

# Results of Routine Restaurant Inspections Can Predict Outbreaks of Foodborne Illness: The Seattle-King County Experience

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**Abstract:** To analyze the association between the results of routine inspections and foodborne outbreaks in restaurants, we conducted a matched case-control study using available data from Seattle-King County, Washington. Case restaurants were facilities with a reported foodborne outbreak between January 1, 1986 and March 31, 1987 (N=28). Two control restaurants with no reported outbreaks during this period were matched to each case restaurant on county health district and date of routine inspection (N=56). Data from the routine inspection that preceded the outbreak (for case restaurants) or the date-matched routine inspection (for control restaurants) were abstracted from computerized inspection records.

Case restaurants had a significantly lower mean inspection score (83.8 on a 0 to 100 point scale) than control restaurants (90.9). Restaurants with poor inspection scores and violations of proper temperature controls of potentially hazardous foods were, respectively, five and ten times more likely to have outbreaks than restaurants with better results. Although this study demonstrates that Seattle-King County's routine inspection form can successfully identify restaurants at increased risk of foodborne outbreaks, it also illustrates that more emphasis on regulation and education is needed to prevent outbreaks in restaurants with poor inspection results. (*Am J Public Health* 1989; 79:586-590.)

## Introduction

Routine inspection of restaurants to prevent foodborne disease is mandated by food sanitation codes throughout the United States<sup>1</sup> and is recommended by the Model Standards for Community Health Practice of the US Public Health Service.<sup>2</sup> Although common sense dictates that the results of routine inspections should predict outbreaks of foodborne illness, this relation has never been studied in food service facilities other than cruise ships.<sup>3</sup> We therefore conducted a case-control study to determine whether routine inspection results and other characteristics were associated with reported foodborne outbreaks in restaurants using available data from Seattle-King County, Washington.

### Restaurant Permit Program

For several decades, the Seattle-King County Department of Public Health has issued annual permits for permanent restaurants. Since January 1, 1986, when 3,076 restaurants had such permits,\* characteristics noted on the permit have been entered into a computerized permit file.<sup>4</sup>

### Restaurant Inspection Program

Sanitarians in five health districts use a standard reporting form developed by the Seattle-King County Department of Public Health for all routine inspections.<sup>5</sup> Data from the current form have been entered into a computerized inspection file since the form was adopted on January 1, 1986. The form identifies 42 types of violations classified as "critical" or "noncritical." Critical violations are thought to have a direct impact on foodborne disease, e.g., the temperature of potentially hazardous foods, food handling practices, the health status of food handlers (Table 1). Noncritical items are thought to play a minor role in foodborne illness, e.g., the cleanliness of nonfood contact surfaces, walls, and ceilings.

A critical violation incurs a debit of 4-5 points from a perfect inspection score of 100, whereas a noncritical violation incurs a debit of 1-2 points. Violations are also classified as to type (food, food protection, personnel). After tallying all debit points, sanitarians assign a final score from 0 to 100 and a result category, which is largely a function of the final score. A score of 86 to 100 indicates a "satisfactory" result. A score of 70 to 85 or a violation of any critical item indicates an "unsatisfactory" result, requiring timely correction of violations. A score of less than 70 points indicates a "suspend permit" result, warranting permit suspension and restaurant closure. These score cutoffs were based on a county-wide study that simultaneously scored restaurants with the old 298-point inspection form and the new 100-point form; restaurants closed on the basis of the old form typically received scores of less than 70 on the new form.\*

### Foodborne Illness Investigations

Epidemiologists in the Seattle-King County Department of Public Health receive about 700 complaints of suspected foodborne illness each year.<sup>7</sup> All suspected outbreaks of foodborne illness are investigated to determine the number of affected persons, the symptoms of illness, the suspected vehicle, the food source, and the preparation, storage, or handling of food. A reported outbreak of foodborne illness is defined as an incident in which two or more persons have the same disease, have similar symptoms, or excrete the same pathogen after eating a common food or beverage. Poisoning by botulism or by a toxic chemical requires only one ill individual.<sup>8</sup>

## Methods

### Restaurants

Case restaurants were permanent restaurants with an active food permit in March 1987 and with a reported foodborne outbreak between January 1, 1986 and March 31, 1987. Although 36 restaurants were associated with an outbreak during this period, only 28 were permanent facilities with an active permit and therefore eligible for further analyses. Control restaurants were permanent restaurants with an active food permit in March 1987 and with no reported foodborne outbreak between January 1, 1986 and March 31, 1987. Two controls were randomly selected from eligible controls that had been matched to each case on health

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RESTAURANT INSPECTION RESULTS PREDICT FOODBORNE OUTBREAKS

TABLE 1—Risk of Foodborne Outbreaks Associated with Routine Restaurant Inspection Results, by Individual Violation, Seattle-King County, Washington, January 1, 1986–March 31, 1987

Number	Violation Type†	Debit Point Value	Odds Ratio	(95% CI)
<b>Food Violations</b>				
1.	Foods from approved source, sound condition, not adulterated: no spoilage, no home canned foods†	5	3.2	(0.3, 36.6)
2.	Original container, properly labeled	1	1.0	(0.1, 18.9)
	Any food violation		2.1	(0.3, 13.1)
<b>Food Protection Violations</b>				
3.	Potentially hazardous foods at safe temperatures during storage, display, service, transport, hot and cold holding (45° or below or 140°F or above)†	5	10.1	(2.2, 45.7)
4.	Potentially hazardous foods properly cooked to 140°F, except pork to 150°F, poultry to 165°F, and rare roast beef to 130°F†	4		(1.2, )*
5.	Potentially hazardous foods properly cooled, 4" food depth cooled to 70°F within 2 hrs to 45°F within 4 hrs; salads made with prechilled ingredients†	5	1.4	(0.4, 5.2)
6.	Potentially hazardous foods properly reheated to 165°F†	4	1.0	(0.1, 11.0)
7.	Enough facilities to maintain proper hot and cold temperatures, properly designed, maintained, operated. Potentially hazardous foods kept under temperature control except during necessary preparation procedures†	4	8.6	(1.0, 74.9)
8.	Thermometers provided and conspicuous	1	2.0	(0.7, 5.4)
9.	Potentially hazardous foods properly thawed	1	6.0	(0.6, 57.7)
10.	General food protection during storage, preparation, display, transportation, service; no double stacking; sneeze guards	2	2.4	(0.8, 7.2)
11.	Foods protected from cross-contamination during preparation and refrigerated storage. Foods not re-served†	4	1.7	(0.4, 7.0)
12.	Handling of food (ice) minimized; proper use of utensils	2	3.9	(0.4, 39.5)
13.	In-use food (ice) dispensing utensils properly stored	1	2.1	(0.5, 9.5)
	Any food protection violation		15.8	(2.0, 124.1)
<b>Personnel Violations</b>				
14.	Personnel with infections or illness restricted†	5		(0.1)*
15.	Hands washed and clean; wash hands after using the restroom; after coughing, sneezing, smoking, eating, drinking; between handling raw and cooked; or otherwise contaminating hands. Good hygienic practices†	5		(0.6)*
16.	Clean clothes, hair restraints	1	NA	
17.	Food and Beverage Workers' Permits current for all personnel	1	1.8	(0.3, 12.0)
	Any personnel violation		3.3	(0.6, 18.0)*
<b>Food Equipment, Utensils Violations</b>				
18.	Food (ice) contact surfaces: designed, constructed, maintained, installed, located	2	1.5	(0.4, 5.0)
19.	Nonfood contact surfaces: designed, constructed, maintained, installed, located	1	0.2	(0.04, 1.1)
20.	Food contact surfaces of equipment and utensils clean	2	1.8	(0.6, 5.4)
21.	Nonfood contact surfaces of equipment and utensils clean	1	0.6	(0.2, 2.2)
22.	Proper storage and handling of clean, sanitized equipment and utensils	1	14.9	(2.6, 85.4)
23.	Single-service articles properly stored and dispensed. No reuse of single-service articles	1	1.7	(0.2, 12.2)
	Any food equipment or utensils violation		1.8	(0.6, 5.8)
<b>Cleaning, Washing, Sanitizing Violations</b>				
24.	Dishwashing facilities designed, constructed, maintained, located, operated (accurate thermometers, chemical test kits provided)	2	4.2	(0.8, 21.9)
25.	Equipment and utensils preflushed, scraped, soaked. Wash and rinse water clean, proper temperature	1		(0.03, )*
26.	Sanitization rinse: clean, proper temperature, concentration, exposure time. Equipment, utensils sanitized†	4	1.9	(0.6, 6.5)
27.	Wiping cloths clean, use restricted, stored in sanitizer	1	0.7	(0.2, 2.3)
	Any "cleaning, washing, sanitizing" violation		1.2	(0.5, 3.1)
<b>Water</b>				
28.	Approved water source, hot and cold, under pressure; safe†	5	NA	
<b>Sewage, Plumbing Violations</b>				
29.	Sewage and waste water disposed sanitarly. No cross-connection, back siphonage, backflow†	5	2.0	(0.1, 32.0)
30.	Plumbing installed, maintained	1	2.0	(0.4, 9.9)
	Any sewage and plumbing violation		1.5	(0.3, 6.7)
<b>Toilet, Hand-Washing Facilities Violations</b>				
31.	Number, convenient, accessible, designed, installed†	4	3.6	(0.7, 19.9)
32.	Toilet rooms enclosed, self-closing doors, fixtures in good repair, clean; hand cleanser, sanitary towels/hand-drying devices provided, proper waste receptacles	2	1.5	(0.5, 4.1)
	Any toilet and hand-washing facilities violation		1.6	(0.6, 4.2)
<b>Garbage, Refuse Disposal Violations</b>				
33.	Containers/receptacles covered, adequate number, insect and rodent proof, pick-up frequency, clean	1	0.7	(0.1, 6.4)
34.	Outside storage area enclosures properly constructed, clean	1	4.0	(0.4, 44.1)
	Any garbage and refuse disposal violation		1.0	(0.2, 5.5)
<b>Insect, Rodent, Animal Control Violations</b>				
35.	Presence of insects/rodents. No birds, turtles, or other animals†	4	6.5	(0.8, 51.1)
36.	Outer openings protected from flying insects/rodent proof	1	3.9	(0.4, 39.5)
	Any insect, rodent, animal control violation		3.8	(0.9, 16.1)
<b>Floors, Walls, Ceilings Violations</b>				
37.	Floors constructed, clean, good repair, covered	1	1.5	(0.5, 4.6)
38.	Walls, ceiling, attached equipment: constructed, good repair, clean, smooth	1	2.0	(0.6, 6.8)
	Any floors, walls, ceilings violation		1.1	(0.4, 3.2)

(continued)

TABLE 1—Continued

Number	Violation Type†	Debit Point Value	Odds Ratio	(95% CI)
<u>Lighting, Ventilation</u>				
39.	Lighting provided as required, fixtures shielded. Rooms and equipment vented as required	1	1.2	(0.3, 5.0)
<u>Other Operations</u>				
40.	Toxic items properly stored, labeled, used†	4	1.9	(0.5, 7.4)
41.	Premises maintained free of litter, unnecessary articles; living/sleeping quarters separate; authorized personnel; dressing rooms, lockers	1	0.8	(0.2, 3.0)
42.	Clean, soiled linen properly stored	1		(0.1, )*
<u>Any "Critical" Violation†</u>			6.3	(1.8, 22.5)

\*Odds ratio was indeterminate in matched and unmatched analyses; only the lower 95% confidence interval could be calculated in the matched analysis.

†"Critical" violations are numbers 1, 3-7, 11, 14, 15, 26, 28, 29, 31, 35, 40

NA—No restaurants had this violation

district and routine inspection date ( $\pm 30$  days), yielding 56 control restaurants for analysis.

**Data**

Data on each outbreak were collected from the Seattle-King County investigation files, including number of affected persons; implicated agent, vehicle, and contributory cause; and laboratory test results. We analyzed two variables from the permit file: type of ownership (corporate versus non-corporate) and seating capacity. All case and control restaurants had known values for at least one of these variables and were included in these analyses. Using the inspection file, we compared the routine inspection that preceded the outbreak for case restaurants with the date-matched inspection for control restaurants. We analyzed overall score, result category, specific violations, classes of violations, and inspection duration. One case and one control restaurant were excluded from the analyses because of incomplete inspection data.

In June 1987, managers of the 28 case and 56 control restaurants were telephoned to collect additional risk factor data. After obtaining informed consent, a trained interviewer questioned the restaurant manager on duty at the time of the call about restaurant characteristics, food preparation practices, employee turnover, training in food sanitation, and attitudes on food poisoning. After exclusions for non-response and interview refusal, 25 case and 48 control restaurants remained for analysis.

Mean scores, t tests, and confidence intervals (CI) were calculated using methods described by Ury.<sup>9</sup> Odds ratios and 95% CI for matched case-control analyses were calculated using PECAN.<sup>10,11</sup> Although we planned to match two control restaurants per case restaurant, exclusions during analysis necessitated a variable matching ratio. When sparse data made odds ratios in the matched analysis indeterminate, but at least one case restaurant and one control restaurant were exposed to a given factor, we calculated unmatched odds ratios and 95% CI.<sup>12</sup> When this was not possible, we applied exact methods to the matched data to calculate the lower 95% CI.<sup>13</sup>

**Results**

As shown in Table 2, the foodborne outbreaks affected from one to six persons with a mean of 2.9 persons. The implicated pathogen was unknown for most outbreaks; poultry was the most commonly implicated vehicle. The implicated contributory cause for most outbreaks was improper temperature control of food during cooking, cooling, reheating, holding, or storage. The interval between index inspec-

tion and outbreak ranged from 2.0 to 14.1 months, with a mean interval of 3.7 months. This interval is less than the four-month inspection interval recommended for all restaurants by the Seattle-King County Public Health Department.<sup>14</sup>

Case restaurants had a significantly lower mean inspec-

TABLE 2—Characteristics of Reported Foodborne Outbreaks in 28 Seattle-King County, Washington Restaurants, January 1, 1986–March 31, 1987

Characteristics	N
<u>Number Persons Ill</u>	
1	1
2	15
3-4	7
5-6	5
Total	28
<u>Implicated Agent</u>	
Unknown	22
<i>Clostridium perfringens</i>	2
<i>Salmonella heidelberg</i>	1
<i>Shigella flexneri</i>	1
Copper	1
Alkaline cleaner	1
Total	28
<u>Implicated Vehicle</u>	
Poultry	8
Rice	5
Fish	5
Beef	4
Pork	3
Beans	3
Other	4
Unknown	4
Total	36*
<u>Implicated Contributory Cause</u>	
Improper temperature control of potentially hazardous foods	25
Unsafe food source	5
Improper storage of toxic chemical	1
Cross-contamination	1
Poor food handler hygiene	1
Total	33*
<u>Restaurant/Cuisine Type</u>	
American	9
Chinese	7
Mexican	7
Seafood	2
French	1
Japanese	1
Moroccan	1
Total	28

\*Totals do not add up to 28 because in some outbreaks more than one vehicle or contributory cause was implicated.

TABLE 3—Factors Associated with Foodborne Outbreaks in Restaurants, Seattle-King County, Washington, January 1, 1986–March 31, 1987

Factors	Factor Present Cases/Controls*	Factor Absent Cases/Controls*	Odds Ratio	(95% CI)
Any improper food protection practice (violations 3–13)	25/31	2/22	15.8	(2.0, 124.1)
Improper storage or handling of equipment and utensils (violation 22)	6/1	21/52	14.9	(2.6, 85.4)
Potentially hazardous foods at unsafe temperature (violation 3)	15/10	12/43	10.1	(2.2, 45.7)
Any "critical" violation	22/24	5/29	6.3	(1.8, 22.5)
Inspection lasting $\geq$ 37 minutes	13/22	4/27	5.6	(1.1, 26.9)
Score $\leq$ 86 points	13/10	14/43	5.4	(1.5, 19.8)
Corporate owner	21/28	5/17	5.3	(1.1, 24.4)
"Unsatisfactory" or "Suspend Permit" result	20/22	7/31	3.9	(1.4, 11.0)
Restaurant size $\geq$ 150 seats	12/11	16/45	3.4	(1.1, 9.9)
Potentially hazardous food not cooked to proper temperature (violation 4)	3/0	24/53	†	(1.2, —)†
American cuisine specialty	9/32	16/16	0.2	(0.1, 0.7)

\*Presented for unmatched data only.

†Odds ratio was indeterminate in unmatched analysis; only the lower 95% confidence interval could be calculated in the matched analysis.

tion score (83.8) than control restaurants (90.9) (difference = 7.1, 95% CI = -13.3, -2.18). Restaurants with an overall score of less than 86 were about five times more likely to have an outbreak than those with better scores. Restaurants that received an inspection result of "unsatisfactory" or "suspend permit" were about three times more likely to have an outbreak than those with "satisfactory" results (Table 3). Several specific violations significantly increased the risk of an outbreak, including any improper food protection practice (violations 3–13), especially improper temperature control of potentially hazardous foods (violations 3 and 4), improper storage and handling of equipment (violation 22), and any "critical" violation. Several other individual violations related to improper food protection practices had odds ratios of 2.0 but the confidence intervals included 1.0 (Table 1). Restaurants with inspections lasting longer than 36 minutes, with corporate owners, or with 150 or more seats were also more likely to have outbreaks than restaurants without these characteristics (Table 3). Two factors identified through telephone interviews were positively associated with outbreaks: Chinese cuisine specialty (OR=5.0, 95% CI=1.0, 25.8), and any Asian cuisine specialty (OR=4.0, 95% CI=1.0, 15.6). One factor, American cuisine specialty, had a clearly negative association with outbreaks (OR=0.2, 95% 0.1, 0.7) (Table 3).

### Discussion

This study demonstrates that restaurants with poor routine inspection results were at increased risk of foodborne outbreaks. Key risk factors included a low score (less than 86 points), an inspection result warranting follow-up inspection or permit suspension, and violations of recommended food protection measures.

Our study was based on the inspection form used in Seattle-King County which differs from forms used by other locales and the US Food and Drug Administration<sup>15</sup> by assigning greater weight to violations of proper temperature controls of potentially hazardous foods. Most outbreaks in

this series were probably caused by improper heating, cooling, cooking, holding, or storage of food—a finding consistent with a nationwide series of outbreaks reported to the Centers for Disease Control.<sup>1</sup> Inspection forms that give less weight to these temperature control factors may be less predictive.

It is widely believed that inspection results vary according to the sanitarian who performs an inspection.<sup>14</sup> We were unable to directly evaluate the quality of inspection data used in this study because Seattle-King County does not routinely require more than one sanitarian to do the same inspection. A recent evaluation in one district of the county where several sanitarians inspected the same restaurant at the same time suggested that the sanitarians were fairly consistent in identifying violations of proper temperature controls and cross-contamination but less consistent on overall score or the combination of violations accounting for that score.\*

The strong association between outbreaks and improper storage and handling of equipment (violation 22) is difficult to explain on a biologic basis, and may be spurious because it is based on extremely sparse data. Conceivably, certain equipment violations, such as improper storage or handling of meat slicers, could be hazardous. Alternatively, improper use of equipment may reflect food-handling techniques more directly related to foodborne illness, a consideration if sanitarians do not use standard techniques for identifying violations.

Inspections lasting 37 minutes or more may have been associated with foodborne outbreaks because more time is needed to identify and record multiple violations. Large restaurant size may represent a risk factor simply because such restaurants serve numerous patrons, thus increasing the likelihood of finding two ill persons needed to identify an outbreak. Alternatively, large restaurants may be more likely to have an outbreak because of poor control of food temper-

\*Unpublished data, Food Protection Program, Seattle-King County Department of Public Health.

atures, greater food volume, more complex menus, or less closely supervised food handlers. The association of the outbreaks with corporate ownership largely reflects the association of outbreaks with restaurant size. Compared with small noncorporate restaurants, large noncorporate restaurants were more likely (OR=5.0, 95% CI 0.5, 47.1) than small corporate restaurants (OR=2.5, 95% CI 0.6, 10.4) to have an outbreak.

We cannot rule out chance as an explanation for the positive associations with Asian or Chinese restaurants because the lower confidence bounds were 1.0, but these positive associations are plausible because certain food preparation practices in Cantonese-style restaurants have been found to be hazardous.<sup>16</sup> On the other hand, reporting bias could also explain these associations if Seattle-King County residents were more likely to report foodborne illness after eating in Asian restaurants than in other restaurants. Similarly, the apparent "protective" effect of American cuisine specialty could reflect less hazardous food preparation and sanitation practices or less intensive reporting of foodborne illness from American-style restaurants.

Poor inspection results should trigger appropriate education and regulatory action, such as follow-up inspection or permit suspension, which in turn should prevent outbreaks. Because our study illustrates that restaurants with poor inspection results are *more* likely to have outbreaks, it appears that the resulting regulatory action and education were not sufficient to prevent these outbreaks or that the restaurants did not adopt the recommended improvements on a long-term basis. Although we did not directly address this issue in our study, it probably reflects several problems. Restaurants with suspended permits are typically closed for less than 24 hours, a reprimand which might have little impact on a restaurant's profits or reputation. In addition, some restaurant managers complained during the telephone interviews that the education offered by sanitarians at the time of routine inspection is cursory or inconsistent. Finally, sanitarians in Seattle-King County and other locales<sup>17</sup> often report that food sanitation procedures taught at routine inspection have been abandoned by the next inspection.

Although this study demonstrates that the Seattle-King County inspection form can successfully identify restaurants at increased risk of foodborne outbreaks, it also illustrates that more emphasis is needed on regulation and education to prevent outbreaks in restaurants with poor inspection results. Permit suspension and timely follow-up inspections are clearly warranted when low scores or critical violations are noted. Detailed education to food handlers and their supervisors on the risks associated with specific violations is also needed. The risk estimates in Table 1 provide a simple instruction tool: for example, a sanitarian who notes unsafe storage temperatures of potentially hazardous foods (violation 3) could explain that this increases the risk of an outbreak

ten-fold. Food protection programs should also assure that sanitarians use appropriate inspection techniques and that food handlers are certified in proper food preparation techniques. Finally, investigation of all complaints of foodborne illness will also help to monitor restaurants that pose an unusual public health risk.

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