Annual reports

Monitoring the incidence and causes of diseases potentially transmitted by food in Australia: Annual report of the OzFoodNet Network, 2006

The OzFoodNet Working Group

Abstract

In 2006, OzFoodNet sites reported 24,598 notifications of seven diseases or conditions that are commonly transmitted by food, representing an increase of 2.5% over the mean of the previous 5 years. The most frequently notified aetiological agents were *Campylobacter* (15,492 notifications) and *Salmonella* (8,331 notifications). *Salmonella* notifications increased in 2006 by 5.2% when compared to historical reports. The most common *Salmonella* serotype notified in Australia during 2006 was *Salmonella* Typhimurium, as in previous years. *S.* Saintpaul was the second most common serotype notified during 2006 as a result of a large multistate outbreak associated with rockmelons. During 2006, OzFoodNet sites reported 1,544 outbreaks of gastrointestinal illness including those transmitted by contaminated food. In total, these outbreaks affected 34,916 people and resulted in 769 people being admitted to hospital and 27 deaths. Food was suspected or confirmed as the primary cause for 115 of these outbreaks and affected 1,522 persons, hospitalised 146 persons but did not result in any deaths. *S.* Typhimurium was the most common aetiological agent in foodborne outbreaks and restaurants were the most common setting for foods implicated in foodborne outbreaks. Sixteen outbreaks were related to eggs during 2006 compared to five outbreaks in 2005. Eighty-one per cent (13/16) of these egg-associated outbreaks were due to various phage types of *S.* Typhimurium. Fresh fruits and vegetables, categorised as fresh produce were responsible for four outbreaks, all due to salmonellosis. Public health laboratories provided complete serotype and phage type information on more than 97% of all *Salmonella* notifications during 2006. Completeness of reporting for *Salmonella* was equivalent to 2005 and was essential to identifying and investigating outbreaks. This report demonstrates OzFoodNet's ability to detect and investigate the burden and causes of foodborne disease in Australia. OzFoodNet efforts assist agencies to develop food safety policy and prevent foodborne illness. *Commun Dis Intell* 2007;31:345–365.

Keywords: foodborne disease, surveillance, disease outbreak

Introduction

Foodborne illnesses are a substantial burden in Australia, with an estimated 5.4 million cases occurring annually, costing an estimated $1.2 billion dollars per year.[1] Most foodborne illnesses are mild and do not require medical attention, with the majority of cost associated with the large number of affected people taking time from work to recover or care for affected family members. There are numerous enteric pathogens commonly transmitted through food that may cause illness; only a handful of these illnesses are specifically notifiable to health departments.[2] Most foodborne illnesses are underreported in surveillance statistics collected by health departments.[3] The proportion of cases that are notified varies considerably by disease, as the severity of various illnesses differ markedly.[4,5]

Health departments use surveillance of infectious diseases for monitoring trends in illness, detecting outbreaks, and monitoring the effects of interventions.[6] The source of infection can be difficult to determine in sporadic cases of enteric diseases, that is, cases not associated with an outbreak, as they may be acquired through a variety of transmission routes including contaminated water or foods, other infected persons, animals, or other sources within the environment. In outbreaks of enteric infections, the mode of transmission is more likely to be determined, allowing development of policy to prevent further disease.[7]

In 2000, the Australian Government Department of Health and Ageing established OzFoodNet to provide national intelligence on foodborne disease.[8] OzFoodNet was modelled on the Centers for Disease Control and Prevention's FoodNet surveillance system.[9] The OzFoodNet network consists of epidemiologists employed by each state and territory health department to conduct investigations and applied research of foodborne disease. The network involves many different collaborators in addition to OzFoodNet site staff, including the National Centre for Epidemiology and Population Health and the Public Health Laboratory Network.

OzFoodNet has a member on the Communicable Diseases Network Australia, which is Australia's peak body for communicable disease control.[10] The Australian Government Department of Health and Ageing funds OzFoodNet and convenes committees to manage the network and review the scientific basis for various research projects.

This is the sixth annual report of OzFoodNet and covers data and activities for 2006.

Methods

Population under surveillance

In 2006, the coverage of the network included the entire Australian population, which was estimated to be 20,605,488 persons.[11] All states and territories in Australia (New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, the Northern Territory, and the Australian Capital Territory) participated in OzFoodNet in 2006. In addition, surveillance in New South Wales was supplemented by an additional OzFoodNet site hosted by the Hunter New England Area Health Service.

Data sources

Notified infections

All Australian states and territories require doctors and/or pathology laboratories to notify patients with infectious diseases that are important to public health. OzFoodNet aggregated and analysed data on the following seven diseases or conditions, a proportion of which may be acquired from food:

- non-typhoidal *Salmonella* infections;
- *Campylobacter* infections (except in New South Wales);
- *Listeria* infections;
- *Shigella* infections
- typhoid; and
- Shiga toxin-producing *Escherichia coli* (STEC) infections and haemolytic uraemic syndrome (HUS).

To compare notifications in 2006 to historical totals, crude numbers and rates of notification were compared with either the mean of the previous 5 years or with data from the previous year. Specific sub-types of infecting organisms were analysed using data from the National Notifiable Diseases Surveillance System (NNDSS) and OzFoodNet sites. This report used a NNDSS dataset provided in June 2007 and was analysed by the date a notification was received by a jurisdiction. Numbers and rates may vary from those in the NNDSS 2006 annual report, which used a later NNDSS dataset and was analysed by date of diagnosis. The estimated resident populations for each state or territory as at June 2006[11] was used to calculate rates of notification. Birth data from the Australian Institute of Health and Welfare, National Perinatal Statistics Unit was used to calculate the incidence of neonatal listeriosis.[12]

Gastrointestinal and foodborne disease outbreaks

OzFoodNet collected information on gastrointestinal and foodborne disease outbreaks that occurred in Australia during 2006. An outbreak of foodborne disease was defined as two or more people with a particular infection or illness associated with a common food or meal. A cluster was defined as an increase in infections that were epidemiologically related in time, place or person where investigators were unable to implicate a vehicle or determine a mode of transmission.

OzFoodNet epidemiologists collated summary information about the setting where the outbreak occurred, where food was prepared, the month the outbreak occurred, the aetiological agent, the number of persons affected, the type of investigation conducted, the level of evidence obtained, and the food vehicle responsible for the outbreak. To summarise the data, outbreaks were categorised by aetiological agents, food vehicles and settings where the implicated food was prepared. Data on outbreaks due to transmission from water or from investigation of a cluster were also summarised. The number of outbreaks and documented causes reported here may vary from summaries previously published by individual jurisdictions as these can take time to finalise.

Results

Rates of notified infections

In 2006, OzFoodNet sites reported 24,598 notifications of seven diseases or conditions that are commonly transmitted by food. This represents a 2.5% increase from the mean of 24,020 notifications for the previous 5 years. Reports of these seven diseases make up almost a fifth of the notifications to the NNDSS.[2] A summary of the number and rate of notification of these is shown in Table 1.

Salmonella infections

In 2006, OzFoodNet sites reported 8,331 cases of *Salmonella* infection, a crude rate of 40.4 cases per 100,000 population. The 2006 rate was a 5.2% increase over the mean of the previous 5 years (Table 1). Notification rates ranged from 27.6 cases per 100,000 population in Victoria to 193 cases per 100,000 population in the Northern Territory,

Table 1. Number of notified cases, rate and 5-year mean rate per 100,000 population of potentially foodborne diseases, Australia, 2001 to 2006, by disease and state or territory

Disease		State or territory								
		ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Aust
Salmonella	Notified cases, 2006	125	2,081	399	2,749	574	193	1,406	804	8,331
	Rate, 2006	38.0	30.5	193.0	67.8	36.9	39.5	27.6	39.2	40.4
	Mean rate, 2001–2005	26.9	29.9	187.2	65.7	35.3	37.5	25.2	37.3	38.4
Campylobacter	Notified cases, 2006	414	*	272	4,006	2491	598	5,710	2001	15,492
	Rate, 2006	125.9	*	131.6	98.8	160.2	122.3	112.1	97.6	112.4
	Mean rate, 2001–2005	122.0	*	123.0	106.5	155.8	136.9	116.0	113.9	118.5
Listeria	Notified cases, 2006	1	24	0	3	5	0	13	13	59
	Rate, 2006	0.30	0.35	0.00	0.07	0.32	0.00	0.26	0.63	0.29
	Mean rate, 2001–2005	0.37	0.33	0.10	0.34	0.24	0.29	0.28	0.44	0.32
Typhoid	Notified cases, 2006	0	32	3	6	2	1	18	12	74
	Rate, 2006	0.00	0.47	1.45	0.15	0.13	0.20	0.35	0.59	0.36
	Mean rate, 2001–2005	0.19	0.43	0.20	0.21	0.20	0.08	0.34	0.42	0.33
Shigella	Notified cases, 2006	2	74	123	98	38	4	77	136	552
	Rate, 2006	0.61	1.08	59.5	2.42	2.44	0.82	1.51	6.63	2.68
	Mean rate, 2001–2005	1.12	1.53	65.3	2.11	2.57	0.75	1.56	5.91	2.77
Shiga-like toxin-producing *E. coli*	Notified cases, 2006	0	13	2	15	37	0	3	3	73
	Rate, 2006	0.0	0.2	1.0	0.4	2.4	0.0	0.1	0.1	0.4
	Mean rate, 2001–2005	0.00	0.08	0.00	0.23	2.23	0.08	0.10	0.23	0.29
Haemolytic uraemic syndrome	Notified cases, 2006	0	15	0	0	1	0	1	0	17
	Rate, 2006	0.00	0.22	0.00	0.00	0.06	0.00	0.02	0.00	0.08
	Mean rate, 2001–2005	0.00	0.10	0.30	0.03	0.12	0.08	0.05	0.03	0.07

* *Campylobacter* is not a notifiable disease in New South Wales.

which usually has the highest rate of salmonellosis. The male to female ratio for salmonellosis was 1:1. The highest age-specific rate of *Salmonella* infection was 203 cases per 100,000 population in males aged from 0–4 years. Notifications were also elevated for both males and females in the 5–9 year age group and in the 20–29 year age group.

In 2006, the most commonly reported *Salmonella* serotype was *S.* Typhimurium. The most commonly notified phage type was *S.* Typhimurium 135 (including *S.* Typhimurium 135a), with 751 notifications in 2006 (Table 2). *S.* Saintpaul was the second most common serotype notified in Australia and featured in the top five for all jurisdictions except South Australia. During 2006, there was a large multi-state outbreak of *Salmonella* Saintpaul associated with rockmelons, which contributed to the widespread notification of this serotype.

The highest specific rates for a single serotype were for *Salmonella* Mississippi (13.1 cases per 100,000 population) in Tasmania and *S.* Saintpaul (16 cases per 100,000 population) and *S.* Ball (15 cases per 100,000 population) in the Northern Territory.

Salmonella Enteritidis

Salmonella Enteritidis is an internationally important serotype of *Salmonella* that has caused widespread and prolonged outbreaks in the United States of America (USA) and Europe.[13,14] This serotype can infect the internal contents of eggs through the oviducts of infected chickens[15,16] but has not been associated with Australian egg layer flocks. The majority of cases in Australia are associated with overseas travel. OzFoodNet monitors the incidence of *S.* Enteritidis to detect outbreaks of locally-acquired cases.

During 2006, OzFoodNet sites reported 305 cases of *S.* Enteritidis (Table 3). Of those cases where travel status was reported, 85% (198/233) had travelled overseas and cases often reported visiting several countries. Asian countries were the most frequently reported travel destination, perhaps reflecting that these countries are common travel destinations for Australians. In the Asian region, cases of *S.* Enteritidis infection were reported after travelling to Indonesia (36, 15%), Thailand (30, 13%), and Singapore (24, 10%). The most com-

Table 2. Numbers, rates and proportions of the top 5 *Salmonella* infections, Australia, 2005 to 2006, by OzFoodNet site*

OzFoodNet site	*Salmonella* sero/phage type	2006 n	2006 rate†	Proportion‡ (%)	2005 n	2005 rate	2006/2005 ratio§
Australian Capital Territory	Saintpaul	14	4.3	11	3	0.9	4.7
	Typhimurium 135	12	3.6	10	13	4.0	0.9
	Typhimurium 170/108	11	3.3	9	14	4.3	0.8
	Typhimurium 9	7	2.1	6	10	3.1	0.7
	Typhimurium 44	7	2.1	6	4	1.2	1.8
New South Wales	Typhimurium 170/108	223	3.3	11	375	5.5	0.6
	Typhimurium 135	210	3.1	10	180	2.7	1.2
	Birkenhead	105	1.5	5	82	1.2	1.3
	Saintpaul	103	1.5	5	42	0.6	2.5
	Typhimurium 9	77	1.1	4	155	2.3	0.5
Northern Territory	Saintpaul	33	16.0	8	49	24.1	0.7
	Ball	31	15.0	8	48	23.6	0.6
	Typhimurium 135	21	10.2	5	1	0.5	21.0
	Chester	17	8.2	4	12	5.9	1.4
	Muenchen	16	7.7	4	9	4.4	1.8
	Infantis	16	7.7	4	8	3.9	2.0
Queensland	Saintpaul	267	6.6	10	274	6.9	1.0
	Virchow 8	215	5.3	8	190	4.8	1.1
	Typhimurium 135	177	4.4	6	136	3.4	1.3
	Birkenhead	154	3.8	6	128	3.2	1.2
	Aberdeen	136	3.4	5	136	3.4	1.0
South Australia	Typhimurium 135	79	5.1	14	47	3.0	1.7
	Typhimurium 170/108	62	4.0	11	36	2.3	1.7
	Typhimurium 9	58	3.7	10	57	3.7	1.0
	Infantis	37	2.4	6	48	3.1	0.8
	Anatum	22	1.4	4	6	0.4	3.7
Tasmania	Mississippi	64	13.1	33	59	12.1	1.1
	Typhimurium 135	40	8.2	21	176	36.2	0.2
	Typhimurium 170/108	15	3.1	8	7	1.4	2.1
	Typhimurium 9	15	3.1	8	10	2.1	1.5
	Saintpaul	6	1.2	3	2	0.4	3.0
Victoria	Typhimurium 135	158	3.1	11	191	3.8	0.8
	Typhimurium 9	125	2.5	9	118	2.3	1.1
	Typhimurium 44	115	2.3	8	50	1.0	2.3
	Typhimurium 170/108	100	2.0	7	63	1.3	1.6
	Saintpaul	76	1.5	5	22	0.4	3.5
Western Australia	Oranienburg	82	4.0	10	62	3.1	1.3
	Saintpaul	60	2.9	7	31	1.5	1.9
	Typhimurium 135	54	2.6	7	42	2.1	1.3
	Typhimurium 12	33	1.6	4	28	1.4	1.2
	Muenchen	31	1.5	4	30	1.5	1.0
Australia	Typhimurium 135	751	3.6	9	813	4.0	0.9
	Saintpaul	572	2.8	7	436	2.1	1.3
	Typhimurium 170/108	474	2.3	6	550	2.7	0.9
	Typhimurium 9	358	1.7	4	421	2.1	0.9
	Virchow 8	273	1.3	3	248	1.2	1.1

* Where there were multiple fifth ranking *Salmonella* types all data have been shown, giving more than five categories for some sites.

† Rate per 100,000 population.

‡ Proportion of total *Salmonella* notified for this jurisdiction in 2006.

§ Ratio of the number of reported cases in 2006 compared to the number reported in 2005.

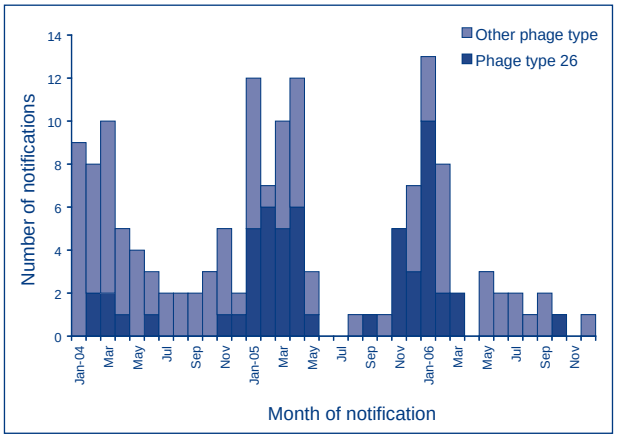
mon infecting phage types among cases who had travelled overseas were 6a (51 cases), 1 (38), 26 (37) and 4 (29). A travel history could not be determined for 24% (72/305) of cases in 2006, which was an increase from 11% (44/387) in 2005. The better reporting of travel history in 2005 may have been due to the completion of enhanced data collection in late 2005, for an OzFoodNet national study of locally-acquired *S.* Enteritidis.

Overall, 15% (35/233) of patients infected with *S.* Enteritidis acquired their infection in Australia. These 35 locally-acquired cases compares with an average of 53 cases per year for the previous 3 years. The median age of locally-acquired cases was 34 years (range 0–91 years) and 55% were male. Just over half of all locally-acquired *S.* Enteritidis cases during 2006 occurred in Queensland (57%, 20/35 cases); most of these cases were due to phage type 26 (65%, 13/20 cases). Locally-acquired *S.* Enteritidis cases continued to be highly seasonal, occurring primarily in the summer (Figure 1).

Table 3. Number of *Salmonella* Enteritidis infections, Australia, 2006, by travel history, and state or territory

OzFoodNet site	History of travel overseas			Total
	Yes	No	Unknown	
Australian Capital Territory	6	2	0	8
New South Wales	43	4	22	69
Northern Territory	6	1	3	10
Queensland	22	20	38	80
South Australia	11	2	1	14
Tasmania	4	0	0	4
Victoria	47	2	5	54
Western Australia	59	4	3	66
Total	198	35	72	305

Figure 1. *Salmonella* Enteritidis infections acquired in Australia, 2004 to 2006, by phage type and month of notification



Campylobacter infections

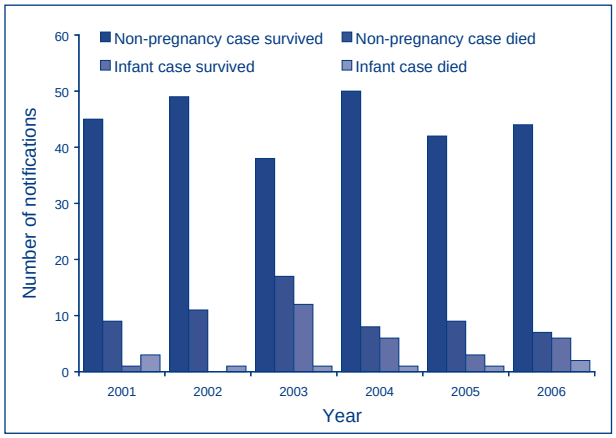
In 2006, OzFoodNet sites (excluding New South Wales) reported 15,492 cases of *Campylobacter* infection; a rate of 112.4 cases per 100,000 population. This rate was equivalent to the mean for the previous 5 years of 118.5 cases per 100,000 population (Table 1). Victoria, Queensland, Western Australia, and Tasmania all reported slight decreases in their rate of notification for 2006 compared to the mean for the previous 5 years. The lowest and highest rates of *Campylobacter* notification were in Western Australia (98 cases per 100,000 population) and in South Australia (160 cases per 100,000 population) respectively. The highest age-specific rate of notifications was in males in the 0–4 year age group (248 cases per 100,000 population) with a secondary peak in the 20–29 year age group for both males and females. Fifty-four per cent of notified cases were male.

Listeria infections

OzFoodNet sites reported 59 cases of listeriosis in 2006; a rate of 0.3 cases per 100,000 population (Table 1). The 2006 notification rate was equivalent to the 5-year historical mean (0.32 cases per 100,000 population).

Eighty-six per cent (51/59) of *Listeria* infections during 2006 were reported in non-pregnant persons, who were either elderly and/or immunocompromised. Among these non-pregnancy related cases, the male to female ratio was approximately 1:1, and 94% (48/51 were reported in persons aged 50 years or greater. Fourteen per cent (7/51) of non-pregnancy associated cases died, which was similar to previous years (Figure 2).

Figure 2. Notifications of *Listeria* showing non-pregnancy related infections and deaths, and materno-foetal infections and deaths, Australia, 2001 to 2006



Eight materno-foetal infections were reported during 2006, giving a rate of 3.1 cases per 100,000 births. New South Wales reported four cases, Western Australia reported two cases, and the Australian Capital Territory and Queensland each reported single cases during 2006. Twenty-five per cent (2/8) of infected neonates died during 2006, which was a consistent outcome reported in previous years.

Shigella infections

OzFoodNet sites reported 552 cases of shigellosis during 2006, a rate of 2.7 cases per 100,000 population (Table 1). This rate was equivalent to the mean for the previous 5 years of 2.8 cases per 100,000 population. As in previous years, the highest rate of notification was in the Northern Territory (60 cases per 100,000 population). In recent years, notification rates for shigellosis have decreased in all jurisdictions except Queensland and Western Australia. The male to female ratio of shigellosis cases was approximately 1:1.1. The highest age-specific notification rates were in the 0–4 years age group for both males (12.5 cases per population) and females (9.2 cases per 100,000 population). Mannitol negative *Shigella flexneri* 4a was the most common type reported in 2006 (Table 4). The most common *Shigella sonnei* biotypes, A and G, decreased during 2006 compared with 2005. It is estimated that approximately 10% of *Shigella* cases in Australia are due to foodborne transmission: other predominant modes of transmission of *Shigella* are overseas travel and through person-to-person transmission.[17] OzFoodNet sites did not identify any food-related outbreaks of *Shigella* during 2006.

Typhoid infections

OzFoodNet sites reported 74 cases of typhoid infection during 2006; a rate of 0.4 cases per 100,000 population (Table 1). This rate was equivalent to the mean for the previous 5 years of 0.3 cases per 100,000 population. The highest rate of typhoid was reported by the Northern Territory (1.5 cases per 100,000 population). The Australian Capital Territory reported no cases of typhoid during 2006.

Travel overseas, which is a significant risk factor for typhoid infection, was reported in 93% (68/73) of typhoid cases (Table 5). A single case (untypable) reported no overseas travel prior to their illness. Over a third of cases reporting travel overseas (27/68 cases) had travelled to India. The predominant typhoid phage types causing illness in travellers returning from India was E1 (14 cases) and E9 (5 cases).

Shiga toxin-producing Escherichia coli *infections*

OzFoodNet sites reported 73 cases of Shiga toxin producing *E. coli* (STEC) infection during 2006; a rate of 0.4 cases per 100,000 population (Table 1). The mean for the previous 5 years was 0.3 cases per 100,000 population. These numbers do not include cases of haemolytic uraemic syndrome (HUS) where an STEC organism was isolated or detected in stool samples as these are notified separately.

South Australia reported the majority of STEC cases and had the highest rate of notification at 2.4 cases per 100,000 population. South Australia continued a screening program for STEC in stools with visible blood. This accounts for the consistently high rate in South Australia compared with other jurisdictions. Other jurisdictions have also, at times, enhanced their screening programs resulting in increased notifications of STEC. The Australian Capital Territory and Tasmania reported no cases of STEC in 2006. The male to female ratio of cases was 0.8:1, similar to the ratio in 2005. The highest reported rate was for females in the 0–4 years age group (1.0 case per 100,000 population).

During 2006, *E. coli* serotype O157 was responsible for 58% (21/36) of infections where serotype information was available, compared to 39% in 2005 (Table 6). *E. coli* serotype O111 and O26 were the second most common serotype each with five cases reported. A serotype was not identified in 51% (37/73) of cases.

Table 4. Numbers, rates and proportions of the top 5 *Shigella* infections, Australia, 2005 to 2006

	2006 n	2006 Rate*	Proportion† %	2005 n	2005 Rate*	2006/2005 Ratio
Shigella flexneri 4a Mannitol negative	93	0.5	18	77	0.4	1.2
Shigella flexneri 4	82	0.4	16	46	0.2	1.8
Shigella sonnei biotype A	77	0.4	15	169	0.8	0.5
Shigella sonnei biotype G	73	0.4	14	136	0.7	0.5
Shigella flexneri 2a	53	0.3	10	78	0.4	0.7

* Rate per 100,000 population.

† Proportion of total *Shigella* notified for 2006.

Table 5. Travel status for notified typhoid cases acquired overseas, Australia, 2006

Country/region	Number of cases	Predominant phage type (# cases)
Asia	1	Degraded (1)
Bali	1	Unknown (1)
Bangladesh	8	D6 (1), E9 (3), degraded (1), untypable (1), unknown (2)
China	1	25 (1)
Ghana	1	A (1)
India	24	A1 (1), E1 (14), E9 (3), K1 (1), 51 (1), untypable (3), unknown (1)
India/other	3	E9 (2), O variant (1)
Indonesia	12	D2 (1), E2 (2), degraded (2), untypable (5), unknown (2)
Kenya	2	E1 (2)
Lebanon	1	D1 (1)
Nepal	1	E9 (1)
Pakistan	6	E1 (2), E9 (1), 38 (1), untypable (1), unknown (1)
Papua New Guinea	1	D2 (1)
Philippines	1	A (1)
Samoa	1	E variant (1)
Thailand	3	E9 (2) M1 (1)
Vietnam	1	Unknown (1)
Unknown	5	A(2), degraded (2), untypable (1)

Haemolytic uraemic syndrome

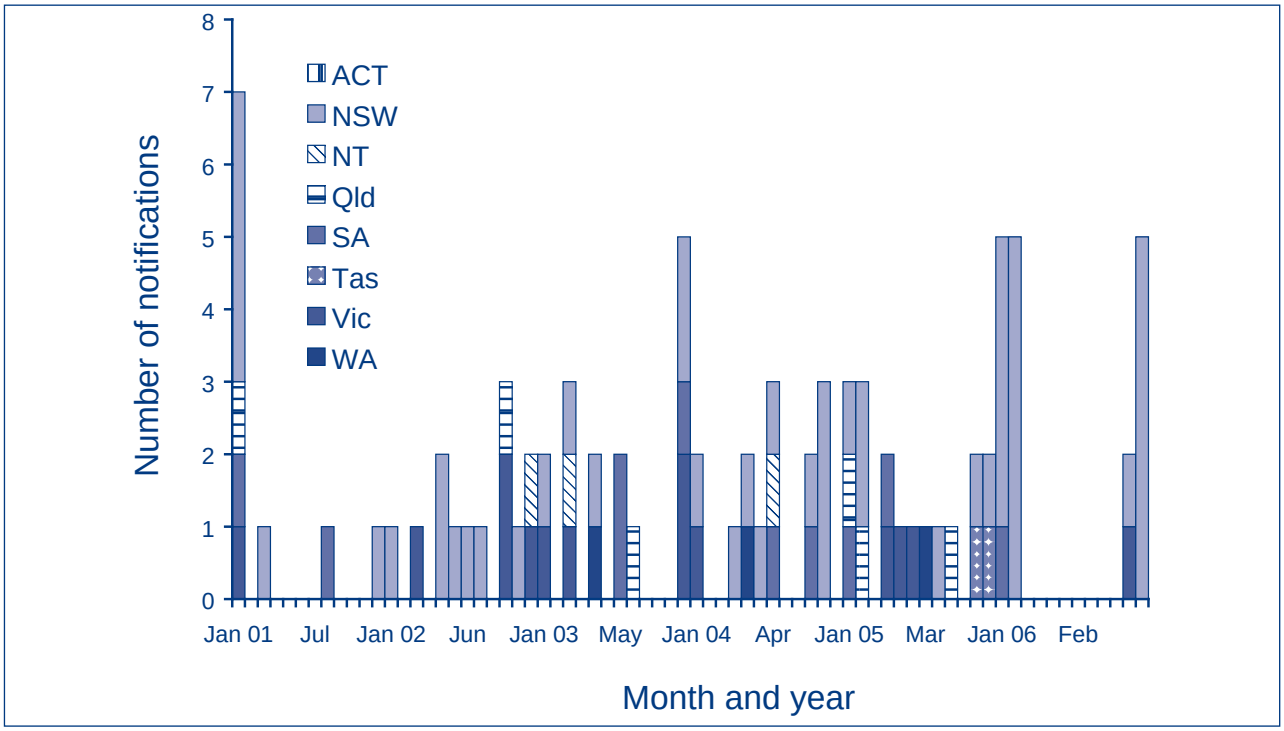
OzFoodNet sites reported 17 cases of haemolytic uraemic syndrome reported during 2006; a rate of 0.08 cases per 100,000 population (Table 1). This was the same number and a comparable rate to that reported in 2005 (Figure 3). New South Wales notified 15 cases, and Victoria and South Australia each reported a single case. Nine of the cases (53%) were female. The median age of HUS cases was 9 years and the age range was 1.2 to 81.4 years. The highest rate of notification was in males aged 0–4 years with a rate of 0.5 cases per 100,000 population. Sites reported that STEC was detected in the faeces of five HUS cases but a serotype was reported for one case from New South Wales (STEC O55).

The 15 HUS cases reported from New South Wales were part of two identified clusters from January/February and November/December 2006 (Figure 3). Enhanced surveillance and active case finding in renal units and children's hospitals may account for the observed increase in HUS cases in NSW. These cases were investigated initially by New South Wales public health units and then re interviewed by OzFoodNet staff to determine whether there were any links between cases. No common links or risk factors for infection were identified during these investigations.[18] OzFoodNet sites did not identify any cases of HUS between March and October 2006.

Table 6. Number of notified cases of Shiga toxin-producing *Escherichia coli*, Australia, 2006, by serotype, and state or territory

Serotype	State						Total
	NSW	NT	Qld	SA	WA	Vic	
O157	2	0	3	14	1	1	21
O111	1	0	3	1	0	0	5
O26	2	0	1	2	0	0	5
O113	0	0	1	0	0	0	1
O55	1	0	0	0	0	0	1
O153	0	0	0	0	1	0	1
Mixed infection	0	0	0	0	0	2	2
Unknown	7	2	7	20	1	0	37
Total	13	2	15	37	3	3	73

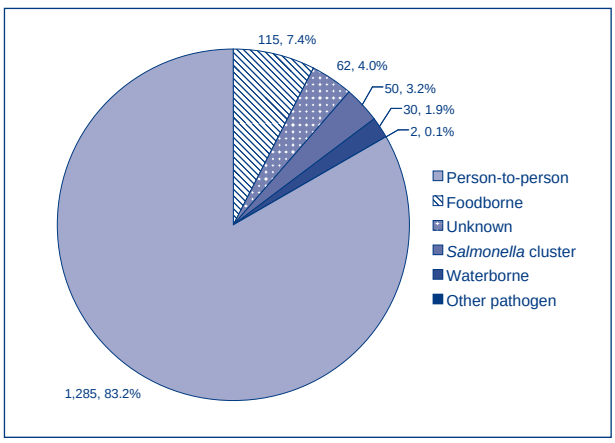
Figure 3. Numbers of notified cases of haemolytic uraemic syndrome, Australia, 2001 to 2006, by state or territory



Gastrointestinal and foodborne disease outbreaks

During 2006, OzFoodNet sites reported 1,544 outbreaks of gastrointestinal illness. These outbreaks affected 34,916 people and resulted in 769 people being admitted to hospital and 27 deaths. Person-to-person transmission was the mode of transmission for 83% (1,285/1,544) of outbreaks (Figure 4) and accounted for 92% (32,155/34,916) of all persons affected by outbreaks including 27 deaths.

Figure 4. Foodborne and gastroenteritis outbreaks (*n*=1544) reported by OzFoodNet sites, Australia, 2006, by mode of transmission



Sixty per cent (777/1,285) of outbreaks associated with person-to-person transmission occurred in aged care facilities, while 20% (259/1,285) and 13% (167/1,285) occurred in hospital and child care settings, respectively. Fifty per cent (636/1,285) of person-to-person outbreaks were caused by norovirus, while 29% (370/1,285) were of unknown aetiology and 10% (132/1,285) were suspected to be due to a viral pathogen. *Cryptosporidium* and rotavirus were each responsible for 3% of person-to-person outbreaks (36/1,285 and 35/1,285, respectively).

There were 16 outbreaks of mixed infections. These outbreaks were due to norovirus in addition to other viral pathogens such as rotavirus, adenovirus, astrovirus, and non-viral pathogens such as *Campylobacter*, *Clostridium difficile*, and *Giardia*.

In 2006, OzFoodNet sites also investigated 30 outbreaks of recreational waterborne illness. These outbreaks affected 169 people, with no hospitalisations. All of these outbreaks occurred in Victoria and all were associated with swimming pools contaminated by *Cryptosporidium*.

Foodborne disease outbreaks

In 2006, there were 115 foodborne disease outbreaks giving an overall rate of 5.6 outbreaks per million population. These outbreaks affected 1,522 persons, hospitalised 146 persons but did not result in any deaths (Appendix 1).

New South Wales reported the largest number of outbreaks (38%, 44/115) (Table 7). The reporting rates of foodborne outbreaks for different OzFoodNet sites ranged from two outbreaks per million population in Tasmania to 14.5 outbreaks per million population in Northern Territory. The majority of outbreaks occurred in summer and autumn (Figure 5).

Aetiological agents

The most common agent responsible for foodborne disease outbreaks was *Salmonella*, which caused 36% (41/115) of outbreaks (Table 8). *S.* Typhimurium was responsible for 61% (25/41) of foodborne *Salmonella* outbreaks.

Figure 5. Outbreaks of foodborne disease, Australia, 2006, by selected aetiological agents and month of notification

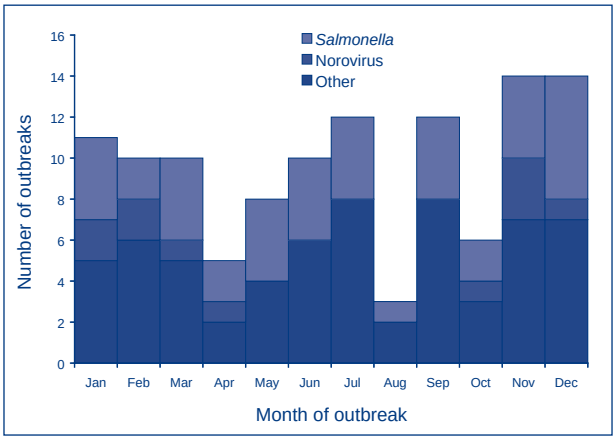


Table 7. Outbreaks of foodborne disease in Australia, 2006, by OzFoodNet site

State or territory	Number of outbreaks	People affected	Mean size (persons)	Hospitalised	Outbreaks per million population
Australian Capital Territory	3	27	9	1	9.1
New South Wales	44	496	11	65	6.4
Northern Territory	3	26	9	5	14.5
Queensland	28	403	14	23	6.9
South Australia	7	65	9	8	4.5
Tasmania	1	9	9	2	2.0
Victoria	21	293	14	18	4.1
Western Australia	5	92	18	4	2.4
Multi-state	3	111	37	20	n/a
Total	115	1,522	13	146	5.6

Table 8. Aetiological agents responsible for foodborne disease outbreaks, number of outbreaks and persons affected, Australia, 2006

Agent category	Number of outbreaks	People affected	Mean size (people)	Hospitalised	Hospitalisation rate
Bacillus cereus	1	14	14	0	0.0
Campylobacter spp.	4	67	17	4	6.0
Ciguatera	7	30	4	8	26.7
Clostridium perfringens	6	199	33	0	0.0
Hepatitis A	1	10	10	1	10.0
Histamine	4	12	3	7	58.3
Norovirus	11	369	34	4	1.1
Salmonella Typhimurium	25	258	10	76	29.5
Salmonella other	16	209	13	31	14.8
Staphylococcus aureus	1	3	3	0	0.0
Sodium nitrite	1	6	6	6	100.0
Vibrio cholerae	1	3	3	2	66.7
Unknown	37	342	9	7	2.0
Total	115	1,522	13	146	9.6

Eleven of the 19 outbreaks of illness due to toxins in 2006 were related to contaminated fish. Outbreaks of ciguatera fish poisoning (7 outbreaks) and histamine poisoning (4 outbreaks) were small with a mean of four and three persons affected, respectively. Other toxin related outbreaks included six outbreaks of *Clostridium perfringens* intoxication, and one outbreak each of *Staphylococcus aureus* and *Bacillus cereus* intoxication.

Aetiological agents responsible for foodborne outbreaks also included 11 outbreaks due to foodborne norovirus (369 people), four outbreaks due to *Campylobacter* species (67 people), one outbreak of hepatitis A (10 people) and one outbreak of *Vibrio cholerae* (3 people).

Thirty-two per cent (37/115) of outbreaks were of unknown aetiology. These outbreaks affected 342 people, including seven people who were hospitalised.

The highest hospitalisation rate was seen in one outbreak of methaemoglobinaemia due to sodium nitrite, where all six notified cases were hospitalised; however, this outbreak was identified via the hospital cases. High hospitalisation rates were also seen in one outbreak of *Vibrio cholerae*, where 67% (2/3 people) of people affected were hospitalised, and in four different outbreaks of histamine, where in total 58% (7/12 people) of people affected were hospitalised.

Food vehicles

There was a wide variety of foods implicated in outbreaks of foodborne disease during 2006 (Table 9), although investigators could not identify a specific food vehicle in 40% (46/115) of outbreaks.

In 2006, eggs and egg-containing dishes were the most common food vehicle and were responsible for 14% (16/115) of foodborne outbreaks. These 16 outbreaks affected 191 people and hospitalised 64 people and all were due to salmonellosis. Outbreaks where investigators epidemiologically or microbiologically implicated eggs eaten alone, that is, not in a dish with other ingredients, or where there was a high degree of suspicion that eggs eaten alone were the responsible vehicle, were included in the egg category. An egg-containing dish was defined as a dish where eggs were one of the main ingredients but not the only ingredient or where cross-contamination from eggs was the cause of the outbreak. Food items included in this category included desserts commonly made with raw eggs, such as gateau (cake) or chocolate mousse, as well as other foods made with raw eggs such as milkshakes and raw pikelet dough. Other foods included were items suspected to be cross-contaminated with eggs in their preparation such as hamburgers and bakery products. Contaminated fish was the second most common food vehicle and was responsible for 11% (13/115) of foodborne outbreaks. Seven outbreaks were due to ciguatera fish poisoning and four outbreaks were due to histamine poisoning. Queensland reported five of the seven ciguatera outbreaks, while Victoria and the Northern Territory reported one ciguatera outbreak each. Two of the four histamine outbreaks were associated with the consumption of tuna, while the other two histamine outbreaks were associated with eating yellowtail kingfish. An outbreak of Vibrio cholerae was caused by consumption of contaminated whitebait imported from Indonesia.[19] Another outbreak of unknown aetiology was associated with the consumption of Nile perch fillets. An outbreak of unknown aetiology was associated with oysters; this outbreak was classified as seafood rather than fish.

There were eight outbreaks associated with mixed dishes; this category includes dishes made up of multiple ingredients as well as buffet meals where a wide variety of foods and dishes were served. These dishes contained a variety of ingredients, including vegetables, meats, and spreads/dressings, which made it difficult to assign the cause to one food category. Consumption of poultry was responsible for six outbreaks and meat other than poultry for four outbreaks.

Table 9. Categories of food vehicles implicated in foodborne disease outbreaks, Australia, 2006

Vehicle category	Number of outbreaks	People affected	Hospitalised
Fish	13	49	17
Egg-containing dish	11	125	50
Mixed dish	8	67	4
Poultry	6	97	3
Eggs	5	66	14
Meat, not poultry	4	94	0
Fresh produce	4	122	19
Sushi	4	17	1
Salad dish	3	38	0
Sandwiches	3	28	1
Cake	2	31	0
Processed meat	2	20	4
Dips	1	2	0
Sodium nitrite	1	6	6
Seafood	1	6	0
Water	1	46	0
Unknown	46	708	27
Total	115	1,522	146

Fresh fruits and vegetables, categorised as fresh produce in Table 9, were responsible for four outbreaks, all due to salmonellosis. Single outbreaks were associated with rockmelon, paw paw, alfalfa sprouts, and in one outbreak bean sprouts were suspected to be the cause.

Other food vehicles implicated in outbreaks included sushi (4 outbreaks), salad dishes (3 outbreaks), sandwiches (3 outbreaks), cake (2 outbreaks), and processed meat (2 outbreaks; one due to salami and one due to capocollo). Single outbreaks were due to dips and drinking water. There was one outbreak of methaemoglobinaemia due to sodium nitrite (sold commercially as 'nutre powder') used in the preparation of food.

Outbreak settings

The most common settings where food was prepared in outbreaks was restaurants (41%, 47/115), and private residences (13%, 15/115). Foods prepared at a takeaway or by commercial caterers were each responsible for 10 outbreaks (Table 10). Foods that were contaminated in primary production environments ('primary produce'), such as fish contaminated with ciguatera toxin and fresh fruits and vegetables contaminated with *Salmonella*, accounted for another 10 outbreaks. Food prepared in aged care facilities and by commercial manufacturers was responsible for five and four outbreaks respectively, while food prepared at bakeries and camps was responsible for two outbreaks each. There was one outbreak each due to food prepared in a child care centre, an institution other than an aged care home or hospital, and a national franchised fast food restaurant. There was one outbreak due to food prepared in the community; this was an outbreak where the suspected food vehicle, eggs, was prepared separately by individual households and resulted in a community wide increase of cases of *S.* Typhimurium 44.

Investigative methods and levels of evidence

States and territories investigated 31 outbreaks using retrospective cohort studies and seven outbreaks using case control studies. Forty-two per cent (13/31) of cohort studies were used for outbreaks of unknown aetiology, which was a similar proportion to previous years. In 69 outbreaks, descriptive information was used to attribute a foodborne cause or identify a food vehicle. No individual patient data was collected in the remaining eight outbreaks.

To attribute the cause of the outbreak to a specific food vehicle, investigators obtained analytical evidence from epidemiological studies in nine outbreaks. Microbiological evidence of contaminated food was found in 14 outbreaks, with a further seven outbreak investigations obtaining both microbiological and analytical evidence. Investigators obtained analytical and/or microbiological evidence for 41% (17/41) of *Salmonella* outbreaks, which was similar to the proportion in 2005 (39%). Seventy-three per cent (85/115) of outbreaks relied on descriptive evidence to implicate a food or foodborne transmission.

Table 10. Food preparation settings implicated in disease outbreaks, Australia, 2006

Setting category	Number of outbreaks	People affected	Hospitalised
Restaurant	47	442	26
Private residence	15	100	22
Takeaway	10	110	9
Commercial caterer	10	202	3
Primary produce	10	141	26
Aged care facility	5	46	4
Commercially manufactured	4	25	4
Bakery	2	25	1
Camp	2	112	2
Child care centre	1	4	0
Community	1	43	9
Institution	1	47	32
National franchised fast food	1	24	0
Other	5	196	8
Unknown	1	5	0
Total	115	1,522	146

Significant outbreaks

There were nine outbreaks affecting 40 or more persons in 2006. Three of these outbreaks were due to norovirus, two were due to *Clostridium perfringens*, two were due to *S.* Typhimurium and there was one each due to *S.* Saintpaul and *Campylobacter jejuni*. In total, these significant outbreaks affected 594 people, with an average of 66 people per outbreak (range 41–122 people) and 56 people were hospitalised.

Multi-state outbreaks

In 2006, OzFoodNet conducted three multi-state investigations into foodborne disease outbreaks. In May, there was an outbreak of *S.* Bovismorbificans 11 in Victoria and South Australia due to capocollo (processed meat) manufactured in Victoria. There were 13 cases from Victoria and two cases from South Australia. This outbreak prompted a consumer level recall of nationally distributed capocollo due to microbial contamination with *S.* Bovismorbificans 11.

In October 2006, New South Wales identified an increase in cases of *S.* Saintpaul and began interviewing cases. OzFoodNet coordinated a multi-state investigation team for this outbreak when other eastern Australian states also reported increases in cases of *S.* Saintpaul. The investigation team conducted a case control study that implicated rockmelons as the source of infection. Identifying the sources of implicated rockmelons was very difficult and various serotypes of *Salmonella* were isolated from rockmelons, in packing environments and on farms.[20]

In November 2006, Western Australia and Queensland investigated a multi-state outbreak of *S.* Litchfield associated with paw paw (papaya) grown in Western Australia. Paw paw was implicated as the responsible food vehicle in a case control study conducted by Western Australia. Food sampling demonstrated that paw paw sold in retail outlets in Western Australia (Perth) were contaminated with *S.* Litchfield, however, the source of the paw paw contamination on specific farms was not found.

Cluster investigations

During 2006, states and territories conducted investigations into 114 clusters where the mode of transmission was unknown. This included 50 clusters of *Salmonella*, two clusters of other pathogens, and 62 clusters of unknown aetiology. These clusters affected 1,070 people and hospitalised at least 40 people.

Forty-three per cent (50/114) of all cluster investigations were related to *Salmonella*, where the mean number of cases was 7.2 per cluster and the total number of persons affected was 360, with at least 15 people hospitalised. *S.* Typhimurium was responsible for 34% (17/50) of *Salmonella* cluster investigations. Clusters of *S.* Typhimurium and non-Typhimurium strains involved similar numbers of people, with a mean of 7.8 persons and 6.9 persons per cluster, respectively. Of the remaining 33 clusters, 26 different *Salmonella* serotypes other than Typhimurium were involved.

There were two investigations into clusters of other pathogens; these were both mixed infections of norovirus and *Clostridium difficile*, one in the community and one in an institution other than an aged care facility or a hospital.

There were 62 investigations into clusters of unknown aetiology where the mode of transmission was unknown. These 62 clusters affected 671 persons (an average of 10.8 cases per cluster) and hospitalised at least 25 persons. Thirty-two per cent (20/62) of these cluster investigations were in aged care facilities, and 11% (7/62) were in the community. Commercial caterers, restaurants, and child care centres each accounted for 8% (5/62) of these clusters.

Completeness of *Salmonella* serotyping and phage typing

Overall, 97.4% of *Salmonella* notifications on state and territory notification databases contained information about serotype and/or phage type (Figure 6). This was similar to the 2005 proportion of 97.5%. On the six serotypes where phage typing was typically performed—Bovismorbificans, Enteritidis, Hadar, Heidelberg, Typhimurium and Virchow—were all greater than 95% complete (Table 11). The Australian Capital Territory reported complete serotype and phage type information for all *Salmonella* notifications during 2006.

Figure 6. Proportion of *Salmonella* infections notified to state and territory health departments with serotype and phage type information available, Australia, 2001 to 2006

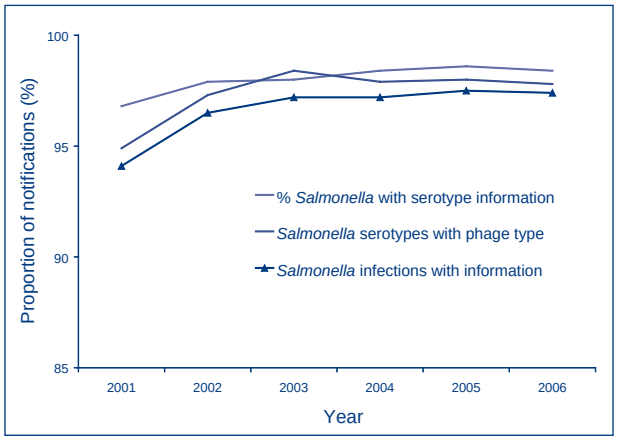


Table 11. Proportion of *Salmonella* infections notified to state and territory health departments with phage type information available for six serotypes, Australia, 2001 to 2006

	2001	2002	2003	2004	2005	2006
S. Bovismorbificans	87.5	96.3	94.6	94.1	94.7	95.7
S. Enteritidis	91.2	95.3	97.1	94.5	96.9	96.4
S. Hadar	77.4	90.9	97.1	89.7	92.0	100.0
S. Heidelberg	88.6	92.6	92.7	94.6	88.4	95.0
S. Typhimurium	96.9	97.9	98.8	98.8	98.7	98.1
S. Virchow	92.5	97.6	98.3	97.1	96.6	98.4

Discussion

This report summarises the rates of gastrointestinal diseases commonly transmitted by foods in Australia. Notification rates have remained stable in recent years, however the incidence was high compared to other countries.[21] The occurrence of campylobacteriosis has been consistently high in Australia and New Zealand compared with other developed countries for over a decade. This is despite identification of the main risk factors for infection.[21,22,23] Campylobacteriosis is responsible for a large burden of illness, but public health agencies are unable to recognise outbreaks due to the lack of a robust typing scheme.[24] In 2006, OzFoodNet sites identified four outbreaks of campylobacteriosis affecting 67 people compared with 15,492 notifications of this illness. There is a need to establish targets for the reduction of the incidence of campylobacteriosis in Australia as have been set in other countries, to assist governments and industry to make changes that will prevent illness.[25]

In 2006, there was an increase in the number of outbreaks relating to eggs and fresh produce. Sixteen outbreaks were associated with eggs or egg-based dishes, compared with five outbreaks in 2005. Eighty-one per cent (13/16) of these outbreaks were due to various phage types of *S.* Typhimurium. Investigations into outbreaks associated with eggs are challenging, as traceback of eggs to their source and to identify the origin of contamination can be difficult. OzFoodNet epidemiologists worked closely with primary production departments and food safety agencies in these outbreaks to ensure a complete traceback of eggs where possible. Food Standards Australia New Zealand has established a committee to develop a national primary production and processing standard for eggs, which, in the long term should reduce the number of outbreaks associated with eggs and egg products.[26]

There were four outbreaks associated with fresh produce in 2006, compared to one outbreak due to fresh produce in 2005. These four outbreaks, including two multi-state outbreaks, highlight the role of fresh fruits and vegetables in causing foodborne disease outbreaks. Although the implicated produce was traced back to farms in two of the outbreaks, the exact source of contamination was difficult to identify. Investigations of the farms producing rockmelons and paw paws revealed multiple *Salmonella* serotypes from a wide range of environmental samples; in particular, the water used to wash the produce during processing was contaminated with multiple *Salmonella* serotypes. This finding highlights a critical point of contamination. Since 2001, there have been 25 outbreaks associated with fresh produce in Australia.[27] The recent increase in produce-related outbreaks in Australia has also been seen in other developed countries. In particular, the USA reported several large outbreaks associated with the consumption of spinach,[28] lettuce,[29] and tomatoes[30] in 2006. There is a need for appropriate health messages for the public consuming potentially contaminated fresh produce as well as appropriate interventions to prevent contamination at the farm level.

In 2006, there were two outbreaks related to imported foods. One outbreak was associated with whitebait from Indonesia. The second outbreak was associated with sodium nitrite ('nutre powder') from China; sold in Chinese grocery stores as a flavour enhancer.[19] From 2001 to 2006, there have been 13 outbreaks associated with imported foods in Australia.[31] These two imported food outbreaks highlight the need to maintain communication with countries that provide Australia with food or items used in food. The outbreak of methaemoglobinaemia due to sodium nitrite was the first of its kind in Australia. Unintentional consumption of sodium nitrite has been the cause of outbreaks in other countries.[32,33]

In 2006, there were four outbreaks associated with sushi. These outbreaks are assumed to be due to inadequate refrigeration/storage.[34] While there are few published reports of gastrointestinal outbreaks associated with sushi, there are many potential avenues for contamination including improper storage of cooked rice and the use of high risk ingredients such as raw-egg mayonnaise.[35]

In 2006, more than 97% of *Salmonella* notifications contained complete information about serotype and/or phage type. The ability to type strains of *Salmonella* was essential for identifying and investigating outbreaks. The principal methods of differentiating *Salmonella* strains are serotyping and phage typing. Serotyping in Australia is conducted by public health reference laboratories in Queensland, New South Wales, Victoria, South Australia, and Western Australia. Tasmania, the Australian Capital Territory, and the Northern Territory forward their *Salmonella* isolates to South Australia or Victoria for serotyping and/or phage typing. Phage typing is conducted by the Microbiological Diagnostic Unit, Public Health Laboratory at the University of Melbourne in Victoria and the Institute of Medical and Veterinary Sciences in South Australia. During 2006, some jurisdictions used other methods to assist in locally differentiating *Salmonella* including multiple-locus variable-number tandem-repeats analysis and pulsed-field gel electrophoresis. Changes to *Salmonella* typing schemes need to be monitored to ensure that they enhance the ability to identify outbreaks and trends in the incidence of infection.

In 2006, all jurisdictions contributed to a fortnightly national report, which identified clusters of foodborne illness occurring across state and territory boundaries. This report was useful for identifying common events affecting different parts of Australia. This supplemented information sharing on a closed list server, teleconferences and at quarterly face-to-face meetings. In addition, OzFoodNet made greater use of web-based databases during the management of outbreaks, in particular the multi-state outbreaks, which greatly improved the timeliness and quality of these investigations.

In 2006, OzFoodNet sites reported 1,544 outbreaks, which was the largest number reported since surveillance began in 2000. The majority of these outbreaks were due to person-to-person transmission of highly infectious norovirus. While some settings, such as aged care homes and hospitals, show up more frequently in these investigations, outbreaks are easier to recognise, and therefore, report, where people live in close quarters. Better strategies are required to control norovirus.[36]

OzFoodNet reported a rate of 5.6 foodborne disease outbreaks per million population in 2006. This compares with rates of outbreak reporting in other developed countries. New Zealand reported a rate of 35 foodborne outbreaks per million population for 2006.[37] Published data on foodborne outbreak rates is available from 2004 for Germany (15 outbreaks per million population)[38] and from 2005 for the USA (estimated rate, 3.3 outbreaks per million population).[39,40] Direct comparisons of these rates are difficult due to the many differences in the surveillance of and reporting of outbreaks in each of these countries.

It is important to recognise some of the limitations of the data used in this report. Limitations of NNDSS surveillance data include differences in the likelihood that certain population groups will have laboratory tests and different testing regimes. This may explain part of the difference in the rates of laboratory-confirmed disease between jurisdictions and over time. Small numbers of notifications also mean that caution is required in the interpretation of differences between jurisdictions and over time. Importantly, some of the most common enteric pathogens are not notifiable, particularly norovirus, *Clostridium perfringens* and enteropathogenic *E. coli*. These organisms may be notified as the cause of outbreaks, but not as individual cases of disease. A limitation of the outbreak data provided by OzFoodNet sites for this report is the potential for variation in categorising features of outbreaks depending on investigator interpretation and circumstances. States and territories are working towards harmonising surveillance and outbreak data to address some of these issues.

Foodborne disease surveillance provides information to assist in the assessment of food safety policies and campaigns. A national program of surveillance for foodborne diseases and outbreak investigation has many benefits including identifying foods that cause human illness. Ongoing efforts to strengthen the quality of these data will ensure continued use by agencies to develop food safety policy and prevent foodborne illness.

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References

1. Abelson P, Potter Forbes M, Hall G. The annual cost of foodborne illness in Australia. Australian Government Department of Health and Ageing, Canberra: 2006.
2. Owen R, Roche PW, Hope K, Yohannes K, Roberts A, Liu C, et al. Australia's notifiable diseases status, 2005: annual report of the National Notifiable Diseases Surveillance System. *Commun Dis Intell* 2007;31:1–70.
3. Majowicz SE, Edge VL, Fazil A, McNab WB, Doré KA, Sockett PN, et al. Estimating the under-reporting rate for infectious gastrointestinal illness in Ontario. *Can J Public Health* 2005;96:178–181.
4. Hall G, Raupach J, Yohannes K Dalton CB, Halliday L, Unicomb LE, Kirk M. An estimate of the under-reporting of foodborne notifiable diseases: *Salmonella*, *Campylobacter*, Shiga-toxin producing *E. coli* (STEC). National Centre for Epidemiology, Australian National University, Canberra: 2006; Working Paper Number 52.
5. Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, et al. Food-related illness and death in the United States. *Emerg Infect Dis* 1999;5:607–625.
6. Allos BM, Moore MR, Griffin PM, Tauxe RV. Surveillance for sporadic foodborne disease in the 21st century: the FoodNet perspective. *Clin Infect Dis* 2004;38:S115–120.
7. O'Brien SJ, Gillespie IA, Sivanesan MA, Elson R, Hughes C, Adak GK. Publication bias in foodborne outbreaks of infectious intestinal disease and its implications for evidence-based food policy. England and Wales 1992–2003. *Epidemiol Infect* 2006;134:667–674.
8. Ashbolt R, Givney R, Gregory JE, Hall G, Hundy R, Kirk M, et al. Enhancing foodborne disease surveillance across Australia in 2001: the OzFoodNet Working Group. *Commun Dis Intell* 2002;26:375–406.
9. Scallan E. Activities, achievements, and lessons learned during the first 10 years of the Foodborne Diseases Active Surveillance Network: 1996–2005. *Clin Infect Dis* 2007;44:718–725.
10. Lindenmayer P. Networking for health protection: the Communicable Diseases Network Australia. *Commun Dis Intell* 2001;25:266–269.
11. Australian Bureau of Statistics. Population by Age and Sex, Australian States and Territories, June 2007. ABS cat. no. 3201.0. Australian Bureau of Statistics, Canberra: 2007.
12. Laws PJ, Grayson N, Sullivan EA. Australia's mothers and babies, 2004. Perinatal statistics series no 18. AIHW cat no. PER 34. Australian Institute of Health and Welfare, National Perinatal Statistics Unit. Sydney: 2006.
13. Braden CR. *Salmonella enterica* serotype Enteritidis and eggs: a national epidemic in the United States. *Clin Infect Dis* 2006;43:512–517.
14. Collard JM, Bertrand S, Dierick K, Godard C, Wildemauwe C, Vermeersch K, et al. Drastic decrease of *Salmonella* Enteritidis isolated from humans in Belgium in 2005, shift in phage types and influence on foodborne outbreaks. *Epidemiol Infect* 2007 24 Jun:1–11. Epub ahead of print.
15. Murase T, Fujimoto K, Nakayama R, Otsuki K. Multiplication and motility of *Salmonella enterica* serovars Enteritidis, Infantis, and Montevideo in *in vitro* contamination models of eggs. *J Food Prot* 2006;69:1012–1016.
16. Shivaprasad HL, Timoney JF, Morales S, Lucio B, Baker RC. Pathogenesis of *Salmonella enteritidis* infection in laying chickens. 1. Studies on egg transmission, clinical signs, fecal shedding, and serologic responses. *Avian Dis* 1990;34:548–557.
17. Hall G, Kirk MD, Becker N, Gregory JE, Unicomb L, Millard G, et al. Estimating foodborne gastroenteritis, Australia. *Emerg Infect Dis* 2005;11:1257–1264.
18. Munnoch S, Lam M, Musto J, on behalf of NSW enteric diseases network. OzFoodNet – enhancing foodborne disease surveillance across Australia, annual report, 2006. New South Wales and Hunter New England Area Health Service, Newcastle: April 2007.
19. Forssman B, Mannes T, Musto J, Gottlieb T, Robertson G, Natoli JD, et al. *Vibrio cholerae* O1 El Tor cluster in Sydney linked to imported whitebait. *Med J Aust* 2007;187:345–347.
20. Munnoch S, Ward K, Sheridan S, Fitzsimmons G, Oxenford C, Piispanen J, et al. A multi-jurisdictional outbreak of *Salmonella* Saintpaul associated with rockmelons highlights concerns about the safety of fresh produce. *Communicable Disease Control Conference,* Canberra 14–15 March 2007.
21. Centers for Disease Control and Prevention. Preliminary FoodNet data on the incidence of infection with pathogens transmitted commonly through food—10 states, 2006. *MMWR Morb Mortal Wkly Rep* 2007;56:336–339.
22. Baker MG, Sneyd E, Wilson NA. Is the major increase in notified campylobacteriosis in New Zealand real? *Epidemiol Infect* 2007;135:163–170.
23. Stafford RJ, Schluter P, Kirk M, Wilson A, Unicomb L, Ashbolt R, et al. A multi-centre prospective case-control study of *Campylobacter* infection in persons aged 5 years and older in Australia. *Epidemiol Infect* 2007;135:978–988.

24. O'Reilly LC, Inglis TJ, Unicomb L. Australian multicentre comparison of subtyping methods for the investigation of *Campylobacter* infection. *Epidemiol Infect* 2006;134:768–779.

25. Samuel MC, Vugia DJ, Shallow S, Marcus R, Segler S, McGivern T, et al. Epidemiology of sporadic *Campylobacter* infection in the United States and declining trend in incidence, FoodNet 1996–1999. *Clin Infect Dis* 2004;38:S165–174.

26. Food Standards Australia New Zealand. Primary Production and Processing Standards. Updated September 2005. Available from: www.foodstandards.gov.au/thecode/primaryproductionprocessingstandards. Accessed on 30 October 2007.

27. Fullerton KE, Gregory J, Fitzsimmons G, Kirk M. Fresh produce outbreaks in Australia, 2001–2006. *Communicable Disease Control Conference,* Canberra 14–15 March 2007.

28. Centers for Disease Control and Prevention. Ongoing multistate outbreak of *Escherichia coli* serotype O157:H7 infections associated with consumption of fresh spinach—United States, September 2006. *MMWR Morb Mortal Wkly Rep* 2006;55:1045–1046.

29. Meadows M. How the FDA works to keep produce safe. *FDA Consum* 2007;41:12–19.

30. Centers for Disease Control and Prevention. Multistate outbreaks of *Salmonella* infections associated with raw tomatoes eaten in restaurants—United States, 2005–2006. *MMWR Morb Mortal Wkly Rep* 2007;56:909–911.

31. Musto J, Kirk M, Gregory J, Fullerton K. Outbreaks in Australia from imported foods, 2001–2006. *Communicable Disease Control Conference,* Canberra 14–15 March 2007.

32. Centers for Disease Control and Prevention. Methemoglobinemia following unintentional ingestion of sodium nitrite—New York, 2002. *MMWR Morb Mortal Wkly Rep* 2002;51:639–642.

33. Khan A, Adams A, Simmons G, Sutton T. Deadly meatballs—a near fatal case of methaemoglobinaemia. *N Z Med J* 2006;119:U2107.

34. OzFoodNet Working Group. OzFoodNet Quarterly Report, 1 July to 30 September 2006. *Commun Dis Intell* 2006;30:467–470.

35. Barralet J, Stafford R, Towner C, Smith P. Outbreak of *Salmonella* Singapore associated with eating sushi. *Commun Dis Intell* 2004;28:527–528.

36. Dolin R. Noroviruses—challenges to control. *N Engl J Med* 2007;357:1072–1073.

37. Population and Environmental Health Group, Institute of Environmental Science and Research Limited. Annual Summary of Outbreaks in New Zealand 2006. April 2007.

38. Krause G, Altmann D, Faensen D, Porten K, Benzler J, Pfoch T, et al. SurvNet Electronic Surveillance System for Infectious Disease Outbreaks, Germany. *Emerg Infect Dis* 2007;13:1548–1555.

39. US Census Bureau. Annual Estimates of the Population for the United States, Regions, States, and for Puerto Rico: April 1, 2000 to July 1, 2006 (NST-EST2006-01). Available from: http://www.census.gov/popest/states/NST-ann-est.html Accessed on 18 October 2007.

40. Centers for Disease Control and Prevention. 2005 Summary Statistics, Foodborne Disease Outbreaks by Etiology. Available from: http://wwwcdcgov/foodborneoutbreaks/us_outb/fbo2005/2005_Linelistpdf Accessed on 18 October 2007.

Appendix

Foodborne outbreak summary for OzFoodNet sites, Australia, 2006

State	Month of outbreak	Setting prepared	Aetiology	Number affected	Hospitalised	Evidence	Epidemiological study	Responsible vehicle
Australian Capital Territory	February	Bakery	Unknown	10	0	D	D	Cake
	November	Primary produce	*Salmonella* Typhimurium 44	4	1	D	D	Free range eggs
	December	Primary produce	*Salmonella* Typhimurium 170	13	0	M	D	Free range eggs
New South Wales	January	Camp	*Salmonella* Typhimurium 170	3	1	D	D	Suspect chicken/beef hamburger cross-contaminated with eggs
	January	Restaurant	Unknown	13	0	D	D	Buffet meal
	January	Restaurant	Unknown	19	1	D	N	Unknown
	February	Restaurant	Scombroid	2	1	D	N	Tuna steaks
	February	Takeaway	Unknown	3	0	D	D	Chicken schnitzel in gravy
	March	Restaurant	*Salmonella* Typhimurium 170 var	2	2	D	D	Suspect pork dish or fried ice cream
	March	Restaurant	Unknown	2	0	D	D	Unknown
	March	Takeaway	*Salmonella* Montevideo	3	2	M	D	Plain hamburger cross-contaminated with eggs
	March	Restaurant	Unknown	22	0	D	C	Unknown
	April	Restaurant	Norovirus	15	0	D	C	Unknown
	May	Restaurant	Unknown	7	2	D	C	Unknown
	May	Commercial caterer	*Clostridium perfringens*	70	0	M	D	Chicken curry
	June	Commercially manufactured	*Salmonella* Typhimurium 170	2	0	D	D	Unknown
	June	Other	Unknown	3	0	D	D	Suspect potato salad
	June	Private residence	Unknown	4	0	D	D	Suspect Nile perch
	June	Private residence	Unknown	6	0	D	C	Suspect oysters
	June	Restaurant	Unknown	8	0	D	D	Unknown
	June	Private residence	Unknown	21	0	A	C	Cake
	July	Takeaway	*Salmonella* Typhimurium 135A	2	1	D	D	Suspected eggs
	July	Restaurant	Unknown	2	0	D	D	Unknown
	July	Child care centre	*Salmonella* Potsdam	4	0	D	D	Suspect pikelets made from whole eggs
	July	Takeaway	*Salmonella* Typhimurium 170	4	2	D	D	Suspect beef/chicken burgers with eggs
	July	Takeaway	*Salmonella* Typhimurium 170	4	3	M	D	Eggs

Foodborne outbreak summary for OzFoodNet sites, Australia, 2006, *continued*

State	Month of outbreak	Setting prepared	Aetiology	Number affected	Hospitalised	Evidence	Epidemiological study	Responsible vehicle
New South Wales, *continued*	July	Restaurant	Unknown	4	1	D	N	Buffet meal
	July	Restaurant	Unknown	5	0	D	D	Unknown
	July	Commercial caterer	Unknown	5	0	D	N	Unknown
	September	Commercially manufactured	*Salmonella* Typhimurium 170	2	0	D	D	Suspect dips
	September	Restaurant	Unknown	2	0	D	C	Chicken pizza
	September	Takeaway	Unknown	4	0	D	D	Unknown
	September	Restaurant	Unknown	5	0	D	D	Unknown
	September	Private residence	Sodium nitrite	6	6	M	N	Nutre powder
	September	Restaurant	Unknown	7	0	D	N	Pasta or pizza
	October	Restaurant	Scombroid	6	6	D	D	Yellowtail kingfish fillets
	October	Commercially manufactured	*Salmonella* Typhimurium 170	6	0	D	D	tuna and salmon sushi rolls
	November	Aged care facility	*Campylobacter jejuni*	3	3	AM	C	Undercooked chicken
	November	Private residence	*Vibrio cholerae*	3	2	D	D	Whitebait
	November	Restaurant	Unknown	7	0	D	N	Unknown
	November	Commercial caterer	*Bacillus cereus*	14	0	AM	C	Cooked chicken
	November	Restaurant	Unknown	15	0	D	D	Sandwiches
	November	Institution	*Salmonella* Typhimurium 170	47	32	AM	CCS	White chocolate mousse
	December	Restaurant	Unknown	5	0	A	CCS	Unknown
	December	Restaurant	Unknown	24	0	D	D	Banquet meal
	December	Commercial caterer	Unknown	25	0	D	C	Unknown
	December	Takeaway	*Clostridium perfringens*	80	0	AM	CCS	Roast pork
Northern Territory	January	Restaurant	Hepatitis A	10	1	D	D	Unknown
	May	Private residence	*Salmonella* Oslo	2	0	D	D	Suspected sticky rice balls with chicken
	September	Primary produce	Ciguatera fish poisoning	14	4	D	D	Slate sweetlips fish

Foodborne outbreak summary for OzFoodNet sites, Australia, 2006, *continued*

State	Month of outbreak	Setting prepared	Aetiology	Number affected	Hospitalised	Evidence	Epidemiological study	Responsible vehicle
Queensland	January	National franchised fast food	Unknown	24	0	D	C	Unknown
	February	Primary produce	Ciguatera fish poisoning	2	0	D	D	Cod
	February	Private residence	Scombroid	2	0	D	D	Blue fin tuna steaks
	February	Camp	Norovirus	66	2	D	D	Unknown
	March	Primary produce	Ciguatera fish poisoning	2	0	D	D	Trevally fish
	March	Primary produce	Ciguatera fish poisoning	4	4	D	D	Spanish mackerel
	March	Restaurant	Unknown	8	0	D	C	Unknown
	March	Restaurant	Norovirus	15	1	D	C	Unknown
	April	Restaurant	*Salmonella* Singapore	2	1	D	D	Chow mein
	April	Takeaway	*Staphylococcus aureus*	3	0	D	D	Sushi roll
	April	Commercial caterer	Unknown	6	3	D	D	Unknown
	April	Private residence	*Salmonella* Typhimurium 135a	11	5	D	D	Unknown
	May	Restaurant	Unknown	2	0	D	N	Chicken teriyaki sushi roll (nori roll)
	June	Restaurant	*Salmonella* Zanzibar	3	1	D	D	Unknown
	July	Primary produce	Ciguatera fish poisoning	2	0	D	D	Spanish mackerel
	July	Takeaway	Unknown	4	0	D	D	Suspected beef/lamb kebab
	July	Restaurant	Unknown	6	0	D	C	Unknown
	July	Restaurant	*Clostridium perfringens*	13	0	M	C	Chicken & lamb guvec
	August	Restaurant	*Salmonella* Typhimurium 135	6	1	D	D	Suspected chicken teriyaki sushi rolls
	September	Restaurant	*Clostridium perfringens*	6	0	D	D	Lamb korma
	September	Private residence	*Salmonella* Typhimurium 8	7	1	D	D	Unknown
	October	Primary produce	Ciguatera fish poisoning	4	0	D	D	Black kingfish
	November	Camp	*Campylobacter jejuni*	46	0	A	C	On-site water tank
	December	Restaurant	*Salmonella* Bareilly	4	0	D	D	Unknown
	December	Restaurant	*Salmonella* Typhimurium 197	7	3	D	D	Unknown
	December	Restaurant	Unknown	9	0	D	C	Unknown
	December	Restaurant	*Salmonella* Typhimurium 197	17	0	D	C	Unknown
	December	Other	Norovirus	122	1	A	C	Unknown

Foodborne outbreak summary for OzFoodNet sites, Australia, 2006, *continued*

State	Month of outbreak	Setting prepared	Aetiology	Number affected	Hospitalised	Evidence	Epidemiological study	Responsible vehicle
South Australia	January	Private residence	*Salmonella* Typhimurium 108	7	0	M	D	Homemade ice cream and ice cream topping
	February	Private residence	*Salmonella* Typhimurium 135	4	0	M	D	Silverside
	February	Restaurant	*Salmonella* Anatum	5	0	D	D	Beef burger with bacon and egg
	May	Other	*Salmonella* Typhimurium 108	23	7	AM	CCS	Ravioli
	June	Restaurant	*Salmonella* Typhimurium 9	6	0	A	C	Sweet potato and feta cheese salad
	December	Commercial caterer	*Campylobacter*	5	0	A	C	Chicken dish
	December	Bakery	*Salmonella* Typhimurium 9	15	1	AM	CCS	Egg through a bakery product
Tasmania	January	Private residence	*Salmonella* Typhimurium 44 and U302	9	2	D	C	Unknown
Victoria	January	Private residence	*Salmonella* Typhimurium 44	4	4	M	D	Milkshake containing raw egg
	January	Aged care facility	Unknown	5	0	D	D	Unknown
	January	Restaurant	Norovirus	9	0	D	D	Unknown
	January	Restaurant	Norovirus	15	0	D	C	Unknown
	February	Restaurant	Scombroid	2	0	M	D	Kingfish
	February	Commercial caterer	Norovirus	41	0	D	C	Unknown
	March	Unknown	*Salmonella* London	5	0	M	D	Salami (non commercial)
	March	Restaurant	*Salmonella* Saintpaul	11	1	M	D	Suspected bean shoots
	May	Commercial caterer	Suspected *Clostridium perfringens*	10	0	D	D	Unknown
	May	Primary produce	*Salmonella* Oranienburg	15	2	M	D	Alfalfa
	June	Aged care facility	Unknown	5	0	D	D	Unknown
	August	Commercial caterer	Unknown	7	0	D	C	Sandwiches
	August	Aged care facility	*Campylobacter*	13	1	D	D	Unknown
	September	Commercial caterer	Unknown	19	0	D	C	Unknown
	October	Restaurant	Norovirus	15	0	D	C	Unknown
	November	Primary produce	Ciguatera fish poisoning	2	0	D	D	Coral perch or coral trout
	November	Private residence	*Salmonella* Typhimurium 44	10	1	A	D	Hazelnut gateau cake made with raw egg mousse filling

Foodborne outbreak summary for OzFoodNet sites, Australia, 2006, *continued*

State	Month of outbreak	Setting prepared	Aetiology	Number affected	Hospitalised	Evidence	Epidemiological study	Responsible vehicle
Victoria, *continued*	November	Restaurant	Norovirus	13	0	D	C	Unknown
	November	Restaurant	Norovirus	29	0	D	C	Unknown
	December	Aged care facility	*Clostridium perfringens*	20	0	D	D	Unknown
	December	Community	*Salmonella* Typhimurium 44	43	9	D	D	Suspected eggs
Western Australia	June	Restaurant	*Salmonella* Anatum	6	1	D	D	Takeaway sandwiches and rolls
	September	Restaurant	*Salmonella* Kiambu	3	1	D	D	Unknown
	September	Restaurant	*Salmonella* Kiambu	35	2	D	C	Unknown
	October	Other	Unknown	19	0	D	C	Unknown
	November	Other	Norovirus	29	0	A	C	Salad
Multi-state	May	Commercially manufactured	*Salmonella* Bovismorbificans 11	15	4	M	D	Capocollo
	October	Primary produce	*Salmonella* Saintpaul	79	12	A	CCS	Rockmelon
	November	Primary produce	*Salmonella* Litchfield	17	4	AM	CCS	Paw paw