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Improving Response to Foodborne Disease Outbreaks in the United States: Findings of the Foodborne Disease Centers for Outbreak Response Enhancement (FoodCORE), 2010–2012

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Abstract

Context—Each year foodborne diseases (FBD) affect approximately 1 in 6 Americans, resulting in 128,000 hospitalizations and 3,000 deaths. Decreasing resources impact the ability of public health officials to identify, respond to, and control FBD outbreaks. Geographically dispersed outbreaks necessitate multijurisdictional coordination across all levels of the public health system. Rapid response depends on rapid detection.

Objective—Targeted resources were provided to state and local health departments to improve completeness and timeliness of laboratory, epidemiology, and environmental health (EH) activities for FBD surveillance and outbreak response.

Design—Foodborne Disease Centers for Outbreak Response Enhancement (FoodCORE) centers, selected through competitive award, implemented work plans designed to make outbreak response more complete and faster in their jurisdiction. Performance metrics were developed and used to evaluate the impact and effectiveness of activities.

Participants—Departments of Health in Connecticut, New York City, Ohio, South Carolina, Tennessee, Utah, and Wisconsin.

Results—From the first year (Y1) of the program in October 2010 to the end of second year (Y2) in December 2012, the centers completed molecular subtyping for a higher proportion of *Salmonella*, Shiga toxin-producing *E. coli*, and *Listeria* (SSL) isolates (86% vs 98%) and reduced the average time to complete testing from a median of 8 to 4 days. The centers attempted epidemiologic interviews with more SSL case-patients (93% vs 99%) and the average time to attempt interviews was reduced from a median of 4 to 2 days. During Y2, nearly 200 EH assessments were conducted. FoodCORE centers began documenting model practices such as streamlining and standardizing case-patient interviewing.

Conclusion—Centers used targeted resources and process evaluation to implement and document practices that improve the completeness and timeliness of FBD surveillance and outbreak response activities in several public health settings. FoodCORE strategies and model practices could be replicated in other jurisdictions to improve FBD response.

Introduction

Every year an estimated 48 million people become ill from foodborne diseases, resulting in 128,000 hospitalizations and 3,000 deaths in the United States[1]. The landscape of food safety in the United States is changing as food production has become increasingly centralized with widely distributed products. The challenges of identifying, investigating, and controlling foodborne disease outbreaks are also changing. Outbreaks involve new and emerging pathogens and antibiotic resistance, novel foods causing illness, new routes of contamination, and can require multidisciplinary and multijurisdictional coordination.

Only a small proportion of all the foodborne illnesses that occur each year are part of recognized and reported outbreaks[2]. However, improved surveillance systems in the United States are detecting more outbreaks that would previously have been missed because they are widely dispersed[2]. In the United States, approximately 1,000 investigated outbreaks are reported annually through the National Outbreak Reporting System, and public health officials investigate many additional potential clusters of illness or outbreaks [3]. Fast and effective investigations are necessary to identify and remove contaminated food from the market to prevent additional illnesses, as well as to identify gaps in the food safety system to prevent similar outbreaks in the future[4,5].

State and local public health agencies are the frontline for disease surveillance and response activities[6,7]. A 2010 survey of state foodborne disease capacity identified the need for additional staff to reach full capacity; all respondents reported barriers to investigating foodborne disease outbreaks[8]. Structural capacity of public health encompasses the entire system of resources (human and non-human) and the relationships necessary to carry out the functions of public health in order to protect the health of the public[9]. Insufficient structural capacity can directly affect the completeness and timeliness of outbreak response activities and ability to participate in multi-jurisdictional activities. This decreases the effectiveness of detecting, responding to, and controlling multi-jurisdictional outbreaks[10,11].

Capacity in three domains is critical to effective public health detection and response: laboratory, epidemiology and environmental health. One key program for the laboratory domain is PulseNet, the national molecular subtyping network for foodborne disease surveillance[12]. PulseNet has demonstrated how standardized laboratory subtyping can improve outbreak detection[12,13]. It was recognized that similar standardization and coordination was needed for outbreak response activities beyond laboratory surveillance, including epidemiologic and environmental health activities, and to integrate cross-cutting activities to have a comprehensive FBD outbreak response program[13].

To help address these challenges, the Centers for Disease Control and Prevention (CDC) launched a program to build structural capacity in state and local health departments to conduct faster, more complete and standardized foodborne disease surveillance and outbreak response. The FoodCORE (Foodborne Diseases Centers for Outbreak Response Enhancement) program supports enhanced outbreak response capacity via targeted resources for staff support, supplies, equipment, and training in seven centers. The central objectives of the FoodCORE program are the collaborative development and implementation of new

and improved methods to detect, investigate, respond to, and control multistate outbreaks of foodborne diseases. FoodCORE aims to improve state and local foodborne disease outbreak response and investigations by building capacity; developing collaborative surveillance and response programs; conducting rapid, coordinated, standardized investigations; developing and implementing measurable performance indicators, and identifying and documenting replicable model practices[14].

This paper describes key results and accomplishments of the FoodCORE program after the first two years of implementation following the one year pilot. This paper also provides an overview of the FoodCORE model practices developed to date. These model practices are based on quantitative measures and capture the lessons learned and processes that the FoodCORE centers have used to successfully improve their outbreak response programs.

Methods

FoodCORE centers were selected through competitive award via CDC's Epidemiology and Laboratory Capacity (ELC) cooperative agreement. During October 1, 2011 to December 31, 2012 (Year Two, Y2), seven centers participated in FoodCORE: Connecticut, New York City, Ohio, South Carolina, Tennessee, Utah, and Wisconsin, covering about 14% of the U.S. population, or about 43 million individuals[15]. The average annual award under this agreement was $360,000 (range approximately $190,000 to $510,000). The centers designed individual work plans to address the core programmatic activity areas in their jurisdiction. The centers implemented their work plans, developed and operationalized FoodCORE performance metrics, collaborated with other food safety programs, conducted trainings, and contributed to the development and testing of new tools and technologies.

Improved laboratory capacity addressed surveillance activities to speed up submitting specimens to the public health laboratories (PHL) in each FoodCORE center, conduct more serotyping and molecular subtyping, and improving communication of laboratory findings to investigative partners. Improved epidemiology capacity addressed conducting rapid, coordinated, standardized investigations so interviews are conducted faster and clusters and outbreaks are detected earlier. Improved environmental health capacity addressed conducting assessments that incorporate laboratory and epidemiologic data to help identify factors most likely related to an outbreak, collecting data for and participating in traceback efforts to help identify food vehicles and sources of contaminations, and providing training for local specialists to standardize environmental health activities.

Laboratory surveillance was improved by hiring additional staff to complete testing and contribute to the timely communication of results to other health department staff as well as to national surveillance systems. Resources were also used to purchase and maintain equipment and reagents necessary to allow faster, more complete laboratory testing. This added capacity allowed the public health laboratories in each center to conduct molecular subtyping for all serotypes. Epidemiologic interviewing and investigation were similarly improved by augmenting the number of staff and supporting the improvement of technology-based solutions for data sharing, outbreak and cluster surveillance, and activity tracking. Six centers used student-based teams to add capacity for interviewing, data entry,

conducting analytic epidemiologic studies, and to assist with other activities as needed at state and local health departments. The seventh center used regional staff to conduct these activities. This additional capacity allowed public health officials to conduct thorough epidemiologic surveillance and investigation activities. Environmental health capacity was improved with support for staff and resources for trainings and cross-cutting activities that enhance collaboration and communication between laboratory, epidemiology, and environmental health staff. See Table 1.

FoodCORE centers capitalized on the completeness and timeliness of specimen subtyping to quickly identify clusters of illness. Results were routinely analyzed and compared to centralized databases (e.g., PulseNet) so clusters of isolates with indistinguishable subtypes can be detected. Laboratory surveillance data were rapidly and routinely exchanged between the core areas. The FoodCORE centers had standing meetings and routine reports for cluster detection and laboratory results as well as protocols to exchange data in real-time during an outbreak so findings from all areas inform ongoing activities.

The FoodCORE metrics were used to evaluate progress towards goals, identify gaps, and document successes. These metrics, available at http://www.cdc.gov/foodcore/metrics.html, were based on chapter 8 of the CIFOR Guidelines and are reported separately by pathogen[16,17]. Metrics data were reported for the burden, completeness, and timeliness of foodborne disease activities from surveillance and outbreak detection through investigation, response, control, and implementation of prevention measures. Over time, metrics data quantitatively demonstrate changes in completeness and timeliness[18].

Metrics data for *Salmonella*, Shiga toxin-producing *E. coli*, and *Listeria* (SSL) were reported for the first half of Year One, Y1, (10/1/2010 – 3/31/2011), all of Y1 (10/1/2010 – 9/30/11) and all of Y2. A full description of the performance metrics data for Y1, including within-year comparisons, is available on the FoodCORE website[18]. Metrics for investigations for norovirus, other etiologies (i.e., not norovirus or SSL), and unknown etiologies, collectively referred to as NOU, were operationalized during Y2. Representative pre-funding data are generally not available for the FoodCORE centers as collection and reporting of performance metrics did not begin until additional resources were available. Therefore, data from the first half of Y1 were used as a comparative baseline. While using this as comparative baseline under-represents the full scale of improvements achieved under FoodCORE, it was the most complete representation of performance during program initiation. Analyses were conducted using SAS 9.3.

Results

Improving Laboratory Surveillance Activities

The FoodCORE laboratories, the PHL in each FoodCORE center, received an average, or mean, of nearly 9,000 isolates and isolate-yielding specimens of SSL from clinical laboratories, foods, and environmental sampling each year during Y1 and Y2. The first or representative SSL isolate or sample from each person or non-human testing unit is called a primary isolate. During Y1, the laboratories received 8,547 primary SSL isolates; 7,677 (90%) *Salmonella*, 787 (9%) STEC, and 83 (1%) *Listeria* isolates. During Y2, the

FoodCORE laboratories received 8,161 primary isolates; 6,786 (83%) *Salmonella*, 1,190 (15%) STEC, and 185 (2%) *Listeria* isolates.

During Y2, the average time from isolation or specimen collection to receipt at the PHL decreased from a median of 8 days (9, 5, and 10 days for *Salmonella*, STEC, and *Listeria*, respectively) at baseline, to a median of 6 days (7, 5, and 7 days for *Salmonella*, STEC, and *Listeria*, respectively) in Y1, and further reduced to a median of 5 days (6 days for both *Salmonella* and *Listeria* and 5 days for STEC) in Y2. The average proportion of *Salmonella* isolates that were serotyped was maintained at 99% during Y2. The average proportion of STEC isolates serotyped increased from 86% at baseline, to 88% in Y1, and to 95% in Y2 (supplemental digital content). For *Salmonella*, the turnaround time (TAT) to complete serotyping, the number of days from receipt of an isolate until serotyping is completed, decreased from an average 8-day median during baseline to 6 days in Y1 and further to 4 days (2 – 6 days) during Y2. The average TAT for STEC serotyping was maintained at the same levels as baseline (5 day median) and the longest TAT decreased from a high of 42 days during Y1 to 7 days in Y2 (Table 2).

Similar improvements for the completeness and timeliness of PFGE subtyping were documented in Y2. The average proportion of isolates with PFGE data increased as follows: for *Salmonella* from 82% (range 28 – 100%) during baseline to 98% (range 94 – 100%) in Y2; for STEC from 93% (range 67 – 100%) during baseline to 97% (range 89 – 100%) in Y2; and for *Listeria* from 82% (range 26 – 100%) during baseline to 99% (91 – 100%) in Y2 (Figure 1). The average TAT for SSL PFGE, the number of days from receipt of an isolate until PFGE results are uploaded to PulseNet, was reduced from a median of 13 days during baseline to 5 days in Y2 for *Salmonella* (range 4 – 40 days and 2 – 13 days, respectively); from 5 days during baseline to 4 days in Y2 for STEC (range 3 – 8 days and 2 – 7 days, respectively); and from 6 days during baseline to 4 days in Y2 for *Listeria* (range 2 – 16 days and 2 – 7 days, respectively), (Table 2).

Improving Epidemiologic Interviews and Investigations

During Y2, epidemiology programs were notified of 8,001 SSL case-patients including 6,800 (85%) *Salmonella*, 1,061 (13%) STEC, and 140 (2%) *Listeria* case-patients. On average, an interview was attempted for nearly every SSL case-patient during Y2 (average 99%, range 98 – 100%), this is an increase from the baseline period when the average was 93% (range 88 – 100%). Pathogen-specific proportions of case-patients with an attempted interview improved as follows: for *Salmonella*, from 88% (range 53 – 100%) during baseline to 98% (range 94 – 100%) in Y2; for STEC from 90% (range 60 – 100%) during baseline to 98% (90 – 100%); on average all (100%) of *Listeria* case-patients had an attempted interview during both time periods (Figure 2). Centers also attempted interviews more quickly, reducing the average TAT for attempting SSL interviews, the number of days from notification to interview attempt, from nearly 4 days to 2 days.

Interview data collected from ill persons by FoodCORE Centers align with the *Listeria* Initiative Case-patient Report Form[20], the Shiga toxin-producing *Escherichia coli* Standardized Case-patient Report Form[21], and the Core Elements defined within the Standardized National Hypothesis Generating Questionnaire[22]. The centers increased the

proportion of case-patients with an exposure history, with a baseline average of 69% versus Y2 average of 86%.

Improving Cross-Cutting Outbreak Response Activities

During Y2, the FoodCORE centers identified a total of 594 SSL clusters of illness and conducted 442 NOU illness investigations. The centers usually identified clusters early when the number of case-patients was small; on average, the SSL clusters of illness had a median of only two associated illnesses. As part of these investigations, 178 environmental health assessments were conducted and 92 food, environmental, or other non-human samples were collected for testing (supplemental digital content). A total of 122 analytic studies were conducted (30 *Salmonella*, 20 STEC, 2 *Listeria*, 44 norovirus, 14 other etiology, and 12 unknown etiology). On average, 17% of SSL illness clusters and 33% of NOU illness investigations identified a suspect vehicle or source; a confirmed vehicle or source was identified in 13% of SSL illness clusters and 21% of NOU illness investigations. A total of 118 public health actions were taken in response to SSL and NOU investigations with an identified vehicle or source, including exclusion of ill person(s), remediation or closure of an establishment, educational campaigns, media or public messaging, and food product recalls and holds (supplemental digital content).

Success Stories

These investigations and public health actions helped stop or control outbreaks and kept additional people from becoming ill. There are numerous examples of the successful investigations and intervention activities in the FoodCORE centers. A catalog of success stories is maintained on the FoodCORE website with details about investigations and the center's outbreak response activities: http://www.cdc.gov/foodcore/successes.html. The success stories are short, easy-to-read, one to two page documents that describe a specific event or outbreak. From outbreaks of *Salmonella* infections associated with raw scraped ground tuna, queso fresco, and chicken livers, to norovirus outbreaks related to infected animals or contaminated recreational water, the centers used targeted resources to detect more outbreaks, conduct thorough investigations, control outbreaks faster, and help stop the spread of foodborne disease.

For example, FoodCORE played a key role in solving a 2012 multistate outbreak of *Salmonella* infections linked to imported frozen raw scraped ground tuna, a substitute for minced tuna in sushi. FoodCORE laboratories in five of the seven centers identified people infected with the same rare serotypes, Bareilly and Nchanga. These centers contributed critical evidence that accelerated the investigation. Public health officials in the centers rapidly interviewed case-patients to determine which foods and where the sick people ate. Many reported eating sushi the week before they became sick. This information was crucial to focus the investigation and identify a suspect food vehicle. Ultimately 425 cases from 28 states and the District of Columbia were identified in the outbreak[23]. The FoodCORE centers efficiently worked together with other involved health departments and regulatory partners to pinpoint the ground tuna product as the likely source of illness and were among the first to find the *Salmonella* PFGE strains in the contaminated tuna. The product was recalled, which likely prevented many more illnesses, since the frozen product would have

been available for consumption for many more months if it had not been removed from the market.

Model Practices for Improving Outbreak Response

Through the application of performance metrics, FoodCORE centers complete ongoing process evaluation to identify practices that effectively improve completeness and timeliness for outbreak response activities that are consistently successful across the various public health infrastructures represented within the program. During Y2, the centers began documenting these model practices to make them available for other public health jurisdictions to use as a resource to inform evaluation and improvement efforts. The FoodCORE model practices are drafted by program staff and reviewed by all the centers and are publically available on the FoodCORE website[24].

The first model practice for initial case-patient interviewing describes successful triage and routing of case-patient reporting and the process of attempting interviews with case-patients, recommends categories and elements identified as essential to ascertain during an initial enteric disease interview, and provides a checklist to determine alignment of initial interview practices with the FoodCORE model practice. The second model practice for laboratory completeness and timeliness describes the successful laboratory practices used by FoodCORE PHLs for isolate and specimen submissions, subtyping of enteric pathogens, communication of laboratory results, and cluster detection reports. Additional model practice documents are forthcoming, including practices for integration across activities and successfully using student interview teams.

Discussion

FoodCORE centers have demonstrated that relatively modest targeted investments can improve the completeness and timeliness of outbreak response activities. The centers have leveraged FoodCORE resources to coordinate with local jurisdictions, other states and federal partners, and other food safety programs. Overall, they have built-up outbreak response programs for routine and surge capacity needs to conduct faster, better, more complete investigations, to ultimately help stop the spread of foodborne disease.

FoodCORE PHLs report that they are PFGE subtyping nearly all received isolates (average of 98% for SSL). By completing PFGE subtyping for a high proportion of isolates FoodCORE laboratories have identified clusters of illness earlier than they would have previously, including clusters that would likely have been missed entirely before implementing complete PFGE subtyping.

FoodCORE centers have the capacity to attempt interviews with nearly every reported case-patient (average of 99% for SSL). The centers capitalize on having additional staff so they can conduct interviews as soon as case-patients are identified. Prompt interviewing improves the chances of a case-patient remembering what they ate before becoming ill and decreases recall bias because interviewers are asking about recent exposures instead of about a month or more in the past.

Faster and more complete interviewing in centers with a decentralized infrastructure was the result of close collaboration with local public health jurisdictions. In a decentralized infrastructure local health departments, including county, city, rural, or regional departments, independently provide public health services. Therefore, FoodCORE staff in decentralized states built on partnerships with local officials to determine how they could implement centralized interviewing together to complement local efforts and provide much needed relief or surge capacity for interviewing.

Quickly identifying and investigating clusters helps develop hypotheses about the vehicle causing illness. The earlier a suspect vehicle is identified, the more quickly public health officials can focus on collecting information about suspect items, such as how they were prepared, when and where they were purchased, and their source. They can also try to collect products or non-human samples to test for the causative agent.

Some average measures did not show improvement, but were maintained at the same level overtime. Pathogens with fewer cases and that may cause more severe infection (e.g. STEC or *Listeria*) may not be as subject to triage if there is limited capacity.

Collaborations between laboratory, epidemiology, and environment health partners ensure that pertinent information is shared throughout a cluster investigation. When multidisciplinary teams coordinate to conduct fast, thorough investigations it increases the likelihood of identifying the food vehicle or other source of an outbreak, controlling the outbreak by removing that source to keep additional people from getting sick, and pinpointing how and why contamination occurred so that similar outbreaks can be prevented in the future.

Strengths

The FoodCORE performance metrics allow for a quantitative approach to process evaluation. The metrics are used to identify when a strategy has successfully improved completeness and timeliness, help set and gauge the success of meeting realistic program goals related to outbreak response activities, and quantify the workload required to support the ultimate goal of controlling outbreaks. In addition to applying performance metrics, FoodCORE documents the strategies used to successfully improve completeness and timeliness of outbreak response activities. By documenting these model practices, the lessons learned by the FoodCORE centers are available to other jurisdictions wishing to improve their foodborne outbreak response activities. The FoodCORE model practices, coupled with resources like the CIFOR Guidelines, can help other jurisdictions make process and system changes that have been shown to improve completeness and timeliness.

Limitations

This report is subject to at least two main limitations. Only two years of metrics data were available and data were not reported separately for all four quarters of Y1 and Y2. These factors limited analyses of trends, but additional analyses will become feasible in the future with continued reporting.

The remarkable achievements documented during Y1 and Y2 only represent a fraction of the improvements that have been realized in the FoodCORE centers. Because representative data available are not generally available from before the program began, the successes of the FoodCORE centers are all framed as increases over a baseline period that occurred after initial funding. Limited data available in a few sites indicate that the true, pre-funding status from which the centers have progressed was likely much lower, so these results underestimate what was accomplished. For example, the average proportion of *Salmonella* cases with an interview attempt was 88% during the baseline period; this increased to 98% in Y2. However, in New York City, available pre-funding data show a much larger increase. Before funding, interviews were only attempted for 7% of *Salmonella* case-patients compared to nearly 90% currently. Similarly, in Connecticut, pre-funding data show that before FoodCORE, only about half of *Salmonella* case-patients were interviewed; since joining FoodCORE, this proportion has increased to over 80%. Despite the serious limitation of not having representative pre-funding data, the results presented and discussed here indicate that with modest, targeted resources great gains for faster, more complete outbreak response are achievable and similar investments in other public health jurisdictions or programs could yield similar results.

Conclusion

FoodCORE demonstrates that the application of targeted resources coupled with process evaluation is an effective means to identify, implement, and document model practices that successfully improve the completeness and timeliness of foodborne disease outbreak response activities. Through the second year of enhanced outbreak response activity implementation, the FoodCORE centers documented improvements and maintenance of complete and timely laboratory and epidemiologic activities related to foodborne disease outbreak investigation and response. By conducting fast, thorough investigations, FoodCORE centers contribute critical information to help solve outbreaks quickly, remove contaminated foods from commerce, and protect additional people from getting sick.

Sustained support of this program is needed to maintain improved outbreak response activities in FoodCORE centers so that they can continue to fully contribute to the identification and control of multistate foodborne disease outbreaks. FoodCORE centers will continue to identify and document more model practices that can be applied in various public health settings. These model practices can inform efforts to improve outbreak response in other state and local health departments or international public health settings with similar infrastructures for foodborne disease surveillance and response. Cost effectiveness analyses are needed to quantitatively determine short and long-term utilities for targeted application of funds for initial program start-up and maintenance of the gains achieved with enhanced structural capacity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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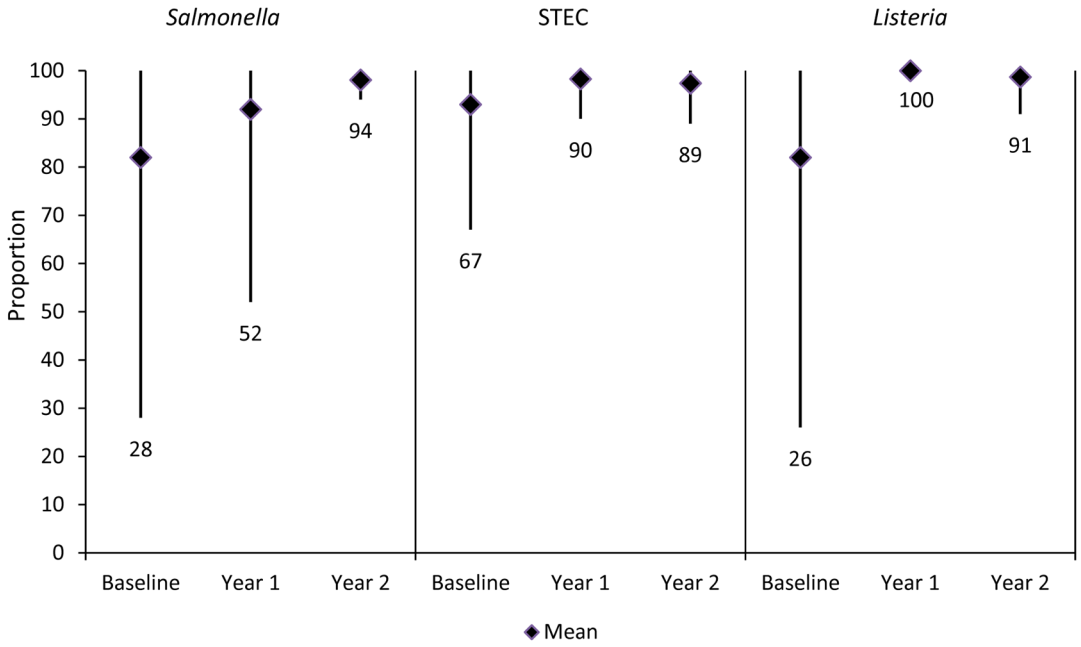

Figure 1. Mean and range of the proportion of *Salmonella*, Shiga toxin-producing *Escherichia coli* (STEC), and *Listeria* isolates with PFGE subtyping data available for the baseline period of Year 1, all of Year 1, and Year 2*

*For *Salmonella*, n(baseline)=1618, n(Y1)=7677, n(Y2)=6786; For STEC, n(baseline)=216, n(Y1)=787, n(Y2)=1190; For *Listeria*, n(baseline)=53, n(Y1)=83, n(Y2)=185.

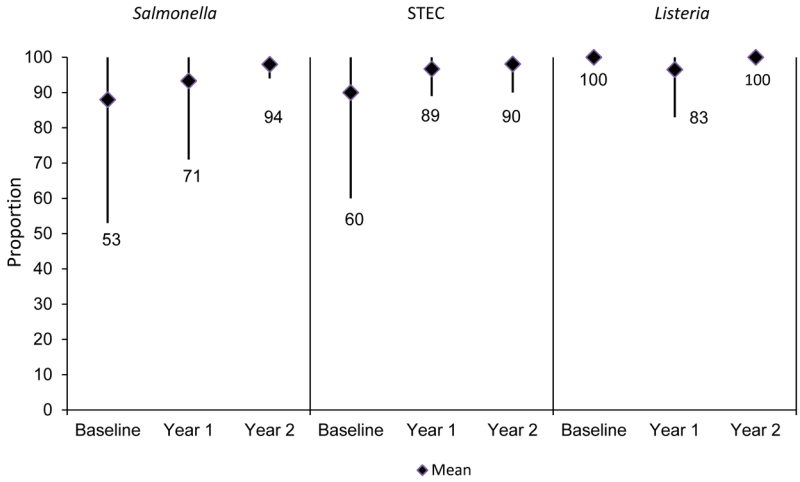

Figure 2. Average and range of the proportion of *Salmonella*, Shiga toxin-producing *Escherichia coli* (STEC), and *Listeria* case-patients with an attempted interview for the baseline period of Year 1, all of Year 1, and Year 2*

*For *Salmonella*, n(baseline)=1626, n(Y1)=7039, n(Y2)=6800; For STEC, n(baseline)=194, n(Y1)=820, n(Y2)=1061; For *Listeria*, n(baseline)=31, n(Y1)=92, n(Y2)=140.

Table 1

FoodCORE Center organizational structure, disease burden, and center-specific work plan details.

Center	Structure	Year joined FoodCORE	LAB		EPI		Environmental Health (EH)
			Molecular serotyping	Courier Service	Centralized Interviewing for SSL cases	Initial Interview Responsibility	
New York City	Centralized	2009	Yes	Yes	Student Team	Centralized interviewing for SSL	Collaborations with EHS-Net[2] and NYC Office of Environmental Investigations
Connecticut	Decentralized	2012	Yes	No	Student Team	Centralized interviews for STEC and Listeria; LHD[1] s interview Salmonella cases with centralized assistance	Collaborations with CT Food Protection Program
Ohio	Decentralized	2010	Yes	Yes	Student Team	LHDs interview for SSL; Some LHDs participate in routine centralized interviewing for their SSL cases	Collaborations with Department of Agriculture and LHD Sanitarians and EH Specialists
South Carolina	Centralized	2010	No	Yes	Regional Staff	Regional interviewers (state staff) interview SSL in 4 regions, coverage of all state regions as seasonal burden allows	Foodborne epidemiologists in Division of Acute Disease Epi and EH; Work closely together; EH staff directly supported
Tennessee	Decentralized	2010	Yes	Yes	Student Team	LHDs interview SSL cases with centralized assistance; Some LHDs participate in routine centralized interviewing for their SSL cases	Collaborations with EHS-Net and General and EH Section
Utah	Decentralized	2009	Yes	Yes	Student Team	LHDs interview SSL cases with centralized assistance	Collaborations with Department of Agriculture and Food, Environmental Epidemiology, and LHD Sanitarians
Wisconsin	Decentralized	2009	Yes	Yes	Student Team	LHDs interview SSL cases with centralized assistance	EH staff directly supported

[1] LHD = Local health department

[2] EHS-Net = Environmental Health Specialists Network

Table 2

Mean and range for median turn-around times[1], from receipt of isolate to completion of serotyping and PFGE subtyping, and from notification to attempting an interview with a case-patient for the baseline period of Year 1[2], all of Year 1[3], and Year 2[4].

	Salmonella			**STEC**			***Listeria***		
	Baseline	**Year One**	**Year Two**	**Baseline**	**Year One**	**Year Two**	**Baseline**	**Year One**	**Year Two**
Serotype	8 (4–14)	6 (3–8)	4 (2–6)	5 (4–8)	11 (1–42)	5 (3–7)	--	--	--
PFGE	13 (4–40)	7 (2–20)	5 (2–13)	5 (3–8)	5 (2–9)	4 (2–7)	6 (2–16)	4 (2–10)	4 (2–7)
Interview	1 (0–3)	0.6 (0–2)	2 (0–4)	3 (1–5)	1 (0–2)	2 (0–5)	7 (3–11)	1 (0–2)	2 (0–8)

[1] Turn-around time; mean (range) in days

[2] Baseline period: 10/1/2010 – 3/31/2011

[3] Year 1: 10/1/2012 – 9/30/2011

[4] Year 2: 10/1/2011 – 12/31/2012.