Relationship Between Food Safety and Critical Violations on Restaurant Inspections: An Empirical Investigation of Bacterial Pathogen Content

Pre-published digitally November 2012,
National Environmental Health Association.

Valerie A. Yeager, MPH, Mphil, DrPH
Tulane University

Nir Menachemi, MPH, PhD
University of Alabama at Birmingham

Bruce Braden
Devon M. Taylor, MPH
Bryn Manzella, MPH
Jefferson County Department of Health

Claude Ouimet, MD, FAAFP
SuccessEHS

Abstract

While various safety control measures exist within the U.S. food system, foodborne illness remains a costly and persistent problem. The purpose of the study described here was to examine the relationship between violations of critical restaurant inspection items ("critical items") and food safety as measured by the bacterial load of illness-causing pathogens. Specifically, the authors' study looked at bacterial pathogens present in foods of two groups of restaurants, those that consistently scored poorly on critical items as compared to restaurants that performed superiorly in the same types of evaluation in Jefferson County, Alabama. Laboratory analyses indicated that 35.7% of the foods tested had detectable levels of *Staphylococcus aureus*, but no difference occurred between the two groups of restaurants. No other bacterial pathogens were found in any of the tested samples. A total of 45.2% of the food samples were received outside of recommended temperatures. Findings draw attention to the ongoing need to improve temperature control and hygienic practices, specifically handwashing practices, in restaurants.

Introduction

It is estimated that foodborne illness costs the U.S. economy $10–$83 billion a year (Food and Drug Administration [FDA], 2004). Additionally, recent estimates indicate that contaminated food ultimately results in 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths annually (Scallan et al., 2011). Laboratory-confirmed foodborne infections show that *Salmonella*, *Campylobacter*, *Shigella*, *Cryptosporidium*, and Shiga toxin-producing *E. coli* O157 are the top five foodborne pathogens affecting Americans (Centers for Disease Control and Prevention [CDC], 2009).

Although *Staphylococcus aureus* is believed to contribute to many cases of foodborne illness in the U.S., the true incidence of illness resulting from the toxin produced by *S. aureus* is unknown for a number of reasons, including the misdiagnosis of this illness and the lack of sample collection for laboratory testing (FDA, 2011a). A recent article reviewing the burden of foodborne illness in the U.S. highlighted the frequency with which Americans consume foods prepared outside the home as one of the five primary factors contributing to the occurrence of foodborne illness (Jones & Angulo, 2006; Nyachuba, 2010). Approximately 50% of funds budgeted for food by Americans are spent in restaurants (Creel, Sharkey, McIntosh, Anding, & Huber, 2008), where, according to the Centers for Disease Control and Prevention (CDC), half of foodborne outbreaks occur (CDC, 2006). While various safety control measures exist within the U.S. food system, foodborne illness remains a costly and persistent problem.

Local public health agencies routinely inspect restaurants for risks to human health by focusing on factors believed to be associated with food safety. Because it is difficult to measure the impact of these inspections on the reduction of risk to human health, the majority of food safety studies have focused on nonhealth outcomes (Cates et al., 2009; Chapman, Eversley, Fillion, Maclaurin, & Powell, 2010; Green & Selman, 2005; Kassa, Silverman, & Baroudi, 2010; Lee, Almanza, Nelson, & Ghiselli, 2009; Phillips, Elledge, Basara, Lynch, & Boatright, 2006; Reske, Jenkins, Fernandez, VanAmber, & Hedberg, 2007). In fact, much of the peer-reviewed research on food safety and restaurant inspections examines the validity and reliability of inspection scores (Klein & DeWall, 2008; Lee et al., 2009; Phillips et al., 2006; Reske et al., 2007) and the relationship between scores with other factors such as the presence of a food safety–trained kitchen manager (Cates et al., 2009; Kassa et al., 2010).

Although the frequency of foodborne illness can be assessed by the number of related hospitalizations and emergency department visits, these measures suffer from severe underreporting because people do not commonly seek medical care for mild cases (symptoms lasting 24–48 hours) of foodborne illness (FDA, 2011b; FDA Retail Food Program Steering Committee, 2000; Mead et al., 1999). Underreporting also results in inaccurate outbreak counts (CDC, 2006; Nyachuba, 2010). Despite these issues, one county-based study by Jin and Leslie measured foodborne illness hospitalizations in relation to changes in how restaurant inspections were scored and displayed for consumers (numerical versus letter scores) (Jin & Leslie, 2003). They found that mandating the display of letter scores was associated with a significant decrease in the number of foodborne illness hospitalizations.

Two additional studies examined the relationship between outbreaks and inspection scores but had contradictory findings (Irwin, Ballard, Grendon, & Kobayashi, 1989; Jones, Pavlin, LaFleur, Ingram, & Schaffner, 2004). In the absence of reliable and available estimates of foodborne illness, an examination of bacterial pathogens in food may shed light on the risk of foodborne illness in restaurants. Examining foods for bacterial pathogens may also provide information about the presence of bacteria, such as *S. aureus*, which are not commonly tested for in laboratory tests. Such pathogens cause acute cases of illness that people frequently endure without seeking medical care or, when they do seek care, physicians do not request specific testing (FDA, 2011a; Mead et al., 1999; Roberts, 2007; Scallan et al., 2006).

The purpose of our study was to examine the relationship between violations of critical restaurant inspection items ("critical items") and food safety as measured by the bacterial load of illness-causing pathogens. Specifically, we looked at bacterial pathogens present in foods of restaurants that consistently scored poorly on critical items as compared to restaurants that performed superiorly in the same types of evaluation. Our study simulates real-world scenarios by utilizing to-go food samples, measuring the temperatures at which they are received, and testing the samples for pathogens. By providing information relevant to our current public health food safety practices and their relationship to human health, our study will be of interest to practitioners and decision makers in public health.

Methods

Study Design and Population

We conducted a matched cohort study of 42 restaurants in Jefferson County, Alabama. The following section details the inclusion criteria, food sample collection and analysis, variables collected, and statistical methods employed.

Inclusion Criteria

Restaurant inclusion in the study was based on performance on recent public health inspections. In Jefferson County, restaurants are routinely inspected three times per year, unless they receive an inspection score below 85, in which case they receive a reinspection prior to the next scheduled one. Using retrospective Jefferson County Department of Health (JCDH) inspection data for the period of April 1 through October 31, 2010, we identified restaurants that lost points on the same critical human health–related violation during two back-to-back routine inspections (FDA Retail Food Program Steering Committee, 2000; U.S. Department of Health and Human Services, 2009). These restaurants were considered for inclusion in the cohort of Group A restaurants. The control cohort (Group B restaurants) was identified as restaurants that lost no points on critical violations across two routine food safety inspections during the study period. We matched Group A and Group B restaurants based on food type (American, fast food, Asian, or Mediterranean) and location (zip code). American food included barbeque and home-style restaurants, steak houses, and bar and grill restaurants. Fast food establishments included chain restaurants in which foods are regularly prepared and quickly available. Asian restaurants included those that serve sushi, Chinese, and Indian foods. Mediterranean restaurants included those that serve Greek and Italian foods. A total of 21 matched pairs were included in our study.

Food Sample Collection and Analysis

The same type of food samples were collected from each matched pair of restaurants on the same day. Food samples were collected as "to go" orders to mimic real-life food service scenarios. Immediately after collection, the temperature of each sample was systematically assessed following sterility protocols established to prevent contamination of study samples (Carson & Dent, 2007). All samples were collected during the same lunch period, deidentified, packed in dry ice, and shipped overnight to an independent laboratory for analysis. By deidentifying all samples the laboratory was blinded to restaurant groupings.

Food safety was determined by laboratory analysis of each individual food sample obtained from each study restaurant as follows. Samples that included chicken were tested for the presence of *Salmonella* and *Campylobacter*. Samples that included beef products were tested for *E. coli* O157 and *Clostridium perfringens*. Foods that contained rice and pasta were also tested for *Bacillus cereus*. Any meats that were possibly cooled and stored (e.g., chicken salad) were also tested for *Listeria*. Lastly, high protein foods that were likely to have been handled by hands during preparation (e.g., chicken salad, hamburgers, meatloaf, etc.) were tested for *S. aureus*. Due to the increased likelihood of the development of staphylococcal enterotoxins as *S. aureus* increases, higher levels of *S. aureus* are associated with greater human health risk (FDA, 2011a). In our study, any samples that contained *S. aureus* were also tested for staphylococcal enterotoxins.

Food samples were aseptically sampled and tested by the laboratory using approved scientific protocols. The following microbiological methods were used to test for the presence of pathogens: FDA-BAM Ch. 14 (*B. cereus*), ISO 16140 (*Campylobacter*), AOAC 976.30 (*C. perfringens*), AOAC RI 060903 (*E. coli* O157), AOAC RI 020901 (*Salmonella),* AOAC 975.55 (*S. aureus*), AOAC 070404 (staphylococcal enterotoxins), and AOAC 2004.02 (*Listeria monocytogenes*). Results of pathogen analyses were reported as negative or positive per 25 grams with the exception of *S. aureus*, which were reported as CFU/g. The laboratory issued a certificate of analysis upon completion of the testing. The study protocol was deemed exempt by our university institutional review board for not focusing on human subjects; nevertheless, all food samples, laboratory reports, and study findings were deidentified by name and location of restaurant.

Variables Collected

We collected the following variables for analysis: type of restaurant (e.g., American, fast food, Asian, or Mediterranean); type of food collected (e.g., hot-served chicken, cold-served chicken salad, hamburger, steak, hot dog, meatballs, meatloaf, sausage, rice, pasta, or mashed potatoes); food sample temperature; and total pathogen count for each pathogen present.

Statistical Methods

Descriptive statistical analyses were conducted to examine variable distributions. Chi squared or Fisher's exact tests indicated if differences existed between the two groups of restaurants with respect to presence of bacterial pathogens, food temperature, and whether foods were served at temperatures recommended by the Food and Drug Administration (FDA) (U.S. Department of Health and Human Services, 2009). FDA's 2009 *Food Code* recommends temperatures of ≥135°F for foods that are served hot and ≤41°F for foods that are served cold. Lastly, logistic regression analyses were used to examine the presence of any pathogens as it relates to restaurant and food characteristics. All analyses were computed in STATA version 11 and statistical significance was considered at the .05 level.

Results

Of the 42 restaurants sampled, 40.5% (n = 17) served American food, 23.8% (n = 10) served fast food, 19% (n = 8) served Asian foods, and 16.7% (n = 7) served Mediterranean foods (Table 1). A total of 42 primary food samples were collected and included such items as chicken, hamburgers, steaks, hot dogs, meatball dishes, sausages, meatloaf, rice, pasta, or mashed potatoes (Table 1).

Laboratory analyses indicated that 35.7% of the samples (n = 15) had detectable levels of *S. aureus*. Two of the 15 samples (4.8%) had *S. aureus* levels >10 CFU/g, indicating a greater potential for human health risk; one was chicken salad (70 CFU/g) and one was a hot dog (30 CFU/g). Both of these samples were tested for staphylococcal enterotoxin, but at the time of testing the colony had not produced toxins. One hundred percent of the chicken salad samples (n = 5) tested positive for *S. aureus*. Additionally, *S. aureus* was found in 100% of the hot dogs (n = 2), 100% of the meatloaf (n = 1), 62.5% of hamburger samples (n = 8), 50% of sausages (n = 2), and 5% of chicken (n = 20). None of the other bacterial pathogens (*E. coli* O157, *C. perfringens*, *Campylobacter*, *Salmonella*, *Listeria*, or *B. cereus*) were found in any of the tested samples.

No difference occurred between the percentage of Group A and Group B restaurants that contained *S. aureus* (33.3% vs. 38.1%, p = .75) (see Table 2). Additionally, Group A and Group B restaurants were not significantly different in regard to whether hot foods (57.9% vs. 55.6%, p = .89) or cold food items (50% vs. 66.7%, p = .71) were delivered at the recommended temperature. Moreover, restaurants that served foods outside of the recommended temperature were not associated with food samples containing *S. aureus* (p = .35).

A total of 42.9% (n = 18) of the 42 primary food samples were delivered at temperatures measuring below the recommended hot temperature (135°F) or above the recommended cold temperature (41°F) (see Table 3). Hot foods ranged from 84.9°F to 193°F with an average temperature of 142.6°F. Cold foods ranged from 36.9°F to 74.8°F with an average temperature of 49.1°F.

Regression analyses modeling the relationship between the outcome of detectable *S. aureus* as it relates to cuisine, food type, and recommended temperature found no significant differences.

Discussion

The key findings of our study are that no difference occurred in bacterial pathogen content or food temperatures between the restaurants in our two groups. These findings provide encouraging evidence regarding the public health restaurant inspection program, yet they also highlight ongoing challenges in restaurant food safety. While the overall findings suggest that the JCDH's current inspection program seems to be working, our findings also identify areas that may need more attention, including improved hand washing, safe holding temperatures, and ensuring timely food safety training to address risks associated with employee turnover.

Jefferson County follows the guidelines provided in the 2005 *Food Code* supplement, which prohibits bare hand contact with exposed, ready-to-eat food (U.S. Department of Health and Human Services, 2005). Also, when restaurant inspectors identify critical violations, restaurants are often required to complete a plan for remediating the problematic practices. Inspectors may also conduct repeat visits to ensure that such restaurants can demonstrate correct food safety practices, thereby increasing the likelihood that these restaurants provide foods equally as safe as restaurants without critical violations. Having found no difference in microbial colonization in the food samples from the matched cohorts in our study on the day of food collection, both cohorts provided foods that were equally safe.

Nevertheless, our study also indicated that several types of foods, most of which require extensive human hand contact to prepare, were contaminated with *S. aureus* regardless of restaurant group. The lack of a difference between groups may be due to the fact that poor hand washing and hygiene practices are difficult to identify during inspections, and as such, critical violations are often not directly related to these issues (Kassa et al., 2010). Consistent with the Hawthorne effect, food workers are more likely to practice good hand washing in the presence of inspectors (Kohli et al., 2009).

Despite not knowing the true incidence of illness caused by *S. aureus* (FDA, 2011a), the presence of *S. aureus* in 36% of food samples collected in our study suggests that it may be common in real-world food samples. Further, as *S. aureus* presence is related to poor hand washing and hygienic practices, this finding draws attention to the widespread need for improved emphasis and training on the importance of hygiene (Food Doctors, 2011; Franco, Hsu, & Simonne, 2010; Le Loir, Baron, & Gautier, 2003). In an effort to understand how to improve hand washing, previous researchers conducted a focus-group study with 11 groups of food service workers across five states (Green & Selman, 2005). They assessed perceptions on kitchen practices and foodborne risks and found that management emphasis and negative consequences were identified as facilitators to improving hand washing. Additionally, a recent study by Chapman and co-authors found that food safety info sheets (designed to initiate dialogue among food handlers) led to significant improvements in hand washing attempts (Chapman et al., 2010). Future research should examine the application of these interventions on hand washing in diverse "real-world" restaurant settings.

Though none of the 15 samples positive for *S. aureus* had levels above FDA's accept-

TABLE **1**

Sample Characteristics

Characteristic	# Sampled (%)
Restaurant types	
American	17 (40.5)
Fast food	10 (23.8)
Asian	8 (19.0)
Mediterranean	7 (16.7)
Total restaurants	42 (100)
Foods sampled	
Primary samples	
Hot-served chicken	20 (47.6)
Hamburger	8 (19.0)
Cold chicken salad	5 (11.9)
Steak	2 (4.8)
Hot dog	2 (4.8)
Meatball dish	2 (4.8)
Sausage	2 (4.8)
Meatloaf	1 (2.3)
Total primary samples	42 (100)
Additional samples	
Rice	13 (86.6)
Pasta	1 (6.7)
Mashed potatoes	1 (6.7)
Total additional samples	15 (100)

TABLE **2**

Presence of *Staphylococcus aureus* (SA) and Food Temperature by Restaurant Group

Parameter Tested	Group A Restaurants	Group B Restaurants	*p*-Value
Presence of SA			
% Samples with any level of SA	33.3	38.1	.75
% Samples with SA levels >10 CFU/g	4.8	4.8	1.0
Food temperature			
% Hot samples delivered at recommended temperatures	57.9	55.6	.89
% Cold samples delivered at recommended temperatures	50	66.7	.71

Note. Routine laboratory tests are sensitive to SA levels at 10 CFU/g. Group A includes those restaurants selected for our study that consistently lost points for critical violations in repeat food safety inspections. Group B refers to the cohort of restaurants that lost no points for critical violations during the two-year study period.

able level of 1,000 CFU/g, it is important to draw attention to the potential human health risk introduced by the mere presence of *S. aureus* in foods. First, small populations of *S. aureus* at the time of testing could be remnants of larger populations destroyed after cooking that were able to produce enterotoxins (which are not deactivated by heat); therefore, small populations at the time of testing are not necessarily an indication of a safe food (FDA, 2001). Second, as indicated in the following example, poor hygiene combined with the right conditions for *S. aureus* growth can create the potential for food poisoning. In an *S. aureus* outbreak involving chicken salad, 1,364 children suffered from foodborne illness (FDA, 2011a). Poor hygiene practices led to the contamination of *S. aureus* in the chicken deboning process, though improper cooling and holding temperatures created the conditions for *S. aureus* to grow. Once present, *S. aureus* colonies can grow when food is not held above 140°F or below 45°F (FDA, 2011a). Increased *S. aureus* leads to an increased likelihood of staphylococcal enterotoxin production, which causes vomiting and diarrhea in humans (Franco et al., 2010; Le Loir et al., 2003; Mead et al., 1999; FDA, 2011a). Staphylococcal enterotoxins are produced at temperatures ranging from 57.2°F to 111.2°F and once present cannot be inactivated by cooking or reheating (FDA, 2011a; Schmitt, Schuler-Schmid, & Schmidt-Lorenz, 1990). Since temperature is a key factor in the growth of bacteria in food and given that 45.2% of foods collected in our study were not served at the recommended temperature, greater attention should be given to ensuring safe holding and cooling practices in addition to improved food handling practices.

Because illness caused by *S. aureus* enterotoxins occurs relatively acutely (lasting 24–48 hours), people often do not to seek medical care and when they do the lack of laboratory confirmation complicates the ability to know the true incidence of cases (FDA, 2011a; Mead et al., 1999). Despite this, preliminary data presented herein reminds us of the ongoing need to address hygiene and hand washing practices throughout the restaurant industry. Improved hygienic practices would also impact the occurrence of norovirus in foods served to the public. Although laboratory testing for norovirus was unavailable for our study, previous research indicates that it has been the cause of 47% of laboratory-confirmed, outbreak-associated illnesses (Jones & Angulo, 2006). While recent headlines have focused on large-scale outbreaks stemming from problems in large-scale animal and farming practices, poor hand washing causes illness in proportionally more Americans and is often underemphasized despite being remediable (Hutchinson, 2010; Neuman, 2010).

Strengths and Limitations

To our knowledge, this is the first study to examine bacterial pathogens in food samples as an indication of risks to human health. Studies of this nature may be limited partly due to the costs associated with the laboratory testing of food samples. Even though this preliminary study examined a relatively small sample of restaurants, it included a diverse group of establishments and tested a wide variety of foods, adding to the representativeness of its findings. Another strength of our study design is that it was conducted in a real-world scenario, providing a reasonable assessment of the state of foods served to the public. Foods analyzed in our study were packed in dry ice immediately upon being collected; thus, little time elapsed for foods to be held at room temperature before being tested for pathogens. Since foods that are held at room temperatures have a greater likelihood of bacterial growth, the threat to human health becomes more apparent the longer foods are outside recommended temperatures. It is conceivable that many customers may not immediately consume their purchased food and in such instances the threat to human health may in fact be greater than indicated by our study. Finally, laboratories available for testing were unable to examine samples for the presence of viruses, including norovirus.

TABLE **3**

Food Temperatures by Type of Food

Type of Food	Delivered at Recommended Temperatures	Delivered at Nonrecommended Temperatures
Hot foods	**% ≥135°F**	**% <135°F**
Hot dogs (*n* = 2)	100	0
Meatloaf (*n* = 1)	100	0
Chicken (*n* = 20)	70	30
Sausage (*n* = 2)	50	50
Hamburgers (*n* = 8)	37.5	62.5
Meatball dish (*n* = 2)	0	100
Steak (*n* = 2)	0	100
Total hot foods	54.1	45.9
Cold foods	**% ≤41°F**	**% >41°F**
Chicken salad (*n* = 5)	60	40
Total all foods	**57.1**	**42.9**

Conclusion

While the current system seems to have strengths in preventing foodborne illness, both groups of restaurants had issues with bacterial contamination, suggesting that room for improvement exists. Further, even though the true incidence of foodborne illness caused by *S. aureus* toxins is unknown (FDA, 2011a), its presence in over a third of food samples collected in our study suggests that it may be common in real-world food samples and draws attention to the importance of proper hand hygiene and hot and cold holding temperatures. Future research should examine restaurant characteristics associated with critical violations related to poor hygiene, the lack of hand washing, and noncompliance with holding temperatures to better inform inspection and educational practices. Perhaps educational programs can be most effective if targeted to restaurants documented to have greater likelihood of such violations.

Acknowledgements: The authors would like to thank Sally Engler, Alva Ferdinand, Lee Howard, Dnika Joseph, Su Jin Jeong, Payal Patel, Gabriel Tajeu, and Saurabh Rahurkar, all from the University of Alabama at Birmingham School of Public Health, for their valuable assistance during this study.

Corresponding Author: Valerie A. Yeager, Assistant Professor, Tulane University, School of Public Health and Tropical Medicine, Department of Global Health Systems and Development. 1400 Canal Street, Suite 1900, New Orleans, LA 70112. E-mail: vayeager@tulane.edu.

References

Carson, P.A., & Dent, N. (Eds.). (2007). *Good clinical, laboratory, and manufacturing practices*. Cambridge, UK: The Royal Society of Chemistry.

Cates, S.C., Muth, M.K., Karns, S.A., Penne, M.A., Stone, C.N., Harrison, J.E., & Radke, V.J. (2009). Certified kitchen managers: Do they improve restaurant inspection outcomes? *Journal of Food Protection, 72*(2), 384–391.

Centers for Disease Control and Prevention. (2006). Surveillance for foodborne-disease outbreaks—United States, 1998–2002. *Morbidity Mortality Weekly Report, 55*(SS10), 1–34.

Centers for Disease Control and Prevention. (2009). Preliminary FoodNet data on the incidence of infection with pathogens transmitted commonly through food—10 States, 2008. *Morbidity Mortality Weekly Report, 58*(13), 333–337.

Chapman, B., Eversley, T., Fillion, K., Maclaurin, T., & Powell, D. (2010). Assessment of food safety practices of food service food handlers (risk assessment data): Testing a communication intervention (evaluation of tools). *Journal of Food Protection, 73*(6), 1101–1107.

Creel, J.S., Sharkey, J.R., McIntosh, A., Anding, J., & Huber, J.C., Jr. (2008). Availability of healthier options in traditional and nontraditional rural fast-food outlets. *BMC Public Health, 8*, 395.

Food and Drug Administration. (2001). *Bacteriological analytical manual*. Retrieved from http://www.fda.gov/Food/ScienceResearch/

References

LaboratoryMethods/BacteriologicalAnalyticalManualBAM/ucm071429.htm

Food and Drug Administration. (2004). *Produce safety from production to consumption: 2004 action plan to minimize foodborne illness associated with fresh produce consumption*. Retrieved from http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/FruitsVegetablesJuices/FDAProduceSafetyActivities/ProduceSafetyActionPlan/ucm129487.htm

Food and Drug Administration. (2011a). *Bad bug book: Foodborne pathogenic microorganisms and natural toxins handbook*. Retrieved from http://www.fda.gov/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathogensNaturalToxins/BadBugBook/default.htm

Food and Drug Administration. (2011b). *What you need to know about foodborne illness–causing organisms in the U.S*. Retrieved from http://www.fda.gov/Food/ResourcesForYou/Consumers/ucm103263.htm

Food and Drug Administration Retail Food Program Steering Committee. (2000). *Report of the Food and Drug Administration retail food program database of foodborne illness risk factors*. Retrieved from http://www.fda.gov/downloads/Food/FoodSafety/RetailFoodProtection/FoodborneIllnessandRiskFactorReduction/RetailFoodRiskFactorStudies/ucm123546.pdf

Food Doctors. (2011, April 8) *The food safety file:* Staphylococcus aureus. Retrieved from www.fooddoctors.com/FSF/S_aureus.pdf

Franco, W., Hsu, W.Y., & Simonne, A.H. (2010). Survival of *Salmonella* and *Staphylococcus aureus* in Mexican red salsa in a food service setting. *Journal of Food Protection, 73*(6), 1116–1120.

Green, L.R., & Selman, C. (2005). Factors impacting food workers' and managers' safe food preparation practices: A qualitative study. *Food Protection Trends, 25*(12), 981–990.

Hutchinson, C. (2010, August 23). Cracks in the system: Egg recall reveals FDA flaws. *ABC News*. Retrieved from http://abcnews.go.com/Health/Wellness/salmonella-outbreak-egg-recall-shows-fda-flaws/story?id=11445664

Irwin, K., Ballard, J., Grendon, J., & Kobayashi, J. (1989). Results of routine restaurant inspections can predict outbreaks of foodborne illness: The Seattle-King County experience. *American Journal of Public Health, 79*(5), 586–590.

Jin, G.Z., & Leslie, P. (2003). The effect of information on product quality: Evidence from restaurant inspection grade cards. *The Quarterly Journal of Economics, 118*(2), 409–451.

Jones, T.F., & Angulo, F.J. (2006). Eating in restaurants: A risk factor for foodborne disease? *Clinical Infectious Diseases, 43*(10), 1324–1328.

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*(4), 688–692.

Kassa, H., Silverman, G.S., & Baroudi, K. (2010). Effect of a manager training and certification program on food safety and hygiene in food service operations. *Environmental Health Insights, 4*, 13–20.

Klein, S., & DeWall, C.S. (2008). *Dirty dining: Have reservations? You will now*. Washington, DC: Center for Science in the Public Interest. Retrieved from http://cspinet.org/new/pdf/ddreport.pdf

Kohli, E., Ptak, J., Smith, R., Taylor, E., Talbot, E.A., & Kirkland, K.B. (2009). Variability in the Hawthorne effect with regard to hand hygiene performance in high- and low-performing inpatient care units. *Infection Control and Hospital Epidemiology, 30*(3), 222–225.

Lee, J.E., Almanza, B.A., Nelson, D.C., & Ghiselli, R.F. (2009). Using health inspection scores to assess risk in food services. *Journal of Environmental Health, 71*(7), 28–33.

Le Loir, Y., Baron, F., & Gautier, M. (2003). *Staphylococcus aureus* and food poisoning. *Genetics and Molecular Research, 2*(1), 63–76.

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*(5), 607–625.

Neuman, W. (2010, May 8). Tainted lettuce linked to illness in three states. *The New York Times*, p. A10. Retrieved from http://www.nytimes.com/2010/05/08/us/08lettuce.html

Nyachuba, D.G. (2010). Foodborne illness: Is it on the rise? *Nutrition Review, 68*(5), 257–269.

Phillips, M.L., Elledge, B.L., Basara, H.G., Lynch, R.A., & Boatright, D.T. (2006). Recurrent critical violations of the food code in retail food service establishments. *Journal of Environmental Health, 68*(10), 24–30, 55.

Reske, K.A., Jenkins, T., Fernandez, C., VanAmber, D., & Hedberg, C.W. (2007). Beneficial effects of implementing an announced restaurant inspection program. *Journal of Environmental Health, 69*(9), 27–34, 76.

Roberts, T. (2007). WTP estimates of the societal costs of U.S. foodborne illness. *American Journal of Agricultural Economics, 89*(5), 1183–1188.

Scallan, E., Hoekstra, R.M., Angulo, F.J., Tauxe, R.V., Widdowson, M.A., Roy, S.L., Jones J.L., & Griffin, P.M. (2011). Foodborne illness acquired in the United States—major pathogens. *Emerging Infectious Diseases, 17*(1), 7–15.

Scallan, E., Jones, T.F., Cronquist, A., Thomas, S., Frenzen, P., Hoefer, D., Medus, C., Angulo, F.J., & FoodNet Working Group. (2006). Factors associated with seeking medical care and submitting a stool sample in estimating the burden of foodborne illness. *Foodborne Pathogen Disease, 3*(4), 432–438.

Schmitt, M., Schuler-Schmid, U., & Schmidt-Lorenz, W. (1990). Temperature limits of growth, TNase and enterotoxin production of *Staphylococcus aureus* strains isolated from foods. *International Journal of Food Microbiology, 11*(1), 1–19.

U.S. Department of Health and Human Services. (2005). *Food code 2005*. Retrieved from http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/Foodcode/FoodCode2005/default.htm

U.S. Department of Health and Human Services. (2009). *Food code 2009*. Retrieved from http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2009/default.htm