Surveillance for Foodborne Disease Outbreaks —
United States, 2009–2015
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Surveillance for Foodborne Disease Outbreaks — United States, 2009–2015

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Abstract

Problem/Condition: Known foodborne disease agents are estimated to cause approximately 9.4 million illnesses each year in the United States. Although only a small subset of illnesses are associated with recognized outbreaks, data from outbreak investigations provide insight into the foods and pathogens that cause illnesses and the settings and conditions in which they occur.

Reporting Period: 2009–2015

Description of System: The Foodborne Disease Outbreak Surveillance System (FDOSS) collects data on foodborne disease outbreaks, which are defined as the occurrence of two or more cases of a similar illness resulting from the ingestion of a common food. Since the early 1960s, foodborne outbreaks have been reported voluntarily to CDC by state, local, and territorial health departments using a standard form. Beginning in 2009, FDOSS reporting was made through the National Outbreak Reporting System, a web-based platform launched that year.

Results: During 2009–2015, FDOSS received reports of 5,760 outbreaks that resulted in 100,939 illnesses, 5,699 hospitalizations, and 145 deaths. All 50 states, the District of Columbia, Puerto Rico, and CDC reported outbreaks. Among 2,953 outbreaks with a single confirmed etiology, norovirus was the most common cause of outbreaks (1,130 outbreaks [38%]) and outbreak-associated illnesses (27,623 illnesses [41%]), followed by Salmonella with 896 outbreaks (30%) and 23,662 illnesses (35%). Outbreaks caused by Listeria, Salmonella, and Shiga toxin-producing Escherichia coli (STEC) were responsible for 82% of all hospitalizations and 82% of deaths reported. Among 1,281 outbreaks in which the food reported could be classified into a single food category, fish were the most commonly implicated category (222 outbreaks [17%]), followed by dairy (136 [11%]) and chicken (123 [10%]). The food categories responsible for the most outbreak-associated illnesses were chicken (3,114 illnesses [12%]), pork (2,670 [10%]), and seeded vegetables (2,572 [10%]). Multistate outbreaks comprised only 3% of all outbreaks reported but accounted for 11% of illnesses, 34% of hospitalizations, and 54% of deaths.

Interpretation: Foodborne disease outbreaks provide information about the pathogens and foods responsible for illness. Norovirus remains the leading cause of foodborne disease outbreaks, highlighting the continued need for food safety improvements targeting worker health and hygiene in food service settings. Outbreaks caused by Listeria, Salmonella, and STEC are important targets for public health intervention efforts, and improving the safety of chicken, pork, and seeded vegetables should be a priority.

Public Health Action: The causes of foodborne illness should continue to be tracked and analyzed to inform disease prevention policies and initiatives. Strengthening the capacity of state and local health departments to investigate and report outbreaks will assist with these efforts through identification of the foods, etiologies, and settings linked to these outbreaks.

Introduction

Approximately 800 foodborne disease outbreaks are reported in the United States each year, accounting for approximately 15,000 illnesses, 800 hospitalizations, and 20 deaths (1). Outbreak-associated foodborne illnesses are only a small subset of the estimated 9.4 million foodborne illnesses from known pathogens that occur annually in the United States (2). However, the food sources and exposure settings for illnesses that are not part of outbreaks can be determined only rarely. Outbreak investigations, on the other hand, often link etiologies with specific foods, allowing public health officials, regulatory agencies, and the food industry to investigate how foods become contaminated. Foodborne outbreak data also can be used to identify emerging food
safety issues and to assess whether programs to prevent illnesses from particular foods are effective.

This report summarizes foodborne disease outbreaks reported in the United States in which the first illness occurred between January 1, 2009, and December 31, 2015. The report highlights a few large outbreaks as well as novel foods and food-pathogen pairs responsible for outbreaks during the reporting period.

Methods

A foodborne disease outbreak is defined as two or more cases of a similar illness resulting from ingestion of a common food (3). When exposure to a contaminated food occurs in a single state, the outbreak is classified as a single-state outbreak; when exposure occurs in two or more states, the outbreak is classified as a multistate outbreak. Local, state, and territorial health departments voluntarily report foodborne outbreaks to CDC through the Foodborne Disease Outbreak Surveillance System (FDOSS) (https://www.cdc.gov/fdoss/). CDC staff also report multistate foodborne disease outbreaks to FDOSS; these outbreaks are identified by PulseNet, the national molecular subtyping network (4). Initially a paper-based surveillance system, FDOSS reporting became electronic in 1998. In 2009, FDOSS was incorporated into the newly created National Outbreak Reporting System, a web-based platform that also includes reports of outbreaks attributable to waterborne, person-to-person, animal contact, environmental, and indeterminate or unknown modes of transmission.

Etiologies reported to FDOSS include bacterial, parasitic, and viral pathogens as well as chemicals and toxins. Outbreak etiologies are classified as unknown, suspected, or confirmed. Specific criteria (i.e., laboratory testing and clinical syndrome) are used to classify etiologies of outbreaks as suspected or confirmed (5). An outbreak is categorized as a multiple etiology outbreak if more than one agent is reported.

Foods and ingredients are identified as outbreak sources (i.e., implicated) using one or more of the following types of evidence: epidemiologic, laboratory, traceback, environmental assessment, or other data. Some outbreak investigations do not identify a source and in these instances the food is reported as unknown. CDC categorizes foods implicated in outbreak investigations on the basis of a hierarchical scheme (6). One of 24 food categories (e.g., mollusks) is assigned if a single contaminated ingredient (e.g., raw oysters) is reported as the source or if all implicated ingredients belong to the same category (e.g., raw oysters and raw clams). When a food or contaminated ingredient cannot be assigned to a single category, the outbreak is classified as not attributed to a single food category (7). The place where the implicated food was prepared is reported as one of 23 locations (e.g., a camp, farm, grocery store, or private home).

Population-based reporting rates were calculated for each state by use of U.S. Census Bureau estimates of the mid-year state populations for 2009–2015 (8). This report includes all foodborne outbreaks with a date of first illness onset from January 1, 2009, through December 31, 2015, but reported to FDOSS and finalized as of April 10, 2017.

Results

During 2009–2015, FDOSS received reports of 5,760 outbreaks, resulting in 100,939 illnesses, 5,699 hospitalizations, and 145 deaths (Figure 1). Outbreaks were reported by all 50 states, the District of Columbia, Puerto Rico, and CDC (Figure 2). The single-state outbreak reporting rate was 2.6 outbreaks per 1 million population. The overall national reporting rate (which includes multistate outbreaks) during 2009–2015 was also 2.6 outbreaks per 1 million population. Single-state outbreaks accounted for 5,583 (97%) of all outbreaks with 89,907 cases (median: 8 cases per outbreak; range: 2–800 cases). Four percent of these ill persons (3,733) were reported as being hospitalized. Multistate outbreaks accounted for 177 (3%) of all outbreaks with 11,032 cases (median: 20 cases per outbreak; range: 2–1,939 cases). Eighteen percent of these ill persons (1,966) were hospitalized.

Etiologic Agents

A single confirmed etiology was reported for 2,953 (51%) outbreaks, resulting in 67,130 illnesses, 5,114 hospitalizations, and 140 deaths (Table 1). Among 2,953 outbreaks with a single confirmed etiology, norovirus was the most common cause of outbreaks (1,130 outbreaks [38%]) and outbreak-associated illnesses (27,623 illnesses [41%]). Salmonella was the second most common single confirmed etiology reported, with 896 outbreaks (30%) and 23,662 illnesses (35%), followed by Shiga toxin-producing Escherichia coli (STEC) (191 outbreaks [6%]), Campylobacter (155 [5%]), Clostridium perfringens (108 [4%]), scombroid toxin (95 [3%]), ciguatoxin (80 [3%]), Staphylococcus aureus (35 [1%]), Vibrio parahaemolyticus (35 [1%]), and Listeria monocytogenes (35 [1%]). Listeria, Salmonella, and STEC were the most common causes of hospitalizations (82%) and deaths (82%) reported among persons in outbreaks with a single confirmed etiology.
Location of Food Preparation

A location of preparation was provided for 5,022 outbreak reports (87%), with 4,696 (94%) indicating a single location (Table 2). Among outbreaks reporting a single location of preparation, restaurants were the most common location (2,880 outbreaks [61%]), followed by catering or banquet facilities (636 [14%]) and private homes (561 [12%]). Sit-down dining style restaurants (2,239 [48%]) were the most commonly reported type of restaurant. The locations of food preparation with the most outbreak-associated illnesses were restaurants (33,465 illnesses [43%]), catering or banquet facilities (18,141 [24%]), and institutions, such as schools (9,806 [13%]). The preparation location with the largest average number of illnesses per outbreak was institutions (46.5), whereas restaurants had the smallest (11.6).

Foods

Outbreak investigators identified a food in 2,442 outbreaks (42%). These outbreaks resulted in 51,341 illnesses (51%) (Table 3). The food reported belonged to a single food category in 1,288 outbreaks (61%), followed by catering or banquet facilities (636 [14%]) and private homes (561 [12%]). Sit-down dining style restaurants (2,239 [48%]) were the most commonly reported type of restaurant. The locations of food preparation with the most outbreak-associated illnesses were restaurants (33,465 illnesses [43%]), catering or banquet facilities (18,141 [24%]), and institutions, such as schools (9,806 [13%]). The preparation location with the largest average number of illnesses per outbreak was institutions (46.5), whereas restaurants had the smallest (11.6).

Multistate Outbreaks

Multistate outbreaks comprised only 3% of outbreaks but were responsible for 11% of illnesses, 34% of hospitalizations, and 54% of deaths. Multistate outbreaks involved a median of seven states with a range of two to 45 states in which exposure occurred. The largest of the 177 multistate outbreaks was caused by Salmonella serotype Enteritidis and due to contaminated shell eggs. An estimated 1,939 persons were infected in 10 states beginning in 2010. An outbreak of Salmonella serotype Poona infections attributed to cucumbers in 2015 had the second highest number of illnesses (907 illnesses in 40 states). This outbreak also had the most outbreak-associated hospitalizations (204 [22% of cases]). An outbreak of Salmonella serotype Heidelberg infections attributed to chicken during 2013–2014 had the second most hospitalizations (200 [32% of cases]) and involved persons from 29 states and Puerto Rico. An outbreak of Listeria monocytogenes infections attributed to cantaloupes in 28 states in 2011 had the most deaths (33 [22% of cases]), followed in 2014 by an outbreak in 12 states of Listeria monocytogenes infections attributed to...
caramel apples, another novel food vehicle (9), in which seven persons (20% of cases) died.

Discussion

Despite considerable advances in food safety in the United States during recent decades, foodborne disease outbreaks remain a serious public health problem. The majority of the outbreaks reported had relatively small case counts, and affected persons often were exposed in a single state. However, outbreaks with the largest case counts and most severe outcomes (e.g. highest proportion of ill persons hospitalized and most deaths) typically involved exposures in multiple states, reflecting factors such as the geographical distribution of the implicated food and the characteristics of the pathogens involved. Foods produced in other countries sometimes were implicated, highlighting the interconnectedness of the U.S. food supply with that of other nations, and the continued need to ensure that all foods are safe to eat (10).

As reported in previous summaries (11), norovirus remains the leading cause of foodborne disease outbreaks and outbreak-associated illnesses in the United States. Most foodborne norovirus outbreaks are associated with ready-to-eat foods contaminated during preparation by infected food workers in restaurants and other food service settings (12).
such, continued efforts are needed to strengthen and ensure compliance with requirements in the FDA Model Food Code (13), specifically those that exclude symptomatic and post-symptomatic workers, prohibit bare-hand contact with ready-to-eat foods, and ensure appropriate hand washing. Contaminated raw food products, specifically leafy vegetables, fruits, and mollusks, also have been implicated in norovirus outbreaks (12); thus, upstream contamination during production also should be considered in foodborne norovirus outbreak investigations.

Fish was the most frequently implicated food, but the number of illnesses associated with these outbreaks tended to be small compared with other food vehicles, largely because of the pathogens involved. Differences in outbreak size are in part attributable to how pathogens contaminate foods: toxins are produced in individual fish, whereas Salmonella and other bacterial pathogens, such as STEC, can contaminate large amounts of product across vast distribution chains (14). This helps explain why bacterial pathogens are the most common causes of multistate outbreaks and why many persons can become ill during a single bacterial disease outbreak.

Identification of novel food sources provides insight into evolving food preferences in the United States and the types of foods that pathogens can contaminate. It also raises important scientific questions regarding how these pathogens remain viable in these foods long enough to cause infection. During the study period, a few novel food vehicles were identified as the sources of multistate outbreaks of Listeria, Salmonella, and STEC infections. Some of these (chia seed powder, raw wheat flour, and moringa leaf powder) are dried, shelf-stable foods not usually considered as possible sources of illness. These outbreak reports provide additional evidence that Salmonella and STEC can survive extensive processing steps as well as months in a desiccated state. This ability of pathogens to remain viable combined with the long shelf life of these products emphasizes the need for clear, well-publicized product recall notices.

Salmonella and STEC were two of the most common causes of large outbreaks. Regulatory-focused public health interventions, such as the 2009 Egg Safety Rule, the 2011 Food Safety Modernization Act, and the 2013 Salmonella Action Plan, were designed and implemented in part to help ensure the safety of foods that can be contaminated by these pathogens (15–17). Some members of the food industry also are promoting a culture of food safety by requiring growers, producers, and distributors to adhere to strict safety guidelines designed to prevent contamination. Additional efforts will likely be needed by both government and industry to help control these pathogens.

Limitations

The findings of this report are subject to at least four limitations. First, because CDC’s foodborne outbreak surveillance is dynamic and agencies can submit, update, or delete reports at any time, the results of this analysis might differ slightly from previous or future reports. Second, not all outbreaks are identified and the majority of foodborne illnesses occur outside the context of a recognized outbreak. The degree to which the food vehicles, etiologies, and locations implicated in outbreaks represent the vehicles, etiologies, and locations of sporadic foodborne illness is unknown. Third, some outbreaks have an unknown food vehicle, an unknown etiology, or both, and analyses and conclusions drawn from outbreaks with an identified food vehicle and confirmed etiology might not be representative of all outbreaks. Finally, pathogens that are not known to cause illness sometimes are reported as a confirmed or suspected etiology.

Conclusion

Foodborne disease outbreaks remain an important public health issue. Data collected during outbreak investigations provide insight into the foods and pathogens that cause illnesses and the settings and conditions in which they occur. Continued efforts must be made to track and to analyze the causes of foodborne illness to inform targeted prevention efforts. In particular, strengthening the capacity of state and local health departments to investigate and to report outbreaks will improve foodborne disease outbreak surveillance and could help decrease the burden of foodborne illness through identification of foods, etiologies, outbreak settings, and specific points of contamination, which can inform intervention efforts.

Conflict of Interest

No conflicts of interest were reported.

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### TABLE 1. Number and percentage of foodborne disease outbreaks, outbreak-associated illnesses, and hospitalizations, by etiology (confirmed or suspected) — Foodborne Disease Outbreak Surveillance System, United States and Puerto Rico, 2009–2015

| Etiology | Outbreaks | Illnesses | Hospitalizations | Deaths |
|----------|-----------|-----------|------------------|--------|
|          | CE* | SE | Total | % | CE | SE | Total | % | CE | SE | Total | % | CE | SE | Total | % |
| **Bacterial** |     |     |       |   |     |     |       |   |     |     |       |   |     |     |       |   |
| Salmonella† | 896 | 53 | 949 | 23 | 23,662 | 510 | 24,172 | 30 | 3,168 | 39 | 3,207 | 60 | 29 | 0 | 29 | 20 |
| Escherichia coli, Shiga toxin-producing (STEC)§ | 191 | 12 | 203 | 5 | 2,378 | 87 | 2,465 | 3 | 672 | 21 | 693 | 13 | 12 | 1 | 13 | 9 |
| Campylobacter§ | 155 | 46 | 201 | 5 | 2,095 | 214 | 2,309 | 3 | 134 | 17 | 151 | 3 | 1 | 0 | 1 | 1 |
| Clostridium perfringens | 108 | 90 | 198 | 5 | 5,132 | 2,702 | 7,834 | 10 | 16 | 2 | 18 | 0 | 4 | 0 | 4 | 3 |
| Staphylococcus aureus | 35 | 40 | 75 | 2 | 1,255 | 426 | 1,681 | 2 | 69 | 17 | 86 | 2 | 0 | 0 | 0 | 0 |
| Bacillus cereus | 23 | 42 | 65 | 2 | 551 | 288 | 839 | 1 | 2 | 4 | 6 | 0 | 0 | 0 | 0 | 0 |
| Vibrio parahaemolyticus | 35 | 14 | 49 | 1 | 227 | 53 | 280 | 0 | 18 | 2 | 20 | 0 | 0 | 0 | 0 | 0 |
| Shigella** | 32 | 7 | 39 | 1 | 1,193 | 33 | 1,226 | 1 | 108 | 2 | 110 | 2 | 1 | 0 | 1 | 1 |
| Listeria monocytogenes | 35 | 1 | 36 | 1 | 380 | 8 | 388 | 0 | 334 | 7 | 341 | 6 | 74 | 1 | 75 | 52 |
| Clostridium botulinum | 19 | 2 | 21 | 1 | 85 | 6 | 91 | 0 | 72 | 6 | 78 | 1 | 4 | 0 | 4 | 3 |
| Escherichia coli, Enterotoxigenic | 6 | 1 | 7 | 0 | 437 | 19 | 456 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Staphylococcus spp. | 2 | 4 | 6 | 0 | 38 | 15 | 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yersinia enterocolitica | 3 | 1 | 4 | 0 | 20 | 4 | 24 | 0 | 7 | 0 | 7 | 0 | 1 | 0 | 1 | 1 |
| Vibrio cholerae | 1 | 2 | 3 | 0 | 3 | 14 | 17 | 0 | 3 | 1 | 4 | 0 | 1 | 0 | 1 | 1 |
| Streptococcus, Group A | 2 | 1 | 3 | 0 | 72 | 40 | 112 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Escherichia coli, Enterotoaggregative | 3 | 0 | 3 | 0 | 50 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vibrio other | 2 | 0 | 2 | 0 | 7 | 0 | 7 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Vibrio vulnificus | 0 | 1 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| Aeromonas hydrophila | 0 | 1 | 1 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Caesiella burnetti | 0 | 1 | 1 | 0 | 0 | 5 | 5 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Franciscella novicida | 1 | 0 | 1 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 1 | 0 | 1 | 1 |
| Brucella spp. | 1 | 0 | 1 | 0 | 4 | 0 | 4 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Clostridium other | 1 | 0 | 1 | 0 | 12 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Escherichia coli, Enteropathogenic | 1 | 0 | 1 | 0 | 30 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Enterococcus faecalis | 1 | 0 | 1 | 0 | 13 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 34 | 34 | 1 | 0 | 469 | 469 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Subtotal** | 1,553 | 353 | 1,906 | 47 | 37,647 | 4,899 | 42,546 | 52 | 4,611 | 120 | 4,731 | 88 | 128 | 3 | 131 | 92 |
| **Chemical and toxin** |     |     |       |   |     |     |       |   |     |     |       |   |     |     |       |   |
| Scombroid toxin/histamine | 95 | 6 | 101 | 2 | 280 | 19 | 299 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 |
| Ciguatoxin | 80 | 13 | 93 | 2 | 294 | 43 | 337 | 0 | 32 | 7 | 39 | 1 | 0 | 0 | 0 | 0 |
| Myctoxins | 13 | 1 | 14 | 0 | 36 | 6 | 42 | 0 | 22 | 0 | 22 | 0 | 4 | 0 | 4 | 3 |
| Puffer fish tetrodotoxin | 3 | 0 | 3 | 0 | 9 | 0 | 9 | 0 | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| Paralytic shellfish poison | 3 | 0 | 3 | 0 | 12 | 0 | 12 | 0 | 6 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| Pesticides | 2 | 0 | 2 | 0 | 42 | 0 | 42 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Amnesic shellfish poison | 1 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Other | 20 | 20 | 40 | 1 | 106 | 175 | 281 | 0 | 20 | 6 | 26 | 0 | 1 | 0 | 1 | 1 |
| **Subtotal** | 217 | 40 | 257 | 6 | 781 | 243 | 1,024 | 1 | 89 | 14 | 103 | 2 | 5 | 0 | 5 | 3 |

See table footnotes on the next page.
### TABLE 1. (Continued) Number and percentage of foodborne disease outbreaks, outbreak-associated illnesses, and hospitalizations, by etiology (confirmed or suspected) — Foodborne Disease Outbreak Surveillance System, United States and Puerto Rico, 2009–2015

| Etiology       | Outbreaks | Illnesses | Hospitalizations | Deaths |
|----------------|-----------|-----------|------------------|--------|
|                | CE*       | SE        | Total            | %      |
|                |            |           |                  |        |
| Parasitic      | 10        | 2         | 12               | 0      |
| Cryptosporidium| 100%      | 0%        | 0%               |        |
| Trichinella    | 80%       | 20%       | 100%             |        |
| Cyclospora     | 80%       | 20%       | 100%             |        |
| Giardia        | 80%       | 20%       | 100%             |        |
| Subtotal       | 30        | 33        | 100%             |        |
| Viral          | 1,130     | 740       | 1,870            | 46     |
| Norovirus      | 1,130     | 740       | 1,870            | 46     |
| Hepatitis A    | 10        | 7         | 17               | 100%   |
| Sapovirus      | 80%       | 20%       | 100%             |        |
| Rotavirus      | 80%       | 20%       | 100%             |        |
| Astrovirus     | 80%       | 20%       | 100%             |        |
| Other          | 80%       | 20%       | 100%             |        |
| Subtotal       | 1,153     | 745       | 1,898            | 46     |
| Single etiology†† | 2,953     | 1,141     | 4,094            | 71     |
| Multiple etiologies§§ | 33     | 50        | 83               | 1      |
| Unknown etiology¶¶ | 0        | 0         | 1,583            | 27     |
| Total          | 2,986     | 1,191     | 5,760            | 100%   |

**Abbreviations:** CE = confirmed etiology; SE = suspected etiology.

* Guidelines for reporting agencies are to consider an etiology confirmed if it meets confirmation criteria (https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/confirming_diagnosis.html); otherwise, it is considered suspected. Agents that are not listed in confirmation criteria or that are not known to cause illness are sometimes reported as confirmed or suspected etiologies.

† Salmonella serotypes causing more than five outbreaks were Enteritidis (264 outbreaks), Typhimurium (102), Newport (73), Heidelberg (49), I4,[5],12:i:- (41), Javiana (37), Braenderup (29), Infantis (24), Montevideo (20), Muuenchen (18), Thompson (17), Saintpaul (16), Oranienburg (15), Paratyphi B (10), Uganda (9), Agona (8), Typhimurium var Cope (8), Hadar (7), Mbandaka (7), Miami (6), and Virchow (6).

‡ STEC serogroups O157 (156 outbreaks), O26 (14), O111 (7), O121 (6), O145 (5), multiple serogroups (4), O45 (4), O103 (3), unknown serogroup (3), and O186 (1).

§ Campylobacter jejuni (140 outbreaks), Campylobacter unknown species (49), Campylobacter multiple species (6), Campylobacter coli (5), and Campylobacter other (1).

** Shigella sonnei (33 outbreaks), Shigella flexneri (4), and Shigella unknown species (2).

†† The denominator for the etiology percentages is the single etiology total. The denominator for the single etiology, multiple etiologies, and unknown etiology is the total. Because of rounding, numbers might not add up to the single etiology total or the total.

§§ If at least two etiologies are confirmed in an outbreak, it is considered a confirmed multiple etiology outbreak; otherwise it is considered a suspected multiple etiology outbreak.

¶¶ An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.
### TABLE 2. Number and percentage of foodborne disease outbreaks and outbreak-associated illnesses, by location of food preparation — Foodborne Disease Outbreak Surveillance System, United States and Puerto Rico, 2009–2015

| Location                        | Outbreaks |   | Illnesses |   | Mean illnesses per outbreak |
|---------------------------------|-----------|---------------|-----------|---------------|-----------------------------|
|                                 | No.       | %             | No.       | %             |                             |
| Restaurant                      | 2,880     | 61            | 33,465    | 43            | 12                          |
| Sit-down dining                 | 2,239     | 48            | 25,150    | 33            | 11                          |
| Fast-food                       | 369       | 8             | 4,414     | 6             | 12                          |
| Buffet                          | 9         | 0             | 97        | 0             | 11                          |
| Other or unknown type           | 229       | 5             | 3,231     | 4             | 14                          |
| Multiple types                  | 34        | 1             | 573       | 1             | 17                          |
| Catering or banquet facility   | 636       | 14            | 18,141    | 24            | 29                          |
| Private home                    | 561       | 12            | 8,080     | 10            | 14                          |
| Institutional location          | 211       | 4             | 9,806     | 13            | 46                          |
| School                          | 69        | 1             | 2,164     | 3             | 31                          |
| Prison or jail                  | 67        | 1             | 5,077     | 7             | 76                          |
| Camp                            | 29        | 1             | 904       | 1             | 31                          |
| Day care                        | 7         | 0             | 193       | 0             | 28                          |
| Office or indoor workplace      | 26        | 1             | 937       | 1             | 36                          |
| Other                           | 13        | 0             | 531       | 1             | 41                          |
| Other location                  | 26        | 1             | 482       | 1             | 19                          |
| Other commercial location       | 258       | 5             | 4,284     | 6             | 17                          |
| Grocery store                   | 104       | 2             | 1,611     | 2             | 15                          |
| Fair, festival, or temporary mobile service | 37 | 1 | 620 | 1 | 17 | |
| Farm or dairy                   | 79        | 2             | 1,178     | 2             | 15                          |
| Other                           | 38        | 1             | 875       | 1             | 23                          |
| Hospital or nursing home        | 68        | 1             | 1,527     | 2             | 22                          |
| Nursing home                    | 55        | 1             | 1,349     | 2             | 25                          |
| Hospital                        | 13        | 0             | 178       | 0             | 14                          |
| Other private location          | 44        | 1             | 1,203     | 2             | 27                          |
| Place of worship                | 32        | 1             | 1,014     | 1             | 32                          |
| Picnic                          | 5         | 0             | 37        | 0             | 7                           |
| Other                           | 7         | 0             | 152       | 0             | 22                          |
| Hotel or motel                  | 8         | 0             | 151       | 0             | 19                          |
| Ship or boat                    | 4         | 0             | 31        | 0             | 8                           |
| Single location*                | 4,696     | 82            | 77,170    | 76            | 16                          |
| Multiple locations              | 326       | 6             | 10,920    | 11            | 33                          |
| Unknown location                | 738       | 13            | 12,849    | 13            | 17                          |
| **Total**                       | **5,760** | **100**       | **100,939** | **100**       | **18**                      |

* The denominator for the location percentages is the single location total. The denominator for the single location, multiple locations, and unknown location is the total. Numbers might not add up to the single location total or the total due to rounding.
TABLE 3. Number and percentage of foodborne disease outbreaks and outbreak-associated illnesses, by food category — Foodborne Disease Outbreak Surveillance System, United States and Puerto Rico, 2009–2015

| Food category* | Outbreaks | Illnesses |
|----------------|-----------|-----------|
|                | No. | %  | No. | %  |
| Aquatic animal |     |    |     |    |
| Crustaceans    | 12  | 1  | 74  | 0  |
| Mollusks†      | 105 | 8  | 846 | 3  |
| Fish           | 222 | 17 | 1,353| 5  |
| Other aquatic animals | 5  | 0  | 15  | 0  |
| Subtotal       | 344 | 27 | 2,288| 9  |
| Land animal    |     |    |     |    |
| Dairy§         | 136 | 11 | 1,639| 6  |
| Eggs           | 36  | 3  | 2,470| 9  |
| Beef           | 106 | 8  | 1,934| 7  |
| Pork           | 89  | 7  | 2,670| 10 |
| Other meat (e.g., sheep or goat) | 6  | 0  | 50  | 0  |
| Chicken        | 123 | 10 | 3,114| 12 |
| Turkey         | 50  | 4  | 1,675| 6  |
| Other poultry  | 6   | 0  | 71  | 0  |
| Game           | 13  | 1  | 86  | 0  |
| Subtotal       | 565 | 44 | 13,709| 52 |
| Plant          |     |    |     |    |
| Oils and sugars| 4   | 0  | 18  | 0  |
| Fungi          | 16  | 1  | 56  | 0  |
| Sprouts        | 21  | 2  | 766 | 3  |
| Root and other underground vegetables¶ | 20 | 2 | 383 | 1 |
| Seeded vegetables** | 44 | 3 | 2,572| 10 |
| Herbs          | 7   | 1  | 476 | 2  |
| Vegetable row crops†† | 81 | 6 | 1,972| 7 |
| Fruits§§       | 78  | 6  | 2,420| 9  |
| Grains and beans¶¶ | 52 | 4 | 838 | 3 |
| Nuts and seeds*** | 11 | 1 | 245 | 1 |
| Subtotal       | 334 | 26 | 9,746| 37 |
| Other          | 38  | 3  | 807 | 3  |
| Food reported, attributed to a single food category††† | 1,281 | 22 | 26,550| 26 |
| Food reported, not attributed to a single food category | 1,161 | 20 | 24,791| 25 |
| No food reported | 3,318 | 58 | 49,598| 49 |
| Total†††       | 5,760| 100| 100,939| 100|

* Source: Interagency Food Safety Analytics Collaboration (IFSAC) food categorization scheme (https://www.cdc.gov/foodsafety/ifsac/projects/food-categorization-scheme.html).
† Bivalve mollusks (102 outbreaks) and nonbivalve mollusks (3).
‡ Unpasteurized dairy products (109 outbreaks), pasteurized dairy products (20), and pasteurization unknown (7).
¶ Tuber (12 outbreaks), roots (5), and bulbs (3).
** Solanaceous seeded vegetables (23 outbreaks), vine-grown seeded vegetables (11), legumes (7), other seeded vegetables (2), and seeded vegetables not further classified (1).
†† Leafy vegetables (77 outbreaks) and stem vegetables (4).
§§ Fruits not further classified (24 outbreaks), pome fruits (15), melons (14), small fruits (11), sub-tropical fruits (7), tropical fruits (5), and stone fruits (2).
¶¶ Grains (32 outbreaks), beans (15), and grains and beans not further classified (5).
*** Nuts (8 outbreaks) and seeds (3).
††† The denominator for the food category percentages is the “food reported, attributed to a single food category” total. The total comprises “food reported attributed to a single food category,” “food reported, not attributed to a single food category,” and “no food reported.” Numbers might not add up exactly due to rounding.
### TABLE 4. Most common confirmed pathogen-food category pairs resulting in outbreaks, outbreak-associated illnesses, hospitalizations, and deaths — Foodborne Disease Outbreak Surveillance System, United States and Puerto Rico, 2009–2015

| Characteristic                                      | Food category | No. outbreaks | No. illnesses | No. hospitalizations | No. deaths |
|-----------------------------------------------------|---------------|---------------|---------------|-----------------------|------------|
| **Top 5 pathogen-food category pairs resulting in outbreaks** |               |               |               |                       |            |
| **Etiology**                                        |               |               |               |                       |            |
| Scombroid toxin/histamine                           | Fish          | 85            | 250           | 1                     | 0          |
| Ciguatoxin                                          | Fish          | 72            | 269           | 31                    | 0          |
| Campylobacter                                       | Dairy         | 60            | 917           | 31                    | 0          |
| Salmonella                                          | Chicken       | 49            | 1,941         | 372                   | 0          |
| Salmonella                                          | Pork          | 43            | 1,539         | 206                   | 3          |
| **Top 5 pathogen-food category pairs resulting in outbreak-associated illnesses** |               |               |               |                       |            |
| **Etiology**                                        |               |               |               |                       |            |
| Salmonella                                          | Eggs          | 31            | 2,422         | 41                    | 1          |
| Salmonella                                          | Seeded vegetables | 25      | 2,203         | 419                   | 7          |
| Salmonella                                          | Chicken       | 49            | 1,941         | 372                   | 0          |
| Salmonella                                          | Pork          | 43            | 1,539         | 206                   | 3          |
| Campylobacter                                       | Dairy         | 60            | 917           | 51                    | 1          |
| **Top 5 pathogen-food category pairs resulting in outbreak-associated hospitalizations** |               |               |               |                       |            |
| **Etiology**                                        |               |               |               |                       |            |
| Salmonella                                          | Seeded vegetables | 25      | 2,203         | 419                   | 7          |
| Salmonella                                          | Chicken       | 49            | 1,941         | 372                   | 0          |
| Salmonella                                          | Fruits        | 24            | 838           | 227                   | 6          |
| Salmonella                                          | Pork          | 43            | 1,539         | 206                   | 3          |
| Listeria monocytogenes                              | Fruits        | 3             | 184           | 179                   | 41         |
| **Top 5 pathogen-food category pairs resulting in outbreak-associated deaths** |               |               |               |                       |            |
| **Etiology**                                        |               |               |               |                       |            |
| Listeria monocytogenes                              | Fruits        | 3             | 184           | 179                   | 41         |
| Listeria monocytogenes                              | Dairy         | 14            | 106           | 70                    | 14         |
| Salmonella                                          | Seeded vegetables | 25      | 2,203         | 419                   | 7          |
| Salmonella                                          | Fruits        | 24            | 838           | 227                   | 6          |
| Listeria monocytogenes                              | Vegetable row crops | 2 | 29            | 29                    | 6          |

*Source: Interagency Food Safety Analytics Collaboration (IFSAC) food categorization scheme: https://www.cdc.gov/foodsafety/ifsac/projects/food-categorization-scheme.html.*
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