Foodborne disease outbreaks in Australia, 1995 to 2000

Craig B Dalton,[1] Joy Gregory,[2] Martyn D Kirk,[3] Russell J Stafford,[4] Rod Givney,[5] Ed Kraa,[6] David Gould[7]

Abstract

Health agencies are increasingly conducting systematic reviews of foodborne disease outbreak investigations to develop strategies to prevent future outbreaks. We surveyed state and territory health departments to summarise the epidemiology of foodborne disease outbreaks in Australia from 1995 to 2000. From 1995 through 2000, 293 outbreaks were identified, with 214 being of foodborne origin. One hundred and seventy-four (81%) had a known aetiology, and accounted for 80 per cent (6,472/8,124) of illnesses. There were 20 deaths attributed to foodborne illness. Of the 214 outbreaks, bacterial disease was responsible for 61 per cent of outbreaks, 64 per cent of cases and 95 per cent of deaths. The most frequent aetiology of outbreaks was *Salmonella* in 75 (35%) outbreaks, *Clostridium perfringens* in 30 (14%), ciguatera toxin in 23 (11%), scombrotoxin in 7 (3%) and norovirus in 6 (3%). Salmonellosis was responsible for eight of the 20 (40%) deaths, as was *Listeria monocytogenes*. Restaurants and commercial caterers were associated with the highest number of outbreak reports and cases. Outbreaks in hospitals and aged care facilities were responsible for 35 per cent of deaths. The most frequently implicated vehicles in the 173 outbreaks with known vehicles were meats 64 (30%), fish 34 (16%), seafood 13 (6%), salad 12 (6%), sandwiches 11 (5%) and eggs 9 (4%). Chicken, the most frequently implicated meat, was associated with 27 (13%) outbreaks. This summary demonstrates the serious nature of foodborne disease and supports the move to risk-based food safety interventions focusing on mass catering and hospital and aged care facilities. *Commun Dis Intell* 2004;28:211–224.

Keywords: foodborne disease, disease outbreaks, surveillance, Salmonella, Campylobacter, hepatitis A, *Clostridium perfringens*, ciguatera toxin, *Staphylococcus aureus, Listeria monocytogenes, Bacillus cereus, Escherichia coli, Shigella,* norovirus, toxoplasma, scombroid

Background

Foodborne disease is a significant cause of morbidity and mortality throughout the world.[1] Contaminated food causes serious outbreaks that can result in significant societal costs. In addition, outbreaks have major implications for the food industry through lost earnings, lawsuits and damaged consumer confidence.[2,3]

Many countries systematically review outbreaks to develop strategies to prevent foodborne illness.[3,4] These reviews allow health agencies to identify high-risk foods, hazardous food processing procedures, and pathogens commonly associated with foodborne disease outbreaks. Summary findings can then be translated into policy to reduce foodborne disease. In the United States of America, reviews of outbreak data led to changes in the recommendations about eating undercooked eggs and hamburgers and the development of processing standards for ready to eat foods.[5,6,7]

In Australia, doctors notify foodborne disease outbreaks to state and territory health departments under state public health laws.[8] Members of the public, local government authorities and other agencies may voluntarily report foodborne outbreaks. Health agencies use standard techniques to investigate these outbreaks, and summarise the results for historical and legal purposes.[9] Health agencies only publish the results of a very small proportion of these investigations, making summary reviews more important.

1. Public Health Physician, Hunter Population Health, Wallsend, New South Wales
2. Epidemiologist, OzFoodNet Victoria, Department of Human Services, Melbourne, Victoria
3. Coordinating Epidemiologist, OzFoodNet, Department of Health and Ageing, Canberra, Australian Capital Territory
4. Epidemiologist, OzFoodNet Queensland, Queensland Health, Archerfield, Queensland
5. Director, Communicable Disease Control Branch, Department Human Services, Adelaide, South Australia
6. Safe Food Production NSW, PO Box A2613, Sydney South, New South Wales
7. Senior Environmental Health Officer, Communicable Diseases Unit, Queensland Health, Brisbane, Queensland

Corresponding author: Dr Craig Dalton, Public Health Physician, Hunter Population Health, University of Newcastle, Locked Bag 10, Wallsend NSW 2287. Telephone: +61 2 4924 6477. Facsimile: +61 2 4924 6490. Email: craig.dalton@hunter.health.nsw.gov.au

There have been several reviews of foodborne disease outbreaks in Australia, although their accuracy and completeness has varied considerably.[10–12] Until the establishment of the OzFoodNet program in 2000, there had been no systematic collection of national foodborne disease data.[13,14] The objective of this study was to summarise the epidemiology of foodborne disease outbreaks in Australia from 1995 to 2000, as background to the OzFoodNet initiative.

Methods

Identification of outbreaks

We surveyed state and territory health departments in 1998, 2000 and 2002 to elicit summary information on confirmed and suspected outbreaks in their jurisdiction from January 1995 to December 2000. Medline searches were conducted using the keywords Australia, foodborne disease, food poisoning, outbreak, and the specific pathogens (*Salmonella, Campylobacter*, hepatitis A, *Clostridium perfringens*, ciguatera toxin, *Staphylococcus aureus, Listeria monocytogenes, Bacillus cereus,* enterohaemorrhagic *Escherichia coli, Salmonella* Typhi, *Shigella, Vibrio,* Norwalk virus, toxoplasma, scombroid); state and commonwealth health agency bulletins, conference proceedings of the Australian Society of Microbiology, the Public Health Association, and the Communicable Diseases Network Australia were reviewed to identify any other foodborne outbreaks.

For each outbreak, health department staff completed a survey form that identified the pathogen, date and setting of outbreak, number of cases, number of fatalities, the attack rate among those consuming the implicated food, the mode of transmission, the type of study and whether food microbiology was positive. We provided a dummy outbreak report as an example to guide respondents in the use of the form.

Definition of foodborne outbreak

An outbreak was defined as foodborne if two or more people experienced a similar illness after sharing a common food or meals. However, for some settings and pathogens further analytical epidemiological and/or microbiological evidence was required. For example, outbreaks occurring in an institution required epidemiological or microbiological evidence of foodborne transmission to be included as a foodborne outbreak. For outbreaks due to hepatitis A, *Shigella* or *Giardia*, which are more commonly transmitted person-to-person in Australia, epidemiological and/or microbiological evidence was required for inclusion regardless of the setting. For outbreaks due to pathogens that are more commonly associated with foodborne transmission such as *Salmonella, Campylobacter, Staphylococcus aureus, Bacillus cereus* and *Clostridium perfringens*, and fish toxins such as scombrotoxin and ciguatoxin, that occurred after common foods or meals were shared, only epidemiological (or microbiological) evidence was required to identify that the outbreak was foodborne. However, the specific food vehicle responsible for the outbreak did not have to be identified.

Clusters of seemingly unrelated cases of *Salmonella* of a common subtype clustered in time and place were not included unless a particular food vehicle or a particular meal was implicated through investigation. If the pathogen was unknown, epidemiological evidence implicating a specific food vehicle was required. Waterborne outbreaks were not included in this summary. Where health department summary outbreak forms provided inadequate information, we contacted outbreak investigators or reviewed departmental reports to determine the evidence of foodborne disease transmission.

Classification of food vehicle and outbreak settings

Vehicles were grouped into a hierarchical classification system for food vehicle types. We adapted the food classification system used in the Centers for Disease Control and Prevention Electronic Foodborne Outbreak Reporting System (EFORS) (personal communication, Alana C Sulka, March 2002). Vehicles were coded into four levels of classification. For example, level one foods include broad food groups such as dairy, meat, fish, seafood and eggs. Level two breaks the foods into a second level such as cheese (dairy), beef (meat), herring (fish), crab (seafood) and egg sauces (eggs). Levels three and four became increasingly more specific.

Common Australian foods that were not in this system were added where relevant, such as pork rolls, which featured a number of times as vehicles for transmission in outbreaks. These were defined as level 1—sandwiches; level 2—sandwich, red meat based, and level 3—sandwich pork. The ‘soups and sandwiches’ descriptor used in EFORS was separated to reflect separate meal types, as there is no reason to combine these food types in an Australian setting.

Food vehicle groupings were presented as level 1 except where meats were broken down to level 2, oysters were shown as a level 2 subset of seafood, and fruit juice was shown as a level 3 subset of ‘non-dairy beverages’.

A coding system was used for classifying the settings where outbreaks occurred. We looked separately at where the food was prepared and where the food was eaten as the former more accurately reflects, where possible, food handling errors may have occurred. Most of the settings definitions are self evident. Restaurants included cafes and meals served in hotels where patrons sat down to eat. Take-away included milk bars and fast food outlets. Commercial caterer was defined as a setting in which food was produced for a special function or group (e.g. wedding and airlines) either in a private function room or at a location distant from the commercial caterer's kitchen. Contaminated primary produce was defined as food that routinely underwent no further processing before consumption. Commercial manufactured food was defined as foods that were prepared by large commercial processing groups and widely distributed.

Data management and analysis

Summary information was entered into Epi Info 6.04b and analysed in Epi Info 2002 and Excel 2000. The number of foodborne disease outbreaks per capita by state or territory were calculated using 1998 Australian Bureau of Statistics population projections.[15]

Results

Participation and response

There were 293 outbreak reports for the six-year period. Of these, 214 outbreaks were due to foodborne transmission and were included in the analysis. Seventy-nine outbreaks were excluded from analysis. For 78 outbreaks there was no epidemiological association with a food source, including:

- 37 outbreaks of unknown aetiology;
- 15 outbreaks of viral aetiology (mostly noroviruses);
- 5 bacterial outbreaks (4 of *Salmonella* and 1 of *Campylobacter*) in institutional settings;
- 6 outbreaks that were suspected person-to-person transmission including 3 *Shigella* outbreaks, two parasitic outbreaks and one hepatitis A outbreak;
- 10 waterborne outbreaks; and
- 5 *Salmonella* clusters.

One foodborne outbreak was excluded because the cases were infected while travelling overseas.

Time and state or territory of outbreak

From 1995 through 2000, there were 214 outbreaks of gastroenteritis of foodborne origin resulting in 8,124 cases. More outbreaks were reported annually during the data collection period from 1998–2000 compared to the retrospective collection of the 1995–1997 data (Table 1). Victoria and New South Wales recorded the highest number of outbreaks during the six-year period, the average number of outbreaks per million population by jurisdiction for the six-year period was highest in the Northern Territory, South Australia and Victoria. There were six multistate outbreaks resulting in 945 cases. Outbreaks were more frequently reported in the warmer months of October through March (Figure) predominantly due to the higher incidence of *Salmonella* outbreaks in these months. One hundred and seventy-four (81%) outbreaks had a known aetiology and these outbreaks accounted for 79 per cent (6,472/8,124) of illnesses (Table 2). The median number of cases for foodborne outbreaks was 17 (range 2 to 862). There were 20 deaths associated with the outbreaks, equating to a fatality rate of 0.3 per cent.

Figure. Seasonality of all foodborne disease and *Salmonella* outbreaks, 1985 to 2000

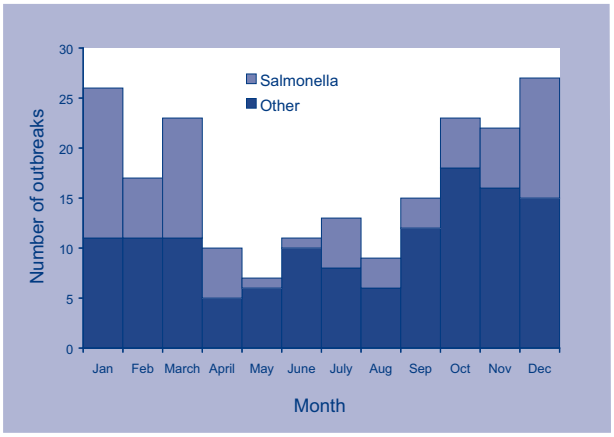

Table 1. Foodborne disease outbreaks and number of people affected, 1995 to 2000, by state or territory and year

		1995	1996	1997	1998	1999	2000	Total 1995–2000	Average annual reports per million population 1995–2000
New South Wales	Cases	71	144	475	226	422	216	1,554	41
	Outbreaks	5	6	10	11	8	8	48	1
Victoria	Cases	–	69	1,213	358	669	325	2,634	95
	Outbreaks	–	2	11	19	24	17	73	3
Queensland	Cases	–	564	–	119	189	127	999	48
	Outbreaks	–	4	–	3	14	12	33	2
South Australia	Cases	97	173	89	378	543	60	1,340	150
	Outbreaks	2	3	4	7	4	5	25	3
Western Australia	Cases	4	–	59	146	72	151	432	39
	Outbreaks	1	–	3	8	2	6	20	2
Tasmania	Cases	–	32	–	15	–	–	47	17
	Outbreaks	–	1	–	1	–	–	2	1
Australian Capital Territory	Cases	26	–	–	–	–	23	49	26
	Outbreaks	1	–	–	–	–	1	2	1
Northern Territory	Cases	–	–	20	43	5	56	124	108
	Outbreaks	–	–	1	2	1	1	5	4
Australia*	Cases	362	1,243	2,322	1,339	1,900	958	8,124	72
	Outbreaks	11	18	30	52	53	50	214	2

* Six multi-state outbreaks and 945 associated cases were only included in the total for Australia hence the annual columns for each state or territory do not sum to the total for Australia.

Aetiological agent

Of the 214 outbreaks, bacterial disease was responsible for 61 per cent of outbreaks, 64 per cent of cases and 95 per cent of deaths (Table 2). Most frequent were non-typhoidal salmonellae in 75 (35%) outbreaks, *Clostridium perfringens* in 30 (14%), ciguatera toxin in 23 (11%), scombrotoxin in 7 (3%), and norovirus in 6 (3%). *Campylobacter* spp. and *Listeria monocytogenes* were responsible for only 6 (3%) and 5 (2%) outbreaks respectively. Salmonellosis was responsible for eight of the 20 (40%) deaths, as was *Listeria monocytogenes*. Enterohaemorrhagic *E. coli* was responsible for two deaths, and *C. perfringens* and hepatitis A, one death each.

The largest outbreaks were 862 cases of illness associated with Asian-style pork rolls in Victoria in 1997 in which *Salmonella* Typhimurium phage type 1 was confirmed as the aetiological agent,[16] 502 cases of illness in South Australia in 1999, associated with unpasteurised orange juice in which *Salmonella* Typhimurium phage type 135A was confirmed as the aetiological agent (personal communication, Ingrid Tribe, SA Department of Human Services, May 2004) and 466 cases of hepatitis A in New South Wales in 1998, associated with oysters.[17]

Fourteen different serotypes of *Salmonella* were responsible for foodborne outbreaks, with serotype Typhimurium responsible for 49 (65%) of all *Salmonella* outbreaks and 2,716 (66%) of all *Salmonella* cases. The most common phage types of *S.* Typhimurium were phage type 135 (16 outbreaks, 1,014 cases); phage type 9, (13 outbreaks, 454 cases); and phage type 64 (4 outbreaks, 81 cases). *S.* Virchow was the second most common serotype responsible for eight outbreaks, with phage type 34 accounting for seven outbreaks (78 cases). The following serotypes were also implicated: Chester (4 outbreaks, 62 cases); Bredeney (2 outbreaks, 183 cases); Heidelberg (2 outbreaks, 507 cases); Mbandaka (2 outbreaks, 175 cases). Serotypes Anatum, Bareilly, Brandenburg, Hessarek, Mississippi, Muenchen, Oranienburg, and Saintpaul each caused one outbreak with a total of 248 cases ranging from two to 102 cases per outbreak.

Table 2. Foodborne disease outbreaks, cases, and deaths, Australia, 1995 to 2000, by aetiology (% of total)

Aetiology	Outbreaks		Cases		Deaths		Median number of cases per outbreak	Range
	n	%	n	%	n	%		
Bacterial	131	61	5,356	64	19	95	17	2–862
Salmonella	75	35	4,123	51	8	40	18	2–862
Clostridium perfringens	30	14	787	10	1	5	25	2–171
Campylobacter spp.	6	3	136	2	–	–	14	4–74
Listeria monocytogenes	5	2	41	<1	8	40	5	4–23
Staphylococcus aureus	5	2	78	<1	–	–	13	2–33
Bacillus cereus	2	1	28	<1	–	–	14	4–24
Enterohaemorrhagic *E. coli*	3	1	35	<1	2	10	6	6–23
Salmonella Typhi	1	0.5	4	<1	–	–	–	–
Shigella	2	1	42	<1	–	–	–	13–29
Streptococcus pyogenes	1	0.5	72	<1	–	–	–	–
Vibrio cholerae non O1, non O139	1	0.5	10	<1	–	–	–	–
Viral	8	4	780	10	1	5	40	10–466
Norovirus	6	3	297	4	–	–	40	10–97
Hepatitis A	2	<1	483	6	1	5	–	17–466
Protozoal (toxoplasma)	1	0.5	12	<1	0		–	–
Chemical	34	16	324	4			6	2–56
Ciguatera	23	11	179	2	–	–	5	2–33
Scombroid	7	3	34	<1	–	–	4	3–9
Dinophysis species	2	1	78	<1	–	–	–	22–56
Wax ester (escolar)	2	1	33	<1	–	–	–	14–19
Unknown	40	19	1,652	20	0		28	5–200
Total	214	100	8,124	100	20	100	17	2–862

Setting of outbreaks

Setting of food preparation

Ninety-four per cent (202/214) of outbreaks were associated with food prepared commercially or in settings other than private residences. Restaurants were associated with the highest number of outbreak reports and commercial caterers with the highest number of cases (Table 3).

The median number of cases per outbreak was much higher for commercial caterers (30 cases), take-away (23 cases) and commercially manufactured food (17 cases) than for restaurants (13 cases) reflecting the relative scale of production in these industry sectors. Aged care and hospital settings were responsible for 35 per cent of deaths despite being associated with only five per cent of outbreaks and less than three per cent of cases. There were seven deaths among 231 (3%) cases in aged care and hospital settings compared to 13 deaths among 5,297 cases (0.3%) in other settings in which deaths occurred.

Table 3. Foodborne disease outbreaks, cases, and deaths, Australia, 1995 to 2000, by setting prepared (% of total)

Setting prepared	Outbreaks		Cases		Deaths		Median number of cases per outbreak	Range
	n	%	n	%	n	%		
Restaurants	60	28	1,084	13	4	20	13	3–96
Commercial caterer	43	20	2,264	28	1	5	30	5–500
Contaminated primary produce	34	16	996	13	2	10	8	2–466
Take-away non franchised	17	8	1,397	17	–	–	23	2–862
Commercial manufactured food	14	7	967	12	5	25	17	2–502
Private residence	12	6	237	3	–	–	16	4–55
Aged care institution	8	4	167	2	4	20	22	4–37
Institution not elsewhere specified	5	2	304	4	–	–	72	17–85
Camp	4	2	252	3	–	–	22	9–200
Fair, festival, other temporary/mobile service	4	2	125	2	1	5	20	12–74
Hospital	3	1	64	<1	3	15	13	5–46
School	3	1	188	2	–	–	74	24–90
Grocery store/deli/ supermarket	3	1	24	<1	–	–	8	6–10
Military institution	1	<1	8	<1	–	–	–	–
Contaminated imported food	1	<1	17	<1	–	–	–	–
Other	1	<1	3	<1	–	–	–	–
Unknown	1	<1	27	<1	–	–	–	–
Total	214	100	8,124	100	20	100	17	2–862

Setting of food consumption

The setting where people consumed the implicated food was usually the same as where the food was prepared. The exception was where foods were purchased from a take-away store, a grocery store, delicatessen, or a supermarket. Foods contaminated in a commercial manufacturing setting or where the food was grown, were also consumed elsewhere. Foods prepared in settings where consumption occurred elsewhere resulted in 39 outbreaks and 3,288 cases in the community, and 37 outbreaks and 398 cases clustered in private residences.

Implicated food vehicles

A food vehicle was implicated in 173 (81%) of the 214 outbreaks. The most frequent vehicles were meats 64 (30%), fish 34 (16%), seafood 13 (6%), salad 12 (6%), sandwiches 11 (5%), desserts 9 (4%) and eggs 9 (4%) (Table 4). Chicken was the most frequently implicated meat and was associated with 27 (13%) outbreaks. Fish was the next most common cause of outbreaks but it was responsible for a relatively smaller number of cases as most were small outbreaks of ciguatera poisoning. When all outbreaks containing foods in which egg was the main high-risk ingredient were collated, a total of 16 potentially egg-associated outbreaks were identified. *Salmonella* was the aetiological agent for 14 of the 16 potentially egg-associated outbreaks. Salad, egg, dessert, and sandwich (pork roll) associated outbreaks tended to result in higher numbers of cases per outbreak. Seventy per cent (565/803) of cases attributed to seafood outbreaks were due to oyster consumption in the Wallis Lake oyster outbreak responsible for 446 cases of hepatitis A.[17]

Selected food vehicles, aetiological agents and settings combinations

Meats, particularly chicken were associated with 33 per cent of *Salmonella* and 60 per cent of *C. perfringens* outbreaks (Table 5). Restaurants, commercial caterers, and take-away settings were associated with 61 per cent of *Salmonella* outbreaks (Table 6). Meats were associated with a significant number of outbreaks across a range of settings (Table 7).

Table 4. Foodborne disease outbreaks, cases, and deaths, Australia, 1995 to 2000, by vehicle of transmission (% of total)

Vehicle	Outbreaks		Cases		Deaths		Median number of cases per outbreak	Range
	n	%	n	%	n	%		
Meats	64	30	1,846	23	7	35	17	2–200
Chicken	27		899		3		21	2–171
Beef	9		313		1		15	2–200
Pork	4		126		–	–	26	15–60
Lamb	2		16		–	–	–	4–12
Processed meats-consumed cold	6		97		2		16	8–24
Other meats*	16		395		1		20	4–85
Fish	34	16	281	4	–	–	6	2–33
Seafood	13	6	803	10	1	5	22	2–466
Oysters	3		565		1		97	2–466
Salads	12	6	587	7	3	15	29	4–176
Sandwiches	11	5	1,321	16	1	5	42	11–862
Eggs	9	4	773	10	–	–	36	7–500
Desserts	9	4	439	6	–	–	45	8–102
Grains	5	2	178	2	–	–	37	24–48
Dairy	5	2	81	1	–	–	12	9–27
Specialty/ethnic dishes	5	2	46	<1	1	5	6	3–24
Soup	2	<1	80	<1	–	–	–	13–67
Fruit	2	<1	60	<1	1	5	–	6–54
Vegetables	1	<1	54	<1	–	–	–	–
Fruit juice	1	<1	502	6	–	–	–	–
Miscellaneous	37	17	1,004	13	6	30	10	3–164
Unknown	4	2	69	<1	–	–	17	10–26
Total	214	100	8,124	100	20	100	17	2–862

* Includes meats in above categories that may be mixed together and meats not in above categories, or where type of meat was not known.

Discussion

This is the most comprehensive summary of foodborne outbreaks in Australia since the publication of a summary from 1980 to 1995 by Crerar, *et al.*[11] Crerar's 16 year summary identified 128 outbreaks—an average of eight outbreaks per year and six deaths in 15 years. Our collection of outbreaks identified 214 outbreaks over six years and 20 deaths—an average of 36 outbreaks per year and an average of 52 outbreaks during the contemporaneous collection from 1998 to 2000. We believe this reflects an improvement in the documentation of outbreaks due to improved availability of records and better recollection of more recent outbreaks. It is unlikely to be due to increased diagnostic capability as primary identification methods for the most common aetiological agents in this review have not changed substantially during this period. This highlights the importance of contemporaneous reporting of outbreaks in a standardised format. The new OzFoodNet outbreak surveillance system facilitates such reporting but this must be well supported at the local and state level.[14]

This summary of outbreaks contains some important information for policy makers involved in preventing foodborne illnesses. These data suggest a need for initiatives in commercial catering and aged care and hospital catering settings and for special attention to be given to particular high risk foods.

Table 5. Foodborne disease outbreaks and number of people affected, Australia, 1995 to 2000, by selected aetiological agents and food vehicle implicated

	Aetiological agent																			
	Salmonella				*Clostridium perfringens*				Norovirus				*Campylobacter*				Unknown			
	Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases	
Vehicle	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Meats	25	33	658	17	18	60	572	73	1	17	96	32	1*	17	4	3	11	28	401	24
Chicken	10		335		6		312		1		96		–	–	–	–	6		112	
Beef	4		67		2		32		–	–	–	–	–	–	–	–	3		214	
Pork	2		37		1		29		–	–	–	–	–	–	–	–	1		60	
Lamb	–	–	–	–	2		16		–	–	–	–	–	–	–	–	–	–	–	–
Processed meats–consumed cold	4		61		–		–	–	–	–	–	–	–	–	–	–	–	–	–	–
Other meats†	5		158		7		183		–	–	–	–	–	–	–	–	1		15	
Eggs	8	11	701	17	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sandwiches	7	9	1,205	29	–		–	–	–	–	–	–	–	–	–	–	3	8	103	6
Desserts	6	8	254	6	–		–	–	1	17	51	17	–	–	–	–	2	5	134	8
Fruit	2	3	60	1	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seafood	2	3	14	< 1	2	7	76	10	2	33	111	37	–	–	–	–	1	3	27	2
Dairy	1	1	12	< 1	1	3	27	3	–	–	–	–	3	50	42	31			–	–
Fish	1	1	26	< 1	–	–	–	–	–	–	–	–	–	–	–	–	1	3	9	< 1
Fruit juice	1	1	502	12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Salads	1	1	21	< 1	–	–	–	–	–	–	–	–	1	17	74	54	8	20	459	28
Vegetables	1	1	54	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Specialty/ethnic dishes	–	–	–	–	2	7	32	4	–	–	–	–	–	–	–	–	1	3	5	< 1
Grains	–	–	–	–	–	–	–	–	1	17	29	10	–	–	–	–	3	8	125	8
Soups	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	5	80	5
Miscellaneous	18	24	573	14	6	20	70	9	1	17	10	3	–	–	–	–	8	20	309	19
Unknown	2	3	43	1	1	3	10	1	–	–	–	–	1	17	16	12	–	–	–	–
Total	75	100	4,123	100	30	100	787	100	6	100	297	100	6	100	136	100	40	100	1,652	100

* Poultry.

† Includes meats in above categories that may be mixed together and meats not in above categories, or where type of meat was not known.

Table 6. Foodborne disease outbreaks and number of people affected, Australia, 1995 to 2000, by selected aetiological agents and setting where the food was prepared

Setting Prepared	Aetiological agent																			
	Salmonella				*C. perfringens*				Norovirus				*Campylobacter*				Unknown			
	Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Restaurants	19	25	395	10	8	27	89	11	3	50	120	40	2	33	20	15	15	38	336	20
Commercial caterer	16	21	992	24	9	30	388	49	2	33	80	27		–	–	–	14	35	754	46
Contaminated primary produce	6	8	164	4		–	–	–	1	17	97	33	1	17	12	9	–	–	–	–
Take-away non-franchised	11	15	1,316	32		–	–	–	–	–	–	–	–	–	–	–	2	5	59	4
Commercial manufactured food	10	13	933	23	2	3	2	< 1	–	–	–	–	–	–	–	–	–	–	–	–
Private residence	4	5	26	< 1	2	7	63	8	–	–	–	–	–	–	–	–	2	5	74	5
Aged care	2	3	25	< 1	5	17	138	18	–	–	–	–		–	–	–	–	–	–	–
Institution not elsewhere specified	1	1	85	2	1	3	56	7	–	–	–	–	1	17	74	54	1	3	17	1
Camp	1	1	22	< 1	–	–	–	–	–	–	–	–	2	33	30	22	1	3	200	12
Fair, festival, other temporary/ mobile service	2	3	101	3	2	7	24	3	–	–	–	–	–	–	–	–	–	–	–	–
Hospital	1	1	46	1	–	–	–	–	–	–	–	–	–	–	–	–	1	3	13	< 1
School	–	–	–	–	1	3	24	3	–	–	–	–	–	–	–	–	2	5	164	11
Grocery store/deli/supermarket	2	3	18	< 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Military institution	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	8	< 1
Contaminated imported food	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Other	–	–	–	–	1	3	3	< 1	–	–	–	–	–	–	–	–	–	–	–	–
Unknown	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	27	2
Total	75	100	4,123	100	30	100	787	100	6	100	297	100	6	100	136	100	40	100	1,652	100

Table 7. Foodborne disease outbreaks and number of people affected, Australia, 1995 to 2000, by food vehicle and selected settings where the food was prepared

Vehicle	Setting																					
	Restaurant				Take-away				Commercial caterer				Commercial manufactured food				Private residence				Hospital/aged care			
	Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases		Outbreaks		Cases	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Meats	20	33	372	34	6	35	203	15	11	26	499	22	8	57	105	11	6	50	94	40	3	27	105	46
Chicken	10		242		6		203		5		314		2	14	14	2	2		38		1		32	
Beef	2		23		–	–	–	–	2		89		2	14	17	2	2		38		1		37	
Pork	1		15		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1		36	
Lamb	1		4		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Processed meats–consumed cold	–	–	–	–	–	–	–	–	1		23		3	21	51	5	1		13		–	–	–	–
Other meats*	6		88		–	–	–	–	3		73		1	7	23	2	1		5		–	–	–	–
Eggs	2	3	96	9	–	–	–	–	4	9	580	26	–	–	–	–	–	–	–	–	2	18	25	11
Sandwiches	–	–	–	–	5	29	1,096	79	3	7	84	4	1	7	78	8	–	–	–	–	1	9	46	20
Desserts	2	3	84	8	3	18	68	5	2	5	111	5	1	7	102	11	–	–	–	–	–	–	–	–
Fruit	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seafood	3	5	51	5	–	–	–	–	1	2	43	2	2	14	16	2	1	8	33	14	–	–	–	–
Dairy	–	–	–	–	–	–	–	–	1	2	27	1	–	–	–	–	–	–	–	–	–	–	–	–
Fish	9	15	72	7	–	–	–	–	1	2	26	1	–	–	–	–	1	8	4	2	–	–	–	–
Fruit juice	–	–	–	–	–	–	–	–	–	–	–	–	1	7	502	52	–	–	–	–	–	–	–	–
Salads	3	5	61	6	–	–	–	–	4	9	347	15	–	–	–	–	2	17	74	31	1	9	4	2
Vegetables					–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grains	1	2	48	4	–	–	–	–	3	7	106	5	–	–	–	–	1	8	24	10	–	–	–	–
Soup	–	–	–	–	–	–	–	–	1	2	67	3	–	–	–	–	–	–	–	–	1	9	13	6
Specialty/ethnic dishes	2	3	11	1	1	6	3	< 1	–	–	–	–	–	–	–	–	–	–	–	–	1	9	8	4
Miscellaneous	16	27	256	24	2	12	27	2	10	23	338	15	1	7	164	17	1	8	8	3	2	18	30	13
Unknown	2	3	33	3	–	–	–	–	2	5	36	2	–	–	–	–	–	–	–	–				
Total	60	100	1,084	100	17	100	1,343	100	43	100	2,264	100	14	100	967	100	12	100	237	100	11	100	231	100

* Includes meats in above categories that may be mixed together and meats not in above categories, or where type of meat was not known.

High-risk settings

Outbreaks in aged-care and hospital facilities were associated with 35 per cent of all deaths. These data lend support to the recent draft National Risk Framework that prioritises catering for immune compromised people and commercial catering as high-risk settings.[12] Ensuring high-risk patients do not receive high-risk foods could prevent many of these deaths. In this review the case fatality rate was three per cent for aged care and hospital settings compared to 0.3 per cent for all foodborne outbreaks. This raises the need for urgent implementation of food safety plans in these settings. While *Listeria monocytogenes* outbreaks occur rarely, the high case-fatality rate of approximately 20 per cent highlights the need for attention, particularly in institutions where residents are immune-compromised.[18] The NSW Health Department issued a circular on listeriosis control in such settings which emphasises implementation of Hazard Analysis Critical Control Points (HACCP); separating high risk foods from high risk patients, food temperature control, and cross contamination control.[19] Policy makers and regulators should ensure that HACCP is implemented in these settings.

Commercial caterers were responsible for the largest number of cases of any setting or 27 per cent of all cases. Commercial caterers are a special risk because they prepare large volumes of food and may be required to cater in venues with inadequate cooking, storage, transport, cooling, and reheating facilities. Several aspects of commercial catering make it difficult for regulators to identify and inspect these operations. Commercial caterers may be highly mobile and prepare or serve food in different settings from week to week including private residences, leased function rooms, and public venues and their operations are often conducted on weekends. Identifying and inspecting these operations for compliance with the Food Standards Code will help ensure that appropriate facilities are used and reduce the potential for outbreaks.

High-risk foods

Food vehicles that need special attention for interventions include chicken, eggs, certain fish species, salads, seafood (particularly prawns and oysters) and sandwiches.

Chicken was the most common meat associated with outbreaks. Chicken is a commonly consumed food and needs to be produced in as safe a manner as possible. The high proportion of chicken associated outbreaks due to *Salmonella* and *Clostridium perfringens* suggest the need for efforts at the point of primary production, processing, and food preparation. Reduction of contamination at the processing level and appropriate food handling in restaurants and homes and effective cooking can reduce the risk of foodborne infection. Interventions to reduce bacterial contamination at farm and processing levels can significantly reduce human infection as has been demonstrated in Iceland and Denmark.[20,21]

Egg-based foods were commonly reported in this series of foodborne outbreaks. We cannot be certain how many of these outbreaks were due to direct contamination from the surface of eggs, from internally contaminated eggs, or contamination of an egg-based food. Nevertheless, the high proportion of egg associated outbreaks that were due to *Salmonella* suggests the need for vigilance. *Salmonella* Typhimurium phage types 9 and 135 were the predominant pathogens identified in egg-associated outbreaks. The link between eggs and outbreaks of salmonellosis has been well established in Europe and the United States of America due to transovarian transmission of infection.[22,23] There is no evidence of transovarian transmission of disease in Australia, nevertheless these data suggest that there is a need for the egg industry to monitor egg production hygiene issues closely. Additionally, control of temperature and prevention of cross contamination of eggs in processing, storage, and food preparation is extremely important. Since the compilation of these data there have been further egg-associated outbreaks, some of which were traced back to layer farms that were positive for the outbreak strain of *Salmonella.*[24] Even quite low contamination rates (e.g. < 0.01%) of eggs can pose a significant public health problem.[25]

Reef fish are a significant cause of ciguatera poisoning which causes a severe illness occasionally with a fatal outcome.[26] Better education of restaurateurs, fish wholesalers, and recreational fisherman is required to prevent the consumption of high-risk fish. Public health traceback investigations may identify specific reefs that are high risk for ciguatera. There are no suitable routine tests to detect ciguatera toxin in fish, nor can the toxin be detected in the fish by its appearance, odour, texture or taste. In general terms, the risk of poisoning is increased by consuming larger and presumably older fish, but poisoning can sometimes occur following the consumption of relatively small fish. These risks are increased for people who regularly consume fish soups using the head or viscera of smaller fish, where the toxin concentrations may be higher.

In this review seafood associated outbreaks included three oyster outbreaks (*Salmonella*, norovirus, and hepatitis A) and four prawn-associated outbreaks (hepatitis A, *C. perfringens* (2), and *Salmonella* Typhi). Hepatitis A, while rare, causes serious illness with an average of 12.5 days of work missed.[27] In this summary, the hepatitis A outbreak associated

with Wallis Lake oysters shows the potential of this disease to cause large widespread outbreaks. These outbreaks are difficult to investigate due to the long incubation period of hepatitis A.[17]

Salads were responsible for 12 outbreaks. While salads are not often considered a high-risk food the minimal post-harvest processing of salads requires good on-farm HACCP as consumers and retailers have minimal opportunity to prevent illness.[28,29]

Four outbreaks were associated with Asian-style pork rolls, a high risk food by virtue of the ingredients and method of preparation. One of these outbreaks was the largest single documented outbreak in our review with 862 cases.[16] Pork rolls include a range of high-risk foods including eggs, chicken liver pate, and pork.

Sandwiches are not usually considered a high-risk food. This perception and the use of sandwiches in mass catering—particularly where sandwiches may be stored for many hours at room temperature for convenience—may contribute to temperature abuse and subsequent food poisoning. Temperature control of sandwiches should be a high priority with a 'use by time' label to manage sandwich safety in mass catering settings.

Barriers to surveillance and limitations of outbreaks summaries

The number of outbreaks per million residents differs greatly across states and territories. This reflects differences in detection, and investigation of outbreaks, and formal systems of documentation rather than real differences in outbreak activity. This is exemplified by the disparity in outbreaks reported to the US Centers for Disease Control and Prevention from 1993 to 1995 with interstate incidence ranging from 73 outbreaks per million population to 0.65 in some years.[4] While much research is needed into the usefulness of this population-based ratio, it may be useful as a tool for evaluation of surveillance systems.[30,31] The lack of any reports from Victoria in 1995 is explained by difficulties in recall or identification of records rather than an absence of outbreaks or outbreak investigation. Victoria began to systematically record outbreaks in August 1995 (personal communication, Joy Gregory, December 2003). The prospective reporting of outbreaks to OzFoodNet from 2001 should redress these reporting disparities.

This summary is biased by patterns of reporting, analysis, investigation and laboratory testing for foodborne disease outbreaks. The number of outbreaks documented by setting is very dependent on reporting biases.[3] Patient and doctor behaviour is affected by the patient's symptoms. Patients are more likely to present to a doctor and be tested if their diarrhoeal illness lasts more than two days or involves bloody diarrhoea (personal communication, Gill Hall, October 2003). Outbreaks are more likely to be recognised and investigated where an established social, work, or familial group share a common meal—leading to greater recognition of restaurant and catered function outbreaks. The relatively smaller number of outbreaks associated with commercial manufactured food may reflect quality assurance processes in this sector. Alternatively, outbreaks due to high volume commercial products with wide distribution may have such low attack rates that a common source of illness is difficult to identify.

Patterns of laboratory testing may bias outbreak summaries leading to greater recognition of pathogens such as *Salmonella*, *Campylobacter*, and *Shigella* which are identified by routine stool cultures ordered by general practitioners. Norovirus, *C. perfringens*, *Staphylococcus aureus*, *Bacillus cereus* outbreaks are less likely to be detected because tests for these agents are not routinely ordered by general practitioners. Tests for these pathogens are usually requested by public health officials only after an outbreak with typical symptom or incubation period profile is recognised. Additionally many of these agents are only excreted in stool for a short period making detection less likely if there is a delay in stool testing.

The real time collection of outbreak summaries and enhancement of foodborne disease investigation and surveillance under OzFoodNet and advances in laboratory methods will ensure better information for food safety initiatives in the future. The number of cases and deaths are very likely an underestimate of those occurring even within the reported outbreaks as complete case ascertainment could not be confirmed and cases were not followed up to confirm recovery. Immune-compromised persons may die many weeks or months after suffering a foodborne disease, however, attributing the cause of death may be difficult.[32]

Data collected on potential factors contributing to outbreaks were not included here because of the lack of standard systems for inspection and criteria for linking inspection findings with outbreak causation. Because environmental inspections are always conducted after an outbreak, it is difficult to know if the conditions found during the inspection were associated with the outbreak.

Conclusion

The outbreaks reported here are biased by multiple layers of surveillance barriers and constitute only a small proportion of the outbreaks, cases and deaths that actually occurred. Nevertheless, food safety regulators rely on these summaries as they provide evidence of repeated failures in the system. This review highlights the major areas of concern during 1995 to 2000. During the period there were several serious and large outbreaks, causing at least 20 deaths. Clearly, this burden of illness justifies the attention given to foodborne disease and food safety in Australia.[33] There is an urgent need for Australia to prioritise initiatives for high-risk foods, high risk settings, and production methods to prevent outbreaks and sporadic disease.

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