An Outbreak of Acute Infectious Nonbacterial Gastroenteritis in a High School in Maryland

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Synopsis

An outbreak of acute infectious nonbacterial gastroenteritis (AING) occurred in a high school in Maryland in 1984. Thirty-six percent of students surveyed met the case definition of gastroenteritis, as did 24 percent of school employees. Eating lunch in the cafeteria on January 30 was significantly associated with illness. After controlling for other food items consumed during the January 30 lunch, only the sandwiches were significantly associated with illness, but the source of the contamination was not identified. Four of 17 serum pairs from sick students and none of the 8 serum pairs from exposed controls (a nonsignificant difference) showed at least a 4-fold rise in antibody titre to Norwalk virus between acute- and convalescent-phase specimens. This outbreak of AING is believed to be the first to implicate epidemiologically sandwiches as vehicles of transmission. The outbreak highlights the need for investigators to look for a viral etiology in gastroenteritis outbreaks.

NORWALK VIRUS, rotavirus, calicivirus, astrovirus, and other viruses have been implicated as etiologic agents in sporadic cases of acute infectious nonbacterial gastroenteritis (AING), as well as in community and institutional outbreaks (*1*). Person-to-person transmission has been implicated in outbreaks (*1–6*), as well as waterborne transmission (*5–11*). Except for two outbreaks (one linked to vegetable hors d'oeuvre) (*12*), and the other to bakery products (*13*), reports of foodborne illness have been limited to shellfish (*4, 14–17*), and to salads (tossed, potato, cole slaw, and fruit) (*4, 12, 18–19*). We describe an outbreak in a high school of AING, possibly involving a Norwalk-like virus, in which sandwiches were implicated epidemiologically as the vehicle of transmission.

The 1-building high school, located in rural southeastern Maryland, had 402 students and 45 employees, 31 of whom were teachers. At the time of the outbreak, 10 construction workers were involved in the school's multi-million dollar renovation program, which included work on electrical and water systems. The central cafeteria served students and employees during 3 35-minute lunch periods. Food for the school lunch program was provided daily by the county's central distributor, which served 10 other schools in the county-wide area. Usually, all schools served the same items for lunch, 1 entree and side orders; the items usually were prepared in each school's kitchen each day. The school water supply was drawn from the community water system.

High school officials notified the local health department on Wednesday morning, February 1, 1984, about an outbreak of gastroenteritis among about 120 students, as well as teachers, cafeteria workers, and construction workers. The most prevalent symptoms were vomiting and diarrhea. The earliest reported cases were on the afternoon of January 31, but most had symptom onset that evening or the next morning. Milkshakes served during lunch on January 31 were mentioned as a possible source of the infection.

Outbreak Investigation

A questionnaire on food and water consumption was administered to all those in the school at noon on February 2, during an assembly in the gymnasium. Those not present were interviewed by telephone that day or in the school the following day. The questionnaire asked for basic demographic data; when lunch was eaten, and what was consumed at lunch, or from vending machines on

January 30 and 31; about water consumption and school shower exposure during those days; symptoms and duration of illness; and about any secondary spread of the illness in household contacts. Surveillance for gastrointestinal illness at the local hospital and in 10 other schools in the county was begun on February 2.

A case of gastroenteritis was defined as symptoms of vomiting or diarrhea (more than 3 loose or watery stools in 24 hours), in the period January 30 to February 2, in anyone present in the school on January 30 or 31. A secondary case was defined as similar symptoms being present in a household contact of a primary case-patient, provided that the household contact had not been exposed at the school on January 30 or 31, and the illness began within 2 days of the primary case. Cafeteria employees were thoroughly questioned about recent illnesses and those of family members. Statistical methods used in the data analysis included Fisher exact test, chi-square with Yates correction, chi-square for trend, and log-linear multivariate analysis.

Sanitary inspection. The sanitary facility inspection following the outbreak included dye tests of the sewage system; a water audit of pressures and flows within the school water system; bacterial (total coliform count), chlorine, and heavy metal analyses of water samples; an examination of construction sites; and a review of the workmen's daily work schedules for 2 months prior to the outbreak. A food-service inspection and a thorough evaluation of food-handling practices were conducted. Available leftovers used to make lunches on January 30 and 31 and cultures of kitchen surfaces and appliances obtained on February 1 were collected and analyzed by standard bacteriologic methods.

Laboratory tests. Stool cultures were obtained from 19 sick persons (including 5 of 6 cafeteria workers) within 2 days of onset of illness and from 5 well persons. Specimens were examined by routine methods for *Salmonella* sp., *Shigella* sp., *Staphylococcus* sp., *Bacillus cereus*, and *Campylobacter* sp. by the Maryland Department of Health and Mental Hygiene. Stool cultures from 10 of the 19 sick persons were analyzed for toxigenic *Escherichia coli* at the Centers for Disease Control (CDC). Frozen stool specimens from 16 of the 19 sick persons and 6 well persons were tested for rotavirus antigen by enzyme immunoassay at CDC. Paired serum specimens from 17 of the 19 sick persons (including 4 cafeteria workers) and 8 well persons were tested for Norwalk antibody by radioimmunoassay at CDC. Convalescent serum specimens were obtained 3 to 4 weeks after onset of illness.

Investigation results. Of 407 completed questionnaires, 352 of a possible 402 (88 percent) were from students, 31 of 31 (100 percent) were from teachers, 6 of 6 (100 percent) were from cafeteria workers, 1 of 2 (50 percent) were from clericals, and 10 of 10 (100 percent) were from construction workers and 7 other persons. One-hundred and thirty-nine persons met the case definition, giving a crude attack rate of 34 percent, or 139 of 407 persons. The attack rate for students was 36 percent, or 126 of 352 persons, and for employees was 24 percent, or 13 of 55 persons. Predominant symptoms of cases included vomiting (86 percent), diarrhea (78 percent), loss of appetite (76 percent), abdominal pain (76 percent), and nausea (75 percent). Median duration of symptoms was 2 days.

Twenty-three ill persons were seen by physicians; none was hospitalized. The median age of students who were cases was 16 years, and for employees who were cases was 35 years. The outbreak period peaked within 31 to 36 hours of the first case and lasted about 3 days (see chart).

Outbreak Analysis

Student characteristics. Attack rates for students did not vary significantly by home-room or grade. The range for attack rates was 29 percent for grade 9 (25 of 85 students) to 39 percent for grade 11 (39 of 101 students). The age range was 30 percent for 14-year-olds (19 of 64 students) to 47 percent for 18-year-olds (8 of 17 students). The range by race was 38 percent for whites (74 of 193 students) to 33 percent for blacks (52 of 159 students). The range of attack rates for males was 46 percent (78 of 170 students), and 26 percent for females (48 of 182 students) (chi-square = 13.7, $P = 0.0002$). Attack rates for the first lunch period were 45 percent (62 of 137 students), 39 percent for the second period (27 of 69 students), and 25 percent for the third period (37 of 146 students). Lunch period rates showed a significant downward trend (chi-square for the trend = 12.2, $P = 0.0002$).

Illness was not significantly associated with eating from the vending machines on January 30 or 31, or with water consumption (either from the school fountains, cafeteria, or inadvertently from

Table 1. Gastroenteritis attack rates, by type of consumption [1], for students at a high school in Maryland

Consumption	Food-specific attack rate: Percent sick among exposed	Food-specific attack rate: Percent sick among nonexposed	Relative risk	P value
Vending machine				
1/30/84	34.2	35.5	1.0	[2] NS
1/31/84	32.0	36.1	0.9	NS
Water				
1/30/84	39.7	31.3	1.3	NS
1/31/84	39.0	30.5	1.3	NS
Lunch				
1/30/84	39.7	5.3	7.5	0.0001
1/31/84	39.5	14.0	2.8	0.0009
Lunch				
None 1/30/84				
Yes 1/31/84	6.3	7.1	0.9	NS
Lunch				
Yes 1/30/84	27.6	7.1	3.9	.04
None 1/31/84				

[1] Persons unsure of consumption were not included in totals.
[2] NS = Not significant at $P = 0.05$ level, chi-square, or Fisher exact test, two-tail.

taking a shower) on those days (table 1). Illness was significantly associated with eating cafeteria food during lunch January 30 (chi-square = 16.0, $P = 0.0001$), or January 31 (chi-square = 11.1, $P = 0.0009$) (table 1). However, for those case-patients who did not eat cafeteria food on January 30, but did the following day, illness was no longer significantly associated with eating cafeteria food on January 31. Conversely, illness still remained significantly associated with eating cafeteria food on January 30 for those not eating there the following day (Fisher exact test, two-tail, $P = 0.04$) (table 1). The mean incubation period, calculated from lunch on January 30, was 38.6 hours.

Four items of food eaten during lunch on January 30 were significantly associated with illness; however, one of these items (gelatin) was eaten by no more than 10 sick persons (table 2). Thus, three highly correlated food items (sandwiches, potato chips, and milkshakes) remained for further analysis. Using three-way tables and controlling for those who ate sandwiches, consumption of milkshakes was not significantly associated with illness (table 3). However, when controlling for those who drank milkshakes, consumption of sandwiches was significantly associated with illness (chi-square = 17.6, P less than 0.0001). Similarly, for those who ate potato chips, only consumption of sandwiches was significantly associated with illness (chi-square = 8.2, $P = 0.004$). The results were confirmed using log-linear multivariate analysis examining consumption of these three items alone and in various combinations. When examining the three items together, only consumption of sandwiches was associated with a 95 percent lower-confidence-limit relative risk above one (4.26 to 53.66) (table 2).

When controlling for those who ate sandwiches (one served per person), illness was no longer significantly associated with one lunch period more than another. For the first lunch period, illness was associated with 53 percent of students (59 of 111), with 53 percent for the second lunch period (26 of 49), and 41 percent for the third lunch period (37 of 91). However, male gender was significantly associated with illness for those who ate sandwiches during the first lunch period, but not during the second or third.

For the first lunch period, 45 of 67 male students were sick, together with 14 of 44 female students (chi-square = 11.9, $P = 0.0006$). For the second lunch period, 12 of 19 male students were sick, together with 14 of 30 female students. For the third lunch period, 17 of 47 male students were sick, together with 20 of 44 female students. Surveillance of the local hospital and the other schools in the county did not reveal excess reports of gastrointestinal illness for the 2 weeks prior to February 2.

Employee characteristics. Among the employees who ate cafeteria food on January 30, the attack rate for men (25 percent, or 3 of 12) was significantly lower than for women (71 percent, or 10 of 14) (chi-square = 3.9, $P = 0.05$), but not for white employees (43 percent, or 9 of 21) compared to blacks (80 percent, or 4 of 5).

Attack rates for employees who ate cafeteria food for lunch on January 30 were significantly greater for cafeteria workers (100 percent, or 4 of 4) *versus* students (40 percent, or 124 of 313) (Fisher exact test, two-tail, $P = 0.03$), but not teachers (44 percent, or 7 of 16). Of 10 construction workers who responded, only 3 ate in the cafeteria, 1 of whom became sick. Of the food items eaten on January 30, mustard, ketchup, and sandwiches were significantly associated with illness, but only sandwiches were eaten by more than 50 percent of the employees who were sick. The attack rate for those who ate sandwiches was 71 percent (12 of 17), and 11 percent for those who did not (1 of 9) (Fisher exact test, two-tail, $P = 0.01$).

Secondary cases. Of the household contacts of case-patients, 33 noted onset of similar symptoms, and 27 of these contacts noted onset of symptoms

Table 2. Food-specific gastroenteritis attack rates [1] for students at a high school in Maryland

Food	Food-specific attack rate		Univariate analysis (Relative risk)	Log-linear multi-variate analysis	
	Percent sick among exposed	Percent sick among nonexposed		P value	Relative risk [2]
Sandwich	48.0	6.8	7.1	0.00001	15.12 (4.26–53.66)
Potato chips	45.7	24.7	1.9	0.0014	0.98 (0.49–1.95)
Lettuce	49.3	38.5	1.3	[3] NS	...
Tomato	46.9	39.7	1.2	NS	...
Mixed fruit	47.9	36.0	1.3	NS	...
Milk	50.0	39.8	1.3	NS	...
Milkshake	43.0	26.0	1.7	0.04	1.38 (0.64–2.97)
Gelatin	71.4	39.2	1.8	0.03	...
Ketchup	39.9	41.0	1.0	NS	...
Mustard	45.5	39.9	1.1	NS	...
Cake	29.3	42.9	0.7	NS	...
Crackers	47.1	39.5	1.2	NS	...

[1] Persons unsure of eating specific food item were not included in totals.
[2] 95 percent confidence intervals.
[3] NS = Not significant at the $P = 0.05$ level, chi-square test of significance.

after the case-patient. Of these 27 contacts, 23 reported illness that occurred within the first 2 days after onset of illness in the case-patient.

Sanitation. Dye testing of the plumbing in the school revealed no cross-connection. The water audit did not reveal problems with pressure or flow within the water system. On February 1 and 2, water samples from several sites throughout the school, including the water main entering the school, showed zero residual chlorine. Water from the main outside pipe, about 100 yards from water within the school, showed residual chlorine levels of 1.5 parts per million (ppm). On January 6, the main outside water pipe was connected to the school's new water pipe system. Residual chlorine levels above 1.0 ppm were noted both on and outside school grounds. Except for patching a hot water boiler 10 days prior to the outbreak, no one had worked on the water system for the previous 2 months. All water samples, taken between February 1 and 3, as well as membrane filters, showed low plate counts (less than 230 per milliliter). Negligible levels of cadmium, chromium, and other heavy metals were noted.

The cafeteria kitchen was rated very highly on a food services facilities report on February 2. No gross abnormalities were noted. Food preparation and storage were adequate. The sandwiches consisted of one slice of American cheese and a thin slice of sandwich meat placed on a bun. The cheese was sliced from a 5-pound block the morning of January 30 and stored in the refrigerator. The cheese came from a 40-pound carton of 8 5-pound blocks of cheese, some of which were used prior to and after the January 30 lunch without incident. The sandwich meat slices were each separated by thin wax paper. Once separated by hand, the meat was placed on wax paper-lined pans and put in an oven for 8 minutes, removed with tongs, and placed on slices of cheese already on a bun. The buns came 6 to a package. Food handlers did not wear gloves, although their general hygiene was considered adequate.

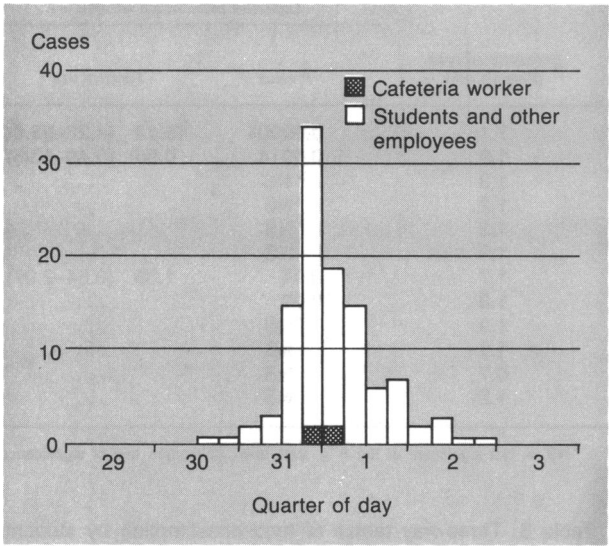
None of the other 10 schools that served these

Table 3. Three-way tables of food consumption by students on January 30, 1984, at a high school in Maryland

Consumption	Sick	Not sick	Total
Ate sandwich and milkshake	109	116	225
Ate sandwich, did not eat milkshake	13	16	29
Total	122	132	254
	[1] RR = 1.08, [2] $P = 0.86$		
Ate milkshake and sandwich	109	116	225
Ate milkshake, did not eat sandwich	4	34	38
Total	113	150	263
	RR = 4.60, $P = 0.00003$		
Ate sandwich and potato chips	105	112	217
Ate sandwich, did not eat potato chips	17	20	37
Total	122	132	254
	RR = 1.05, [2] $P = 0.92$		
Ate potato chips and sandwich	105	112	217
Ate potato chips, did not eat sandwich	1	14	15
Total	106	126	232
	RR = 7.26, $P = 0.004$		

[1] Relative risk.
[2] Not significant at the $P = 0.05$ level, chi-square test of significance.

Cases [1] of gastroenteritis at a high school in Maryland, January 29–February 3, 1984, by date of onset.



[1]Cases exclude 29 persons whose day of onset of illness is known, but time of onset is not known.

sandwiches reported illness. Lot numbers of cheese and production date numbers of the meat were not available from the subject high school. The meat packer, processor, and distributors were contacted and no other sources of illness could be linked.

Although no leftover sandwiches were available for testing, some of the cheese and sandwich meat used in making the sandwiches were negative for *Salmonella*, *Shigella*, *Campylobacter*, *Staphyloccus*, *Clostridium perfringens*, and *B. cereus*. The meat had an *E. coli* count of 43 per gram. The cheese slicer and milkshake machine were negative for the same organisms as the cheese and meat; however, their surfaces had been cleaned after use on January 30 and 31.

Laboratory results. Stool specimens for bacterial culture were negative. All isolates from 10 stool cultures sent to CDC were negative for *E. coli* heat-labile and heat-stable enterotoxin production and no common serotypes were observed. The frozen stool specimens were negative for rotavirus studies. Paired serum specimens from 4 of 17 (24 percent) case-patients and none from 8 noncases (a nonsignificant difference) showed at least a 4-fold rise in titer to Norwalk virus.

Discussion

The characteristic features of illness noted in this outbreak are consistent with AING (*4*). The features are the relatively long incubation period; the high prevalence of vomiting, diarrhea, nausea, and abdominal cramps; the relatively short mean duration of illness; and the benign course. Furthermore, laboratory testing provided no evidence to support rotavirus, bacterial pathogens, including *E. coli*, or chemical intoxication as the cause of the outbreak.

Four of 17 case-patients showed at least a 4-fold increase in antibody titre to Norwalk virus between acute- and convalescent-phase serum specimens. Such a small number of seroresponses to Norwalk virus is commonly seen in investigations of outbreaks of AING. In a review of 70 of these outbreaks, only 24 appeared to be serologically related to Norwalk virus or a virus antigenically similar to Norwalk virus (*20*). In each of the remaining 46 outbreaks, less than 50 percent of affected persons had at least a 4-fold rise in titre to Norwalk antigen (*20*). These moderate seroresponses may be consistent with serologic cross-reactivity between antigenically related viruses, as has previously been noted with enteroviruses (*21*). Serologic tests for these Norwalk-like 27-nm viruses are not yet available.

Although secondary attack rates in household contacts of case-patients could not be calculated because of insufficient data, secondary cases presumably occurred as a result of person-to-person transmission, a very common feature of outbreaks of AING (*2–7, 22–26*). Our data suggests a common point-source, food-borne etiology for the illness in the majority of primary cases. Water could not be implicated statistically, nor could laboratory testing implicate contaminated water as the cause of the outbreak. The lack of residual chlorine in water within the school could have such explanations as increased detention times, increased iron in municipal water, anaerobic bacterial growth associated with a dead-end line, and pipe corrosion without leaks.

Based on the absence of illness in the 10 other schools in the county serving the same food items, contamination of the sandwiches most likely occurred within the high school. Although all 6 cafeteria workers denied prior illness in themselves or their families, 4 were symptomatic during the outbreak and had onsets of illness concurrent with other cases (see chart). One asymptomatic and two symptomatic cafeteria workers had helped prepare the sandwiches; all three had eaten sandwiches but none showed a 4-fold rise in antibody titre to Norwalk virus. Another symptomatic cafeteria worker who placed sandwiches on plates (without gloves) on the food service line had a significant 8-fold rise in titre (1 to 100 to 1 to 800). It could

be conjectured that this worker was shedding virus approximately 36 hours prior to her reported time of onset of illness, although shedding of virus is usually coincident with onset of symptoms (*27*). Based on the high acute titres (greater than or equal to 1 to 800) in the remaining symptomatic worker, it could be conjectured that the worker may have had an earlier onset of illness than reported, although this was denied. No evidence points to cross-contamination from other foods.

The significant difference in attack rates for employees by sex is accounted for by the fact that 4 of 10 sick employees were cafeteria workers, all of whom were female.

From 1976 through 1980, CDC investigated 74 outbreaks of AING for a viral cause of illness, and NIH investigated 7. In 4 of the 38 confirmed Norwalk-type outbreaks food was implicated as the vehicle of transmission (2 involved oysters and 2 involved salads). Food was implicated as the vehicle in none of the 17 outbreaks possibly related to Norfolk virus. In 3 of 26 Norwalk-negative outbreaks, food was implicated as the vehicle (3 involved salads). Of the published reports on AING (other than clearly proven Norwalk-type outbreaks), many investigations have suggested that a common-source of exposure was the mode of transmission. Of these, only water or salads (as noted previously) were implicated or suspected sources of illness (*4–6, 9–11*).

We believe this study to be the first to implicate epidemiologically sandwiches as a vehicle of transmission in an outbreak of AING. This investigation highlights the need to seek a viral etiology in gastroenteritis outbreaks.

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