A Prolonged Outbreak of Salmonella Montevideo Infections Associated with Multiple Locations of a Restaurant Chain in Phoenix, Arizona, 2008

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ABSTRACT

An outbreak of Salmonella serotype Montevideo infections associated with multiple locations of restaurant chain A in Phoenix, AZ, was identified in July 2008. One infected individual reported eating at a chain A catered luncheon where others fell ill; we conducted a cohort study among attendees to identify the vehicle. Food and environmental samples collected at six chain A locations were cultured for Salmonella. Restaurant inspection results were compared among 18 chain A locations. Routine surveillance identified 58 Arizona residents infected with the outbreak strain. Three chain A locations, one of which catered the luncheon, were named by two or more case patients as a meal source in the week prior to illness onset. In the cohort study of luncheon attendees, 30 reported illness, 10 of which were later culture confirmed. Illness was reported by 30 (61%) of 49 attendees who ate chicken and by 0 of 7 who did not. The outbreak strain was isolated from two of these three locations from uncooked chicken in marinade, chopped cilantro, and a cutting board dedicated to cutting cooked chicken. Raw chicken, contaminated before arrival at the restaurant, was the apparent source of this outbreak. The three locations where two or more case patients ate had critical violations upon routine inspection, while 15 other locations received none. Poor hygiene likely led to cross-contamination of food and work areas. This outbreak supports the potential use of inspections in identifying restaurants at high risk of outbreaks and the need to reduce cross-contamination of raw products at the source and prevent cross-contamination at the point of service.

Salmonella is the most common bacterial cause of foodborne outbreaks in the United States, resulting in an estimated 1.4 million infections and 400 deaths annually, and the incidence has changed little in the last decade (5, 14, 21). Previous Salmonella outbreaks have been associated with a wide range of food items, including meat, poultry, eggs, fruits, and vegetables (3–5). Chicken is a commonly identified vehicle in outbreaks of Salmonella infections (16, 18). Chicken is contaminated with Salmonella because the organism lives in its intestines. Furthermore, Salmonella can be passed vertically from a breeder chicken to the ova; Salmonella can also be introduced to clean chickens via physical contact with infected chickens, via their feed source, or via rodent transmission (8, 22).

Salmonella enterica is not a uniform species, and over 2,500 serotypes of S. enterica have been identified with certain serotypes having a predilection for certain vehicles. S. enterica serotype Montevideo is in the top 10 most common serotypes causing human infections; Salmonella Montevideo is also one of the 10 most common Salmonella serotypes isolated from chicken (6, 10).

On 28 July 2008, PulseNet, the national molecular subtyping network for foodborne disease surveillance, identified 23 persons infected with S. enterica serotype Montevideo with an indistinguishable pulsed-field gel electrophoresis (PFGE) pattern (the “outbreak strain”; PulseNet XbaI PFGE pattern JIXX01.0126); 21 cases were in Arizona. This report describes the results of the investigation, which identified contaminated chicken as the apparent source that, aided by multiple additional factors, resulted in a prolonged outbreak of Salmonella.
Montevideo infections in Arizona associated with a restaurant chain.

**MATERIALS AND METHODS**

**Epidemiology.** Case patients infected with the outbreak strain of *Salmonella Montevideo* were interviewed by Maricopa County Department of Public Health and Arizona Department of Health Services epidemiologists using a standardized questionnaire to collect information on >200 food items, restaurant patronage, and other nonfood exposures, such as animal and water exposures, in the week before illness. After a number of case patients reported eating at chain A restaurants in the week prior to illness onset, a supplemental questionnaire was developed and administered to those case patients.

An interview of a case patient infected with the outbreak strain identified an August luncheon (event A) attended by ill persons that was catered by location A of chain A. A questionnaire that collected information on illness and lunch food items consumed at event A was administered to all attendees. Attendees who had gastrointestinal symptoms within 7 days of the luncheon were asked to provide a rectal swab for *Salmonella* culture.

**Laboratory.** Clinical laboratories that isolated *Salmonella* from patient specimens forwarded isolates to the Arizona State Public Health Laboratory. Food samples and environmental swabs from inspected restaurants and rectal swabs from ill luncheon attendees were submitted to Arizona State Public Health Laboratory or the Centers for Disease Control and Prevention for *Salmonella* isolation and serotyping. All *Salmonella* isolates were subtyped, using PFGE, by the Arizona State Public Health Laboratory and the Centers for Disease Control and Prevention by standard methods (1, 17, 19).

**Environment.** Reports of routine restaurant inspections of chain A locations conducted between April and August 2008 were obtained from the Maricopa County Environmental Services Department (MCESD). Inspection reports contained data on the restaurants’ performance in >30 categories of possible violations, ranging from minor violations (such as lacking hand soap and paper towels at the hand wash sink) to critical violations that can directly result in foodborne illness (such as serving undercooked foods). Weighted points were assigned for each violation, with critical violations being assigned more points than minor violations. All points were summed; therefore, restaurants with poorer routine inspections had more points, also referred to in this article as negative points. Maricopa County gives “Gold Awards” to the top 25% of restaurants, based on their routine inspections. A Gold Award is given based on the results of a single routine inspection report and is not cumulative over time.

All restaurants named by two or more case patients infected with the outbreak strain as a meal source in the week prior to illness onset underwent a foodborne illness outbreak environmental assessment by MCESD to identify possible problems. Multiple food samples and environmental swabs were collected from inspected restaurants and cultured for *Salmonella* as described in the “Laboratory” section above.

Traceback investigations to determine the supplier of chicken to the implicated restaurants were conducted by U.S. Department of Agriculture, Food Safety and Inspection Service (FSIS). Traceback investigations to determine the supplier of cilantro were conducted by the U.S. Food and Drug Administration.

**Statistical analysis.** Statistical analyses were conducted using SAS 9.2 (SAS Institute, Cary, NC). Relative risks and 95% confidence intervals were calculated for the cohort investigation, while Fisher’s exact *P* values were calculated for the study of the routine restaurant inspection data.

**RESULTS**

**Epidemiology.** From 1 January 1996 to 31 October 2008, 6,002 *Salmonella Montevideo* isolates were submitted to the PulseNet database from state health departments nationwide; in this database, 1.98% of the *Salmonella* Montevideo isolates have PFGE pattern JIX001.0126 (the outbreak strain). The first submission of this strain to the PulseNet database was in May 2002, with the first submission isolated from an Arizona resident in April 2004 (Fig. 1). In 2007, there were 26 submissions of the outbreak strain, 16 (62%) of which were isolated from Arizona residents.

Between 1 January and 1 October 2008, 69 case patients infected with the outbreak strain were reported to PulseNet; 61 were reported between May and October (Fig. 2). Fifty-eight (95%) of the 61 case patients resided in Arizona, and 1 patient each resided in New York, California, and Pennsylvania. Among the 58 Arizona case patients, the median age was 36.5 years (range, 10 months to 77 years); 59% were female. Fifty-five culture-confirmed Arizona case patients were interviewed: 53 (96%) reported diarrhea, 48 (87%) reported abdominal cramps, 44 (80%) reported fever, and 22 (40%) reported bloody diarrhea; 19 (35%) case patients were hospitalized, and there were no deaths. Fifty-six (97%) of the Arizona case patients were residents of Maricopa County; two (3%) lived in neighboring Pinal County.

Thirty-nine (71%) of 55 interviewed case patients reported eating at a chain A location in the 7 days before illness onset. Of the 39 case patients who ate at chain A, 18 (46%) ate at location A, 11 (28%) ate at location B, and 6 (15%) ate at location C. One patient each ate at locations D, E, and F, and one patient ate at chain A but could not recall the location. Among the 35 case patients who ate at locations A, B, or C, 29 (83%) reported eating menu items
containing chicken, and 24 (69%) reported eating menu items containing cilantro.

Location A of chain A catered a luncheon with 56 attendees on 12 August 2008. Of the 56 attendees, 30 (54%) reported onset of diarrhea or hematochezia within 7 days of the luncheon. Of the ill attendees, 27 (90%) reported fever and 4 (13%) reported hematochezia. Twenty-six (87%) ill attendees had an illness onset ≤ 36 h following the luncheon. Eight (27%) sought medical care, and one attendee was hospitalized. Illness was reported by 30 (61%) of 49 attendees who ate chicken and by none of the 7 attendees who did not eat chicken (relative risk, ∞). Illness was reported by 29 (59%) of 49 attendees who ate cilantro and by 1 (13%) of 7 attendees who did not eat cilantro (relative risk, 4.1; 95% confidence interval, 0.7 to 25.8) (Table 1).

To ensure that an ill food handler was not confounding the results, all food handlers involved in this luncheon preparation were queried. No food handler reported being ill in the week before food preparation.

**Laboratory.** Thirteen ill event A attendees provided rectal swabs on 3 September 2008. The mean time between illness onset and specimen collection was 21 days (range, 20 to 22 days). Nine (69%) of the 13 rectal swabs submitted from ill luncheon attendees yielded *Salmonella* Montevideo; seven (78%) strains were the outbreak strain, and two were one band different by PFGE from the outbreak strain.

The outbreak strain was also isolated from 6 of the >150 food samples and environmental swabs collected from six chain A locations. The outbreak strain was isolated from (i) uncooked cilantro chopped in the restaurant collected on 5 August from location A, (ii) uncooked cilantro chopped in the restaurant collected on 13 August from location B, (iii) uncooked cilantro-cheese garnish prepared in the restaurant collected on 13 August from location B, and (iv) an environmental swab of the surface of a cutting board used exclusively for cooked chicken collected on 8 September from location B. Of note, the marinade did not contain any cilantro (Fig. 2).

Various cuts of uncooked chicken collected over the span of 2 months at locations A and B yielded *Salmonella* serotypes Kentucky, Heidelberg, Typhimurium, and Uganda. An environmental swab of the area surrounding the cutting board collected on 12 September from location C yielded *Salmonella* Senftenberg.

**Environment.** In response to patient interviews, MCESD sanitarians conducted 14 foodborne illness outbreak environmental assessments of five chain A locations (locations A, B, C, D, and E). Inspectors discovered multiple problems at locations A, B, and C during the initial assessments including potential for cross-contamination and poor food handling practices. For example, clean utensils and cutting boards were in close proximity to where raw chicken was prepared and had the potential to be contaminated. Additionally, equipment used in raw chicken preparation came in contact with raw produce preparation areas in the restaurants.

A review of the most recent routine inspection results was conducted, comparing the three locations of chain A (locations A, B, and C) implicated by more than one case patient to the locations (n = 15) that were not implicated. Three chain A locations named by only one case patient each as a meal source in the week before illness onset were
excluded. The last routine inspections for all 18 locations occurred between April and August 2008. Gold Awards, presented to the top 25% of Maricopa restaurants by MCESD, were not given to any of the affected locations on their last inspection, while 12 (80%) of the 15 unaffected locations received a Gold Award ($P = 0.02$). Affected locations had worse inspection scores, as they received a median of nine negative points compared with the median of two negative points received by the unaffected locations ($P = 0.08$). Additionally, all three affected locations were cited for at least one critical violation, compared with 5 (33%) of 15 unaffected chain A locations ($P = 0.07$). Furthermore, during these inspections, locations A, B, and C each had at least one citation related to incomplete cleaning of food contact surfaces, specifically cutting boards, compared with only 1 (7%) of the other 15 locations ($P = 0.005$) (Table 2).

All chain A locations in Arizona received poultry from the same distribution center, which was supplied by a large number of poultry slaughter establishments (suppliers). The distributor changed suppliers depending on market forces and distributed similar products to all 38 Restaurant chain A restaurants in Arizona with a typical fresh poultry turnover of 1 to 3 days. The distributor did not record which chicken products were prepared on specific days. Due to insufficient distributor and restaurant recordkeeping, FSIS was unable to identify the poultry supplier(s) for the positive marinated chicken specimens. However, several possible poultry suppliers were identified. FSIS pathogen reduction/hazard analysis and critical control point (PR/HACCP) Salmonella testing had been conducted at two of these supplying establishments in 2008. A sample from one establishment yielded Salmonella Montevideo, but the PFGE pattern differed from the outbreak strain.

U.S. Food and Drug Administration investigators determined that the cilantro served in restaurant chain A originated from the same distributor; cilantro samples from unopened products collected at the distributor were negative for Salmonella. However, it is unknown from which lots the positive cilantro samples came, and therefore, it is impossible to know if the positive cilantro samples came from the same lot as those tested by the U.S. Food and Drug Administration.

**DISCUSSION**

Contaminated food sold by at least three locations of a restaurant chain caused a prolonged outbreak of Salmonella Montevideo infections in Arizona in 2008. Routine surveillance identified 58 laboratory-confirmed cases in Arizona, which is likely an underestimate of the true burden of disease caused by this outbreak among Arizona residents; only an estimated 3% of Salmonella infections are laboratory confirmed and reported to the foodborne surveillance systems (21). In this outbreak, active case findings conducted as part of the cohort investigation identified nine other confirmed salmonellosis infections as well as 20 probable infections, none of which were reported to our passive routine systems. Additionally, the duration of the outbreak may have been longer than 5 months, as a gradual increase in cases was seen starting in 2007. Results from the cohort study and the environmental assessments indicate that cross-contamination of other food items by Salmonella-contaminated chicken and the undercooking of chicken at the restaurants were contributing factors in this outbreak. The isolation of the outbreak strain from two restaurant locations suggests that the chicken was contaminated with the outbreak strain prior to receipt at the restaurants.

Chicken-related Salmonella outbreaks result in many cases of human illnesses every year (5, 7, 13). To reduce the incidence of Salmonella infections, prevention efforts are needed at the poultry farms and the processing plant, as well as in the kitchen. In 1996, FSIS launched a PR/HACCP program in poultry establishments to reduce disease-causing bacteria. In 2008, FSIS announced 11 new initiatives to encourage poultry establishments to reassess their food safety systems to achieve and maintain consistent process control. As one of these new initiatives, FSIS increased testing frequency in establishments with variable or highly variable process control compared with those showing consistent process control. Efforts by FSIS and the industry to decrease the burden of illness attributable to poultry are ongoing.

In this outbreak, all 21 locations of restaurant chain A received chicken from the same distributor, but illness was primarily reported in association with 3 locations. This may be due to poor food-handling practices at the three locations, resulting in cross-contamination of various foods including cilantro and cooked chicken. In this outbreak, cilantro and a...
cutting board both were sources of *Salmonella* in addition to chicken, showing that cross-contamination was occurring. The continued occurrence of illnesses associated with restaurant chain A over a 5-month period suggests that either a nidus of contamination was present at each of the three locations of chain A or the outbreak strain intermittently entered the restaurants from contaminated chicken. The latter appears most likely both because the chance of having a nidus of the same outbreak strain taking hold in three locations is low and because cases continued to occur even after the restaurants were cleaned thoroughly. Once introduced or reintroduced into the restaurant, the outbreak strain of *Salmonella* could then cross-contaminate produce items, such as cilantro, and environmental surfaces, such as the cutting board. These events underscore the need to reduce *Salmonella* contamination in chicken and promote the education and training of food handlers in the proper handling and preparation of raw poultry in order to decrease *Salmonella*-related illnesses that arise from cross-contamination.

Since processed cilantro and marinated chicken samples both yielded the outbreak strain, one of the challenges of this investigation was determining whether cilantro, chicken, or another factor, such as ill food handlers, was the source of this outbreak. Chicken was determined to be the most likely source for several reasons: (i) the cohort study implicated chicken more strongly than cilantro; (ii) the raw marinated chicken samples that yielded the outbreak strain were collected at points early in the food flow in the restaurant, before it was possible for cilantro to have come in contact with the chicken; (iii) cilantro does not come into contact with the cutting board at any point in the food flow; (iv) sealed bags of cilantro collected at the distributor tested negative for *Salmonella*; (v) cilantro from the distributor went to multiple restaurants as well as multiple locations, but illness was associated with only three locations; (vi) food flow in the kitchen indicated that raw chicken could easily cross-contaminate cilantro; and (vii) cilantro was removed from the affected stores on 19 August, but illness continued after this date.

It is important to note that the role of food handlers in this outbreak is not fully known. Those who prepared the food for the catered event did not report being ill; additionally no food handlers reported coming to work while ill. However, in a review, the Committee on Control of Foodborne Illnesses of the International Association for Food Protection found that 34 of 816 outbreaks were epidemiologically linked to food handlers who denied illness (20). Medus et al. (15) found that 53% of *Salmonella*-positive food handlers reported no recent gastrointestinal symptoms. In order to determine if food handlers were sources in this continuing outbreak, franchise X required all food handlers of locations A, B, and C to submit a stool specimen for *Salmonella* testing in September 2008; all tests were reported as negative. This does not mean the food handlers were negative throughout the entire outbreak, and they still may have played a role in the longevity of this outbreak.

As mentioned previously, illness was primarily reported in association with three Maricopa County locations; therefore, we conducted an evaluation of the most recent routine inspection reports to evaluate if cross-contamination or other issues were documented. This evaluation found that the three affected locations were less likely to have received a Gold Award while they were more likely to have a higher median negative point score. These affected locations were also more likely to have had critical violations and to have had cutting boards that were not easy to clean as noted on the inspection reports. Taken together, the affected locations had worse overall inspections than the unaffected locations. However, this case-control study does have a few large limitations. First, as only 18 locations were involved in this study, power was limited. Second, while inspections were conducted by a number of trained personnel, there can be interinspector variability as well as inspector bias. It is also challenging to generalize such results, as this study was conducted on retrospective data from Maricopa County and might not be applicable to other counties that might follow different food codes and have different restaurant inspection standards. Nine of the routine inspections were conducted in August 2008, during the course of this outbreak, and inspections could have been more rigorous as a result. Additionally, all of the reported inspections were “routine inspections,” though some were done as part of other types of inspections. The three affected locations had routine inspections done as part of “foodborne illness inspections”; one unaffected location had its routine inspection done as part of a “complaint inspection.” Foodborne illness inspections focus on risk factors for the organism in question (i.e., *Salmonella*); interviews are conducted with this in mind, and therefore, there are possibly more chances for violations to be found during this process than during a routine inspection. Foodborne illness inspections are also conducted with oversight by sanitarians from the county’s foodborne illness program. Complaint inspections focus on the complaint in question. While all three types of inspections use the same evaluation form and scoring system, bias can be introduced by analyzing all routine inspections together as was done here. Despite these limitations, the routine restaurant inspections were useful tools in identifying the factors that could have played a role in this outbreak. Although restaurants in the United States are routinely inspected by health departments, there is little conclusive evidence in the literature to correlate inspections and foodborne illness. Jones et al. (12) examined 7 years’ worth of statewide restaurant inspection data and found that mean scores between outbreak- and non–outbreak-related restaurants were indistinguishable. A review of inspection data from Miami-Dade County also found that inspection scores were not predictive of future foodborne outbreaks (9). However, a case-control study from 1 year of Seattle-King County restaurant inspection data found that restaurants associated with outbreaks had poorer preexisting inspection scores than did non–outbreak-related restaurants inspected during the same time period and that critical violations were associated with future foodborne outbreaks (11). A study evaluating Los Angeles County data showed that food protection violations on inspections were predictors of future foodborne outbreaks in a restaurant (2). Due to
the limitations in this study, it is hard for us to say that restaurants with poor inspection reports are more likely to be involved in foodborne disease outbreaks, but this study does highlight an area that needs further evaluation. Regardless, efforts should continue to address poor inspection reports in a timely manner.

Based on the epidemiologic and environmental investigations, chicken is the most likely vehicle for this outbreak with cross-contamination at the three restaurant locations playing a key role. The long duration of this outbreak most likely resulted from intermittent entry of chicken contaminated with Salmonella Montevideo into multiple restaurant locations combined with poor chicken-handling practices leading to cross-contamination of cilantro. Additionally, the positive sample from the cooked chicken cutting board suggests the possibility that undercooked chicken was being served. Finally, once the cutting board became contaminated, improper cleaning resulted in Salmonella Montevideo contaminating other fully cooked chicken pieces. Those restaurants that more closely followed the food code and therefore had better inspection scores were less likely to have been involved in this outbreak. Education and training of food handlers in the proper handling and preparation of raw poultry should be promoted to prevent cross-contamination between raw chicken and ready-to-eat items such as produce. Lastly, this outbreak underscores the need to reduce Salmonella contamination in chicken.

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