



Surveillance for Foodborne Disease Outbreaks
United States, 2016: Annual Report



Centers for Disease
Control and Prevention
National Center for Emerging and
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United States**

2016 Annual Report

Contents

Highlights.....	1
Background.....	1
Methods.....	1
Findings.....	2
Limitations.....	3
References.....	3
Figure: Rate of reported foodborne disease outbreaks per one million population and number of outbreaks, by state and confirmed and suspected etiology.....	4
Table 1: Foodborne disease outbreaks, outbreak-associated illnesses, and hospitalizations, by etiology.....	6
Table 2a: Foodborne disease outbreaks and outbreak-associated illnesses, by food category.....	7
Table 2b: Most common pathogen-food category pairs resulting in outbreaks, outbreak-associated illnesses, hospitalizations, and deaths.....	8
Table 3a: Foodborne disease outbreaks and outbreak-associated illnesses, by location of food preparation.....	9
Table 3b: Foodborne disease outbreaks and outbreak-associated illnesses, by confirmed etiology and location of food preparation.....	10
Table 3c: Foodborne disease outbreaks and outbreak-associated illnesses, by suspected etiology and location of food preparation.....	11
Table 4: Multistate foodborne disease outbreaks.....	12
Appendix: Foodborne disease outbreaks by etiology and contributing factors.....	13

Highlights

- In 2016, 839 foodborne disease outbreaks were reported, resulting in 14,259 illnesses, 875 hospitalizations, 17 deaths, and 18 food product recalls.
- Norovirus was the most common cause of confirmed, single-etiology outbreaks, accounting for 145 (36%) outbreaks and 3,794 (42%) illnesses. *Salmonella* was the next most common cause, accounting for 132 (33%) outbreaks and 3,047 (33%) illnesses, followed by Shiga toxin-producing *Escherichia coli*, which caused 25 (6%) confirmed, single-etiology outbreaks and 366 (4%) illnesses.
- Fish (26 outbreaks), mollusks (21), and dairy (19) were the most common single food categories implicated. The most outbreak-associated illnesses were from mollusks (529 illnesses), pork (438), and grains and beans (383).
- As reported in previous years, restaurants (459 outbreaks, 61% of outbreaks reporting a single location of preparation), specifically restaurants with sit-down dining (363, 48%), were the most commonly reported locations of food preparation associated with outbreaks.

Background

Foodborne diseases due to known pathogens are estimated to cause 9.4 million illnesses each year in the United States.¹ Although relatively few of these illnesses occur in the setting of a recognized outbreak, data collected during outbreak investigations provide insight into the pathogens and foods that cause illness. Public health officials, regulatory agencies, and the food industry can use these data to inform efforts to prevent foodborne disease.

Methods

An outbreak of foodborne disease is defined as the occurrence of two or more cases of a similar illness resulting from ingestion of a common food. CDC conducts surveillance for foodborne disease outbreaks in the United States through the Foodborne Disease Outbreak Surveillance System. Public health agencies in all 50 states, Washington, D.C., and U.S. territories

submit reports of outbreaks investigated by their agencies using a web-based reporting platform, the National Outbreak Reporting System (NORS) (<http://www.cdc.gov/nors/>). This annual summary includes foodborne disease outbreaks reported by February 7, 2018, in which the first illness onset occurred in 2016. Agencies use a standard form (<https://www.cdc.gov/nors/downloads/form-52-13.pdf>) to report foodborne disease outbreaks. Data requested for each outbreak include the reporting state; date of first illness onset; number of illnesses, hospitalizations, and deaths; etiology; implicated food(s) and ingredient(s); locations of food preparation; and factors contributing to food contamination (see appendix). The form also allows for reporting the reason(s) a particular food is suspected as the source; five choices are provided (<http://www.cdc.gov/nors/downloads/guidance.pdf>). All foods implicated were included in analyses, regardless of the reasons suspected. Implicated foods were classified into 1 of 24 single-food categories if a single contaminated ingredient was identified or if all ingredients belonged to that category.^{2,3} Outbreaks attributed to foods that could not be assigned to one of these categories, or for which the report contained insufficient information for category assignment, were not attributed to a category. Reported etiologies were grouped as bacterial, chemical or toxin, parasitic, or viral. Etiologic agents were classified as confirmed if predefined criteria were met;⁴ otherwise, they were labeled suspected. In some outbreaks, the etiologic agent was not identified. If more than one agent was reported in an outbreak, it was categorized as a confirmed or suspected multiple etiology outbreak. Multistate outbreaks are defined as outbreaks in which exposure to the implicated food occurred in more than one state or territory. Implicated foods in multistate outbreaks were classified as confirmed or suspected based on epidemiologic, traceback, and laboratory evidence. A food was considered the confirmed source of a multistate outbreak if two types of evidence were obtained, while a food was considered suspected if only one type of evidence was available.

Population-based outbreak reporting rates were calculated for each state using U.S. Census Bureau estimates of the 2016 state populations (<http://www.census.gov/popest>). Multistate outbreaks were included in state population-based outbreak reporting rates by assigning one outbreak to each state that reported a case in the outbreak.

Findings

During 2016, 839 foodborne disease outbreaks were reported (Table 1), resulting in 14,259 illnesses, 875 hospitalizations, and 17 deaths. Outbreaks were reported by public health officials from 50 states, Puerto Rico, and Washington, D.C., (Figure). The median reporting rate per million population was 3.6 outbreaks; rates ranged from 0.8 in Texas to 11.2 in Hawaii.

Etiologic Agents

A single etiologic agent was confirmed in 399 (48%) outbreaks (Table 1), which resulted in 9,123 (64%) illnesses. Bacteria caused the most outbreaks (219 outbreaks, 55%), followed by viruses (149, 37%), chemicals (26, 7%), and parasites (5, 1%). Norovirus was the most common cause of confirmed, single-etiology outbreaks, accounting for 145 (36%) outbreaks and 3,794 (42%) illnesses. *Salmonella* was the next most common cause, accounting for 132 (33%) outbreaks and 3,047 (33%) illnesses. Among the 125 confirmed *Salmonella* outbreaks with a serotype reported, Enteritidis was the most common (21 outbreaks, 17%), followed by I 4,[5],12:i:- (13, 10%), Newport (13, 10%), and Typhimurium (13, 10%). Shiga toxin-producing *Escherichia coli* (STEC) caused 25 confirmed, single-etiology outbreaks, of which 19 (76%) were caused by serogroup O157. Of the 9,123 outbreak-associated illnesses caused by a single confirmed etiologic agent, 812 (9%) resulted in hospitalization (Table 1). Among confirmed, single-etiology outbreaks, *Salmonella* caused the most outbreak-associated hospitalizations (456 hospitalizations, 56%), followed by hepatitis A virus (HAV) (141, 17%) and STEC (98, 12%). Outbreaks caused by *Clostridium botulinum* resulted in the highest proportion of ill persons hospitalized (100%), followed by *Listeria monocytogenes* (93%) and HAV (31%). Among the 17 deaths reported, 14 (82%) were

attributed to bacterial etiologies (*Listeria monocytogenes* [3], *Salmonella* [3], STEC [3], *Clostridium botulinum* [2], *Clostridium perfringens* [1], *Staphylococcus aureus* [1], and *Vibrio cholera* [1]). Two deaths were attributed to HAV and one death had an unknown etiology.

Food Categories Implicated

A food source was reported for 323 (38%) outbreaks. In 180 (56%) of these outbreaks, the food could be classified into a single category (Table 2a). The categories most commonly implicated were fish (26 outbreaks, 14%), mollusks (21, 12%), dairy (19, 11%), and pork (18, 10%). All dairy outbreaks were due to unpasteurized products. The most outbreak-associated illnesses were from mollusks (529 illnesses), pork (438), grains and beans (383), and chicken (356).

Etiologic Agents and Food Category Pairs

The pathogen-food category pairs responsible for most outbreaks were scombroid toxin (histamine) in fish (12 outbreaks), ciguatoxin in fish (11), and *Salmonella* in chicken (8) (Table 2b). The pathogen-food category pairs responsible for the most illnesses in outbreaks were *Bacillus cereus* in grains and beans (348 illnesses), *Salmonella* in chicken (307), and HAV in mollusks (281). The pathogen-food category pairs responsible for the most hospitalizations in outbreaks were HAV in mollusks (71 hospitalizations), HAV in fruits (57), and *Salmonella* in beef (44). Deaths were reported for the following pathogen-food category pairs: HAV in mollusks (2 deaths), *Listeria monocytogenes* in dairy (2), *Salmonella* in chicken (1), *Vibrio cholerae* in mollusks (1), and *Salmonella* in beef (1).

Location of Food Preparation

Among the 751 outbreaks and 12,622 illnesses with a reported single location where food was prepared, 459 outbreaks (61%) and 5,353 associated illnesses (42%) were attributed to foods prepared in a restaurant (Table 3a, Table 3b, and Table 3c). Among these outbreaks, sit-down dining restaurants were the type of facility most commonly reported (363 outbreaks, 48%).

Recalls

Eighteen outbreaks resulted in product recalls. The foods recalled following a single state outbreak were oysters (3 outbreaks), cheese, cilantro, frozen scallops, masa dough, raw milk, and seaweed and sea asparagus (1 each). Beef (2 outbreaks), alfalfa sprouts, cucumbers, frozen strawberries, hazelnuts, pistachios, raw milk, and shell eggs (1 each) were recalled in multistate outbreaks.

Multistate Outbreaks with First Identified Illness Onset during 2016

Thirty-nine multistate outbreaks (5% of all outbreaks) were reported (Table 4), resulting in 1,055 illnesses (7% of illnesses), 283 hospitalizations (32% of hospitalizations), and eight deaths (47% of deaths). These outbreaks involved a median of six states (range: 2–22). Twenty-eight outbreaks were caused by *Salmonella*; the most frequent serotypes were Enteritidis (4 outbreaks), Newport (4), and Javiana (3). Seven multistate outbreaks were caused by STEC, six of which were due to serogroup O157. Two outbreaks were caused by *Listeria*, one was caused by HAV, and one was caused by norovirus. The food sources for multistate *Salmonella* outbreaks were cucumber (2 outbreaks), cantaloupe, chicken, eggs, ground beef, hazelnuts, nuts, peppers, pistachios, prepackaged leafy greens, and salad mix. In addition, alfalfa sprouts, avocado, bean sprouts, chicken, mung bean sprouts, onion, and pork were suspected sources. A food was not identified for nine outbreaks caused by *Salmonella*. The food sources for STEC outbreaks were beef (two outbreaks) and alfalfa sprouts; iceberg lettuce was suspected in one STEC outbreak, and three did not have a food identified. One of the *Listeria* outbreak investigations implicated unpasteurized soft cheese and the other did not identify a food. The food implicated in the HAV outbreak was strawberries and the norovirus outbreak had an unidentified food.

Multistate Outbreaks Spanning Multiple Years

Nine multistate outbreaks investigated in 2016 were not included in the 2016 tally because the first outbreak-associated illness occurred before 2016. Four were caused by *Salmonella*; the implicated foods

were chia seed powder (first illness in 2014), alfalfa seeds and sprouts (first illness in 2015), cucumber (first illness in 2015), and moringa leaf powder (first illness in 2015). Three outbreaks were caused by *Listeria*. The implicated food in one outbreak was prepackaged lettuce. In addition, hummus (first illness in 2013) and smoked fish (first illness in 2014) were suspected sources in two *Listeria* outbreaks. STEC caused the remaining two outbreaks; the implicated food was flour (first illness in 2015) in one outbreak and pizza dough mix (first illness in 2015) was the suspected source in the other outbreak.

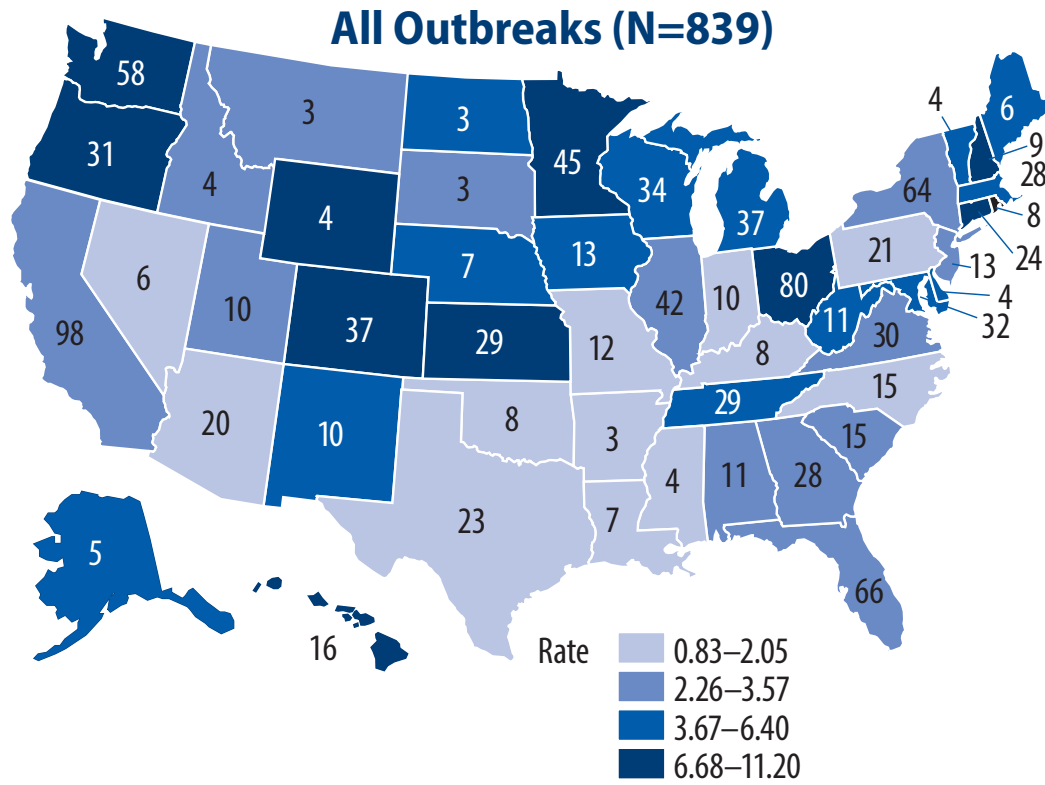
Limitations

The findings in this report have at least three limitations. First, only a small proportion of foodborne illnesses that occur each year are identified as being associated with outbreaks. The extent to which the distribution of food vehicles and locations of preparation implicated in outbreaks reflect the same vehicles and locations as sporadic foodborne illnesses is unknown. Second, many outbreaks had an unknown etiology, an unknown food vehicle, or both, and conclusions drawn from outbreaks with a confirmed etiology or food vehicle might not apply to other outbreaks. Finally, CDC's outbreak surveillance system is dynamic. Agencies can submit new reports and change or delete reports as information becomes available. Therefore, the results of this analysis might differ from those in other reports.

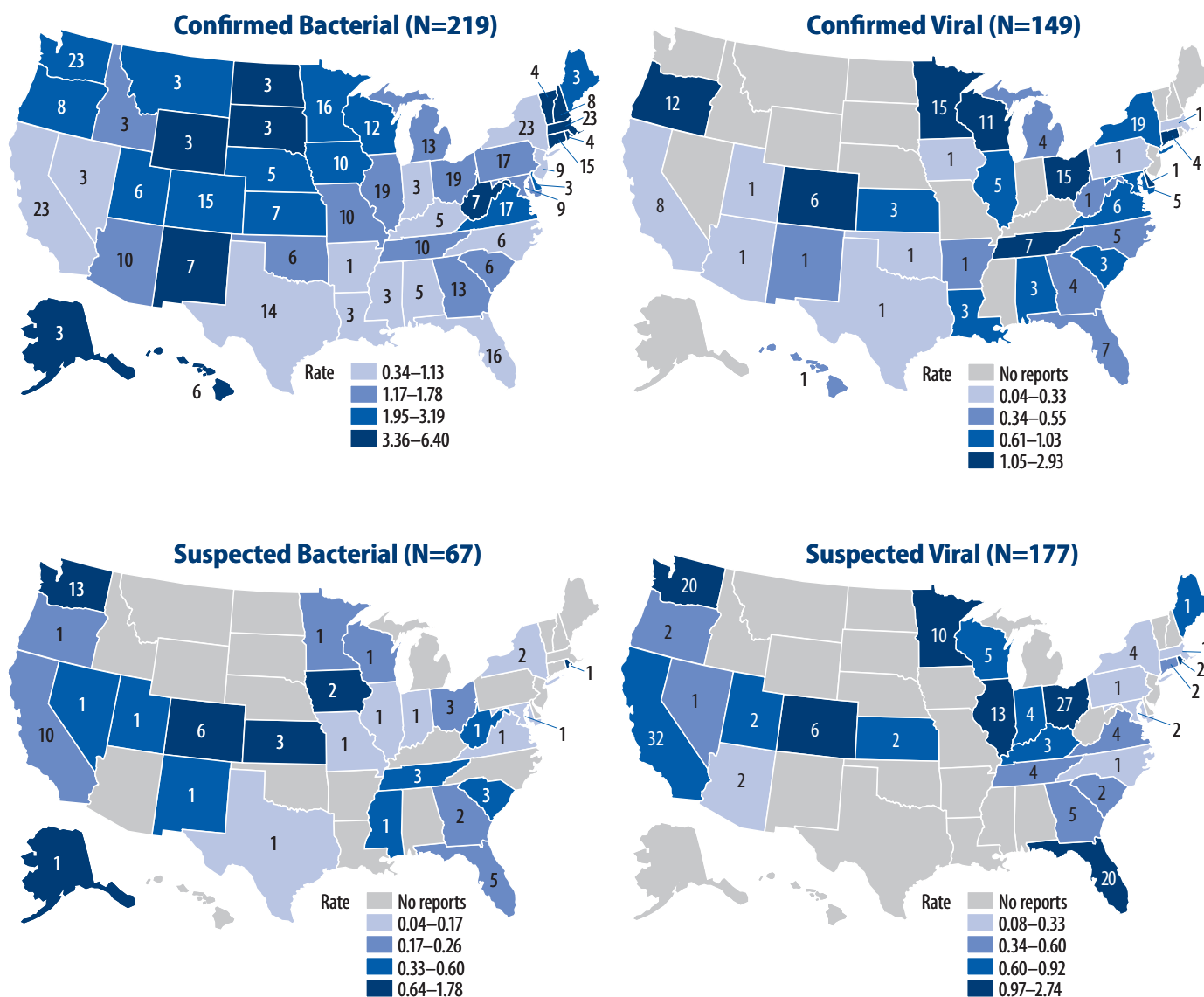
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Figure: Rate of reported foodborne disease outbreaks per one million population* and number of outbreaks,† by state‡ and confirmed and suspected etiology§ — Foodborne Disease Outbreak Surveillance System, United States, 2016.



Note: Full data table for map at <https://www.cdc.gov/fdoss/files/All-Outbreaks-2016.csv>



Note: Data table for confirmed bacterial map at <https://www.cdc.gov/fdoss/files/Confirmed-Bacterial-2016.csv>

Data table for confirmed viral map at <https://www.cdc.gov/fdoss/files/Confirmed-Viral-2016.csv>

Data table for suspected bacterial map at <https://www.cdc.gov/fdoss/files/Suspected-Bacterial-2016.csv>

Data table for suspected viral map at <https://www.cdc.gov/fdoss/files/Suspected-Viral-2016.csv>

*Cut points for outbreak rate categories determined using quartiles. Legend differs for each map. Overlap in quartile ranges are due to rounding.

[†]Reported outbreaks in each state. Puerto Rico reported seven outbreaks and Washington, D.C., reported one outbreak (not shown).

[‡]Includes 39 multistate outbreaks (i.e., outbreaks in which exposure occurred in more than one state) assigned as an outbreak to each state involved. Multistate outbreaks involved a median of six states (range: 2–22).

[§]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.

Table 1: Foodborne disease outbreaks, outbreak-associated illnesses, and hospitalizations, by etiology (confirmed or suspected)*—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	No. Outbreaks				No. Illnesses				No. Hospitalizations			
	CE	SE	Total	%	CE	SE	Total	%	CE	SE	Total	%
Bacterial												
<i>Salmonella</i> [†]	132	3	135	21	3047	34	3081	25	456	0	456	54
<i>Clostridium perfringens</i>	18	12	30	5	512	244	756	6	3	5	8	1
<i>Escherichia coli</i> , Shiga toxin-producing (STEC) [‡]	25	2	27	4	370	16	386	3	98	5	103	12
<i>Campylobacter</i> [§]	18	7	25	4	152	35	187	2	17	1	18	2
<i>Bacillus cereus</i>	6	13	19	3	340	301	641	5	0	0	0	0
<i>Staphylococcus aureus</i> enterotoxin	4	10	14	2	173	64	237	2	17	4	21	2
<i>Vibrio parahaemolyticus</i>	3	3	6	1	13	6	19	0	2	0	2	0
<i>Vibrio cholerae</i>	4	1	5	1	8	6	14	0	4	0	4	0
<i>Shigella</i> [¶]	2	1	3	0	21	3	24	0	2	0	2	0
<i>Clostridium botulinum</i>	1	1	2	0	2	3	5	0	2	2	4	0
<i>Listeria monocytogenes</i>	2	0	2	0	15	0	15	0	14	0	14	2
<i>Escherichia coli</i> , Enteroinvasive	0	1	1	0	0	23	23	0	0	1	1	0
<i>Staphylococcus</i> spp	1	0	1	0	16	0	16	0	5	0	5	1
<i>Escherichia coli</i> , Enteroaggregative	1	0	1	0	10	0	10	0	0	0	0	0
<i>Brucella</i> spp	1	0	1	0	3	0	3	0	3	0	3	0
<i>Vibrio</i> other	1	0	1	0	2	0	2	0	0	0	0	0
Other	0	13	13	2	0	62	62	1	0	0	0	0
Subtotal	219	67	286	44	4684	797	5481	45	623	18	641	76
Chemical and toxin												
Scombroid toxin/Histamine	12	0	12	2	35	0	35	0	0	0	0	0
Ciguatoxin	11	0	11	2	33	0	33	0	3	0	3	0
Mycotoxins	1	0	1	0	7	0	7	0	0	0	0	0
Other	2	1	3	0	66	9	75	1	0	0	0	0
Subtotal	26	1	27	4	141	9	150	1	3	0	3	0
Parasitic												
<i>Cryptosporidium</i>	2	0	2	0	9	0	9	0	0	0	0	0
<i>Trichinella</i>	2	0	2	0	8	0	8	0	1	0	1	0
<i>Giardia</i>	0	1	1	0	0	25	25	0	0	0	0	0
<i>Cyclospora</i>	1	0	1	0	15	0	15	0	0	0	0	0
Subtotal	5	1	6	1	32	25	57	0	1	0	1	0
Viral												
Norovirus	145	177	322	50	3794	2140	5934	49	44	17	61	7
Hepatitis A virus	3	0	3	0	457	0	457	4	141	0	141	17
Sapovirus	1	0	1	0	15	0	15	0	0	0	0	0
Subtotal	149	177	326	51	4266	2140	6406	53	185	17	202	24
Single etiology**	399	246	645	77	9123	2971	12094	85	812	35	847	97
Multiple etiologies confirmed or suspected††	4	13	17	2	87	377	464	3	2	2	4	0
Unknown etiology†††	0	177	177	21	0	1701	1701	12	0	24	24	3
Total	403	436	839	100	9210	5049	14259	100	814	61	875	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 (21 outbreaks), I 4,[5],12:- (14), Typhimurium (13), Newport (13), Saintpaul (8), and Javiana (7).

[‡] STEC serogroups O157 (20 outbreaks), multiple serogroups (2), O5 (1), O121 (1), O111 (1), O26 (1), and unknown serogroup (1).

[§] *Campylobacter jejuni* (14 outbreaks), *Campylobacter* unknown species (9), *Campylobacter coli* (1), and *Campylobacter* multiple species (1).

[¶] *Shigella sonnei* (3 outbreaks).

** 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 2a: Foodborne disease outbreaks and outbreak-associated illnesses, by food category*—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Food Category*	No. Outbreaks		No. Illnesses	
	Total	%	Total	%
Aquatic animals				
Crustaceans	6	3	118	3
Mollusks†	21	12	529	14
Fish	26	14	82	2
Other aquatic animals	2	1	8	0
Subtotal	55	31	737	20
Land animals				
Dairy‡	19	11	252	7
Eggs	6	3	161	4
Beef	11	6	340	9
Pork	18	10	438	12
Other meat (sheep, goat, etc.)	1	1	50	1
Chicken	17	9	356	9
Turkey	3	2	62	2
Game	1	1	3	0
Subtotal	76	42	1662	44
Plants				
Oils and sugars	1	1	12	0
Fungi	1	1	7	0
Sprouts	5	3	104	3
Root and other underground vegetables§	3	2	118	3
Seeded vegetables¶	6	3	106	3
Herbs	1	1	96	3
Vegetable row crops**	7	4	144	4
Fruits††	10	6	347	9
Grains and beans‡‡	8	4	383	10
Nuts and seeds§§	3	2	22	1
Subtotal	45	25	1339	35
Other	11	6	247	6
Food reported, attributed to a single food category¶¶	180	21	3776	26
Food reported, not attributed to a single food category	143	17	2939	21
No food reported	516	62	7544	53
Total¶¶	839	100	14259	100

* Interagency Food Safety Analytics Collaboration (IFSAC) food categorization scheme: <http://www.cdc.gov/foodsafety/ifsac/projects/completed.html>.

† Bivalve mollusks (20 outbreaks) and non-bivalve mollusks (1).

‡ Unpasteurized dairy products (19 outbreaks).

§ Bulbs (1 outbreak), roots (1), and tubers (1).

¶ Vine-grown seeded vegetables (4 outbreaks), other seeded vegetables (1), and solanaceous seeded vegetables (1).

** Leafy vegetables (6 outbreaks) and vegetable row crops not further classified (1).

†† Sub-tropical fruits (3 outbreaks), fruits not further classified (2), melons (2), small fruits (2), and pome fruits (1).

‡‡ Grains (5 outbreaks) and beans (3).

§§ Nuts (3 outbreaks).

¶¶ The denominator for the food category percentages is the “food reported, attributed to a single food category” total. The denominator for the “food reported attributed to a single food category,” “food reported, not attributed to a single food category,” and “no food reported” is the total. Because of rounding, numbers might not add up to the “food reported, attributed to a single food category” total or the total.

Table 2b: Most common pathogen-food category pairs resulting in outbreaks, outbreak-associated illnesses, hospitalizations, and deaths—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Top 5 pathogen-food category pairs resulting in outbreaks

Etiology	Food Category*	No. Outbreaks	No. Illnesses	No. Hospitalizations	No. Deaths
<i>Scambroid toxin/histamine</i>	Fish	12	35	0	0
<i>Ciguatoxin</i>	Fish	11	33	3	0
<i>Salmonella</i>	Chicken	8	307	42	1
<i>Campylobacter</i>	Dairy	7	57	5	0
<i>Norovirus</i>	Mollusks	6	209	3	0
<i>Salmonella</i>	Pork	6	96	12	0
<i>Vibrio parahaemolyticus</i>	Mollusks	6	19	2	0

Top 5 pathogen-food category pairs resulting in outbreak-associated illnesses

Etiology	Food Category*	No. Outbreaks	No. Illnesses	No. Hospitalizations	No. Deaths
<i>Bacillus cereus</i>	Grains and beans	5	348	0	0
<i>Salmonella</i>	Chicken	8	307	42	1
<i>Hepatitis A virus</i>	Mollusks	1	281	71	2
<i>Norovirus</i>	Mollusks	6	209	3	0
<i>Staphylococcus aureus enterotoxin</i>	Pork	4	170	18	0

Top 5 pathogen-food category pairs resulting in outbreak-associated hospitalizations

Etiology	Food Category*	No. Outbreaks	No. Illnesses	No. Hospitalizations	No. Deaths
<i>Hepatitis A virus</i>	Mollusks	1	281	71	2
<i>Hepatitis A virus</i>	Fruits	1	137	57	0
<i>Salmonella</i>	Beef	2	110	44	1
<i>Salmonella</i>	Chicken	8	307	42	1
<i>Salmonella</i>	Dairy	4	138	23	0

Pathogen-food category pairs resulting in outbreak-associated deaths

Etiology	Food Category*	No. Outbreaks	No. Illnesses	No. Hospitalizations	No. Deaths
<i>Hepatitis A virus</i>	Mollusks	1	281	71	2
<i>Listeria monocytogenes</i>	Dairy	1	10	9	2
<i>Salmonella</i>	Chicken	8	307	42	1
<i>Vibrio cholerae</i>	Mollusks	3	6	3	1
<i>Salmonella</i>	Beef	2	110	44	1

Interagency Food Safety Analytics Collaboration (IFSAC) food categorization scheme: <http://www.cdc.gov/foodsafety/ifsac/projects/completed.html>.

Table 3a: Foodborne disease outbreaks and outbreak-associated illnesses, by location of food preparation—
Foodborne Disease Outbreak Surveillance System, United States, 2016.

Location	No. Outbreaks		No. Illnesses	
	Total	%	Total	%
Restaurant	459	61	5353	42
Sit-down dining	363	48	4139	33
Fast-food	62	8	768	6
Buffet	16	2	240	2
Other or unknown type	24	3	374	3
Multiple types	10	1	72	1
Catering or banquet facility	102	14	3116	25
Private home	76	10	895	7
Institutional location	21	3	1377	11
School	8	1	785	6
Prison or jail	5	1	437	3
Camp	4	1	56	0
Day Care	2	0	46	0
Office or indoor workplace	2	0	53	0
Other location	7	1	113	1
Other commercial location	40	5	723	6
Grocery store	15	2	239	2
Fair, festival, or temporary mobile service	13	2	290	2
Farm or dairy	11	1	192	2
Other	1	0	2	0
Hospital or nursing home	16	2	412	3
Nursing home	16	2	412	3
Other private location	7	1	234	2
Place of worship	6	1	224	2
Other	1	0	10	0
Hotel or motel	7	1	159	1
Single location*	751	90	12622	89
Multiple locations	40	5	830	6
Unknown location	48	6	807	6
Total	839	100	14259	100

* 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. Because of rounding, numbers might not add up to the single location total or the total.

Table 3b: Foodborne disease outbreaks and outbreak-associated illnesses, by confirmed etiology* and location of food preparation†—Foodborne Disease Outbreak Surveillance System, United State, 2016.

Etiology	Catering or banquet facility		Restaurant		Other commercial location		Hospital or nursing home		Institutional location		Private home		Other private location		Other location	
	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI
Bacterial																
<i>Salmonella</i>	6	255	53	794	11	363	3	11	10	507	17	310	2	51	1	2
<i>Clostridium perfringens</i>	3	106	9	255	– [‡]	–	–	–	–	–	3	72	1	35	–	–
<i>Escherichia coli</i> , Shiga toxin-producing	1	10	7	46	4	60	–	–	–	–	2	14	–	–	–	–
<i>Campylobacter</i>	2	20	8	85	4	37	–	–	–	–	3	7	–	–	–	–
<i>Bacillus cereus</i>	1	39	2	187	–	–	–	–	2	110	1	4	–	–	–	–
<i>Staphylococcus aureus</i> enterotoxin	2	157	1	4	–	–	–	–	–	–	1	12	–	–	–	–
<i>Vibrio parahaemolyticus</i>	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–
<i>Vibrio cholerae</i>	–	–	2	4	1	2	–	–	–	–	–	–	–	–	–	–
<i>Shigella</i>	2	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Clostridium botulinum</i>	–	–	–	–	–	–	–	–	–	–	1	2	–	–	–	–
<i>Listeria monocytogenes</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Escherichia coli</i> , Enteroinvasive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Staphylococcus</i> spp	–	–	1	16	–	–	–	–	–	–	–	–	–	–	–	–
<i>Escherichia coli</i> , Enteroaggregative	–	–	–	–	1	10	–	–	–	–	–	–	–	–	–	–
<i>Brucella</i> spp	–	–	–	–	–	–	–	–	–	–	1	3	–	–	–	–
<i>Vibrio</i> other	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–
Other	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	17	608	84	1393	22	474	3	11	12	617	29	424	3	86	1	2
Chemical and toxin																
Scombroid toxin/histamine	–	–	9	29	–	–	–	–	–	–	3	6	–	–	–	–
Ciguatoxin	–	–	–	–	1	2	–	–	–	–	9	25	–	–	–	–
Mycotoxins	–	–	–	–	–	–	–	–	–	–	1	7	–	–	–	–
Other	1	64	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Subtotal	1	64	9	29	1	2	–	–	–	–	13	38	–	–	1	2
Parasitic																
<i>Cryptosporidium</i>	–	–	–	–	2	9	–	–	–	–	–	–	–	–	–	–
<i>Trichinella</i>	–	–	–	–	–	–	–	–	–	–	2	8	–	–	–	–
<i>Giardia</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cyclospora</i>	–	–	1	15	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	–	–	1	15	2	9	–	–	–	–	2	8	–	–	–	–
Viral																
Norovirus	28	1051	85	1426	2	93	5	187	2	529	5	60	2	100	3	112
Hepatitis A virus	–	–	2	418	–	–	–	–	–	–	1	39	–	–	–	–
Sapovirus	–	–	1	15	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	28	1051	88	1859	2	93	5	187	2	529	6	99	2	100	3	112
Single etiology	46	1723	182	3296	27	578	8	198	14	1146	51	581	5	186	6	128
Multiple etiologies confirmed[§]	–	–	2	22	–	–	–	–	–	–	2	65	–	–	–	–
Total	46	1723	184	3318	27	578	8	198	14	1146	53	646	5	186	6	128

Abbreviations: NO = number of outbreaks; NI = number of illnesses; 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.

† Reported locations were grouped as follows: catering or banquet facility, restaurant, other commercial location, hospital or nursing home, other institutional location, private home, other private location, and other location (see Table 3a).

‡ No outbreaks in the data reported fall into this category.

§ 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.

Table 3c: Foodborne disease outbreaks and outbreak-associated illnesses, by suspected etiology* and location of food preparation—Foodborne Disease Outbreak Surveillance System, United State, 2016.

Etiology	Catering or banquet facility		Restaurant		Other commercial location		Hospital or nursing home		Institutional location		Private home		Other private location		Other location	
	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI
Bacterial																
<i>Salmonella</i>	1	25	1	7	– [†]	–	–	–	–	–	–	–	–	–	–	–
<i>Clostridium perfringens</i>	7	121	2	11	1	11	–	–	–	–	1	17	–	–	–	–
<i>Escherichia coli</i> , Shiga toxin-producing	–	–	–	–	–	–	–	–	–	–	2	16	–	–	–	–
<i>Campylobacter</i>	–	–	2	6	1	6	–	–	–	–	1	15	–	–	–	–
<i>Bacillus cereus</i>	3	260	9	38	–	–	–	–	–	–	–	–	–	–	–	–
<i>Staphylococcus aureus</i> enterotoxin	–	–	7	23	–	–	–	–	–	–	2	29	–	–	1	12
<i>Vibrio parahaemolyticus</i>	–	–	2	4	–	–	–	–	–	–	1	2	–	–	–	–
<i>Vibrio cholerae</i>	–	–	1	6	–	–	–	–	–	–	–	–	–	–	–	–
<i>Shigella</i>	–	–	–	–	–	–	–	–	1	3	–	–	–	–	–	–
<i>Clostridium botulinum</i>	–	–	–	–	–	–	–	–	–	–	1	3	–	–	–	–
<i>Listeria monocytogenes</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Escherichia coli</i> , Enteroinvasive	1	23	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Staphylococcus</i> spp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Escherichia coli</i> , Enteroaggregative	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Brucella</i> spp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Vibrio</i> other	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Other	1	26	11	34	1	2	–	–	–	–	–	–	–	–	–	–
Subtotal	13	455	35	129	3	19	–	–	1	3	8	82	–	–	1	12
Chemical and toxin																
Scombroid toxin/histamine	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ciguatoxin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mycotoxins	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Other	1	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	1	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Parasitic																
<i>Cryptosporidium</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Trichinella</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Giardia</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cyclospora</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Viral																
Norovirus	14	459	127	1058	6	86	3	121	3	94	5	51	1	8	6	121
Hepatitis A virus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sapovirus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	14	459	127	1058	6	86	3	121	3	94	5	51	1	8	6	121
Single etiology	28	923	163	1392	9	105	3	121	4	97	13	133	1	8	7	133
Multiple etiologies suspected[‡]	2	17	5	32	–	–	–	–	1	68	2	28	–	–	–	–
Unknown etiology[§]	26	453	107	611	4	40	5	93	2	66	8	88	1	40	1	11
Total	56	1393	275	2035	13	145	8	214	7	231	23	249	2	48	8	144

Abbreviations: NO = number of outbreaks; NI = number of illnesses; 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.

† Reported locations were grouped as follows: catering or banquet facility, restaurant, other commercial location, hospital or nursing home, other institutional location, private home, other private location, and other location (see Table 3a).

‡ No outbreaks in the data reported fall into this category.

§ 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 4: Multistate foodborne disease outbreaks—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Month of first illness onset	Etiology	No. illnesses	No. hospitalizations	No. deaths	No. states involved	Implicated food*		
						Name	Confirmed	Recall
January	<i>Salmonella</i> Montevideo; Senftenberg	11	2	0	9	Pistachios	Yes	Yes
January	Shiga toxin-producing <i>E. coli</i> O157:NM (H-)	11	2	0	2	Alfalfa sprouts	Yes	Yes
March	<i>Salmonella</i> Sundsvall	6	1	0	2	No food reported	–	No
March	<i>Salmonella</i> Oslo	14	3	0	8	Cucumbers	Yes	No
April	<i>Salmonella</i> Goldcoast	12	1	0	5	Pork	No	No
April	Shiga toxin-producing <i>E. coli</i> O5	4	0	0	4	No food reported	–	No
April	<i>Salmonella</i> Bareilly	21	3	0	7	No food reported	–	No
April	<i>Salmonella</i> Braenderup	32	6	0	14	Mung bean sprouts	No	No
April	<i>Salmonella</i> Enteritidis	7	0	0	2	Prepackaged leafy greens	Yes	No
April	<i>Salmonella</i> Oranienburg	8	2	0	3	Shell Eggs	Yes	Yes
May	Hepatitis A virus	137	57	0	9	Strawberries	Yes	Yes
May	<i>Salmonella</i> Reading; Abony	36	7	0	9	Alfalfa sprouts	Yes	No
May	<i>Salmonella</i> Enteritidis	59	7	0	19	Avocado	No	No
May	<i>Salmonella</i> Anatum	32	8	0	9	Peppers	Yes	No
May	<i>Salmonella</i> Javiana	29	6	0	8	Onion	No	No
June	<i>Salmonella</i> Enteritidis	28	7	0	6	Salad mix	Yes	No
June	<i>Salmonella</i> Minnesota	10	3	0	8	Cantaloupe	Yes	No
June	<i>Salmonella</i> Javiana	17	3	0	6	No food reported	–	No
June	Shiga toxin-producing <i>E. coli</i> O157:H7	14	5	0	3	Beef	Yes	Yes
June	<i>Salmonella</i> Saintpaul	10	3	0	3	Cucumber	Yes	Yes
June	Shiga toxin-producing <i>E. coli</i> O157:H7	11	4	0	3	Iceberg lettuce	No	No
June	<i>Salmonella</i> I 4,[5],12:i-	5	2	0	2	Nuts	No	No
June	Shiga toxin-producing <i>E. coli</i> O157	11	7	0	5	Ground beef	Yes	Yes
July	<i>Salmonella</i> I 4,[5],12:i-	64	16	0	13	Chicken	Yes	No
July	<i>Salmonella</i> Javiana	45	9	0	19	No food reported	–	No
July	<i>Salmonella</i> Saintpaul	70	12	0	11	Chicken	No	No
August	<i>Salmonella</i> Newport	12	4	0	5	No food reported	–	No
August	<i>Salmonella</i> Newport	53	9	1	17	No food reported	–	No
September	<i>Listeria monocytogenes</i>	5	5	1	3	No food reported	–	No
September	<i>Listeria monocytogenes</i>	10	9	2	5	Unpasteurized soft cheese	Yes	Yes
September	Shiga toxin-producing <i>E. coli</i> O157:H7	20	7	2	6	No food reported	–	No
October	<i>Salmonella</i> Enteritidis	20	3	0	7	Bean sprouts	No	No
October	<i>Salmonella</i> Newport	107	43	1	22	Ground beef	Yes	No
October	<i>Salmonella</i> Typhimurium	6	1	0	2	Hazelnuts	Yes	Yes
October	Shiga toxin-producing <i>E. coli</i> O157	13	10	1	5	No food reported	–	No
November	<i>Salmonella</i> Montevideo	19	2	0	6	No food reported	–	No
November	<i>Salmonella</i> Newport	25	9	0	8	No food reported	–	No
December	<i>Salmonella</i> Goldcoast	16	5	0	14	No food reported	–	No
December	Norovirus GII.4 untypeable	45	0	0	2	No food reported	–	No

* Implicated foods in multistate outbreaks are further classified as confirmed or suspected based on epidemiologic, traceback, and laboratory evidence. A food is considered the confirmed source if two types of evidence are obtained, while a food is considered suspected if only one type of evidence is available.

Appendix Table 1: Foodborne disease outbreaks by confirmed etiology* and contributing factors†—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	Contamination Factors															Outbreaks with reported contributing factors	Total outbreaks	
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15			≥1 factor reported
Bacterial																		
<i>Salmonella</i>	1	– [§]	–	–	–	12	11	3	21	3	3	2	3	4	4	41	48	132
<i>Clostridium perfringens</i>	1	–	–	–	–	2	–	–	1	–	–	–	–	3	2	9	15	18
<i>Escherichia coli</i> , Shiga toxin-producing	1	–	–	–	–	1	5	–	5	1	–	1	–	4	2	11	12	25
<i>Campylobacter</i>	–	–	–	–	–	2	7	1	2	1	1	1	–	–	1	10	10	18
<i>Bacillus cereus</i>	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	5	6
<i>Staphylococcus aureus</i> enterotoxin	–	–	–	–	–	1	–	–	2	–	–	–	–	–	1	3	4	4
<i>Vibrio parahaemolyticus</i>	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	1	2	3
<i>Vibrio cholerae</i>	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	3	3	4
<i>Shigella</i>	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	1	1	2
<i>Clostridium botulinum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
<i>Listeria monocytogenes</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
<i>Escherichia coli</i> , Enteroinvasive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Staphylococcus</i> spp	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	1	1
<i>Escherichia coli</i> , Enteroaggregative	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
<i>Brucella</i> spp	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1
<i>Vibrio</i> other	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	1	1	1
Other	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	4	–	–	–	–	19	28	5	33	6	4	4	3	12	11	83	104	219
Chemical and toxin																		
Scombroid toxin/histamine	9	–	–	–	–	–	2	–	1	–	–	–	–	–	–	10	10	12
Ciguatoxin	11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	11	11
Mycotoxins	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1
Other	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1	1	2
Subtotal	20	–	1	1	–	–	2	–	1	–	–	–	–	–	1	23	23	26
Parasitic																		
<i>Cryptosporidium</i>	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	2	2	2
<i>Trichinella</i>	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2	2	2
<i>Giardia</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cyclospora</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Subtotal	1	–	–	–	–	1	2	–	–	–	–	–	–	–	–	4	4	5
Viral																		
Norovirus	1	–	–	–	–	1	6	2	2	32	24	38	10	1	3	83	84	145
Hepatitis A virus	–	–	–	–	–	–	2	–	1	–	–	–	1	–	–	3	3	3
Sapovirus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Subtotal	1	–	–	–	–	1	8	2	3	32	24	38	11	1	3	86	87	149
Single etiology	26	–	1	1	–	21	40	7	37	38	28	42	14	13	15	196	218	399
Multiple etiologies confirmed	–	–	–	–	–	1	–	–	–	1	–	1	–	–	–	2	2	4
Total	26	–	1	1	–	22	40	7	37	39	28	43	14	13	15	198	220	403

Footnotes are on page 19.

Appendix Table 2: Foodborne disease outbreaks by confirmed etiology* and contributing factors†—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	Proliferation/Amplification Factors													Outbreaks with reported contributing factors	Total outbreaks
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	≥1 factor reported		
Bacterial															
<i>Salmonella</i>	21	10	3	5	6	– [§]	7	6	–	1	1	2	35	48	132
<i>Clostridium perfringens</i>	7	5	–	2	6	–	10	7	–	–	–	1	14	15	18
<i>Escherichia coli</i> , Shiga toxin-producing	4	1	1	1	3	1	1	2	–	–	–	–	5	12	25
<i>Campylobacter</i>	1	–	–	1	–	–	–	1	–	–	–	1	2	10	18
<i>Bacillus cereus</i>	2	–	–	–	1	–	–	–	–	–	–	–	2	5	6
<i>Staphylococcus aureus</i> enterotoxin	2	2	1	–	–	–	–	–	–	–	–	–	4	4	4
<i>Vibrio parahaemolyticus</i>	–	–	–	–	–	–	–	–	–	–	–	1	1	2	3
<i>Vibrio cholerae</i>	–	1	–	–	–	–	1	–	–	–	–	–	2	3	4
<i>Shigella</i>	–	1	–	–	–	–	–	–	–	–	–	–	1	1	2
<i>Clostridium botulinum</i>	–	–	–	–	–	–	–	–	–	1	1	–	1	1	1
<i>Listeria monocytogenes</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
<i>Escherichia coli</i> , Enteroinvasive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Staphylococcus</i> spp	–	–	–	–	–	1	–	1	–	–	–	–	1	1	1
<i>Escherichia coli</i> , Enteroaggregative	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
<i>Brucella</i> spp	1	–	–	–	–	–	–	–	–	–	–	–	1	1	1
<i>Vibrio</i> other	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Other	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	38	20	5	9	16	2	19	17	–	2	2	5	69	104	219
Chemical and toxin															
Scombroid toxin/histamine	–	–	–	2	2	–	–	–	–	–	–	–	4	10	12
Ciguatoxin	–	–	–	–	–	–	–	–	–	–	–	–	–	11	11
Mycotoxins	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Other	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Subtotal	–	–	–	2	2	–	–	–	–	–	–	–	4	23	26
Parasitic															
<i>Cryptosporidium</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2
<i>Trichinella</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2
<i>Giardia</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cyclospora</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Subtotal	–	–	–	–	–	–	–	–	–	–	–	–	–	4	5
Viral															
Norovirus	–	1	–	–	–	–	–	–	–	–	–	–	1	84	145
Hepatitis A virus	–	1	–	–	–	–	–	–	–	–	–	–	1	3	3
Sapovirus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Subtotal	–	2	–	–	–	–	–	–	–	–	–	–	2	87	149
Single etiology	38	22	5	11	18	2	19	17	–	2	2	5	75	218	399
Multiple etiologies confirmed	–	–	–	–	–	–	–	–	–	–	–	–	–	2	4
Total	38	22	5	11	18	2	19	17	–	2	2	5	75	220	403

Footnotes are on page 19.

Appendix Table 3: Foodborne disease outbreaks by confirmed etiology* and contributing factors—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	Survival Factors						Outbreaks with reported contributing factors	Total outbreaks
	S1	S2	S3	S4	S5	≥1 factor reported		
Bacterial								
<i>Salmonella</i>	14	6	1	3	4	23	48	132
<i>Clostridium perfringens</i>	2	8	1	– [§]	2	10	15	18
<i>Escherichia coli</i> , Shiga toxin-producing	2	1	–	2	4	7	12	25
<i>Campylobacter</i>	4	–	–	–	–	4	10	18
<i>Bacillus cereus</i>	1	2	–	–	1	4	5	6
<i>Staphylococcus aureus</i> enterotoxin	1	–	–	–	1	2	4	4
<i>Vibrio parahaemolyticus</i>	1	–	–	–	–	1	2	3
<i>Vibrio cholerae</i>	1	–	–	–	1	2	3	4
<i>Shigella</i>	–	–	–	–	–	–	1	2
<i>Clostridium botulinum</i>	1	–	–	–	–	1	1	1
<i>Listeria monocytogenes</i>	–	–	–	–	–	–	–	2
<i>Escherichia coli</i> , Enteroinvasive	–	–	–	–	–	–	–	–
<i>Staphylococcus</i> spp	–	–	–	–	–	–	1	1
<i>Escherichia coli</i> , Enteroaggregative	–	–	–	–	–	–	–	1
<i>Brucella</i> spp	–	–	–	–	1	1	1	1
<i>Vibrio</i> other	–	–	–	–	–	–	1	1
Other	–	–	–	–	–	–	–	–
Subtotal	27	17	2	5	14	55	104	219
Chemical and toxin								
Scombroid toxin/histamine	1	–	–	–	–	1	10	12
Ciguatoxin	–	–	–	–	–	–	11	11
Mycotoxins	–	–	–	–	–	–	1	1
Other	–	–	–	–	–	–	1	2
Subtotal	1	–	–	–	–	1	23	26
Parasitic								
<i>Cryptosporidium</i>	–	–	–	–	–	–	2	2
<i>Trichinella</i>	2	–	–	–	–	2	2	2
<i>Giardia</i>	–	–	–	–	–	–	–	–
<i>Cyclospora</i>	–	–	–	–	–	–	–	1
Subtotal	2	–	–	–	–	2	4	5
Viral								
Norovirus	2	1	–	2	4	7	84	145
Hepatitis A virus	–	–	–	–	–	–	3	3
Sapovirus	–	–	–	–	–	–	–	1
Subtotal	2	1	–	2	4	7	87	149
Single etiology	32	18	2	7	18	65	218	399
Multiple etiologies confirmed	1	–	–	–	–	1	2	4
Total	33	18	2	7	18	66	220	403

Footnotes are on page 19.

Appendix Table 4: Foodborne disease outbreaks by suspected etiology* and contributing factors†—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	Contamination Factors															Outbreaks with reported contributing factors	Total outbreaks	
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15			≥1 factor reported
Bacterial																		
<i>Salmonella</i>	— [§]	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	1	3
<i>Clostridium perfringens</i>	1	—	—	—	—	1	—	—	—	—	—	1	—	1	1	3	7	12
<i>Escherichia coli</i> , Shiga toxin-producing	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	1	2
<i>Campylobacter</i>	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	3	3	7
<i>Bacillus cereus</i>	1	—	—	—	—	1	—	—	2	—	—	—	—	1	1	6	9	13
<i>Staphylococcus aureus</i> enterotoxin	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	3	6	10
<i>Vibrio parahaemolyticus</i>	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	1	3	3
<i>Vibrio cholerae</i>	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	1
<i>Shigella</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1
<i>Clostridium botulinum</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
<i>Listeria monocytogenes</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Escherichia coli</i> , Enteroinvasive	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
<i>Staphylococcus</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Escherichia coli</i> , Enteroaggregative	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Brucella</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Vibrio</i> other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	2	3	7
Subtotal	2	—	—	—	—	3	4	1	7	1	—	1	1	3	4	23	40	67
Chemical and toxin																		
Scombroid toxin/histamine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ciguatoxin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mycotoxins	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Parasitic																		
<i>Cryptosporidium</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Trichinella</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Giardia</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
<i>Cyclospora</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Viral																		
Norovirus	—	—	—	—	—	—	—	—	8	35	30	18	7	8	20	71	72	177
Hepatitis A virus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapovirus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	8	35	30	18	7	8	20	71	72	177
Single etiology	2	—	—	—	—	3	4	1	15	36	30	19	8	11	24	94	112	246
Multiple etiologies suspected	1	—	—	—	—	1	—	—	—	—	—	—	—	—	2	4	5	13
Unknown etiology [¶]	2	—	—	—	—	1	2	1	10	9	5	2	3	7	7	29	42	177
Total	5	—	—	—	—	5	6	2	25	45	35	21	11	18	33	127	159	436

Footnotes are on page 19.

Appendix Table 5: Foodborne disease outbreaks by suspected etiology* and contributing factors†—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	Proliferation/Amplification Factors													Outbreaks with reported contributing factors	Total outbreaks	
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	≥1 factor reported			
Bacterial																
<i>Salmonella</i>	1	— [§]	—	—	—	—	—	—	—	—	—	—	—	1	1	3
<i>Clostridium perfringens</i>	3	4	1	1	2	1	3	5	—	—	—	—	—	7	7	12
<i>Escherichia coli</i> , Shiga toxin-producing	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2
<i>Campylobacter</i>	1	—	—	—	1	—	1	—	—	—	—	—	—	2	3	7
<i>Bacillus cereus</i>	5	5	1	—	4	—	2	4	—	—	—	1	—	9	9	13
<i>Staphylococcus aureus</i> enterotoxin	2	5	—	1	3	—	3	1	—	1	—	1	—	6	6	10
<i>Vibrio parahaemolyticus</i>	—	—	—	—	—	—	—	—	—	—	—	—	2	2	3	3
<i>Vibrio cholerae</i>	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	1
<i>Shigella</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
<i>Clostridium botulinum</i>	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1
<i>Listeria monocytogenes</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Escherichia coli</i> , Enteroinvasive	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
<i>Staphylococcus</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Escherichia coli</i> , Enteroaggregative	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Brucella</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Vibrio</i> other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other	2	4	—	3	1	—	2	4	—	—	1	—	—	7	7	13
Subtotal	14	18	2	5	11	1	11	14	—	1	2	5	36	40	67	
Chemical and toxin																
Scombroid toxin/histamine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ciguatoxin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mycotoxins	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Parasitic																
<i>Cryptosporidium</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Trichinella</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Giardia</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
<i>Cyclospora</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Viral																
Norovirus	—	—	—	—	1	—	—	—	—	—	—	—	—	1	72	177
Hepatitis A virus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapovirus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subtotal	—	—	—	—	1	—	—	—	—	—	—	—	—	1	72	177
Single etiology	14	18	2	5	12	1	11	14	—	1	2	5	37	112	246	
Multiple etiologies suspected	3	1	—	—	—	—	2	—	—	—	—	—	4	5	13	
Unknown etiology[¶]	8	11	5	7	12	—	9	3	—	—	—	3	31	42	177	
Total	25	30	7	12	24	1	22	17	—	1	2	8	72	159	436	

Footnotes are on page 19.

Appendix Table 6: Foodborne disease outbreaks by suspected etiology* and contributing factors†—Foodborne Disease Outbreak Surveillance System, United States, 2016.

Etiology	Survival Factors						Outbreaks with reported contributing factors	Total outbreaks
	S1	S2	S3	S4	S5	≥1 factor reported		
Bacterial								
<i>Salmonella</i>	– ^s	–	–	–	1	1	1	3
<i>Clostridium perfringens</i>	2	4	–	–	–	5	7	12
<i>Escherichia coli</i> , Shiga toxin-producing	–	–	–	–	–	–	1	2
<i>Campylobacter</i>	1	–	–	–	–	1	3	7
<i>Bacillus cereus</i>	3	1	–	–	4	6	9	13
<i>Staphylococcus aureus</i> enterotoxin	–	2	–	–	1	3	6	10
<i>Vibrio parahaemolyticus</i>	–	–	–	–	–	–	3	3
<i>Vibrio cholerae</i>	–	–	–	1	–	1	1	1
<i>Shigella</i>	–	–	–	–	–	–	1	1
<i>Clostridium botulinum</i>	–	–	–	–	1	1	1	1
<i>Listeria monocytogenes</i>	–	–	–	–	–	–	–	–
<i>Escherichia coli</i> , Enteroinvasive	–	–	–	–	–	–	–	1
<i>Staphylococcus</i> spp	–	–	–	–	–	–	–	–
<i>Escherichia coli</i> , Enteroaggregative	–	–	–	–	–	–	–	–
<i>Brucella</i> spp	–	–	–	–	–	–	–	–
<i>Vibrio</i> other	–	–	–	–	–	–	–	–
Other	1	2	–	2	2	5	7	13
Subtotal	7	9	–	3	9	23	40	67
Chemical and toxin								
Scombroid toxin/histamine	–	–	–	–	–	–	–	–
Ciguatoxin	–	–	–	–	–	–	–	–
Mycotoxins	–	–	–	–	–	–	–	–
Other	–	–	–	–	–	–	–	1
Subtotal	–	–	–	–	–	–	–	1
Parasitic								
<i>Cryptosporidium</i>	–	–	–	–	–	–	–	–
<i>Trichinella</i>	–	–	–	–	–	–	–	–
<i>Giardia</i>	–	–	–	–	–	–	–	1
<i>Cyclospora</i>	–	–	–	–	–	–	–	–
Subtotal	–	–	–	–	–	–	–	1
Viral								
Norovirus	1	–	–	2	2	5	72	177
Hepatitis A virus	–	–	–	–	–	–	–	–
Sapovirus	–	–	–	–	–	–	–	–
Subtotal	1	–	–	2	2	5	72	177
Single etiology	8	9	–	5	11	28	112	246
Multiple etiologies suspected	2	1	–	–	–	2	5	13
Unknown etiology^a	5	5	–	1	2	13	42	177
Total	15	15	–	6	13	43	159	436

Footnotes are on page 19.

Appendix: Reported foodborne disease outbreaks, by confirmed and suspected etiology* and contributing factors†—Foodborne Disease Outbreak Surveillance System, United States, 2016

* 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. 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.

† Contributing factors are defined as risk factors that either enable an outbreak to occur or amplify an outbreak caused by other means. Contributing factors are classified into three categories: contamination factors (factors that introduce or otherwise permit contamination), proliferation/amplification factors (factors that allow proliferation or growth of the etiologic agent), and survival factors (factors that allow survival or fail to inactivate a contaminant). More than one contributing factor might be reported per outbreak.

‡ Contributing factors:

- C1: toxic substance part of the tissue
- C2: poisonous substance intentionally/deliberately added
- C3: poisonous substance accidentally/inadvertently added
- C4: addition of excessive quantities of ingredients that are toxic in large amounts
- C5: toxic container
- C6: contaminated raw product—food that was intended to be consumed after a kill step
- C7: contaminated raw product—food was intended to be consumed raw or undercooked/underprocessed
- C8: foods originating from sources shown to be contaminated or polluted (such as a growing field or harvest area)
- C9: cross-contamination of ingredients (cross-contamination does not include ill food workers)
- C10: bare-handed contact by a food handler/worker/preparer who is suspected to be infectious
- C11: glove-handed contact by a food handler/worker/preparer who is suspected to be infectious
- C12: other mode of contamination (excluding cross-contamination) by a food handler/worker/preparer who is suspected to be infectious
- C13: foods contaminated by non-food handler/worker/preparer who is suspected to be infectious
- C14: storage in a contaminated environment
- C15: other source of contamination
- P1: food preparation practices that support proliferation of pathogens (during food preparation)
- P2: no attempt was made to control the temperature of implicated food or the length of time food was out of temperature control (during food service or display of food)
- P3: improper adherence of approved plan to use Time as a Public Health Control
- P4: improper cold holding due to malfunctioning refrigeration equipment
- P5: improper cold holding due to an improper procedure or protocol
- P6: improper hot holding due to malfunctioning equipment
- P7: improper hot holding due to improper procedure or protocol
- P8: improper/slow cooling
- P9: prolonged cold storage
- P10: inadequate modified atmospheric packaging
- P11: inadequate processing (acidification, water activity, fermentation)
- P12: other situations that promoted or allowed microbial growth or toxin production
- S1: insufficient time and/or temperature control during initial cooking/heat processing
- S2: insufficient time and/or temperature during reheating
- S3: insufficient time and/or temperature control during freezing
- S4: insufficient or improper use of chemical processes designed for pathogen destruction
- S5: other process failures that permit pathogen survival

§ No outbreaks in the data reported fall in this category.

¶ An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.



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