Beware More than Just the Yellow Snow! A Norovirus Outbreak Associated with a Ski Resort

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Received date: Nov 10, 2015; Accepted date: May 13, 2016; Published date: May 20, 2016

Abstract

A laboratory-confirmed Norovirus outbreak occurred at an Arizona ski resort February 2013. A case-control study was performed by the University of Arizona’s student outbreak response team (SAFER) in collaboration with county and state health departments. 46 cases and 25 controls were interviewed quickly. Having eaten at a restaurant at the ski resort was significantly associated with being a case (odds ratio [OR]=9.7) and in particular, the base restaurant (OR=24.9). While the outbreak was likely the result of environmental contamination in the restaurant, the consumption of French fries may have played a significant role. This investigation highlights a successful collaboration between academic and applied public health.

Methods

Student run outbreak investigation

The SAFER team was contacted by PCHD on Wednesday, February 27 after they received numerous calls from citizens self-reporting acute symptoms of vomiting, diarrhea and nausea. All cases reported travel history to a local ski resort the previous week. PCHD provided SAFER with an initial line list and outbreak questionnaire.

Within four hours of the request for assistance, the team had identified and interviewed 13 cases and 8 controls. By Monday, March 4, 46 cases and 25 controls, had been interviewed. On Friday, March 8, the Arizona Department of Health Services (ADHS) and PCHD closed the investigation.

Statistical analyses

To determine if secondary transmission was taking place, indicated by an onset time longer than the initial 24-48 incubation period for norovirus, case onset times were converted to hours since the onset of the earliest case. This was necessary because initial analyses did not indicate a particular point source of exposure (such as one common shared meal) and it was uncertain when during the five days the first exposure occurred. Summary statistics were calculated for both cases and controls including: onset date; restaurant exposure; lodging type and occupancy; illness duration; onset time relative to the first case; and age.

Basic univariate analyses were performed, including student’s t-test or ANOVA (or their non-parametric equivalent) or simple logistic or linear regressions. For the multivariate analyses, logistic models were built using the case definition dependent variable, while for the onset time and illness duration dependent variables, multiple linear regressions was used.

Due to the communicability of norovirus, all multivariate models were adjusted for clustering by shared lodging. When selecting the multivariate models, potential interaction variables and confounders
were considered and tested for using standard techniques. Diagnostics and assumptions were tested on all models using goodness-of-fit tests. All analyses were performed using State versions 11 and 12 (Statacorp, College Station, Texas). For analyses of food items, combination foods, such as chili fries, were analyzed for each separate component as well as combined. All food analyses were also adjusted for food and shared lodging.

**Results**

Among the subjects interviewed, 46 (64.8%) were cases, and 25 (35.2%) were controls; 55 (77.5%) had eaten at one of the restaurants while 16 (22.5%) had not. There were 14 different lodging sites, with the number of people staying at each ranging from 1 to 13.

More than half (59.2%) of people reported having eaten at the base restaurant, while less than ten people reported eating at each of the other restaurants. The mean onset time following the first case was 47.3 hours with average illness duration of 47.8 hours (range 5-72). The mean age was 27.3 years, the median age of all people interviewed was 17 years (Table 1).

The epidemic curve followed a standard shape of a point source outbreak, with only a few cases occurring on the first and last days (4 and 5, respectively), and the bulk of cases occurring on the middle two days (n=21 and n=15 respectively). The majority of the cases had exposure to the base restaurant, as opposed to the other options (Figure 1).

| Variable                  | Count (%) |
|---------------------------|-----------|
| Case                      | 46 (64.8) |
| Control                   | 25 (35.2) |
| **Onset date**            |           |
| 22-Feb                    | 4 (8.9)   |
| 23-Feb                    | 21 (46.7) |
| 24-Feb                    | 15 (33.3) |
| 25-Feb                    | 5 (11.1)  |
| **Onset Time (relative to first case reported)** | |
| 0-12 hrs.                 | 1 (2.2)   |
| 13-24 hrs.                | 3 (6.7)   |
| 25-36 hrs.                | 2 (4.4)   |
| 37-48 hrs.                | 22 (48.9) |
| 49-60 hrs.                | 7 (15.6)  |
| 61-72 hrs.                | 6 (13.3)  |
| 73+ hrs.                  | 4 (8.9)   |
| **Ate at restaurant**     |           |
| No                        | 16 (22.5) |
| Yes                       | 55 (77.5) |
| **Restaurant**            |           |
| Apache = Top 1            | 6 (8.5)   |
| Base                      | 42 (59.2) |
| Base 3                    | 3 (4.2)   |
| Cyclone                   | 3 (4.2)   |
| Mid-Mountain              | 9 (12.7)  |
| Sun Top = Top 2           | 3 (4.2)   |

*Table 1*: Summary statistics. Some people ate multiple restaurants; counts are number of people who did eat at a given restaurant. *Onset date missing for one case. Percentages based on n=45 cases.
Based on the univariate analyses, whether someone ate at a restaurant (OR=9.7, 95% confidence interval (CI): 2.3-46.7) and lodging location (Fisher's exact probability=0.02) were significantly associated with reporting symptoms. Among the individual restaurants, the base and “Mid-Mountain 2” restaurants were significantly associated with whether someone became ill. None of the factors analyzed were strongly significantly associated with illness duration, although whether someone ate at any restaurant showed borderline significance (Wilcoxon p-value=0.0794). Age was significantly associated with onset time (coefficient=-0.352, 95% CI: -0.656 to -0.0477), meaning that younger people tended to get sick before those who were older.

Cases peaked on Friday and Saturday, with 80 percent of cases occurring on those two days. Eating at a restaurant was found to be a statistically significant risk factor for illness. Age was negatively, significantly associated with onset time. Eating at a restaurant was significantly associated with shorter illness durations; however this may only be anomaly in the data. It could also be that people who ate at restaurants developed symptoms and transmitted the illness at higher dosages (through environmental contamination of a shared bathroom/living space) to people staying in the same places. As mentioned in the methods section, due to the nature of pathogens such as norovirus, the multivariate models adjusted for clustering by lodging type, which improves the robustness of the standard errors of the parameters, without including lodging type as a covariate.

**Limitations**

The small sample size limited the (scope) of the analysis, including making it difficult to test individual foods, affecting the statistical power, including by forcing the use of non-parametric alternatives to commonly-used tests; and making the assumptions for regression models difficult to check.

Unfortunately, as is common in many foodborne outbreaks, analyses of food items were not available for laboratory testing. Results found there to be a high odds of illness associated with consumption of French fries, although this could be due to the handling practices or an environmental contaminant near the food area, rather than the food itself given its cooking procedures.

This investigation which covered multiple jurisdictions at the state and county levels was performed in conjunction with the environmental health investigation. The environmental health portion of the investigation did not note any violations, but were conducted approximately a week after the potential exposure period.

**Conclusions**

This outbreak investigation is an example of a timely response of a health department working with a student response team. The time from notification to the completion of the interviews was five days from Wednesday, February 27, to Monday, March 4 with the vast majority of interviews being conducted by the students on a voluntary basis. Students also volunteered to clean and analyze the data, submitting their results to the health department such that action could be taken as deemed appropriate by environmental services.

The analyses found the source of the outbreak was likely the base restaurant at the ski resort, followed by secondary transmission. French fries were identified as a possible source, but could not be confirmed through laboratory analyses. While at least one previous study [12] has found an outbreak of Staphylococcus aureus associated with fried chicken, it is more likely that the association with French fries found in our analysis was the result of environmental contamination, e.g., a sick food worker.

**Acknowledgements**

We would like to thank the epidemiologists at the Pima County Health Department and Arizona State Health Department for working so closely with our team and directing the response efforts. Thank you to all the students in SAFER who worked on this investigation and conducted the interviews for the analyses.
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