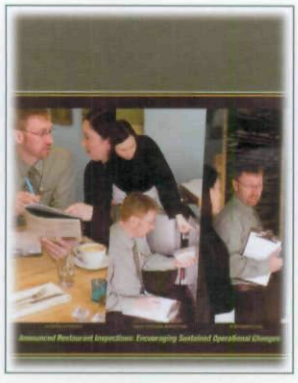

Beneficial Effects of Implementing an Announced Restaurant Inspection Program

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Abstract

Announced inspections are being incorporated into restaurant inspection programs to support active managerial control; however, their effectiveness is unknown. The study reported here examined the results of 1,314 inspections conducted from June 2001 through August 2003 in Minneapolis, Minnesota. Of these, 343 were routine inspections that preceded and 157 were routine inspections that followed an announced inspection, and 501 were routine inspections of restaurants that did not undergo an announced inspection. Significant reductions in frequency of citations for critical violations in two food safety categories—1) the person-in-charge demonstrates knowledge of foodborne-disease prevention and 2) prevention of cross-contamination—were seen in establishments that had undergone an announced inspection (relative risk [RR] of 0.7, $p = .007$, and RR of 0.4, $p = .001$, respectively). The frequency of citation for these critical violations did not decline in establishments that did not undergo an announced inspection. Announced inspections appear to be effective in supporting active managerial control and represent a promising approach to improving food safety in restaurants.

Introduction

Restaurant-acquired foodborne illness is a major public health concern. In 1999, Mead and co-authors estimated that infections with known foodborne pathogens caused 55,512 hospitalizations and 1,809 deaths each year (Mead et al., 1999). National surveillance from 1993 to 1997 identified more outbreaks associated with restaurants, delicatessens, and cafeterias than with any other sources (Olsen, MacKinnon, Goulding, Bean, & Slutsker, 2000).

Routine restaurant inspections performed by local or state environmental health specialists have traditionally served as a primary regulatory strategy to prevent restaurant-associated foodborne illnesses. Research on the effectiveness of traditional inspections is inconclusive, however. Restaurant inspection results were found to predict the likelihood of small foodborne-illness outbreaks in Seattle-King County (Irwin, Ballard, Grendon, & Kobayyashi, 1989). In addition, lower inspection scores were one of several factors significantly associated with the occurrence of foodborne incidents investigated in Los Angeles County (Buchholz, Run, Kool, Fielding, & Mascola, 2002).

Other studies, however, have not been able to duplicate these results. Routine restaurant inspections did not predict the occurrence of foodborne-disease outbreaks in Miami-Dade County, Florida (Cruz, Katz, & Suarez, 2001). The inspection process could not distinguish two restaurants that had recently experienced *Salmonella enteritidis* outbreaks from similar restaurants that had not experienced outbreaks (Mullen, Cowden, Cowden, & Wong, 2002). Of the 15 violations cited most frequently in 167,574 restaurant inspections conducted in Tennessee from 1993 through 2000, only one was a critical violation (Jones, Pavlin, LaFleur, Ingram, & Schaffner, 2004). The authors of that study concluded that inspection scores alone might not be a good indicator of restaurant sanitation or a predictor of foodborne-disease outbreaks. The Alabama Department of Public Health investigated an outbreak of foodborne illness associated with a restaurant that had passed four inspections; one of these inspections had been performed two days before the outbreak occurred (Penman, Webb, Woernle, & Currier, 1996).

Concerns about the effectiveness of the traditional inspection paradigm have led to various changes in the process. Food handler education, food safety certification, and increasing inspection frequency are three strategies commonly promoted to improve sanitation in restaurants (Bader, Blonder, Henriksen, & Strong, 1978; Campbell, et al., 1998; Cotterchio, Gunn, Coffill, Tormey, & Barry, 1998; Mathias, Sizto, Hazlewood, & Cocksedge, 1995; Raval-Nelson & Smith, 1999). The Los

Angeles County Department of Health Services modified its inspection process to include a combination of owner-initiated inspections, unannounced inspections, food handler certification, and the public posting of inspection results (Buchholz, Run, Kool, Fielding, & Mascola, 2002; Fielding, Aguirre, & Palaiologos, 2001; Fielding, Aguirre, Spear, & Frias, 1999). This approach is consistent with the growing trend for active managerial control in restaurants. Active managerial control emphasizes a preventive approach to food safety, encouraging restaurant operators to identify and control potential hazards specific to the operation of their establishment. The importance of this approach is confirmed by recent findings from the Environmental Health Specialists Network (EHS-Net) that most restaurants provide food workers with on-the-job food safety training and that the presence of a kitchen manager certified in food safety appeared to be protective against foodborne-illness outbreaks (Hedberg et al., 2006).

Minneapolis, Minnesota, has a population of 382,000 in a metropolitan area with a population over 2,000,000. The food safety program of the Minneapolis Department of Regulatory Services Division of Environmental Health licenses and inspects approximately 1,000 restaurants with high-risk food service operations. Minneapolis Environmental Health Food Safety initiated an active managerial control–based, announced inspection program in June 2002 to better provide restaurant operators with the information, tools, and support they need to manage food safety challenges and prevent foodborne illness. Under the program, each facility receives two inspections per year: an announced inspection followed by an unannounced inspection. The announced inspections begin with an in-depth interview with the person-in-charge of the establishment. During this interview, the environmental health specialist seeks to better understand the food safety hazards specific to that establishment, assess the person-in-charge's understanding of foodborne-illness risks, and move the person-in-charge toward active control of these risk factors. A standard walk-through inspection follows the interview, and the person-in-charge receives a copy of the inspection report detailing the violations cited. Each establishment is subject to a second, unannounced inspection within a year to ensure that the food safety issues identified during the announced inspection have been adequately addressed.

Despite the recent interest in active managerial control as an alternative to traditional regulatory practices, data are scarce on the food safety impact of announced inspections. To address this lack of knowledge, the results of the Minneapolis Announced Inspection Program were analyzed retrospectively to test the hypothesis that announced inspections could improve restaurant inspection results and food safety.

Methods

The results of all routine inspections conducted from June 2001 through early August 2003 were included in a retrospective cohort study. The data included one year's data from before the announced-inspection program was implemented and slightly more than a year's data from the period during which environmental health specialists conducted both announced and unannounced inspections. The study was limited to routine inspections conducted in full-service, general restaurants. A routine inspection, whether announced or unannounced, includes a full walk-through of the establishment's premises, whereas nonroutine inspections do not always reflect a comprehensive evaluation of all aspects of restaurant sanitation.

Each restaurant was scheduled to receive alternating announced and unannounced inspections on an annual basis; however, environmental health specialists had flexibility in scheduling and prioritizing on the basis of the food safety needs of facilities. Also, a restaurant with persistent food safety problems could receive more than two inspections per year. Data were collected in similar ways during unannounced inspections and the walk-through component of announced inspections, but data from announced inspections were supplemented with information acquired during an interview that the environmental health specialist conducted with the restaurant's person-in-charge.

Inspections were divided into four categories for analysis: Category A, announced inspections; Category B, unannounced inspections conducted before the announced inspection; Category C, unannounced inspections that followed the announced inspection; and Category D, unannounced inspections in establishments that did not undergo an announced inspection during the study period. Median numbers of critical and noncritical violations cited during routine inspections were calculated for each inspection category.

Violation citation rates were analyzed across inspection categories. Violation citation frequencies for Category B inspections were compared with frequencies for Category D inspections to determine the relationship between the two study populations at baseline. To determine the impact of announced inspections, violation citation frequencies for Category C inspections were compared with those for Category B inspections. For violations for which the frequency of citations differed significantly before and after an announced inspection, a comparable analysis was performed to identify contemporaneous changes in Category D inspections. For this analysis, Category D inspections were divided into two groups: inspections performed before June 1, 2002 (the start of the announced inspection program) and inspections performed on or after June 1, 2002. The period from June 2001 through May 2002 was defined as the "early" phase. The period from June 2002 through August 2003 was defined as the "late" phase. These results were analyzed to determine if the changes that were observed following announced inspections were also observed in restaurants that did not receive an announced inspection.

Data were abstracted from the Minneapolis Environmental Health Food Safety restaurant complaint database on the numbers and types of complaints filed about full-service, general restaurants during the study period. Each complaint was linked with the inspection status of the corresponding restaurant at the time of the complaint. Rates of total complaints and foodborne-illness complaints per 1,000 establishment-months of observation were calculated for each inspection category. A sample of restaurants included in the study was surveyed to determine the attitudes of the operators toward the announced inspections and the size of the establishments. Analyses of inspection category and complaints were stratified by restaurant size. An attempt was made to compare rates of foodborne-illness outbreaks among restaurants that had and had not undergone announced inspections; however, too few confirmed foodborne-illness outbreaks occurred during the study period to allow for any meaningful analysis.

Chi-square analyses were performed throughout, and $p \leq .05$ was considered significant. Epi Info 6.04 and 2002 (Centers for Disease Control and Prevention, Atlanta, Georgia) were used for all analyses. The University of Minnesota Institutional Review Board approved the study.

Results

The results of 1,314 inspections were analyzed. The cohort included 313 Category A (announced) inspections and 1,001 unannounced inspections, of which 343 were Category B

TABLE 1

Critical and Noncritical Violations Cited in Routine Inspections (n = 1,314)

Restaurant Category	Inspection Category[a]	Number of Inspections	Critical Violations (Median)	Noncritical Violations (Median)
Announced				
	A	313	2	2
	B	343	4	6
	C	157	3	4
Unannounced				
	D	501	3	5

[a] Inspections were divided into four categories for analysis: Category A, announced inspections; Category B, unannounced inspections conducted before the announced inspection; Category C, unannounced inspections that followed the announced inspection; and Category D, unannounced inspections in establishments that did not have an announced inspection during the study period.

TABLE 2

Frequency of Citations for Selected Violations

Restaurant Category	Inspection Category	Violation Category[a]	Citation Frequency N (%)
Underwent an announced inspection			
	A		
		Person in charge demonstrates knowledge of foodborne-disease prevention	143 (46)
		Cold-holding	91 (29)
		Employee bathroom has nailbrush	80 (26)
		Food contact surfaces kept clean	79 (25)
		Sanitizing solution test kit provided for dishwasher	50 (16)
		Food protected from cross-contamination	43 (14)
		Equipment maintained in state of repair	43 (14)
		Date marking	43 (14)
		Clean physical facilities	36 (12)
		Non-food-contact surfaces kept clean	34 (11)
		Food protected from contamination during storage	32 (10)
		Accessible employee handwashing lavatory	17 (5)
	B		
		Clean physical facilities	175 (51)
		Non-food-contact surfaces kept clean	154 (45)
		Person-in-charge demonstrates knowledge of foodborne-disease prevention	146 (43)
		Food protected from contamination during storage	132 (39)
		Equipment maintained in state of repair	123 (36)
		Food contact surfaces kept clean	110 (32)
		Employee bathroom has nailbrush	107 (31)
		Cold-holding	84 (24)
		Date marking	82 (24)
		Food protected from cross-contamination	70 (20)
		Accessible employee handwashing lavatory	62 (18)

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TABLE 2 *continued from page 29*

Frequency of Citations for Selected Violations

Restaurant Category	Inspection Category	Violation Category[a]	Citation Frequency *N* (%)
Underwent an announced inspection			
	C		
		Food contact surfaces kept clean	63 (40)
		Clean physical facilities	62 (40)
		Non-food-contact surfaces kept clean	54 (34)
		Person-in-charge demonstrates knowledge of foodborne-disease prevention	47 (30)
		Temperature-measuring device in warmest/coolest part of storage unit	45 (29)
		Date marking	41 (26)
		Employee bathroom has nailbrush	40 (25)
		Cold-holding	38 (24)
		Food protected from contamination during storage	32 (20)
		Accessible employee handwashing lavatory	28 (18)
		Equipment maintained in state of repair	26 (17)
		Food protected from cross-contamination	14 (9)
Underwent an unannounced inspection			
	D		
		Clean physical facilities	224 (45)
		Person-in-charge demonstrates knowledge of foodborne-disease prevention	192 (38)
		Non-food-contact surfaces kept clean	177 (35)
		Food protected from contamination during storage	158 (32)
		Employee bathroom has nailbrush	136 (27)
		Food contact surfaces kept clean	133 (27)
		Equipment maintained in a state of repair	123 (25)
		Cold-holding	120 (24)
		Date marking	102 (20)
		Food protected from cross-contamination	81 (16)
		Accessible employee handwashing lavatory	54 (11)

[a] Violations were selected for their relevance to food safety or high citation frequency. The top five violations listed under each inspection category were the five violations most frequently cited in inspections in that category.

inspections (conducted before an announced inspection), 157 were Category C inspections (conducted after an announced inspection), and 501 were Category D inspections (conducted in restaurants that did not undergo an announced inspection during the study period) (Table 1). The median number of violations cited was lowest for Category A inspections (two critical, two noncritical violations) and highest for Category B inspections (four critical, six noncritical violations). Among the five most frequently cited violations in each inspection category, the ratio of critical to noncritical violations was 4:1 in Category A inspections and 2:3 in Category C and Category D inspections (Table 2).

Violations that were more relevant to food safety or that in general incurred citations with high frequency throughout the study period were cited more often in unannounced inspections conducted before an announced inspection than in unannounced inspections conducted in restaurants that did not receive an announced inspection during the study period (Table 3). The differences were significant for four violations: accessible employee handwashing lavatory ($p = .003$), clean non-food-contact surfaces ($p = .005$), equipment maintained in state of repair ($p < .001$), and food protected during storage ($p = .04$).

Six violations were cited significantly less frequently in unannounced inspections that followed an announced inspection than in unannounced inspections that were conducted before an announced inspection. These included violations in two critical categories (person-in-charge demonstrates knowledge of foodborne-disease prevention [$p = .007$] and prevention of cross-contamination [$p = .001$]); and violations in four noncritical cataegories (clean physical facilities [$p = .02$], nonfood contact surfaces kept clean [$p = .03$], equipment maintained in state of repair [$p < .001$], and food protected from contamination during storage [$p < .001$]).

TABLE 3

Violation Frequency Analysis

Violation	Restaurant and Inspection Category								
	Category B versus Category D			Category C versus Category B			Category D[a]		
	Relative Risk	95% CI	*p*-value	Relative Risk	95% CI	*p*-value	Relative Risk	95% CI	*p*-value
Violations in critical categories									
Person-in-charge[b]	1.1	(0.9–1.3)	.22	0.7	(0.5–0.9)	.007	1.0	(0.8–1.3)	0.83
Cold-holding	1.0	(0.8–1.3)	.86	1.0	(0.7–1.4)	.94	Not analyzed		
Nailbrush in restroom	1.2	(0.9–1.4)	.20	0.8	(0.6–1.1)	.19	Not analyzed		
Clean food contact surfaces	1.2	(0.98–1.5)	.08	1.3	(0.98–1.5)	.08	Not analyzed		
Date marking	1.2	(0.9–1.5)	.22	1.1	(0.8–1.5)	.60	Not analyzed		
Cross-contamination	1.3	(0.95–1.7)	.11	0.4	(0.3–0.8)	.001	0.8	(0.6–1.3)	0.41
Accessible handwashing lavatory	1.7	(1.2–2.4)	.003	1.0	(0.7–1.5)	.95	Not Analyzed		
Violations in noncritical categories									
Clean physical facilities	1.1	(0.99–1.3)	.07	0.8	(0.6–0.96)	.02	0.7	(0.5–0.8)	<0.001
Clean non-food-contact surfaces	1.3	(1.1–1.5)	.005	0.8	(0.6–0.98)	.03	0.7	(0.5–0.9)	0.001
Maintain equipment	1.5	(1.2–1.8)	<.001	0.5	(0.3–0.7)	<.001	0.7	(0.5–0.97)	0.03
Food protected during storage	1.2	(1.01–1.5)	.04	0.5	(0.4–0.7)	<.001	0.7	(0.6–0.9)	0.02

[a] Late time period versus early time period.
[b] Person-in-charge demonstrates knowledge of foodborne-disease prevention.

By comparison, in restaurants that did not undergo an announced inspection, violations in four noncritical categories showed significant decreases from the early time period to the late time period: clean physical facilities ($p < .001$), non-food-contact surfaces kept clean ($p = .001$), equipment maintained in a state of repair ($p = .03$), and food protected from contamination during storage ($p = .02$). Violations in the two critical categories, however, showed no statistically significant change in these restaurants from the early time period to the late time period (Table 4).

The highest rate of complaints received by the Minneapolis environmental health complaint line was for restaurants following an announced inspection. The overall rate of complaints in these restaurants was 39.1 per 1,000 establishment-months of observation, and the rate of foodborne-illness complaints was 24.9 per 1,000 establishment-months of observation (Table 5). The lowest rate of complaints was for restaurants that did not undergo an announced inspection, for which the overall rate was 19.6 per 1,000 establishment-months of observation and the foodborne-illness complaint rate was 6.70 per 1,000 establishment-months of observation. For restaurants that had an announced inspection, complaint rates increased from the period before the announced inspection to the period after; however, that trend was not mirrored in restaurants that did not undergo an announced inspection.

Restaurant size appeared to confound the relationship between inspection category and presence of a foodborne-illness complaint. The median seating capacity of a restaurant incurring a foodborne-illness complaint was 150, compared with 85 for restaurants not incurring a foodborne-illness complaint ($p = .001$, Mann-Whitney U test). The size of restaurants that incurred a complaint unrelated to foodborne illness and the size of restaurants that did not incur such a complaint did not differ significantly (median = 100 for both; $p = .8$). The median capacity of restaurants that received an announced inspection was 100, compared with a median capacity of 64 in restaurants that did not receive an announced inspection ($p = .04$). The relationship between restaurant size, foodborne-illness complaints, and inspection category is summarized in Table 5. A dose-response relationship existed between restaurant size and foodborne-illness complaint status for announced inspections; a total of 19 percent of the restaurants incurring a foodborne-illness complaint had a capacity of less than 100 seats, whereas 50 percent had a capacity of greater than 200 seats ($p = .01$). A similar relationship was seen for restaurants that did not undergo an announced inspection; among this group, 13 percent of restaurants incurring a foodborne-illness complaint had a capacity of less than 100, while 50 percent of restaurants had a capacity of greater than 200 seats, although, because of the small numbers involved, this pattern did not reach statistical significance ($p = .1$).

Restaurant operators expressed generally positive attitudes about announced inspections. For example, 59 percent of restaurant operators surveyed said they thought announced inspections led to better relationships with inspectors. Two-thirds of respondents voiced no opinion about which type of inspection did a better job focusing on food safety issues. Among those who had a preference, however, twice as many respondents felt that the announced in-

spections gave them a better understanding of why food safety standards are important and encouraged them to make valuable food safety improvements.

Discussion

The quantitative evaluations comparing restaurants that received announced inspections with restaurants that received only routine unannounced inspections demonstrated several important benefits from the implementation of announced inspections. First, the announced inspections consistently focused on helping the restaurant operator identify and manage critical food safety issues. This observation was confirmed by the following circumstances: 1) the number of food safety violations cited during announced inspections was reduced by one-half for critical violations and two-thirds for noncritical violations. This result is consistent with a greater emphasis being placed on discussion and education than on enforcement. 2) The ratio of critical to noncritical violations cited during and following the announced inspections shifted to emphasize critical violations. Critical violations directly related to food safety comprised four out of the top five violations cited during announced inspections. 3) Restaurant operators expressed favorable attitudes. The announced inspections were qualitatively different than the other routine inspections, and this difference was demonstrated by the clear quantitative differences in citations for food safety violations.

A second major finding of the study was that the performance of restaurants that had undergone an announced inspection improved following the announced inspections with respect to two critical food safety measures: 1) person-in-charge demonstrating knowledge of foodborne-disease prevention and 2) prevention of cross-contamination. Citation frequencies for violations in these critical areas declined by 30 percent and 60 percent, respectively, during routine inspections that followed the announced inspections. The importance of these findings is highlighted by the results of outbreak and non-outbreak restaurant evaluations conducted by EHS-Net (Hedberg, et al., 2006). The reduced risk of foodborne-illness outbreaks associated with the presence of certified kitchen managers was most likely due to their possession and use of knowledge of foodborne-disease prevention. Although 45 percent of the outbreaks evaluated by EHS-Net were caused by norovirus, cross-contamination was the third most common contributing factor identified (Hedberg et al., 2006). Thus, improved performance of restaurants in these areas should reduce the risk of foodborne-disease transmission.

TABLE 4

Complaint Rates

Restaurant Category	Inspection Category	Complaints	
		Total	Foodborne Illness
		N (rate[a])	*N* (rate[a])
Underwent an unannounced inspection			
	D—overall	120 (19.6)	41 (6.7)
	D—early time period	24 (15.7)	11 (7.2)
	D—late time period	96 (20.9)	30 (6.5)
Underwent an announced inspection			
	B	97 (25.8)	55 (14.6)
	C	121 (39.1)	77 (24.9)

[a] Per 1,000 establishment-months of observation.

TABLE 5

Relationship Between Restaurant Category and Restaurant Size in Foodborne-Illness Complaint Rates

Restaurant Category	Foodborne-Illness Complaint	Restaurant Size[a]			*p*-value[b]
		<100 (*N* [%])	100-199 (*N* [%])	>200 (*N* [%])	
Underwent an announced inspection					0.01
	Yes	11 (19)	11 (25)	14 (50)	
	No	46 (81)	32 (75)	14 (50)	
Underwent an unannounced inspection					0.1
	Yes	2 (13)	1 (20)	2 (50)	
	No	14 (87)	4 (80)	2 (50)	

[a] Maximum seating capacity.
[b] Chi-square test for trend.

With respect to apparent foodborne-disease transmission, the increase in foodborne-illness complaints about restaurants that received announced inspections seems counter-intuitive. A reduction in the risk of foodborne-illness transmission could be expected to be accompanied by a reduction in foodborne-illness complaints. A Food-Net population survey demonstrated, however, that most people who attributed their illnesses to meals eaten outside the home incorrectly believed that foodborne illnesses typically occur within a few hours of the time when the contaminated food was eaten (Green et al., 2005). The Minneapolis Environmental Health complaint database relies on self-report by restaurants and restaurant patrons either directly or through the Minnesota Department of Health Foodborne Illness Hotline. Complaints are assigned within 24 hours of receipt and investigated with the assistance of Hennepin County and the Minnesota Department of Health. The data collected on the patron's illness and food history is provided to the Minnesota Department of

Health and Hennepin County for analysis. Outbreaks are handled by a cross-functional team of experts among agencies.

The increased rate of complaints in restaurants that received announced inspections could reflect greater awareness on the part of the restaurant operators and the public that people should report suspected foodborne illness to public health authorities. Media attention to foodborne outbreaks could stimulate increased reporting. Minneapolis environmental health specialists have stressed the importance of illness reporting with restaurant operators and have promoted the foodborne-illness hotline at community health fairs and events. Increased awareness should result in more foodborne-illness complaints. The lack of an increase in foodborne-illness complaints about restaurants that did not receive announced inspections suggests that increased public awareness, by itself, is an unlikely explanation for these findings. Announced inspections, however, provide more time for the environmental health specialist and the person-in-charge to discuss in greater detail the requirements and benefits of illness reporting. Given the attitudes that restaurant operators expressed about improved relationships with environmental health specialists, the increased rate of foodborne-illness complaints following announced inspections could be another beneficial effect of the announced inspections. Unfortunately, it is not possible to determine whether restaurant operators played any role in stimulating the reporting of these complaints.

It seems most likely that restaurant size confounded the relationship between inspection category and complaint rates. Several previous studies have identified larger restaurant size as a risk factor for foodborne-disease outbreaks (Buchholz et al., 2002; Cruz et al., 2001; Olsen et al., 2000). The study reported here demonstrated that larger restaurants were significantly more likely both to incur a foodborne-illness complaint and to receive an announced inspection. Similar dose-response relationships between restaurant size and history of foodborne-illness complaint were seen both among restaurants that received an announced inspection and among those that did not. Because the number of restaurants surveyed that did not receive an announced inspection was small, however, the statistical significance of the difference was limited. Nevertheless, half of all restaurants in the largest size category incurred foodborne-illness complaints. Thus, it appears that larger restaurants were more likely to incur complaints because they served more patrons.

This analysis is the first to systematically assess the impact of implementing a risk-based, active managerial control–driven restaurant inspection program. The results suggest that the Minneapolis Environmental Health announced-inspection program has improved restaurant sanitation in areas that traditional restaurant inspection programs have not. In an analysis of restaurant inspections done in Tennessee, Jones and co-authors found only one critical violation among the 15 most frequently cited violations (2004). While several critical violations appeared in the top five in the Minneapolis data, many of the violations most frequently cited during unannounced inspections were still noncritical. The high frequency of citations for critical violations during the announced inspections, together with the subsequent significant improvement in the frequency of two of these violations during unannounced inspections that followed, suggests that announced inspections are producing improvements in restaurant sanitation that unannounced inspections are unable to accomplish. Critical violations are more complex than noncritical violations. Reducing the citation frequency of the cross-contamination and person-in-charge violations after announced inspections suggests that the restaurants have made long-term, procedural changes that can reduce the presence of foodborne-disease hazards in their facilities. These improvements demonstrate that announced, risk-based inspections could help restaurants make sustained changes in their operations that reduce the risk of foodborne illness in their establishments.

The results of the study support the conclusion that education of restaurant managers and food workers is an effective way to improve inspection outcomes, as suggested by previous studies (Campbell et al., 1998; Cotterchio et al., 1998; Mathias et al., 1995; Raval-Nelson & Smith, 1999). Education is an integral part of the announced inspection process; the environmental health specialist takes time to learn from the operator how food is handled and prepared, and to thoroughly discuss food safety hazards unique to each establishment. This emphasis on education and communication may be the primary cause of the significant improvements seen in the frequency of violation cited for the critical category of the person-in-charge demonstrating knowledge of foodborne-disease prevention; those improvements should reduce the risk of foodborne-illness transmission.

The study reported here opens several avenues for further study. A major limitation of the study was the underlying assumption that improvement in restaurant inspection outcomes entails decreased risk of foodborne illness. As mentioned previously, an attempt was made to identify foodborne-illness outbreaks in Minneapolis during the study time and relate them to restaurant inspection status. The number of confirmed foodborne outbreaks during the study time period was too small, however, to allow for any meaningful analysis. Because of the relative rarity of foodborne-disease outbreaks and the newness of the Minneapolis complaint database, it would be worthwhile to re-evaluate this relationship after the announced inspection program has been in place for a few more years. Re-evaluation of data from subsequent years will also reveal whether the improvements seen after announced inspections are sustained when announced inspections are no longer new but have become standard practice.

Conclusion

The results of the Minneapolis Environmental Health announced-inspection program indicate that risk-based restaurant inspections may be an effective way to improve restaurant sanitation and decrease the risk of acquiring foodborne illness from eating in restaurants.

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REFERENCES continued from page 33

Bader, M., Blonder, E., Henriksen, J., & Strong, W. (1978). A study of food service establishment sanitation inspection frequency. *American Journal of Public Health, 68,* 408-410.

Buchholz, U., Run, G., Kool, J.L, Fielding, J., & Mascola, L. (2002). A risk-based restaurant inspection system in Los Angeles County. *Journal of Food Protection, 65*(2), 367-372.

Campbell, M.E., Gardner, C.E., Dwyer, J.J., Isaacs, S.M., Krueger, P.D., & Ying, J.Y. (1998). Effectiveness of public health interventions in food safety: A systematic review. *Canadian Journal of Public Health, 89*(3), 197-202.

Cotterchio, M., Gunn, J., Coffill, T., Tormey, P., & Barry, M.A. (1998). Effect of a manager training program on sanitary conditions in restaurants. *Public Health Reports, 113*(4), 353-358.

Cruz, M.A., Katz, D.J., & Suarez, J.A. (2001). An assessment of the ability of routine restaurant inspections to predict food-borne outbreaks in Miami-Dade County, Florida. *American Journal of Public Health, 91,* 821-823.

Fielding, J.E., Aguirre, A., & Palaiologos, E. (2001). Effectiveness of altered incentives in a food safety inspection program. *Preventive Medicine, 32*(3), 239-244.

Fielding, J.E., Aguirre, A., Spear, M.C., & Frias, L.E. (1999). Making the grade: changing the incentives in retail food establishment inspection. *American Journal of Preventive Medicine, 17*(3), 243-247.

Green, L.R., Selman, C., Scallon, E., Jones, T.F., Marcus R., & EHS-Net Population Survey Working Group. (2005). Beliefs about meals eaten outside the home as sources of gastrointestinal illness. *Journal of Food Protection, 68,* 2184-2189.

Hedberg, C.W, Smith, S.J., Kirkland, E., Radke, V., Jones, T.F., Selman, C.A., & the EHS-Net Working Group. (2006). Systematic environmental evaluations to identify food safety differences between outbreak and non-outbreak restaurants. *Journal of Food Protection, 69,* 2697-2702.

Irwin, K., Ballard, J., Grendon, J., & Kobayyashi, J. (1989). Results of routine restaurant inspections can predict outbreaks of foodborne illness: The Seattle-King County experience. *American Journal of Public Health, 79,* 586-590.

Jones, T.F., Pavlin, B.I., LaFleur, B.J., Ingram, L.A., & Schaffner W. (2004). Restaurant inspection scores and foodborne disease. *Emerging Infectious Diseases, 10,* 688-692.

Mathias, R.G., Sizto, R., Hazlewood, A., & Cocksedge, W. (1995). The effects of inspection frequency and food handler education on restaurant inspection violations. *Canadian Journal of Public Health, 86*(1), 46-50.

Mead, P.S., Slutsker, L., Dietz, V., McCaig, L.F., Bresee, J.S., Shapiro, C., Griffin, P.M., & Tauxe, R.V. (1999). Food-related illness and death in the United States. *Emerging Infectious Diseases, 5,* 607-625.

Mullen, L.A., Cowden, J.M., Cowden D., & Wong, R. (2002). An evaluation of the risk assessment method used by environmental health officers when inspecting food businesses. *International Journal of Environmental Health Research, 12*(3), 255-260.

Olsen, S.J., MacKinnon, L.C., Goulding, J.S., Bean, N.H., & Slutsker, L. (2000). Surveillance for foodborne-disease outbreaks—United States, 1993–1997. *Morbidity and Mortality Weekly Report, CDC Surveillance Summaries, 49*(1), 1-62.

Penman, A.D., Webb, R.M., Woernle, C.H., & Currier, M.M. (1996). Failure of routine restaurant inspections: Restaurant-related foodborne outbreaks in Alabama, 1992, and Mississippi, 1993. *Journal of Environmental Health, 58*(8), 23-25.

Raval-Nelson, P., & Smith, P.M. (1999). Food safety certification and its impacts. *Journal of Environmental Health, 61*(7), 9-12.