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A large salmonellosis outbreak associated with a frequently penalized restaurant

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SUMMARY

Between January and June 1990, Restaurant A in Greenville, South Carolina repeatedly failed local health department inspection and was repeatedly sanctioned. In September 1990, two persons, hospitalized with salmonellosis after attending a convention catered by Restaurant A, contacted the South Carolina Department of Health and Environmental Control. We inspected Restaurant A, interviewed food handlers, and surveyed by telephone persons from every sixth business attending the convention. Of 398 persons interviewed, 135 (34%) reported gastroenteritis. Nine had culture-confirmed salmonella infection. People who ate turkey were 4·6 times more likely to become ill than those who did not eat turkey (95% confidence interval 2·0, 10·6). We estimate that of 2430 attendees, 824 became ill. Sanitarians judged Restaurant A's kitchen too small to prepare over 500 meals safely. The cooked turkey was unrefrigerated for several hours, incompletely rewarmed, and rinsed with water to reduce its offensive odour prior to serving. Stronger sanctions may be needed against restaurants that repeatedly fail local health department inspection.

INTRODUCTION

Between 1983 and 1987, 2397 outbreaks of food-borne disease affecting 91678 persons and causing 139 deaths were reported to the United States Centers for Disease Control [1]. Most of these outbreaks of known aetiology were caused by common bacterial organisms (salmonella, staphylococcus, clostridium and shigella) for which control measures are well known. Although routine restaurant inspection in most US counties is designed to ensure that restaurants comply with hygienic standards necessary to prevent the spread of common pathogens, in 52% of these outbreaks the implicated food was prepared by a restaurant, delicatessen, or cafeteria. We describe the largest food-borne outbreak ever reported in the state of South Carolina which occurred after intensive efforts by the health department to improve the sanitary practices at the implicated restaurant.

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During the first 6 months of 1990, Restaurant A in Greenville, South Carolina, was cited by the Greenville County Health Department for 23 health code violations. These infractions included poor cleanliness of food preparation areas, temperature violations of hot foods, temperature violations of cold food at the salad bar, poor lighting, transporting cooked chicken in an unrefrigerated truck, a rat feeding near where food was being prepared, and raw meat stored directly above an open bucket of salad dressing in the refrigerator.

After each violation, Greenville County sanitarians explained to employees and management the reasons the restaurant was being cited and instructed them how to avoid future problems. Restaurant A's manager was required to take an examination on proper food handling practices which he passed in February 1990. Because of these multiple violations, Restaurant A lost its publicly displayed A rating with the health department four times in the first half of 1990. After each downgrade Restaurant A personnel would make the necessary changes to regain their A rating within a few days and request reinspection which they generally passed. On three occasions, however, when Greenville County sanitarians reinspected the restaurant unannounced several weeks later, multiple food handling violations were again noted.

On 4 September 1990, the South Carolina Department of Health and Environmental Control received two reports of persons in nearby states hospitalized with salmonellosis. Both had eaten from a buffet lunch catered by Restaurant A at a large hardware convention in Greenville, South Carolina, on 26 August.

We obtained a partial list of hardware stores who had personnel attending the convention. We telephoned 10 stores in the three-country area surrounding Greenville and interviewed 26 convention attendees. Of these 26 attendees, 13 reported diarrhoea in the 5 days following the convention. Because of this 50% attack rate and a preliminary estimate of 4000 persons attending the convention, we undertook a larger investigation.

METHODS

A case of probable salmonellosis was defined as an individual with an onset of diarrhoea ($\geqslant 3$ loose stools in a 24-h period) in a convention attendee, during or in the 5 days after the convention. Because multiple meals were evaluated on 2 days, when food or meal-specific attack rates were analysed in univariate analysis we required onset of illness to occur $\geqslant 6$ h after eating a convention meal to meet the case definition.

Every sixth name was selected from a complete list of hardware stores and hardware product manufacturing firms who had representatives attending the convention and each selected business was telephoned. We attempted to interview all persons who had attended the convention from that place of business, whether in an official capacity or as a friend or family member of one of the attendees. Similarly, every sixth employee of the convention's sponsor, Hardware Wholesaler X, who had worked at the convention was telephoned and interviewed along with any of their friends or family members who had attended with them.

Restaurant A was inspected and food handlers questioned concerning symptoms of illness and the process of food preparation. All food handlers submitted stool samples for culture.

All salmonella isolates obtained from convention attendees' stool samples that could be located and were still viable were forwarded to the South Carolina Department of Health and Environmental Control, Bureau of Laboratories, for serotyping. Forwarded isolates were first grown on blood agar, analyed through a standard 15-stage biochemical battery, and serotyped by antisera testing of O and H antigens. Stool isolates from Restaurant A employees who were involved in food preparation were sent directly to the Bureau of Laboratories and grown on standard selective media for isolation of enteric pathogens.

Relative risks and confidence intervals were calculated by Cornfield's approximation, and significance tests by Yates corrected chi square or when appropriate Fisher Exact test using Epi Info software [2]. Statistical significance was defined as $P \leqslant 0{\cdot}05$. Summary relative risks [3] were calculated with Epi Info and multiple logistic regression performed with Logress software [4].

RESULTS

Epidemiological investigation

Through our systematic selection, 405 convention attendees were identified from 16 states and ultimately 398 (98%) were interviewed. Of these 398 persons, 135 (34%) met the case definition for illness (Fig. 1). The convention began with breakfast on Saturday morning, 25 August, and ended after lunch on Sunday afternoon, 26 August. The earliest case reported onset of illness on Sunday, 26 August at 4 a.m.

Ill persons were sick a median 4 days, and missed a median 1 day of work. Twenty-one percent consulted a physician, and 2% were hospitalized. We learned of no deaths attributable to the outbreak. Attendees reported five cases of secondary spread of a similar illness to household members who had not attended the convention.

Greenville area hospitals reported no increased diarrhoeal illness among persons who did not attend the convention. Among convention attendees, attack rates did not differ significantly by age group, telephone area code, or group affiliation (hardware store, manufacturer, or wholesaler). Men, however, were 1·4 times more likely to become ill than women (95% confidence interval, 1·0, 2·0).

Eating food at the convention increased the risk of illness. Of the 367 persons who ate convention food, 135 (37%) reported illness. Of the 31 convention attendees who did not eat convention food, none became ill (relative risk, undefined, $P < 0{\cdot}001$). Among the 367 persons who ate, two meals significantly increased risk of illness (Table 1). Persons who ate the Sunday lunch were much more likely to become ill than persons who did not (47% versus 0%, relative risk undefined, $P < 0{\cdot}00000001$). Eating Saturday dinner also significantly increased risk of illness, but the relative risk was 1·4, substantially less than that for the Sunday lunch.

We calculated the food-specific attack rates for Sunday lunch foods for the 245 persons who ate the Sunday lunch and who did not report symptoms of illness before

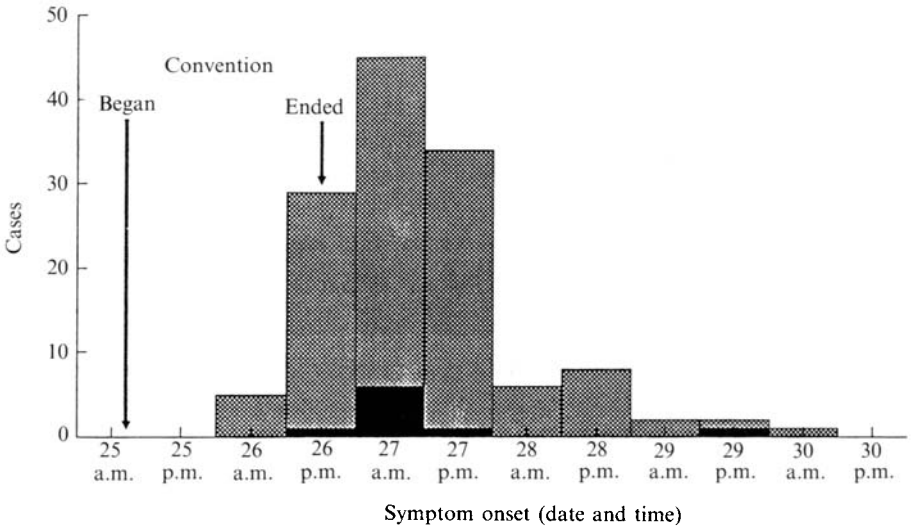

Fig. 1. Date of onset of illness–salmonella outbreak, Greenville, South Carolina, August 1990. Cases: ■, culture confirmed; ▩, clinical.

Table 1. *Risk of illness by meals among persons who ate convention food – Greenville, South Carolina salmonella outbreak, August 1990**

	Ate meal			Did not eat meal			
Meal	Total	Case	AR %	Total	Case	AR %	RR (95% CI)
Saturday breakfast	91	29	32	276	106	38	0·8 (0·6, 1·2)
Saturday lunch	252	86	34	115	49	43	0·8 (0·6, 1·1)
Saturday dinner	181	78	43	186	57	31	1·4 (1·1, 1·9)
Sunday breakfast†	104	43	41	248	77	31	1·3 (1·0, 1·8)
Sunday lunch†	245	120	49	107	0	0	undefined

* AR indicates attack rate; RR, relative risk, and CI, confidence interval.

† Total number of cases is not 135, because persons who developed illness before or less than 6 h after the meal are excluded from the analysis of this meal.

or less than 6 hours after the meal (Table 2). Persons who ate turkey were 4·6 times more likely to become ill than persons who did not eat turkey. Of the 135 ill persons, 124 (92%) ate turkey from the luncheon buffet and 115 (85%) met the case definition of illness with symptom onset over 6 h after eating the Sunday lunch. There was a dose–response effect among persons who ate turkey: 23% of persons who ate 'three bites or less' became ill, 58% of persons who ate "a small serving" became ill, 58% of persons who ate "a normal adult serving' became ill, and 62% who ate 'a large serving' became ill (chi square for linear trend, $P = 0{\cdot}01$). When sex-specific attack rates, which demonstrated a significantly increased risk of illness for males, were stratified for the amount of turkey eaten, there was no difference in risk for illness between males and females.

To evaluate the effect of exposures other than turkey we performed stratified analysis controlling for exposure to turkey. There was a small increased risk of illness, independent of eating turkey, among persons who ate either the Saturday dinner (summary relative risk 1·3, 95% confidence interval 1·0, 1·7) or the ham

Table 2. *Food-specific attack rates for persons who ate Sunday lunch – Greenville, South Carolina salmonella outbreak, August 1990**

	Ate			Did not eat				
Food	Total	Case	AR %	Total	Case	AR %	RR (95% CI)	*P* value
Turkey	204	115	56	41	5	12	4·6 (2·0, 10·6)	< 0·001
Ham	121	65	54	122	54	44	1·2 (0·9, 1·6)	0·178
Dressing	186	99	53	59	21	36	1·5 (1·0, 2·2)	0·027
Gravy	159	85	53	85	35	41	1·3 (1·0, 1·7)	0·090
Macaroni	139	76	55	106	44	42	1·3 (1·0, 1·7)	0·056
Beans	183	96	52	61	23	38	1·4 (1·0, 2·0)	0·065
Corn	153	80	52	92	40	43	1·2 (0·9, 1·6)	0·229
Rolls	158	78	49	84	41	49	1·0 (0·8, 1·3)	0·958
Butter	88	47	53	157	73	46	1·2 (0·9, 1·5)	0·365
Tea	203	102	50	42	18	43	1·2 (0·8, 1·7)	0·482
Coffee	28	9	32	217	111	51	0·6 (0·4, 1·1)	0·090
Cranberries	74	42	57	171	78	46	1·2 (1·0, 1·6)	0·144

* AR indicates attack rate; RR, relative risk, and CI, confidence interval.

Table 3. *Multivariate analysis of risk of illness for exposures – Greenville, South Carolina salmonella outbreak, August 1990*

Exposure	Odds ratio	95% Confidence interval
Meals		
Saturday breakfast*	0·4	0·2, 0·8
Saturday lunch	0·8	0·5, 1·5
Saturday dinner*	2·2	1·3, 3·7
Sunday breakfast	1·4	0·7, 2·8
Sunday lunch*	24·9	9·6, 64·7
Foods		
Beef tips	1·0	0·6, 1·8
Fried chicken	1·0	0·6, 1·8
Baked beans	1·6	0·7, 3·4
Roast pork	1·4	0·7, 2·9
Saturday dinner ham	1·6	0·7, 3·4
Turkey*	12·6	5·6, 28·6
Sunday lunch ham*	2·1	1·2, 3·6
Macaroni	1·7	1·0, 2·9
Dressing	1·2	0·6, 2·5
Gravy	0·9	0·5, 1·7

* Indicates statistically significant relationship.

served at Sunday lunch (summary relative risk 1·4, 95% confidence interval 1·1, 1·8). No specific food item at the Saturday dinner was implicated, and no other food exposures significantly independently increased the risk of illness.

To evaluate further the relative contribution of exposures other than turkey to illness, we constructed two multiple logistic regression models (Table 3). In the first model, we included all of the meals as potential exposures. As in the univariate analysis both the Saturday dinner and Sunday lunch independently increased risk of illness. In our second multivariate model we included the food exposures from all meals which we judged most biologically likely to transmit salmonellosis and found that both turkey and ham served at the Sunday lunch

independently increased risk of illness. No individual Saturday dinner food independently increased illness risk.

By univariate analysis several other exposures and host factors did not significantly increase risk of illess. These included the time a person ate Sunday lunch, which of the 3 buffet tables or 6 serving lines they took their food from, antibiotic use in the 4 weeks before the convention, anti-ulcer therapies, non-steroidal anti-inflammatory drug use, regular coffee consumption and prior typhoid fever vaccination. Projecting from our systematic sample we estimate there were 2430 convention attendees. With an illness attack rate of 34%, we estimate that 824 persons became ill.

Laboratory investigation

Of the 135 ill persons interviewed, 11 (8%) had submitted stool specimens to their health care provider for culture. From one sample, no enteric pathogens were isolated and one sample was lost. The remaining nine cultures all grew salmonella and no other enteric pathogens. Six of these were serotyped. Five were identified as *S. agona*, and one was *S. hadar*. The patient whose stool culture grew *S. hadar* also had blood cultures that grew *S. hadar*. Four other persons who met the case definition and had stool cultures positive for salmonella, but were not a part of the systematic sample, were identified during the investigation. All four of their stool cultures grew *S. agona*.

Two of the 18 stool specimens submitted by food handlers at Restaurant A also grew *S. agona*. The positive specimens were from Restaurant A's manager and from an employee who worked as a dishwasher, but also assisted in setting up the food. Both had eaten the turkey, and both denied symptoms of illness.

At the time of inspection, all leftover convention food had already been discarded and so was unavailable for analysis.

Environmental investigation

Restaurant A's kitchen is adequately sized for its 120-seat dining room with enough equipment to prepare the 200–300 meals per day required for routine business. During the weekend of the convention, however, the restaurant staff prepared as additional 7000 meals in a 30-h period, 10–15 times the number of meals licensed sanitarians judged the kitchen was designed to prepare. The kitchen had only 1 four-burner stove, 1 large griddle, 2 ovens, 2 deep fryers, 2 walk-in refrigerators, and 2 preparation tables (the larger table measured 3×8 feet and the smaller 3×6 feet).

Ninety-two frozen turkey breasts were delivered to Restaurant A on Friday, 24 August. One employee reported that when he arrived at work at 7 a.m., Saturday, 25 August, the first day of the convention and the day before the turkey was served, approximately 20 cooked, but not yet boned, turkey breasts were sitting unrefrigerated on the large preparation table. He reported that the turkey remained unrefrigerated on the table during his entire work shift while foods for Saturday dinner were prepared. The turkey was still on the table when the employee left work 10 hours later at 5 p.m.

The other 72 turkey breasts, after being delivered to Restaurant A, were transported by unrefrigerated truck one hour north to another kitchen in North

Carolina, a kitchen that Restaurant A's manager also directs. These 72 turkey breasts were cooked in North Carolina on Saturday, 25 August. This cooked turkey was reloaded onto the unrefrigerated truck on the morning of the Sunday lunch and was enroute back to South Carolina when the truck broke down and was temporarily abandoned. An hour later another Restaurant A employee arrived with another unrefrigerated truck to complete transport. The ambient temperature in the Greenville area on that Sunday morning at 11 a.m. was 27 °C (National Weather Service, personal communication, 1991).

The turkey was rewarmed before serving by reheating the water originally used to boil it, then pouring this water over the cooked meat. While setting up the buffet lines, Restaurant A employees noted that much of the turkey had a particularly offensive odour and so returned over half of the turkey to Restaurant A's kitchen with a request for more turkey that did not smell. Personnel in the kitchen had no more turkey, so they rinsed the malodorous turkey under cold tap water for 2 min, rewarmed it with a hot tap water rinse for 1 min, and sent it back to the convention centre, where it was served to the convention attendees.

Although we did not ask for a description of the turkey's taste and smell as part of the structured interview, 17 (8%) of the 213 persons who ate turkey mentioned that the turkey either smelled or tasted bad. In the more open-ended preliminary survey, 4 (22%) of the 18 persons who ate turkey described the turkey's smell or taste as unpleasant or offensive.

DISCUSSION

We estimate that over 800 persons developed salmonellosis after attending the hardware convention. Turkey served at the Sunday lunch was the primary vehicle of transmission. Of all evaluated exposures, eating turkey carried the greatest risk of illness. It is a biologically plausible vector since *S. agona* and *S. hadar* are frequently isolated from poultry flocks [5]. Eighty-five percent of ill persons were exposed to the turkey $\geqslant 6$ h before their illness began, and eating larger amounts of turkey increased risk of illness.

The intestinal tract of domestic turkey is commonly colonized with salmonella [6]. During processing of the birds, especially during evisceration of the intestinal tract, turkey meat is frequently contaminated with salmonella. To prevent transmission of salmonella, turkey must be cooked thoroughly. The cooked turkey must not be contaminated by raw turkey or surfaces or utensils contaminated by raw turkey, and the cooked turkey must be properly refrigerated and reheated if not immediately served [7].

In Restaurant A's limited space, with the huge volume of food prepared, it is likely there were instances in which raw turkey contaminated during slaughter with salmonella or surfaces or utensils that contacted this raw turkey contacted cooked turkey or other food products. The 10 h (at least) the 20 cooked turkeys were unrefrigerated on Saturday and the 2 h the 72 turkeys were left in the unrefrigerated truck on Sunday provided opportunities for salmonella to multiply. Pouring hot water over cooked turkey does not increase meat temperature enough to sterilize it. Washing the cooked turkey under hot and cold tap water also does not sterilize the meat, although it might improve the smell of affected turkey by

removing the pungent water-soluble organic acids associated with bacterial putrefaction.

Twenty cases of illness (15%) were not attributable to turkey. Indeed, 11 cases (8%) did not eat turkey, and 5 cases (4%) reported onset of illness before the turkey was even served. Although these 20 cases had no single exposure in common, eating ham served at the Sunday lunch or eating at the Saturday dinner increased the risk of illness. We were unable to identify which specific Saturday dinner food(s) increased the risk of illness because there were too few cases who ate Saturday dinner, but not Sunday lunch to permit definitive statistical analysis. Nevertheless, eating Saturday dinner foods significantly increased the risk of illness in both univariate and multivariate analysis and Saturday dinner foods were prepared in the kitchen at the same time the cooked turkey was reported to be out on the preparation table on Saturday afternoon. For Sunday lunch, the ham was next to the turkey in the buffet lines. Therefore, some persons might have used the turkey utensils to take pieces of ham. Whatever the specific details, preparing 7000 extra meals in a 30-h period in a kitchen designed for 200–300 meals per day created a high-risk environment for cross-contamination. The finding that a food other than turkey and a meal other than the Sunday lunch independently increased the risk of illness suggests that cross-contamination did in fact occur.

Restaurant A's failure to comply with basic standards of sanitary food preparation was not a result of lack of knowledge. In the 9 months before the outbreak, the Greenville County Health Department repeatedly worked with Restaurant A's employees and managers to ensure they understood how to prepare food safely. Indeed, Restaurant A's manager had passed an examination demonstrating his knowledge of sanitary practice. Personnel at Restaurant A knew how to prepare food safely. The decision to rinse putrid meat and serve it rather than discard it suggests that neither their knowledge nor the risk to health of the persons eating their food provided sufficient motivation to affect the staff's behaviour.

This outbreak demonstrates the failure of conventional restaurant inspection to prevent a food-borne outbreak. In South Carolina as in most states in the US, the health department closes commercial food establishments only when they pose an imminent threat to the public health. Local health authorities attempted repeated educational interventions and used multiple sanctions against Restaurant A, including downgrading the restaurant, publishing the results of the inspections in the local newspaper, and requiring the manager to take an examination on sanitary practice, but these efforts did not affect the staff's behaviour sufficiently to prevent a large outbreak.

A similar pattern was noted by Irwin and colleagues in Seattle-King County, Oregon. Restaurants which later hosted outbreaks were five times more likely to have had poor inspection scores and ten times more likely to have temperature violations during their prior routine inspections than matched control restaurants [8].

Efforts by the local health department were unable to prevent the outbreak for two reasons. First, the sanctions available to local health department sanitarians did not change the staff's behaviour at Restaurant A. The sanctions cost

Restaurant A's owner very little. Since education, concern for human health, and repeated lowering of the restaurant's grade did not improve the sanitary practices, stronger sanctions might be more effective. These measures might include revoking an establishment's permit to operate, either temporarily or permanently, based on restaurant inspection scores, linking liability insurance rates to results of restaurant inspections, fines, revoking liquor licences, or criminal proceedings for negligence.

Second, Restaurant A's practice of exceeding the safe cooking capacity of their kitchen is not addressed by standard regulations. The competitive bidding process may inadvertently reward operators with smaller kitchens, less equipment, fewer staff, and therefore less overhead with large volume catering. Current US Food and Drug Administration model guidelines do not address the issue of safe kitchen size [9], and we found sanitarians reluctant to make judgements on adequacy of facility size in the absence of explicit guidelines.

This largest ever reported food-borne outbreak in South Carolina is a dramatic example of the consequence of a health department's inability to alter sanitary practices in a restaurant that repeatedly failed inspections. When commercial food preparers repeatedly fail inspection, stronger sanctions should be considered.

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