A Norovirus Outbreak Related to Contaminated Surfaces

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We investigated an outbreak of norovirus infection affecting 12 of 16 auto dealership employees (75%) subsequent to a staff meeting. Take-out sandwiches initially seemed the likely source, but a cohort study found no association between illness and food consumption. Employees reported seeing a toddler with diarrhea in a dealership restroom shortly before the luncheon. Indistinguishable norovirus was isolated from employees and the child (genotype GII6.C) and from a diaper-changing station in the restroom (genogroup GII). Counterintuitively, this point-source outbreak following a meal was caused by environmental exposures, not food. Environmental exposures should be considered even in routine outbreak investigations.

Keywords. norovirus; disease outbreak; environmental contamination; diaper changing station.

Noroviruses are the leading cause of acute gastroenteritis outbreaks in the United States and many other parts of the world [1]. Viral particles are shed in the stool and vomit of infected persons [2]. Food can become contaminated by contact with inadequately washed hands or other means. Although specific vehicles are only infrequently identified, food handlers working while ill are often presumed to be the cause of noroviral outbreaks [3, 4], and health departments may focus on food and food handlers without sufficiently considering other possibilities. Other environmental exposures are increasingly recognized as the cause of both sporadic cases and outbreaks [1, 5, 6].

We investigated a point-source norovirus outbreak that initially appeared to be caused by consumption of contaminated take-out sandwiches. Further investigation revealed that, contrary to expectation, the outbreak had an environmental origin.

BACKGROUND

On 16 May 2012, the Washington County, Oregon, health department received a complaint from a local auto dealership of acute gastroenteritis affecting persons who had attended a staff meeting on 13 May. The meeting was held in an open space off the showroom floor. Submarine sandwiches, chips, and condiments from a nearby fast-food restaurant had been provided to attendees. We investigated to determine the scope and etiology of the outbreak and to take appropriate control measures.

METHODS

We conducted a retrospective cohort study among meeting attendees, using a standard questionnaire to ask about food, environmental exposures, and any history of illness. We defined primary cases as meeting attendees who developed vomiting or diarrhea (defined as ≥3 loose stools within a 24-hour period) within 72 hours after the meeting. Household contacts of cases who developed similar symptoms in subsequent days were considered to have secondary illnesses. Questionnaire data were keypunched, tabulated, and analyzed using an outbreak database tool.

Environmental health staff evaluated the operations of the restaurant that provided the food, with particular attention to hand washing, food preparation practices, and recent employee illness. Stool specimens were solicited from ill persons and were assayed for norovirus as previously described [5]. We collected environmental samples for norovirus testing from a diaper-changing station at the auto dealership and from a convenience sample of similar diaper-changing stations in public restrooms throughout Washington County. Surfaces were vigorously swabbed with polyester swabs moistened with sterile water, followed by RNA extraction, polymerase chain reaction, and sequencing as previously described [5]. Recommended cleaning protocols for the diaper-changing station at the dealership were obtained from the manufacturer.

Because this was a routine public health investigation of a reported outbreak, no institutional review board approval was indicated.
RESULTS

Sixteen persons attended the lunch meeting, of whom 12 became ill and met the case definition. The 12 cases ranged in age from 22–69 years (median, 49 years); 7 (58%) were men. Eleven (92%) of the cases reported vomiting, 10 (83%) reported diarrhea, and 10 (83%) reported a fever; symptoms persisted for 1–4 days (median duration, 1 day). No cases sought medical attention; 3 cases reported missing work. Assuming exposure at the meeting, incubation periods ranged from 29–45 hours (median, 38 hours; Figure 1).

No other recent common food exposures were reported by the staff. All staff members working on 13 May attended the luncheon. Four presumptive secondary cases were identified.

The auto dealer reported the outbreak to the sandwich shop, which failed to relay the report to the health department as required by law. Fortunately, the dealer also contacted the health department directly. Environmental health staff were dispatched to the sandwich shop to review relevant operations. No recent gastrointestinal illness (within previous 2 weeks) was reported by food handlers or restaurant managers. No other patrons had complained. The restaurant was cited for 2 violations defined by environmental health staff as critical: presence of potentially hazardous food not maintained at proper hot or cold holding temperatures and presence of open beverages on the food preparation table.

When staff at the auto dealership were interviewed, we learned of an incident that occurred approximately 15 minutes before the luncheon began. A female staff member (employee A) had entered the sole women’s restroom at the dealership to discover a customer managing a toddler with diarrhea by holding the incontinent child over the trash receptacle while the toddler was (in the staff member’s words) “spraying.” The wall-mounted diaper changing station (brand X) was deployed and was visibly soiled with fecal material, as were the floor, walls, and trash can. The child’s mother left the mess for employee A, who attempted to clean up with dry paper towels. No gloves or disinfectants were used, but employee A reported subsequently washing her hands with soap and water.

Meanwhile, employee B had gone to pick up the food for the meeting. Immediately after cleaning the restroom, employee A opened the door for employee B when the latter returned with the food. Employee A was the first to take one of the unwrapped sandwiches off the platter. Four of 5 female cases reported eating a sandwich, as did 6 of 7 male cases.

All 5 female employees working that day became ill; all reported use of the restroom after the diarrheal incident. Seven of 11 male employees (64%) became ill—not a statistically significantly different rate. None of the men entered the women’s restroom. None of the food or environmental exposures assessed, including entering the women’s restroom, was significantly associated with becoming a case ($P > .05$). No leftover food or food containers were available for testing.

Stool specimens from 2 employees and the toddler—who was located through auto sales records—were positive for norovirus (genotype GI.6.C) with indistinguishable sequences. According to the mother, the child had been ill for 1 day before the visit to the auto dealership. Although the dealership diaper-changing station had allegedly been routinely cleaned twice by a professional janitorial service, using quaternary ammonium disinfectants, we observed corporeal brown matter inside and underneath the changing station (Figure 2). Swabs of the changing station were positive for norovirus (genotype GII), although the samples did not amplify in region C or D, rendering sequencing impossible.

To assess the background prevalence of norovirus on diaper-changing stations in Washington County, we tested a convenience sample of 14 diaper-changing stations in various restroom locations (1 restaurant, 3 parks, 3 grocery stores, 1 gas station, 2

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**Figure 1.** Epidemic curve of gastroenteritis among auto dealership employees in Washington County, Oregon, May 2012. Timeline shows outbreak events by 8-hour intervals. Each box represents 1 case. Presumptive secondary infections are not shown.

**Figure 2.** Photograph of underneath the diaper changing station involved in this outbreak, which had allegedly been cleaned twice by janitorial staff. This level of soiling was consistently viewed in public restroom diaper-changing stations.
shoping malls, 1 aquatic center, 2 libraries, and 1 public health clinic. Eight of 14 stations (57%) had visible brown discoloration on the underside of the fold-down hinge or bed area. Fourteen of 14 dispensers for disposable bed liners were empty. We did not detect norovirus on any of the diaper changing stations tested other than the one at the auto dealership.

The manufacturer’s printed recommendations for cleaning brand X diaper-changing stations included cleaning with a detergent followed by sanitizing with a disinfectant—neither of which were specified. When contacted, the manufacturer suggested the use of quaternary ammonium compounds. They discouraged the use of chlorine bleach, which might damage the changing station components.

**DISCUSSION**

The restaurant in question had historically done poorly on routine inspections, and the initial reports were consistent with a commonplace foodborne norovirus outbreak. The absence of any food item significantly associated with illness is not uncommon and can reflect multiple items being contaminated or a lack of statistical power. It would have been easy (and common) to blame the outbreak on unidentified food handlers at the sandwich shop.

Fortunately, 2 employees mentioned the incident involving the customer’s ill child during interviews, which suggested another scenario. The identification of matching genogroup virus in the child’s specimen and on the diaper-changing station confirmed that the child was the source of the outbreak, not the luncheon food. The female employees were likely exposed to contaminated surfaces in and around their restroom, and induced sufficient contamination of the wider environment, including uncovered sandwiches and shared-contact surfaces, to expose many of the male employees. We could not assess whether other visitors to the dealership that afternoon became ill, but one might suspect that they did.

A diaper-changing station would seem a perfect fomes for the transmission of gastrointestinal disease. By design, they are routinely contaminated with fecal material. Thorough disinfection between uses rarely occurs, and often even routine janitorial service may be inadequate. Aboard cruise ships—notorious for frequent and persistent norovirus outbreaks [7]—a rigorous investigation of public bathrooms found the diaper-changing station to be the worst cleaned surface [8]. Surface testing of public restrooms and diaper-changing stations for the presence of blood, sweat, urine, or mucus indicated that 25% of surfaces were positive for biochemical markers of these fluids [9].

There are no universal cleaning guidelines for diaper-changing stations. In one study, it was necessary to first clean visibly contaminated surfaces with a cloth soaked in detergent before applying a combined hypochlorite/detergent formulation (5000 ppm available chlorine) to produce any significant reduction in norovirus viability [10]. The manufacturer of the brand X device at the auto dealership recommended the use of disinfectants that are probably ineffective against norovirus. The use of disposable bed liners is highly recommended, but our small survey suggests that they often unavailable.

This outbreak underscores the importance of environmental cleaning in the control of norovirus transmission. Studies with surrogate viruses suggest that norovirus can persist on surfaces for weeks with minimal loss of infectivity [11]. Many common disinfectants, including the quaternary ammonium product reportedly used at the dealership, are of limited efficacy against noroviruses [11–13]. Viruses can be readily transferred from contaminated fingers to environmental surfaces (eg, faucet, door handles, and telephones) [10]. Adequate environmental decontamination [10] is critical to prevent the initiation and spread of norovirus outbreaks because of the high viral load in feces [14] and the ease of transmission [5, 15]. Best practices are uncertain when manufacturer’s recommendations are inadequate to kill norovirus. We recommend that high-risk restroom surfaces—such as diaper-changing stations—be sanitized with an antimicrobial product considered effective against norovirus, such as chlorine bleach [12].

Outbreak investigators should consider potential environmental exposures even when foodborne transmission appears likely. Although protocols are not well established, environmental testing for norovirus may be a useful adjunct to some investigations.

**Notes**

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**References**


