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Investigation of a norovirus outbreak at a catered social event, Australian Capital Territory, 2024

Clare L Kinnear, Timothy Sloan-Gardner, Natasha Waters, Victoria Wansink, Lyndell Hudson, Jenny Post

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Australian Centre for Disease Control

GPO Box 795, Canberra ACT 2601

Australia

Website: **cdc.gov.au/cdi**

Email: **cdi.editor@cdc.gov.au**

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Abstract

Background

An outbreak of gastrointestinal illness was notified, affecting attendees at a private function in the Australian Capital Territory (ACT) in 2024. Investigations were conducted to determine the infectious agent, source of illness and mode of transmission, as well as to determine any public health actions required to prevent further illness.

Methods

Function attendees were surveyed using a modified standard gastroenteritis questionnaire. A confirmed outbreak case was defined as an individual who was unwell after attending the event and had a norovirus-positive clinical sample; a probable outbreak case was defined as an individual who was unwell with clinically compatible symptoms after attending the event. A case-control study was conducted to identify food items associated with illness. Food safety inspections were performed, and food samples were tested at the ACT Government Analytical Laboratory. Clinical samples were collected from unwell attendees and from an asymptomatic food handler.

Results

There were approximately 250–500 attendees at the function; 224 attendees completed the questionnaire and there were 65 cases (5 confirmed and 60 probable). A food handler who had previously been unwell, and who prepared fruit and meat platters for the function more than 96 hours after their symptoms had resolved, subsequently tested positive for norovirus. Environmental Health investigations showed the venue had good food practices and handwashing; the investigation identified no ongoing risks to the public. Testing of food samples did not detect any bacterial foodborne pathogens. Epidemiological investigations identified consumption of fresh fruit (odds ratio [OR]: 5.3; 95% confidence interval [95% CI]: 2.4–12.6; $p < 0.001$) and cured meat (OR: 2.7; 95% CI: 1.2–6.2; $p = 0.02$) as significantly associated with disease.

Conclusion

Epidemiological and clinical evidence indicates that norovirus was transmitted via contaminated fresh fruit and cured meat platters. Despite the venue having good food handling and handwashing practices, it was likely due to a food handler who had been unwell in the week prior to the function and prepared the implicated foods more than 96 hours after their symptoms resolved. This outbreak investigation shows that safe food practices and exclusion periods reduce but do not eliminate risk completely. Our findings highlight the need for continued education on effective hand hygiene in food preparation settings, especially following gastrointestinal illness.

Keywords: outbreak; norovirus; gastroenteritis; foodborne disease; hand hygiene; food handler

Introduction

Acute gastroenteritis is a major cause of morbidity and mortality worldwide and results in significant economic costs. Estimates of gastroenteritis rates in Australia range from 0.74 to 0.92 cases/person per year, with a quarter of these attributed to contaminated food.[1–3] Foodborne disease costs Australia an estimated 2.81 billion Australian dollars (AUD) a year due to healthcare related costs, premature mortality, pain and suffering and lost productivity.[4]

Norovirus is regularly identified as the main non-bacterial cause of gastroenteritis outbreaks in developed countries including Australia,[2,5–7] and the main cause of food-related illness in the United States of America.[8] Infections with norovirus are characterised by gastrointestinal illness with high rates of vomiting compared to fever, absence of bloody stool, and a mean incubation period of 24–48 hours.[9,10] Norovirus is spread faecal-orally through direct contact, through contaminated food and water, or through environmental and fomite contamination.[11]

Three factors make norovirus well adapted to cause large outbreaks. Firstly, norovirus particles are highly infectious with a low infectious dose.[7,12] Secondly, norovirus has been demonstrated to be shed for up to eight weeks after infection, with peak titres commonly found in samples collected after the resolution of symptoms.[13] Finally, norovirus can survive for long periods in the environment.[14] Hygiene measures including hand washing and surface cleaning are highly effective at reducing transmission.[15]

Foodborne transmission of norovirus can occur via contamination at the food source: common examples are contamination of oysters due to poor sanitation around farming estuaries,[16] and contamination of berries due to poor sanitation of irrigation water.[17] However, around half of all foodborne norovirus outbreaks specifically implicate food handler contamination as the source of infection,[18,19] with up to 90% noting food handlers as the possible source.[20] As a result, in the Australian Capital Territory (ACT), it is recommended that any food handler suffering from vomiting or diarrhoea does not work for at least 48 hours after cessation of symptoms.[21]

In 2024, the ACT Health Directorate (ACT Health) received a report of an outbreak of gastroenteritis from an organiser of a private function. The organiser stated that approximately 20 individuals who attended a catered function two days prior were unwell with a gastrointestinal illness. An outbreak investigation was conducted to determine the cause of the illnesses and to assess and respond to any ongoing risk to the public.

Methods

Environmental health investigation

Environmental Health Officers (EHOs) from ACT Health attended the venue three days after the function and conducted a food safety inspection. Details of the function, and other functions held on the same weekend, were collected. Samples of retained food served at the function were taken for laboratory analysis as required by the *Food Act 2001* (ACT).

Laboratory investigation

Food and environment samples

Food samples were processed and tested by the ACT Government Analytical Laboratory (ACTGAL). Samples were tested by preliminary screening using polymerase chain reaction (PCR) for *Salmonella* spp. and *Listeria monocytogenes*; by enumerative culture analysis for *Escherichia coli* (*E. coli*); and by standard plate counts. Results were compared to the Food Standards Australia and New Zealand (FSANZ) Compendium for the Microbiological Criteria for Food.[22] Food and environmental samples were not tested for norovirus, as this is not available at ACTGAL.

Clinical samples

Faecal samples were tested for bacterial pathogens (*Campylobacter*, *Shigella* and *Salmonella*) by culture, and for norovirus by nucleic acid testing (NAT). Dependent on the laboratory, some samples were tested for protozoan parasites by microscopy or bacterial and viral PCR panels, and for *Clostridium difficile*. Samples positive for norovirus were sequenced at New South Wales Health Pathology.

Epidemiological investigation

Study design

A descriptive analysis of the outbreak was performed to define and characterise the outbreak, and to determine the likely pathogen responsible for the outbreak. Subsequently, a case-control study was conducted to assess the likely source of infection.

Data collection

Function attendees were surveyed via REDCap[i] using a standard gastrointestinal outbreak questionnaire adapted to the catered menu, and were questioned regarding their interaction with other attendees in the two weeks prior to the function. Individuals invited to the function were sent a link to the REDCap survey by the function organiser, with the survey open to anyone with the attached link, as not all attendees would have received a direct invitation to the event. ACT Health was not provided with a full list of attendees and therefore could not contact cases directly. ACT Health contacted organisers of other functions at the venue on the same weekend, to determine if illness was reported among attendees at those events.

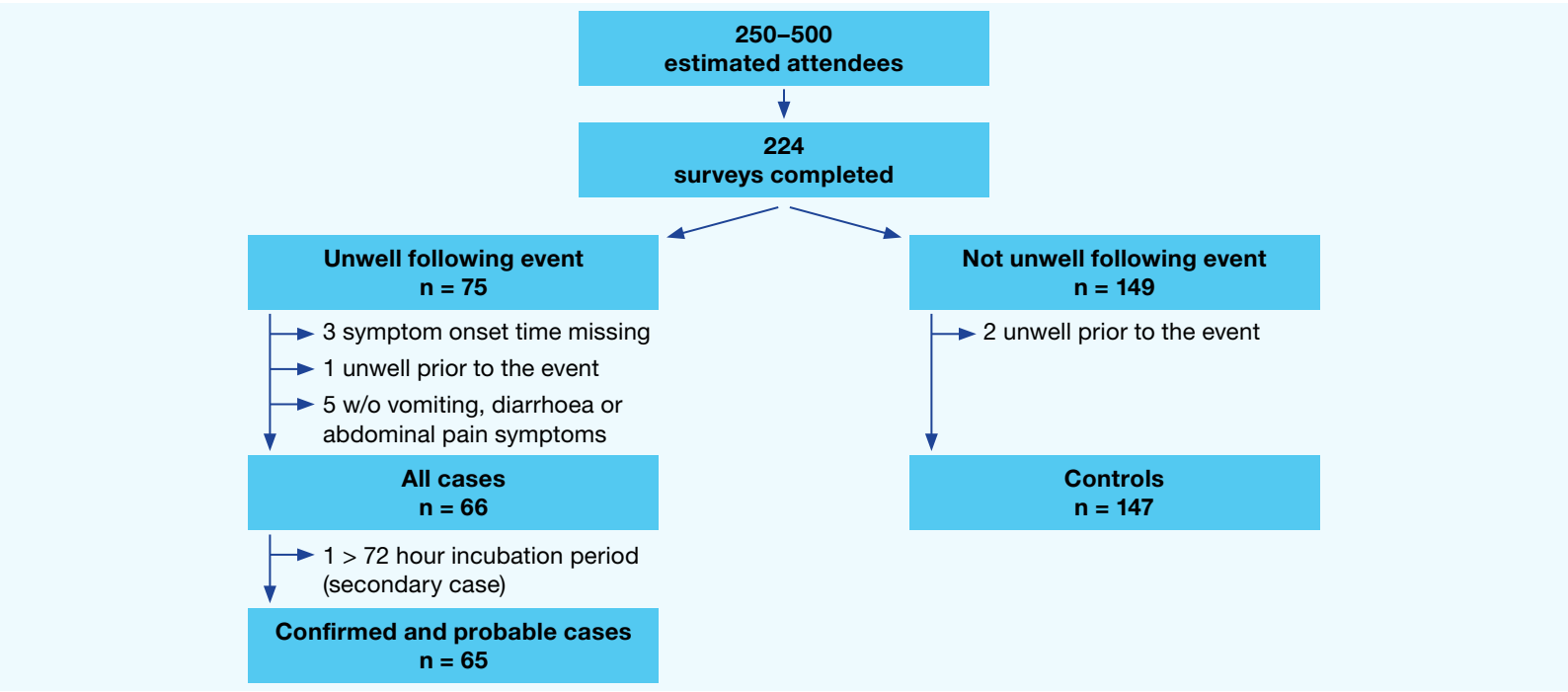
Case definition

A probable case was defined as a person who reported gastrointestinal symptoms (vomiting and/or diarrhoea and/or abdominal pain) commencing 6–72 hours after attending the private function. A confirmed case met the probable case definition and returned a norovirus-positive stool sample. A secondary case was defined as a person who reported gastrointestinal symptoms with an incubation period greater than 72 hours and who was a household contact of a probable or confirmed case. Controls were persons who attended the function and reported having no gastrointestinal symptoms.

Case-control inclusion criteria

Individuals were excluded from the analysis if they reported being unwell with gastrointestinal symptoms in the two weeks prior to the function, if they were identified as a secondary case on the basis of an incubation period exceeding 72 hours, or if they were unwell after attending the event but did not provide enough details about the time of symptom onset to categorise them as a case (Figure 1). Probable and confirmed cases were included as cases in the case-control study.

Figure 1: Case-control study inclusion criteria for cases and controls, norovirus outbreak, Australian Capital Territory, 2024



i ‘Research Electronic Data Capture’ web application: https://project-redcap.org/.

Statistical analysis

Data were analysed in Microsoft Excel and R Statistical Software (v4.4.0; R Core Team 2024). Age group and gender of cases and controls were compared using chi-squared analysis. Univariate (Fisher's exact test) and multivariable (logistic regression) analyses of exposures were performed. The multivariable analysis included age, as well as any food exposure from the univariate analyses that had a p-value < 0.2 and an odds ratio (OR) > 1. All individual variables and interactions of age group with each of the food exposure variables were included in the full model. Non-statistically significant variables were removed in a backwards stepwise elimination method. Akaike information criteria were used to assess goodness of fit for each model. Adjusted odds ratios for each variable of the final model are reported.

Ethical considerations

Ethics approval was not required for this outbreak, as it fell under the *Public Health Act 1997* (ACT) as a public health investigation. This work also falls under the Australian National University (ANU) waiver of consent protocol: 2017/909 for research performed as part of an outbreak investigation.

Results

Environmental health investigation

A review of the food preparation areas, food storage facilities and conditions, and handwashing stations did not identify any areas of non-compliance. Eight food samples were collected: four cured and dried meats; three commercially prepared dips; and one tartare sauce. Any remaining food that had been received and/or prepared for the function was discarded and therefore did not present an ongoing risk to the public. Venue staff noted that catering for the event was provided by the venue in a private room, though attendees could also purchase food from a restaurant which was open to the public.

Venue staff described the venue's staff illness and exclusion policy (a requirement under the Australia New Zealand Food Standard Code (FSC), Standard 3.2.2, Division 4 (Health and hygiene requirements).[23] Despite this, it appeared this was being applied inconsistently across the venue, as there were reports of staff returning to work within 48 hours of their last symptom of gastrointestinal illness.

One food handler was identified as having been unwell five days prior to the event, and subsequently prepared fruit platters and cured and dried meat platters for the event but did not work at the event. This food preparation occurred two days after the recommended 48 hour exclusion period for gastrointestinal symptoms. The food handler provided a stool sample four days after the event.

Laboratory investigation

Food samples

Listeria monocytogenes and *Salmonella* spp. were not detected in any food samples, and *E. coli* was within allowable detectable limits for all samples. Standard plate count results were within the expected range for all samples except the tzatziki dip, which was in the marginal range (11,000,000 colony forming units per gram [cfu/g]).

Clinical samples

Norovirus was detected in all six clinical samples (five attendees and the food handler who prepared the fruit and meat platters), with genotyping determining all to be *Norovirus* GII.6 type. No bacterial pathogens were isolated from the clinical samples.

Epidemiological investigation

Descriptive analysis

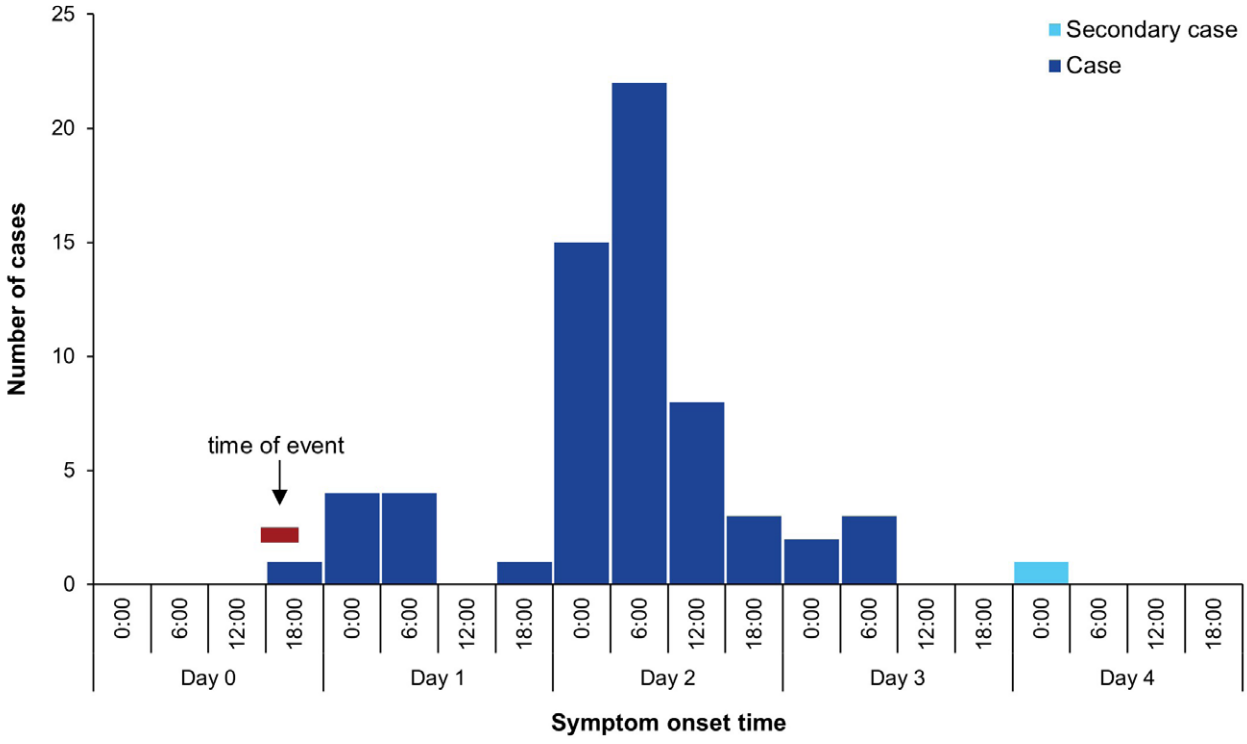
The total number of attendees at the function is unknown but was estimated to be between 250 (estimated by the event manager at the venue) and 500 (estimated as the number of invitees by the function organiser). The REDCap survey was completed by 224 individuals between three and five days post function. Seventy-five individuals (33%) reported being unwell following the function; of these, 60 were probable cases and five were confirmed cases. Of the ten ill people who did not meet the outbreak case definition: one individual was excluded as they reported also being unwell prior to the event; three were excluded due to missing onset time information; five were excluded as they reported symptoms but did not meet the case definition; and one was determined to be a secondary case (Figure 1). Controls included 147 individuals who attended the function and reported having no gastrointestinal symptoms following the event. Two individuals were excluded from the control group, as they had been ill with gastrointestinal symptoms prior to attending the function.

The secondary case was assumed to have resulted from transmission among household members. This case reported an incubation period of 83 hours from the start of the function; prior to their onset, at least one other member of their household was ill after attending the function.

There were no unwell individuals reported by the organisers of other events held on the same weekend. Several news articles were published in the days following the notification of the outbreak and this did not result in further reports of illness associated with the venue.

The median incubation period was 37.8 hours (range: 6.0–63.0 hours; interquartile range [IQR]: 34.3–42.5 hours; Figure 2). The median duration of symptoms was 27.3 hours (range: 0.3–56.0 hours; IQR: 12.8–32.4 hours); however, the duration of illness was only available for 16 cases, due to most cases reporting still being unwell when the survey was completed. Vomiting (n = 51/65; 78%), nausea (n = 49/65; 75%) and abdominal pain (n = 44/65; 68%) were the most common symptoms reported, followed by headache, diarrhoea, and fever in more than half the cases. No cases reported blood in the stool. Four cases attended the Emergency Department; however, none were hospitalised. The ANU FSANZ calculator estimated the financial burden of the outbreak at $29,800 (AUD) in direct medical costs, lost productivity and pain and suffering.[24]

Figure 2: Epidemic curve of symptom onset day and time of cases, norovirus outbreak, Australian Capital Territory, 2024



Statistical analysis / case-control study

Initial analysis included all cases and control and there was no difference in gender between these groups (χ^2 = 2.4; degrees of freedom [df] = 1; p = 0.12). The representation of different age groups in cases and controls varied significantly (χ^2 = 13.4; df = 2; p = 0.001): overall, cases were younger (median age = 16 years; range = 9–53 years) than controls (median age = 34 years; range = 9–80 years; Table 1).

Consumption of any food at the event was significantly associated with illness (OR: 57.8; 95% CI: 12.4–1368.3; p < 0.001; Table 2). There was no significant association between illness and socialising with other attendees prior to the function (OR: 1.0; 95% CI: 0.6–1.9; p = 1; Table 2). Of the cases that ate food at the venue, 61 out of 64 (95%) reported eating food catered for the event (OR: 10.2; 95% CI: 3.3–46.8; p < 0.001; Table 2), while consumption of food from the public restaurant was not associated with illness (OR: 0.7; 95% CI: 0.3–1.3; p = 0.30; Table 2).

Table 1: Age and gender of all cases and controls, norovirus outbreak, Australia Capital Territory, 2024

		Cases		Controls		Total	
Category	**Characteristic**	**n**	**%**	**n**	**%**	**n**	**%**
Total	**—**	**65**	**—**	**147**	**—**	**212**	**—**
Gender	Male	29	44.6	84	57.1	113	53.3
	Female	36	55.4	63	42.9	99	46.7
Age group (years)	0–17	37	56.9	49	33.3	86	40.6
	18–39	13	20.0	28	19.0	41	19.3
	40+	13	20.0	65	44.2	78	36.8
	Missing	2	3.1	5	3.4	7	3.3

Table 2: Summary of attack rates and odds ratios for univariate analysis of function and food exposures, norovirus outbreak, Australian Capital Territory, 2024

		Cases			Controls			Univariate analysis[a]		
Exposure category	**Detail**	**n**	**Total**	**%**	**n**	**Total**	**%**	**OR**	**95% CI**	***p***
Attended other group social events prior	—	25	65	38.5	56	147	38.1	1.0	0.6–1.9	1
Ate food at the venue	Total	64	65	98.5	72	147	49.0	57.8	12.4–1368.3	< 0.001
	Ate at the restaurant	24	64	37.5	34	72	47.2	0.7	0.3–1.3	0.30
	Ate in function room	61	64	95.3	47	72	65.3	10.2	3.3–46.8	< 0.001
Catered foods in the function room	Turkish bread	18	61	29.5	12	47	25.5	1.2	0.5–2.9	0.67
	Dip	11	61	18.0	14	47	29.8	0.5	0.2–1.3	0.17
	Cheese	5	61	8.2	6	47	12.8	0.6	0.2–2.2	0.53
	Fruit	45	61	73.8	16	47	34.0	5.3	2.4–12.6	< 0.001
	Semi-dried tomato	2	61	3.3	2	47	4.3	0.8	0.1–7.6	1
	Cured or dried meat	31	61	50.8	13	47	27.7	2.7	1.2–6.2	0.02
	Olives	6	61	9.8	4	47	8.5	1.2	0.3–5.0	1
	Quiche	18	61	29.5	22	47	46.8	0.5	0.2–1.1	0.07
	Party pie	20	61	32.8	15	47	31.9	1.0	0.5–2.4	1
	Sausage roll	26	61	42.6	17	47	36.2	1.3	0.6–2.9	0.56
	Meatball	6	61	9.8	6	47	12.8	0.8	0.2–2.6	0.76
	Spinach and feta filo	12	61	19.7	14	47	29.8	0.6	0.2–1.4	0.26
	Spring roll	12	61	19.7	13	47	27.7	0.6	0.3–1.6	0.36
	Other	8	61	13.1	7	47	14.9	0.9	0.3–2.7	0.79

a OR: odds ratio; 95% CI: 95% confidence interval.

Table 3: Age and gender of cases and controls who consumed food in the function room, norovirus outbreak, Australian Capital Territory, 2024

Category	Characteristic	Cases		Controls		Total	
		n	%	n	%	n	%
Total (N)	**—**	**61**	**—**	**47**	**—**	**108**	**—**
Gender	Male	28	45.9	25	53.2	53	49.1
	Female	33	54.1	22	46.8	55	50.9
Age group	0–17 years	36	59.0	12	25.5	48	50.0
	18–39 years	11	18.0	11	23.4	22	14.8
	40+ years	12	19.7	23	48.9	35	32.4
	Missing	2	3.3	1	2.1	3	2.8

Following the initial analysis, cases and controls were restricted to those that had consumed food at the venue to determine the likely source of infection. Within this group, there was no significant difference in gender between cases and controls (OR: 1.3; 95% CI: 0.6–3.1; $p = 0.56$); however, as seen for the full case-control group, the case group was younger (median age = 16 years) than the control group (median age = 39.5 years; *t*-value: -3.9; df = 93.8; $p < 0.001$; Table 3).

Univariate analysis of the catered foods provided in the function room found that consumption of fruit (OR: 5.3; 95% CI: 2.4–12.6; $p < 0.001$; Table 2) and cured or dried meat (OR: 2.7; 95% CI: 1.2–6.2; $p = 0.02$; Table 2) were the only items significantly associated with illness. The cured or dried meat and age group interaction was excluded from the multivariable analysis, as it resulted in complete separation preventing convergence of a maximum likelihood estimate. The multivariable analysis selected the most appropriate model to include fruit (adjusted odds ratio [aOR]: 4.4; 95% CI: 1.6–12.6; $p < 0.001$), cured or dried meat (aOR: 7.0; 95% CI: 2.4–24.4; $p < 0.001$), and age group (0–17 years: aOR: 3.9; 95% CI: 1.0–15.7; $p = 0.05$; > 39 years: aOR: 0.6; 95% CI: 0.1–2.1; $p = 0.4$; Table 4). Despite the increased risk of illness in those aged < 18 years compared to 19–39 year olds, including age group as a main effect in the multivariate model did not change the significance of consumption of fruit or cured and dried meats as independent risk factors associated with being a case.

Fifty-five cases (85%) reported consuming at least one of these items. Of the ten cases that did not report consuming the implicated food items, three reported unwell household contacts, and a further four had incubation periods in the top quartile, indicating that these could have resulted from secondary infections. One case had a very short incubation period (9 hours) and one case reported eating the catered food, but did not identify any items that they ate.

Table 4: Summary of multivariable analysis of food exposures and age, norovirus outbreak, Australian Capital Territory, 2024

Exposure Classification	Category	Cases[a]			Controls[a]			Multivariable analysis[b]		
		n	N	%	n	N	%	aOR	95% CI	*p*-value
Food	Fruit	44	59	74.6	15	46	32.6	4.4	1.6–12.6	< 0.01
	Cured or dried meat	30	59	50.8	13	46	28.3	7.0	2.4–24.4	< 0.001
Age group	0–17 years	36	59	61.0	12	46	26.1	3.9	1.0–15.7	0.05
	18–39 years	11	59	18.6	11	46	23.9	—	—	—
	> 39 years	12	59	20.3	23	46	50.0	0.6	0.1–2.1	0.37

a n: number conforming to indicated category; N: total cases or controls for purpose of multivariable analysis.

b aOR: adjusted odds ratio; 95% CI: 95% confidence interval.

Discussion

The reported symptom profile of this outbreak was consistent with norovirus: the most reported symptom was vomiting (78%), which was more commonly reported than fever (51%); no cases reported blood in the stool.[9,10] The median incubation period was 37.8 hours, which is within the typical range for norovirus of 24–48 hours;[9,10] the median duration of symptoms was 27.3 hours, though this is likely not representative of all cases, with the actual duration likely to be longer (noting that many people were still reporting symptoms at the time of interview). Finally, no notifiable enteric bacteria were identified in the stool samples collected from five cases. These factors satisfy both Kaplan's[10] and Lively's[9] criteria for identifying norovirus in acute gastroenteritis outbreak investigations and are therefore highly suggestive of norovirus infection, which in this outbreak was confirmed by laboratory testing.

Among surveyed attendees, consumption of food at the function was the strongest risk factor for illness, indicating food as a vehicle for infection rather than person-to-person transmission. Of the catered foods, consumption of fruit or cured and dried meats were each individually associated with illness, and this effect was robust to age. Food-handler related norovirus outbreaks have commonly been associated with foods such as salads and sandwiches that have no kill step and/or are subject to extensive handling,[25] which is the case for both foods identified.

Ten cases did not report consuming either fruit or meat platters at the function. The occurrence of infections without reported exposure to the implicated foods could have occurred in several ways. Firstly, non-congruent results could be a result of recall bias or data entry errors due to self-reporting on surveys where food exposures were recorded by a check box rather than by a direct yes or no question, meaning a non-response is interpreted as a non-exposure, which could have resulted in an under-reporting of exposures. Secondly, cases could have resulted from secondary infections. This is a likely explanation for three cases who reported unwell household contacts. Further, norovirus infection can result in asymptomatic carriage,[26,27] and as most attendees came with other household members or social contacts, secondary cases without clear contact to a primary case are plausible. Thirdly, some probable cases may have acquired an independent gastrointestinal illness with coincidental timing.

Finally, for those that reported eating the catered food but not the fruit or meat platters, there is the possibility of cross-contamination of other items during the evening, which could have resulted in infection without those items being identified by the analytical study.

Laboratory testing of food samples did not detect any unacceptable contamination; however, there was no remaining fruit available for testing, and testing for norovirus was not able to be performed. Despite the lack of laboratory evidence to show contamination of fruit and meats, the epidemiological evidence was highly robust.

One of the key limitations of the study was the inability to conduct a cohort study due to the lack of access to the full attendee list. However, distribution of the survey by the function organiser likely resulted in more rapid reporting and a higher response rate overall, due to the survey coming from a known individual and the vested interest of the social group in finding a source of infection. This resulted in rapidly achieving a 2:1 ratio of controls to cases. While precise attendee numbers are unknown, the response rate is estimated to be ~45–90% of all attendees. The maximum time between the event and survey completion was five days, reducing the impact of recall bias.

The most likely source of norovirus contamination in this outbreak was a food handler, who was unwell with a norovirus-compatible illness prior to the function and who tested positive after the event for the same norovirus type as the function attendees. This food handler prepared the implicated foods outside of the recommended exclusion period for gastrointestinal illness; however it is likely that they unwittingly introduced contamination while preparing these foods. There was no pre-function sample from the food handler, so it is not possible to say conclusively that they were carrying norovirus at the time of food preparation. However, they did not work on the day of the function, making acquisition of their infection from the same source as the attendees unlikely, though community acquisition after preparation of the food or another common source at the venue cannot be ruled out.

Transmission of norovirus from food handlers through contamination of raw food products has been documented on numerous occasions,[20,25,28] with the casual nature of the hospitality workforce often a challenge to adherence to exclusion period recommendations.

While transmission from symptomatic individuals is commonly identified, transmission from asymptomatic food handlers has also been detected.[29] Here we demonstrate the potential for transmission of norovirus from food handlers outside the range of the usual exclusion period for gastroenteritis which has been reported previously, with norovirus transmitted via food handler-contamination four days after symptoms ceased.[30]

Conclusion

This outbreak of norovirus at a catered event was most likely caused by food contaminated by a food handler at the venue, despite the food venue being observed to have adequate food preparation processes and handwashing facilities, and despite the preparation of implicated foods occurring over 96 hours since the food handler's last symptoms, in accordance with the 48-hour post-symptom resolution exclusion period stipulated by local public health guidelines. This outbreak investigation shows that safe food practices and exclusion periods reduce but do not completely eliminate risk. Our findings highlight the need for continued education on effective hand hygiene in food preparation settings, especially when handling ready-to-eat foods and following gastrointestinal illness.

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We declare no conflicts of interest.

Author details

Dr Clare L Kinnear,[1,2]

Timothy Sloan-Gardner,[1]

Natasha Waters,[3]

Victoria Wansink,[3]

Lyndell Hudson,[4]

Jenny Post[1]

1. Public Health Intelligence and Reporting, Preparedness, Planning and Surveillance, Population Health, ACT Health and Community Services Directorate
2. National Centre for Epidemiology and Population Health, Australian National University, Acton, Australia
3. ACT Government Analytical Laboratory, Research, Programs and Scientific Services, Population Health Division, Health and Community Services Directorate
4. Environmental Health, Health Protection Service, Population Health Division, Health and Community Services Directorate

Corresponding author

Dr Clare Kinnear

Preparedness, Planning and Surveillance Branch, ACT Health and Community Services Directorate, 25 Mulley Street, Holder ACT 2611

Email: clarelkinnear@gmail.com

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