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Case Report

An acute gastroenteritis outbreak caused by GII.17 norovirus in Jiangsu Province, China

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SUMMARY

Noroviruses are a common cause of acute gastroenteritis around the world; however, reports of outbreaks caused by GII.17 norovirus are rare. An outbreak caused by GII.17 norovirus in a senior high school in Wuxi, Jiangsu Province, China is reported here. An epidemiological investigation, pathogen detection, and case–control study were performed. Epidemiological data combined with the epidemic curve indicated that this outbreak was a point source type initially, followed by secondary transmission. The first case was identified as most likely the source of the outbreak. Risk analysis showed exposure to patients and sharing a communal water cooler to be associated with the spread of infection. Sequence analysis of GII-positive samples confirmed that the norovirus GII.17 variant was the etiological agent of this outbreak.

1. Introduction

A meta-analysis published in 2014 suggested that norovirus causes almost a fifth of all cases of acute gastroenteritis worldwide.[1] Genogroups I, II, and IV, including at least 25 genotypes, are responsible for human infections.[2] For norovirus, the fecal–oral route is the leading mode of transmission. Contaminated water, food, and other fomites are important transmission vehicles.

Over the past two decades, new variants of GII.4 were found to be responsible for 55–85% of norovirus-associated outbreaks worldwide.[3,4] Prior to 2014, reports on acute gastroenteritis caused by norovirus GII.17 were rare.[5,6] It was noted that during the 2014–15 norovirus epidemic season, a new GII.17 variant emerged locally in the provinces of Guangdong and Jiangsu in China and in Japan.[7–9]

On December 11, 2014, it was reported that 57 students at a senior high school in the city of Wuxi, China had developed acute diarrhea and vomiting. Rectal swab samples from nine of the patients were found to be positive for norovirus GII.17 using reverse transcriptase PCR (RT-PCR). In order to provide effective control measures, the outbreak was surveyed to verify additional cases and the source of infection, the vehicle for infection, and the mode of transmission.

2. Methods

For the epidemiological investigation, suspected cases were defined as those with vomiting accompanied by nausea, diarrhea, abdominal pain, or fever. Confirmed cases were those with the same criteria and with positive laboratory confirmation of the norovirus. Non-cases were defined as students or staff members without symptoms of diarrhea or vomiting at 72 h (the longest incubation period of norovirus) after exposure to suspected risk factors. All of the case students (suspected and confirmed) and asymptomatic students in a ratio of 1:1, matched by class and age (±1 year), were enrolled in the case–control study.

In accordance with the Surveillance Program for the Viral Diarrhea Outbreak of Jiangsu Province, a total of 30 rectal swabs were collected, 10 from the case group, 10 from cafeteria food handlers, and 10 from the non-case group. As this was a highly transmissible environmental contagious agent, surface swabs were also collected from kitchen rags, kitchen cabinets, cafeteria tables, and the communal water cooler dispensers in the affected classrooms. A 10-l water sample was also collected from the communal water coolers in every affected classroom.

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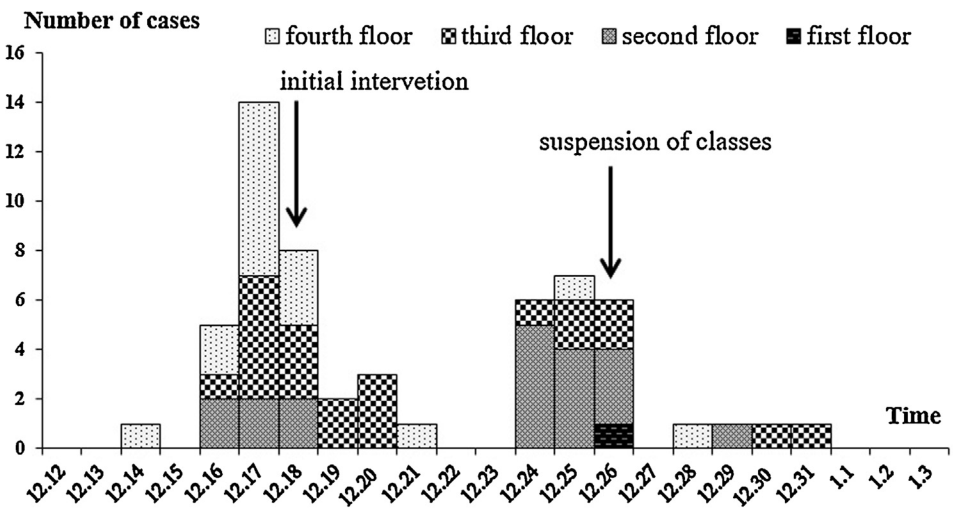

Figure 1. Distribution of cases grouped by floor by date of outbreak onset.

Water samples were first concentrated using a NanoCeram electropositive filter (Argonide Corp., USA) and Centricon Plus-70 centrifugal filter (Millipore Corp., USA) before RNA extraction.[10] Stool samples and environmental samples were tested for the presence of pathogenic bacteria and intestinal viruses. The bacterial pathogens were tested according to the technical procedures for diarrheal pathogenic spectrum surveillance formulated by the China Centers for Disease Control (CDC), with processing for bacterial isolation, culture, and purification. After RNA extraction using a Roche MagNA Pure LC instrument (Roche Applied Science, IN, USA), the swabs and concentrated water samples were tested for viral agents by real-time reverse transcription PCR on an ABI 7500 system using the corresponding detection kits (Shanghai ZJ Bio-tech Corp., Shanghai, China).

Conditional logistical regression analysis was used to calculate the odds ratios (OR) and 95% confidence intervals (CI) of various risk factors to predict cases, at a significance level of $p < 0.05$. Statistical analyses were performed using SPSS for Windows version 17.0 (SPSS Inc., Chicago, IL, USA).

3. Results

On December 14, 2014, the earliest suspected norovirus case, an extern student in grade three, vomited several times in public areas including the classroom and the washroom. Over the next 3 days, 27 further cases occurred, which were mainly located on the fourth floor (12 cases) and third floor (nine cases). Thus, the epidemic reached its first incidence peak (Figure 1). A decrease in cases followed after the implementation of control measures such as quarantine and disinfection. However, several days later, the attack rate peaked again on December 25. In contrast to the first peak, this time the student cases were mainly distributed on the second floor (12 cases) and third floor (five cases). To control further spread of the disease, the school was closed temporarily. As a result, the outbreak came to an end on the last day of 2014 (Figure 1).

According to the epidemiological questionnaire results, a total 57 of 2209 people were recorded as cases up to December 31, 2014, giving an attack rate of 2.58%. The cases were all students ranging

Table 1
Risk factor analysis

Variables	Cases, *n* (%)	Controls, *n* (%)	*p*-Values[a]	OR (95% CI)
History of contact with cases	57	57		
Yes	44 (77.2%)	26 (45.6%)	0.001	4.04 (1.80–9.06)
No	13 (22.8%)	31 (54.4%)		1.00 (reference)
Drinking water from water cooler in the classroom	57	57		
Yes	40 (70.2%)	28 (49.1%)	0.022	2.44 (1.13–5.26)
No	17 (29.8%)	29 (50.9%)		1.00 (reference)
Washing hands after toilet	57	56		
Yes	18 (31.6%)	34 (60.7%)	0.002	0.30 (0.14–0.65)
No	39 (68.4%)	22 (39.3%)		1.00 (reference)
Sharing a toilet	57	57		
Yes	28 (49.1%)	23 (40.4%)	0.346	1.43 (0.68–3.00)
No	29 (50.9%)	34 (59.6%)		1.00 (reference)
Eating cold food	57	57		
Yes	16 (28.1%)	21 (36.8%)	0.317	0.67 (0.30–1.47)
No	41 (71.9%)	36 (63.2%)		1.00 (reference)
Drinking unboiled water	57	57		
Yes	2 (3.5%)	4 (7.0%)	0.402	0.48 (0.09–2.74)
No	55 (96.5%)	53 (93.0%)		1.00 (reference)
Source of drinking water	57	57		
Bottled water	17 (29.8%)	27 (47.4%)	0.140	–
Boiled water from the dormitory	21 (36.8%)	14 (24.6%)		–
Both of the above water	19 (33.3%)	16 (28.1%)		–

OR, odds ratio; CI, confidence interval.
[a] Conditional logistical regression analysis.

in age from 16 to 19 years. The main symptoms were diarrhea (80.7%), vomiting (64.9%), abdominal cramps (47.4%), and fever (7.0%). The 57 student cases were distributed across 3 grades and 21 classes. The attack rate of students in grade 3 (5.0%, 35/700) was significantly higher than those in grade 2 (2.0%, 13/650) and grade 1 (1.46%, 9/616) ($p < 0.05$).

Risk factor analysis showed that the incidence of gastroenteritis among those exposed to patients was 4.04-fold (95% CI 1.80–9.06) higher than in those with no contact with infected persons. Furthermore, the incidence of gastroenteritis among those who drank water from water cooler was 2.44-fold (95% CI 1.13–5.26) higher than in those who did not drink the water ($p < 0.05$) (Table 1).

During the outbreak, nine of 30 rectal swab samples tested positive for norovirus GII. Surface swabs and water samples from the water coolers tested negative for norovirus in the outbreaks. The GII-positive samples were further genotyped by semi-nested PCR and sequencing.[11,12] Phylogenetic analysis showed that the strains isolated in this outbreak were grouped with the GII.17 strains isolated from Guangdong Province (**KP718639**, 2014), Taiwan (**KJ156329**, 2013), and Japan (**AB983218**, 2014).

4. Discussion

Previous epidemiological data suggest that in the past 2 years, GII.4 Sydney 2012 has been the major circulating norovirus genotype worldwide.[4,13] GII.17 cases have only been reported sporadically in Africa, Asia, Europe, North America, and South America.[14] However, a sharp increase in the number of cases caused by this novel virus was observed during the 2014–15 winter season in Japan and Guangdong Province in China.[8,9] An outbreak caused by GII.17 norovirus in one high school in Wuxi, Jiangsu Province is described here.

Norovirus infection is characterized by the sudden onset of vomiting or diarrhea, or both symptoms. Human experimental infection studies with norovirus show that the predominant symptom can vary from person to person. In this norovirus outbreak, diarrhea and vomiting were the predominant clinical features.

Norovirus is extremely contagious and humans are the only known reservoir for human norovirus. Transmission occurs via fecal–oral route in four general ways: direct person-to-person, foodborne, waterborne, or through environmental fomites. Negative results for norovirus in the water samples and kitchen surface specimens did not support the hypothesis of a foodborne or waterborne origin of the outbreak. As the act of vomiting generates an infectious aerosol, airborne transmission of norovirus from the first case who vomited in the classroom most probably initiated the outbreak. Students in the classroom where the vomiting occurred and those nearby (fourth floor and third floor) became ill in a much shorter period of time than students in classrooms far from where the vomiting occurred (first floor and second floor) in the initial 96 h. This is compatible with the person-to-person mode of transmission. The descriptive epidemiological investigation combined with epidemic curve supports a point source outbreak with secondary transmission towards the end, and the first case was most likely the source of the outbreak.

According to the analyses of risk factors, exposure to patients and sharing a water cooler in the classroom increased the risk of transmission of the norovirus, suggesting that transmission occurred primarily via person-to-person route and secondly through environmental fomites. It is speculated that the dispenser on the water cooler may have served as the transmission vehicle of infection despite it testing negative for norovirus.

Sequence analysis of GII-positive samples suggested that the norovirus GII.17 variants in this outbreak were highly homologous to the strains isolated in Guangdong, Japan, and Taiwan. The prevalence of this novel norovirus may be attributed to its wide spectrum of Histo-blood group atigens (HBGA)-associated susceptibility, like for GII.4 norovirus, so it might have the potential to spread globally in the near future.[15]

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Ethical approval: This outbreak investigation was conducted by public health agencies as part of their legally authorized mandate and was therefore considered a minimal risk research and was exempted from ethical approval by the institutional review boards.

Conflict of interest: The authors declare no conflict of interest.

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