary to foodborne gastroenteritis was approximately 20,000 new cases of IBS secondary to foodborne *Salmonella/Campylobacter/Shigella* each year. This is about 30–40% of the total estimated incidence of all cases of IBS in Australia. A specialist gastroenterologist and researcher in the area thought that probably about 25% of IBS cases are a sequel to gastroenteritis (pers. comm.). A proportion of 30% foodborne was therefore used for subsequent calculations relating to visits to GPs and hospitalisations.

Health care

Visits to GPs were estimated from BEACH data 1998–2003. The raw number of visits for all IBS in the sample was 1,416, which was extrapolated to the total Australian population to give a national annual estimate of 305,500 encounters for both old and new cases of IBS (BEACH 2004). The proportion due to food was estimated at 30%, to give an estimate of 91,650 visits due to a foodborne sequel. The age breakdown for visits was 2% for children under 15 years (1,833), 74% for people aged 15–64 years (67,821) and 24% for those over 65 years (21,996).

Treatments, tests, imaging and referrals to specialists/endoscopy were calculated from BEACH data for old and new cases. The data from BEACH therefore include the cost of ongoing cases of IBS.

The National Hospital Morbidity Database 1998–99 to 2002–03 was used to estimate the number of hospital admissions for a principal diagnosis of IBS. There were just over 9,000 admissions per year, leading to an estimate of about 2,700 admissions due to a foodborne sequel. This is probably an underestimate since it is likely that IBS might be coded as an additional diagnosis rather than a principal diagnosis.

Mortality

The mortality data 1998–2002 showed an average of 10 deaths per year where IBS was a contributing cause, leading to an estimate of three deaths due to a foodborne sequel.

Time lost

Although lifelong, IBS is generally a mild disease for most cases. Time lost was calculated as time spent in health care, without any extra time accounted for. This is likely to be an underestimate since a proportion of cases are likely to have some effect on activities and work.

Guillain-Barré syndrome (GBS)

Incidence of GBS and preceding bacterial gastroenteritis

A recent study in Japan has estimated that 23% of GBS occurs as a sequel to *Campylobacter* gastroenteritis (Kuwabara 2004). Other studies have indicated similar findings of 15% in the United Kingdom (Tam et al. 2003) and 25% in Sweden (McCarthy & Giesecke 2001). An estimate of 20% of GBS being a sequel to foodborne *Campylobacter* gastroenteritis was used in this costing study.

The incidence of GBS in the general population is around 0.3 per 100,000 population (McCarthy & Giesecke 2001) to 1.3 per 100,000 population (Kuwabara 2004). A cohort of people with *Campylobacter* infection had a rate of developing GBS of 30.4 per 100,000 cases (McCarthy & Giesecke 2001).

It is very likely that all cases of GBS are admitted to hospital, at least for observation. The total number of hospital admissions in one year was therefore taken as the number of cases in Australia, and 20% of these were considered to be a sequel to foodborne campylobacterosis. This gave an estimate of 123 cases per year.

Uncertainty

The variation in yearly hospitalisations for a principal diagnosis of GBS 1998–99 to 2002–03 was used as the basis for simulating a distribution of yearly estimates of cases of GBS of 123, with a credible interval of 94 to 155.

As a validation check, the number was also estimated using the incidence of cases following *Campylobacter* infection. In Sweden the incidence was 30.4 cases of GBS per 100,000 *Campylobacter* cases (McCarthy & Giesecke 2001). The total number of *Campylobacter* foodborne infections in Australia per year has been estimated at 208,246 (95% CrI: 66,834–349,658) (Hall & the OzFoodNet Working Group 2004). Applying the Swedish incidence to this total gives an expected number of 63 cases of GBS as a sequel to foodborne *Campylobacter* per year in Australia, which is less than the hospital data suggests.

It is possible that the hospital data may have cases that were transferred between hospitals, which would give an overestimate of the number of cases. Examination of unit record data will give more information about this.

Health care and duration

It was assumed that all cases would be treated in hospital with one visit to a GP prior to admission (although it could have been a visit to an emergency department) and

six visits for follow-up after discharge. Mean duration of illness among survivors was estimated at 90 days, although some people can have residual lifelong disability (Hahn 1998). Visits for rehabilitation of survivors after discharge from hospital were assumed to be six sessions of physiotherapy.

Mortality

In studies overseas mortality has been estimated at around 5–10% of cases (Hahn 1998; Kuwabara 2004). A case fatality of 10% of cases was used in this costing study.

The Australian mortality data 1999–2002 gave a mean of 11 deaths per year for GBS as the main cause; and 23 deaths where GBS was a main or contributing cause. GBS as a foodborne sequel is about 20% of all cases, so deaths attributable to foodborne disease are about three to five per year from this source.

Reactive arthritis (ReA)

Incidence of ReA and preceding bacterial gastroenteritis

Variation in the proportion of confirmed cases of bacterial gastroenteritis leading to ReA is shown in the following table. Most work was done in Finland. An estimated 7% (95% CrI: 2–10%) of bacterial cases of gastroenteritis lead to a sequel of ReA (Leirisalo-Repo et al. 1997; Hannu et al. 2002a, 2002b, 2003, 2004).

In a study looking backwards from cases of ReA, about one-third of cases were found to have bacterial gastroenteritis identified as an antecedent illness (Stoilov et al. 1990).

Table A11 **Incidence of reactive arthritis after bacterial gastroenteritis**

Reference	Cases with reactive arthritis post bacterial gastroenteritis	Country	Other comments
Hannu et al. 2002a	Post *Campylobacter* infection: 7%.	Finland	Mild ReA
Hannu et al. 2004	Post *Campylobacter* outbreak: 2.6%	Finland	Mild ReA
Hannu et al. 2003	Post *Yersinia* infection: 2%	Finland	Severe ReA Duration > 6 months
Hannu et al. 2002b	Post *Salmonella* outbreak: 8–10%	Finland	Mild ReA
Leirisalo-Repo et al. 1997, citing Mäkki-Ikola 1992	Post *Salmonella* infection: 2–10%	Finland	
Hannu et al. 2003	Post *Yersinia* infection (pseudotuberculosis): 12%	Finland	Age 40–47 years Duration over 6 months Severe clinical picture
'Specialists' in Australia (Catalano 2002)	General opinion	Australia	In Victoria 'possible about 500 new cases emerged each year', Dr McColl.
McColl et al. 2000	19/424 post *Salmonella* outbreak: 4%	Australia	

Uncertainty

The proportion of cases of *Salmonella/Campylobacter/Yersinia* that led to a sequel of ReA, 7% (95% CrI: 2–10%), was simulated as a distribution and was applied to the simulated distribution of the estimate of the number of cases of acute gastroenteritis due to the three pathogens (Hall & the OzFoodNet Working Group 2004). The resultant estimate was for approximately 21,000 cases (CrI: 6,000–36,000 cases) of ReA as a sequel to bacterial gastroenteritis per year in Australia.

Except for the hospital admissions and mortality data, the rest of the estimates on health care and missed time depend on this estimate of ReA. This makes them subject to a large degree of uncertainty.

Age and sex distribution, and duration of illness

The age distribution of cases post *Campylobacter* infection showed that children are rarely affected, and mean age was 37 years (range 1–87 years). Being female (RR 3) and duration of diarrhoea were also risk factors for ReA. Median duration of illness was four to six months post *Campylobacter* and mean duration was cited as 4.7 months in a post *Salmonella* study (Hannu & Leirisalo-Repo 1988; Hannu et al. 2002b). The age distribution of illnesses in cases post *Salmonella* infection was similar to *Campylobacter* (Hannu et al. 2002a).

Long-term illness can occur in some patients. In 63 hospitalised patients with ReA post *Salmonella* in Finland, 20 recovered in three to five months but 26 had ongoing symptoms intermittently over 10 years of follow-up (Leirisalo-Repo et al. 1997).

Health care

Arthritis is mild in most cases with about one case in five visiting a physician (Hannu et al. 2002a). This was used as the basis for estimating the number of visits to GPs. Five years of BEACH data had only five GP visits recorded for a diagnosis of ReA. The reason for this is not clear, but may be related to a coding issue where this kind of arthritis is classified into another category.

The number of tests and treatments depends on the estimate for the number of GP visits that in turn depends on the estimate of new cases per year. It was assumed that all of those visiting a GP would have certain investigations and require treatment, and 20% of those visiting would have imaging and referral to a specialist. The types of tests and treatment were taken from data in the studies in Finland and a public discussion by an Australian physician recently (Hannu et al. 2002a; Phelps 2002).

There were extremely few admissions to hospital in the National Hospital Morbidity Database principal diagnosis 1998–89 to 2002–03. This is almost certainly an underestimate probably due to coding of ReA as an additional diagnosis. Examination of the National Hospital Morbidity Database may show a considerable increase in admissions as additional diagnoses. The number of admissions used in this costing study can be considered underestimates.

Time lost

Mean duration of ReA was taken as five months or 143 days (Hannu & Leirisalo-Repo 1988; Hannu et al. 2002a). Days lost were assumed to be among those that visited a GP, with 10% of days lost during the illness (that is, an average of 14.3 days lost).

Appendix B Sources of data for costing health care services

This appendix describes the sources of data used to estimate the costs of health care services for this report. Where possible, items are valued in 2002 prices.

B1 Hospital data

Hospital data were extracted from the AIHW's National Hospital Morbidity Database as described in Chapter 4. The AIHW databases were also interrogated to identify the relevant ICD-10-AM codes and DRG codes for the disease.

Hospital cost data were extracted as DRG costs from the National Hospital Cost Database Collection Round 6 (2001–02) as published on the website of the Casemix Branch of the DoHA. The DRG patient classification system groups patient episodes that use similar resources in a clinically meaningful way. The average cost of all 661 codes provides a reference value with a weight of one, against which all other DRG average costs may be compared. The DRG average cost provides a value based on actual resource consumption and the national DRG costs, used in this study, includes all outliers. The website address is < http:www.health.gov.au/casemix/costing/costmain/htm > .

The identification of the hospital cost parameter for each illness required the interrogation of a number of disease classification systems. Firstly, each disease was identified by its ICD-10-AM code, for instance AO9 for diarrhoea and gastroenteritis. The AIHW website provides a search facility for this purpose. These codes are grouped into 23 Major Diagnostic Categories, which are organised by body system. For example, Chapter VI contains Diseases and Disorders of the Digestive System. These codes are the basis of the DRG system. The DoHA Casemix site was interrogated to identify the relevant Major Diagnostic Categories and then the relevant DRG codes. The actual DRG costs and cost weights for 2001–02 were found in the appendix to the Round 6 (2001–02) report.

It was possible to classify the ICD-10-AM codes to a number of DRGs, usually adjacent, and so reflect variations in levels of severity and therapeutic intervention. In the absence of detailed utilisation data, it was necessary to make assumptions about the likelihood of case classification to particular DRGs. In general, we used ALOS to identify the relevant DRG. The potential DRGs, the selected cost parameter and the instances of deviations from the ALOS assumption are presented in Chapter 4.

B2 Emergency department data

The number of emergency department visits was estimated from the National Gastrointestinal Survey 2001–02 or other sources (see Chapter 3).

The cost of emergency department visits was extracted from *Australian hospital statistics 2001–02* published by AIHW (2003). There are 11 emergency department triage levels each with an unique average cost based on average resource consumption—four for admitted patients, four for not admitted patients and one for those who did not wait.

Triage level costs range from $111 to $791, with an average cost of $212. The incidence data did not always identify the level of severity so emergency department presentations were valued at the average cost. No presentations were valued at admitted triage level 1 but listeriosis cases were admitted at triage level 2 ($393).

B3 General practitioner visits

The number of visits to GPs was estimated from the National Gastrointestinal Survey 2001–02 or other sources (see Chapter 3).

The cost of visits as published in the MBS fees on the DoHA website at <http://www.health.gov.au/pubs/mbs> were considered unrepresentative of the true cost so we adopted an average cost of $60 for an initial long GP consultation and $40 for a repeat GP visit.

B4 Specialist visits

The number of specialist visits was estimated from the National Gastrointestinal Survey 2001–02 or other sources (see Chapter 3).

As with the value of visits to GPs, the MBS fees were considered unrepresentative of the true cost so specialist consultations outside the hospital were valued at $90 for the initial visit and $75 for a repeat visit.

B5 Laboratory tests and medical imaging

The number of laboratory tests was estimated from the National Gastrointestinal Survey 2001–02 or other sources (see Chapter 3).

The cost of the identified tests and examinations was extracted from the MBS fees, Pathology Services and Medical Imaging Services, as published on the DoHA website at <http://www.health.gov.au/pubs/mbs>. Table B1 lists the cost of all the laboratory and medical imaging tests ordered for the eight different disease categories.

B6 Pharmaceuticals

The type and quantity of pharmaceuticals consumed was estimated from the National Gastrointestinal Survey 2001–02 or other sources (see Chapter 3).

The cost of the identified tests was extracted from the Pharmaceutical Benefits Schedule of fees, as published on the DoHA website at < http://www.health.gov.au/pubs/mbs > .

For gastroenteritis there was a range of proprietary medications consumed within each category and, as the proportions had been estimated, a weighted average cost was derived as the cost parameter. Each medication used in the treatment of non-gastroenteritis diseases was valued separately. The costs of medications are presented in Table B1.

Table B1 **Pharmaceutical costs, 2002**

Pharmaceutical	Unit cost ($)
Antibiotics	
Amoxycillin	8.87
Trimethaprim–sulphamethoxazole	8.57
Cloxacillin, dicloxacillin	11.28
Doxycycline	7.34
Erythromycin	7.88
Metronidazole	8.66
Metronidozole	6.68
Penicillin	11.44
Weighted average cost	*9.14*
Diarrhoea treatment	
Charcoal	
Electrolyte	12.61
Loperamide	7.46
Diphenoxylate–atropine	7.89
Weighted average cost	*8.83*
Pain relief	
Aspirin	6.95
Paracetamol + codeine	11.50
Dymadon	7.67
Paracetamol	7.53
Tramadol hydrochloride	11.06
Morphine	11.52
Weighted average cost	*8.12*

Pharmaceutical	Unit cost ($)
Cramp relief	
Hyoscine-N-butylbromide	15.37
Valium	8.00
Weighted average cost	*13.53*
Nausea treatment	
Antacid	12.92
Promethazine	12.81
Metoclopramide	7.26
Prochlorperazine	9.21
Weighted average cost	*8.83*
Non-GE medications	
Mebeverine hydrochloride	28.56
Psyllium fibre	19.25
Pyrimethamine	13.80
Prednisone	7.55
Sulfadiazine	18.14
Naproxen	17.42

Table B2 **Laboratory and pathology diagnostic tests/examinations costs, 2002**

Test/examination	Code	Unit cost ($)
Laboratory tests		
Electrolytes	65060	9.75
Antibody titres	69475	15.75
IgG	711066	14.80
IgM	71072	14.80
IgA	711068	14.80
Creatinine	66500	9.75
Stool (occult blood)	12500	252.05
Stool culture	69345	51.65
HLA-B27	71147	110.15
Liver function	66500	9.75
Erythrocyte sedimentation rate	65060	7.95
Full blood count	65070	17.20
Urinalysis	69333	6.40
Microscopy of urine	69312	20.70
Rheumatoid factor	71106	11.50
Stool microbiology testing	69330	128.85
Medical imaging		
Barium meal	12533	74.25
Abdominal X-ray	58900	33.65
Ultrasound lower limb	55834	99.90
Lumbosacral X-ray	58106	72.55
Abdominal ultrasound	55036	101.95
Colonoscopy	32087	170.15

Appendix C Cost of foodborne illness: results from the Australia New Zealand Food Authority and Applied Economics

This appendix compares the costs of foodborne illness estimated in this report with the costs estimated by the Australia New Zealand Food Authority in 1999, and published in the report *Food safety standards costs and benefits: an analysis of the regulatory impact of the proposed national food safety reforms*.

The *Food safety standards costs and benefits* report estimated the national cost of foodborne illness to be about $2.6 billion per year, being the product of an estimated 4.2 million cases of foodborne illness per year and an average of $630 per case. This compares with our estimate here of $1.25 billion per year.

The 4.2 million cases of foodborne illness identified in the *Food safety standards costs and benefits* report was derived from the average of four surveys:

- 1989&1995 National Health surveys[12] 2.7 million
- 1996 Australian Bureau of Statistics survey 4.7 million
- 1997–98 Monash University and Melbourne Water Corporation Study 5.4 million
- Data from National Notifiable Diseases Surveillance System 4.0 million

Drawing on work by Access Economics, estimations were made of the proportions of the sample that would fall into four categories: work lost, employment of carers, visits to GPs, hospital admissions. For each category the illness was estimated to last an average of two days. This produced an estimated average cost of $315 per case for the quantified costs.

In the *Food safety standards costs and benefits* report the average cost of $315 was doubled to allow for pain and suffering, costs to industry, litigation and public investigation costs. Thus the average cost for all effects was estimated at $630 per case.

The *Food safety standards costs and benefits* report does not state whether the estimates are based only on gastroenteritis cases or whether they include non-gastroenteritis cases. But to make comparisons, we focus here on our estimates for gastroenteritis, which account for an estimated $1.01 billion of the total $1.25 billion that we estimate for all diseases.

12 Australian Bureau of Statistics.

For this report the estimate of gastroenteritis costs is based on 5.4 million cases at an imputed cost of $187 per case. Thus it is evident that our cost per case is only one-quarter of that used in the *Food safety standards costs and benefits* report. This is the critical difference. A number of the other key reasons for the differences are given in the following table.

Table C2 **Differences between costs in *Food safety standards costs and benefits* and this report**

	Food safety standards costs and benefits report	This report
Hospitalisation	10%	0.03%
Employment lost and carer-time costs	73%	40%[a]
Days of lost work per case	2 days per case (total $8.4 million)	1 day[a] (total $5.8 million)
Estimation of other costs	$1.323 billion[b]	$10 million – $20 million
Total estimated costs	$2.6 billion	$1.249 billion

(a) *Foodborne illness in Australia: annual incidence circa 2000* (Hall & Kirk 2005).

(b) Based on an estimate of 4.2 million cases at $315 per case.

Abbreviations

AIDS	acquired immune deficiency syndrome
AIHW	Australian Institute of Health and Welfare
ALOS	average length of stay
APSU	Australian Paediatric Surveillance Unit
BEACH	Bettering the Evaluation and Care of Health
CI	confidence interval
CrI	credible interval
D	days (with illness)
DALY	disability-adjusted life year
DHS	Department of Human Services (Victoria)
DoHA	Australian Government Department of Health and Ageing
DRG	diagnosis related group
ED	emergency department
ESR	erythrocyte sedimentation rate
FBC	full blood count
FSANZ	Food Standards Australia New Zealand
GBS	Guillain-Barré syndrome
GP	general practitioner
HDC	household productivity and disruption costs
HIV	human immunodeficiency virus
HLA	human leucocyte antigen
HUS	haemolytic uraemic syndrome
IBS	irritable bowel syndrome
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification
Ig	immunoglobulin
LFC	lifestyle (residual) costs
LFT	liver function test
MBS	Medicare Benefits Schedule
NCEPH	National Centre for Epidemiology and Population Health
NDSS	(state or territory) notifiable diseases surveillance system
NEPSS	National Enteric Pathogens Surveillance Scheme
NHMD	National Hospital Morbidity Database
NNDSS	National Notifiable Diseases Surveillance System
NSAID	nonsteroidal anti-inflammatory drug
PV	present value
QoL	quality of life

ReA	reactive arthritis
RF	rheumatoid factor
RR	relative risk
SD	standard deviation
STEC	shiga-like toxin-producing *Escherichia coli*
SW	severity weight
TC	total costs
VDH	value of a day of good health
VTEC	verotoxigenic *Escherichia coli*
WPC	workplace costs
WTP	willingness to pay

Symbols

$	Australian dollars, unless otherwise specified
$m	million dollars
g	gram
kg	kilogram
mg	milligram
–	minus
—	nil or rounded to zero
n.a.	not available
p.a.	per annum
..	not applicable
%	per cent
’000	thousands
>	more than
<	less than

References

Abelson P 2003a, *Public economics: principles and practice*, Sydney: Applied Economics.

Abelson P 2003b, 'The value of life and health for public policy', *The Economic Record*, special issue, June, vol. 79, pp. s2–s13.

AIHW (Australian Institute of Health and Welfare) 2003, *Australian hospital statistics 2001–02*, Health Services Series No. 20, Cat. No. HSE 25, Canberra: AIHW.

AIHW 2004, National Hospital Morbidity Database, Interactive DataCube, Canberra: AIHW. Viewed November 2003, < http://www.aihw.gov.au/hospitaldata/datacubes/index.html > .

AIHW: Mathers C, Vos T & Stevenson C 1999, *The burden of disease and injury in Australia*, Cat. No. PHW 17, Canberra: AIHW.

Allen Consulting Group 2002, *Food safety management systems: costs, benefits and alternatives*, Canberra: Australian Government Department of Health and Ageing & enHealth Council.

Applied Economics 2003, *Guidelines for economic evaluation of environmental health planning and assessment, volume 2—case studies*, Canberra: Australian Government Department of Health and Ageing & enHealth Council.

Applied Economics 2005, 'Cost of foodborne illness to industry: developing a survey instrument for estimating costs to industry', prepared for the Australian Government Department of Health and Ageing, Canberra.

APSU (Australian Paediatric Surveillance Unit) 2004, 'Haemolytic uraemic syndrome: studies in progress: HUS 2000', entry in annual report, Westmead, NSW: APSU. Viewed November 2003, < http://apsu.inopsu.com/hus2000.pdf > .

Australia New Zealand Food Authority 1999, *Food safety standards costs and benefits: an analysis of the regulatory impact of the proposed national food safety reforms*, Canberra: Australia New Zealand Food Authority.

Australian Bureau of Statistics, *Tourist Accommodation Small Area Data NSW*, Cat. No. 8635.1, Canberra: Australian Bureau of Statistics.

Australian Bureau of Statistics 1998–2002, Registered deaths data, Brisbane: Australian Bureau of Statistics.

Australian Bureau of Statistics 1997, *1995 National Health Survey: summary of results, Australia*, Cat. No. 4364.0, Canberra: Australian Bureau of Statistics.

Australian Gastroenterology Institute 2001, *Irritable bowel syndrome*, Sydney: Australian Gastroenterology Institute. Viewed November 2004, < http://www.gesa.org.au/consumer/publications/ibs.pdf > .

BEACH data 2004, *Bettering the Evaluation and Care of Health: a special commissioned analysis on irritable bowel syndrome in general practice April 1998 – March 2003*. Conducted 2004.

Brain Foundation 2003, *Guillain-Barre syndrome*, Crows Nest, NSW: Brain Foundation. Viewed November 2003, < http://www.brainaustralia.org.au/AZ_of_Brain_Disorders/guillainbarre_syndrome > .

Britt H, Miller GC, Knox S, Charles J, Valenti L, Henderson J et al. 2003, *General practice activity in Australia 2002–03*, General Practice Series No. 14, Cat. No. GEP 14, Canberra: Australian Institute of Health and Welfare.

Brooker B 1997, *The impacts of waste water on commercial and recreational activities*, mimeograph, Coffs Harbour: Centre for Environmental Training.

Catalano C 2002, 'How a rare arthritis hits its targets', *The Sunday Age*, Melbourne, 9 June, p. 7. Viewed November 2003, <http://www.theage.com.au/articles/2002/06/08/1022982783060.html?oneclick=true>.

CDC (Centers for Disease Control) 2003, *Toxoplasmosis: fact sheet*, Atlanta, Georgia: CDC. Viewed November 2003, <http://www.cdc.gov.ncidod/dpd/parasites/toxoplasmosis/factsht_toxoplasmosis.htm>.

CDC 2004, *Listeriosis: technical information*, Atlanta, Georgia: CDC. Viewed November 2003, <http://www.cdc.gov/ncidod/dbmd/diseaseinfo/listeriosis_g.htm>.

Conaty S, Bird P, Bell G, Kraa E, Grohmann G & McAnulty JM 2000, 'Hepatitis A in New South Wales, Australia, from consumption of oysters: the first reported outbreak', *Epidemiology and Infections*, vol. 124, pp. 121–30.

Dalton C 2004a, 'Foodborne disease surveillance in New South Wales', guest editorial, *NSW Public Health Bulletin*, vol. 15, pp. 1–2.

Dalton C 2004b, 'Foodborne disease surveillance in NSW: moving towards performance standards', *NSW Public Health Bulletin*, vol. 15, pp. 2–5.

Deeble J 2002, 'Stage 2 report: financing of public laboratory services, draft report to the National Public Health Partnership', Canberra.

Deeble J, Adams T & Beaton S 1999, 'Stage 1 report: the financing of public health laboratory services, issues paper, report to the National Public Health Partnership', Canberra.

Department of Agriculture, Fisheries and Forestry 2003, *Export assurance—national competition policy review of the Export Control Act 1982*, Canberra: Department of Agriculture, Fisheries and Forestry.

DHS (Department of Human Services Victoria) 1997, *Guidelines for the control of infectious diseases*, Melbourne: DHS. Viewed November 2003, <http://hna.ffh.vic.gov.au/phb/hprot/inf_dis/bluebook/toxplas.htm>.

DHS 1998, *Verotoxin-producing E. coli (VTEC)*, Melbourne: DHS. Viewed November 2003, <http://hna.ffh.gov.au/phd/9803057/>.

DHS 2000, *Guidelines for the control of infectious diseases: listeriosis*, Melbourne: DHS. Viewed November 2003, <http://hna.ffh.vic.gov.au/phb/hprot/inf_dis/bluebook/listerio.htm>.

Gregory J & Lalor K 2004, 'Victorian OzFoodNet annual report 2003', report to the Australian Government Department of Health and Ageing, Canberra.

Gwee K, Graham J, McKendrick M, Collins S, Marshall J, Walters S & Read N 1996, 'Psychometric scores and persistence of irritable bowel after infectious diarrhoea', *Lancet*, vol. 347(8995), pp. 617–18.

Hahn A 1998, 'Guillain-Barré syndrome', *Lancet*, vol. 352(9128), pp. 635–41.

Hall G & Kirk M 2005, *Foodborne illness in Australia: annual incidence circa 2000*, Canberra: Australian Government Department of Health and Ageing.

Hall G & the OzFoodNet Working Group 2004, *How much gastroenteritis in Australia is due to food? Estimating the incidence of foodborne gastroenteritis in Australia*, NCEPH Working Paper No. 51, Canberra: National Centre for Epidemiology and Population Health.

Hall G, Kirk MD, Becker N, Gregory JE, Unicomb L, Millard G, Stafford R, Lalor K & the OzFoodNet Working Group 2005, 'Estimating foodborne gastroenteritis, Australia', *Emerging Infectious Diseases*, vol. 11, no. 8. Viewed August 2005, <http://www.cdc.gov/ncidod/EID/vol11no08/04-1367.htm>.

Hannu TJ & Leirisalo-Repo M 1988, 'Clinical picture of reactive salmonella arthritis', *The Journal of Rheumatology*, vol. 15, no. 11, pp. 1668–71.

Hannu T, Kauppi M, Tuomala M, Laaksonen I, Klemets P & Kuusi M 2004, 'Reactive arthritis following an outbreak of *Campylobacter jejuni* infection', *The Journal of Rheumatology*, vol. 31(3), pp. 528–30.

Hannu T, Mattila L, Nuorti JP, Ruutu P, Mikkola J, Siitonen A & Leirisalo-Repo M 2003, 'Reactive arthritis after an outbreak of *Yersinia pseudotuberculosis* serotype O:3 infection.' *Annals of the Rheumatic Diseases*, vol. 62, no. 9, pp. 866–9.

Hannu T, Mattila L, Rautelin H, Pelkonen P, Lahdeme P, Siitonen A & Leirisalo-Repo M 2002a, '*Campylobacter*-triggered reactive arthritis: a population-based study', *Rheumatology* (Oxford), vol. 41, no. 3, pp. 312–18.

Hannu T, Mattila L, Siitonen A & Leirisalo-Repo M 2002b, 'Reactive arthritis following an outbreak of *Salmonella Typhimurium* phage type 193 infection', *Annals of the Rheumatic Diseases*, vol. 61, no. 3, pp. 264–6.

Health Insurance Commission 2002, Medicare Benefits Scheme item reports, Canberra: Health Insurance Commission.

Hellard ME, Sinclair MI, Harris AH, Kirk M & Fairley CK 2003, 'Cost of community gastroenteritis', *Journal of Gastroenterology and Hepatology*, vol. 18, no. 3, pp. 322–8.

Jones R & Lydeard S 1992, 'Irritable bowel syndrome in the general population', *British Medical Journal*, vol. 304, no. 6819, pp. 87–90.

Kaldor J, Cameron AS, Harris A, Mead P & Kennedy M 2002, *Report of the External Review Team, OzFoodNet*, Canberra: Australian Government Department of Health and Ageing.

Kirk M 2004, 'Foodborne surveillance needs in Australia: harmonisation of molecular laboratory testing and sharing data from human, animal, and food sources', *NSW Public Health Bulletin*, vol. 15, nos 1–2, pp. 13–17.

Kirk MD, Little CL, Lem M, Fyfe M, Genobile D, Tan A, Threlfall J, Paccagnella A, Lightfoot D, Lyi H, McIntyre L, Ward L, Brown DJ, Surnam S & Fisher IST 2004, 'An outbreak due to peanuts in their shell caused by *Salmonella enterica* serotypes Stanley and Newport—sharing molecular information to solve international outbreaks', *Epidemiology & Infection*, vol. 132, pp. 571–7.

Kirk M, Prasopa-Plaizier N et al. 2002, 'The epidemiology of listeriosis in Australia', study for the Australian Government Department of Health and Ageing, Canberra.

KPMG 1998, 'Food regulation: current costs to state and local governments, report to the Australia New Zealand Food Authority', Canberra.

KPMG 1999, 'Costs of implementing proposed food hygiene standards: final report, report to the Australia New Zealand Food Authority', Canberra.

Kuwabara S 2004, 'Guillain-Barré syndrome: epidemiology, pathophysiology and management', *Drugs*, vol. 64(6), pp. 597–610.

Leirisalo-Repo M, Helenius P, Hannu T, Lehtinen A, Kreula J, Taavitsainen M & Koskimies S 1997, 'Long term prognosis of reactive salmonella arthritis', *Annals of the Rheumatic Diseases*, vol. 56, no. 9, pp. 516–20.

McCarthy N & Giesecke J 2001, 'Incidence of Guillain-Barré syndrome following infection with *Campylobacter jejuni*', *American Journal of Epidemiology*, vol. 153, no. 6, pp. 610–14.

McColl GJ, Diviney MB, Holdsworth RF, McNair PD, Carnie J, Hart W & McCluskey J 2000, 'HLA-B27 expression and reactive arthritis susceptibility in two patient cohorts infected with *Salmonella* Typhimurium', *Australian and New Zealand Journal of Medicine*, vol. 30, no. 1, pp. 28–32.

McKendrick MW 1996, 'Post *Salmonella* irritable bowel syndrome—5 year review', *The Journal of Infection*, vol. 32, no. 2, pp. 170–1.

McLaughlin V, Butler J et al. 2004, 'Direct and indirect costs of hepatitis A infection: a study in Western Australia'.

Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, Griffin PM & Tauxe RV 1999, 'Food-related illness and death in the United States', *Emerging Infectious Diseases*, vol. 5, pp. 607–25.

Minter Ellison 2002, 'Appendix D', in: Food Science Australia & Minter Ellison Consulting, *National risk validation project: final report*, Canberra: Australian Government Department of Health and Ageing.

Neal KR, Hebden J & Spiller R 1997, 'Prevalence of gastrointestinal symptoms six months after bacterial gastroenteritis and risk factors for development of the irritable bowel syndrome: postal survey of patients', *British Medical Journal*, vol. 314, no. 7083, pp. 779–82.

National Notifiable Diseases Surveillance System 2004, Notifiable Diseases Surveillance System Database, Canberra: Australian Government Department of Health and Ageing.

NSW Roads and Traffic Authority 2004, *Economic appraisal manual*, Sydney: NSW Roads and Traffic Authority.

Outbreak Investigation Team, Australia 2002, 'An international outbreak of Salmonella serotypes Stanley and Newport associated with peanuts in shell—Australia', report to the Communicable Disease Network of Australia.

OzFoodNet Working Group 2003, 'Foodborne disease in Australia: incidence, notifications and outbreaks. Annual report of the OzFoodNet network, 2002', *Communicable Diseases Intelligence*, vol. 27, pp. 209–43.

Parry SD, Stansfield R, Jelley D, Gregory W, Phillips E, Barton JR & Welfare MR 2003a, 'Does bacterial gastroenteritis predispose people to functional gastrointestinal disorders? A prospective, community-based, case-control study', *The American Journal of Gastroenterology*, vol. 98, no. 9, pp. 1970–5.

Parry SD, Stansfield R, Jelley D, Gregory W, Phillips E, Barton JR & Welfare MR 2003b, 'Is irritable bowel syndrome more common in patients presenting with bacterial gastroenteritis? A community-based, case-control study', *The American Journal of Gastroenterology*, vol. 98, no. 2, pp. 327–31.

Phelps K 2002, AMA media transcript on reactive arthritis, for 'Today' program, Channel 9, 5 June 2002.

Queensland Health 2004, *Hepatitis A*, Brisbane: Queensland Health. Viewed November 2003, < http:www.health.qld.gov.au/phs/ehu/ > .

RCPA (Royal College of Pathologists of Australasia) 2004a, *RCPA manual: haemolytic uraemic syndrome*, 4th edn, Surry Hills, NSW: RCPA. Viewed November 2003, < http://www.rcpamanual.edu.au/sections/clinicalproblem.asp?s = 25&i = 285 > .

RCPA 2004b, *RCPA manual: hepatitis A*, Surry Hills, NSW: RCPA. Viewed November 2003, < http://www.rcpamanual.edu.au/sections/clinicalproblem.asp?s = 25&i = 285 > .

Rodriguez LA & Ruigomez A 1999, 'Increased risk of irritable bowel syndrome after bacterial gastroenteritis: cohort study', *British Medical Journal*, vol. 318, no. 7183, pp. 565–6.

Scallan E, Majowicz S, Hall G, Banerjee A, Bowman C, Daly L et al. 2005, 'Prevalence of diarrhea in the community in Australia, Canada, Ireland and the United States', *International Journal of Epidemiology*, vol. 34, pp. 545–60.

Stafford RJ, McCall BJ, Neill AS, Leon DS, Dorricott GJ, Towner CD & Micalizzi GR 2002, 'A statewide outbreak of *Salmonella* Bovismorbificans phage type 32 infection in Queensland', *Communicable Diseases Intelligence*, vol. 26, pp. 568–73.

Stoilov R, Andreev T, Martinov S, Natskova V & Trunkova V 1990, 'Triggering bacterial infections in reactive arthritis', *Vutreshni Bolesti* [Internal Diseases], vol. 29, no. 5, pp. 74–8.

Tam CC, Rodrigues LC & O'Brien SJ 2003, 'Guillain-Barre syndrome associated with *Campylobacter jejuni* infection in England, 2000–2001', *Clinical Infectious Diseases*, vol. 37, no. 2, pp. 307–10.

Thacker SB, Stroup DF, Parrish RG & Anderson HA 1996, 'Surveillance in environmental public health: issues, systems, and sources', *American Journal of Public Health*, vol. 86, pp. 633–8.

Thornley J, Jenkins D, Neal K, Wright T, Brough J & Spiller R 2001, 'Relationship of *Campylobacter* toxigenicity in vitro to the development of postinfectious irritable bowel syndrome', *The Journal of Infectious Diseases*, vol. 184, pp. 606–9.

Westmead Children's Hospital 1994, *The children's handbook; Section 18—Renal Medicine*, Sydney: McGraw Hill.

Wu L & Garcia R 2003, *Toxoplasmosis*, Omaha, Nebraska: eMedicine. Viewed November 2003, < http//:www.emedicine.com/OPH/topic707.htm > .

Yohannes K 2002, 'Chapter 3: Salmonellosis in Australia: the societal cost of illness', in: 'A journey in public health', Master of Applied Epidemiology thesis, Canberra: The Australian National University.

Yohannes K, Roche P, Blumer C, Spencer J, Milton A, Bunn C, Gidding H, Kirk M & Della-Porta T 2004, 'Australia's notifiable diseases status, 2002: annual report of the National Notifiable Diseases Surveillance System', *Communicable Diseases Intelligence*, vol. 28, pp. 6–68.