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ORIGINAL ARTICLE

Outbreak of *Salmonella javiana* Infection at a Children's Hospital

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OBJECTIVE. To determine the source of an outbreak of *Salmonella javiana* infection.

DESIGN. Case-control study.

PARTICIPANTS. A total of 101 culture-confirmed cases and 540 epidemiologically linked cases were detected between May 26, 2003, and June 16, 2003, in hospital employees, patients, and visitors. Asymptomatic employees who had eaten in the hospital cafeteria between May 30 and June 4, 2003, and had had no gastroenteritis symptoms after May 1, 2003, were chosen as control subjects.

SETTING. A 235-bed academic tertiary care children's hospital.

RESULTS. Isolates from 100 of 101 culture-confirmed cases had identical pulsed-field gel electrophoresis patterns. A foodhandler with symptoms of gastroenteritis was the presumed index subject. In multivariate analysis, case subjects were more likely than control subjects to have consumed items from the salad bar (adjusted odds ratio [aOR], 5.3; 95% confidence interval [CI], 2.3-12.1) and to have eaten in the cafeteria on May 28 (aOR, 9.4; 95% CI, 1.8-49.5), May 30 (aOR, 3.6; 95% CI, 1.0-12.7), and/or June 3 (aOR, 4.0; 95% CI, 1.4-11.3).

CONCLUSIONS. Foodhandlers who worked while they had symptoms of gastroenteritis likely contributed to the propagation of the outbreak. This large outbreak was rapidly controlled through the use of an incident command center.

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Salmonella javiana causes 4% of nontyphoidal *Salmonella* infections in the United States each year.[1] The illness is typically self-limited; diarrhea, abdominal pain, and fever are common.[2,3] The median duration of symptoms has been reported to be 5 days.[3] Resolution of symptoms with subsequent relapse of infection has been described.[4] Serious illnesses due to *S. javiana,* including liver abscess, meningitis, and cholecystitis with gallbladder perforation, have been reported.[5-7]

S. javiana was first isolated from a child with gastroenteritis on the island of Java.[8] Isolation of *S. javiana* has been reported worldwide.[9-15] The primary reservoirs for *S. javiana* are thought to be reptiles and amphibians that contaminate low-lying produce.[14,16] *S. javiana* has been isolated from domestic and farm animals,[14,17,18] from coconut,[19] and from products from India.[20]

In previous outbreaks of *S. javiana* infection, tomatoes,[2,21] cheese,[3,4] paprika,[11] watermelon,[16] and chicken sandwiches[22] have been implicated as the source. Persons with gastroenteritis who handle food,[3,22] cross-contamination of food-processing equipment,[3] and inadequate sanitation practices at food-processing centers[3] have facilitated disease transmission. The infectious dose is estimated to be 0.04-0.45 organisms per gram of food.[11]

We describe an outbreak of *S. javiana* infection at a 235-bed, academic tertiary care children's hospital that involved 101 individuals with confirmed infection and 540 individuals with epidemiologically linked symptoms between May 26, 2003, and June 16, 2003.

METHODS

Outbreak Recognition

On June 6, 2003, the infection control team at St. Louis Children's Hospital (St. Louis, MO) was notified of 3 hospital employees with stool cultures positive for *Salmonella* species who had sought care at other healthcare facilities in the area. A fourth hospital employee had been hospitalized for dehydration with symptoms of gastroenteritis and had colonies suggestive of *Salmonella* organisms on stool cultures after 24 hours of incubation. Employee screening for symptoms of

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TABLE 1. Time Line of Emergency Control Measures Initiated in Response to an Outbreak of *Salmonella javiana* Infection in a Children's Hospital

Time	Event(s)
Day 1	
Outbreak discovered	IC notified of 3 employees with stool cultures positive for *Salmonella* organisms who had sought treatment at other healthcare facilities; screening of HCWs scheduled to work the next shift is initiated
30 min after report to IC	IC notified that a fourth employee has been hospitalized with symptoms of gastroenteritis; 10 symptomatic HCWs are found through screening; emergency meeting of IC and hospital administration is scheduled; local health department is contacted
2 h after report to IC	Emergency meeting of administration and IC; 20 HCWs are now confirmed to have gastroenteritis symptoms; facsimile message describing the outbreak is sent out to the community via the Health Alert Network; command center is opened; stool specimens are obtained from symptomatic employees for culture; case definition for diagnosis of gastroenteritis is developed; criteria for returning to work after recovering from gastroenteritis is developed; policies for the treatment of ill parents are developed; additional risk groups (hospital day care center attendees and their parents, recipients of catering services, and employees at neighboring hospitals) are identified and notified of the outbreak
5 h after report to IC	Cafeteria is closed and inspected; foodhandlers undergo interviews and provide stool specimens for culture; arrangements are made to bring food into the hospital from an outside source; informational flyers are made for hospital employees and their families
6 h after report to IC	Charge nurses and chief residents are briefed; flyers are distributed to hospital employees; screening of employees scheduled to work the upcoming shift is initiated
9 h after report to IC	Cafeteria inspection is completed by the health department; environmental and food cultures obtained
Day 2	Script for answering command center phone is developed; communications log is begun; lists for telephone notification of hospital and university employees begun; additional personnel are recruited to staff the OH; food history questionnaire is developed; press release is submitted; list of case subjects and symptomatic persons is created with an epidemic curve; OHs at neighboring hospitals and university are notified; charge nurses are briefed every shift about the outbreak; 50 symptomatic HCWs have now been found via active surveillance
Day 3	A total of 11 case subjects (6 employees and 5 patients) and 100 symptomatic HCWs have been found to be symptomatic for gastroenteritis; patient medical records are reviewed; the CDC is contacted; information about the outbreak is posted on electronic listservs; letter sent to parents of children who attend the day care center; hospital medical director attends weekly meeting of the local health department; case-control study is initiated; food is moved off-site to a freezer truck; kitchen is cleaned; media interviews are conducted
Day 4	A total of 200 symptomatic persons and 21 case subjects have been found to this point; first serotype information is available; a second Health Alert Network bulletin is sent; data entry screens for food exposure histories are built; press conference is conducted
Day 5	Data collection for the case-control continues, and data entry is begun
Day 6	A total of 300 symptomatic persons and 32 case subjects have been found to this point; plan and time line for reopening cafeteria are developed
Day 8	A total of 450 symptomatic persons and 83 case subjects have been found to this point; environmental and food specimens are sent for culture; first decrease in the number of visits to the OH is noted
Day 10	Decreased rate of new cases (7 new cases during days 9 and 10); only 1 person seen in the OH in the previous 24 hours; onset of symptoms associated with final case occurs on day 5 of the outbreak; command center is closed; cafeteria is reopened; media interviews are conducted

NOTE. "Case subjects" are defined in Methods. CDC, Centers for Disease Control and Prevention; HCW, healthcare worker; IC, infection control department; OH, occupational health service.

gastroenteritis began immediately. The local health department and the Centers for Disease Control and Prevention were contacted; no concurrent outbreaks of *Salmonella* infection or colonization were reported. Details of this outbreak were posted on a national foodborne outbreak electronic listserv (FoodNet; available at: http://www.cdc.gov/foodnet/). The pulsed-field gel electrophoresis pattern of the isolates was posted on a second electronic listserv (PulseNet; available at: http://www.cdc.gov/pulsenet/). Local food and soft-drink distributors were contacted; no foodborne illnesses in facilities served by these distributors were reported.

Emergency Control Measures

Members of the infection control team, the division of infectious diseases, the occupational health service, the food and

nutrition department, the media relations department, the hospital administration, and the local health department met immediately. A detailed time line of the emergency control measures is provided in Table 1. A Health Alert Network bulletin was broadcasted via facsimile to area hospitals, physicians, and microbiology laboratories stating that an outbreak of *Salmonella* infection had been recognized in the metropolitan area, and it advised practitioners to obtain a stool specimen from symptomatic patients for culture. Given that *Salmonella* infection is often a foodborne illness and that 2 of the 4 initial employees with culture results positive for *Salmonella* or *Salmonella*-like organisms worked in the food and nutrition department, the hospital cafeteria was voluntarily closed immediately. Additional groups that receive food prepared in the hospital cafeteria were identified (including inpatients, children at the hospital day care center, recipients of catering services, and employees of 2 neighboring hospitals), and notification about the outbreak was provided to them or their parents. Food for patients, employees, and children at the day care center was brought in from an outside source.

A working case definition for symptomatic gastroenteritis was developed. Employees scheduled to work the next day's shift were contacted at home and screened before coming to work. Results of stool cultures and histories of symptoms and food exposure were obtained for symptomatic employees. Symptomatic employees were excluded from work, pending results of stool cultures and resolution of symptoms. All foodhandlers were screened for symptoms, submitted stool specimens for culture, and were excluded from work until they had a negative result of a stool culture and were asymptomatic. Foodhandlers with a stool culture positive for *Salmonella* organisms were excluded from work until they were asymptomatic and had 3 successive stool cultures with negative results. Active surveillance for *Salmonella* organisms among hospital employees was continued for 30 days after the symptom onset date (ie, 3 times the longest incubation period) for the last culture-positive case. The surveillance included daily questioning of foodhandlers about gastroenteritis symptoms and culturing of stool specimens from symptomatic personnel.

The cafeteria was inspected by the hospital's infection control team and representatives from the local health department. A total of 84 food specimens and 123 environmental specimens were obtained for culture. The cafeteria remained closed from June 6 until June 15, 2003, and was reopened after all opened food items were removed, all equipment was cleaned and disinfected, and foodhandlers were reeducated about proper protocols for hand hygiene, preparing food, and cleaning equipment.

An incident command center with 20 phone banks was opened in the hospital boardroom to handle phone calls and organize and staff the employee screening program. Policies regarding ill parents (ie, triage, patient visitation, and breastfeeding) were developed. Flyers were distributed to families and employees, and an informational letter was sent to parents of children at the day care center.

Case-Control Study

Case definitions. A case subject was defined as a person with stool or blood cultures positive for *S. javiana* between May 31 and June 16, 2003. A control subject was defined as a person who ate in the hospital cafeteria between May 30 and June 4, 2003, and who had had no gastroenteritis symptoms after May 1, 2003. Control subjects were randomly selected from among hospital employees.

Data collection. A detailed history of symptoms and exposures was obtained for all case subjects, control subjects, and symptomatic personnel. A detailed history of food exposure both in and out of the hospital during the 6 days before symptom onset was also obtained from persons in these 3 groups, using menus and calendars to aid recall.

Statistical analysis. Data were analyzed using SPSS, version 11.0 (SPSS). Crude odds ratios (ORs) were calculated for the risk of *S. javiana* infection after any exposure to food types consumed by more than 5% of cases. We created a composite variable for consumption of items from the salad bar, which included lettuce, tomato, cheese, cucumber, mushroom, bacon bits, broccoli, carrots, cottage cheese, salad bar eggs, green peppers, green beans, ranch dressing, and onions; lettuce and tomatoes were also served as garnishes at the grill and food bars serving daily specials. Multivariate analysis was performed using a logistic regression model. Food types significantly associated with case subject status (ie, those with a 2-tailed P value of less than .1) were entered into the model as a block. Interaction terms between the composite variable and other covariates were created. Food types that were not biologically plausible vehicles for transmission (ie, bottled and fountain drinks) were excluded from the model after local distributors had been contacted and no other concurrent outbreaks of *S. javiana* infection had been identified. Separate univariate analysis and multivariate analysis were performed for each day of exposure from May 30 to June 4. The model with the best Hosmer-Lemshow fit and lowest log-likelihood ratio was chosen as the final model.

Stool cultures. The hospital microbiology laboratory performed culture of stool specimens from symptomatic personnel, using standard methods.[23-26] All isolates that were identified as *Salmonella* species were sent to the Missouri State Health Laboratory in Jefferson City for further serotyping.

Food culture and polymerase chain reaction (PCR) analysis. Culture of food specimens was performed at the St. Louis City Health Department Laboratory. PCR analysis of food specimens was performed at the Missouri State Health Department Laboratory, using standard methods.[27-29] Eight types of foods that were implicated by statistical analysis as being associated with the outbreak were cultured again using increased quantities. PCR analysis of these same 8 types of food was performed with the Qualicon BAX PCR system

(DuPont) according to Association of Analytical Communities International method 2003.09.

RESULTS

Demographic Characteristics and PFGE Findings

A total of 101 case subjects with a culture positive for *S. javiana* were identified; all case subjects had a positive result of a stool culture, and 1 case subject also had a positive result of a blood culture. The date of symptom onset ranged from May 26 to June 16, 2003 (Figure 1). Forty-four case subjects were hospital employees who did not work in the food and nutrition department, 14 were employees at one of two neighboring hospitals, 16 were hospital visitors, 9 were employees of the affiliated university, 4 were patients, and 14 were employees in the food and nutrition department. Four of the 14 foodhandlers were asymptomatic. A total of 114 of 120 foodhandlers at the hospital provided samples for culture. No employees or attendees of the child day care center were culture positive. The hospital cafeteria serves a mean of 4,000 customers each weekday and 1,825 customers each weekend day.

All isolates except 1 were identical by pulsed-field gel electrophoresis (Figure 2). A small point mutation was detected in the isolate with a different PFGE pattern. This isolate was from an infant who consumed only formula and was the only case subject who had not eaten in the hospital cafeteria. Symptoms in the infant began on June 12. The infant's mother had eaten in the hospital cafeteria, and she had symptoms of gastroenteritis that began on June 1. The mother had a negative result of a stool culture.

Symptoms

Case subjects were more likely to have diarrhea, chills, fever, and nausea, compared with symptomatic people with negative results of culture (Table 2). Diarrhea among case subjects was also more likely to be bloody or streaked with mucus.

Case-Control Study

A total of 104 asymptomatic hospital employees who had eaten in the hospital cafeteria between May 30 and June 4, 2003, were interviewed as control subjects. Only 1 of the 101 case subjects refused an interview about food exposure history.

Twenty-nine types of food were identified as statistically significantly more likely to have been consumed by case subjects than by control subjects; the majority of these items were from the salad bar. In multivariate analysis, case subjects were more likely than control subjects to have consumed items from the salad bar (adjusted OR [aOR], 5.3; 95% confidence interval [CI], 2.3-12.1). Multivariate models incorporating individual dates as covariates in addition to salad bar exposure revealed that eating in the cafeteria on May 28

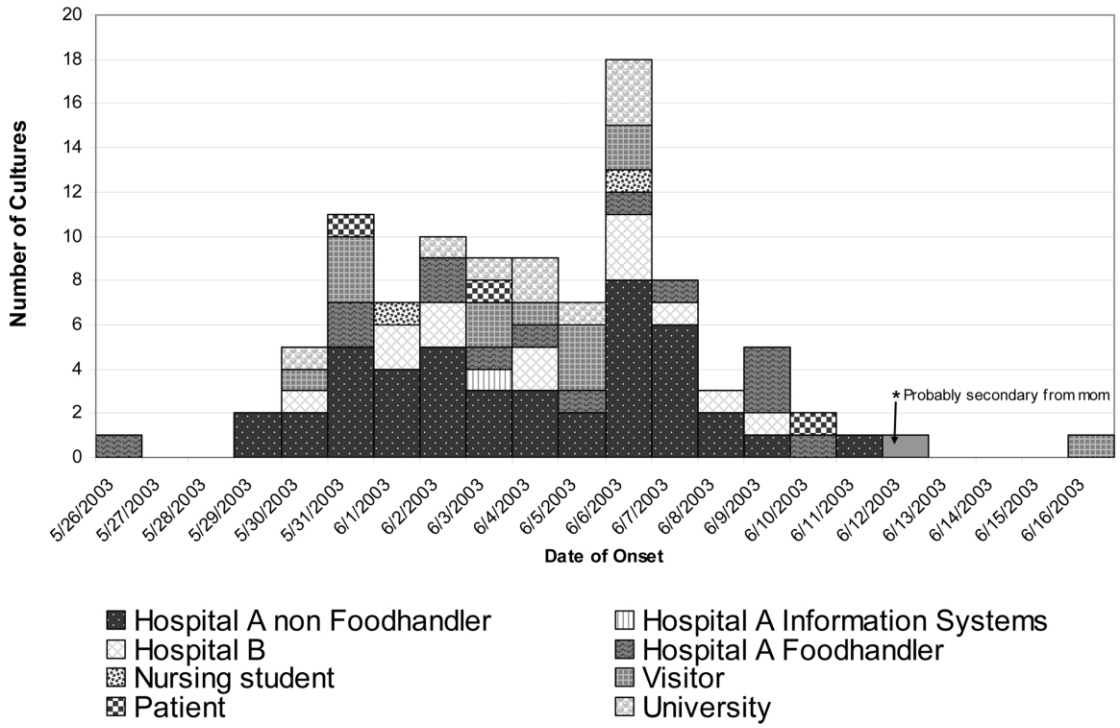

FIGURE 1. Time line of symptom onset among subjects with positive results of culture for *Salmonella javiana* during an outbreak of *S. javiana* infection in a children's hospital.

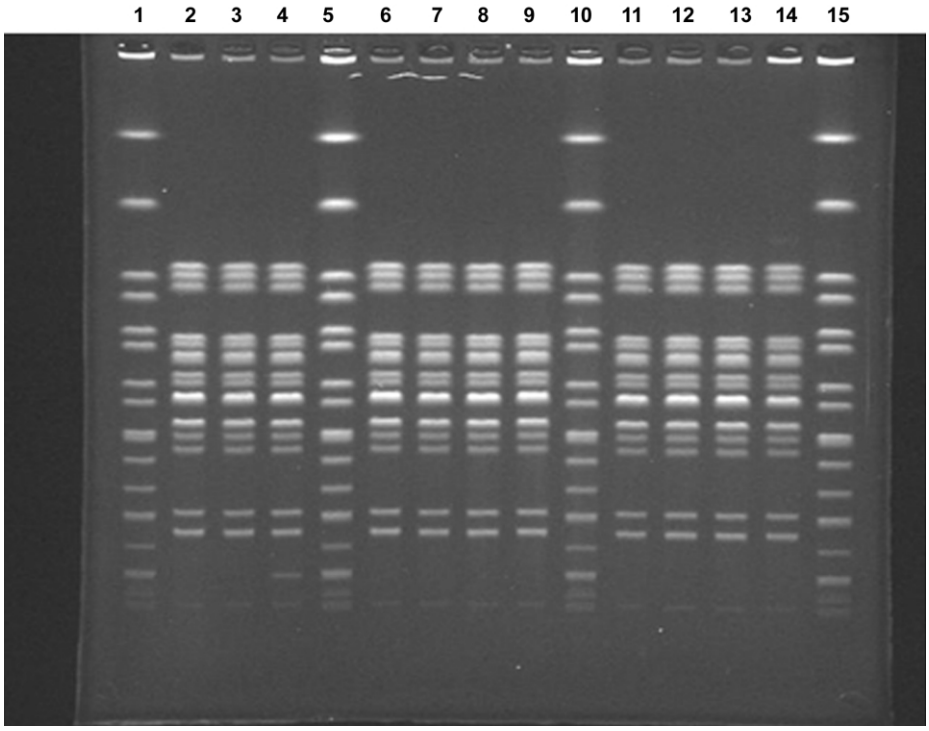

FIGURE 2. Sample pulsed-field gel electrophoresis patterns of *Salmonella javiana* isolates recovered during an outbreak of *S. javiana* infection in a children's hospital. *Lanes 1, 5, 10,* and *15,* standards; *lanes 2-4, 6-9,* and *11-14, S. javiana* isolates from culture-positive case subjects.

(aOR, 9.4; 95% CI, 1.8-49.5), May 30 (aOR, 3.6; 95% CI, 1.0-12.7), and/or June 3 (aOR, 4.0; 95% CI, 1.4-11.3) was statistically significantly associated with case subject status. Twenty-six case subjects consumed only one meal from the hospital cafeteria during the outbreak period; 24 of these case subjects consumed items from the salad bar.

Environmental Investigation

A total of 84 food samples were obtained on the evening the outbreak was identified. Repeated cultures and PCR for *S. javiana* were performed on tomato, lettuce, onion, cheese, and ranch dressing specimens. Cultures of 123 environmental specimens were performed, including swab specimens from the outer screen, inner rim, and inside of the drain from each sink; cutting boards; food processors; knives; ice and ice cream machines; meat thermometers; and electronic badge readers. Results of culture and PCR of all food and environmental specimens were negative.

Interviews with the presumed index subject revealed that they had worked primarily at the coffee bar station, where their responsibilities included filling the coffee machine with water, preground coffee beans, and milk; slicing cooked pizza; and pouring prepackaged ice cream mix into a machine and placing toppings on it. The index subject obtained ice from a common bin in the back of the cafeteria; a scoop was used to fill a smaller cooler that was brought back to the coffee bar station. The index subject occasionally helped to wipe down the salad bar but could not recall whether this task had been performed when symptoms of gastroenteritis were present. The index subject had had no reptile or amphibian contact and no ill contacts at home and had not traveled outside the local area. Several symptomatic foodhandlers who worked primarily as cashiers had helped stock the salad bar with food and ice.

TABLE 2. Gastroenteritis Symptoms in Case Subjects With Confirmed *Salmonella javiana* Infection and in Epidemiologically Linked Symptomatic Subjects With Negative Culture Results

Symptom	No. (%) of case subjects (n = 101)	No. (%) of symptomatic subjects (n = 540)	P
⩾3 stools/day	85 (84)	361 (67)	<.01
Mucus in stool	43 (43)	94 (17)	<.01
Bloody stool	21 (21)	20 (4)	<.01
Watery diarrhea	75 (74)	263 (49)	<.01
Chills	65 (64)	193 (36)	<.01
Fever	58 (57)	162 (30)	<.01
Headache	71 (70)	335 (62)	.11
Nausea	69 (68)	292 (54)	.01
Vomiting	28 (28)	181 (34)	.25
Abdominal cramps	83 (82)	400 (74)	.08
Fatigue	60 (59)	310 (57)	.71

DISCUSSION

We describe a large outbreak of *S. javiana* infection in a hospital setting. One hundred of 101 cases subjects ate in the hospital cafeteria. The presumed index subject was a foodhandler. Fourteen of the 101 cases occurred in foodhandlers. Case subjects were more likely than control subjects to have consumed salad bar items and vegetable garnishes and more likely to have eaten in the cafeteria during May 28-30 and on June 3. The presumed index subject had contact with a common ice bin, which could have led to contamination of the salad bar and vegetable items. Alternatively, one of the subjects with an earlier case of *S. javiana* infection who worked as a foodhandler could have contaminated the salad bar while preparing and stocking it.

Contamination of the salad bar and fresh vegetable garnishes seems to be the most likely vehicle of transmission. This hypothesis is supported by results of multivariate analysis. Several possible links between infected foodhandlers and the salad bar were found, including the index subject's handling of ice that could later have been used to stock the salad bar. Other *Salmonella* species have been shown to be capable of surviving in ice.[30] Vegetables and cheese were shown to be the point source of *S. javiana* infection outbreaks in other published studies.[2,3,21] The paucity of cases among pediatric inpatients and day care center attendees is also consistent with contamination of fresh vegetables, because these populations do not routinely access the salad bar and are unlikely to consume vegetable garnishes.

This outbreak is similar to previously described outbreaks of *S. javiana* infection in that foodhandlers working with symptoms of gastroenteritis may have initiated and were likely to have contributed to ongoing transmission of infection.[3,22] Similar to other hospital outbreaks of infection caused by different *Salmonella* species, we had no evidence of transmission from healthcare workers to patients, despite the proximity of a patient population at high risk for acquiring invasive *Salmonella* disease.[31,32]

This study had a few limitations. The case-control study design is subject to recall bias, with case subjects potentially more motivated than control subjects to recall foods they ate. We believe that recall bias was reduced by using menus and calendars as visual aids for recall. Many of the case subjects could not recall every item they had eaten in the hospital cafeteria, which may account for our inability to identify a single type of food that every case subject had eaten. It is possible that the presumed index case was not truly the first case. Many foodhandlers may have not recalled earlier symptoms or may have been reluctant to state that they had had symptoms earlier in the month. The low dose at which *S. javiana* was infectious (0.04-0.45 organisms per gram of food) may have hindered our ability to culture this pathogen from samples of the implicated foods. Contamination of the salad bar could have been transient and/or occurred at an earlier time in the outbreak The source of the *S. javiana* strain found in the presumed index subject remains unclear.

Rapid identification, investigation, and control of the outbreak were facilitated by a multidisciplinary team and an incident command center. Closing the hospital cafeteria upon recognition of the outbreak was crucial in controlling the outbreak and likely prevented more cases from occurring. Prolonged surveillance after the outbreak was important for assuring that *Salmonella* transmission did not recur.

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