

# **Foodborne disease**

**Towards reducing foodborne illness**

**in Australia**

December 1997

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From the Foodborne Disease Working Party for the  
Communicable Diseases Network Australia and New Zealand

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# Preface

The Foodborne Diseases Working Party was established in 1995 following advice from the National Health Advisory Council (NHAC) of the National Health and Medical Research Council (NHMRC). The NHMRC requested that the Working Party examine the status of foodborne disease in Australia and make recommendations for reducing its incidence and effects.

The Working Party commenced work under the Communicable Diseases Standing Committee (CDSC) of the NHMRC. With the conclusion of the NHMRC 1994-96 triennium, the Working Party continued its work under the auspices of the National Centre for Disease Control (NCDC), located within the Public Health Division of the Department of Health and Family Services, and the Communicable Diseases Network Australia New Zealand (CDNANZ).

A public consultation was conducted in June 1995. Submissions were considered in the context of the terms of reference and suggestions incorporated into the Working Party's agenda where possible. Interim recommendations were discussed at the Public Health Association Conference "Unravelling the Maize : Food Safety in Australia", held in Melbourne from 29-31 May 1996.

A world wide increase in the incidence of foodborne illness has resulted in significant social and economic impact. There are however, substantial gaps in our understanding of this problem.

Foodborne illness is generally most severe in the more vulnerable sections of our communities: young children, the elderly, immunocompromised and people of low socio-economic status. Strategies to decrease foodborne illness therefore need to encompass all sections of the community as well as all sectors of the food industry.

Decreasing the incidence of foodborne illness will reduce morbidity and mortality. It will also decrease the burden on health care resources and reduce indirect costs such as those suffered by industry. A coordinated and concerted effort across all sectors, a "paddock to the plate" approach, is seen as the most effective means of reducing the overall burden of foodborne illness.

To facilitate this multidisciplinary approach, the Working Party brought together experts in epidemiology, public health, microbiology, veterinary science and clinical practice as well as representatives from primary industry, manufacturing and consumer agencies.

The Working Party recognises that foodborne disease can only be reduced by all sectors sharing responsibility for food safety. Improved surveillance systems, application of quality

assurance systems such as Hazard Analysis Critical Control Point (HACCP) and a uniform approach to food hygiene and legislation are strategies recommended by the Working Party.

This document emphasises the pivotal roles that surveillance and outbreak control systems play in controlling foodborne diseases and in generating valuable information on their incidence, causes and impact. A strategy for the reduction of foodborne disease in Australia is presented in Chapter 3. This strategy provides an approach by which surveillance and knowledge of foodborne illness can be improved in Australia. Through improved surveillance systems the true extent of the problem can be better defined, and sources of significant foodborne pathogens identified. This in turn will enable public health authorities to act more promptly in outbreak situations, enable policy makers to focus policy and funding on areas of essential need, and assist food industry sectors to identify the key factors and processes for targeting future quality control systems.



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# Terms of reference of the working party

1. To review the causes of and factors affecting foodborne disease in Australia and to identify gaps in current knowledge.
2. To develop guidelines for national surveillance of foodborne disease and linkage of this information to other health intelligence relating to foodborne illness.
3. To develop national strategies for reducing foodborne disease.
4. To make recommendations on the implementation and evaluation of the proposed guidelines and strategies.



# 1 Introduction

Foodborne illness is a significant public health problem with major economic and social effects (Altekruse and Swerdlow 1996). Although it is currently impossible to assess the cost and extent of foodborne illness in Australia, it is likely to be comparable per capita to countries such as the United States of America (USA) and the United Kingdom (UK). Based on data from the USA, there are likely to be about 2 million food poisoning episodes per year in Australia. The cost of foodborne illness to the Australian community is estimated at \$487 million to \$1900 million per year (ANZFA 1996).

As well as the significance of foodborne diseases in terms of morbidity and mortality, these illnesses have enormous implications for primary industry, food manufacturing and retail industry, and for trade.

## 1.1 Context

The main purpose of this report is to identify gaps in our knowledge of foodborne disease and to develop national strategies/recommendations for the reduction of foodborne disease in Australia, thereby reducing the financial, social and health burden of these diseases. There are significant differences among States and Territories in current legislation and implementation of food safety issues. A nationwide approach is essential in order to enact nationally uniform legislation, to obtain adequate meaningful data from all States and Territories, to collate data and interpret it appropriately, and to provide an overall picture of the extent and cost of foodborne illness in Australia.

Food is produced in the primary industry sector (agriculture, aquaculture, fishing) and continues through manufacturing and retail to be prepared and consumed by the Australian public. Organisms causing foodborne illness can enter this food production chain at any stage. In addition, the many factors that can contribute to foodborne illness such as inadequate storage conditions are rarely confined to one sector alone - hence the term 'paddock to plate'.

With the paddock to plate approach, we are beginning to operate in a new framework of quality assurance (QA). This new framework, to be successful, demands that individuals, group leaders, companies and organisations take responsibility for the standard of their work. Primary producers, manufacturers, retailers and consumers all need to be aware of foodborne disease and share the responsibility for ensuring food safety. Legislative changes are necessary to ensure the production of safe food in Australia. In its document (ANZFA 1996) the Australia New Zealand Food Authority addresses foodborne disease issues through its proposal of two main reforms: a national food hygiene standard and appropriate changes to

State and Territory food legislation. The proposed hygiene standard would enable a preventative rather than a reactive approach to food safety and ensure that uniform hygiene standards operate throughout Australia. New legislation would therefore follow the principle of food safety as a shared responsibility.

Inherent in QA is an analysis of systems, in this instance to identify the most likely stages for the entry of foodborne disease agents and hence the best ways of controlling contamination. The Working Party supports the implementation of QA-based schemes that include components of the Hazard Analysis Critical Control Point (HACCP) system. Many food industries are introducing HACCP programs to ensure food safety (Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 1995; Altekruse and Swerdlow 1996). The July 1995 report of ARMCANZ has been important in identifying issues regarding HACCP and also in clarifying the risks of foodborne disease that currently exist from paddock to plate (DPIE 1995).

This introduction provides a brief overview of the incidence, cost and causes of foodborne disease in Australia. Further details of the incidence of foodborne pathogens and the emergence of new organisms in foodborne disease is discussed in Chapter 2. The Working Party's recommendations and proposed framework for reducing foodborne diseases in Australia are presented in Chapter 3. Supplementary information on food safety issues pertaining to primary industry, manufacturing and retail, and the consumer perspective is contained in Appendices A, B, C and D.

## 1.2 The incidence of foodborne disease

Trends in foodborne illness in the USA, the UK and Europe indicate that the incidence of foodborne illness is increasing, and that it is likely to remain a threat to public health well into the next century. The emergence of foodborne pathogens such as strains of *Salmonella*, *Campylobacter jejuni* and enterohaemorrhagic *Escherichia coli* (EHEC) present major public health concerns. Australia and New Zealand appear to be following these trends. In Australia, the notification rate and case rates for diseases such as salmonellosis and campylobacteriosis, considered to be primarily foodborne, have been increasing since the 1980s (Crerar et al 1996). Organisms such as EHEC (Cameron et al 1995) and *Vibrio vulnificus* (Kraa 1990) have also emerged as important foodborne pathogens. Chapter 2 provides further details on the incidence of foodborne diseases.

## 1.3 Costs of foodborne disease

Health economists have acknowledged that it is very difficult to estimate the full cost of foodborne disease (Sockett 1991a) and estimates of the financial cost vary across publications.



Some examples of annual cost estimates are given below. The overall message, despite individual estimates, is that foodborne disease is costly to the economy and to communities.

### 1.3.1 United States of America

- direct cost of bacterial foodborne illness, up to US\$23 billion - eg *Salmonella* alone estimated at US\$3,991 million (Sockett and Roberts 1991);
- total economic loss from foodborne illness between US\$5.6 billion and US\$9.4 billion (May 1995, Chief of the Food Safety Branch of the United States Department of Agriculture) - eg salmonellosis (3.8 million cases), \$US0.6-3.5 billion in medical costs and lost productivity (Buzby and Roberts 1995).

### 1.3.2 Australia and New Zealand

- Australia - between \$487 million and \$1900 million (ANZFA 1996) - eg 1995 outbreak of HUS in South Australia caused by *E. coli* 0111 contaminated mettwurst (Cameron et al 1995); conservative estimate of \$20 million in direct costs such as those incurred by health authorities and industries;
- New Zealand - NZ\$100 million (Explanatory Note to the New Zealand Food Amendment Bill 1996).

## 1.4 Causes of the rising incidence of foodborne disease

Several factors may be influencing the epidemiology of foodborne disease in Australia.

- different patterns of food consumption resulting from greater diversity of food available and changing consumer demand (1.4.1)
- changes in food manufacturing, retail, food distribution and storage (1.4.2)
- emergence of new food pathogens (Chapter 2)
- increasing numbers of more susceptible individuals (1.4.3).

### 1.4.1 Changing patterns of food consumption

Changing patterns of food consumption have had a major influence in the increasing incidence of foodborne disease. In the past, food was produced and consumed locally. Traditionally, Australian food was simple and well cooked. Today, the pattern is fewer meals cooked at home and more reliance on ready-to-cook, ready-to-eat foods and takeaway meals. A trend towards eating fresh unprocessed foods and processed foods without preservatives permits the growth of foodborne pathogens (Altekruse and Swerdlow 1996). Minimally processed and extended shelf life food also carry inherent risks to increased contamination. Cultural diversity within Australia has contributed to a far wider selection of food, incorporating a greater range

of ingredients. Raw foods of animal origin are increasingly being included into our diet. For example, raw fish, popular in Japanese, Korean and several other cultures has become increasingly popular with Australian consumers who may be unaware of the different handling and storage techniques used in the traditional preparation of these raw foods or the risks of foodborne disease caused by *Vibrio parahaemolyticus*, the principal cause of foodborne outbreaks in Japan (Osawa et al 1996).

### **1.4.2 Changes in food manufacturing, retail, food distribution and storage**

The influence of the food industry on consumption patterns and food quality is a major factor in foodborne disease incidence. Whilst the move towards large centralised food processing presents an opportunity to apply better quality control through centralised prevention strategies, it also carries a risk for larger outbreaks (Altekruse and Swerdlow 1996). Food products are now available from diverse sources and food is often transported over large distances and/or handled many times between its points of production and consumption. Refrigeration is frequently used as a means of preservation. In contrast to the sterility achieved with canning, refrigeration allows the survival of microorganisms. The belief that food would remain safe if kept cold has been challenged with the realisation that some pathogens like *Listeria monocytogenes* grow well in some refrigerated foods, and can reach populations as high as  $10^6$  cells/gram without the product showing adverse signs of spoilage (Brackett 1992). The food industry has become one of the largest sectors of Australia's manufacturing industry, employing about 700,000 people with an annual turnover in excess of \$80 billion (one thousand million) (ANZFA 1996). The Australian food industry is expected to be a major source of value-added food in the Asian region by the year 2000 with a target of \$7 billion annually in exports. The main emphasis of the food export initiative is the image of Australian food as 'clean and green'. A failure to produce safe food would have a significant financial effect on the food industry, and Australia.

### **1.4.3 Heightened susceptibility in some population groups**

An increasing proportion of our population has a heightened susceptibility to foodborne disease, which increases the public health impact of these illnesses. Factors which may increase the risk or severity of foodborne infection (Foegeding and Roberts 1996) include the following.

- age (less than 5 or greater than 60 years)
- pregnancy
- hospitalisation
- consumption of antibiotics
- excessive iron in blood

- reduced liver and/or kidney function
- surgical removal of portions of stomach or intestine
- compromised immune system (due to cancer and HIV/AIDS).

The Australian population is ageing and medical technology has extended the life expectancy of many people with chronic illnesses. By the year 2030 the number of Australians over the age of 65 is estimated to reach 19.1 per cent of the total population. In 1990 this figure was only 11.2 per cent. The elderly, the very young, immunocompromised people such as those with HIV infections, cancer and organ transplant patients (Motejemi et al 1993; MMWR 1994; Altekruise and Swerdlow 1996) are particularly susceptible because a much smaller infective dose of foodborne pathogens can cause them severe illness. Results of studies of listeriosis monitored by the USA Centres of Disease Control and Prevention (CDC) demonstrate the degree to which health status can influence sensitivity to foodborne illness (Schuehat et al 1991). Pregnant women and elderly people are at increased risk of fatality from listeriosis, and AIDS patients have a 300-fold greater risk of dying from listeriosis than do healthy individuals (Brackett 1992). There is also increasing evidence that an isolated food poisoning episode in certain people can lead to a range of chronic conditions such as arthritis and other auto-immune conditions including Guillain-Barre Syndrome (Archer and Young 1988; Smith 1994; Rees et al 1995). The enteric pathogens *C. jejuni*, *S. Typhimurium*, *S. Enteritidis*, *Shigella dysenteriae*, *Sh. flexneri*, *Sh. sonnei* or *Yersinia enterocolitica* can trigger infections at non-articular sites, leading to reactive arthritis or Reiter's Syndrome in people that are genetically predisposed (Archer and Kvenberg 1985; Smith 1994). *C. jejuni* is also regarded as the chief precipitant of Guillain-Barre Syndrome (Rees et al 1995).

## 1.5 Surveillance

Surveillance systems within Australia cannot currently accommodate the level of surveillance required to accurately determine the overall incidence or effect of foodborne disease. Surveillance data are limited and difficult to collect for reasons which are addressed in subsequent chapters. The importance of foodborne disease surveillance cannot be understated, as it is used to quantify the number of reported illnesses, identify emerging pathogens and determine the hazards that increase the risks of disease. Outbreak investigation, laboratory-based reporting, physician reporting of illnesses and active surveillance each play a unique and essential role in overall surveillance, but each also has strengths and weaknesses that require careful balancing of resources and strategies. New initiatives under the National Communicable Diseases Surveillance Strategy (NCDSS), currently operating through the NCDC of the Commonwealth Department of Health and Family Services, will assist in focusing activities around Australia and provide a framework for expanding and improving surveillance in foodborne illness. This will facilitate a more comprehensive approach to disease surveillance and assist in establishing a more accurate picture of foodborne disease in Australia.

This brief overview alludes to just a few of the underlying factors of foodborne disease in Australia. The challenge facing Australia, like most industrialised countries, is to find appropriate strategies to reduce foodborne disease which interface with activities across the full spectrum of the food chain, from production at the primary industry and manufacturing level through to retail and consumers.

## 2 Trends in epidemiology

### 2.1 Introduction

With the increasing incidence of foodborne disease in many developed countries, surveillance and epidemiology are important in understanding and controlling foodborne pathogens and their patterns of transmission, and in assessing the emergence of new pathogens.

The occurrence of similar trends in Australia demands that our surveillance systems, reporting procedures and policy development be thorough and responsive. Epidemiological data must form the foundation of practical health policies to safeguard against major outbreaks of preventable foodborne disease.

Together with the increased incidence of foodborne disease has been the emergence of new foodborne pathogens. The early 1980s saw the confirmation of *Y. enterocolitica*, *L. monocytogenes* and *C. jejuni* as foodborne disease agents (Bryan 1980; Nelson 1985). *Campylobacter* is now the most common cause of bacterial enteric disease reported in the developed world, including Australia and New Zealand (Crerar et al 1996; Wright 1996). *S. Enteritidis* is the predominant pathogen responsible for foodborne disease outbreaks in parts of Europe and the USA (Griffin and Tauxe 1991; Cowden et al 1995). Foodborne infections caused by *E. coli* 0157:H7 and other EHEC serotypes have emerged as major public health concerns in Europe, the USA (Griffin and Tauxe 1991; Hedberg et al 1994; Coia et al 1995; Wall et al 1996) and recently in Australia (Cameron et al 1995).

Australia has a national data set, the National Notifiable Disease Surveillance System (NNDSS), and this includes some foodborne disease pathogens based on laboratory reporting. There is no State/Territory or national collation of foodborne disease outbreaks.

This chapter presents a review of surveillance data from multiple data sources and retrospectively solicited reports of foodborne outbreaks from State and Territory health departments to provide a snapshot of the major causes of foodborne disease in Australia and highlight apparent deficiencies in surveillance.

## 2.2 Recent overseas experiences in foodborne disease

### 2.2.1 Laboratory reports of foodborne infections

#### Salmonella

Throughout the 1980s and early 1990s the United Kingdom and Northern America recorded a sudden increase in laboratory reported *Salmonella* infections. Much of the increase was attributed to *S. Enteritidis*, differing from the situation before the 1980s, in which *S. Typhimurium* was considered the main cause of foodborne infections throughout the developed world (Rodrigue et al 1990). In the north-eastern USA, there was a seven-fold increase in the rate of *S. Enteritidis* infections between 1976 and 1986 (Bean and Griffin 1990). By the end of the 1980s the incidence of *S. Enteritidis* in the United Kingdom had doubled, most cases being caused by phage type 4 (Sockett et al 1993). Similar increases were reported from many other European countries (Rodrigue et al 1990). During the late 1980s increasing evidence identified hens eggs as the main source of *S. Enteritidis* infections. Phage type 4 predominated in Europe and the United Kingdom (Coyle et al 1988; Cowden et al 1989) whereas phage types 8 and 13 were most frequently associated with egg-related outbreaks in the USA (St Louis et al 1988; Mishu et al 1994). In contrast, poultry meat and other meat products are the main sources for *S. Typhimurium* and other *salmonella* species (Sockett et al 1993; Sharp and Reilly 1994).

#### Campylobacter

Since first being recognised as a significant human pathogen in the early 1970s, *Campylobacter* species have become the most frequently identified cause of gastroenteritis in many countries (Bean and Griffin 1990; Lane and Baker 1993; O'Brien et al 1993; Crerar et al 1996). Most of these infections are thought to be foodborne in origin (Richmond Report 1990) and most cases appear sporadically, with relatively few point-source outbreaks reported (Sockett et al 1993; Adak et al 1995; Crerar et al 1996). However, the ability to identify outbreaks is limited by the absence of effective subtyping techniques. Poultry meat, other meat products, untreated milk and shellfish have all been implicated as food vehicles, although very seldom confirmed bacteriologically (Lane and Baker 1993; Adak et al 1995). Cross contamination from raw meats has been recognised as a mode of transmission for campylobacteriosis (Adak et al 1995).

#### Enterohaemorrhagic *Escherichia coli* (EHEC)

EHECs are recently described foodborne pathogens with major public health significance. Infection with these agents has been shown to cause haemorrhagic colitis (HC), haemolytic uraemic syndrome (HUS) and thrombotic thrombocytopenic purpura (Griffin and Tauxe 1991). The predominant EHEC serotype responsible for cases of HUS both in the USA and

the United Kingdom is *E. coli* O157:H7 (Griffin and Tauxe 1991; Wall et al 1996). In the United States, *E. coli* O157:H7 is estimated to cause more than 20,000 infections and as many as 500 deaths each year and is now the most common cause of acquired renal failure in the USA (Boyce et al 1995). Initially, outbreaks of HC and HUS were shown to be associated with the consumption of inadequately cooked ground beef (Bell et al 1994). However, other vehicles such as untreated milk (MacDonald et al 1988), unpasteurised apple cider (MMWR 1997a) and alfalfa sprouts (MMWR 1997b) have been identified. Other modes of transmission have also been documented, including transmission from drinking water (Swerdlow et al 1992), transmission to persons swimming in a faecally contaminated lake (Keene et al 1994), and secondary transmission from person to person (Belongia et al 1993). The ease with which *E. coli* O157:H7 is spread from person to person suggests that the infectious dose is low. This has been supported by quantification of contamination levels in outbreaks ranging from four to 930 organisms/gram (Bell et al 1994; Roberts et al 1995).

### **Listeria monocytogenes**

*Listeria monocytogenes* is a bacterium found widely in the environment. It causes listeriosis, a relatively uncommon disease compared with most other foodborne infections, but one that can be particularly severe in immunocompromised persons and pregnant women. Infection in pregnant women can lead to abortion and still birth.

For many years before the early 1980s, fewer than 100 cases of listeriosis were recorded annually throughout the UK (Sharp and Reilly 1994). A marked increase was observed in reports of listeriosis in several countries during the mid 1980s, reaching epidemic proportions in the UK by 1988 when over 300 cases were recorded. The incidence of listeriosis returned to pre-epidemic levels when education strategies to decrease the risk of infection were implemented (McLauchlin et al 1991; Tappero et al 1995).

### **Viral foodborne infections**

In the 1980s outbreaks of viral gastroenteritis due to small round structured viruses (SRSV) including Norwalk virus increased in England and Wales, with many of these outbreaks attributed to sewage-contaminated shellfish (O'Hara et al 1983). The increase in SRSV gastroenteritis reports probably reflected improved identification, diagnosis and reporting of these infections (Sockett et al 1993).

Outbreaks of hepatitis A have been linked to many foods and are usually a result of direct spread from an infected food handler or the consumption of contaminated seafood (Latham and Schable 1982; Sockett et al 1993; Cowden et al 1995). The potential for explosive and extensive outbreaks of viral foodborne disease was demonstrated in early 1997 when over 600 cases of hepatitis A infection were reported throughout Australia, linked to the consumption of contaminated oysters. The point source of this outbreak was shown to be Wallis Lake, one of

the estuarine Great Lakes on the mid-north coast of New South Wales and one of the largest oyster growing areas in Australia (Dr J McAnulty, personal communication).

## 2.2.2 Reports of foodborne disease outbreaks

In the USA, data for foodborne disease outbreaks for the years 1973 to 1987 showed that most outbreaks were caused by bacteria. Aetiological agents were confirmed for 38 per cent of outbreaks, of which *Salmonella* constituted 28 per cent of outbreaks and 45 per cent of the cases. Thirteen per cent of outbreaks with an aetiology were caused by *Staphylococcus aureus*, 8.1 per cent by *Clostridium botulinum*, 4.1 per cent by *Shigella* and 2 per cent by *Campylobacter*. Most deaths were caused by *Salmonella* species and *Cl. botulinum*, with an average of 29 and eight deaths per year respectively (Bean and Griffin 1990). Reported outbreaks of *E. coli* O157 increased from four in 1992 to 30 in 1994 (Boyce et al 1995), most likely due to increased recognition of these outbreaks.

In the UK in 1992 and 1993, *Salmonella* species and *Cl. perfringens* were responsible for three-quarters of all foodborne disease outbreaks recorded. *S. Enteritidis* phage type 4 accounted for 41 per cent of all outbreaks and 71 per cent of outbreaks of *Salmonella* (Cowden et al 1995). The number of outbreaks attributed to *E. coli* O157 in the UK increased from seven in 1989-91 to 18 in 1992-94; 76 and 173 people ill respectively. Of the cases from 1992-94, there were five deaths, 38 per cent of cases were admitted to hospital and 21 per cent of cases developed antecedent diarrhoea (Wall et al 1996).

## 2.3 Australian data and trends

### 2.3.1 Specific surveillance systems

#### The National Notifiable Disease Surveillance System

The NNDSS is administered through the Surveillance and Management Section of the Commonwealth Department of Health and Family Services. The NNDSS collates data on communicable diseases notifiable under State and Territory public health legislation under the auspices of the Communicable Diseases Network Australia New Zealand (CDNANZ). The number of notifications for selected enteric diseases and their corresponding rates per 100,000 population, as received by the NNDSS from 1991 to 1996, are shown in Table 1.



**Table 1 Notification of selected foodborne diseases - National Notifiable Disease Surveillance System**

Notified disease	1991	1992	1993	1994	1995	1996
Campylobacteriosis	8,672 (75.8)	9,135 (54.2)	8,111 (69.6)	1,0117 (85.8)	10,933 (91.6)	12,158 (100.4)
Salmonellosis	5,440 (31.4)	4,614 (27.4)	4,731 (26.8)	5,283 (29.6)	5,895 (32.7)	5,819 (31.8)
Hepatitis A <sup>A</sup>	2,195 (12.7)	2,109 (12.5)	2,006 (11.4)	1,894 (10.6)	1,601 (8.9)	2,150 (11.7)
Shigellosis <sup>A</sup>	902 (7.9)	694 (6.2)	708 (6.1)	724 (6.1)	734 (6.1)	676 (5.6)
Yersiniosis	515 (4.6)	567 (3.4)	459 (3.9)	414 (3.5)	306 (2.6)	268 (2.2)
Typhoid	89 (0.5)	50 (0.3)	72 (0.4)	50 (0.3)	69 (0.4)	84 (0.5)
Listeriosis	44 (0.3)	38 (0.3)	53 (0.3)	34 (0.2)	58 (0.3)	70 (0.4)

Upper figure shows number of notifications of foodborne disease.

Figures in parentheses show the rate per 100,000 population.

Figures do not include overseas acquisition.

<sup>A</sup> Predominantly person-to-person transmission.

The NNDSS data indicate that *Campylobacter* is the predominant foodborne pathogen reported by laboratories in Australia (Herceg et al 1996). *Campylobacter* notifications show a gradual rise in notifications since 1980, when testing first became available (Figure 1) with more marked increases evident since the early 1990s.

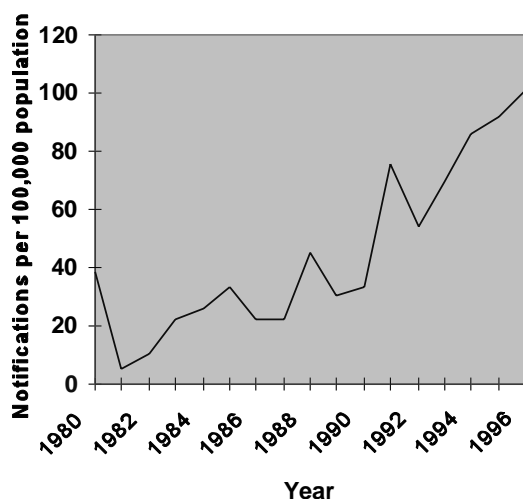
There is a consistent and marked difference in incidence rates throughout the country from a low of 78 per 100,000 in Victoria to a high of 179 per 100,000 in South Australia in 1996. New South Wales has not collected data on *Campylobacter* since 1991 other than as foodborne illness in two or more related cases.

*Salmonella* notifications show a gradual increase since the 1950s with marked increases since the late 1980s (Figure 2).

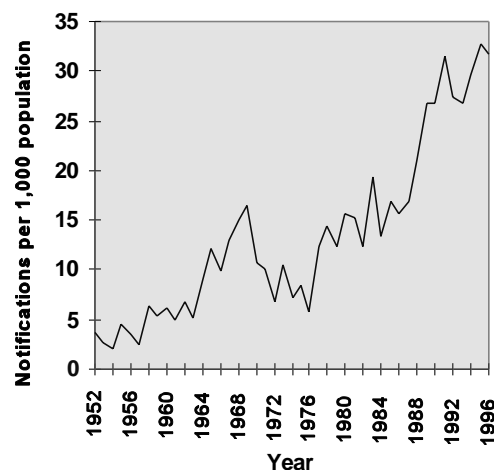
No information on the respective *Salmonella* serovars is received by the NNDSS. However, laboratories that serotype *Salmonella* isolates voluntarily forward reports to the National Enteric Pathogen Surveillance Scheme (NEPSS) (see below).

Other diseases transmitted predominantly by foodborne routes that are notified to the NNDSS include listeriosis, typhoid and yersiniosis. The reported incidence of these pathogens has remained steady except for typhoid which has decreased (Herceg et al 1996). Although hepatitis A and shigellosis may also be transmitted by food, transmission is primarily person to person (PHLS Salmonella Committee 1995). The reported incidence of these pathogens has decreased in recent years in Australia (Crerar et al 1996).

**Figure 1 Notification rate for campylobacteriosis, 1980-96.**



**Figure 2 Notification rate for salmonellosis, 1952-96.**



### The National Enteric Pathogen Surveillance Scheme (NEPSS)

NEPSS [originally the National *Salmonella* Surveillance Scheme] is a national surveillance system which collects information on isolates of importance in foodborne disease and enteric disease. NEPSS also collects and reports on isolates from foods, animals, dairy, eggs and environmental origins and collates data. Reporting of *Salmonella* serovars to NEPSS appears to be at least as complete as the NNDSS as similar numbers of *Salmonella* are reported to both systems. *S. Typhimurium* was the predominant *Salmonella* serovar reported to the NEPSS from 1990-95 and ranged from 29 to 38 per cent of all *Salmonella* reports (National *Salmonella* Surveillance Scheme 1991-95; Dr D Lightfoot, personal communication). The most consistently reported *S. Typhimurium* phage types are 9 and 13. Other *Salmonella* serovars frequently reported during this period were *S. Virchow*, *S. Saintpaul*, *S. Heidelberg* and *S. Bovismorbificans*.

There appear to be differences among States/Territories in the relative incidence of *Salmonella* serovars. In general, the proportion of *S. Typhimurium* cases is greatest in States with higher urban populations and lowest in the Northern Territory and Queensland. In Queensland *S. Virchow* is the most common serovar reported. The Northern Territory, Queensland and Western Australia appear to have greater diversity of *Salmonella* serovars. Most *S. Enteritidis* infections reported in Australia are acquired in other countries and the numbers have gradually increased since 1990, as has the proportion that are phage type 4 (Dr D Lightfoot, personal communication).

### **Australian Paediatric Surveillance Unit**

The Australian Paediatric Surveillance Unit (APSU) administers a surveillance system coordinated by the Australian College of Paediatrics to collect data on rare diseases of childhood. The system has collected data on HUS since July 1994. Notification of 64 definite cases of HUS were received by APSU between July 1994 and March 1996 (Elliot et al 1995; Elliot et al unpublished report). Twenty-three of these cases occurred during Australia's first epidemic of HUS, in Adelaide, South Australia, during January-February 1995 (Cameron et al 1995). From the 28 apparently sporadic cases reported during 1995, the annual incidence rate was 0.62 per 100,000. Cases were reported from all States and Territories except the Northern Territory and occurred predominantly in summer. All but one of these cases had reported diarrhoeal prodromes and nine had antecedent bloody diarrhoea. No associations were made with specific food items. EHEC serotypes were implicated in six of 28 cases only and included *E. coli* O111 (three), O157 (one), O26 (one) and O113 (one).

Unlike in the USA and the UK, a greater range of pathogens is associated with outbreaks of bloody diarrhoea and HUS in Australia.

### ***Escherichia coli* Reference Laboratory**

The *E. coli* Reference Laboratory is based at the Victorian Infectious Diseases Reference Laboratory. It was established in the late 1980s to study strains of *E. coli* submitted from various sources throughout Australia.

Faeces and strains of *E. coli* isolated from a series of cases of HC and HUS occurring in States and Territories since 1987 were submitted to the *E. coli* Reference Laboratory for serotyping and verocytotoxic assays. Of the 30 human isolates studied, 14 were *E. coli* O157:H- and one isolate was *E. coli* O157:H7. Of the 15 non-O157 *E. coli* isolates, seven were serotype O111 (Goldwater and Bettelheim 1995).

### **2.3.2 Review of outbreaks**

In the absence of nationwide data on foodborne disease, the Working Party, in consultation with the States and Territories health agencies attempted to determine the major causes of foodborne disease in Australia and highlight deficiencies in surveillance.

#### **Methodology**

Information on foodborne disease outbreaks occurring between January 1980 and July 1995 was collected by:

- soliciting reports of outbreaks from State and Territory health agencies using a standardised questionnaire;

- manually searching the Bulletin *Communicable Diseases Intelligence (CDI)*
- conducting Medline searches using the keywords: Australia, food poisoning, foodborne disease, foodborne illness and outbreak.

The following definitions were used:

- *foodborne outbreak*: two or more related cases of illness caused by consumption of food or drink containing infectious agents or a single case of chemical or toxic poisoning if laboratory evidence indicated food to be contaminated by the chemical or toxin
- *household outbreak*: involved persons within a private residence only, and not connected with any other case or outbreak
- *institutional outbreak*: involved persons who attended the same institution, including day care centres, nursing homes, hospitals, prisons, academic residences, and not connected with any other case or outbreak.

The vehicle was determined through either an epidemiological association (as determined by the reporting health authority) or finding a pathogen in the food consistent with the pathogen's incubation period among persons with an illness who consumed the food. The outbreak questionnaire included a minimum set of data on all outbreaks, including details of the setting, mode of transmission, causative organism, and details of epidemiological and laboratory investigations.

## **Results**

In total 128 outbreaks were reported from January 1980 to December 1995, of which 105 (82%) occurred after 1989. One hundred and five reports were received from the States and Territories and 23 were identified in *Communicable Diseases Intelligence*. Three outbreak reports were found in the literature but are not quoted as they were independently reported by the State or Territory. The location of the outbreaks is shown in Table 2.

**Table 2** Location of foodborne outbreaks reported in 1980-95

State or Territory	Number of outbreaks
New South Wales	49
Victoria	26
South Australia	23
Queensland	12
Australian Capital Territory	7
Northern Territory	5
Western Australia	4
Tasmania	2
Total	128

**Classification of outbreaks**

Of the outbreak reports received, 41 (32%) occurred in a commercial mass-catering setting. A further 11 outbreaks occurred in institutional settings and 13 were associated with non-commercial mass catering. Eleven outbreaks were confined to private households.

**Confirmation of pathogens**

A specific pathogen was implicated in 86 (67%) of the reported outbreaks with isolation from cases in 70 outbreaks and isolation from a specific vehicle in 44 outbreaks.

**Morbidity and mortality**

A total of 5,952 people were affected in the 128 outbreaks, with a median of 24 per outbreak. Of these, 1,758 people visited a doctor with a median of seven per outbreak. The total number of people hospitalised was 185. Six people were recorded to have died, one in each of six separate outbreaks (Table 3).

**Table 3 Foodborne disease outbreaks, cases and deaths by aetiology - Australia, 1980-95**

AETIOLOGY	Outbreaks		Cases		Deaths	
	No.	%	No.	%	No.	%
<b>Bacterial</b>						
<i>Bacillus cereus</i>	5	3.9	27	0.5	0	0
<i>Campylobacter</i> species	5	3.9	106	1.8	0	0
<i>Clostridium botulinum</i>	1	0.8	1	0.02	0	0
<i>Clostridium perfringens</i>	14	10.9	280	4.7	0	0
<i>Escherichia coli</i> O111	1	0.8	23	0.4	1	16.7
<i>Listeria monocytogenes</i>	2	1.6	13	0.2	0	0
<i>Salmonella</i> serovars	27	21.1	1,323	22.2	1	16.7
<i>Staphylococcus aureus</i>	9	7.0	99	1.7	1	16.7
<i>Vibrio parahaemolyticus</i>	4	3.1	181	3.0	2	33.3
<b>Total bacterial</b>	68	53.1	2,053	34.5	5	83.3
<b>Chemical</b>						
Ciguatera toxin	1	0.8	30	0.5	0	0
Mushroom poisoning	1	0.8	5	0.08	0	0
Scombrototoxin	2	1.6	8	0.1	0	0
<b>Total chemical</b>	4	3.1	43	0.7	0	0
<b>Protozoal</b>						
<i>Toxoplasma</i>	1	0.8	13	0.2	1	16.7
<b>Total protozoal</b>	1	0.8	13	0.2	1	16.7
<b>Viral</b>						
Hepatitis A	1	0.8	7	0.1	0	0
Small round structured viruses	11	8.6	2,267	38.1	0	0
Rotavirus	1	0.8	55	0.9	0	0
<b>Total viral</b>	13	10.2	2,329	39.1	0	0
<b>Confirmed aetiology</b>	86	67.2	4,438	74.6	6	100.0
<b>Unknown aetiology</b>	42	32.8	1,514	25.4	0	0
<b>TOTAL</b>	128	100.0	5,952	100.0	6	100.0

## Evidence implicating food vehicles

One or more specific foods were implicated as vehicles of infection in 72 outbreaks (Table 4). The vehicle was confirmed by microbiological examination of the food in 44 outbreaks (42%), by epidemiological association alone in 28 (27%) and by both in 18 (17%).

**Table 4** Specific food vehicles implicated in foodborne outbreaks<sup>A</sup> in Australia, 1980-95

Pathogen	Meat	Seafood	Poultry	Eggs	Salad and vegetables	Multiple foods	Miscellaneous
<i>Salmonella</i> seravars (19) <sup>B</sup>	9		2	2		1	5 <sup>C</sup>
Small round structured viruses (7)		6					1 <sup>D</sup>
<i>Clostridium perfringens</i> (5)	4					1	
<i>Staphylococcus aureus</i> (5)	1		1			1	2 <sup>E</sup>
<i>Vibrio parahaemolyticus</i> (4)		4					
<i>Bacillus cereus</i> (1)					1		
<i>Campylobacter</i> species (1)					1		
<i>E. coli</i> O111:H- (1)	1						
<i>Listeria monocytogenes</i> (1)		1					
Rotavirus (1)					1		
Unknown (27)	6	10	1	1	9		
Total (72)	21	21	4	3	12	3	8

<sup>A</sup> By isolation from the food, or epidemiological association.

<sup>B</sup> The most common *Salmonella* serovar was *S. Typhimurium* (8 outbreaks), followed by *S. Bovismorbificans* (4), *S. Anatum* (2), *S. Brandenburg*, *S. Bredeney*, *S. Johannesburg*, *S. Newport* and *S. Stanley* (1 outbreak each).

<sup>C</sup> Comprising deep-fried ice cream and fruit salad (2 outbreaks each) and imported coconut (1 outbreak).

<sup>D</sup> Orange juice.

<sup>E</sup> Pizza, noodles.

## Factors contributing to outbreaks

One or more possible contributing factors were recorded in 70 of 86 outbreaks with microbiological evidence. The most commonly reported factors were inadequate cooking, 19, and inappropriate holding temperatures (food stored too long or too warm), 14 (Table 5)

### Salmonella

*Salmonella* seravars were associated with 27 of the foodborne outbreaks reported. The most common *Salmonella* identified was *S. Typhimurium* causing 11 outbreaks, with salami, raw eggs and deep-fried ice cream shown to be vehicles. Other identified outbreaks were caused by *S. Bredeney* (cross contamination from a meat product), *S. Newport* (salami), *S. Anatum*

(several foods and cross contamination identified), *S. Stanley* (imported coconut) and *S. Bovismorbificans* (fruit salad and salami).

The first locally acquired outbreak of *S. Enteritidis* phage type 4 occurred in South Australia in October 1994. All 14 cases identified consumed the same unfermented sausage product containing pork which was positive for *S. Enteritidis* phage type 4 (Beers 1996a).

The outbreak of *S. Mbandaka* in 1996 from contaminated peanut butter (Ng et al 1996) illustrated the potential for a specific product to cause foodborne illness throughout Australia.

**Table 5 Foodborne disease outbreaks by aetiology and contributing factors - Australia, 1980-95**

Pathogen	Improper holding temperatures	Inadequate cooking	Contaminated equipment	Food from unsafe source	Poor personal hygiene	Other
<i>Salmonella seravars</i>		4	8	3		4
<i>Clostridium perfringens</i>	5	7	1			
Small round structured viruses				6	3	
<i>Staphylococcus aureus</i>	3	4	2		2	
<i>Campylobacter</i> species	1	1	1	3		
<i>Vibrio parahaemolyticus</i>	2	1	1			
<i>Bacillus cereus</i>	1	1				
<i>Listeria monocytogenes</i>				1		
<i>E. coli</i> O111:H-						1
Rotavirus					1	
Scombrototoxin	2					
<i>Toxoplasma</i> species		1				
Total	14	19	13	13	6	5

### **Enterohaemorrhagic *Escherichia coli***

Outbreaks of EHECs with important implications for foodborne disease in Australia occurred during this review. In 1995 the first documented outbreak of HUS due to *E. coli* O111:H- was recorded in Australia. Twenty-three children aged from 14 months to 14 years developed HUS after consuming mettwurst and one child died. Many more cases developed gastroenteritis (Cameron et al 1995).



The first outbreak of diarrhoea and bloody diarrhoea due to *E. coli* O157:NM was recorded in southern Queensland in 1996 (not included in analysis). Serotype *E. coli* O157:NM was isolated from three children with watery and/or bloody diarrhoea and three asymptomatic adults. Two of the adults were food handlers and one reported having diarrhoea shortly before the detection of the outbreak. No specific food source was identified but all six cases had contact with a specific delicatessen and an infected food handler was considered by the investigators to be the route of transmission in this outbreak (McCall et al 1996) .

## 2.4 Discussion

These data present a snapshot of foodborne disease in Australia that may be useful for determining priorities for foodborne disease surveillance and research and planning future food safety programs. However, it is important to consider the limitations of these data so that the information can be appropriately interpreted.

Beginning with the NNDSS, there are many barriers to reporting to the national system. A person with foodborne illness must initially present to a doctor who may request a test on the patient's stool. The patient must then submit a stool specimen which must be appropriately tested and the result then reported to the State/Territory and national systems.

Similar surveillance systems in the USA may detect less than 1 per cent of the actual cases of salmonellosis in an outbreak (Henessey et al 1996). However, in Australia, true increases in the incidence of these pathogens are likely to have occurred since there have been no appreciable changes to the NNDSS reporting system during 1991-96. Furthermore, these trends are corroborated by similar trends in many other developed countries.

The data from the survey of foodborne disease outbreaks must be interpreted with caution.

The questionnaires were completed from files that were up to 15 years old and sometimes from memory. Total morbidity and mortality rates for foodborne outbreaks are likely to be much higher than those depicted by these outbreaks as the data vastly under represent the number of outbreaks that occurred.

The interpretation of the epidemiological association with implicated foods was left to the discretion of the respondents in each State or Territory. Since these data were not collected in a systematic prospective manner there may have been a bias towards recording or recalling outbreaks that affected many people or caused excessive morbidity.

Larger more serious outbreaks are more likely to be investigated and those occurring at organised functions more easily detected and successfully investigated. Some foodborne pathogens, such as *Salmonella*, are more likely to be tested for and are more easily detected than others. Because of the need to collect specimens soon after onset of disease and the lack

of access to electron microscopy in many States and Territories, it is likely that outbreaks due to SRSV are greatly under reported.

Identification of contributing factors may have been unreliable because of the time elapsed before environmental investigations.

Mindful of the above limitations, it is still worthwhile to compare the available information on foodborne disease to the data available from countries (which may have similar or differently biased information sources) with similar agricultural sectors, food preferences, and level of development. In this respect, Australia's experience of foodborne disease seems similar to that of the UK and the USA. For example, non-typhoidal *Salmonella* were the most commonly reported cause of foodborne disease outbreaks in Australia, as in the United States, England and Wales (Bean and Griffin 1990; Cowden et al 1995). Similarly, laboratory-based surveillance systems (similar to the NNDSS) in those countries reported that the incidence of these organisms was second only to that of *Campylobacter* species (Dr D Ross personal communication). In 1994, notification rates of *Salmonella* for the USA, and England and Wales were 12 per 100,000 and 59 per 100,000, respectively. Data from the NNDSS indicated that Australia had a rate of about 30 per 100,000 for salmonellosis in 1994 (see Table 1).

There were, however, some notable differences between Australia and other industrialised countries. Firstly, Australia has yet to see the widespread outbreaks caused by *S. Enteritidis* phage type 4 and other *S. Enteritidis* serotypes witnessed throughout the United Kingdom, United States and Europe during the 1980s and early 1990s (Bean and Griffin 1990; Rodrigue et al 1990; Sockett et al 1993). *S. Enteritidis* is not endemic in Australian chicken layer flocks (Dr J Fairbrother personal communication) and good husbandry practices may have helped, so far, to prevent its establishment. Widespread infection of layer flocks with *S. Sofia* in Australia suggests that *S. Sofia* may competitively exclude *S. Enteritidis* in layer chickens (Szabo and Eyles 1995a).

Although most cases of *S. Enteritidis* infection diagnosed in Australia are acquired overseas (Dr D Lightfoot, personal communication), the 1994 outbreak in South Australia suggests that outbreaks of salmonellosis, especially those caused by *S. Enteritidis*, should be aggressively investigated to determine the source. A greater capacity for rapid investigation of outbreaks and clusters such as this is therefore essential.

Secondly, in the USA and UK, EHEC infections, specifically those caused by *E. coli* O157:H7 and predominantly associated with contamination of minced meat, have caused large and serious outbreaks (Bell et al 1994; Wall et al 1996). The first outbreak of HUS in Australia was caused by another EHEC serotype, *E. coli* O111:H-. *E. coli* O111 is far more important in Australia than O157:H7; more than half the documented sporadic cases of HUS in Australia have been associated with O111. This supports the argument for broadening the diagnostic

approach to bloody diarrhoea, HC and HUS to include methodologies that will detect a broader range of EHEC infections.

Focusing entirely on *E. coli* O157:H7 might be inappropriate as screening methods such as Sorbitol MacConrey agar (designed to detect sorbitol negative colonies such as *E. coli* O157:H7) may fail to detect Shiga-like toxin (SLT) positive strains such as O111 (March and Ratnam 1986; Goldwater and Bettelheim 1995). Screening primary faecal cultures from cases of bloody diarrhoea (especially in children) for SLT genes should be considered, or directly for SLTs using polymerase chain reaction or assays for toxin (Goldwater and Bettelheim 1995). Before this, however, studies are needed to address the incidence and effects of EHEC infections in Australia.

Mandatory notification of EHEC infections and associated conditions throughout Australia would increase awareness and provide baseline data for assessing the success of interventions.

Outbreaks of SRSV such as the Norwalk agent are much more commonly reported in the UK than in the USA. However, many of the outbreaks of unknown aetiology in the USA are clinically consistent with illness due to SRSV (Bean and Griffin 1990; Cowden et al 1995). A relatively high number of SRSV outbreaks were reported in the Australian collection of foodborne outbreaks. The importance of these agents is underlined by some studies which suggest that as many as 40 per cent of foodborne outbreaks of unknown cause may be related to SRSVs (Fleissner et al 1989). Greater access to electron microscopy and appropriate serological testing would facilitate detection of SRSV outbreaks. Outbreaks due to SRSV may well be the most common cause of foodborne disease outbreaks in Australia.

Since humans are the reservoir for SRSVs, infection of foods can only occur if they have been produced in an environment contaminated by human sewage or contaminated by infected food handlers. Viruses do not grow in food and are unlikely to be transferred by cross-contamination from raw to prepared foods. Unlike most bacterial agents these agents require a very low infectious dose, and the strictest hygiene measures may still result in contamination of food (Hedberg and Osterholm 1993). Infected food handlers were implicated in three of the SRSV outbreaks, which highlights the importance of avoiding contact with ready-to-eat foods and adhering to strict hygienic practices. People working in the catering industry should not be allowed to work while they have symptoms of infectious intestinal disease (Richmond Report 1990).

In 27 per cent of foodborne outbreaks, epidemiological investigations identified likely vehicles of infection by showing an association between consumption of food items and illness. This emphasises the importance of using epidemiological methods from the start of an investigation. Epidemiological methods may also be more sensitive than bacteriological ones in identifying the sources of outbreaks resulting from sporadic or low-level contamination of a widely

distributed food product. Therefore, consideration should be given to base product recalls on results of epidemiological analyses (Henessey et al 1996).

In summary, while acknowledging the difficulty of comparing data from different surveillance systems, Australia appears to have a similar experience of foodborne disease as the USA and the UK. Notable differences are:

- Australia is yet to see the widespread outbreaks caused by *S. Enteritidis*; and
- the major *E. coli* serotype responsible for HUS has been O111:H-, unlike in the USA and the UK where *E. coli* O157:H7 has been the major serotype responsible for outbreaks of bloody diarrhoea and HUS.

A comprehensive system for foodborne disease surveillance, together with adequate capacity to investigate foodborne disease outbreaks and conduct research, are essential to understanding the epidemiology of foodborne disease in Australia. An outbreak surveillance system would allow the analysis of well-defined cohorts to determine the food vehicles and contributing factors responsible for outbreaks, the monitoring of trends in disease, the evaluation of food safety interventions, and the detection of new threats to food safety.

Australia lags behind most other developed countries in that it lacks a national surveillance system for foodborne disease outbreaks. The establishment of a national surveillance system should be our major priority for food safety in Australia. It is impossible to assess the burden or control the risk of diseases that are not being systematically counted, collated and analysed.

## 3 A strategy for reducing foodborne disease

### 3.1 Scope for improvement

The Working Party recognises an urgent need for comprehensive information on foodborne illness in Australia. Current surveillance systems for human foodborne illness, zoonoses and food contaminants have many limitations; they are generally poorly coordinated across agencies, they provide incomplete and inconsistent data and the information is not readily accessible to many stakeholders who need it.

A primary objective of the recommendations presented in this report is to address the problem of foodborne diseases by developing a more conducive environment in which primary health providers, health authorities, laboratories, industry and consumers can generate and exchange high quality information. This approach supports the philosophy that food safety is a shared responsibility. The Working Party promotes a multilateral approach to food safety and supports a move towards prevention-based systems throughout the food supply chain and across all sectors. While this report promotes a multi-sector approach, the diversity of stakeholders and the complexity of food safety issues restricts the Working Party from developing recommendations that specifically involve all sectors. The report therefore concentrates on recommendations for which public health agencies can take direct responsibility.

The recommendations also aim to provide strategies which, over time, will fill the gaps in our current knowledge of foodborne disease and rectify the deficiencies inherent in many of the surveillance activities identified in the report. The recommendations focus on three main strategies:

- enhancing national surveillance activities;
- suggesting areas for future research; and
- promoting behavioural and attitudinal changes to food safety by consumers, the food industry and government agencies.

Consistent surveillance and investigation will lead to an ability to accurately assess the incidence and impact of foodborne disease. It will also facilitate better monitoring and validation of industry based food safety programs. Ultimately this information should provide sound evidence based arguments on which to base risk assessment, public health policy and interventions, and determine priorities for research and public health activities.

Many of the recommendations in this report are already being implemented through such forums as the Communicable Diseases Network Australia and New Zealand (CDNANZ) and the Public Health Laboratory Network (PHLN). Progress of individual recommendations and associated strategies are discussed in the remainder of this chapter.

## 3.2 Recommendations

### 3.2.1 Surveillance and outbreak control

#### Recommendation 1

**Develop best practice guidelines for surveillance, investigation and control of foodborne disease.**

The NCDC, in collaboration with the CDNANZ and the National Centre for Epidemiology and Population health (NCEPH), has recently finalised work on the development of best practice guidelines for the investigation and control of foodborne disease outbreaks. NCEPH has also been commissioned to develop benchmarks for surveillance of communicable diseases of public health importance in Australia, including those transmitted by food. The outcomes of these processes will be the development of standards, by NCEPH, for surveillance that will assist in planning and working towards specific targets by the year 2001.

#### Recommendation 2

**Establishment of a national laboratory network to identify gaps in laboratory diagnosis/investigation of foodborne disease, including specimen submission, and make recommendations for improved detection.**

The newly established PHLN is initially examining foodborne disease in the context of improving laboratory practices in areas of diagnosis and reporting of foodborne illness. The PHLN is an expert group with representatives from States and Territories. It was established to provide strategic advice to the NCDSS Implementation Group on a co-ordinated approach to public health microbiology for the surveillance and control of communicable diseases. The PHLN will help develop best practice guidelines for public health laboratory testing in cases of suspected foodborne disease. It will also have the role of advising on mechanisms for funding of microbiological tests on clinical specimens important for foodborne disease surveillance and/or public health management.

#### Recommendation 3

**A mechanism be established by which all States and Territories have adequate access to and funding for public health laboratory services considered important for foodborne disease surveillance and/or public health management.**

Some States and Territories do not currently have adequate public health laboratory services for timely detection (and therefore investigation) of foodborne disease outbreaks, such as those caused by *Salmonella*. As a result, investigations are often delayed or not initiated at all. The PHLN, in conjunction with the NPHP, will examine the need for a national public health laboratory system whereby all States and Territories have access to laboratories capable of typing organisms in a timely manner, and tests considered important for public health management can be funded centrally.

#### **Recommendation 4**

**State and Territory health agencies, in consultation with local and regional authorities, formulate projects to determine the extent of barriers to the reporting of foodborne disease and develop guidelines on sampling, testing and reporting of foodborne disease to facilitate more effective public health investigations.**

**Aspects would include:**

- **assessment of patient and enteric illness;**
- **appropriate testing of stool samples; and**
- **advising public health officials to facilitate public health investigations.**

A Department of Victorian Human Services' study is currently examining the practices of patients, general practitioners and laboratories regarding enteric illness. The study will include how often patients present to general practitioners, how often and under what circumstances general practitioners request samples, and review laboratory protocols for the testing of potential foodborne pathogens. This information will be used to make recommendations on the sampling and testing for foodborne pathogens under various conditions, with the view to benefit public health investigations. The Commonwealth Department of Health and Family Services, through the NPHP, is encouraging other States and Territories to perform similar studies to help validate this information. Projects to address the barriers to reporting may then be developed and funded on a national scale.

#### **Recommendation 5**

**In the longer term develop a joint list of notifiable diseases/conditions covering these diseases in both animals and in humans. Such diseases should be notifiable in all States and Territories.**

To improve the current NNDSS, nationally consistent case definitions and surveillance methodology need to be developed. Data must be comparable between jurisdictions to determine accurate national trends in foodborne disease. The NHMRC has published nationally agreed case definitions for notifiable diseases, but their implementation is the responsibility of States and Territories. The current definitions need to be reviewed and expanded if necessary.

In the first instance the NPHP will refer this matter to their legislative working party in consultation with the CDNANZ. Development of the list will need to address the problem of inconsistent reporting of foodborne diseases that currently exists between different States and Territories.

A national system must be flexible enough to allow new and emerging organisms or syndromes to be added if they have a significant effect on public health or require an immediate public health response. In this respect, diseases such as giardiasis, cryptosporidiosis, HUS and other EHEC infections should be considered for notification nationally. Timeliness of the system could be improved by electronic notification by laboratories to health authorities.

The responsibility for the development of the animal notifiable diseases list lies primarily with the Department of Primary Industries and Energy (DPIE). The development of a joint list of animal and human notifiable diseases will improve the links between the agriculture and health portfolios and contribute useful information on zoonoses and transmission of pathogens to humans. The National Animal Health Information System (NAHIS) provides a vehicle by which improved information between animal and human health information systems may occur.

The success of a NNDSS will depend on the level of commitment of all stakeholders. General practitioners need to work with public health authorities to improve the reporting of foodborne disease. Liaison between local health authorities and Divisions of General Practice is essential for this to occur. Other mechanisms to improve reporting should also be investigated such as involving pharmacists in supplying information on the quantity of anti-diarrhoeal medication purchased as an indication of trends in diarrhoeal illness.

## **Recommendation 6**

### **Develop and implement a National Foodborne Disease Outbreak Surveillance System (NFDOSS) and initially locate NFDOSS in the NCDC of the Commonwealth Department of Health and Family Services.**

Currently there is no national data collection of foodborne disease outbreaks. This deficiency contributes to our limited understanding of outbreaks and the less than ideal processes for identifying and investigating outbreaks. An outbreak surveillance system would:

- provide systematic recording of the incidence and causes of foodborne disease;
- give early warnings of new and emerging foodborne pathogens; and
- lead to appropriate disease control strategies.

To initiate action in this area, a consultant has been appointed under the auspices of the CDNANZ, the NCDC and NCDSS Implementation Group, to investigate options and develop a blueprint for the establishment and operation of a NFDOSS. Recognising resource limitations, the initial blueprint will be restricted to current resource capabilities, but will accommodate future expansion. The consultancy, which is due to be completed in November



1997, will present the blueprint to the CDNANZ for endorsement and then to the NPHP to facilitate implementation of the NFD OSS.

While the Working Party recognises that NFD OSS is likely to place an added burden on public health agencies, the system should be regarded as a requirement of good public health practice. To be successful, it will need to be embraced as a core function of both national and State and Territory surveillance strategies.

To provide a central focus and support to the NFD OSS, the national database should (at least initially) be held by the NCDC in the Commonwealth Department of Health and Family Services. This arrangement could be reviewed after three years, during which evaluation of the system will be undertaken.

### **Recommendation 7**

#### **NCDC, ANZFA and DPIE to continue discussions to determine how best foodborne illness surveillance can be linked to food and animal health surveillance.**

A major deficiency of current surveillance and outbreak control systems is the lack of coordination between food- and animal-based surveillance and illness-based or people-based surveillance.

The implementation of the Australian Food Safety Network (AFSIN) will provide a link between ANZFA and State and Territory health agencies and should improve the information flow between these entities. Information regarding food recalls and surveys should be fed back to industry through ANZFA.

The Australia New Zealand Food Authority Advisory Committee (ANZFAAC) has commissioned a project with the aim to map current food surveillance activities occurring within agencies throughout Australia and how information from this has been utilised. The project will make recommendations on an agreed set of natural priorities for food surveillance and how the information can be linked to foodborne illness and animal industries data more effectively. The Animal Health Committee (AHC) is currently developing a strategy which will build stronger links between animal disease surveillance and public health authorities thereby more effectively alerting authorities to potential public health problems.

### **Recommendation 8**

#### **CDNANZ to continue to facilitate use of consistent methodologies and generate greater capacity across States and Territories for the investigation of foodborne disease outbreaks.**

To a large extent the reporting of foodborne disease outbreaks will be facilitated through the NFD OSS once it is established. This system will be further promoted by the PHLN. Consistency across all jurisdictions is fundamental to establishing a clear picture of the

epidemiology of foodborne diseases in Australia. The CDNANZ continues to build capacity in this area by: encouraging consistent methodology across States and Territories when multi-state outbreaks occur; providing a valuable resource of expertise in public health and disease outbreak control; and, in conjunction with NCEPH, providing resources to jurisdictions that require assistance. Capacity for assistance at the national level is limited at present and is an area that requires further attention.

### **Recommendation 9**

**Government, industry, NHMRC and other national research bodies need to foster basic and applied research into foodborne illness. Specifically research into the following is recommended.**

- **population-based sentinel studies to establish the background incidence of diarrhoeal disease and to identify the relative significance of different pathogens**
- **case control studies over months to years to identify:**
  - **risk factors for illness;**
  - **opportunities for prevention;**
  - **vehicles of infection in the absence of microbiological confirmation; and**
  - **sources of foodborne pathogens**

In Australia, like the USA and UK, most reported foodborne infections are sporadic rather than associated with well-defined outbreaks. This may be because sporadic disease occurs more frequently due to poor food handling practices in the home and is truly unrelated to wider outbreaks in the community. Alternatively, sporadic disease may be unrecognised as part of a wider outbreak due to subclinical disease, low attack rates, and an inability of health agencies to identify foodborne outbreaks. Case-control studies of sporadic disease over months to years can identify risk factors for illness and offer opportunities for prevention. They may also identify vehicles of infection in the absence of microbiological confirmation. Sporadic cases notified to health authorities under public health legislation could be investigated in this manner. Results from case-control studies would enable better interpretation of NNDSS data and the identification of associated risks factors.

Population-based studies may also form the basis of enhanced surveillance for enteric pathogens and be used to explore risk factors for illness. These studies allow the determination of the relative incidence of different pathogens within a defined community. For example, a population-based study in a health maintenance organisation in Seattle established that *E. coli* O157:H7 was the third most common bacterial pathogen and had an annual incidence of 8/100,000. The highest incidences were recorded for campylobacteriosis (50/100,000) and salmonellosis (21/100,000) and infection with *Shigella* had an incidence of 7/100,000

(MacDonald et al 1988). In addition, a nested case-control study within the study population identified consumption of raw ground beef as a risk factor for *E. coli* O157:H7 infection. This study was important as it allowed this infection to be recognised as an important public health problem and provided information on the changing epidemiology of diarrhoeal disease in the respective community.

Population-based studies examining the incidence of *Listeria monocytogenes* in the United States from 1989 to 1993 demonstrated the effectiveness of interventions during this period by the food processing industry (Tappero et al 1995). A pilot study on the incidence, types of pathogens, risk factors and socioeconomic costs of infectious intestinal disease was conducted in the United Kingdom using eight general practices (Roderick et al 1995). Results from the pilot study suggested that a national study was feasible and the CDC is conducting similar population-based studies in nine sentinel sites in the USA.

Given the enormous financial burden that foodborne diseases have on the health system and the wider economy, case-control and population-based studies should be a priority in Australia so that the relative incidence of disease due to foodborne pathogens, the vehicles associated with illness and the cost of illness can be accurately determined. Both government and industry need to provide greater funding and support for this research. The NHMRC is urged to give foodborne diseases priority or special consideration.

### **3.2.2 The wider research and regulatory context**

#### **Recommendation 10**

##### **Research should be conducted into:**

- **the microbiological status of food and ecology of foodborne pathogens**
- **the behaviour of food handlers and consumers that predispose the public to foodborne disease**
- **prevalence of relevant organisms/diseases in domestic livestock and the waters from which seafoods are harvested**
- **methods for reducing microbial contamination of agricultural products that enter the food supply chain**
- **significance of natural toxins to public health.**

Information currently available on the microbiological status of Australian food comes from a variety of sources and has limitations. ANZFA conducts a survey of the Microbiological Status of Foods, although coverage is relatively limited. State and Territory health agencies also conduct microbiological surveys and microbiological test data are generated on a number of risk foods under the auspices of the Imported Food Inspection Program (IFIP). The Commonwealth Scientific Industrial Research Organisation (CSIRO) and the universities generate information on the microbiological status of foods. Some individual industry sectors,

often with leadership from the industry research corporations, either have programs for generating data on microbiological contaminants in foodstuffs or are moving towards such programs. Further, some individual businesses collect these data for their products, although such data are not generally available in the public arena.

Information, including quantitative data on the microbiological status of the food products, is sometimes insufficient for making appropriate policy decisions in some areas of food safety such as quantitative risk assessment and the setting of food standards. There is a need to have sufficient knowledge to understand the risk implied by the baseline prevalence of pathogenic microorganisms in food products. Additionally, there is scope for increasing our understanding of natural toxins. Data needs to be generated on a national scale. For some commodities this may simply involve consolidation, at national level, of information already available, but for many products the development of national plans will be necessary.

### **Recommendation 11**

**HACCP and other similar preventative strategies are supported. These should be encouraged across all sectors of the food supply chain and implemented through:**

- **Departments of Primary Industry and Energy continuing to work with industry associations and research institutions to encourage a move towards a HACCP-based approach**
- **on-farm HACCP plans and conduct of appropriate research to support these plans**
- **ongoing training in quality assurance and HACCP across all food sectors.**

There is worldwide acknowledgment by food safety scientists and experts that HACCP programs are the best defence against foodborne hazards within food production establishments.

This preventative approach to food safety is being sought across many sectors of the food supply chain, including the primary manufacturing sector which incorporates establishments such as abattoirs. Moreover, Commonwealth, State and Territory Health Ministers are collaborating with ANZFA to develop uniform national food hygiene regulations that will apply to all food businesses. ANZFA distributed a draft on the initial parts of the food hygiene standard for second stage public consultation in June 1997. The standard proposes a nationally consistent prevention-based approach to food safety in line with international trends and will incorporate the need for education and training strategies throughout all sectors of the food supply chain.

Individual companies will be required to take on an increased level of responsibility for the safety of their products. Small business will need government assistance in the development and monitoring of these programs. Furthermore, research is needed to develop more rapid and

sensitive microbiological tests to facilitate the monitoring of HACCP programs. Government, industry and research bodies need to work together to achieve the best possible outcomes.

### **Recommendation 12**

#### **Uniform food safety legislation and standards be adopted throughout Australia.**

Uniform adoption of food safety legislation and standards is crucial in helping to ensure a safe food supply. The development of national food hygiene standards and the review of the Model Food Act, both currently being undertaken by ANZFA, will form the basis of a consistent food regulatory system. The National Review of Food Regulation (NRFR) will also expedite a consistent approach to food regulation by having as its objective the streamlining of food regulatory requirements across the food sector, whilst at the same time, protecting public health and safety.

### **Recommendation 13**

#### **Government and industry initiatives which increase public and industry awareness of foodborne diseases such as the National Food Safety Awareness Week and incorporation of food safety and hygiene into school curricula be promoted.**

The Working Party recognises that the control of foodborne disease partially lies in improving food safety awareness and food practices throughout the food supply chain. The need for education campaigns that inform consumers and food handlers of contemporary foodborne hazards, their risks and preventative methods is widely recognised. The Food Safety Campaign Group, a partnership between government, industry, consumer and professional associations was established in early 1997 to develop and implement a national communication program to raise awareness of safe food handling practices. The Group was officially launched on 5 August 1997 and its activities will culminate in Australia's first Food Safety Awareness Week to be held from 9-15 November 1997. Key food safety campaign messages will cover personal cleanliness, cross-contamination and temperature control within the domestic setting. Subsequent programs will focus on educating and training food handlers and developing food safety programs to be incorporated into school curricula.

The switch to more prevention-based systems has compelled industry to take a greater responsibility for the development and implementation of food safety programs, and many large manufacturing and primary industry organisations have implemented strategies to educate and train employees in food safety. Other industries are in a more embryonic stage but include the Horticulture 2000 Group, which is beginning to address food safety as a component of quality management, and an industry group, 'Fresh Produce Watch' which was formed to investigate food safety and environment issues in the production of fruit and vegetables.

In the development of new national food hygiene standards, ANZFA has recognised that several infrastructure initiatives will be required to enable implementation of the standards by

State and Territory authorities. These include food industry guidelines for each of the major food industry sectors and a national food safety training system. ANZFA will develop guidelines in these areas in close association with peak industry bodies, the National Training Authority and States and Territories.

# Appendices





# A Current surveillance activities

## A.1 The National Notifiable Disease Surveillance System

The National Notifiable Disease Surveillance System (NNDSS) collates data on communicable diseases notifiable under State and Territory public health legislation. Communicable diseases in this system that may be associated with foodborne illness are botulism, campylobacteriosis, cholera, hepatitis A, listeriosis, non-typhoidal salmonellosis, shigellosis, toxoplasmosis, typhoid and yersiniosis. Information is collated in a minimum data set that includes aboriginality, age, date of onset, postcode of residence and gender. More comprehensive data are collated at the State and Territory level. The national data provide important trend information for some foodborne diseases. However, the system does not have the sensitivity to detect clusters, cannot detect specific serogroups, and does not provide information on risk factors.

Rates of disease reported to the NNDSS vastly underestimate the true rate of foodborne illness. This is due to:

- many people not attending a doctor for foodborne illness;
- only a small proportion of affected people having laboratory testing performed upon visiting a doctor;
- appropriate laboratory testing not always being performed, resulting in a negative result; and
- the laboratory not always notifying the isolate to the relevant public health authority. Overseas studies indicate that reports in the notification system represent less than 10 per cent of the true infection rate (FAO 1992).

Other diseases that may be foodborne and notified by individual States and Territories include giardiasis, cryptosporidiosis and *Vibrio parahaemolyticus* infections. Information on clusters of foodborne disease and gastroenteritis in institutions is notifiable in some jurisdictions. For example, in New South Wales, 'foodborne illness in two or more related cases' and 'gastroenteritis in an institution', are notifiable conditions upon diagnosis by medical practitioners or chief executive officers of hospitals. Notification and subsequent investigation of these clusters may facilitate more timely public health interventions. An essential component in the investigation of clusters of foodborne illness is procuring information on food consumption histories, and obtaining food and clinical samples. The opportunity to collect both information and specimens vanishes rapidly after foodborne incidents, and consequently, effective public health action relies on their timely notification.

The reporting of foodborne diseases needs to be enhanced by reviewing the National Notifiable Disease Surveillance System to ensure national consistency, greater flexibility and timeliness.

## A.2 The National Enteric Pathogen Surveillance Scheme

The National Enteric Pathogen Surveillance Scheme (NEPSS) [originally the National *Salmonella* Surveillance Scheme (NSSS)] is a national surveillance system which collects information on isolates important in foodborne disease and enteric disease. This national scheme, based at the Microbiological Diagnostic Unit (MDU) in Melbourne, Victoria, has existed for over 10 years and contains information on over 100,000 isolates.

Information is collected from human, human food, non-human food, animal, environmental, water and other isolates, and is provided by public and private sectors. Isolates may originate from investigations of an individual or population, or via routine or legislated testing. NEPSS collects data on *Salmonella*, *Shigella*, *Yersinia*, *Aeromonas*, *Campylobacter*, pathogenic *Escherichia coli* and *Vibrio* species, and more recently, enterohaemorrhagic *E. coli* (EHECs). Trends and clusters of disease may be detected upon screening of data by personnel in addition to regular scanning of the database by a computer program designed to note variations from the usual pattern. Once important trends are detected, they are communicated in a timely way to relevant public health officials and jurisdictions.

NEPSS publishes quarterly and annual summaries of human and non-human isolates. Information is provided to the National Animal Health Surveillance Scheme (NAHIS) and interfaces are maintained with other national schemes such as the Australian Paediatric Surveillance Unit (APSU).

## A.3 The Australian Paediatric Surveillance System

APSU is a surveillance system coordinated by the Australian College of Paediatrics and collects data on rare childhood diseases. The system has monitored cases of HUS since July 1994. APSU has provided information on cases of HUS in children younger than 16. Although the surveillance is useful for monitoring long-term trends, data on causative organisms are often incomplete, so that public health action cannot be preventative. Therefore, HUS needs to be notified to public health agencies within 24 hours of diagnosis to ensure appropriate public health action. Closer working relationships between primary care providers and health authorities would facilitate more timely notifications.

## A.4 Other data sources on human disease outbreaks

Data on foodborne disease outbreaks are available from State and Territory health authority reports (eg. *New South Wales Public Health Bulletin*) and the peer-reviewed literature (eg. journals). These sources of information often constitute reports of investigated outbreaks, and have obtained information on associated risk factors and causative organisms. However, the reports are not amenable to systematic analysis and represent a very small proportion of foodborne outbreaks.

Applied research on foodborne disease may be commissioned by State and Territory public health authorities and researchers may apply for funding from the National Health and Medical Research Council (NHMRC) and other agencies for specific projects. Information from these sources often lacks a national perspective, or may be designed to answer a specific research question rather than to inform on public health policy.

## A.5 Surveillance undertaken by non-health authorities

Other surveillance activities undertaken by non-health authorities that may provide information on foodborne disease include the following:

- the Commonwealth Department of Primary Industries and Energy (DPIE) has recently initiated a NAHIS to collate information on microbial isolates from primary industry;
- the Institute of Medical and Veterinary Science in Adelaide, South Australia, collects data on isolates from primary and secondary industry;
- primary industry often collects information on isolations from their manufacturing processes, but information is not always readily available to health authorities;
- State and Territory health authorities conduct microbiological surveys of food in retail premises and other specific venues, but nationally consistent methodology to collect this information is not available.

National access to much of these data may be improved by a communication link, The Australian Food Safety Information Network (AFSIN), being developed by ANZFA.



## B Primary production

### B.1 Introduction

For many foods, particularly those of animal origin, a low baseline of contamination is impossible to avoid. Available epidemiological evidence from other countries indicates that the major factors contributing to foodborne disease occur along the production chain, not directly from contaminated raw materials (Sockett 1991b). Nevertheless, zoonoses and pre-harvest contamination of food with pathogens can cause foodborne illness in their own right and are a source of organisms for human infection. The situation in Australia is unlikely to be significantly different from other countries (see Chapter 2).

Foods and food products of animal origin are often implicated as causes of gastro-intestinal and other disease (Murrell 1986) for several reasons:

- animals carry a large population of microbes in their gastrointestinal tract, and contamination of raw food can occur at slaughter, during milking and at egg-laying;
- animals can harbour pathogens which are transmissible to humans upon consumption of contaminated meat, milk and other products;
- foods derived from animals provide an ideal environment for the growth of microorganisms; and
- food of animal origin can become contaminated with pathogens from external sources such as dust and soil and through contact with rodents and other wild animals.

Australia has a very favourable animal health status. It remains free from most of the major livestock diseases that cause public health concerns and severe production losses in other parts of the world (Animal Health in Australia 1993).

The National Animal Health Information System, NAHIS, has been established to provide an objective overview of Australia's animal health status on a national basis (Garner and Nunn 1995). It is based on the routine monitoring by animal health services of selected diseases and is supplemented by special studies and surveys. NAHIS is initially targeting 21 endemic diseases and disease-organisms, including *Salmonella* and certain variants of *E. coli*, and 15 animal diseases declared exotic to Australia.

Many of the organisms causing disease in humans do not always, or may only infrequently, cause overt disease in infected livestock, fish, shellfish or plants and many cannot be detected by visual inspection of food. For example *Salmonella*, *Campylobacter* and *Listeria* occasionally produce symptoms of disease in domestic animals, but disease is rare compared to

the frequency of gastrointestinal tract colonisation. *C. jejuni* is generally not pathogenic in commercial chickens and salmonellae become localised in the caeca of chickens without inducing clinical disease. *E. coli* O157:H7 is a pathogen for people but not cattle.

Certain species of *Aspergillus* and *Penicillium* can be plant pathogens or commensals but are more commonly associated with commodities or foods during drying and storage.

One consequence of infection not always (or infrequently) being accompanied by disease in animals, fish or plants is that producers can be unaware of contamination in their produce. Another consequence is that disease surveillance in livestock or fish may fail to foreshadow a human health problem. However, health surveillance of animals remains a priority because overt disease can clearly indicate problems for public health. Formal links between public health and animal health sectors for the reporting of zoonoses may facilitate the investigation of food safety incidents and the prediction of emerging food safety problems. Accordingly, a consistent national approach to the notification of zoonoses with implications for food safety would be valuable.

Food safety issues differ for each of the primary production sectors. Each sector therefore requires different control measures. Many industry sectors have been working to introduce quality assurance (QA) procedures and some, but not all, have programs such as Hazard Analysis Critical Control Point (HACCP) systems (DPIE 1995) in place which aim to reduce or eliminate microbiological contamination of foods.

QA systems at the farm level are currently being introduced in the dairy and citrus industries. The cattle and sheep industries have embarked on a similar approach. The focus of these QA systems, however, is not on microbiological food safety alone (DPIE 1994).

The following sections identify pathogens which present the highest risk across several food industry sectors and provides a summary of recent initiatives to address food safety through HACCP, legislative reform and Government policy.

## **B.2 Food safety by sector**

### **B.2.1 Sheep, cattle, game, rabbit and some other red meats**

Pathogenic bacteria are the major disease-causing agents of foodborne illness associated with red meat. *Campylobacter* spp. and *Salmonella* spp. are of concern for both the beef and sheep meat industries. Studies by CSIRO have shown that the total viable bacteria counts for beef carcasses are comparable to those found in the United States of America and New Zealand (MRC/CSIRO 1996).

A comparison of sheep carcasses from Australia and New Zealand also showed comparable levels of hygiene. Pathogenic bacteria like species of *Salmonella*, *Campylobacter*, *Listeria* and

*E. coli* O157:H7 occur at low levels on Australian beef and sheep carcasses. The CSIRO survey (MRC/CSIRO 1996) indicated that there are no major problems of bacterial contamination at the preslaughter stage and earlier stages on-farm.

Most attention is required at and after the abattoir stage of the meat supply chain, highlighting the importance of adequate temperature control at the abattoir, during transport and during further primary processing (boning, packaging, freezing).

The red meat industry is fully aware of the potential impact of foodborne pathogenic organisms on the community and the flow-on effects for the industry, as seen recently with the 1996 outbreak of *E. coli* foodborne illness in Japan (Osawa et al 1996). The Meat Industry Council (MIC) has developed a Food Safety Strategy (Review of Food Safety Issues in Australia Quarantine and Inspection Service (AQIS) Draft Report, Meat Products for the DPIE Food Safety Management Committee) to ensure the safety of Australian-produced meat. A key goal is to have all enterprises, from producer to retail, operate in accordance with accredited HACCP-based QA systems by the end of 1999.

Both the cattle and sheep industries have developed on-farm QA systems (Cattlecare, Q-care, Flockcare). Although these systems focus primarily on reducing chemical residues through the responsible use of chemicals, they also cover presentation of animals for slaughter.

The saleyard and livestock transport sectors are also developing QA systems. Uniform national standards for stockfeeds are being developed to protect animal and consumer health.

The Meat Research Council (MRC) has a Food Safety Key Program (MRC 1996) including projects to minimise human pathogen carriage and prevalence in preslaughter cattle and sheep. The organisms to be studied in this project are *Salmonella* species, *E. coli* 0157, *L. monocytogenes*, *Staphylococcus aureus* and thermotolerant *Campylobacter* and *Yersinia* species. Other projects cover quantitative microbiological risk assessment, application of predictive microbiology, contamination of carcasses during slaughter, dressing and chilling, and improved handling techniques to reduce employee contamination of products.

ARMCANZ together with Standards Australia have endorsed the following Standards (Standing Committee on Agriculture and Resource Management [SCARM] 1997):

- *Australian Standard for Construction of Premises Processing Meat for Human Consumption* (SCARM Report Number 53);
- *Australian Standard for Hygienic Production of Meat for Human Consumption - Second Edition* (SCARM Report Number 54);
- *Australian Standard for Construction of Premises Processing Animals for Human Consumption* (SCARM Report Number 55); and
- *Australian Standard for Transportation of Meat for Human Consumption* (SCARM Report Number 56).

Three more reports covering game (SCARM Report Number 57), poultry (2.3 *Poultry meat* section) and rabbit meat (SCARM Report Number 59) have been produced. Additional standards dealing with crocodile meat, emu and ostriches, sausage casings and pet food will be finalised progressively and published during 1997 and 1998 (SCARM 1997).

The legislation to support these standards was required to be introduced by relevant governments by January 1996 and the standards are now being implemented in all State jurisdictions. The Standards are supported by appropriate audit and sanctions. All slaughtering and processing plants were required to apply HACCP principles by January 1997.

### **B.2.2 Pig meat**

As for other meat, the major causes of foodborne disease associated with pig meat at the on-farm production stages are bacterial, with *E. coli*, *Salmonella* and *Campylobacter* species at the top of the list (Coates, Kolega, Barlow et al National fresh pig meat survey, in preparation).

The Pig Research and Development Corporation (PRDC) has funded a project on the microbiological status of pig meat and carcasses (Coates, Kolega, Barlow et al, National fresh pig meat survey, in prep.). A small preliminary survey targeted key pathogens (*Salmonella*, *Campylobacter*, *Y. enterocolitica*, *S. aureus*, EHECs) and total viable bacterial counts in meats from retail display outlets. The sample size chosen (120) gave 95% certainty of including at least one positive sample if 3% or more packs were contaminated with the organism under investigation.

No *Salmonella*, *Campylobacter* (*C. jejuni* or *C. coli*), *Y. enterocolitica* or *E. coli* O157 were isolated in the survey. This indicated an incidence of these pathogens of less than 3 per cent and suggested that contamination was at the lower end of the range encountered in the rest of the world (CAST 1994).

Three samples were positive for *Listeria*, suggesting an incidence of 2.5 per cent. *S. aureus* was recovered from 8.3 per cent of samples.

Just over 70 per cent of samples were coliform positive and 24.2 per cent of samples were positive for *E. coli*. These values are of the same order of magnitude as those found for beef and sheep meat.

The Australian pig industry is developing HACCP-based QA systems from the farm to the abattoir. The pig industry, through the PRDC, has completed major projects identifying hazards and hazard controls for microbial spoilage and is incorporating these into the HACCP structure.



### B.2.3 Poultry meat

As for red meat, pathogenic bacteria are the major disease-causing agents of foodborne illness caused by poultry. *Campylobacter* and *Salmonella* are the pathogens of principal concern to the poultry industry at present and poultry meat is frequently contaminated with both organisms (Grau 1989a, b).

Contamination of feedstuffs is believed to be the most common source of *Salmonella* infection of poultry. However, the industry owns a substantial proportion of its feed suppliers and regularly tests feed product. The heat processing used in the manufacture of pelleted feed should be sufficient to destroy or at least reduce the level of contamination, but this may fail if the conditions of treatment are inadequate or if the finished product is recontaminated and/or inadequately stored (Mossel and Drake 1990; Baird-Parker 1994).

Microbiological pathogens found on poultry meats are derived predominantly from avian microflora entering the processing plant in the gut, on skin and among the feathers of live birds. It is important that the poultry industry has procedures in place to minimise contamination and some of the most effective control measures for minimising carcass contamination by *Campylobacter* are at the farm level (Szabo and Eyles 1995b).

The extent to which poultry meat is a vehicle for transmission of *Salmonella* or *Campylobacter* species to humans is unclear. Currently, over 80 per cent of *Salmonella* positive carcasses are contaminated by *S. Sofia*, a species regarded as having virtually no virulence for humans, with other salmonellae each accounting for less than about 5 per cent of positive carcasses. Not unexpectedly, each year 30-40 per cent of *Salmonella* isolates from humans are *S.*

Typhimurium, a relatively pathogenic bacterium to humans, whereas the incidence of *S. Sofia* is very low, probably due to its low pathogenicity in humans. For *Campylobacter*, about 60 per cent of the types found on poultry carcasses are not found in the human population (J Fairbrother, personal communication). Further research is being done on the similarities and differences between the strains of *Campylobacter* found in poultry carcasses and people (J Fairbrother, personal communication).

The chicken meat industry recently commissioned a report, *Poultry Production and Human Health*, from the CSIRO Division of Food Science and Technology and recommendations from the report will provide the basis for targeting future research.

The national minimum mandatory standards for the poultry industry are covered by the *Australian Standard for Hygienic Production of Poultry Meat for Human Consumption* (SCARM Report Number 58) (SCARM 1997).

The poultry industry is proceeding towards HACCP approaches based on AQIS systems, with the two major operators (which account for 70% of production) well into the program.

## B.2.4 Dairy

Bacteria are the major disease-causing agents of foodborne illness that may enter dairy products at the production stage. *Salmonella* species and *L. monocytogenes* are frequently isolated pathogens. *Mycobacterium paratuberculosis*, the cause of Johne's disease in animals and a possible cause of Crohn's disease in humans, is under contention. Pasteurisation of milk maintains effective control over *Salmonella* and *L. monocytogenes* but is not completely effective against *M. paratuberculosis*. Care needs to be taken to avoid post-processing contamination.

ANZFA's Food Standards Code specifies that fresh milk sold for human consumption be pasteurised, except where the applicable law of a State or Territory expressly provides otherwise. In South Australia, Queensland and New South Wales, non-pasteurised cow's milk can be sold directly to consumers, and in Western Australia, Queensland and New South Wales goat milk can be unpasteurised. Unpasteurised milk must be accompanied by a statement 'WARNING: UNPASTEURISED' in both of these instances. Milk which has not been subjected to pasteurisation or an equivalent heat treatment is prohibited in the making of both hard, dry or soft, moist cheeses.

The Australian dairy industry is substantially committed to HACCP-based quality control approaches, with most dairy manufacturers having already implemented HACCP-based programs and many companies producing to ISO 9000 requirements. Some small processors, however, are not covered by safety and quality programs.

At the farm level, the industry is currently developing enhanced quality management/assurance arrangements. An example of this is the 'Dairy First' initiative, a HACCP-based system aimed at increasing food safety issues among farmers. Qualified milk tanker drivers will perform quality parameter tests on milk at the farm gate.

## B.2.5 Eggs

Eggs with intact shells have been identified as the major vehicle of transmission of *S. Enteritidis* to people in most countries (Cox 1995). Outbreaks of foodborne illness in Europe and North America from this source have been large and widespread (Bean and Griffin 1990; Rodrigue et al 1990; Sockett et al 1993). Australia has yet to see the widespread outbreaks caused by *S. Enteritidis* phage type 4 and other serotypes. *S. Enteritidis* is not endemic in Australian layer flocks (J Fairbrother, personal communication) and good husbandry practices may have helped, so far, to prevent its establishment. Widespread infection of layer flocks with *S. Sofia* in Australia suggests that *S. Sofia* may competitively exclude *S. Enteritidis* in layer chickens (Szabo and Eyles 1995b).

*Salmonella Enteritidis* accounts for only a small percentage of human *Salmonella* isolates in this country (3.2% in 1993) and most are acquired overseas. Australian isolates of *S. Enteritidis* are generally avirulent, while most UK strains are virulent (Cox 1995). The low

incidence of *S. Enteritidis* and the apparent avirulence of *S. Enteritidis* in Australian poultry has been said to indicate that this organism does not pose an immediate threat (Szabo and Eyles 1995b). However, *S. Enteritidis* is common in countries adjacent to Australia and there is some risk of its establishment and spread if vigilance is not maintained. The issue is being addressed through ongoing monitoring of Australian breeder flocks. Flocks will be destroyed if positive samples are found.

A greater capacity for rapid investigation of outbreaks and clusters such as those caused by *S. Enteritidis* is essential.

The egg industry is in the early stages of developing HACCP systems. However, no nationally consolidated data are available regarding the levels of important pathogens in eggs with intact shells or egg products.

## **B.2.6 Seafood**

Seafood is a high risk food with respect to microbiological contamination and the seafood industry has recently begun to embrace the issue of food safety and quality. Despite the initiatives in place, as discussed below, there is a clear need for industry, scientists and regulatory authorities to evaluate seafood safety risks .

Assessed microbiological risks in fin fish and crustacea are generally low at the production stage. Risks for fin fish can come from zoonotic organisms including *Vibrio* species, particularly enteropathogenic *V. parahaemolyticus*, *Clostridium perfringens* and *Cl. botulinum* (Nemetz and Shotts 1993). Cross-contamination during later handling, processing and preparation constitute the major hazard and organisms such as *S. aureus*, *Salmonella* species and *E. coli* are prominent.

In contrast, the molluscan shellfish industry has several potential risk factors that operate at the growing stage and onwards (eg Gillespie et al 1986). Risk is exacerbated by many shellfish products being consumed raw (Gerba 1988). Bivalve shellfish filtering matter from seawater are important vehicles for the transmission of Norwalk virus and hepatitis A virus (Guzewich and Morse 1986; Gerba 1988). Rock oysters have been implicated in several incidents of foodborne illness (Murphy et al 1979; Gill et al 1983; Kraa 1990). Sydney (Georges River) oysters contaminated with Norwalk virus were implicated in foodborne illness outbreaks in June/July 1978 and December 1978 which affected over 2,000 and 60 people, respectively (Kraa 1990). Outbreaks due to hepatitis A virus can also be large, as indicated by a recent (February 1997) outbreak associated with consumption of contaminated oysters in NSW which involved over 400 cases in this State alone (Dr J McAnulty personal communication).

The Fish Research Development Corporation is supporting national strategies focused on implementation of HACCP and is funding several projects associated with safety and quality issues. Moves are also underway to improve education and training standards within the seafood industry and postharvest handling of seafood (Victorian Fisheries 1996).

## B.2.7 Horticultural produce

The use of contaminated water for irrigation or the use of fertilisers contaminated with pathogenic organisms can be a problem, particularly for salad vegetables which are eaten raw (Merton and Salter 1995). Bean sprouts have been occasionally incriminated in outbreaks of salmonellosis. Tree nuts can become contaminated with salmonellae when domestic animals graze in areas where nuts are grown and harvested from the ground, but such contamination is rare except for coconuts.

Mushrooms are also products with potential food safety problems. Post-harvest rots in mushrooms have been identified as a potential microbiological food safety problem. Presently, there are testing programs in place for coliforms, *Salmonella* and yeasts and moulds in nuts. *Salmonella* contamination can occur during the harvesting, drying and preparation of spices.

'Fresh-cut' product (ie fresh vegetables cut and packaged for quick and convenient use) and ready-to-eat salads are areas of some concern. Hazards for ready-to-eat salads come more from cross-contamination during preparation and handling rather than from agricultural production. The fresh-cut sector is developing rapidly and faces increased contamination risks compared with fresh produce because a longer shelf life is intended for the product and enclosed packages are used. These circumstances are more conducive to microbiological contamination and growth than those operating for fresh unpackaged produce. HACCP-based quality management systems have been adopted at the enterprise level to address potential food safety problem areas in the fresh-cut sector. It is expected that once well established, HACCP-based QA programs operating within processing and packaging companies will assist in reducing foodborne disease from these food sources.

Other approaches to food safety in this area are the Horticulture 2000 Group, which is beginning to address food safety as a component of quality management, and an industry group, 'Fresh Produce Watch' which was formed to investigate food safety and environment issues in the production of fruit and vegetables. However, it has not yet addressed food safety issues to any great extent.

## B.2.8 Grains

The major microbiological food safety issue for the grains industry is mycotoxin contamination (WHO 1990). The three fungal genera producing the most important mycotoxins are *Aspergillus* (which produce aflatoxins), *Fusarium* and *Penicillium*. The presence of mycotoxins in Australian grains is an intermittent problem which may arise from adverse seasonal conditions (Zemanovic 1994). Australian grains are normally low in moisture content and not highly subject to fungal activity. However, fungal contamination during farm storage has been identified as a particular area of concern. Many of the mycotoxins that may contaminate grain can pass into the food supply chain for people by way of stock feeds. As a

consequence, food standards exist in Australia for mycotoxins (ANZFA's *Food Standards Code*).

As well as mycotoxins from fungal contamination of grain, other natural toxins which can contaminate agricultural produce (grains, pastures, hay) and have the potential for passing up the food supply chain include the corynetoxins, pyrrolizidine alkaloids (WHO 1988a; WHO 1990), indospicine, ptaquiloside and the simplexin esters (J Edgar, personal communication)

Stored grains and other food seeds can become contaminated with bacteria such as salmonellae or *Bacillus cereus*. Contamination with salmonellae can occur by direct or indirect contact with animal or human faeces via animal contact in the field, mice nesting in machinery, transport in trucks contaminated by previous carriage of animals or animal by-products (WHO 1988b). While grains and other food seeds are too dry to allow the growth of contaminants, the organisms can persist on them for long periods.

The food safety focus of the grains industry has been mainly on ensuring that any chemical residues in grain remain below relevant maximum residue limits (MRLs). However, the Grains Council of Australia (GCA) is making efforts to coordinate QA initiatives in the grains industry and is aware that one of the major issues that a more structured QA program has to address is food safety (Zemanovic 1994).

There are no formal on-farm QA schemes in place for coarse grain production. Quality standards for coarse grains require the grain to meet certain physical criteria of soundness and freedom from weed seeds and pests. If grain meets these standards, the potential for contamination with microorganisms and toxins is reduced.



## **C Manufacturing and retail**

### **C.1 Introduction**

Food manufacturing, distribution and retailing are the central links in the food chain from raw material to the consumer. Food manufacture is the process of converting the products of agriculture and of primary production into products ready for direct retail to the consumer or for use by the food service industry eg restaurants, caterers and other ready-to-eat food outlets. Manufacturing includes packaging, transport and storage of this food. Each of these stages may include many processes and are made up of businesses of an equally diverse range of size and complexity.

Foods, either in the form of ingredients or whole foods, may be naturally or accidentally contaminated by microorganisms, chemicals or foreign bodies at any stage in the food chain. Thus food manufacturers, retailers and food service establishments have a shared responsibility with both suppliers and consumers in maintaining control of food safety. They must use safe and good quality raw materials, control, reduce or eliminate contamination during processing and use packaging, storage and distribution systems which prevent post-process contamination.

Manufactured and retail foods should be categorised as high, medium or low risk according to the hazards they present to public health so that the appropriate controls can be applied to a particular risk category. A risk- assessment approach to food safety control is required (CAST 1994; Bernard et al 1995).

### **C.2 The effect of the food industry on foodborne disease**

The factors contributing to outbreaks of foodborne illness in the food manufacturing, retail and catering sectors vary. In a summary of contributing factors in the United States of America 1973-82, inadequate temperature control during processing and storage were the major factors in manufacturing and food service establishments followed by poor quality raw ingredients (Bryan 1988). These factors were reversed in outbreaks associated with home prepared food (CAST 1994). Whether the data from the investigation of outbreaks can be directly extrapolated to sporadic cases remains to be determined, although the factors are likely to be similar.

### C.2.1 Variation in the incidence of foodborne disease among industry sectors

Data available from the USA (Bryan 1988), Canada (Todd 1992, 1996) and the UK (Sockett 1991b) attempt to distinguish between where the food was obtained, mishandled and consumed. In Canada, foods associated with foodborne illness were obtained from food service establishments (43%), retail stores (32%) and homes (19%). Between 1980 and 1989, 294 reported outbreaks of foodborne illness were associated with manufactured foods in the UK (Sockett 1991b), representing less than 5 per cent of the total foodborne disease outbreaks reported during the same period. In each country, food prepared in food service establishments has been associated with the largest number of cases of foodborne illness and food prepared in manufacturing establishments has been responsible for the least (Table 6). In the USA, the percentage of the total reported outbreaks associated with food prepared in commercial and institutional establishments increased from 63 per cent during 1973-75 to 80 per cent during 1985-87 and the median size of the outbreaks also increased. The latter reflects the increasing ability of the commercial food industry to mass produce perishable food which may be widely distributed both nationally and internationally to large numbers of consumers.

**Table 6 Foodborne disease outbreaks and incidents and the place where the food was mishandled in the USA and Canada**

Report	Number of incidents/outbreaks (%)		
	Food service	Food processing	Home
USA outbreaks 1973-87 (Bean and Griffin 1990)	5,703 (79)	-	1,516 (21)
USA outbreaks 1973-82 (Bryan 1988)	660 (61)	75 (7)	34 (32)
Canada incidents 1975-84 (Todd 1992)	2,857 (33)	714 (8)	1,419 (16)

### C.2.2 Variation in disease-causing agents

Overseas data also shows that disease-causing agents vary among the food sectors. In Canada (Todd 1992) and the USA (Bryan 1988) microbiological agents (*Salmonella*, *Bacillus cereus*, *Staphylococcus aureus*, *Clostridium perfringens*) were responsible for most cases in all sectors, although manufacturing plants and retail stores were more often associated with foods contaminated with chemicals and extraneous materials. Some aetiologies were an exception eg botulism resulted more often from food mishandled in the home as were illnesses due to mushroom poisoning and ciguatera resulting from the procurement of naturally contaminated or poor quality foods. In the UK, *Salmonella* was responsible for 45 per cent of 294 outbreaks due to manufactured food between 1980 and 1989 (Sockett 1995).



In the USA, foods prepared in commercial establishments and institutions included most of the outbreaks associated with meat, poultry, egg, seafood and dairy foods (Bean and Griffin 1990). In the UK, cooked and processed meat were the most significant vehicles of foodborne illness associated with manufactured food (Sockett 1995).

### C.3 Costs and effects

A foodborne disease incident or poor publicity and consumer anxiety can result in a costly food recall. Food recalls affect a whole industry sector, not only the implicated company (Pointon 1995). A major incident can lead to the closure of a company and the loss of many jobs. As Australians become more aware of the potential to recover damages as a result of a foodborne disease episode it is likely that more food businesses will close as a result of a food safety failure.

The extent of the wider financial burden of foodborne disease was presented in Chapter 1. The effects of foodborne disease incidents associated with, or suspected to be associated with, the food manufacturing, transport and food service industries, are demonstrated by the following examples:

- a smallgoods foodborne disease outbreak resulted in one death, unspecified social and financial costs, an insurance payout of about \$10 million and closure of the company (Beers 1996b);
- according to newspaper reports, the total cost to a food manufacturing company of a recent peanut butter foodborne disease outbreak could be as high as \$55 million (ANZFA 1996);
- during 1996, an outbreak of *E. coli* foodborne disease in Japan affected more than 8,000 people with at least 11 deaths (WHO 1996);
- in 1994 in the USA, a single foodborne salmonellosis outbreak, associated with ice cream, involved about 225,000 people (Hennessey et al, 1996); and
- in 1990, in the UK, an outbreak of salmonellosis resulted in the loss of about \$44 million to the implicated baby food company, the closure of their factory and the loss of 100 jobs (Sumner 1995).

The effects of foodborne disease may extend beyond the domestic market and reduce a country's export earnings as a result of a loss of international consumer and customer confidence (Motejemi et al 1995) and a failure to meet our 'clean and green' image (see Chapter 1).

## C.4 Requirements for the manufacture of safe food

There are factors common to all food businesses that affect the safety of the food they produce.

The following factors were identified by the Richmond Committee (Richmond Report 1990b) as part of a review of the food manufacturing industry in the UK, and would equally apply in Australia:

- appropriate starting materials;
- appropriate processes;
- well-designed machines;
- well-designed premises;
- well-trained staff;
- well-conceived controls and monitoring; and
- positive commitment by management to high microbiological standards at all stages.

The feasibility and practicalities of the implementation of these factors is, however, variable and readers are referred to the Richmond Report (1990b) for further details.

## C.5 Strategies for control

Food manufacturing, retail and catering businesses vary in their ability to satisfy the requirements for food safety, listed in Section 4, *Requirements for the manufacture of safe food*. The various food industry sectors have to be considered individually to address the strategies and approaches a food business must incorporate to enhance food safety.

The following were identified by the Richmond Committee (Richmond Report 1990b) as the major categories of food businesses, having been grouped on the basis of common characteristics influencing their approach to food safety control:

- large-scale food manufacturers;
- small-scale food manufacturers;
- retail food outlets (including restaurants, mobile/temporary food outlets, caterers, supermarkets, institutions); and
- other food outlets of concern (including imported foods, self-service food centres).

The following sections give a brief overview of the food safety strategies required for the various food businesses. Readers are referred to the Richmond Report (1990b) for further details.

### C.5.1 Large-scale food manufacturing

Controls applied by manufacturers include good manufacturing practice (GMP), voluntary implementation of HACCP systems, microbiological analyses in monitoring, and staff training. Food industry associations eg the Rural Industries Research Councils, provide valuable funds to support external research and to foster understanding of hazards in the area of food safety (DPIE 1995). Successful industry initiatives in food safety control have, in some instances, become the industry standard and later the basis for national and international regulations.

There is increasing recognition by large-scale food manufacturers in Australia, and internationally, that integration of HACCP principles with an ISO 9000 Quality Assurance (QA) system offers the most comprehensive approach for the management of food safety in the food industry. The proposed national food hygiene standard is consistent with this approach taken by large-scale food manufacturers (ANZFA 1996).

Large-scale food manufacturers in Australia generally favour an internationally harmonised HACCP-based QA system in order to enhance trade opportunities. An FAO Expert Technical Meeting on the Use of HACCP Principles in Food Control, 1994, identified various regulatory issues which require attention in working towards an internationally harmonised HACCP-based QA system, whether voluntary or mandatory (Hathaway 1995; Kvenberg et al 1995). Australia, as a signatory to the establishment of the World Trade Organisation (WTO), recognises the importance of aligning food standards. The proposed national hygiene standard would achieve this alignment. It is important that the new food hygiene standard should, wherever possible, be in line with the Codex HACCP guidelines (Codex 1993).

Irrespective of the final form of the proposed Australian food hygiene standard, guidelines for the appropriate level of regulatory involvement and responsibility may be needed in the following areas:

- technical support for the design and application of HACCP plans;
- national programs to ensure the quality, scientific validity and consistent application of HACCP systems;
- regulatory sanctions which may apply if an industry sector does not take up HACCP in a voluntary environment eg increased frequency of inspection and increased requirements for traditional process control;
- regulatory verification and audit, including access to industry records;
- regulatory response to inadequate HACCP plans and inadequate application;
- regulatory guidelines for appropriateness and severity of corrective action eg with reference to microbiological criteria - the Codex Committee on Food Hygiene holds the view that rejection of products as being unfit for their intended use as only one of the regulatory actions that can be taken;

- regulatory response to failure to take corrective action;
- training of regulatory personnel, and regulatory responsibilities with respect to industry training programs; and
- utilisation of third parties in development, validation and audit of HACCP systems.

### **C.5.2 Small-scale manufacturers**

Small-scale food manufacturers are a significant component of the Australian food industry in terms of participation rate.

The food produced or sold by these businesses can often represent a significant risk to public health. This may be due to limited access to capital, and lack of experience and knowledge of food hygiene, and limited training, which is often not seen as relevant or affordable (DPIE 1995). The lack of food hygiene knowledge is one of the most important issues to be addressed (ANZFA 1996).

Low or variable turnover of stock and financial pressures means that doubtful product that would normally be discarded or not purchased may be retained or purchased for eventual sale. Technical factors which contribute to the poor quality of these products are the quality of the raw materials used and processing factors which should be managed by a correctly applied food safety system based on HACCP.

Small-scale operators often do not have sufficient trained staff to develop and operate even a rudimentary HACCP system (Bernard et al 1995). A solution to this dilemma may be for Environmental Health Officers (EHOs) to take on the role of HACCP facilitator for these food operations. EHOs may require additional training for this role as they would shift from being an inspector to a trainer and an auditor (WHO 1995). However, questions of legal liability need to be resolved. Industry associations could also take a more active role in supporting their members in these endeavours. Food manufacturers must also participate and cooperate in the process as they are essential members of the HACCP team. Together, industry representatives, EHOs, trainers and researchers, could form a shared pool of expertise available at relatively low cost.

It may be appropriate to offer small-scale food operators access to generic food safety programs based on the principles of HACCP. EHOs could assist operators to tailor HACCP to individual requirements. In this way it would be possible to remove the onerous components of HACCP eg recording and monitoring of results, while preserving those components that enhance food safety (Kvenberg et al 1995).

Existing methodology for monitoring Critical Control Points (CCP) and verification of the success, of the process, is often complex and expensive. Process monitoring is therefore out of the reach of most small businesses. Government should encourage professionals in universities and research agencies to develop rapid, low-cost microbiological procedures (Fung 1995).

### **C.5.3 Retail food outlets**

The retail food sector distributes both primary produce and manufactured food through shops and supermarkets. These foods may undergo further processing or preparation before sale in retail premises or in food service establishments such as restaurants and canteens. Food service is a growing industry and in addition to the traditional permanent establishments, includes: mobile and temporary vendors; caterers, professional or amateur, who prepare food for consumption at another site than that of preparation; institutional kitchens; and school tuck-shops, to name the most common.

The diversity of food handling practices, products and facilities available in the post-manufacturing and retail food sectors parallel those of the manufacturing sector and the factors required for safe food preparation are similar. The retail sector can similarly be divided into large-scale establishments eg supermarket and restaurant chains, and the smaller or individual operators. Sectors are characterised by the availability of knowledge, experience and capital. There are unique aspects of the various sectors which require different approaches to food safety control (Bryan 1992).

The retail and food service sectors usually handle a diversity of products at any one production time and the product may change regularly. A daily change in menu may introduce new hazards which require different control measures. It is impossible to have specific HACCP-based food safety controls for each food prepared and flexibility is required where the foods are classified into food service systems eg cook/serve, cook/chill for which CCPs can be identified (Bryan and Doyle 1995). While a generic-based food safety might not embrace the seven HACCP principles (Codex 1993), it offers greater control over food safety than traditional inspections. Another limitation to the application of HACCP may be the lack of equipment or facilities for monitoring of CCPs. However, regulatory bodies or consultants should attempt to work with these establishments to identify practical solutions (Bernard et al 1995).

The work force in the retail and food service sector has a high rate of turnover and is characterised by a diversity of educational and cultural origins. This presents particular challenges to the conduct of education programs and emphasises the need to apply the HACCP concept, which targets CCPs and their monitoring as key education messages (WHO 1988a).

Several food service establishments or outlets were identified as requiring particular attention due to the high risk of transmission of foodborne disease and the increasing introduction of the foods from these operations in our community (MMWR 1994). These are discussed separately.

## Self service food

Self service food is unpackaged ready-to-eat food which is displayed to customers for self service. Approaches to self service foods include:

- smorgasbords openly displaying food for consumption on the premises
- food display cabinets eg with sneeze guards, hot/cold holding of foods to be consumed on the premises
- displays in appliances or on counters in shops and supermarkets where customers package ready-to-eat foods for take away or home consumption
- displays in fully sealed dispensing appliances.

The demand for self service food has increased markedly and extended from smorgasbords to the retail sector eg shops, large supermarkets and total self service restaurants. Self service food benefits both consumers and the food industry: customers can select the individual food items in quantities they wish to consume, and costs are reduced as fewer staff are required.

Health authorities have reacted cautiously to self service retailing. In some States, self service retailing contravenes the provisions of existing food hygiene regulations (NFA 1994).

Authorities have generally responded with Codes of Practice which allow self service of foods under controlled conditions eg the National Food Authority Code of Practice Self-serve Takeaway Salad Bars, November 1994 (NFA 1994) or the NSW Health Department Self-Service Food Industry Advisory Code for the Hygienic Aspects of Self-Service Food in NSW, March 1995 (NFA 1994).

Self service outlets retail potentially hazardous foods containing protein ingredients such as meat, poultry, eggs, fish and dairy foods and have specific functional features which make the control of critical points difficult. Self service foods are exposed to contamination by both consumers, when serving themselves, as well as the food preparers eg via direct food handling and respiratory aerosols and droplets, reused plates and utensils and the return of unwanted or partially consumed food to displays. Time/temperature control is difficult to maintain in open display cabinets, storage may be for excessively long periods and display containers are constantly 'topped up'. The risks associated with these foods may be exacerbated by uncontrolled storage of take away foods by consumers subsequent to purchase.

The guidelines and codes produced by ANZFA (ANZFA 1996) and States (NFA 1994) specifically address the problems associated with self service food and should be implemented nationwide. As with other food suppliers, a HACCP-based approach is appropriate to identify CCPs. One way of reaching the consumer is at the point of sale or consumption by providing notices in prominent positions with warnings to consumers regarding appropriate food handling.

Staff should monitor consumer activity as well as process CCPs.

### **Temporary and mobile vendors**

Temporary and mobile vendors frequently do not have access to the facilities available to the permanent establishments for the practice of food safety. Mobile vendors do not have permanent power supplies for refrigeration and cooking and may have access only to public toilet and washing facilities. Foods retailed by these suppliers are usually ready-to-eat food prepared in advance or cooked on site. The problems of personal and kitchen hygiene and the control of temperature during preparation and storage is critical in this situation (FAO 1990).

Temporary and mobile food vendors are popular both with the local communities and tourists and should not be discouraged. Control of food safety, however, is essential.

### **Imported foods**

All food imported into Australia must comply with the requirements of the Australian Foods Standards Code. Compliance is monitored under the Imported Food Inspection Program (IFIP) by officers of AQIS. The operations of the program are defined by the Imported Food Control Act 1992 and the Imported Food Control Regulations 1993. IFIP operates on a cost recovery basis with the importers paying a documentation fee and the cost of laboratory testing.

IFIP is the subject of a memorandum of understanding (MOU) between ANZFA and AQIS. ANZFA is responsible for developing assessment policies in relation to food imported into Australia, including risk assessment and risk categorisation.

In undertaking risk assessments of imported food ANZFA identified hazards associated with particular foods and the probability of those hazards occurring. Based on these assessments, food is placed into one of three categories:

- 1 *Risk*: Food is classified as a risk food if it has potential to pose a high or medium risk to public health. High-risk foods are held by AQIS pending the outcome of testing. Medium risk may be released after inspection and sampling.
- 2 *Active surveillance*: Food for which there is insufficient data to determine the potential hazard may be put into this category for at least 6 months. At the end of this time, the results are reviewed and a decision taken to elevate the food to the risk category or remove its entry.
- 3 *Random surveillance*: All remaining imported foods are placed in this category. At any time, 5 per cent of these foods will be targeted at random by the Australian Customs Service computer for inspection, sampling and testing.

IFIP commenced with the inspection of the high-risk foods in late 1992 and became fully operational in July 1993. The active surveillance category inspections commenced in February and the random surveillance category in June 1993.

IFIP, which is a risk-based inspection program, is generally more closely aligned with the HACCP-based trends in food safety than the inspection of domestically produced food. ANZFA's proposed food hygiene standard will eventually require imported food to be produced under the same HACCP-based approach that Australian food businesses will be required to comply with. In this way all food, imported and domestically produced, will have to meet the same requirements.



# D Consumer role in preventing foodborne illness

## D.1 Introduction

Consumers have multiple roles with respect to food safety. They not only purchase and receive food products but also process and provide foods for themselves and for others. It is essential for food safety that consumers are aware of both their responsibilities towards handling and preparation of food after purchase and their entitlement to safe foods. When purchasing foods in ready-to-eat form, consumers depend fully upon the supplier of the food for the safety of the product at the time of purchase. After purchase, responsibility for storage and handling of food lies with the consumer.

Incidents such as the 1995 HUS outbreak associated with metwurst (Cameron et al 1995) and the salmonellosis outbreak in 1996 caused by *Salmonella* Mbandaka in peanut butter (Ng et al 1996), received extensive media coverage, increasing public awareness of foodborne diseases. However, these incidents occur because of a failure along the complex chain of events from the paddock to the plate, and media coverage of these failures is only one aspect of consumer education.

Consumers today are likely to be aware that not all food is contaminant free. The increasing incidence of foodborne illness is in part related to changes in patterns of food consumption and changes in food production and distribution. International trade in a wide range of food, including perishable food, has increased with a corresponding reliance on the hygiene and production standards of other, often developing, countries. In some cases, new or changed technologies are being used in food production. Consumers are also increasingly demanding 'natural' foods with reduced salt, fat and preservatives with little realisation of the effects of these changes on food stability. All these changes in themselves demand an increased awareness by consumers not only of their entitlement to receive safe food, but also their responsibilities for handling food during preparation, cooking and storage, and their participation in a system of food and safety monitoring.

## D.2 Consumer education

Consumer education programs, using the resources of the food industry and government in partnership, will be a key component in providing purchasers and consumers with the knowledge to maintain and improve food safety.

Education about foodborne diseases for the consumer in the late 1990s needs to cover:

- how to correctly handle, store or prepare foods, particularly those using new or changed technologies
- how to assess and understand the various risks of foodborne disease
- responsibilities for, and entitlements to, safe food.

An example of the partnership between the food industry and government is *Foodlink*, a national food safety campaign in the UK. *Foodlink* was developed by the UK Food and Drink Federation in association with the UK Institution of Environmental Health Officers with the aim of improving food safety at all stages in the food chain. This campaign prepared a program and developed, printed and distributed materials and resource packs including press materials to over 400 local authorities for distribution during a National Food Safety Week. The campaign was targeted at people who buy and prepare food with a key audience of women aged 25-40 years.

The food industry and government frequently rely on the skills of professionals who have the technical knowledge concerning food safety to communicate messages about food safety, generally in an uncoordinated fashion. Food safety professionals should utilise the skills of health promotion specialists and trained educators to convey information to consumers as part of coordinated national food safety programs and campaigns. The Australian Food Safety Campaign Group was established in early 1997 to develop and implement effective strategies for consumer food education. The Group is an industry led consortium with representation from the food industry, government, consumers and professional associations. Its aim is to raise the profile of food safety through a consumer mass media campaign, including an annual National Food Safety Awareness Week.

A widest possible range of forums, media and technologies should be used to convey appropriate information to consumers. For example, the UK Ministry of Agriculture, Fisheries and Food (MAFF) ran a competition open to all schools and colleges in England, Wales and Scotland aimed at encouraging an understanding of the environmental sciences and the development of communication skills. Entries were invited from classes/project teams in several age groups to design posters and public information leaflets. Cash prizes were offered to the schools for use in support of science education. The competition was advertised on the MAFF Internet home page.

Particular emphasis should be placed on food hygiene education for school children. School children are a valuable target group, not only because they are food handlers but also because they are useful agents in conveying messages to parents, particularly to those families where English is a second language. Food hygiene concepts should be introduced early in the school curriculum and then be built on progressively.

## D.3 Consumer responsibilities

Consumers are a critical final link in the food control chain to assure food quality. They have responsibilities as purchasers, storers, providers and processors of food and need to be conscious of the nature and safety of food products. Consumers therefore have a responsibility to:

- reject food they believe may be substandard
- complain to appropriate authorities when they become aware of food contamination or unsatisfactory food safety practices
- report incidents of suspected foodborne illness
- correctly and diligently handle, transport, store and prepare the foods they purchase.

Little is known about the extent of the contribution of inappropriate food handling, transport, storage and preparation by consumers to the incidence of foodborne illness in Australia.

## D.4 Consumer entitlements

It is technically possible to render all food commercially sterile before sale. Consumers, however, would find many foods treated in this manner unpalatable or otherwise unacceptable. While needing to recognise the difficulty in rendering all foods absolutely safe, consumers are entitled to expect that:

- the food industry will accept major responsibility and obligation to ensure risks to consumers are minimised
- all food purchased will be of the highest microbiological quality possible, consistent with the nature of the food
- staff involved in preparing and selling food will have been educated about how food becomes contaminated and about appropriate food hygiene control measures
- government will, by applying a well structured, adequately resourced and efficiently administered food control system, ensure that industry meets its obligation to provide safe food
- food control by government will include mechanisms which develop and maintain the necessary compliance policy to assure fair and equal application of legal sanctions and that food law will enforce the use of evidence-based strategies to reduce health risk in the population
- they will have access to information enabling them to assess the performance of government agencies with responsibility for food control

- government agencies will actively seek information on consumers complaint about foodborne illness and provide contact points and readily accessible information about the authority responsible for the investigation of complaints, and consequently act in response to the information supplied
- comprehensive and uniform reporting and data analysis of notifications of foodborne disease will be undertaken, and sources will be traced and effective controls implemented
- they will be informed, clearly and objectively, of the risk associated with consuming particular foods and the likely magnitude so they can make informed choices about risk-taking behaviours
- they will be given access to information enabling them to buy, transport, store, prepare and serve the particular foods they purchase in a manner which ensures they are able to consume safe foods.

Greater collaboration and co-ordination of activities between government agencies with carriage of food, consumer and public health issues is essential if consumer entitlements and expectations are to be met.

ANZFA has a critical role in developing uniform food hygiene standards and model food legislation. These will form the framework in which to build a culture where all stakeholders, including consumers, actively contribute to food safety.

## **E List of submissions received from consultations**

Aboriginal and Torres Strait Islander Commission, General Manager

ACT Department of Health, General Manager, Public Health Division

Campbell, Ms M

Cleaves, Mr N

CSIRO Division of Food Science and Technology, Program Manager, Food Safety and Hygiene

Dairy Industry Quality Centre, Victoria, Director

Department of Community and Health Services, Tasmania, Director of Environmental and Public Health

Education Department of Western Australia, Director-General

Flinders Medical Centre, Director, Department of Microbiology and Infectious Diseases

Health Department of Western Australia, Director of Environmental Health

Institute of Medical and Veterinary Science, South Australia

La Trobe University, Victoria, Faculty of Science and Technology

New South Wales Nurses' Association, General Secretary

Queensland Department of Health, Environmental Health Branch

Queensland Livestock and Meat Authority, General Manager

Royal Australian College of Obstetricians and Gynaecologists, President

Royal Brisbane Hospital, Queensland, Director of Microbiology

Royal College of Nursing, Australia, Executive Director

Royal College of Pathologists of Australasia, Honorary Secretary



## List of abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AHC	Animal Health Committee
ANZFA	Australia New Zealand Food Authority
ANZFAAC	Australia New Zealand Food Authority Advisory Committee
AFSIN	Australian Food Safety Information Network
APSU	Australian Paediatric Surveillance Unit
AQIS	Australian Quarantine and Inspection Service
CAST	Council for Agricultural Science and Technology
CDC	Centres for Disease Control and Prevention
CDNANZ	Communicable Disease Network Australia New Zealand
CDSC	Communicable Disease Standing Committee
CDI	Communicable Diseases Intelligence
DPIE	Department of Primary Industries and Energy
EHEC	Enterohaemorrhagic <i>Escherichia coli</i> (EHEC)
EHO	Environmental Health Officer
FAO	Food and Agriculture Organization
GMP	Good Manufacturing Practice
GCA	Grains Council of Australia
HUS	Haemolytic Uraemic Syndrome
HC	Haemorrhagic Colitis
HACCP	Hazard Analysis Critical Control Point
IFIP	Imported Food Inspection Program
ISO	International Standard Organisation
MAFF	Ministry of Agriculture, Fisheries and Food
MDU	Microbiological Diagnostic Unit
MIC	Meat Industry Council
MOU	Memorandum of Understanding
MRC	Meat Research Council

MRL	Maximum Residue Limit
NAHIS	National Animal Health Information System
NCDC	National Centre for Disease Control
NCEPH	National Centre for Epidemiology and Population Health
NCDSS	National Communicable Diseases Surveillance Strategy
NEPSS	National Enteric Pathogen Surveillance Scheme
NFDOSS	National Foodborne Disease Outbreak Surveillance System
NHAC	National Health Advisory Committee
NHMRC	National Health and Medical Research Council
NNDSS	National Notifiable Disease Surveillance System
NPHP	National Public Health Partnership
NRFR	National Review of Food Regulation
NSSS	National Salmonella Surveillance Scheme
PHLN	Public Health Laboratory Network
PHLS	Public Health Laboratory System
PRDC	Pig Research and Development Corporation
QA	Quality Assurance
SCARM	Standing Committee on Agriculture and Resource Management
SLT/SLTEC	Shiga-like toxin produced by <i>Escherichia coli</i>
SRSV	Small round structured virus
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation
WTO	World Trade Organisation



# Glossary

ARMCANZ	The Agriculture and Resource Management Council of Australia and New Zealand consists of the Australian Federal, State/Territory and New Zealand Ministers responsible for agriculture, soil, water (both rural and urban) and rural adjustment policy issues.
AHC	An industry funded body established to monitor Australia's animal disease status and advise on policy for its surveillance and control.
Antecedent diarrhoea	A previous history of diarrhoea.
ANZFA	Commonwealth statutory authority, previously National Food Authority (NFA). Makes recommendations on the development, variation and review of food standards. Aims to protect public health and safety, provide information to consumers, prevent fraud and deception, and promote fair trading in food and consistency between domestic and international food standards.
ANZFAAC	Advisory body to ANZFA. Advises on issues such as establishment and review of food standards, and food safety education and regulations pertaining to food.
Australian Customs Service	Commonwealth organisation responsible for regulating the import and export of goods into and out of Australia
AFSIN	A computer network established by the Australia New Zealand Food Authority to facilitate exchange of information throughout Australia relating to food incidents and recalls.
Australian Food Standards Code	The code produced by the Australia New Zealand Food Authority that specifies the standards for which food sold in Australia must comply.
APSU	A surveillance unit established under the Australian College of Paediatrics with the objectives of facilitating national, active prospective surveillance of selected rare paediatric diseases.
AQIS	An operating group within the Department of Primary Industries and Energy, responsible for quarantine, export certification, and the <i>Imported Food Control Act 1992</i> .

Botulism	A disease of humans and animals caused by <i>Clostridium botulinum</i> , characterised by acute bilateral cranial nerve impairment and descending weakness or paralysis.
Campylobacteriosis	An acute bacterial enteric disease of variable severity caused by <i>Campylobacter</i> species, usually characterised by diarrhoea, abdominal pain, malaise, fever, nausea and vomiting
Case-control study	A study that compares the history of exposure to a suspected risk factor between people who exhibit symptoms (cases) and control group (no symptoms) matched to cases in such respects as age and sex.
CDC	A USA authority that complements State and local health authorities to identify and control disease outbreaks, conduct research and provide education on treatment and prevention of disease.
Cholera	An acute bacterial disease caused by <i>Vibrio cholerae</i> serogroup 01, characterised in its severe form with sudden onset, profuse painless watery stools, occasional vomiting, and in untreated cases, rapid dehydration, acidosis, circulatory collapse, hypoglycaemia in children, and renal failure.
Cohort	A designated group of persons who are followed or traced over a period of time.
Commensal	An organism that lives harmlessly in the gut or on another body surface.
CDNANZ	Commonwealth body with representatives from Commonwealth, State/Territory health agencies and other Government and research bodies. Its aims are to improve surveillance and management of communicable diseases, develop policy recommendations and train public health staff.
CCP	A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.
Cryptosporidiosis	A parasitic infection of humans and animals caused by <i>Cryptosporidium</i> species. The major symptom is diarrhoea. Infection may be particularly severe in those with HIV/AIDS where the disease has a prolonged and fulminant course, contributing to death.
DPIE	A Commonwealth government department whose aim is to contribute to the sustainable, competitive growth of Australia's resource based industries.

EHEC	Strains of <i>E. coli</i> that produce a shiga-like toxin (also known as verotoxin) and have the ability to cause haemorrhagic colitis or haemolytic uraemic syndrome.
Electron microscopy	A form of microscopy which provides magnification great enough to detect virus particles in human/animal tissues.
EHO	An officer authorised by local or State Government to administer various public health legislation including food safety and quality legislation.
FAO	An international organisation belonging to the World Health Organisation responsible for promoting equivalency in international food and agriculture policies and regulations.
Foodborne illness	Stated to occur when a case or cases of illness are caused by the consumption of food containing infectious, toxic or chemical agents.
Giardiasis	A parasitic infection caused by <i>Giardia</i> species, while often asymptomatic, may be associated with a variety of intestinal symptoms, such as chronic diarrhoea, steatorrhoea, abdominal cramps, bloating, frequent loose and pale greasy stools, fatigue and weight loss.
GMP	A standard of manufacturing practice that ensures a safe and effective product for the customer. A set of guidelines, rules and regulations make up the Australian Code of Good Manufacturing Practice.
GCA	The industry organisation represents the interests of Australian grain growers.
Guillain-Barre syndrome	A neurological condition characterised by the onset of acute paralysis caused by an immune-mediated attack on the myelin sheath of peripheral nerves.
HUS	An acute renal condition of children defined by the presence of haemolytic uraemia, thrombocytopenia and renal failure. The syndrome may occur subsequent to infection with a wide variety of organisms including <i>Escherichia coli</i> serotypes, <i>Shigella</i> , <i>Salmonella</i> , <i>Campylobacter</i> , <i>Yersinia</i> and enteroviruses.
HC	Inflammation of the colon characterised by haemorrhage of its lining.
HACCP	A system which identifies, evaluates and controls hazards that are significant for food safety.

Hepatitis A	An infection of the liver caused by hepatitis A virus. Usually characterised by an acute onset of fever, malaise, anorexia, nausea and abdominal discomfort, followed within a few days by jaundice. Most often a mild illness of 1-2 week duration. Many infections are asymptomatic, particularly in children. Severe illness is rare.
IFIP	Under the <i>Imported Food Control Act 1992</i> , all food imported into Australia must comply with the <i>Australia New Zealand Food Standards Code</i> . AQIS is responsible for the IFIP, but under a memorandum of understanding with the Australia New Zealand Food Authority, the latter is responsible for determining risk policy to ensure the safety of imported food.
Incubation period	The time period between invasion (or consumption in the case of food) by an infectious agent and the appearance of the first sign or symptom of the disease in question.
ISO 9000	International Standard Organisation 9000 series; a standard dealing with quality systems that can be used for external quality assurance purposes.
Listeriosis	A bacterial disease caused by <i>Listeria monocytogenes</i> and usually manifested as meningoencephalitis and/or septicaemia in newborns and adults and abortion in pregnant women.
MRL	The maximum concentration of a residue, resulting from use of an agricultural chemical, that is recommended to be legally permitted or recognised as acceptable in or on food, agricultural commodity, or animal feed.
MIC	Peak body representing the interests of the red meat (beef and sheep meat) industry.
MRC	Peak research body advising on and administering appropriate research in the red meat (beef and sheep meat) industry.
MDU	A laboratory situated within the University of Melbourne, Victoria with prime responsibility for public health microbiology in Victoria.
MAFF	United Kingdom government department responsible for agriculture, fisheries and food.
Morbidity	Any departure, subjective or objective, from a state of physiological or psychological well-being.
Mortality rate	The estimate of the proportion of a population that dies during a specified period.

Mycotoxin	A toxin produced by certain types of fungi.
NAHIS	An Australian national surveillance system based on passive reports of disease which covers 21 endemic diseases and 15 exotic diseases in animals.
NCDC	A branch within the Public Health Division of the Commonwealth Department of Health and Family Services with the responsibility for policy and management in response to national communicable diseases of public health importance.
NCEPH	The National Centre for Epidemiology and Population Health is a national centre based at the Australian National University, Canberra that undertakes policy-relevant research into public health, with a particular emphasis on classical epidemiology.
NCDSS	A strategy initiated by the chief health officers of Australia and coordinated by the National Centre for Disease Control that aims to reduce the social and economic impact of communicable diseases in Australia, through the provision of a national framework to monitor communicable diseases and to plan and prioritise interventions.
NEPSS	A scheme/central data base, designed, instigated and operated by the Microbiological Diagnostic Unit, for the notification of enteric pathogens including <i>Salmonella</i> , <i>Shigella</i> , <i>Yersinia</i> and <i>Vibrio</i> species as well as specific serotypes of <i>E. coli</i> .
NFDOSS	A proposed national surveillance scheme that will systematically document and analyse reports of foodborne disease outbreaks at local and State and Territory level in order to determine the causes of and the food vehicles and contributing factors responsible for foodborne disease outbreaks, trends in disease, the effectiveness of interventions and the detection of new threats to food safety.
NHMRC	The National Health and Medical Research Council is a statutory authority within the portfolio of the Commonwealth Minister for Health and Family Services that advises the Australian community and Commonwealth, State and Territory Governments on standards of individuals and public health, and supports research to improve these standards.

NNDSS	A surveillance system conducted under the auspices of the Communicable Disease Network Australia New Zealand which coordinates the national surveillance of more than 40 communicable diseases or disease groups that are notified to States and Territories under the provisions of their respective public health legislations.
NPHP	The National Public Health Partnership is a working arrangement between the Commonwealth Department of Health and Family Services and State/Territory health agencies that plans, coordinates and provides a strategic approach to public health activities within Australia.
Notifiable disease	A disease that, by statutory requirements, must be reported to a public health authority in the pertinent jurisdiction when the diagnosis is made.
Paddock to plate	A concept relating to and extending through all levels of the food production chain, originating at its beginnings with on farm production, encompassing all stages of manufacturing and processing, and ending at the point of consumption of the product by the consumer.
Pathogen	An agent, eg a bacterium or virus, capable of causing disease in humans or animals.
Phage type	A virus capable of infecting and lysing bacteria - bacterial strains can be characterised by their patterns of resistance or susceptibility to a standard set of phages. Phage typing is used to further differentiate strains of a particular serotype, eg <i>Salmonella</i> Enteritidis phage type 4, and <i>Escherichia coli</i> 0157:H7.
Point-source outbreak	An outbreak of disease due to exposure of a group of persons to a noxious influence that is common to the individuals in the group. When the exposure is brief and essentially simultaneous, the resultant cases all develop within one incubation period of the disease.
Population-based study	The observation of a population for a sufficient amount of time to generate reliable incidence or mortality rates in the population subsets.

PHLN	The Public Health Laboratory Network is a collaborative group of laboratories nominated by State and Territory health departments. They have expertise in public health microbiology and are major providers of public health laboratory services. The aim of the PHLN is to provide strategic advice, define priorities and share expertise at the national level in order to enhance the national capacity for the laboratory based surveillance of communicable diseases in Australia.
QA	Programs/schemes which, through a set of standards and maintenance of production documentation, allows certification the quality of a product produced under the scheme.
Reiter's Syndrome	A disease syndrome characterised by one or more of urethritis, arthritis, uveitis and lesions of the skin and mucous membranes and occurring in a small percentage of genetically predisposed individuals after suffering from either sexually transmitted urethritis or bacterial gastroenteritis, for example after infections with <i>Salmonella</i> , <i>Shigella</i> , <i>Yersinia</i> and <i>Campylobacter</i> species.
Salmonellosis	A bacterial disease caused by a range of <i>Salmonella</i> , usually characterised by acute enterocolitis, sudden onset of headache, abdominal pain, diarrhoea, nausea and sometimes vomiting.
Sentinel sites	A site such as a medical practice that undertakes to maintain surveillance for and report certain specific predetermined events, such as cases of certain communicable diseases.
Serotype, serovar	A serological type - a type distinguishable on the basis of antigenic components, and used in the subclassification of certain micro-organisms such as <i>Salmonella</i> and <i>Shigella</i> species.
Serotyping	A technique to determine the antigenic components of bacterium, used in bacterial typing.
SLT/SLTEC	A toxin (also known as verotoxin) expressed by certain strains of <i>E. coli</i> , <i>Shigella</i> and other bacteria that contributes to the pathogenicity of these organisms.
Shigellosis	Disease caused by <i>Shigella</i> bacteria, usually consisting of diarrhoea, accompanied by fever, nausea and sometimes toxæmia, vomiting and cramps.
SRSV	A category of viruses within the family <i>Caliciviridae</i> capable of causing viral gastroenteritis in man eg Norwalk-like virus.

SCARM	Committee of senior officials from Commonwealth, State/Territory and New Zealand departments of agriculture and resource management.
Subtyping	A process, which tests for/uses one or more biological properties to further differentiate between similar types of bacteria.
Surveillance	Continuous analysis, interpretation and feedback of systematically collected data, generally using methods distinguished by their practicality, uniformity and rapidity rather than by accuracy or completeness.
Toxoplasmosis	A parasitic infection caused by <i>Toxoplasma gondii</i> which is often asymptomatic or present as an acute disease with only lymphadenopathy, or one resembling infectious mononucleosis, with fever, lymphadenopathy and lymphocytosis persisting for days or weeks. Disease may be particularly severe among immunosuppressed hosts, including those with HIV/AIDS. Cerebral toxoplasmosis is a frequent component of AIDS.
Transmissibility	The ability of an infectious agent to spread from a source or reservoir to another person.
Typhoid	A systemic bacterial disease caused by <i>Salmonella Typhi</i> and characterised by insidious onset of sustained fever, severe headache, malaise, anorexia and constipation more commonly than diarrhoea (in adults). Many mild and atypical infections occur.
Vehicle	The mode of transmission of an infectious agent from its reservoir to a susceptible host. This can be person-to-person, food or vector-borne.
World Health Organisation	An independent body of the United Nations comprising representatives from most countries who meet on a regular basis to discuss matters relating to international health. It is the single directing and coordinating authority on international health. Its objective is the attainment of the highest possible level of health by all citizens.
WTO	The organisation that sets world trade policies/measures and reviews technical barriers to trade to provide a framework for managing trade in agricultural products internationally.

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Yersiniosis	An acute bacterial enteric disease caused by <i>Yersinia pseudotuberculosis</i> or <i>Y. enterocolitica</i> and typically manifested by acute febrile diarrhoea (especially in young children), enterocolitis, acute mesenteric lymphadenitis mimicking appendicitis, sometimes complicated by post infectious arthritis and systemic infection.
Zoonosis	An infection or infestation shared in nature by man and lower vertebrate animals.



## References

- Adak GK, Cowden JM, Nicholas S et al 1995, The Public Health Laboratory Service National Case-Control Study of primary indigenous sporadic cases of *Campylobacter* infection, *Epidemiology and Infection*, vol 115, pp15–22.
- Altekruse SF, Swerdlow DL 1996, The changing epidemiology of foodborne diseases, *The American Journal of the Medical Sciences*, vol 311(1), pp23–9.
- Animal Health in Australia 1993, Office of the Chief Veterinary Officer, AGPS, Canberra.
- Archer DL, Kvenberg JE 1985, Incidence and cost of foodborne diarrhoeal disease in the US, *Journal of Food Protection*, vol 48, pp887-94.
- Archer DL, Young RE 1988, Contemporary issues: diseases with a food vector, *Clinical Microbiological Reviews*, vol 1, pp377–98.
- Australia New Zealand Food Authority (ANZFA) 1996, Proposal to develop a national food hygiene standard, Canberra, pp1–44.
- Baird-Parker AC 1994, Foods and microbiological risks, *Microbiology*, vol 140, pp687-95.
- Bean NH, Griffin PM 1990, Foodborne disease outbreaks in the United States, 1973–1987: pathogens, vehicles and trends, *Journal of Food Protection*, vol 53, pp804–16.
- Beers MY 1996a, *Salmonella* Enteritidis phage type 4 outbreak in South Australia, bound with Beers MY, Master of Applied Epidemiology thesis, Australian National University.
- Beers MY 1996b, Outbreak of *E. coli* O111:H- in South Australia, bound with Beers MY, Master of Applied Epidemiology thesis, Australian National University.
- Bell BP, Goldoft M, Griffin PM et al 1994, A multi state outbreak of *Escherichia coli* O157:H7 — associated bloody diarrhoea and haemolytic uraemic syndrome from hamburgers, *Journal of the American Medical Association*, vol 272, pp1349–53.
- Belongia EA, Osterholm MT, Soler JT et al 1993, Transmission of *Escherichia coli* O157:H7 infection in Minnesota child-care facilities, *Journal of the American Medical Association*, vol 269, pp863–87.
- Bernard D, Gavin A, Scott VN 1995, The application of the HACCP system to different sectors of the food industry. In: *FAO Report on Expert Technical Meeting*, Food and Nutrition Paper no 58, Vancouver 12–16 December 1994, Food and Agriculture Organization, Rome.

- Boyce TG, Swerdlow DL and Griffin PM 1995, *Escherichia coli* O157:H7 and the haemolytic-uraemic syndrome, *New England Journal of Medicine*, vol 333, pp364–8.
- Brackett ER 1992, Microbiological safety of chilled foods: current issues, *Trends in Food Science and Technology*, vol 3, pp81–5.
- Bryan FL 1980, Impact of foodborne diseases and methods of evaluating control program, *Journal of Environmental Health*, vol 40, 315-23.
- Bryan FL 1988, Risks associated with practices, procedures and processes that lead to outbreaks of foodborne diseases, *Journal of Food Protection*, vol 51, pp663–73.
- Bryan FL 1992, Hazard analysis critical control point evaluations, a guide to identifying hazards and assessing risks associated with food preparation and storage, World Health Organization, Geneva.
- Bryan FL, Doyle MP 1995, Health risks and consequences of *Salmonella* and *Campylobacter jejuni* in raw poultry, *Journal of Food Protection*, vol 58, pp326–44.
- Buzby JC, Roberts T 1995, ERS estimates US foodborne disease costs, *Food Review*, vol 18, pp37–42.
- Cameron S, Walker W, Beers M et al 1995, Enterohaemorrhagic *Escherichia coli* outbreak in South Australia associated with the consumption of mettwurst, *Communicable Diseases Intelligence*, vol 19, pp70–1.
- CAST 1994, *Foodborne pathogens, risks and consequences*, Task Force Report no 122, Council for Agricultural Science and Technology, Ames, IA.
- Codex 1993, Guidelines for the application of Hazard Analysis Critical Control Points (HACCP) system, *Codex Alimentarius*, vol 1 — Supp 1.
- Coia JE, Curnow J, Reilly WJ et al 1995, Ten year's experience of *Escherichia coli* O157 infection in Scotland (1984–1993), *Comm. Dis. Scot. Wkly Rep.*, vol 29, pp3–4.
- Cowden JM, Lynch D, Joseph CA et al 1989, Case-control study of infection with *Salmonella* Enteritidis phage type 4 in England, *British Medical Journal*, vol 299, pp771–3.
- Cowden JM, Wall PG, Adak G et al 1995, Outbreaks of foodborne infectious disease in England and Wales, 1992 and 1993, *Communicable Disease Report*, vol 5, ppR109–17.
- Cox JM 1995, *Salmonella* Enteritidis: the egg and I, *Australian Veterinary Journal*, vol 72, pp108–15.
- Coyle EF, Palmer SR, Ribeiro CD et al 1988, *Salmonella* Enteritidis phage type 4 infection, association with hens eggs, *Lancet*, vol 2, pp1295–7.

Crerar SK, Dalton CB, Longbottom HM et al 1996, Foodborne disease: current trends and future surveillance needs in Australia, *Medical Journal of Australia*, vol 165, pp672–5.

DPIE 1994, *Codes of practice and guidelines relating to food and agriculture*, Compiled by the Office of Food Safety, Department of Primary Industries and Energy (Amended 27 July 1994).

DPIE 1995, *Microbial Food Safety Issues*, Report to the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ), Department of Primary Industries and Energy, Canberra.

Elliot E, Henning P, Hogg G et al 1995, Haemolytic uraemic syndrome (HUS) in Australia 1994–95, *Communicable Diseases Intelligence*, vol 19, pp310–12.

Food and Agriculture Organization (FAO) 1990, Street foods. In: *FAO Report on Expert Technical Meeting*, Food and Nutrition Paper no 46, Jakarta, 5–9 December 1988, Food and Agriculture Organization, Rome.

Food and Agriculture Organization (FAO) 1992, *Protecting consumers through improved food quality and safety*, theme paper prepared for the international conference on nutrition 1992, Food and Agriculture Organization, Rome.

Fleissner ML, Hermann JE, Booth JW et al 1989, Role of Norwalk Virus in two foodborne outbreaks of gastroenteritis, definite virus association, *American Journal of Epidemiology*, vol 129, pp165–72.

Foegeding PM, Roberts T 1996, Assessment of risks associated with foodborne pathogens: an overview of a Council for Agricultural Science and Technology report, *Journal of Food Protection*, Supplement, pp19–23.

Fung DYC 1995, What's needed in rapid detection of foodborne pathogens, *Food Technology*, June, pp64–7.

Garner MG, Nunn MJ 1995, The Australian National Animal Health Information System, *Epidemiol. sante anim.*, vol 27, pp143–60.

Gerba CP 1988, Viral disease transmission by shellfish, *Food Technology*, vol 42, pp99–103.

Gill ON, Cubitt WD, McSwiggan DA, Watney BM, Bartlett CLR 1983, Epidemic of gastroenteritis caused by oysters contaminated with small round structured viruses, *British Medical Journal*, vol 287, pp1532–4.

Gillespie NC, Lewis RJ, Pearn JH et al 1986, Ciguatera in Australia. Occurrence, clinical features, pathophysiology and management, *Medical Journal of Australia*, vol 145, pp584–90.

- Goldwater PN, Bettelheim KA 1995, The role of enterohaemorrhagic *Escherichia coli* serotypes other than O157:H7 as causes of disease in Australia, *Communicable Diseases Intelligence*, vol 19, pp2–4.
- Grau FH 1989a, Salmonella: physiology, pathogenicity and control. In KA Buckle ed, *Foodborne microorganisms of public health significance*, Food Microbiology Group, Australian Institute of Food Science and Technology (NSW Branch), pp83–97.
- Grau FH 1989b, *Campylobacter jejuni/coli*. In KA Buckle ed, *Foodborne microorganisms of public health significance*, Food Microbiology Group, Australian Institute of Food Science and Technology (NSW Branch), pp135–51.
- Griffin PM, Tauxe RM 1991, The epidemiology of infections caused by *Escherichia coli* O157:H7, other enterohaemorrhagic *E. coli*, and the associated haemolytic uraemic syndrome, *Epidemiologic Reviews*, vol 13, pp60–98.
- Guzewich JJ, Morse DL 1986, Sources of shellfish in outbreaks of probable viral gastroenteritis: implications for control, *Journal of Food Protection*, vol 49, pp389–94.
- Hathaway S 1995, Harmonisation of international requirements under HACCP-based food control systems, *Food Control*, vol 6, pp267–76.
- Hedberg CW, Osterholm MT 1993, Outbreaks of food-borne and waterborne viral gastroenteritis, *Clinical Microbiological Reviews*, vol 6, pp199–210.
- Hedberg CW, MacDonald KL, Osterholm MT 1994, Changing epidemiology of food-borne disease: a Minnesota perspective, *Clinical Infectious Diseases*, vol 18, pp671–82.
- Henessey TW, Hedberg CW, Slutsker L et al 1996, A national outbreak of *Salmonella* Enteritidis infections from ice cream, *New England Journal of Medicine*, vol 334, pp1281–6.
- Herceg A, Oliver G, Myint H et al 1996, Annual report of the national notifiable disease surveillance system, 1995, *Communicable Diseases Intelligence*, vol 20, pp440–64.
- ILSI Europe Scientific Committee on Microbiology 1995, A scientific basis for regulations on pathogenic microorganisms in foods, *Dairy, Food and Environmental Sanitation*, vol 15, pp301–8.
- Keene WE, McAnulty JM, Hoesly FC et al 1994, A swimming-associated outbreak of haemorrhagic colitis caused by *Escherichia coli* O157:H7 and *Shigella sonnei*, *New England Journal of Medicine*, vol 331, pp579–84.
- Kraa E 1990, Oyster related food poisoning, *New South Wales Public Health Bulletin*, vol 1, p11.

- Kvenberg JE, Schwalm D, Stingfellow D 1995, The role of government in developing HACCP based food safety system. In: *FAO Report on Expert Technical Meeting*, Food and Nutrition Paper no 58, Vancouver 12–16 December 1994, Food and Agriculture Organization, Rome.
- Lane I, Baker M 1993, Are we experiencing an epidemic of *Campylobacter* infection? *Communicable Disease New Zealand*, vol 93, pp57–63.
- Latham RH, Schable CA 1982, Foodborne hepatitis at a family reunion, *American Journal of Epidemiology*, vol 115, pp640–5.
- McCall B, Strain D, Hills S et al 1996, An outbreak of *Escherichia coli* O157 infection on the Gold Coast, *Communicable Diseases Intelligence*, vol 20, pp236–9.
- MacDonald KL, O'Leary MJ, Cohen ML et al 1988, *Escherichia coli* O157:H7, an emerging gastrointestinal pathogen, results of a one-year, prospective, population-based study, *Journal of the American Medical Association*, vol 259, pp3567–70.
- McLauchlin J, Hall SM, Velani SK et al 1991, Human listeriosis and pate, a possible association, *British Medical Journal*, vol 303, pp773–5.
- March SB, Ratnam S 1986, Sorbitol-MacKonkey medium for detection of *Escherichia coli* O157:H7 associated with haemorrhagic colitis, *Journal of Clinical Microbiology*, vol 23, pp869–72.
- Meat Research Corporation 1996, *Business plan for microbial food safety key programme*, May 1996.
- Meat Research Corporation/CSIRO Division of Food Science and Technology 1996, *Microbiological quality of Australian meat*, Report CS.196, February 1996,
- Merton J, Salter K (compilers) 1995, *Review of food safety issues in horticultural products for the DPIE Food Safety Management Committee*, Department of Primary Industries and Energy, February 1995.
- Mishu B, Koechler J, Lee LA et al 1994, Outbreaks of *Salmonella* Enteritidis infections in the United States, 1985–1991, *Journal of Infectious Diseases*, vol 169, pp547–52.
- MMWR 1994, Addressing emerging infectious disease threats: a prevention strategy for the United States, *Morbidity and Mortality Weekly Report*, vol 43, pp1–18.
- MMWR 1997a, Outbreaks of *Escherichia coli* O157:H7 infection associated with eating alfalfa sprouts- Michigan and Virginia, June-July 1997, *Morbidity and Mortality Weekly Report*, vol 46, pp4–8.

- MMWR 1997b, Outbreaks of *Escherichia coli* O157:H7 infection and cryptosporidiosis associated with drinking unpasteurised apple cider - Connecticut and New York, October 1996, *Morbidity and Mortality Weekly Report*, vol 46, pp741–44.
- Mossel DAA, Drake DM 1990, Processing food for safety and reassuring the consumer, *Food Technology*, vol December, pp63–7.
- Motejemi Y, Kaferstein F, Moy G et al 1993, Contaminated weaning food, a major risk food for diarrhoea and associated malnutrition, *Bulletin of the World Health Organisation*, vol 71, pp79–92.
- Motejemi Y, Kaferstein F, Moy G et al 1995, Food technologies and public health, WHO/FNU/FOS/95.12.
- Murphy AM, Grohmann GS, Christopher PJ, Lopez WA, Davey GR, Millsom RH 1979, An outbreak of gastroenteritis from oysters caused by Norwalk virus, *Medical Journal of Australia*, vol 1, pp329–33.
- Murrell WG 1986, Microbiological safety of food in Australia, a critical overview. Part 2, *Food Technology Australia*, vol 38, pp51–8.
- National Communicable Diseases Surveillance Strategy 1996, National Centre for Disease Control, Commonwealth Department of Health and Family Services, Canberra.
- National Food Authority 1994, *Safe food handling Australia: a discussion paper on the future direction of food hygiene regulation*, AGPS, Canberra.
- National *Salmonella* Surveillance Scheme 1991, *Salmonella* surveillance, Australia, 1990 annual report, *Communicable Diseases Intelligence*, vol 15, pp352–9.
- National *Salmonella* Surveillance Scheme 1992, *Salmonella* surveillance, Australia, 1991 annual report, *Communicable Diseases Intelligence*, vol 16, pp442–7.
- National *Salmonella* Surveillance Scheme 1993, *Salmonella* surveillance, Australia, 1992 annual report, *Communicable Diseases Intelligence*, vol 17, pp394–402.
- National *Salmonella* Surveillance Scheme 1994, *Salmonella* surveillance, Australia, 1993 annual report, *Communicable Diseases Intelligence*, vol 18, pp427–35.
- National *Salmonella* Surveillance Scheme 1995, *Salmonella* surveillance, Australia, 1994 annual report, *Communicable Diseases Intelligence*, vol 19, pp618–26.
- Nelson JD 1985, Etiology and epidemiology of diarrhoeal disease in the United States, *American Journal of Medicine*, vol 78, pp76–80.
- Nemetz TG, Schotts EB Jr 1993, Zoonotic diseases. In MK Stoskopf, ed, *Fish medicine*, W.B. Saunders, Philadelphia, pp214–20.



- Ng S, Rouch G, Dedman R et al 1996, Human salmonellosis and peanut butter, *Communicable Diseases Intelligence*, vol 20, pp326.
- O'Brien JM, O'Brien SJ, Geddes AM et al 1993, Tempting fate, control of communicable disease in England, *British Medical Journal*, vol 306, pp1461–4.
- O'Hara H, Naruto H, Watanabe W et al 1983, An outbreak of Hepatitis A caused by consumption of raw oysters, *Journal of Hygiene Cambridge*, vol 91, pp163–5.
- Osawa R, Okitsu T, Morozumi H, Yamai S 1996, Occurrence of urease-positive *Vibrio parahaemolyticus* in Kanagawa, Japan, with specific reference to presence of thermostable direct hemolysin (TDH) and the TDH-related-hemolysin genes, *Applied Environmental Microbiology*, vol 62, pp 725–7.
- PHLS Salmonella Committee 1995, The prevention of human transmission of gastrointestinal infections, infestations and bacterial intoxications, *Communicable Disease Report*, vol 5, ppR158–71.
- Pointon, D 1995, Wintulichs Pty Ltd and marketing environmental disturbance, the 'Garibaldi effect', *Australian Agribusiness Review*, vol 3, pp37–50.
- Rees JH, Soudain SE, Gregson NA et al 1995, *Campylobacter jejuni* infection and Guillain-Barre syndrome, *New England Journal of Medicine*, vol 333, pp1374–9.
- Richmond Report 1990a, Retailing and wholesaling. In: *The microbiological safety of food*, Part II. Report of the United Kingdom Committee on the Microbiological Safety of Food, pp112-125, Science and Engineering Research Council, Swindon.
- Richmond Report 1990b, Manufacturing processes. In: *The microbiological safety of food*, Part 1. Report of the United Kingdom Committee on the Microbiological Safety of Food, pp59–65, Science and Engineering Research Council, Swindon.
- Roberts CL, Mshar PA, Cartter ML et al 1995, The role of heightened surveillance in an outbreak of *Escherichia coli* O157:H7, *Epidemiology and Infection*, vol 115, pp447–54.
- Roderick P, Wheeler J, Cowden J et al 1995, A pilot study of infectious intestinal disease in England, *Epidemiology and Infection*, vol 114, pp277–88.
- Rodrigue DC, Tauxe RV, Rowe B 1990, International increase in *Salmonella* Enteritidis, a new pandemic? *Epidemiology and Infection*, vol 105, pp21–7.
- SCARM 1997, *A guide to the implementation and auditing of HACCP*, SCARM Report 60, CSIRO Publishing for Standing Committee on Agriculture and Resource Management, Collingwood, Vic.

- Schuehat A, Pinner RW, Deaver K, Swaminathan B et al 1991, *Proceedings of an international conference on Listeria and Food Safety*, Association sur l'Asepsie de Production, Laval, France, pp69–73.
- Sharp JCM, Reilly WJ 1994, Recent trends in foodborne infections in Europe and North America, *British Food Journal*, vol 96, pp25–34.
- Smith JL 1994, Arthritis and foodborne bacteria, *Journal of Food Protection*, vol 57, pp935–41.
- Sockett PN 1991a, Food poisoning associated with manufactured foods in England and Wales, 1980–1989, *Communicable Disease Report*, vol 1, ppR105–R109.
- Sockett PN 1991b, The economic implications of human salmonella infection, *Journal of Applied Bacteriology*, vol 71, pp289–95.
- Sockett PN and Roberts JA 1991, The social and economic impact of salmonellosis, *Epidemiology and Infection*, vol 107, pp 335–47.
- Sockett PN, Cowden JM, Le Baigue S et al 1993, Foodborne disease surveillance in England and Wales, 1989–1991, *Communicable Disease Report*, vol 12, ppR160–173.
- Sockett PN 1995, The epidemiology and costs of diseases of public health significance in relation to meat and meat products, *Journal of Food Safety*, vol 15, pp91–111.
- St Louis ME, Morse DL, Potter ME et al 1988, The emergence of grade A eggs as a major source of *Salmonella* Enteritidis infections, new implications for the control of salmonellosis, *Journal of the American Medical Association*, vol 259, pp2103–7.
- Sumner J 1995, *A guide to food quality assurance*, M&S Food Consultants, Devoit, pp258.
- Swerdlow DL, Woodhuff BA, Brady RC et al 1992, A waterborne outbreak in Missouri of *Escherichia coli* O157 associated with bloody diarrhea and death, *Annals of Internal Medicine*, vol 117, pp812–19.
- Szabo L, Eyles M 1995a, Salmonella in the lucky country, *Microbiology Australia.*, vol 16, pp10–11.
- Szabo L, Eyles M 1995b, Poultry production and human health. A review for the Chicken Meat Research and Development Council.
- Tappero JW, Schuchat A, Deaver KA et al 1995, Reduction in the incidence of human listeriosis in the United States - effectiveness of prevention efforts, *Journal of the American Medical Association*, vol 273, pp1118–22.
- Todd ECD 1992, Foodborne disease in Canada — 10 year summary from 1975 to 1984, *Journal of Food Protection*, vol 55, pp123–32.

- Todd ECD 1996, Worldwide surveillance of foodborne disease, the need to improve, *Journal of Food Protection*, vol 59, pp82–92.
- Victorian Fisheries 1996, Department of Natural Resources and Environment 1988?, *A seafood value-adding and quality assurance strategy*, September, 1996.
- Wall PG, McDonnell RJ, Adak GK et al 1996, General outbreaks of vero cytotoxin producing *Escherichia coli* in England and Wales from 1992 to 1994, *Communicable Disease Report*, vol 6, ppR26–33.
- WHO 1988a, *Health education in food safety*, WHO/EHE/FOS/88.7, World Health Organization, Geneva.
- WHO 1988b, *Salmonellosis control, the role of animal and product hygiene*, WHO Technical Report Series no 774, World Health Organization, Geneva.
- WHO 1990, Selected Mycotoxins: Ochratoxins, Trichothecenes, Ergot (1990) Environmental Health Criteria, No. 105, World Health Organization, Geneva.
- WHO 1995, *Hazard analysis critical control point system, concept and application*, Report of a consultation, 29–30 May 1995, WHO/FNU/FOS/95.7, World Health Organization, Geneva.
- WHO 1996, Enterohaemorrhagic *Escherichia coli* infection, *WHO Epidemiology Bulletin*, Summ. 26–30 August 1996, World Health Organization, Geneva.
- Wright J 1996, Gastrointestinal illness, what are the causative pathogens? *Communicable Disease New Zealand*, vol 3, pp9–11.
- Zemanovic S (compiler) 1994, *Review of food safety issues in grains and grain products for the DPIE Food Safety Management Committee*, Food Safety Branch AQIS, Department of Primary Industries and Energy, December 1994.

