Investigation of Norovirus-Induced Gastroenteritis Outbreak among Students in A High School

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From Chinese version, pp, 753-762

Abstract

Outbreaks of norovirus-induced gastroenteritis have occurred on and off in Taiwan. On March 16, 2008, a norovirus-induced gastroenteritis outbreak occurred in A High School in Douliou City, Yunlin County. This investigation was conducted in order to understand the outbreak scale, transmission route, infection origin, possible causes of the outbreak, and to assess the effectiveness of the control and preventive measures. The investigation uses semi-structure questionnaires to collect information from the 12th grade students about disease symptoms and onset dates for the purpose of taking relevant specimens and determining the possible transmission route. In addition, a case-control study was conducted to explore the possibility of occurrence of food poisoning.

Among the 380 questionnaires distributed to the 12th grade students, a total of 138 cases fit the case definition showing an attack rate of 36.3%. Two fecal

Received: July 11, 2008; Accepted: August 20, 2008.
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specimens from student cases were tested positive for norovirus. Due to the fact that norovirus can be confirmed as the source of the infection, this episode can be determined as a norovirus-induced gastroenteritis outbreak. By examining the epidemic curve, we can also determine the transmission route to be of one-point common source infection. Three of the fecal specimens collected from the culinary staff were also tested positive for the same type and strain of norovirus (G2/4) as those of the infected students. After analysis of the lunch prepared by the school on March 15, it is evident that the tuna macaroni (OR=7.445, 95%CL = 2.571~21.554) is statistically linked to this norovirus-induced gastroenteritis outbreak. Therefore, the tuna macaroni is highly suspected to be the cause of this incident of food poisoning. Unfortunately, no food specimens were available to confirm this.

After the disinfection of the school's kitchens, cafeteria, and surrounding environment, the school's kitchen service was halted for a week. In addition, with the absence of the 3 infected culinary staff members, the enhancing of hand washing among the students, and other preventive measures taken, no new cases of vomiting and/or diarrhea occurred as of March 20. We suspected that this norovirus-induced gastroenteritis outbreak was induced by contaminated food. Therefore, it is recommended that corresponding health departments not only needs to carry out the regulation of retaining school lunches for 48 hours, but also to add new testing categories (e.g. norovirus) for the leftover food.

Keyword: norovirus, gastroenteritis, epidemiology, food posioning

Introduction

Norovirus-induced gastroenteritis outbreaks are most common in aged care settings [1], long-term care facilities [2], psychiatric wards [3-4], institutes for the

mentally impaired [5], and schools [6-7]. Norovirus can also cause food poisoning outbreaks. This is due to the fact that the norovirus is most active in low temperatures [10], has a short incubation period (1-2 days), and is highly contagious (it can be quickly transmitted with only 10 viruses) [11]. The norovirus can be transmitted from person to person [12-13] and can also be common source infections through drinking water [14-15] or food [16]. The symptoms, such as diarrhea, abdominal cramps, nausea, vomiting, and fever caused by norovirus are mild enough for the infected person to recover without seeking medical assistance [17].

In the morning of March 17, 2008, the Yunlin County Public Health Bureau received a report notifying a vomiting and diarrhea outbreak occurred in A high school in Douliou City. Starting from 8 p.m. of March 16, students with abdominal pains, vomiting, diarrhea, and other gastro-intestinal symptoms were sent to Yunlin Branch of Taiwan National University Hospital, Tzu-Ai General Hospital, National Cheng-Kung University Hospital Yunlin Branch., Hong-Yang General Hospital, and other hospitals. As of 2 a.m., March 17, a total of 146 students fell ill. On March 18, the 4th Branch and Field Epidemiology Training Program, Taiwan Centers for Disease Control (TCDC), and health officials from Yunlin County Public Health Bureau started the epidemiological investigation at the school. The purpose of the investigation is to determine the outbreak scale, transmission route, infection origin, and possible causes of the outbreak. At the same time, assessment of the effectiveness of the control and preventive measures was also conducted.

Materials and Methods

School background investigation

A High School consists of 3,126 students with 1,220 senior high school students and 1,906 junior high school students. In addition, there are 155 teachers, 9 culinary staff members, and 42 administration and other staff members. The school cafeteria provides all three meals for students living on the campus. Lunches are provided in the student's classrooms whereas dinner is provided in the cafeteria. Students that do not live on campus order box lunches from 2 manufacturers outside of campus. Apart from tap water used for cooking, underground water is used in other circumstances.

Investigated subjects

Due to the fact that the large scale outbreak of vomiting and diarrhea occurred on March 15 (Saturday) and the larger number of senior high school students showing symptoms at school, the 12^{th} grade students became the main investigated subjects in this outbreak.

Investigation methods and tools

This investigation uses the retrospective case-control method. Semi-structure questionnaires were distributed to the investigated subjects in order to collect basic information, symptoms, onset dates, medical diagnosis, and the food items consumed on March 15. Questionnaires were answered by the subjects themselves.

Case Definition

As of March 8, 2008, students in A High School in Yunlin County showed at least two of the following four symptoms: nausea, vomiting, abdominal pains, and diarrhea (occurrence twice or more times a day); additionally, occurrence of at least 2 of the following symptoms: weakness in limbs, headaches, fever, chills, and tenesmus are defined as a case in this vomiting and diarrhea outbreak.

Specimens Collecting and Laboratory Testing

All collected information had been keyed in through the Software Epi Info

3.4.3 version. After data revision and correcting, the information was then stored into the database. The demographic data and symptom distribution of the interviewees are portrayed by frequency and percentage. Relevant transmission route is displayed by the epidemic curve. The food items prepared by the school on March 15 are analyzed through logistic regression analysis. At the same time, the Odds Ratio (OR) and 95% Confidence Limits (CL) of each food were calculated. If the 95% CL does not include 1.0, this represents the fact that the certain food item is statistically significantly related to the vomiting and diarrhea outbreak. The statistic analysis software used is SAS 9.1 Edition.

Results

A total of 380 questionnaires were collected from the 12th grade students. A total of 138 persons fit the case description, including 75 males (54.4%) and 63 females showing an attack rate of 36.3%. Among these cases, 45 live on campus with an attack rate of 34.4%. 93 of the students living outside of campus show an attack rate of 37.4%. The distribution of the symptoms portrayed by the cases are nausea 89.9%, weakness in limbs 84.8%, vomiting 83.3%, headaches 78.3%, diarrhea 61.6%, fever 55.1%, chills 51.5%, and tenesmus 16.7%. Among the cases with diarrhea, 73 (85.9%) also showed symptoms of watery stools and 11(12.9%) showed stool with mucus. However, no bloody stools were shown. Those cases with fever showed temperatures of 37.0 ~ 40.0 ℃ with a median temperature of 38.0 ℃.

The results from laboratory show that among the 25 human bacterial anal swab specimens, only one showed positive for non-toxic *Staphylococcus aureus*. Among the 9 fecal specimens collected from the culinary staff members, 3 were tested positive for norovirus. 2 of the student fecal specimens were also tested

positive for norovirus. The norovirus found in both the culinary staff members and students all belonged to the G2/4 type. The 6 water specimens and 2 food specimens all showed negative for any infectious viruses or bacteria. Among the 6 kitchen environment specimens taken, 1 was tested positive for *Bacillus cereu*s; however, the number of bacteria did not reach the number for possible infection. Water from the school dormitory, kitchen sinks, hallways, and restrooms showed no traces of residual chlorine. However, cooking water from the kitchen did show traces of residual chlorine.

The epidemic curve of onset dates distribution shows a single peak (Figure 1). This indicates that this outbreak of vomiting and diarrhea transmission route is highly likely to be through one-point common source infection. On March 15, a total of 313 12th grade students (82.4%) consumed the lunch prepared by the school. The lunch provided that day consisted of tuna macaroni, braised pork, bean sprouts, fried croquette, green pea-carrot-corn soup, and rice. The results of logistic regression analysis (see Table 1) show that only the tuna macaroni is statistically related to this vomiting and diarrhea outbreak (OR=7.445，95%CL= 2.571~21.554). Braised pork (OR=0.754，95%CL=0.366~1.555), bean sprouts (OR=1.495, 95%CL=0.766~2.918), fried croquette (OR=1.088, 95%CL=0.561~2.110), green pea-carrot-corn soup (OR=0.852, 95%CL=0.521~1.494), and rice (OR=1.905, 95%CL=0.719~5.049) all show no statistical significance with this outbreak of vomiting and diarrhea. Those who had consumed the lunch the school provided on March 15 started to show symptoms (incubation period) from 15 to 102 hours later with a medium of 31 hours.

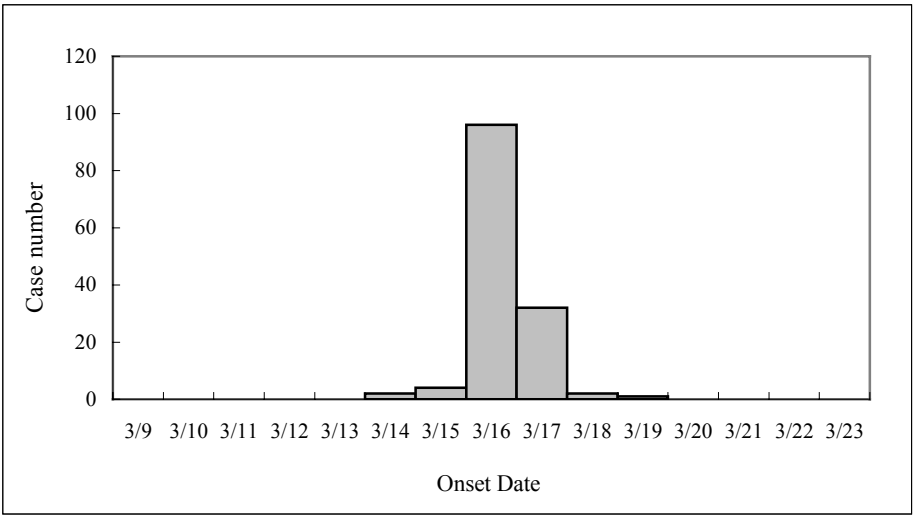

Figure 1. Distribution of Onset Dates of Gastroenteritis Cases in the Outbreak of Vomiting and Diarrhea in A High School, Yunlin County

Conclusion

A total of 138 cases were found among the 380 12th grade students in A High School in Yunlin County in this outbreak of vomiting and diarrhea. The total attack rate is 36.3% (138/380). The ratio between males and females is 1.19:1.00. Due to the fact that both students living on campus (45 cases with an attack rate of 34.4%) and students that did not live on campus (93 cases with an attack rate of 37.4%) shows that this outbreak of vomiting and diarrhea was not limited to either students living on or off campus. Fecal specimens from 3 of the culinary staff and 2 students were tested positive for norovirus. All 138 cases showed symptoms that fit the typical symptoms portrayed by the infection of norovirus gastroenteritis. On the basis that the virus was shown to be in the bodies of the infected cases, it can be concluded that the culprit behind this

vomiting and diarrhea outbreak is indeed norovirus. Also, due to the fact that all of the norovirus found in the culinary staff members and students belonged to genogroup-II, genotype-4, G2/4, we can confirm that the infection originated from the same source.

Table 1. Results of Analysis of Food Items Served on March 15 in Outbreak of Vomiting and Diarrhea in A High School, Douliou City, Yunlin County.

Food Items	Case Group		Control Group		Relative Risk
	Eaten	Not eaten	Eaten	Not eaten	(95% CL)
Tuna macaroni *	127	4	145	34	7.445 (2.571~21.554)
Braised pork	115	16	162	17	0.754 (0.366~1.555)
Bean sprouts	116	15	150	29	1.495 (0.766~2.918)
Fried croquette	114	17	154	25	1.088 (0.561~2.110)
Green pea-carrot-corn soup	98	33	138	41	0.852 (0.521~1.494)
Rice	125	6	164	15	1.905 (0.719~5.049)

* Shows statistical significance (95% CL not including 1.0)

The single peak in the epidemic curve (Figure 1) shows that this outbreak of vomiting and diarrhea is from one-point common source infection. Eliminating the possibilities of airborne and shared utensil infection, the only other possibility would be through drinking water or food. Apart from the tap water used in the kitchen for cooking, all other areas of the school use underground water. Due to the fact that the outbreak ceased after the processing of the underground water, we can say that the water source was not linked to the cause of the outbreak. In addition, the students started to show symptoms of vomiting and diarrhea after consuming the lunch prepared by the school on March 15, we can suspect that the lunch food was linked to this vomiting and diarrhea outbreak. If we assume that the lunch prepared on March 15 was indeed the contaminated source which induced this outbreak, some of the incubation period exceeds the normal period of 24-48 hours expected of the norovirus. In addition, the norovirus can infect a person with only 10 units. Therefore, we do not eliminate the possibility that

some of the cases were infected by other already infected cases [11]. However, with the scale of the outbreak in such a short period of time indicates that this outbreak was mainly due to common source infection.

Among the 380 investigated subjects, 313 had consumed the lunch prepared by the school on March 15. Among the 138 cases, 3 were infected before March 15 and 4 had not consumed the lunch on March 15. Therefore, the analysis of the relationship between the food prepared and this outbreak of vomiting and diarrhea will be examined with 131 persons in the case group and 179 persons in the control group. Using the logistic regression analysis in analyzing each of the food items prepared, we can see from the results that only the tuna macaroni is statistically significant in relevance to this incident of vomiting and diarrhea (OR=7.445, 95%CL=2.571~21.554). In other words, this shows that those cases that consumed the tuna macaroni had 7.445 times higher exposure odd than those who did not consume the tuna macaroni. This ranges from 2.571 to 21.5544.

According to the symptoms shown in the infected students, the results from the fecal specimens collected from the students, and the evidence that shows that infections had already occurred before March15, we can say that norovirus was the cause of the outbreak of gastroenteritis in A High School. The single peak in the epidemic curve of common source infection, the results of the lunch prepared on March 15, the norovirus found in the fecal specimens of the 3 culinary staff members (2 of which started to show the symptoms of gastroenteritis on the midnight of March 17), and the evidence showing that both the culinary staff members and the students were tested positive for the same groups (genogroup-II, genotype-4) of norovirus are all strong evidence that this outbreak of vomiting and diarrhea is correlated to food-poisoning. Apart from the possibility of food poisoning caused by norovirus [15], reports from other countries have also found

norovirus on kitchen staff members that do not show symptoms of the infections. Therefore, with the finding of norovirus on the culinary staff members, we suspect that this food poisoning incident was caused by norvirus [9]. If this incident is indeed a food poisoning incident, the origin would be norovirus from tuna macaroni. However, no specimens from the tuna macaroni were sent for testing, whereas the corn kernels and croquette were sent but not tested for norovirus. Thus, this outbreak of vomiting and diarrhea cannot be confirmed to be a food poisoning incident without more concrete evidence. We can only prove that this incident is an outbreak of norovirus-induced gastroenteritis in A High School. In addition, regulations require that all lunches should be kept for 48 hours for possible testing. However, in this incident, only corn kernels and croquette were tested among the 6 kinds of food prepared that day. Whether the school did not retain the food for 48 hours or that the correlating public health officials collected specimens after 48 hours still need further investigation.

After the disinfection of the school's kitten and cafeteria, the temporary suspension of the kitchen for a week, the suspension of the culinary staff work, and the enhancing of the washing of hands of the students, no further cases of vomiting or diarrhea occurred after March 20. In respect to the occurrences of norovirus-induced gastroenteritis in the recent years, we suspect that most of the incidents are results of food poisoning. Therefore, it is recommended that the concerning officials add testing for viruses (such as norovirus) in future food specimens.

Acknowledgements

We would like to thank the Sections of Disease Control and Food Sanitation members of the Yunlin County Public Health Bureau and the members from the

4th Branch of TCDC in assisting with the investigation and specimen collecting which allowed this investigation to be successfully completed.

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