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An outbreak of Norovirus infections among lunch customers at a restaurant, Tampere, Finland–2015

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Abstract

On January 29th, 2015, the City of Tampere environmental health officers were informed of a possible foodborne outbreak among customers who had eaten lunch in restaurant X. Employees of electric companies A and B had a sudden onset of gastrointestinal symptoms. We conducted a retrospective cohort study to identify the vehicle, source and causative agent of the outbreak. A case was defined as an employee of companies A or B with diarrhea and/or vomiting who ate lunch at Restaurant X on January 26th, 2015. All employees of the companies attending the implicated lunch were invited to participate in the cohort study. Environmental investigation was conducted. Twenty-one responders were included in statistical analysis, of which 11 met with the case definition. Of the 15 food items consumed by participants, four food items were associated with gastroenteritis. Of four kitchen staff, three tested positive for norovirus GIP7, the strain was found earlier in the community. No patient samples were obtained. Level of hygiene in the kitchen was inadequate. Infected kitchen staff probably transmitted norovirus by inadequate hygiene practices. No new cases associated with Restaurant X were reported after the hygiene practices were improved.

Key words: foodborne outbreak; gastroenteritis; Norovirus; Finland

Introduction

Noroviruses (NoV) are one of the leading causes of viral gastroenteritis worldwide (CDC 2011; Glass et al. 2009; Hall 2012; Matthews et al. 2012; Patel et al. 2009). Usually, the infection with NoV is self-limited and symptoms include nausea, vomiting, abdominal pain and diarrhea. The incubation period ranges from 10 to 50 hours (Heymann, 2014). According to surveillance of notifiable diseases, NoV has been the most common cause for food and waterborne outbreaks in Finland since 1997 (Hallanvuo and Johansson, 2010). In 1998-2002, 14% of NoV gastroenteritis outbreaks in Finland were associated with restaurants and canteens, and the most common genogroup was genogroup II (GII), accounting for 219 (87%) of 252 outbreaks, whereas GI caused 33 (13%) outbreaks (Maunula and von Bonsdorff 2005). Genogroup I has been linked to food and water borne outbreaks (Nenonen et al. 2012).

On January 29th, 2015, The City of Tampere environmental health officers were informed of a possible foodborne outbreak among customers who had eaten at Restaurant X. The main symptoms were suggestive of viral infection with sudden onset of gastrointestinal symptoms (abdominal pain, nausea, vomiting, and diarrhea) which were self-limited and no hospitalizations were reported among ill customers.

Restaurant X serves lunch only for the employees of several businesses in the surrounding area. The restaurant serves approximately 200 meals every day, offering a three-option main course with a salad buffet. Notifications of illness were received from two companies (A and B) only. The kitchen staff usually prepare meals, but chopped vegetable products (salads/fruits) are received from external catering companies. We conducted an investigation to assess the extent of the outbreak, identify vehicle and causative agent, and initiate appropriate control measures.

Methods

Initial investigation of ill customers, food-handlers and preparation sites suggested that the lunch served at the restaurant on January 26th, 2015 was most likely the source of the outbreak. We obtained information that ill persons were identified only among employees of companies A and B. We conducted a retrospective cohort study among employees of company A or B who attended lunch at Restaurant X on 26th January 2015. A case was defined as an employee of the cohort with diarrhea and/or vomiting during 26th–28th January 2015.

We submitted a self-administrative, standardized questionnaire on February 5th, 2015 to employees in company A and B who ate the lunch. A reminder was sent a week later to company A to improve response rate. The questionnaire included questions about demographic information, food items consumed, symptoms, and onset time.

On February 5th, the City of Tampere's Environmental Health officers visited the restaurant and conducted hygienic inspection (e.g. kitchen, restroom, hygiene of utensils and conditions of storing of raw and cooked foods). The menu and origin of food ingredients were inspected. Origin of food products including all fresh and frozen products, methods of food preparation and store were reviewed. Environmental Health officers also reviewed health history of kitchen staff and their family members.

Environmental swab samples were tested for NoV and total bacterial count according to ISO 4833:2003 (ISO 2003). Surface samples were taken in the food preparation sites of the restaurant. Cases and suspected cases in companies A and B were requested to provide a fecal sample for microbiological analysis with the help of a registered nurse of a clinic of City of Tampere. A formal requirement was made to the kitchen staff to submit fecal samples.

Data were analyzed by R software (Epi package). Risk ratio (RR) and 90% confidence intervals (CI) were calculated for the consumption of food items by univariate analysis. We used binomial models with log link for food items with a significantly elevated RR (RR > 1) to control for potential confounders.

NoV RNA was extracted using Omega kit (Omega Bio-Tek) or RNeasy® Mini Kit (Qiagen, Germany). Genotyping analysis was done for several Finnish NoV isolates from patients' stools. Viral RNA was amplified in polymerase region A using a one-step RT–PCR kit (Qiagen) according to Vinjé et al. (2004). Sequences were analyzed using Geneious 6.0.5 software (Kearse et al. 2012). NoroNet online software was utilized for genotyping (http://www.rivm.nl/mpf/norovirus/typingtool/). Phylogenetic tree was constructed by the maximum likelihood algorithm implemented in the MEGA 6 program (Tamura et al. 2013) using the Tamura-Nei model. The sequences of Finnish isolates as well as other European isolates were downloaded from online network NoroNet (http://www.rivm.nl/mpf/norovirus/typingtool/). These sequences were utilized to construct the phylogenetic tree.

Results

Descriptive epidemiology

From January 29th to February 15th, 2015, 27 employees in the two companies responded to the survey, of which 21 were included in the cohort study. Six, late-respondents were excluded from the study because of incompleteness of data and possible recall bias with inconsistent information. Median age of participants was 31 years (range from 28 to 50).

We identified 11 cases that met the case definition, and the overall attack rate was estimated to be 52% (11/21). The first two cases occurred on 27 January and the peak of the outbreak was on 28 January, when 9 cases fell ill (Figure 1). The epidemic curve suggested point source outbreak. The main symptoms were nausea (100%), diarrhea (91%), vomiting (82%), stomachache (82%), fever (64%), and headache (55%). Symptoms were self-limited and all cases recovered within one to three days after onset of symptoms. There were no hospitalizations.

The ill persons from the two companies did not have any other common exposures, except the meal at the restaurant on January 26th, 2015. Different food items on the meal menu of January 26th are shown in Table 1. The onset of symptoms ranged from 29.5 to 42 hours after having the meal (median 38.75 hours).

Cohort study

The age distribution of the 11 ill and 10 healthy participants was similar. Of the 15 food items consumed by the participants, strawberry soup, grated salad, bouillabaisse and fruit salad were statistically significant in the univariate analysis (Table 1). The food items with RR > 1 were no longer significant in the multivariate analysis. Furthermore, strawberry soup, bouillabaisse and fruit salad were consumed only by a maximum of three ill persons, therefore could not have been the source of the infection in the remaining eight cases.

Environmental investigation

The kitchen and restaurant were dirty with unpleasant smell. Four family members of one of the three kitchen staff had fallen ill with similar symptoms at the same time as the cohort. This kitchen staff member reportedly took leftover food to home on a regular basis.

The salad buffet contained grated salad (comes ready-to-eat to the restaurant), green salad (prepared in the restaurant), a meal salad (contents unknown) and treaty bits (varies daily, contents unknown). The ingredients for the implicated day had arrived to the kitchen on the morning of Monday 26th. The salad was mixed by the same kitchen staff member who reported taking leftover food, together with another kitchen staff.

Microbiological investigation

None of the case patients submitted fecal samples. Three samples were obtained from the kitchen staff and one from a family member thereof. Three samples from the kitchen staff were positive for norovirus GIP7.

All environmental surface samples were negative for NoV. Two of the samples had very high total bacterial counts of 46.000 to 93.000 CFU/ml with a surface area of 100 cm^2 sampled and diluted to 5 ml of buffer. Of the frozen and fresh produce samples, only a grated salad sample was obtained from one of the salad producers. The grated salad sample taken in the production site (outside the area of Tampere) was negative for NoV, and the production site had good hygiene.

Recommendations to improve the level of hygiene were made. During a subsequent investigation in March 12th, 2015, the kitchen had good hygiene and surface materials had been renewed. No new cases were reported thereafter.

Phylogenetic analysis

Phylogenetic tree of noroviruses for the partial RNA polymerase region (Region A, positions 4570-4875 relative to the NC_001959 reference sequence) was constructed using 46 novel sequences (Figure 2). In the tree, GIP7 formed five cluster A-E. Three different strains were identified belonging to clusters C-E circulating in Finland. The three isolates included in this study 138-140 belong to cluster C and some numbers of which have circulated in Finland since 2012. The sequence of this strain is closely related to the virus sequence (972, 974, Fig. 2) linked to a swimming water related norovirus outbreak from Tampere during summer 2014.

Discussion

Norovirus is estimated to cause over 50% of foodborne outbreaks worldwide (Patel et al. 2009). The virus is considered unique given its remarkably low infectious dose - with 50% risk of infection caused by a single viral particle, copious shedding, and epochal antigenic drifts (Hall 2012; Teunis et al. 2008). We conducted an investigation of the outbreak caused by NoV in the restaurant serving lunch meal for companies in the city of Tampere, Finland, on January 26th, 2015. Our investigation, which included epidemiological, microbiological and environmental components; showed that the outbreak was likely caused by infected kitchen staff and potentiated by inadequate hygiene practices.

Cases had no common exposures other than having lunch at the implicated restaurant on 26 January 2015, which supports the foodborne origin of the outbreak. Cases became ill within 30 to 42 hours after having the meal, which is consistent with the incubation period of norovirus infection (Glass et al. 2009). Most detected NoV outbreaks occur in restaurants, are mostly caused by infected food handlers, and peak in winter through spring (CDC 2014; Makary et al. 2009; Maunula and von Bonsdorff 2005; Schmid et al. 2007). In our cohort, cases who developed illness did not require hospitalization. Usually only 10% of cases with NoV seek medical attention (CDC 2011) and most hospitalizations occur among those <5 or >65 years old (Glass et al. 2009). We were also informed of few secondary cases who were family members of one kitchen staff member who reported taking leftover food on regular basis, which is a common feature (i.e. person-to-person transmission) of NoV (Kroneman et al. 2008).

The epidemiological curve of the outbreak suggested point source transmission (Figure 1). An analysis of 416 outbreaks in Finland showed NoV to be the cause in 60% of reported outbreaks, of which 14% occurred in restaurants (Maunula and von Bonsdorff 2005). However, comparisons of rates between European countries, as well as globally, are limited by difference of surveillance systems implemented (Kroneman et al. 2008). We observed the highest risk ratio among those who consumed grated salad, although the association was only seen in the univariate analysis. Green raw vegetables are known to be common vehicle for NoV (CDC 2014; Makary et al. 2009; Patel et al. 2009). However, this association did not remain in the multivariate analysis, similar to previously reported outbreaks where none of the food items was implicated as possible vehicle and/or source of the outbreak (Polkowska et al. 2014; Schmid et al. 2007). We hypothesize that multiple food items were contaminated by one or all of the three infected kitchen staff whose fecal samples tested positive for NoV genogroup GIP7. Food contamination was likely potentiated by the poor level of kitchen hygiene, which was implied by our environmental inspection as well as the high bacterial count in the environmental samples.

We were able to sequence the NoV strain that was isolated from the three positive fecal samples, and the results showed this strain to be a modification of norovirus strains in swimming water from Tampere in summer 2014, where over 300 people become ill (unpublished data) (Figure 2). This further strengthened that the origin of the outbreak was local. We could not obtain fecal samples from any of the ill employees in the two companies, nor samples from the food items served on the designated dates of the outbreak. All environmental samples were obtained at a point in time following kitchen disinfection, and had negative test results for NoV. Given that some food items were delivered to the restaurant after preparation at another location, we investigated food suppliers thereof and they were ruled out as possible source of the outbreak. This was based on inspection reports from the responsible environmental health officer in the City of Tampere.

Our study has some limitations. First, the small number of respondents from the two companies could affect our analysis, which did not have sufficient power to identify food items that could have implications in the development and progression of the outbreak. The self-limited nature of NoV infection, added to the absence of hospitalizations, might have contributed to the under-reporting in our cohort (Bernard et al. 2014). Second, food menu items on the implicated dates of the onset of the outbreak were not fully identified, and we could not obtain environmental samples before kitchen disinfection as well as specimens from ill employees. However, we based our hypothesis on infected kitchen staff, potentiated by poor kitchen hygiene, as the likely source of the outbreak. Therefore, the inconclusive food item analyses and negative NoV environmental samples may have resulted from low statistical power and post-disinfection environmental sampling, respectively. We also could not rule out the rather unlikely possibility of clients being the source of the outbreak by contaminating the bathroom or commonly used utensils, such as serving utensils at the salad buffet.

In conclusion, we investigated a NoV outbreak that was likely caused by a modified strain still circulating among noroviruses found in swimming water in 2014. This typical outbreak probably resulted from transmission by infected kitchen staff, and was potentiated by inadequate personal hygiene and food hygiene practices. Hand hygiene is believed to be the single most important control measure in NoV outbreak (CDC 2011), in addition to environmental disinfection, exclusion of sick food handlers and prevention of secondary spread of infection (CDC 2014; Glass et al. 2009; Patel et al. 2009). We provided instructions to the kitchen staff on recommended food handling practices and standard personal hygiene, which successfully mitigated the outbreak and prevented the resurgence of new cases. A rapid control of foodborne outbreaks in workplace environments eliminates potential sick days among company employees and consequently controls the potential negative economic impact of such outbreaks.

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Conflict of interest statement

We have no conflicts of interest.

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Titles of figures

Fig. 1 Number of case (n=11) with acute gastroenteritis by time of onset, January 2015, Tampere, Finland

Fig. 2 Phylogenetic analysis of Norovirus GI.7, polymerase region A. The tree was constructed by MEGA 6 program utilizing the maximum likelihood algorithm and all bootstrap values are shown. The UK isolate was used as reference strain (AJ277609).