An outbreak of *Salmonella* Saintpaul gastroenteritis after attending a school camp in the Northern Territory, Australia

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Abstract

An outbreak of salmonellosis occurred following attendance at a school camp between 5 and 8 August 2014 in a remote area of the Northern Territory, Australia. We conducted a retrospective cohort study via telephone interviews, using a structured questionnaire that recorded symptoms and exposures to foods and activities during the camp. A case was anyone with laboratory confirmed *Salmonella* Saintpaul infection or a clinically compatible illness after attending the camp. Environmental health officers from the Environmental Health Branch undertook an investigation and collected water and environmental samples. We interviewed 65 (97%) of the 67 people who attended the camp. There were 60 students and 7 adults. Of the 65 people interviewed, 30 became ill (attack rate 46%); all were students; and 4 had laboratory confirmed *S.* Saintpaul infection. The most commonly reported symptoms were diarrhoea (100% 30/30), abdominal pain (93% 28/30), nausea (93% 28/30) and fever (70% 21/30). Thirteen people sought medical attention but none required hospitalisation. Illness was significantly associated with drinking cordial at lunch on 7 August (RR 3.8, 95% CI 1.3–11, $P < 0.01$), as well as drinking cordial at lunch on 8 August (RR 2.1, 95% CI 1.1–4.2, $P=0.01$). *Salmonella* spp. was not detected in water samples or wallaby faeces collected from the camp ground. The epidemiological investigation suggests the outbreak was caused by environmental contamination of food or drink and could have occurred during ice preparation or storage, preparation of the cordial or from inadequate sanitising of the cooler from which the cordial was served. This outbreak highlights the risks of food or drink contamination with environmental *Salmonella*. Those preparing food and drink in campground settings should be vigilant with cleaning, handwashing and disinfection to prevent outbreaks of foodborne disease. *Commun Dis Intell* 2017;41(1):E10–E15.

Keywords: outbreak, *Salmonella* Saintpaul, gastroenteritis, salmonellosis, foodborne disease, cohort study, public health, camp, environmental *Salmonella*

Introduction

Salmonella Saintpaul is a common *Salmonella* serotype in the Northern Territory of Australia. In 2014 it was the 3rd most commonly reported serovar, accounting for 11% of all salmonellosis notifications.[1] About half of all *S.* Saintpaul infections in the Northern Territory occur in children under 4 years of age, with the majority of these thought to be environmentally acquired.[2] Known reservoirs of *S.* Saintpaul are reptiles (including geckos and lizards),[3–5] amphibians[6–10] and wallabies and kangaroos.[11] In 2013, *S.* Saintpaul was detected in ovine, equine, feline, bovine, primate, kangaroo, beef, vegetables, tree nuts and parkland soil samples that were tested and recorded in the National Enteric Pathogen Surveillance System.[12] However, there have been relatively few outbreaks of *S.* Saintpaul recorded in Australia. In 2000 an outbreak occurred at a construction site in regional Queensland with 28 workers reporting gastroenteritis.[13] Tank water contaminated with mice and frog faeces was identified as the cause. A subsequent outbreak, also in Queensland saw 21 people affected with contaminated bore water the likely cause.[14] In 2006, a nationwide outbreak occurred with 36 cases associated with consumption of rockmelon grown in Northern Australia.[15]

On 14 August 2014, the Northern Territory Centre for Disease Control was alerted to a possible outbreak of gastroenteritis among school students who had recently attended a school camp between 5 and 8 August 2014. This was discovered while conducting hypothesis generating interviews with routine salmonellosis notifications, when it was revealed that 2 cases attended the same school and had attended camp in the week preceding their illness. The school camp was at a remote outback location and was attended by 67 people who slept in tents. Food and drink was prepared and served from a kitchen housed in a caravan. The initial cases reported that other attendees were also sick. An outbreak investigation was initiated to identify the cause of illness and implement appropriate public health measures to prevent further cases.

Methods

Epidemiological investigation

We requested details of other school groups that attended the camp grounds in the week prior to and following 5 to 8 August 2014 in order to determine whether other school groups were affected. There were no reports of illness in other groups.

Once the existence of an outbreak was confirmed, a retrospective cohort study was undertaken in order to try to determine which exposures were associated with illness.

We developed and administered a questionnaire that recorded details on symptoms and health seeking behaviour as well as exposures at the camp based on the camp menu, itinerary, activities and observations made at the environmental health site visits on 18 and 19 August. Active case finding was also undertaken through this questionnaire. We obtained verbal consent from a parent or a guardian prior to conducting telephone interviews with cases. All cases were provided with a salmonellosis fact sheet.

A probable case was defined as a person who attended the camp between 5 and 8 August 2014 and subsequently developed a diarrhoeal illness. A confirmed case was defined as any person who had a diarrhoeal illness and had *S*. Saintpaul isolated from a faecal sample. Data were collected and entered into Microsoft Excel 2010 (Microsoft, USA) and statistical analysis was conducted using StataIC® 13 (StataCorp, USA). Univariate analysis of exposures was conducted and we calculated relative risks (RR); 95% confidence intervals (CI) and *P* values were considered significant at the 0.05 level. Fisher's exact test was used when counts were <5. When a RR was infinite, exact logistic regression was used to calculate an odds ratio (OR) and 95% CI. The χ^2 test was used to analyse gender. Age was analysed using the Mann Whitney Wilcoxon Rank Sum test. We conducted multivariate analysis using logistic regression on all variables which had a $P < 0.05$ after univariate analysis.

Ethics approval was not sought for this investigation as it was conducted under the auspices of public health legislation.[16]

Environmental health investigation

Environmental health officers (EHOs) and an epidemiologist from the Northern Territory Department of Health visited the camp facility on 18 August and then again on 19 August to identify potential sources of infection and any contraventions of the *Northern Territory Food Act*[17] *and Northern Territory Public and Environmental Health Act*.[16] During the investigation, food preparation and storage areas were inspected, food preparation methods investigated, drinking water and sewage disposal infrastructure was inspected, and samples of water from the bore head, header tanks, ablution blocks, drinking water taps, and kitchen facilities were taken. Environmental samples were taken of the lake water, which was used for irrigation of the grounds, and wallaby faeces from the ground where tents were pitched. There was no food leftover from the camp to sample. Cleaning and disinfection of the kitchen, ablution facilities and camping equipment was also investigated.

Laboratory investigation

Water samples were collected from various locations at the campsite and tested at the Northern Territory Department of Primary Industry and Fisheries (DPIF) Water Microbiology Laboratory in Darwin for the presence of coliforms, *Escherichia coli* and enterococci. The results were reported against the Australian Drinking Water Guidelines.[18] Water samples from the hand wash basin, water tank and kitchen tap at the camp were tested by ProMicro, Hillarys, Western Australia for the presence of coliforms, *E. coli* and *Salmonella* spp. A heterotrophic colony count was also performed.

Samples of wallaby faeces were tested for the presence of *Salmonella* spp at the Northern Territory DPIF Veterinary Laboratory in Darwin, Northern Territory.

Stools were cultured using standard techniques. Tests for *Cryptosporidium* and *Giardia* were conducted using antigen detection tests. When *Salmonella* was cultured, isolates were sent to SA Pathology or the Microbiological Diagnostic Unit at the University of Melbourne for serotyping.

Results

Epidemiological investigation

We contacted 65 of 67 (response rate 97%) of those who attended the camp (60 students and 7 adults). Of the 65 people we interviewed, 30 became ill (attack rate 46%) (Table 1). All cases were students. Four people submitted stool samples and all had laboratory confirmed *S*. Saintpaul infection. Another 26 people met the case definition as probable cases. Thirteen people sought medical attention but none required hospitalisation.

There was no statistically significant difference between males and females becoming ill nor was there a difference in ages.

In addition to diarrhoea, 27% (8/30) experienced bloody diarrhoea, 93% (28/30) experienced abdominal pain, 70% (21/30) experienced fever, 93% (28/30) experienced nausea and 47% (14/30) experienced vomiting (Table 1). The median incubation period was 45 hours (range 7 to 160 hours). The epidemic curve was typical of a point source salmonellosis outbreak (Figure).

Table 1: Demographic characteristics and symptoms of cases who attended a school camp in the Northern Territory, 5 to 8 August 2014

Characteristic	n	%
Gender		
Male	18	60
Female	12	40
Symptoms		
Diarrhoea	30	100
Nausea	28	93
Abdominal pain	28	93
Lethargy	26	87
Headache	25	83
Fever	21	70
Vomiting	14	47
Bloody diarrhoea	8	27
Health seeking behaviour		
Sought medical attention	13	43
Hospitalised	0	0

Figure: Epidemiological curve of outbreak cases by onset day after attending a school camp in the Northern Territory, 5 to 8 August 2014 (n=30)

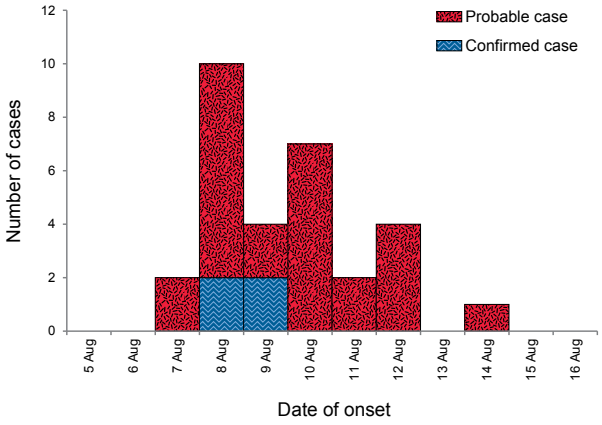

Table 2 shows a selection of risk factors from the univariable analysis which in total measured exposure to 170 variables. Drinking cordial at lunch on 7 August was statistically associated with illness (RR 3.8, 95% CI 1.3–11, $P < 0.01$), as was drinking cordial at lunch on 8 August (RR 2.1, 95% CI 1.1–4.2, $P < 0.01$). Other exposures that had a significant P value but with CI that included 1 were; drinking from a tap near the showers at the camp (RR 1.8, 95% CI 1.0–3.0, $P < 0.04$), using a tent supplied by the camp ground (RR 3.4, 95% CI 0.9–12.4, $P = 0.02$ and eating chicken casserole for dinner on 6 August (OR 8.9, 95% CI 1.2–∞, $P = 0.02$). Drinking cordial at any time between lunch on 7 August and the end of the camp on 8 August had a RR of 2.7 (95% CI 0.9-7.5, $P = 0.03$).

Table 2: Univariable analysis of selected risk factors for salmonellosis among attendees of a school camp in the Northern Territory, 5 to 8 August 2014

Exposure	Exposed			Unexposed			Crude RR	95% CI	*P* value
	Cases	Total	AR%	Cases	Total	AR%			
Drank cordial at lunch on 7 August	26	41	63	3	18	17	3.8	1.3–11.0	0.0015*
Drank cordial at lunch on 8 August	21	55	38	7	31	23	2.1	1.1–4.2	0.0144
Used a supplied tent	28	49	57	2	12	17	3.4	0.9–12.4	0.0217*
Ate chicken casserole at dinner on 6 August	29	54	54	0	6	0	8.9†	1.2–∞†	0.0242
Drank water from tap near showers	16	25	64	12	33	36	1.8	1.0–3.0	0.0370

AR = Attack rate

RR = Relative risk

CI = Confidence interval

* Fisher's exact

† Odds ratio and confidence intervals calculated using exact logistic regression.

Multivariate analysis resulted in a final model that included eating a cheese sandwich at lunch on 7 August (OR 0.2, 95% CI 0.0–0.9, $P = 0.03$), using a supplied tent (OR 6.8, 95% CI 1.1–40.7, $P = 0.04$) and eating chicken casserole for dinner on 6 August, which had an undefined OR as there were no cases who reported not eating it.

Environmental health investigation

The environmental health investigation observed that there were a large amount of animal droppings throughout the camping, activities and play areas. The ablution facilities were not in a clean state and dust, staining and grime was observed on the toilets, showers, hand basins, shower curtains, walls and floors. Drinking water at the camp site was from an untreated bore water supply and stored in header tanks that were gravity fed to the kitchen and ablution facilities. Patrons at the camp also had access to drinking water taps that were unclean and unprotected from environmental contamination. Untreated lake water was used to irrigate the camp ground. The kitchen was in a poor structural state, there was inadequate hand washing facilities and staff had a lack of food safety knowledge which may have resulted in poor practices in the kitchen. No staff illness was reported prior to or after the school camp. A large water container was observed outside the kitchen and dining area which was used to dispense cordial. It was visibly dirty and required cleaning.

Ice was produced onsite using untreated bore water that was poured into open steel containers that were frozen in a chest freezer. This chest freezer was also used to store other items including raw meats. Cordial at the camp contained untreated bore water and the ice prepared onsite.

Children who attended the camp participated in a number of activities which included abseiling, riding a flying-fox, lake walks, orienteering, playing ball games and cane toad hunting. The cane toad hunting activity occurred on the night of 6 August 2014 and involved some students collecting cane toads with gloved hands, placing them in a bag and then euthanasing them by placing the bag in the freezer.

EHOs directed the camp proprietor to treat the drinking water with chlorine prior to its use as a potable drinking water supply. The proprietor was also directed to refurbish or replace the kitchen facilities. Formal legal notices were issued to the proprietor under the *Northern Territory Food Act* and the *Northern Territory Public and Environmental Health Act 2011*. The proprietor voluntarily closed the camp in order to address the issues identified.

Laboratory investigation

Bore water samples collected from the kitchen tap, hand wash basin, shower tap, boys toilet tap, water tanks and from the bore head were all negative for *E. coli*, enterococci and the heterophilic colony count was also negative when assessed against the *Guidelines for Drinking Water in Australia*.[18] Lake water samples collected from a tap used to irrigate a lawn area at the camp ground were tested and recorded a total coliform count of $> 2{,}420$ per 100 mL, 18 *E. coli* per 100 mL and 38 enterococci per 100 mL. No *Salmonella* was detected in any of the samples tested above.

Samples of wallaby faeces tested negative for *Salmonella* spp.

Discussion

The results of this outbreak investigation suggests that food or beverage served at the camp on 7 August and possibly 8 August was responsible for the outbreak, and that a breakdown in cleanliness and food handling practices were the likely contributing factors. *S.* Saintpaul is a common environmental *Salmonella* serovar in the NT and it is likely that this outbreak was caused by the introduction of this organism from the environment into food or drink served at the camp. Unfortunately, no food or drink samples were collected and the specific cause of the outbreak cannot be determined. However, the environmental health investigation identified multiple opportunities for contamination to occur and resulted in formal legal notices being issued to the proprietor under the Northern Territory *Food Act* and the Northern Territory *Public and Environmental Health Act 2011.*

The results of the epidemiological investigation are inconclusive, particularly after multivariable analysis, but univariate analysis revealed an association with consuming cordial at lunch on either 7 or 8 August. The environmental investigation supports this. It revealed that ice used to make cordial was being produced on site in open topped containers that were filled with tap (bore) water. The bore water, along with other water samples at the camp tested negative for pathogens and other indicator organisms and was not considered a cause of the outbreak, unless it became contaminated during preparation of ice or cordial. Containers of ice, which were open containers with no covering, were placed in the chest freezer which was also used for storage of other items. This presented a risk of cross contamination to the ice from other items in the freezer. Apart from food items, it is also plausible that cane toads could have been euthanised in the same freezer. *Salmonella* can survive for extended periods at temperatures below

freezing.[19] When ready for use, the ice was further processed and placed into the containers by hand, which presented another opportunity for contamination. Concerns about the lack of hand washing facilities, availability of hot water for hand washing and actual practices around hand washing presented a further risk of contamination of the ice and add to the number of plausible mechanisms for contamination of the cordial throughout this ice-making process. Additionally, the lack of cleaning and disinfection of equipment, including the cordial container, could have led to contamination of the cordial during service.

There are other possible causes of the outbreak although these are less compelling. Eating the chicken casserole for dinner on the evening of 6 August also yielded a statistically significant association with illness after univariate analysis (OR 8.9, 95% CI 1.2–∞, $P = 0.02$) but there was less confidence in this association compared with that of the cordial. Chicken casserole has an inherent kill step and camp attendees reported that the casserole was served 'piping hot', which makes the chicken casserole an unlikely vehicle for *Salmonella* infection in this instance.

Sleeping in a supplied tent (i.e. supplied by the campground) also had a significantly high risk ratio after univariate analysis (RR 3.4, 95% CI 0.9–12.4, $P = 0.02$) and it is possible that exposure to contaminated tents led to the outbreak. However, exposure to the supplied tents would have led to earlier onset of illness and a pattern of illness consistent with a continuous exposure over the 2 days of the camp. This is in contrast to the pattern seen in the epidemic graph, which strongly suggests a point-source outbreak of illness (or one with a narrow window of exposure) with many cases initially becoming ill at the same time. The majority became ill 6 to 36 hours after lunch on 7 August coinciding with the average incubation period for salmonellosis.[20]

Drinking water from the taps near the shower block was associated with illness after univariate analysis with a relative risk of 1.8 (95% CI 1.0–3.0, $P = 0.03$). This association however, was much weaker than that of drinking cordial at lunch on August 7 and was considered unlikely as a cause as it was also a continuous exposure.

Multivariate analysis was attempted but the final model, which included eating a cheese sandwich at lunch on 7 August using a supplied tent and eating chicken casserole for dinner on 6 August was considered not to be a plausible causal pathway for the outbreak for the same reasons outlined above.

No other foods, activities or exposures in the questionnaire, including hunting cane toads were statistically associated with illness. Nevertheless, it could be that the source of salmonellosis was an unknown environmental exposure on 7 and 8 August. However, regardless of the specific cause, it is likely that the various environmental and infrastructure issues identified by the EHOs contributed to the risk of contamination and therefore illness in the patrons, whether directly from the environment or indirectly through contamination of food or drink prepared at the camp, in this instance, the cordial served at lunch on 7 August.

A major limitation of the investigation was that there was no food, drink or ice available for sampling and thus *S.* Saintpaul was not able to be detected in food or drink samples. Only bore water, lake water and wallaby faeces was collected for sampling and *S.* Saintpaul was not detected in any samples. The exact cause of the outbreak could not be determined but poor food handling practice, sanitation and hygiene could have facilitated contamination.

We were able to contact almost the entire cohort of persons who attended the camp, which minimised selection bias.

The large number of variables tested in this cohort study meant that some exposures could have been identified as being significantly associated with illness by chance alone rather than being a true association.

Conclusion

We conclude that an outbreak of *S.* Saintpaul at a school camp was most likely caused by environmental contamination of food or drink. There were multiple possible mechanisms for contamination to occur due to poor food safety knowledge, poor hygiene and structural deficiencies at the camp.

In order to prevent outbreaks such as this it is essential that those preparing food in campgrounds and outdoor settings have appropriate knowledge of safe food handling procedures and recognise the risks of contaminating food or water with pathogens from the environment, including *Salmonella*. Food handlers, including volunteers need to be adequately trained in safe food preparation procedures including hand washing, cleaning, disinfecting and recognising cross-contamination risks. It is also important to appropriately maintain facilities for food preparation and service. It is important to investigate outbreaks of environmental *Salmonella* in order to identify risks, undertake appropriate public health action and ensure public safety.

Acknowledgements

The authors acknowledge the staff at the following organisations for their assistance with the investigation: Dr Stephanie Davis at the National Centre for Epidemiology and Population Health at the Australian National University, Northern Territory Centre for Disease Control, the Northern Territory Environmental Health Branch, Royal Darwin Hospital pathology laboratory, Western Diagnostic Pathology, SA Pathology, Microbiological Diagnostic Unit, Australian National University and the proprietor of the camp for their cooperation with the investigation.

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