A GASTROENTERITIS OUTBREAK INVESTIGATION AMONGST LEARNERS AND TEACHERS FROM A CAMP TRIP IN KWAZULU-NATAL PROVINCE, JANUARY 2017

Mabore Morifi[1, 2], Arvinda Sooka[3], Karen Keddy[3, 4]

[1]South African Field Epidemiology Training Programme, NICD
[2]School of Health Systems and Public Health, University of Pretoria
[3]Centre for Enteric Diseases, NICD
[4]Faculty of Health Sciences, University of the Witwatersrand

Executive summary

A gastroenteritis outbreak amongst learners and teachers of an urban school in Johannesburg, who were returning from a school camp in KwaZulu-Natal held from 20 to 27 January 2017, was reported through the National Institute for Communicable Diseases (NICD) hotline during the weekend of 28/29 January 2017. A descriptive investigation was conducted to quantify the outbreak, identify the source, and make recommendations to prevent future events. Epidemiologic and environmental investigations were also conducted. Clinical laboratory investigation depended on private laboratories forwarding bacterial culture results or any enteric bacterial pathogens isolates to the Centre for Enteric Diseases, NICD. Ninety people attended the camp and 48.9% (44/90) of them participated in the study. Of these, 42 developed diarrhoea. The median number of days of illness was 7 (IQR: 5-9 days). Approximately 62% (26/42) of the cases sought medical care and two were hospitalised. On the fourth day of camp, there was heavy rainfall and campers fell ill from the day after the storm. The communities neighbouring the valley had no proper sanitation facilities. River and spring-water used by the campers was not treated. Faecal coliforms were identified from river and spring-water samples at higher counts than the standard limits. *Salmonella enterica* subspecies *diarizonae* was isolated from a stool sample of one of the cases. This is an animal species-specific isolate suggesting the infection was through exposure to a contaminated environment. Although not proven epidemiologically, the outbreak was most likely due to a waterborne infection. In order to prevent future outbreaks, treatment of water from natural sources is recommended as is provision of proper sanitation facilities to the surrounding communities. Outbreak investigations would be facilitated by collection of stool specimens from all patients presenting with diarrhoea and full participation of both affected and unaffected persons in the investigation of public health events.

Introduction

Gastrointestinal infections are of enormous public health importance, killing approximately 2.2 million people globally per year.[1] Clinical symptoms of gastroenteritis are fever, headache, diarrhoea and abdominal pain with or without vomiting. Waterborne and foodborne gastroenteritis outbreaks have been reported before and are mostly associated with pathogens such as *Salmonella*, diarrhoeagenic *Escherichia coli* (*E. coli*), *Shigella*, *Vibrio cholerae* O1, *Campylobacter*, norovirus, rotavirus and *Cryptosporidium*.[1] Infections are acquired

through person-to-person contact due to poor personal hygiene or consumption of food or water contaminated with animal or human faeces. Animal-specific isolates include *Salmonella enterica* subspecies identified in pets, farm animals and wildlife. Water sources previously associated with outbreaks of enteric pathogens include lakes, swimming pools, recreational water, natural springs, rivers, coastal water and drinking water.

A class of grade 7 learners and 12 staff members from a preparatory school in Johannesburg attended an outdoor educational camp in KwaZulu-Natal Province from 20 to 27 January 2017. Outdoor education included water activities such as river studies, swimming in the local dam and free time around the river. One facility was used for food preparation to serve the different groups camping in the valley. In addition, the learners participated in a group activity where they bought food from local retailers, which they had to prepare themselves.

On the evening of 27 January 2017, the day they returned to Johannesburg, some learners and teachers experienced fever, chills, headache, diarrhoea with mucus and vomiting: symptoms suggestive of gastroenteritis. A concerned parent, also a doctor, notified the National Institute for Communicable Diseases (NICD) Outbreak Response Unit (ORU) through the NICD hotline during the weekend of 28/29 January 2017 about her child who attended the camp and developed diarrhoeal symptoms. In response, the Centre for Enteric Diseases (CED), NICD, initiated an outbreak investigation on 2 February 2017. The objectives of the investigation were to quantify the extent of the outbreak, identify the source and provide recommendations to prevent future similar outbreaks.

Methods

A descriptive study was conducted. The study population was a group of learners and teachers from an urban preparatory school in Johannesburg who took a trip to a valley for an educational camp. On 24 January 2017 there were heavy rains, and the river in the valley was in flood. However, only attendees from one of three campsites (A) were affected. A probable case was defined as anyone who went camping in the campsite A from 20 to 27 January 2017 and experienced one or more of the following symptoms: fever, abdominal pain, headache, diarrhoea, or joint pain. A confirmed case definition was a probable case with laboratory confirmation of an enteric pathogen. A tailored gastroenteritis case investigation form (CIF) was issued for self-administration by the learners. The CIF requested the following information from respondents: age, gender, time and date of illness onset, symptoms, duration of illness, healthcare consultation, environmental risk exposures (animals, river and recreational water and sewage disposal), food exposures (for the last three days including day of return), hand washing and laboratory specimen collection. The camp management completed a questionnaire to describe sanitation and water supply systems, geographical distribution of sleeping accommodation and water sources.

A site investigation revealed that there is a river flowing across the valley. The site where the learners were camping (Campsite A) was downstream in the direction of water runoff from the surrounding hills. Upstream were Campsites B and C, a natural spring and human settlements beyond the valley boundaries. The sanitation system comprised of septic tanks and French drains; this was a closed system and no sewage leakages were reported by participants. The water sources for the valley are spring and river-water. Spring-water was fed into tanks and distributed to the kitchens by pipes to fill dispensing containers. Untreated river-water was used for toilets and ablutions.

An environmental health inspection was conducted including an assessment of the human settlement neighbouring the valley campsite. Water samples were collected from five points: office kitchen tap, Campsite

A kitchen, river, Campsite A tent 07 and Campsite B kitchen. The CED-NICD issued a list of all camp attendees (full names and dates of birth) to private laboratories requesting information isolates and/or results of specimens collected from camp attendees. Two stool samples from affected campers were obtained from private laboratories and were tested by the NICD for enteric pathogens using culture and polymerase chain reaction (PCR). Participant characteristics were described using descriptive statistics.

Ethical clearance for this outbreak investigation were covered in terms of the NICD blanket ethical clearance for outbreak investigations (M160667). Informed consent was sought from adult camp attendees and additionally, parental consent and child assent forms in minors less than 18 years of age were obtained.

Results

A total of 78 learners and 12 staff members attended an outdoor educational camp from 20 to 27 January 2017. Of the 90 camp attendees, 54 (60%) consented (assent for minors) and 44 (48.9%) participated in the investigation. Of the 44 participants, 42/44 (95%) were ill (probable cases) and 2/42 were not ill (Table1). The majority were learners (84%) and all were males and their ages ranged from 12 to 13 years. The median age of the teachers was 36 years (age range: 24 to 58 years). The attack rate among the respondents was approximately 95%. The median number of days of illness was 7 (IQR: 5-9 days). Sixty-two percent of the cases sought medical care (Table 1). A learner and female teacher were hospitalised for 5 and 3 days respectively. No deaths were reported from this outbreak.

Table 1. Demographic and clinical characteristics of the participants in a gastroenteritis outbreak investigation, Johannesburg, January 2017.

Characteristics		Frequency (N=44)	
		n	%
Sex	Male	40	91
	Female	4	9
Occupation	Learners	37	84
	Teachers	7	16
Clinical status	Ill	42	95
	Not ill	2	5
GP consultation	Yes	26	62
	No	16	38
Hospital Admissions	Admitted	2	5
	No admission	40	95
Duration of illness	</= 7 days	24	57
	> 7 days	17	41
	Missing	1	2

The epidemiologic curve is shown in Figure 1. The first case reported was a learner aged 12 years, who started feeling ill on 24 January 2017. The duration of illness for the case that fell ill on 25 January was 14 days.

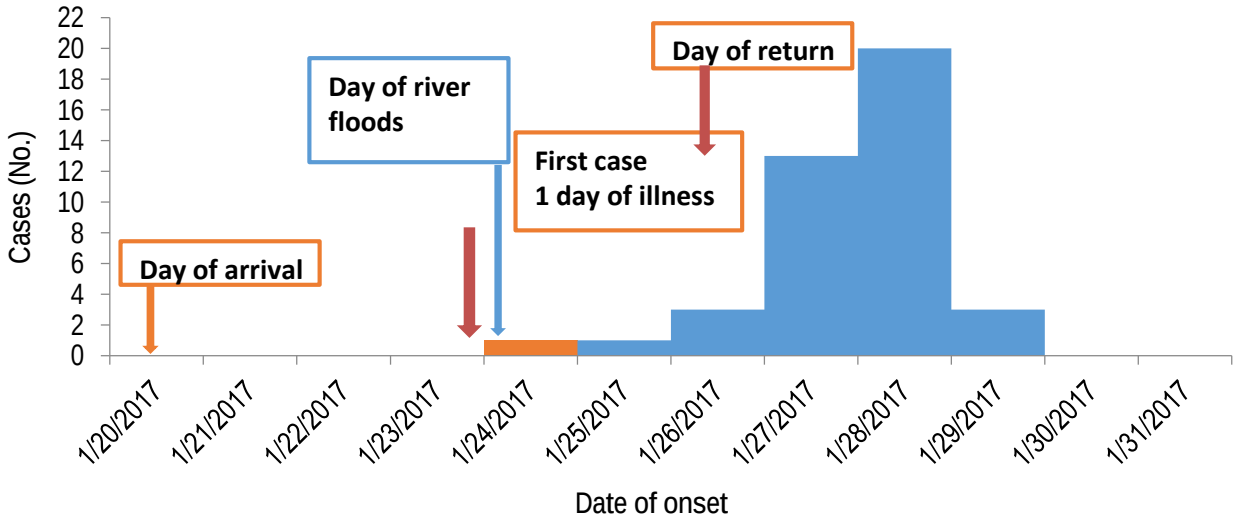
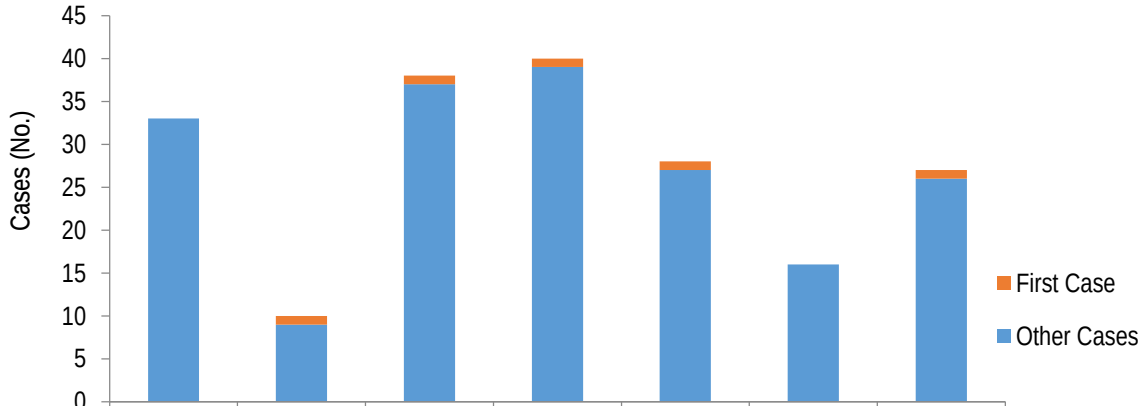


Figure 1. Epidemiologic curve of a gastroenteritis outbreak that occurred at an environmental education facility in KwaZulu-Natal Province, by date of onset of illness, January 2017.

Clinically, the majority of the cases experienced diarrhoea and abdominal pain (Figure 2). Ten cases reported vomiting including the first case with the shortest duration of illness. The second case reported fever, diarrhoea, abdominal pain, joint pain, headache and loss of appetite without vomiting. One of the cases that was hospitalised was treated for dehydration and deep vein thrombosis (DVT).



	Fever	Vomiting	Abdominal pain	Diarrhoea	Headache	Joint pain	Loss of appetite
First Case	0	1	1	1	1	0	1
Other Cases	33	9	37	39	27	16	26

Figure 2. Frequency distribution of symptoms among gastroenteritis cases, Johannesburg, January 2017.

Participants reported multiple food and environmental exposures. Some meals were consumed onsite and lunch packs were prepared to consume offsite when they went on tours. Eight of 44 (18%) respondents indicated exposure to animals including dung beetles, spiders, a puppy from the local village, frogs, crabs, fish, cows, goats and locusts. All the attendees used the river and spring-water sources in the valley for recreation and ablutions. Just over half of the cases (23/44) engaged in river activities after the floods and 57.1% (24/42) reported that they did not wash their hands after camp activities. Hand-washing was done in a shared tub containing water with disinfecting soap. The first case reported was not exposed to animals, but had mud from the river thrown in his face and mouth before the river flooded.

For one of the exercises, the learners were divided into 2 main workgroups to purchase and prepare their own foods; each group took part on a different day. Each group was further sub-divided into smaller groups and prepared different meals for themselves. The attendees were grouped according to responses to the workgroup member list provided by the respondents (Table 2). All groups had at least 1 member who got ill. Based on this variety of food exposures (Table 2), the food purchased for this exercise could be excluded as sources of infection. However, this is challenged by under-representation of most groups by the respondents. The common factor was utilization of river water to cook and boil their foods. Those that did not get ill also consumed food prepared during this exercise.

Table 2. Distribution of cases among workgroups related to a gastroenteritis outbreak, Johannesburg, January 2017.

Groups	Respondents Ill (%)	Respondents not ill (%)	Non-Respondents (%)	Total
1	5 (83.3)	0(0.0)	1(16.7)	6
2	4(80.0)	0(0.0)	1(20.0)	5
3	3(50.0)	0(0.0)	3(50.0)	6
4	2(33.3)	0(0.0)	4(66.7)	6
5	4(57.1)	1(14.3)	2(28.6)	7
6	2(33.3)	0(0.0)	4(66.7)	6
7	4(50.0)	0(0.0)	4(50.0)	8
8	1(13.7)	0(0.0)	5(83.3)	6
9	2(33.3)	0(0.0)	4(66.7)	6
10	3(42.9)	0(0.0)	4(57.1)	7
11	4(66.7)	0(0.0)	2(33.3)	6
12	3(50.0)	1(16.7)	2(33.3)	6
Unknown*	-	-	3	3
Total	**37 (47.4)**	**2(2.6)**	**39 50)**	**78**

*Unknown: Attendees not listed by any of their group members.

The standard of personal hygiene of the kitchen staff was reported as satisfactory by local health officials. Most of the residents in neighbouring settlements had no proper sanitation facilities. Total coliform and *E. coli* counts in river and spring-water were above standard limits according to the essential microbiological criteria of the South African National Standards (SANS) 241. Total coliform count was 241.9/ml in river water and >20/ml in spring water (SANS 241: <=10/ml). *Escherichia coli* count was 770/100ml in river-water and

between 20/ml and 60/ml in spring-water (for drinking water, the South African National Standard (SANS) 241 is nil/ml). These results are suggestive of faecal contamination of river and spring-water. Comments by participants on water quality included identification of black particles in drinking water, murky/yellowish water from taps and toilets and in a swimming pool, and hand-washing in a shared tub of brown-looking water.

Eleven cases had specimens collected for laboratory investigation. The specimens were 9 stools, 2 blood cultures and 1 rectal swab. Ten of these were collected before antibiotic treatment. CED confirmed on serotyping that *Salmonella enterica* subspecies *diarizonae* was identified from a stool specimen of a patient aged 13 years. It should be noted that the report of *Salmonella* Enteritidis, a pathogen that is typically associated with eating contaminated eggs or chicken, from a private laboratory was incorrect and could have misled those involved in a public health intervention. A diffusely adherent *E. coli* was identified from a rectal swab of a 12-year-old learner who presented with dysentery (diarrhoea with blood and mucous). The results for the remaining specimens are either unknown or culture negative for enteric pathogens. No stools submitted to private laboratories thus far were tested for viral enteric pathogens.

Discussion

The investigation studied 44 people and the attack rate among the respondents was 95%, although this is affected by the lack of responses from those camp attendees who did not get ill. Gastroenteritis in this outbreak was severe, with 61% of the respondents seeking medical treatment, and persistent, with 41% of patients being ill for more than a week. The epidemic curve suggests a common source exposure. It is hypothesised that water runoff from heavy rains introduced contaminants from human settlements with poor sanitation systems and the valley environment. The attendees started presenting with gastroenteritis illness after the heavy rains. However, there was limited evidence to epidemiologically link bacteria from water samples to that isolated from stool samples. This made it hard to conclusively identify the source of the outbreak.

At least one patient presented with *Salmonella*, which is a Gram-negative rod-shaped (bacillus) bacterium and has been identified in contaminated riverwater.[2] The first patient developed diarrhoea the same day of heavy rainfall and the river flood. However, this learner fell ill in the morning before the rainfall. His duration of illness was one day and may not be related to the major outbreak in which duration of illness ranged from 2 to 15 days. Although identified in one case, *Salmonella enterica* subspecies *diarizonae* is an environmental isolate and is not associated with exposure to any particular foodstuff or domesticated animals. The reported *Salmonella enterica* subspecies is mostly associated with reptiles, and was previously identified in riverwater after flood events.[3] High counts of total coliform and *E. coli* have been identified previously in springwater due to contamination by animal and human waste disposal. Stormwater runoff is a conduit for the transmission of large diversity of species to surface water.[3] The identified diffusely adherent *E. coli* was not a contributing factor for dysentery in the learner in whom this was identified. This pathogen is primarily associated with diarrhoea, in children under five years of age, and the patient received antibiotics before stool specimen collection.

This study was too limited by lack of food samples, including foods purchased and prepared by the learners, to exclude food items as a source of the outbreak. Another limitation was a low response rate by non-cases; this was a missed opportunity to identify a control group to measure association between exposures and gastroenteritis. Stool specimens should have been requested from all patients presenting with diarrhoea; a missed opportunity to identify a causal agent in this outbreak. Stool specimen testing should have included testing for both viral and bacterial pathogens.

In conclusion, although not proven epidemiologically, the outbreak was most likely waterborne due to contamination of the local water sources to which the campers were exposed by faecal bacteria and possibly viruses. This does not dismiss other potential exposures - analysis of which was limited. With a large proportion of cases seeking health care, the low response rate by the camp attendees may overestimate the severity of illness or underestimate the extent of the outbreak.

Actions taken

Health education was offered to food handlers in the valley on food labelling, personal hygiene and storage of food. However, for patient management, most of the cases consulted health practitioners for treatment in their personal capacity. No secondary cases were reported.

Recommendations

By the time of reporting to stakeholders, it was recommended that treatment of water used for personal care and drinking in the valley adheres to SANS for continuous monitoring of water quality with respect to bacteria and chemicals. To prevent future outbreaks, the valley management made an initiative to engage with the district municipality to assist with water treatment. Furthermore, it is recommended that the communities in the surrounding areas be provided with proper sanitation facilities. In the same light, the communities should be engaged on awareness of water pollution and its economic impact. It is further recommended that both public and private institutions encourage the participation of people who were not affected by a public health event to improve investigation outcomes. Healthcare Practitioners should be encouraged to send stool specimens from patients presenting with diarrhoea prior to antimicrobial treatment, particularly if the diarrhoea is potentially outbreak-associated, and to report potential outbreaks as soon as these are identified. Laboratory results need to be issued with caution as incorrect results may misdirect the outbreak investigation.

Acknowledgements

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