Bacterial Foodborne and Diarrheal Disease National Case Surveillance

Annual Report, 2004

Enteric Diseases Epidemiology Branch
Division of Foodborne, Bacterial and Mycotic Diseases
National Center for Zoonotic, Vector-Borne, and Enteric Diseases
Centers for Disease Control and Prevention

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Executive Summary

The Enteric Diseases Epidemiology Branch (EDEB), Division of Foodborne, Bacterial, and Mycotic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases, is responsible for surveillance of bacterial enteric pathogens. National case surveillance encompasses two systems administered outside EDEB: the National Notifiable Diseases Surveillance System (NNDSS), which is clinical case-based, and the Public Health Laboratory Information System (PHLIS), which is a laboratory isolation-based reporting system. The laboratory-based system alone includes data on important pathogen characteristics such as serotype for *Salmonella*, *Shigella*, and Shiga toxin-producing *Escherichia coli* isolates. Serotype information for these pathogens is crucial for surveillance, outbreak detection, and investigation. PHLIS also includes some pathogens that are not formally nationally notifiable, but may be notifiable at the state level. In addition, EDEB primarily collects information for botulism, typhoid fever, cholera, and other *Vibrio* illnesses, as well as for Shiga toxin-producing *E. coli*, non-O157. Information in this report includes case and isolate counts in 2004 as of November 2006; the numbers may have changed compared with previous publications of 2004 surveillance data.

The number of reported cases of diseases under surveillance is a vast underestimate of the true burden because most episodes of disease never reach the reporting systems. Many ill persons do not seek medical care, medical practitioners may not order the tests to make a specific diagnosis, and laboratories may not conduct the appropriate tests to isolate the causative pathogens. Some pathogens are not included on the list of nationally notifiable diseases (e.g., *Campylobacter* and *Yersinia*) and are not included in this report, though individual states may require reporting and collect surveillance data. The completeness of surveillance data is variable. All reporting from state and territorial departments of public health to the Centers for Disease Control and Prevention (CDC) is voluntary. The Foodborne Diseases Active Surveillance Network (FoodNet) conducted more intensive surveillance in 10 sites in 2004; more information is available at http://www.cdc.gov/foodnet/.

Many illnesses are not included in any surveillance of individual cases, in part because there are no standard clinical tests to detect them. Examples include illnesses due to enterotoxigenic *E. coli* and enterotoxins produced by *Bacillus cereus, Clostridium perfringens,* and *Staphylococcus aureus*. For such conditions, reports of foodborne outbreak investigations provide the best available surveillance information. Foodborne outbreak reports are available at http://www.cdc.gov/foodborneoutbreaks/.

Each year, EDEB summarizes surveillance results in multiple formats, including letters to state and territorial epidemiologists and public health laboratory directors, reports in the CDC publication *Morbidity and Mortality Weekly Report* (*MMWR*), and publications in peer-reviewed scientific journals. More information about these documents is available at the end of this report in the following sections: Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases, Publications by Foodborne and Diarrheal Diseases Branch, 2004, and CDC Internet Sites Relevant to Foodborne and Diarrheal Diseases.

This report is the second in an annual series summarizing results from nationally notifiable

bacterial foodborne and diarrheal diseases case surveillance systems. A description of the surveillance systems is included to explain the differences between these systems and why they sometimes have different case counts for the same disease entity (see the Data Sources and Background section of this report for more information). The specialized sentinel site surveillance system, FoodNet, provides complementary information for a range of foodborne infections of public health concern from 10 sites. FoodNet annual summaries are available at http://www.cdc.gov/foodnet/reports.htm.

Looking forward, EDEB is actively involved in advancing the nation's surveillance for foodborne and diarrheal diseases. CDC-wide integrated surveillance systems are under construction, which may make national surveillance for many types of diseases more efficient. We are working to make more surveillance tools available to state and local public health personnel and more surveillance information available to public health workers, policy makers and the general public through combined reports and information available on the Internet.

The case and isolate counts for eight diseases and pathogens for 2004 are presented in Table 1-1 and described on the following pages.

Table 1-1. Case and isolate counts for foodborne and diarrheal diseases and pathogens, 2004

Pathogen/Disease	Comments	Nationally Notifiable	Data Source		
			NNDSS* No. cases	PHLIS† No. isolates	EDEB§ No. cases or isolates
Botulism	Includes foodborne, wound, infant, and other types	YES	133	NA	138
E. coli O157:H7		YES	2,544	2,161	NA
E. coli, Shiga toxin-producing, non-O157		YES	308	139	248
Hemolytic uremic syndrome		YES	200	NA	NA
Listeriosis		YES	753	NA	NA
Salmonella Typhi (typhoid fever)		YES	322	306	244
Salmonella, non-Typhi (salmonellosis)	Includes >2,400 serotypes	YES	42,197	35,355	NA
Shigella (shigellosis)	Includes 4 subgroups	YES	14,627	9,343	NA
Vibrio cholerae, toxigenic	Includes O1 and O139 serotypes (that cause cholera) and toxigenic non-O1, non-O139 *V. cholerae*	YES	8	NA	8
Other *Vibrios* (vibriosis)	Some species may not be pathogenic	NO	NA	NA	479

* National Notifiable Diseases Surveillance System.
† Public Health Laboratory Information System.
§ Enteric Diseases Epidemiology Branch.

Botulism

A total of 138 cases of foodborne (14), wound (28), infant (91), and other types (5) of botulism were reported to the EDEB botulism surveillance system, including one death (attributed to infant botulism) and two outbreaks (defined as two or more cases as a result of persons ingesting the same food).

Escherichia coli O157:H7 and Other Shiga Toxin-Producing *E. coli*:

Escherichia coli O157:H7 has been nationally notifiable since 1994. In 2000, the Council for State and Territorial Epidemiologists passed a resolution in which all Shiga toxin-producing *E. coli* were made nationally notifiable under the name Enterohemorrhagic *Escherichia coli* or EHEC; national surveillance for EHEC began in 2001. Reported infections with the most well-known pathogen in this group, *E. coli* O157:H7, has increased annually since becoming nationally notifiable, to a peak of 4,744 in 1999. The steady increase in the number of cases

was due in part to an increasing ability of laboratories to identify this pathogen. Coordinated efforts by regulators and industry have been effective in reducing contamination and illness related to ground beef. During 2004, 2,544 cases were reported through the NNDSS.

The National *E. coli* Reference Laboratory at CDC provides serotyping and molecular characterization of virulence factors as a service to state public health laboratories. In 2004, CDC received 248 isolates of Shiga toxin-producing *E. coli*, non-O157. Isolates originated from 30 states and included 30 different O groups. The four most common O groups were O26 (19%), O45 (13%), O111 (13%), and O103 (18%). A total of 308 cases of Shiga toxin-producing *E. coli* non-O157 were reported to the NNDSS.

Hemolytic Uremic Syndrome (HUS), Post-Diarrheal
HUS is defined by the triad of hemolytic anemia, thrombocytopenia, and renal insufficiency. Patients reported in national notifiable diseases surveillance include only those with antecedent diarrheal illness. The most common etiology in the United States is infection with a Shiga toxin-producing *E. coli*, principally *E. coli* O157:H7. About 8% of persons infected with *E. coli* O157:H7 develop HUS. Of the 200 cases of HUS reported in 2004, 73.5% were in children younger than age 10 years.

Listeriosis
Listeriosis became nationally notifiable in 2000. Surveillance is conducted in through NNDSS. During 2004, 49 states or territories reported at least one case, for a total of 753 cases.

***Salmonella* Typhi (Typhoid Fever)**
Infection with *Salmonella* serotype Typhi leads to typhoid fever. The number of cases of typhoid fever (322 in the NNDSS) has been relatively small and constant, mostly associated with travel outside the United States. *S.* Typhi isolates are reported through the National Salmonellosis Surveillance System; 306 isolates were reported in 2004.

***Salmonella*, Non-Typhi (Salmonellosis)**
A total of 35,355 non-Typhi *Salmonella* isolates were reported in 2004. The national rate was 12.0 per 100,000 population. Similar to other years, *Salmonella* was isolated most frequently from children younger than age 5 years, accounting for 27% of isolates. About 10% of isolates came from persons in each of the second through fifth decades of life, with lower proportions from persons in later decades of life. Since 1995, specific control programs have succeeded in the dramatically reducing *Salmonella* serotype Enteritidis, which has been associated with the internal contamination of eggs. However, other serotypes, such as Mississippi, Newport, Paratyphi B var. L(+) tartrate+ (formerly Java), and Javiana, have increased in numbers since 1994. Rates of antibiotic resistance among several serotypes have been increasing. For more information about trends in antibiotic resistance, see the following sections at the end of this report: Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases, Publications by Foodborne and Diarrheal Diseases Branch, 2004, and CDC Internet Sites Relevant to the National Antimicrobial Resistance Monitoring System (NARMS).

***Shigella* (Shigellosis)**
Shigella transmission occurs most commonly via the fecal-oral route. Most *Shigella sonnei*

infections are associated with crowding and poor personal hygiene. Day care centers have been implicated in many *S. sonnei* outbreaks.

A total of 9,343 *Shigella* isolates were reported to PHLIS in 2004. This represents a 50% decrease compared with 1994 and a 41% decrease from 2003. The national rate was 3.2 per 100,000 population. Similar to previous years, children younger than age 5 years accounted for 30.2% of all *Shigella* isolates. Another 31.6% came from persons aged 5–19 years, and 28.8% from persons aged 20–59 years.

Of the 9,343 isolates, 88% were subgrouped. The relative proportions of the four different subgroups remained constant, with *S. sonnei* accounting for the largest percentage of isolates (68.9%), followed by *S. flexneri (*17.2%), *S. boydii* (1.8%), and *S. dysenteriae* (0.4%).

Cholera, Toxigenic Non-O1 and Non-O139 *V. Cholerae*, and Other *Vibrios*

In 2004, eight cases of toxigenic *V. cholerae* were reported. Five patients had cholera and were infected with toxigenic *V. cholera* serogroup O1: one patient acquired the infection in Thailand, two in India, one in the Philippines, and one in Hawaii. Toxigenic *V. cholerae* O141 was isolated from three patients. One patient was a Georgia resident who consumed oysters traced to a Florida harvest site. The second patient was a Georgia resident who reported no exposure to seafood before illness. The third patient was an Alabama resident who consumed oysters that could not be traced back to their harvest site.

Other *Vibrio* isolates (excluding toxigenic *V. cholerae*) were not nationally notifiable in 2004, and not all states report cases. States bordering the Gulf of Mexico have a reporting agreement with CDC; others do not, but are encouraged to report cases. In 2004, 501 other *Vibrio* isolates from 479 patients were reported to the Cholera and Other *Vibrios* Surveillance System. Of these 479 patients, 130 (27%) were from Gulf Coast states, 211 (44%) were from Pacific Coast states, 100 (21%) were from Atlantic Coast states (excluding Florida), and 38 (8%) were from inland states. Among patients for whom information was available, 173 (38%) of 460 were hospitalized, and 39 (9%) of 443 died. *V. parahaemolyticus* was isolated from 240 (51%) patients, and was the most frequently reported *Vibrio* species. *V. vulnificus* was isolated from 92 (19%) patients; 88% were hospitalized and 39% died.

Expanded Surveillance Summaries for Selected Pathogens and Diseases, 2004

The following bacterial foodborne and diarrheal diseases case surveillance summaries for 2004 are derived from individual reports sent to state and territorial epidemiologists and public health laboratory directors. They are compiled here to provide more detailed text, tables, and figures. An expanded summary of *E. coli* O157 infections, typhoid fever, and hemolytic uremic syndrome surveillance (HUS) data is not included in this report; more comprehensive surveillance data concerning these are available in FoodNet reports at http://www.cdc.gov/foodnet/. Only a few select tables and figures, from the *Salmonella Annual Summary, 2004*, and the *Shigella Annual Summary, 2004*, are included here. These complete reports are available at http://www.cdc.gov/ncidod/dbmd/phlisdata.

Botulism

The botulism surveillance case definition is available at http://www.cdc.gov/EPO/DPHSI/casedef/botulism_current.htm. Botulism is a rare but serious paralytic illness caused by a neurotoxin produced by the bacterium *Clostridium botulinum.* There are three main forms of botulism. Foodborne botulism is caused by eating foods that contain the botulism toxin. Wound botulism is caused by toxin produced from a wound infected with *Clostridium botulinum*. Infant botulism is caused by consumption of spores of the *Clostridium botulinum* organism, which then grow in the intestine of infants and release toxin. All forms of botulism can be fatal. Because many people can eat a food contaminated with the botulism toxin, every case of botulism suspected to be foodborne is considered a public health emergency.

EDEB staff members are available to consult with health departments and physicians 24 hours a day. CDC also maintains the only source of antitoxin used to treat botulism in the United States. The request for consultation and release of antitoxin by health departments and physicians is the basis of surveillance for most cases of foodborne and wound botulism. States report cases of infant botulism to EDEB on a yearly basis; therapeutic human antitoxin licensed for treatment of infant botulism is available from the California Department of Health Services. Suspected botulism cases should be reported immediately to local or state public health officials, who then should call the CDC Emergency Operations Center at (770) 488-7100; CDC will immediately connect callers with an on-call botulism consultant. For consultation on suspected infant botulism occurring in any state, the Infant Botulism Treatment and Prevention Program of the California Department of Health Services should be contacted at (510) 231-7600.

A total of 138 cases of botulinum intoxication were reported to CDC in 2004. Among the 14 cases of foodborne intoxication, toxin type A accounted for 12 (86%) cases and toxin type E for 2 (14%) cases. The median age of patients was 41 years; no deaths were reported. There were two multicase outbreaks. One was caused by “pruno,” a bootleg prison-made alcoholic beverage, and the other was caused by home-canned mushrooms.

There were 91 reported cases of infant botulism in 2004. Toxin type B accounted for 54 (59%)

cases, toxin type A for 36 (40%) cases, and toxin type F for one (1%) case. The median age of patients was 15 weeks; one death was reported.

There were 28 reported cases of wound botulism in 2004. Toxin type A accounted for all but 2 cases. All occurred in injecting drug users. The median age of patients was 48 years; no deaths were reported.

There were 4 cases of treatment-related botulism in one common-source outbreak. All 4 patients received cosmetic injections of high-dose, unlicensed botulinum toxin A product not intended for human use. The patients were 34, 40, 52, and 53 years old.

There was 1 reported case of botulism of unknown source. Toxin type F was responsible for this case, and the patient was 26 years old. There were no reported cases of adult colonization botulism.

Table 2-1. Summary of cases of botulism reported to the Botulism Surveillance System, 2004

Type	Cases	Median age	Sex	Toxin type	Comments
Foodborne	14 cases (No reported deaths; 1 unknown)	41 years (range: 23–87 years)	8 (57%) male	12 (86%) type A 2 (14%) type E	2 multicase outbreaks
Infant	91 cases (One reported deaths, 1 unknown)	15 weeks (range: 0–52 weeks)*	52 (57%) male	36 (40%) type A 54 (59%) type B 1 (1%) type F	.
Wound	28 cases (No reported deaths)	48 years (range: 27–57 years)	24 (86%) male	25 (89%) type A 2 (7%) type B 1 (3%) toxin type undetermined	
Treatment-associated	4 cases	45 years	2 (50%) male	4 (100%) type A	4 cases constituting a single multicase outbreak
Unknown	1 case (No reported death)	26 years	1 (100%) male	1 (100%) type F	

Table 2-2. Cases of botulism reported to the Botulism Surveillance System, by state and type, 2004

State/District	Foodborne	Infant	Wound	Other	Total
Arkansas	1				1
Arizona		1			1
California	6	37	21		64
District of Columbia		1			1
Delaware		2			2
Florida		1		4*	5
Hawaii		1			1
Iowa		1			1
Idaho		1			1
Kansas		1			1
Kentucky		1			1
Maryland		6			6
Minnesota		1			1
Montana	1	1			2
Nebraska		1			1
New Hampshire		1			1
New Jersey	1	1			2
Ohio	1	2			3
Oregon	4	1	1		6
Pennsylvania		15			15
South Carolina		1			1
Tennessee		1			1
Texas		3	1		4
Utah		2			2
Virginia		4			4
Washington		2	5	1†	8
West Virginia		2			2
Totals	**14**	**91**	**28**	**5**	**138**

* Treatment-related.
† Unknown source.

Table 2-3. Cases of foodborne botulism reported to the Botulism Surveillance System, by month (N = 14), 2004

Month	State	Age (years)	Sex	Toxin Type	Vehicle	Death
January	Oregon	68	Female	A	Multiple home-canned foods	Unknown
	Ohio	56	Female	A	Home-canned tomatoes	No
April	Alaska	39	Female	E	Seal meat/fat	No
May	New Jersey	41	Female	E	Salted fermented fish	No
July	California*	Unknown	Male	A[†]	"Pruno"[‡]	No
	California*	25	Male	A	"Pruno"	No
	California*	35	Male	A	"Pruno"	No
	California*	20	Male	A	"Pruno"	No
	California*	19	Male	A	"Pruno"	No
	Montana	47	Female	A	Home-canned asparagus	No
August	California	40	Male	A	Unknown	No
September	Oregon	19	Male	A[†]	Stew	Yes
December	Oregon*	51	Male	A	Home-canned mushrooms	No
	Oregon*	57	Female	A	Home-canned mushrooms	No

* Cases involved in multicase outbreak.
[†] Toxin type derived from epidemiologically linked case.
[‡] Bootleg prison-made alcoholic beverage.

Table 2-4. Cases of infant botulism reported to the Botulism Surveillance System, by month (N = 91), 2004

Month	State	Age (weeks)	Sex	Toxin type	Death
January	California	14	Female	B	No
	Colorado	15	Male	B	N
	Pennsylvania	26	Male	B	N
	Washington	27	Male	A	N
	Pennsylvania	26	Male	A	N
	California	21	Male	A	N
	Utah	20	Female	A	N
	West Virginia	8	Female	B	N
February	California	22	Male	A	N
	California	14	Male	B	N
	Pennsylvania	18	Female	B	N
	Ohio	6	Female	B	N
	Minnesota	20	Male	B	N
	Virginia	4	Female	B	N
	Texas	9	Male	A	N
	West Virginia	4	Male	B	N
March	California	52	Female	B	N
	Maryland	5	Female	B	N
	Pennsylvania	21	Female	B	N
	California	28	Male	A	N
	Pennsylvania	24	Male	B	N
	California	4	Female	A	N
	Montana	38	Male	A	N
	Virginia	3	Female	B	N
April	Utah	18	Male	A	N
	California	22	Male	B	N
	Pennsylvania	23	Female	B	N
	Virginia	14	Male	B	N
May	California	9	Female	A	N
	California	4	Male	B	N
	Pennsylvania	13	Female	B	N
June	California	6	Female	A	N
	Kentucky	14	Female	B	N
	Delaware	19	Female	B	N
	California	4	Male	B	N
	California	3	Male	B	N
	Pennsylvania	3	Male	B	N
	California	31	Male	A	N
	Washington	6	Male	B	N
	California	9	Male	B	N
	Pennsylvania	1	Female	B	N
	California	24	Male	A	N

	California	23	Male	A	N
July	Idaho	19	Male	A	N
	California	4	Female	B	N
	California	4	Female	B	N
	Arizona	22	Male	B	N
	Maryland	21	Male	B	N
	Oregon	7	Male	B	Unknown
August	California	15	Female	A	N
	South Carolina	15	Female	A	N
	Texas	24	Female	A	N
	California	11	Male	B	N
	Virginia	10	Female	A	N
	New Jersey	10	Female	B	N
	Maryland	18	Female	B	N
	Pennsylvania	27	Female	B	N
September	California	16	Male	A	N
	California	4	Male	B	N
	Delaware	4	Female	B	N
	Pennsylvania	6	Female	B	N
	Iowa	2	Male	F	Yes*
	Pennsylvania	26	Female	B	N
	New Hampshire	2	Male	B	N
	Maryland	26	Male	A	N
	Tennessee	14	Female	B	N
	Ohio	19	Female	B	N
	Kansas	4	Male	B	N
October	California	3	Male	B	N
	Maryland	22	Male	B	N
	California	16	Female	A	N
	California	22	Male	A	N
	Nebraska	15	Female	A	N
	California	5	Female	A	N
	California	20	Male	A	N
	Florida	18	Male	A	N
November	California	14	Female	A	N
	California	3	Male	A	N
	Hawaii	13	Female	B	N
	Texas	15	Male	A	N
	Pennsylvania	20	Male	B	N
	Pennsylvania	27	Male	B	N
	Maryland	13	Male	B	N
	California	18	Male	A	N
December	California	29	Male	A	N
	Pennsylvania	25	Male	B	N
	California	20	Male	A	N
	California	7	Female	A	N

	District of Columbia	25	Male	B	N
	California	26	Male	B	N
	California	32	Female	A	N

* Patient died from complications arising from *Clostridium difficile* colitis.

Table 2-5. Cases of wound botulism reported to the Botulism Surveillance System by month (N = 28), 2004

Month	State	Age (years)	Sex	Toxin Type	Exposure	Death
March	California	37	Male	A	IDU*	No
	California	54	Male	A	IDU	No
	California	55	Male	B	IDU	No
	Washington	51	Male	A	IDU	No
	Washington	52	Male	A	IDU	No
June	California	33	Male	A	IDU	No
	California	34	Male	A	IDU	No
	California	27	Male	A	IDU	No
	California	54	Male	Unknown†	IDU	No
July	California	53	Male	A	IDU	No
	California	53	Male	A	IDU	No
	Texas	49	Male	A	IDU	No
August	California	49	Male	A	IDU	No
	California	55	Male	A	IDU	No
	Washington	49	Female	A	IDU	No
September	California	50	Male	A	IDU	No
October	California	42	Male	A	IDU	No
	California	47	Female	A	IDU	No
	California	56	Male	A	IDU	No
	Washington	50	Male	A	IDU	No
November	California	52	Male	A	IDU	No
	California	53	Male	A	IDU	No
	California	57	Male	A	IDU	No
	Washington	43	Male	A	IDU	No
December	California	43	Male	A	IDU	No
	California	49	Female	A	IDU	No
	California	52	Male	A	IDU	No
	Oregon	50	Female	B	IDU	No

* Injecting drug user.
†Serum quantity not sufficient for toxin typing.

Table 2-6. Cases of treatment-associated botulism reported to the Botulism Surveillance System (N = 4), 2004 *

Month	State	Age (years)	Sex	Toxin Type	Death
November	Florida	53	Female	A	No
November	Florida	52	Male	A	No
November	Florida	40	Male	A	No
November	Florida	34	Female	A	No

* All were part of a single common-source outbreak.

Table 2-7 Cases of botulism of unknown source reported to the Botulism Surveillance System (N = 1), 2004

Month	State	Age (years)	Sex	Toxin Type	Death
April	Washington	26	Male	F	No

Shiga Toxin-Producing *Escherichia coli,* non-O157

The surveillance case definition for Shiga toxin-producing *Escherichia coli* non-O157 is available at http://www.cdc.gov/EPO/DPHSI/casedef/escherichia_coli_current.htm.
Shiga toxin-producing *Escherichia coli* (STEC) strains cause diarrhea and hemolytic uremic syndrome (HUS). The most common STEC that causes illness in the United States is *E. coli* O157:H7. Non-O157 STEC strains are also important pathogens; they have caused several U.S. outbreaks and, in some U.S. studies, they have been isolated from diarrheal stools as frequently as *E. coli* O157:H7.

In June 2000, the Council of State and Territorial Epidemiologists (CSTE) passed a position statement recommending inclusion of *E. coli* O157 and non-O157 STEC that cause human illness as nationally notifiable. Reporting of non-O157 STEC has increased every year since implementation in 2001. STEC is indicated as enterohemorrhagic *Escherichia coli* (EHEC) in NNDSS for 2004.

During 2004, 308 cases of non-O157 STEC were reported through NNDSS. To better understand the non-O157 STEC serogroups associated with human illness, CDC encourages state health laboratories to forward suspected non-O157 STEC isolates to the CDC's National *Escherichia coli* Reference Laboratory, where confirmatory testing for Shiga toxin genes and serotyping are offered. In 2004, 248 isolates were received by CDC from 30 states (Figure 3-1).

The non-O157 isolates received by CDC in 2004 included 30 different O groups. The predominant groups were O26 (19%) and O103 (18%), followed by O45 (13%), O111 (13%), O145 (6%), and O121 (7%); these six O groups made up 76% of all isolates (Table 3-1). *E. coli* O26 was also the most commonly isolated non-O157 STEC in 2003 and 2002. In 2001, *E. coli* O111 was the most common.

Identification of an STEC requires demonstrating the ability of the *E. coli* isolate to produce

Shiga toxin. Before 1995, Shiga toxin was detected by using highly technical assays available only at reference and research laboratories. Since 1995, the U.S. Food and Drug Administration (FDA) has licensed several rapid enzyme immunoassays (EIA) for the detection of Shiga toxin in human stool specimens and culture broth. Since these EIA kits have become commercially available and the use of polymerase chain reaction (PCR) to identity toxin genes has increased, the number of non-O157 STEC isolates sent to CDC for serotyping has increased each year.

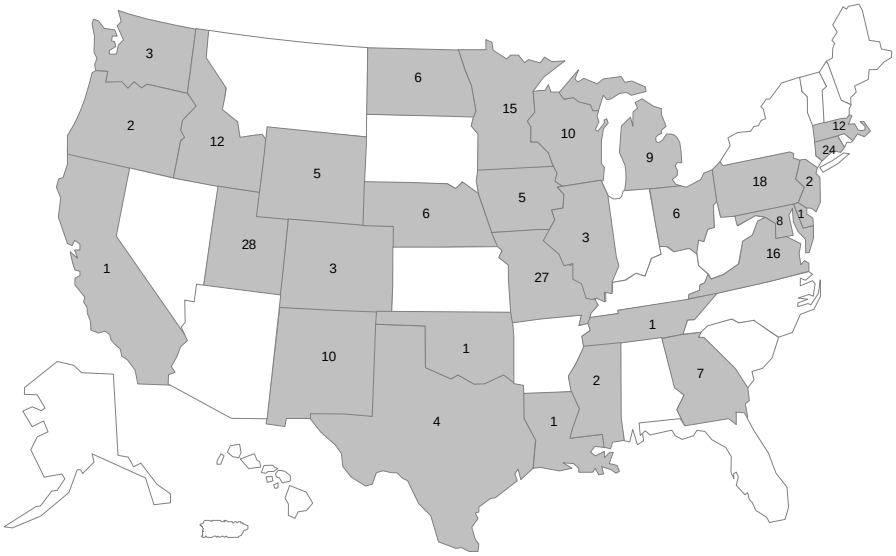
Health care providers evaluating patients with diarrhea or HUS should consider infection with non-O157 STEC in addition to *E. coli* O157. A small number of persons have developed HUS after urinary tract infection with STEC strains; in these cases, urine culture has yielded the pathogen when stool culture was negative.

Health care providers should notify clinical diagnostic laboratories when STEC O157 infection is suspected so that appropriate testing methods can be applied. Clinical laboratories should strongly consider including STEC O157 in their routine bacterial enteric panel (with *Salmonella*, *Shigella*, and *Campylobacter*). The best way to identify all STEC infections is to screen all stool samples submitted for routine enteric bacterial testing for Shiga toxins using EIA or PCR. Ideally, the clinical diagnostic laboratory should culture simultaneously for STEC O157 (e.g., on a sorbitol-containing medium such as sorbitol MacConkey agar). Clinical diagnostic laboratories that use a Shiga toxin EIA, but do not perform simultaneous culture for STEC O157 should culture all Shiga toxin-positive broths for STEC O157 as soon as possible and forward these isolates to a state of local public health laboratory for confirmation and subtyping. When a Shiga toxin-positive broth does not yield STEC O157, then broth culture should be forwarded to the state of local public health laboratory for identification of non-O157 STEC. State and local public health laboratories should confirm the presence of Shiga toxin in broths and should attempt to obtain a STEC isolate. All non-O157 STEC isolates should be sent by public health laboratories to CDC for confirmation and further characterization.

Table 3-1. Serogroup of non-O157 STEC isolates from humans sent to CDC, 2004

Serogroup	Number	Percent
O26	47	19.0%
O103	44	17.7%
O45	33	13.3%
O111	32	12.9%
O121	18	7.3%
O145	14	5.6%
O174	4	1.6%
O118	3	1.2%
O22	3	1.2%
O112	2	0.8%
O132	2	0.8%
O158	2	0.8%
O33	2	0.8%
O76	2	0.8%
O19	1	0.4%
O27	1	0.4%
O49	1	0.4%
O63	1	0.4%
O75	1	0.4%
O77	1	0.4%
O84	1	0.4%
O86	1	0.4%
O88	1	0.4%
O91	1	0.4%
O110	1	0.4%
O126	1	0.4%
O130	1	0.4%
O131	1	0.4%
O153	1	0.4%
O165	1	0.4%
Rough	10	4.0%
Undetermined	14	5.6%
Total	248	100.0%

Figure 3-1. States that submitted non-O157 STEC isolates to CDC, 2004* (N = 30 states)



* Data obtained from the National *Escherichia coli* reference Laboratory and the Epidemic Investigation and Surveillance Laboratory.
Note: Numbers on map indicate the number of isolates submitted for that state.

Listeria
The listeriosis surveillance case definition is available at http://www.cdc.gov/EPO/DPHSI/casedef/listeriosis_current.htm. Infection with *Listeria monocytogenes* is characterized by fever and muscle aches, and sometimes nausea or diarrhea. The nervous system can be affected, resulting in meningitis or cerebritis, with symptoms such as headache, stiff neck, confusion, or convulsions. Pregnant women, newborns, and adults with weakened immune systems are at greatest risk of developing listeriosis. Infection during pregnancy may be asymptomatic, but can result in miscarriage, premature delivery, or infection of the newborn.

Listeriosis has been a nationally reportable disease since 2000. Reports of listeriosis are submitted to CDC through NNDSS. There were 753 cases of listeriosis reported to NNDSS during 2004 (0.3 cases per 100,000 population). The rate of listeriosis was highest among neonates (1.5 cases per 100,000), followed by adults older than age 70 years (1.1 cases per 100,000). More comprehensive surveillance data on listeriosis incidence rates are available in FoodNet reports at http://www.cdc.gov/foodnet/.

The Listeriosis Initiative is an effort to aid in investigations of future *Listeria* outbreaks and clusters. Timely isolation and subtyping of all isolates of *L. monocytogenes* and prompt interviews of patients are means to improving outbreak investigation. During 2004, FoodNet sites piloted the use of a standard interview form for cases of infection with *Listeria*. Data from the standard, detailed report form are maintained in a central database for rapid analysis in the event of an outbreak. These data can be used for case-control analysis of a cluster, where people with non-matching isolates serve as controls. Prompt data collection and analysis could allow earlier public health intervention during an outbreak.

All isolates of *Listeria* should be submitted for subtyping to state or national laboratories. Public health professionals and health care providers should consider interviewing all cases of listeriosis using the standard interview form, available at http://www.cdc.gov/foodborneoutbreaks/documents/ListeriaCaseReportFormOMB0920-0004.pdf.

Salmonella
The *Salmonella* surveillance case definition is available at http://www.cdc.gov/epo/dphsi/casedef/salmonellosis_current.htm. The National *Salmonella* Surveillance System collects reports of isolates of *Salmonella* from human sources from every state. *Salmonella* isolates are submitted to the state public health laboratory by clinical diagnostic laboratories. The state and territorial laboratories confirm the isolates as *Salmonella,* perform serotyping according to the Kauffmann-White scheme, and report the data electronically through PHLIS to EDEB. Unusual or difficult isolates are forward to the National *Salmonella* Reference Laboratory at CDC for further characterization or confirmation. These results are reported back to the state laboratory, where they are reported through PHLIS. Duplicates are removed from the file at the end of the year. Every 20th isolate is forwarded to the National Antimicrobial Resistance Monitoring System (NARMS) at CDC for susceptibility testing.

The capture of isolates in the National *Salmonella* Surveillance System is considered to be

fairly complete. However, some *Salmonella* isolates may not be forwarded to public health laboratories, and therefore are not reported. In addition, irrespective of the surveillance system, many cases of *Salmonella* illness are not reported because the ill person does not seek medical care, the health care provider does not obtain a specimen for diagnosis, or the laboratory does not perform the necessary diagnostics tests. The results of surveillance reported here should be considered underestimates of the true number of infections.

The reporting state represents the state where laboratory confirmation and serotyping were performed. In some instances, the reporting state is not the state of residence of the person from whom the isolate was obtained. For *Salmonella* serotype Typhi, only the first isolation in one year for each person is counted.

A total of 35,661 *Salmonella* isolates were reported from public health laboratories in 49 states and the District of Columbia in 2004. This represents a 5% increase compared with 1994 and a 5% decrease from 2003. The national rate was 12.1 per 100,000 population.

Similar to other years, *Salmonella* was isolated most frequently from children younger than age 5 years, accounting for 27% of isolates. About 10% of isolates came from persons in each of the second through fifth decades of life, with lower proportions from persons in later decades of life. The distribution of isolates between the sexes was different, with a greater proportion of isolates from male than female infants and children, and a smaller proportion of isolates from male than female adults.

The 20 most common serotypes of *Salmonella* in 2004 are listed in Table 4-1. These represent 75% of all *Salmonella* isolates. Of the top 20 serotypes, the two most common serotypes, *S.* Typhimurium and *S.* Enteritidis, had substantial decreases in number during 1994–2004; the largest percent decrease in numbers compared with 1994 were in serotypes Hadar and Enteritidis. A dramatic increase in serotype Mississippi (up 267% from 1994 to 2004) mainly occurred before 1999. Serotypes Javiana, Paratyphi B var. L(+) tartrate+ (formerly serotype Java), and Newport had important increases in numbers since 1994 (up 228%, 106%, and 99%, respectively). In 2004, serotypes Berta and Anatum increased in rank to be included in the top 20 serotypes, whereas serotypes Bareilly and Stanley dropped from the top 20 serotypes compared with 2003.

Salmonella serotype I 4,[5],12:i:- was introduced as the 18th most common serotype in 2002 and has increased in rank to seventh in 2004. This serotype was first tracked in the National *Salmonella* Surveillance System database in 1998, though many isolates may have been classified as only Subspecies I or Group B before then. Since the *2003 Salmonella Surveillance Summary* was published, we reexamined the surveillance data for 1995–2003 and were able to reclassify some isolates submitted in these years as I 4,[5],12:i:- on the basis of additional data submitted with individual isolates. Efforts to correctly classify this serotype are responsible for at least some of the increase that has been documented in recent years. It is unknown how many isolates reported as Subspecies I, Group B could be this serotype. In 1998, this serotype was the fourth most commonly identified in Spain; genetic analysis of the Spanish isolates revealed a close relationship to serotype Typhimurium. Many U.S. isolates of this serotype were characterized by pulsed-field gel electrophoresis (PFGE), and their patterns were submitted to PulseNet, the National Molecular Subtyping Network for Foodborne Disease Surveillance. The PFGE patterns for most I 4,[5],12:i:- isolates were closely related to the PFGE patterns for

serotype Typhimurium, indicating that they are most likely variants of Typhimurium.

The three most common serotypes of *Salmonella* in 2004 (Typhimurium, Enteritidis, and Newport) accounted for 43% of isolates. During the past 10 years, *S.* Typhimurium and *S.* Enteritidis were ranked first and second, respectively; during 1994–1996, their ranks were temporarily reversed (Figure 4-1). A large proportion of *S.* Typhimurium isolates are resistant to multiple antimicrobial drugs. In a 2003 national survey, 45% were resistant to one or more drugs and 26% had a five-drug resistance pattern characteristic of a single phage type, DT104 (see http://www.cdc.gov/narms/). Similarly, serotype Newport has emerged as a major multidrug-resistant pathogen. In 2003, 46 (21%) of 222 Newport isolates submitted to NARMS were resistant to at least seven of 17 antimicrobial agents tested, including extended spectrum cephalosporins. Similar to other years, there were marked regional differences in the frequency of *Salmonella* isolates among serotypes. The rate of isolations by region has been followed closely for serotype Enteritidis as a means of assessing the impact of egg safety regulations and industry improvements. As indicated in Figure 4-2, rates of isolation had been relatively high in the New England, Mid-Atlantic, and Pacific regions, but have shown significant decreases since 1995. Although New England had an increase in serotype Enteritidis in 2000 and 2001 compared with 1999, the rate has decreased since 2001.

Table 4-1. The 20 *Salmonella s*erotypes most frequently reported to PHLIS, 2004

Rank	Serotype	Number	Percent
1	Typhimurium*	6,842	19.2%
2	Enteritidis	5,012	14.1%
3	Newport	3,325	9.3%
4	Javiana	1,772	5.0%
5	Heidelberg	1,757	4.0%
6	Montevideo	870	2.4%
7	I 4,[5],12:i:-	739	2.1%
8	Muenchen	739	2.1%
9	Saintpaul	692	1.9%
10	Braenderup	684	1.9%
11	Infantis	588	1.6%
12	Mississippi	558	1.6%
13	Oranienburg	495	1.4%
14	Thompson	493	1.4%
15	Berta	409	1.1%
16	Agona	406	1.1%
17	Paratyphi B var. L(+) tartrate+	354	1.0%
18	Typhi	306	0.9%
19	Hadar	277	0.7%
20	Anatum	250	0.7%
Subtotal		**26,568**	**74.5%**
All other serotypes		5,651	15.8%
Unknown		2,053	5.8%
Partially serotyped isolates		1,328	3.7%
Rough or nonmotile isolates		61	0.2%
Subtotal		**9,093**	**25.5%**
Total		**35,661**	**100.0%**

* Typhimurium includes var. Copenhagen.

Figure 4-1. Isolation rate per 100,000 population for the top four serotypes of *Salmonella* reported to PHLIS, 1970–2004

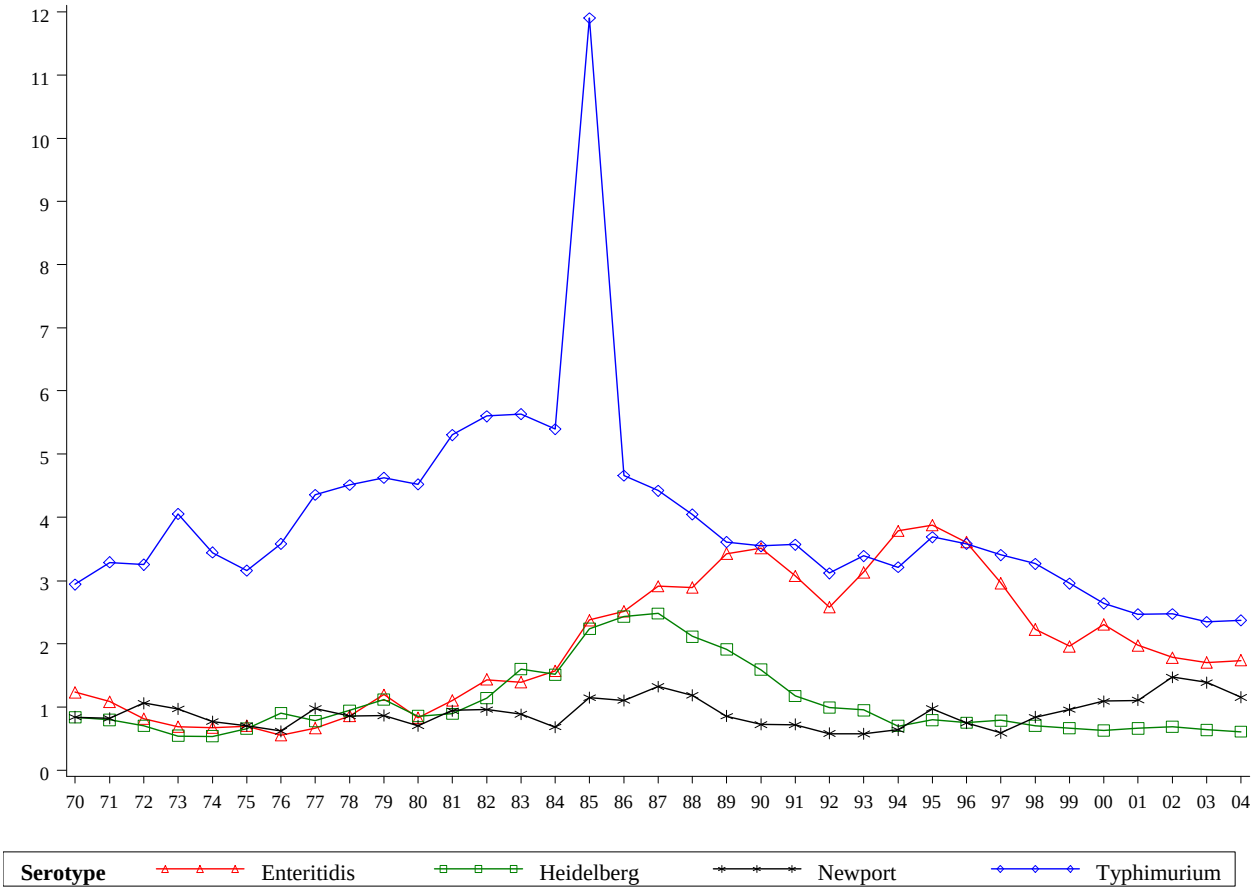
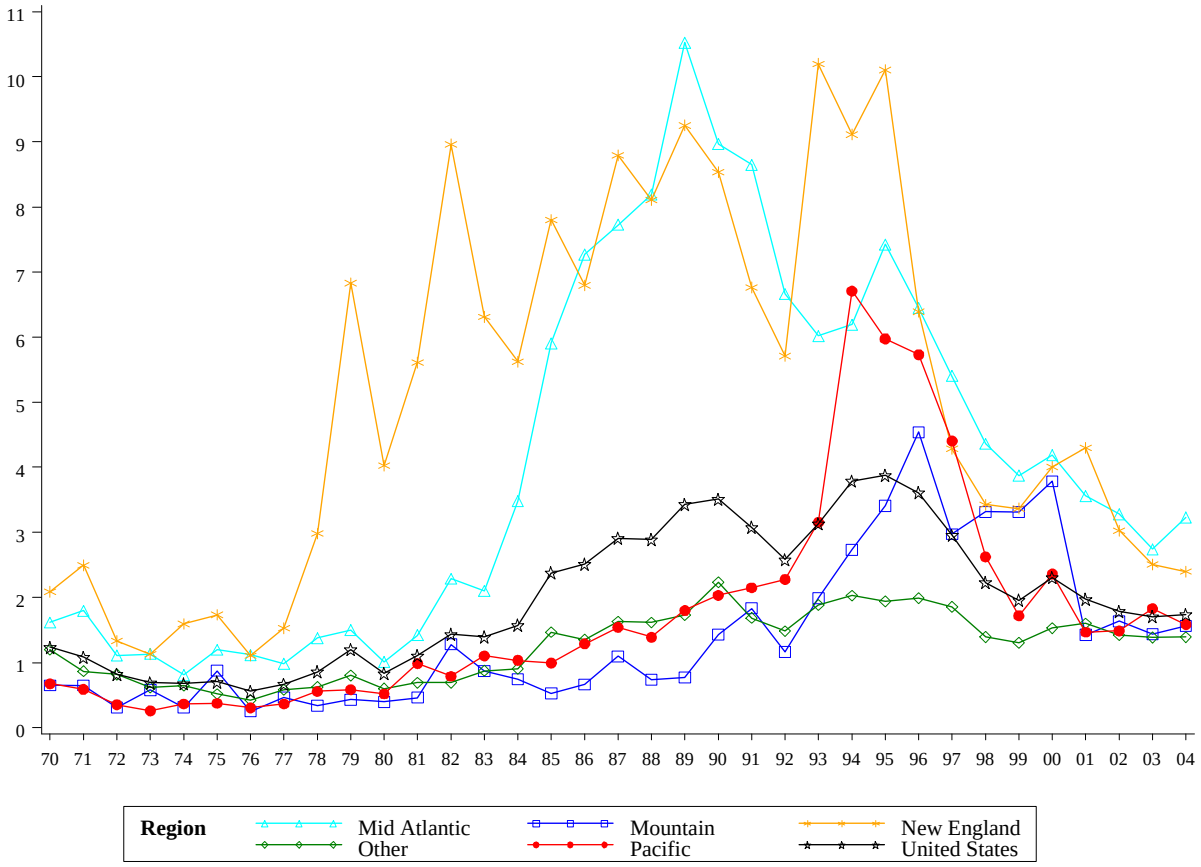


Figure 4-2. Isolation rate per 100,000 population for *Salmonella* Enteritidis reported to PHLIS, by region, 1970–2004



Shigella

The *Shigella* surveillance case definition is available at http://www.cdc.gov/epo/dphsi/casedef/shigellosis_current.htm. The National *Shigella* Surveillance System collects reports of isolates of *Shigella* from every state. *Shigella* isolates are submitted to the state public health laboratory by clinical diagnostic laboratories. The state and territorial laboratories confirm the isolates as *Shigella*, perform subtyping, and report the data electronically through PHLIS to EDEB. Unusual or untypable isolates are forwarded to the National *Shigella* Reference Laboratory at CDC for further characterization or confirmation. These results are reported back to the state laboratory, where they are reported to CDC through PHLIS. Duplicates are removed from the file at the end of the year.

The capture of isolates in the National *Shigella* Surveillance System is considered to be consistent. However, some *Shigella* isolates may not be forwarded or reported to state public health laboratories, and therefore are not captured. In addition, irrespective of the surveillance system, many cases of *Shigella* illness are not reported because the ill person does not seek medical care, the health care provider does not obtain a specimen for diagnosis, or the laboratory does not perform culture for *Shigella*. The results of surveillance reported here are therefore substantial underestimates of the true number of infections.

The reporting state represents the state where laboratory confirmation and subtyping were performed. In some instances, the reporting state is not the same as the state of residence of the person from whom the isolate was obtained.

There are four major subgroups and 44 recognized serotypes of *Shigella* that are differentiated from one another by their biochemical traits (such as ability to ferment mannitol) and antigenic properties (Table 5-1).

A total of 9,343 *Shigella* isolates were reported from public health laboratories in 50 states in 2004 (Table 5-2). This represents a 50% decrease compared with 1994 and a 41% increase from 2003. The national rate was 3.2 per 100,000 population.

Similar to previous years, children younger than age 5 years accounted for 30.2% of all *Shigella* isolates. About 31.6% came from persons aged 5–19 years, and 28.8 % from persons aged 20–59, with declining numbers thereafter. The overall distribution of *Shigella* isolates between the sexes was similar, with females accounting for 48.4% of persons from whom *Shigella* was isolated. The frequency of reported subgroups and the frequency of reported serotypes within these groups for all *Shigella* isolates are shown in Tables 5-2 and 5-3. Of the 9,343 isolates, 8,242 (88.2%) were subgrouped. The relative proportions of the four different subgroups remained constant, with *S. sonnei* accounting for the largest percentage of isolates (68.9%), followed by *S. flexneri* (17.2%), *S. boydii*, (1.8%), and *S. dysenteriae* (0.4%). Over the past decade, the numbers of reported *Shigella* isolates in subgroups *S. flexneri*, *S. boydii*, and *S. dysenteriae* and the proportions of all reported *Shigella* isolates caused by these three subgroups have declined. Slight increases in the number of *S. boydii* isolates were observed in both 2003 and 2004. The number (1,101) and the proportion (11.8%) of all reported *Shigella* isolates that were not identified as belonging to a specific subgroup also increased.

Table 5-1. Classification of *Shigella* subgroups

Subgroup	Subgroup	Serotypes	Fermentation of D-Mannitol	Subgroup B Group Antigens
A	*S. dysenteriae*	15	-	-
B	*S. flexneri*	8*	+	+
C	*S. boydii*	20	+	-
D	*S. sonnei*	1	+	-

***** Serotypes 1–5 are subdivided into 11 subserotypes.

Table 5-2. *Shigella* subgroups reported to PHLIS, 2004

Rank	Subgroup	Number	Percent
1	*S sonnei*	6,433	68.9
2	*S. flexneri*	1,603	17.2
3	*S. boydii*	169	1.6
4	*S. dysenteriae*	37	0.4
Subtotal		**8,242**	**88.2**
Unknown		**1,101**	**11.8**
Total		**9,343**	**100.0**

Table 5-3. Rank and number of isolates of *Shigella* serotypes reported to PHLIS, 2004

Rank	Serotype	Number	Percent
1	*S. sonnei*	6433	68.9%
2	*S. flexneri* unspecified	814	8.7%
3	*S. flexneri* 2 unspecified	185	2.0%
4	*S. flexneri* 3 unspecified	112	1.2%
5	*S. boydii* unspecified	111	1.2%
6	*S. flexneri* 1 unspecified	98	1.2%
7	*S. flex*neri 2a	89	1.0%
8	*S. flexneri* 4 unspecified	69	0.7%
9	*S. flexneri* 3a	53	0.6%
10	*S. flexneri* 4a	53	0.6%
11	*S. flexneri* 6	42	0.5%
12	*S. flexneri* 1b	27	0.3%
13	*S. flexneri* variant y	26	0.3%
14	*S. dysenteriae* unspecified	22	0.2%
15	*S. boydii* 2	20	0.2%
16	*S. boydii* 4	15	0.2%
17	*S. flexneri* 3b	13	0.1%
18	*S. boydii* 1	10	0.1%
19	*S. flexneri* 2b	10	0.1%
20	*S. flexneri* variant x	5	0.1%
21	*S. dysenteriae* 1	4	0.0%
22	*S. dysenteriae* 2	4	0.0%
23	*S. dysenteriae* 3	4	0.0%
24	*S. boydii* 10	3	0.0%
25	*S. boydii* 14	3	0.0%
26	*S. boydii* 5	3	0.0%
27	*S. flexneri* 5 unspecified	3	0.0%
28	*S. boydii* 8	2	0.0%
29	*S. dysenteriae* 12	2	0.0%
30	*S. flexneri* 5a	2	0.0%
31	*S. boydii* 12	1	0.0%
32	*S. boydii* 20	1	0.0%
33	*S. dysenteriae* 4	1	0.0%
34	*S. flexneri* 1a	1	0.0%
35	*S. flexneri* 88-893	1	0.0%
Subtotal		**8,242**	**88.2%**
Unknown		**1,101**	**11.8%**
Total		**9,343**	**100.0%**

Vibrio

The cholera and vibriosis (non-cholera *Vibrio* species) surveillance case definitions are available at http://www.cdc.gov/epo/dphsi/casedef/cholera_current.htm and http://www.cdc.gov/epo/dphsi/casedef/vibriosis.htm. Infection with toxigenic *Vibrio cholerae* O1 and O139, the causative agents of cholera, has been a reportable disease in the United States for many years. More recently, toxigenic *V. cholerae* O141 has emerged as a cause of illness, but it does not cause cholera and is not notifiable.

The Cholera and Other *Vibrio* Illness Surveillance System (COVIS) was initiated by CDC, FDA, and the Gulf Coast states (Alabama, Florida, Louisiana, Mississippi, and Texas) in 1988. CDC has maintained a database of reported *Vibrio* infections from humans in order to obtain reliable information on illnesses associated with *Vibrio* species. Participating health officials collect clinical data, information about underlying illness, history of seafood consumption, and exposure to seawater in the 7 days before illness, and then conduct tracebacks of implicated oysters. This information has been used to educate consumers about the health risks of seafood, as well as to help determine host, food, and environmental risk factors. Since 1997, many other states have also reported *Vibrio* isolates. However, only toxigenic *V. cholerae* O1 and O139, the causative agents of cholera, were nationally notifiable during 2005; thus the true number of *Vibrio* isolates is greater than reported. CDC serotypes all *V. parahaemolyticus* isolates received from state health departments and screens for cholera toxin production in all *V. cholerae* isolates.

Results are summarized using CDC form 52.79, Cholera and Other *Vibrio* Illnesses Surveillance Report and presented in two categories: *V. cholerae* isolates that produce cholera toxin (referred to as toxigenic *V. cholerae*) and all other *Vibrio* isolates (including those *V. cholerae* isolates that do not produce cholera toxin). Results are presented separately for Gulf Coast states versus other states to be consistent with previous reports. Additionally, results are presented by anatomic site of isolation. It is important to note that isolation of some *Vibrio* species from a patient with illness does not necessarily indicate causation. While many *Vibrio* species are well-recognized pathogens, the status of *V. damsela*, *V. furnissii*, *V. metschnikovii*, and *V. cincinnatiensis* as enteric pathogens is less clear.

Isolates of toxigenic *Vibrio cholerae*

In 2004, eight patients with toxigenic *V. cholerae* were reported (Table 6-1). Five patients had cholera and were infected with toxigenic *V. cholerae* serogroup O1. One patient acquired the infection in Thailand, two while traveling in India, one in the Philippines, and one in Hawaii. The two patients who acquired infection during travel in India were unrelated cases, and they traveled to India 4 months apart from each other. Three patients were hospitalized and one died. No isolates of toxigenic *V. cholerae* O139 were identified. Toxigenic *V. cholerae* O141 was isolated from three patients. One patient was a male Georgia resident who consumed oysters 3 days before onset of his symptoms. The oysters were traced to a harvest site in Florida. The second patient was a female Georgia resident who reported no exposure to seafood in the 10 days preceding illness. The third patient was a male Alabama resident who consumed oysters 10 days before onset of his symptoms. The oysters could not be traced back to their harvest site.

Other *Vibrio* isolates (excluding toxigenic *V. cholerae*)

In 2004, 501 *Vibrio* isolates (excluding toxigenic *V. cholerae*) from 479 patients were reported to

COVIS. Among patients for whom information was available, 173 (38%) of 460 were hospitalized and 39 (9%) of 443 died. *V. parahaemolyticus* was isolated from 240 (51%) patients, and was the most frequently reported *Vibrio* species. Of the patients infected with *V. parahaemolyticus*, 20% were hospitalized and 1% died. *V. vulnificus* was isolated from 92 (19%) patients; 88% were hospitalized and 39% died. The following sections provide further information on these non-toxigenic *Vibrio* isolates:

Geographic location: In 2004, we received 130 (27%) reports of *Vibrio* illness from Gulf Coast states, 211 (44%) from Pacific Coast states, 100 (21%) from Atlantic Coast states (excluding Florida), and 38 (8%) from inland states (Figure 6-1). The most frequent *Vibrio* species reported from Gulf Coast states were *V. vulnificus* (47%), *V. parahaemolyticus* (21%), and non-toxigenic *V. cholerae* (9%). The most frequent *Vibrio* species reported from non-Gulf Coast states were *V. parahaemolyticus* (61%), *V. alginolyticus* (11%), *V. vulnificus* (9%), and non-toxigenic *V. cholerae* (7%).

Anatomic site of isolation: Among the 501 *Vibrio* isolates, 265 (53%) were from stool, 87 (17%) from blood, and 72 (14%) from wounds. In addition, 23 (5%) isolates were obtained from the ear, and 20 (4%) were from the gallbladder, urine, or other site. *V. parahaemolyticus* was the species most frequently isolated from stool (199 [75%] of 265 isolates from stool); *V. vulnificus* was the species most frequently isolated from blood (64 [74%] of 87 isolates from blood) and from wounds (28 [39%] of 72 isolates from wounds).

Seasonality: The number of patients from whom *Vibrio* species was isolated had a clear seasonal peak during the summer months (Figure 6-2). The greatest frequency occurred in July for Gulf Coast states and in August for non-Gulf Coast states.

Exposures: Among the 479 patients, 114 (24%) patients reported having a wound either before or during exposure to *Vibrio*. Of those, 43 (38%) reported water activities such as swimming and boating, 19 (17%) reported handling seafood, and 18 (16%) reported contact with marine wildlife. Excluding patients from whom *Vibrio* was isolated from a wound, and among the 255 for whom a food history was available, 223 (87%) reported eating seafood in the 7 days before illness onset. Among the 118 who reported eating a single seafood item (Table 6-4), 69% ate oysters (88% of whom consumed them raw), 10% ate shrimp, and 7% ate finfish. International travel in the 7 days before illness onset was reported by 11 (12%) of patients.

Laboratory: For reports where laboratory confirmation was available, the state public health laboratory confirmed the identification of 165 (95%) of 173 human *Vibrio* isolates. CDC received 81 isolates of *V. parahaemolyticus* from 80 patients. Of these, 76 were viable, four were not viable, and one was not *Vibrio*. Of the viable *V. parahaemolyticus* isolates, 14 (17%) from eight states were serotype O4:K12 (Illinois, Indiana, Louisiana, Massachusetts, Montana, Nevada, New York, and Oregon), 12 (15%) isolates from 10 states were serotype O3:K6 (Arizona, Colorado, Connecticut, Georgia, Hawaii, Illinois, Louisiana, New Hampshire, Texas, and Utah), 10 (12%) isolates from four states were serotype O6:K18 (Alaska, Nevada, Oregon, and Washington), and the remaining 40 isolates were one of 20 serotypes.

Outbreaks: One outbreak of *V. parahaemolyticus* serotype O6:K18 in which 62 persons were ill

(10 culture-confirmed) from consumption of raw oysters harvested from Alaskan waters was reported from Alaska. Individual case reports from this outbreak were not submitted to COVIS and are not included in this summary.

Table 6-1. Isolates of toxigenic *V. cholerae* reported to COVIS, 2004

State	Age	Sex	Onset	Suspected Exposure	Serogroup	Serotype
Hawaii	44	Female	1/9/2004	Exposure in the Philippines	*V. cholerae* O1	Ogawa
Illinois	65	Male	2/10/2004	Exposure to raw seafood in Thailand	*V. cholerae* O1	Inaba
California	48	Female	4/7/2004	Exposure in India	*V. cholerae* O1	Inaba
Hawaii	60	Female	5/16/2004	Exposure to raw, imported seafood	*V. cholerae* O1	Ogawa
Georgia	50	Male	7/27/2004	Exposure to oysters in Georgia	*V. cholerae* O141	Unknown
Georgia	58	Female	7/28/2004	Unknown	*V. cholerae* O141	Unknown
Alabama	63	Male	10/18/2004	Exposure to oysters in Florida	*V. cholerae* O141	Unknown
New York	51	Male	12/16/2004	Exposure in India	*V. cholerae* O1	Inaba

Table 6-2. Number of *Vibrio* isolates (excluding toxigenic *V. cholerae*) reported to COVIS, by species, complications, and site of isolation in patients from Gulf Coast states, 2004

Vibrio Species	Patients		Complications*				Isolates		Site of Isolation			
			Hospitalized		Deaths				Stool	Blood	Wound	Other[†]
	N	(%)	n/N	(%)	n/N	(%)	N	(%)				
V. alginolyticus	7	(5)	3/6	(50)	0/6	(0)	7	(4)	0	0	4	3
V. cholerae (non-toxigenic)[‡]	12	(9)	6/11	(55)	1/11	(9)	13	(9)	6	6	1	0
V. damsela	1	(1)	1/1	(100)	0/1	(0)	1	(1)	0	0	1	0
V. fluvialis	7	(5)	3/7	(43)	0/7	(0)	7	(5)	5	0	1	1
V. hollisae	1	(1)	0/1	(0)	0/1	(0)	1	(1)	1	0	0	0
V. mimicus	5	(4)	2/5	(40)	0/5	(0)	5	(4)	5	0	0	0
V. parahaemolyticus	27	(21)	13/26	(50)	1/24	(4)	28	(20)	19	1	6	2
V. vulnificus	60	(47)	52/59	(88)	19/53	(36)	66	(47)	1	40	20	5
Other	2	(2)	1/2	(50)	0/1	(0)	2	(1)	0	0	1	1
Species not identified	7	(5)	2/5	(40)	1/6	(17)	7	(5)	2	1	2	2
Multiple species[§]	1	(1)	1/1	(100)	0/2	(0)	4	(3)	0	2	2	0
Total	**130**	**(100)**	**84/124**	**(68)**	**22/117**	**(19)**	**141**	**(100)**	**39**	**50**	**36**	**16**

[*] Denominators indicate patients for whom information is known.
[†] Includes ear, eye, gall bladder, peritoneal fluid, sputum, leg tissue, and unknown source.
[‡] Non-toxigenic *V. cholerae*. Includes non-toxigenic *V. cholerae* O1 (1 isolate) and other non-toxigenic *V. cholerae* (non-O1 non-O139) (11 isolates).
[§] *V. parahaemolyticus* and *V. vulnificus* were isolated from the wound and blood of one patient.

Table 6-3. Number of *Vibrio* isolates (excluding toxigenic *V. cholerae*) reported to COVIS, by species, complications, and site of isolation in patients from non-Gulf Coast states, 2004

Vibrio Species	Patients		Complications*				Isolates		Site of Isolation			
			Hospitalized		Deaths				Stool	Blood	Wound	Other[†]
	N	(%)	n/N	(%)	n/N	(%)	N	(%)				
V. alginolyticus	37	(11)	7/35	(20)	1/33	(3)	37	(10)	2	2	17	16
V. cholerae (non-toxigenic)[‡]	28	(7)	6/27	(22)	0/27	(0)	28	(8)	19	3	1	5
V. damsela	2	(1)	2/2	(100)	0/2	(0)	2	(1)	0	0	1	1
V. fluvialis	10	(3)	4/9	(44)	0/10	(0)	10	(3)	6	1	1	2
V. furnissii	2	(1)	1/2	(50)	0/2	(0)	2	(1)	1	0	1	0
V. hollisae	1	(0)	1/1	(100)	0/1	(0)	1	(0)	1	0	0	0
V. mimicus	4	(1)	0/4	(0)	0/4	(0)	4	(1)	3	0	0	1
V. parahaemolyticus	213	(61)	33/204	(16)	2/197	(1)	215	(60)	180	4	6	25
V. vulnificus	32	(9)	28/32	(88)	13/30	(43)	37	(10)	4	24	8	1
Other	1	(0)	0/1	(0)	0/1	(0)	1	(0)	1	0	0	0
Species not identified	15	(4)	5/15	(33)	0/15	(0)	15	(4)	5	1	1	8
Multiple species[§]	4	(1)	2/4	(50)	1/4	(25)	8	(2)	4	2	2	0
Total	**349**	**(100)**	**89/336**	**(26)**	**17/326**	**(5)**	**360**	**(100)**	**226**	**37**	**36**	**61**

* Denominators indicate patients for whom information is known.

[†] Includes ear, urine, sputum, foot tissue, thigh tissue, endotracheal intubation, incision, and unknown source.

[†] Non-toxigenic *V. cholerae*. Includes non-toxigenic *V. cholerae* O1 (2 isolates) and other non-toxigenic *V. cholerae* (non-O1 non-O139) (26 isolates).

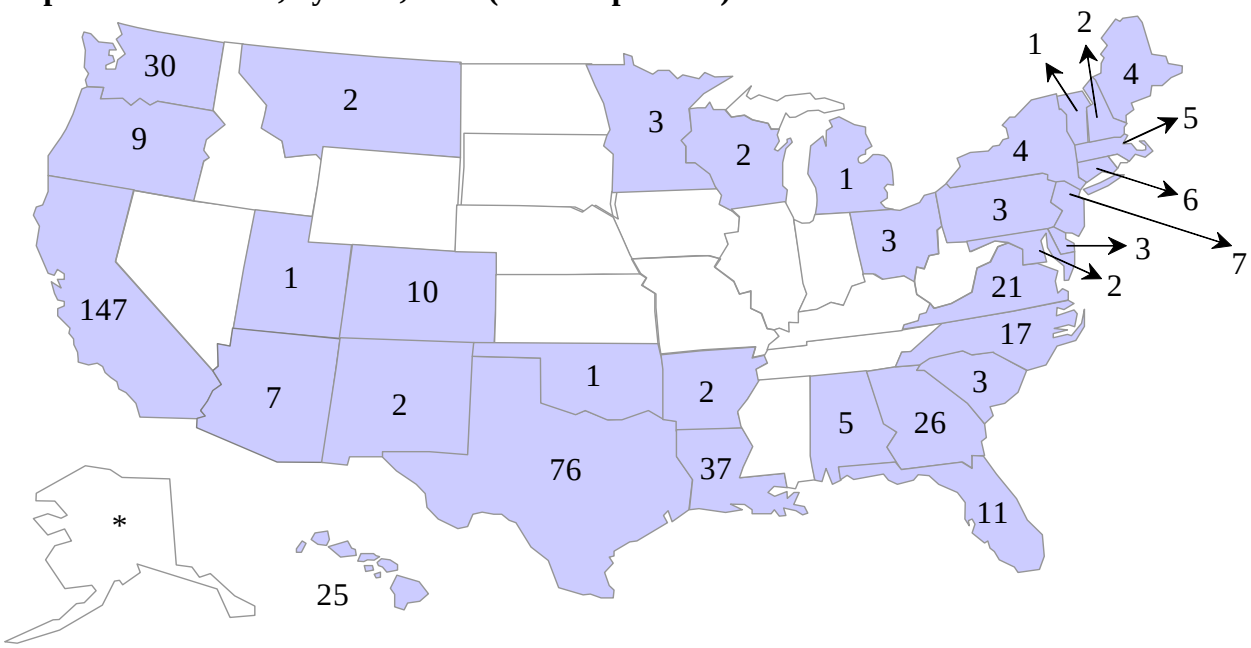
[§] *V. cholerae* non-01, non-0139 and *V. parahaemolyticus* were isolated from the stool of one patient; *V. damsela* and *V. vulnificus* were isolated from the thigh wound of a second patient; *V. cholerae* non-01, non-0139 and *V. mimicus* were isolated from the stool of a third patient; and *V. fluvialis* and *V. furnissii* were isolated from blood of a fourth patient.

Table 6-4. Seafood exposure among patients with foodborne *Vibrio* infection (excluding toxigenic *V. cholerae*) who reported eating a single seafood item in the week before illness onset, 2004

	Mollusks			Crustaceans				Other Shellfish*	Finfish†	Total
	Oysters	Clams	Mussels	Shrimp	Lobster	Crab	Crayfish			
Ate (%)	81 (69)	3 (3)	0 (0)	12 (10)	0 (0)	6 (5)	2 (2)	6 (5)	8 (7)	118
Ate raw (%)	88	67	0	8	0	33	0	33	50	82

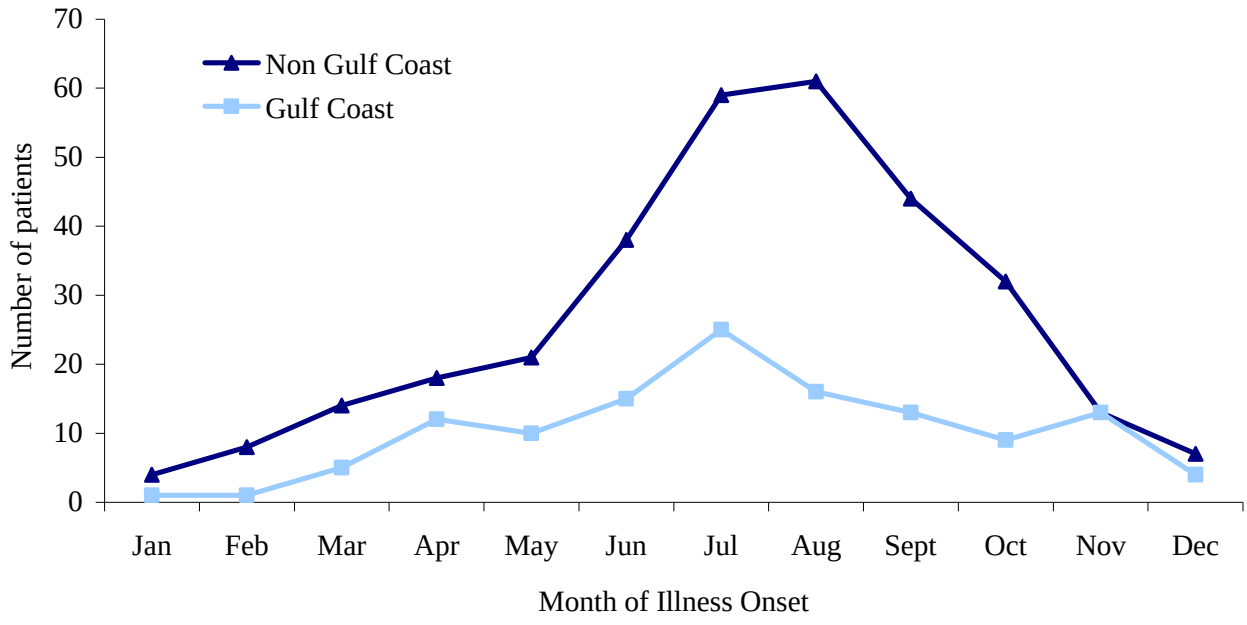
* Other shellfish reported: calamari, squid, and scallops.
† Finfish reported: salmon, trout, catfish, tilapia, sushi, tuna, and eel.

Figure 6-1. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*) reported to COVIS, by state, 2004 (N = 479 patients)



* 62 cases of *Vibrio parahaemolyticus* from an outbreak during summer 2004

Figure 6-2. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*) reported to COVIS, by month*, Gulf Coast states vs. other states, 2004 (N = 475*)



*Onset date missing or unknown for 4 patients

Data Sources and Background

CDC conducts national surveillance to define the magnitude and burden of diseases, to identify outbreaks or high-risk groups so that preventive actions can be taken, and to track the effectiveness of control and prevention measures. The surveillance systems for different foodborne pathogens have evolved over time. There are many distinct surveillance systems, some managed by individual program areas (e.g., botulism surveillance), and others administered and used more broadly.

National Notifiable Diseases Surveillance System (NNDSS)and National Electronic Telecommunications System for Surveillance (NETSS)
The origins of NNDSS date back to 1878 when Congress authorized the U.S. Marine Hospital Service to collect morbidity reports regarding cholera, smallpox, plague, and yellow fever from U.S. consuls oversees. Today, NNDSS is operated by CDC in collaboration with the Council of State and Territorial Epidemiologist (CSTE) and serves as a timely source of national disease data. NETSS is the software and electronic communication pathway by which NNDSS data reach the CDC; this whole system is often identified by the NETSS acronym. NETSS is administered by CDC's National Center for Public Health Informatics (NCPHI).

There are several sources of NETSS surveillance information for individual infections. For many diseases, public health authorities at state departments of health request or require that physicians and other health care workers report cases to the local health department. For some diseases, authorities also request or require clinical laboratories to report the identification or isolation of certain pathogens. These reports are summarized and forwarded to the state department of health, which then sends the information to CDC if the disease is nationally notifiable.

Public Health Laboratory Information System (PHLIS)
In addition to allowing public health authorities to track diagnosed cases of notifiable disease, sending pathogens isolated from patients to public health laboratories to confirm the identity of the organism and its subtype provides an additional public health benefit. This process can identify clusters of a specific subtypes and link events from widely dispersed locations. An example is surveillance for serotype of *Salmonella*. In 1962, CDC, CSTE, and the Association of State and Territorial Public Health Laboratory Directors agreed to serotype *Salmonella* isolates and send the resulting information to CDC weekly. Eight states participated initially. Eventually, all 50 states began transmitting information throuth PHLIS, an electronic network tool developed in the 1980s. PHLIS collects laboratory surveillance information for a large number of pathogens (foodborne and non-foodborne). In 2004, it was administered by the Biostatistics and Information Management Branch of the Division of Bacterial and Mycotic Diseases, located in CDC's National Center for Infectious Diseases. PHLIS information has been used to identify, investigate, and control outbreaks of salmonellosis and other foodborne diseases at local, regional, national, and international levels.

Limitations Common to NETSS and PHLIS
Most surveillance systems for foodborne and diarrheal diseases tend to underestimate the burden of disease. Diseases that cause severe clinical illness are most likely to be reported

accurately if they were diagnosed by a physician. However, persons who have diseases that are clinically mild and infrequently associated with severe consequences might not seek medical care from a health care provider, and these diseases are never diagnosed. Even if these less severe diseases are diagnosed, they are less likely to be reported in surveillance systems.

The information reported about each case is typically limited to age, sex, county of residence, date of diagnosis, and a small number of other variables. The degree of completeness of data reporting is also influenced by the diagnostic facilities available; the control measures in effect; the public awareness of a specific disease; and the interests, resources, and priorities of state and local officials responsible for disease control and public health surveillance. Factors such as changes in the case definitions for public health surveillance, the introduction of new diagnostic tests, or the discovery of new disease entities can cause changes in disease reporting that are independent of the true incidence of disease.

Some important infections that are difficult to diagnose are not included in general surveillance. For example, the diagnosis of enterotoxigenic *E. coli* remains restricted to a few research and large public health laboratories, and tests for this pathogen are not performed in standard clinical laboratories. Surveillance systems cannot track infections by this cause of foodborne diarrheal illness.

Limitations Specific to NETSS and PHLIS

NETSS is a passive surveillance system that relies on a mix of clinicians and laboratories that vary by state and by pathogen to report cases or pathogen isolations. The system includes cases that are diagnosed only clinically (on the basis of symptoms, signs, and the epidemiological setting) as well as cases that are diagnosed by a definitive laboratory test. The willingness of clinicians to report cases varies from disease to disease, and the completeness and timeliness of reporting is problematic for some diseases. The data do not include the specific findings of the public health laboratory, such as a subtype, and therefore are not useful for detecting clusters of a particular subtype. The lack of subtyping for common pathogens makes detection of outbreaks difficult, especially those that are multi-jurisdictional. This is particularly true for *Salmonella* and *Shigella* infections.

PHLIS, a public health laboratory-based surveillance system, is also limited as a passive system; it relies on clinical laboratories to send *Salmonella* and other isolates to the state public health laboratory for subtyping. For example, because there is no routine referral or subtyping of *Campylobacter* strains in the United States, state public health laboratories may report only those strains that they isolate themselves (e.g., from patients in public health clinics or from specimens collected in outbreak investigations). The number of *Campylobacter* isolates reported through PHLIS is typically a small fraction of the number diagnosed. The need to send an isolate from the original clinical laboratory to the state public health laboratory and the need for the state laboratory to do the serotyping means that reports may be delayed. Training and support are required to ensure that state laboratories have the specialized skills and reagents needed to perform serotyping or other subtyping methods. The PHLIS software, written first in the late 1980s, has not been fully integrated into other software used in the states, and its use requires training.

State-to-State Variations in Reported Cases
There is substantial variation in the number of reported cases from one state compared to another, even when taking into account the differences in population sizes among states. One major source of variation is that a given disease may be reportable in one state but not in another, even for nationally notifiable diseases. Reporting requirements are under state jurisdiction. There may also be substantial variation from one state to another depending on local resources, interests, and priorities. When more than one route is available for reporting surveillance data within the public health system, states may choose to use one or the other or more than one. For example, some state public health laboratories report *E. coli* O157:H7 isolates that they receive for confirmation through PHLIS, and some state epidemiology offices report infections with this organism through NETSS.

Some states may chose to submit reports on diseases for which they have collected information, but which are not nationally notifiable. These data indicate the interest and concern with that disease within that specific state.

In addition, there are substantial state-to-state and regional differences in the incidence of certain diseases. For example, PHLIS has demonstrated that some *Salmonella* serotypes are isolated with similar frequency in persons in all U.S. regions, while other serotypes are highly localized. The PHLIS *Salmonella* Surveillance System is a stable system that has been functioning well for several decades with full national participation, so these results are considered valid.

Program-Specific Surveillance Systems
Because both NETSS and PHLIS collect little information beyond very basic patient demographics (e.g., age, sex, race, place, time) and pathogen characteristics, EDEB collects more detailed information on individual cases for some diseases because this information is needed for accurate monitoring and effective intervention. These include botulism, typhoid fever, and cholera and *Vibrio* species infections. For botulism, typhoid fever, and cholera, reporting is nationwide. For the noncholera *Vibrio* species, reporting is mainly through a surveillance alliance with the Gulf Coast states of Alabama, Florida, Louisiana, and Texas. *Vibrio* surveillance also includes voluntary reporting from many other states. These systems and their resulting databases are distinct and separate from each other and from NETSS and PHLIS.

Botulism surveillance has unique attributes. Botulism is an extreme hazard that can be fatal if untreated, and it has caused rare but catastrophic foodborne outbreaks that are public health emergencies. CDC provides the antitoxin used to treat the illness and releases it for treatment of suspected botulism from airport quarantine stations at the request of a state epidemiologist. Clinicians who suspect a patient has botulism can call their state health department or CDC to arrange release through a 24-hour emergency response system. This drug release mechanism means that CDC gets immediate information about suspected cases of botulism, which functions as an early alert surveillance system.

Though not formally part of a surveillance system, EDEB tracks the number and type of non-O157 Shiga toxin-producing *E. coli* received from public health laboratories around the

country. Among public health and clinical laboratories in the United States, only CDC has the capacity to serotype and characterize a wide variety of these isolates. Thus, our collection of isolates is likely representative of those isolated in the United States. and forwarded to public health laboratories.

Surveillance at Selected Sites

For nine foodborne infections, the most detailed and accurate surveillance information comes from the Foodborne Diseases Active Surveillance Network (FoodNet). In 2004, FoodNet included 10 surveillance sites, each comprised of several counties within a state, or a whole state, and covering a population of approximately 44.5 million, or 15% of the U.S. population. FoodNet actively gathers information about nine infections or conditions, integrates it with available laboratory information, and also collects information about the severity and outcome of the illness. In addition, FoodNet conducts population surveys to determine the burden of illness and how many ill persons visited a physician and got tested, as well as surveys of clinical laboratories to determine which pathogens are sought. Because standard surveillance methods are used, FoodNet data can be used to compare rates of illness over time and from one site to another.

Enhancements to Surveillance Systems

Public health surveillance is an evolving effort. As new disease entities are identified and defined as public health problems, surveillance for them begins and improves. As better understanding leads to better prevention, cases may level off, decline, and ultimately disappear. On the list of nationally notifiable diseases, there are several that were once large public health problems, but are now rarely reported. The official list of nationally notifiable diseases changes in accordance with resolutions issued by CSTE.

The methods and information obtained for surveillance also continue to evolve. Active surveillance in sentinel populations (such as FoodNet) can provide reliable and detailed information about detected infections and eliminate the undercount caused by lack of resources or reporting effort. However, this effort is expensive and cannot be applied everywhere. The ongoing revolution in biotechnology is bringing new subtyping and fingerprinting technologies, such as pulsed-field gel electrophoresis (PFGE), into state and local public health laboratories. PulseNet is a national network of public health and food regulatory agency laboratories coordinated by CDC; PulseNet participants use PFGE to characterize isolates of foodborne disease pathogens. Isolate DNA patterns generated by PFGE are submitted electronically to the PulseNet database at CDC, where they are analyzed to identify clusters of illness caused by the same pathogen subtype. This approach is enhancing our capacity to detect outbreaks rapidly, to link widely separated cases, and to track more precisely the results of specific control measures. New electronic reporting media have accelerated reporting and have made possible practical automated cluster detection algorithms, such as the Statistical Outbreak Detection Algorithm (SODA), which has been in operation using PHLIS data for *Salmonella* since 1995. CDC's efforts to produce a new integrated surveillance system, which will bring information directly from the clinical laboratory into a public health database, should improve the timeliness and consistency of reporting for many diseases.

Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases

Many staff members, both within and outside EDEB, are responsible for national surveillance for foodborne and diarrheal diseases. For the purpose of this report, EDEB national case surveillance activity is considered separate from foodborne outbreak surveillance, which is collected by FoodNet and the National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS-EB). Information about FoodNet and NARMS is available in the reference section. Surveillance for foodborne disease outbreaks is available in a report produced by the EDEB Outbreak Response and Surveillance Team. EDEB activities also include surveillance of bacterial pathogens. Surveillance information on viral diseases is reported by CDC's Division of Viral and Rickettsial Diseases, while information on parasitic diseases is reported by the Division of Parasitic Diseases. Surveillance information on chemical intoxications is reported by CDC's National Center for Environmental Health.

Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases

System	Cases Reported	Contact	Title	CDC Division
NNDSS/NETSS	Clinical-case reporting of Campylobacteriosis, Botulism, STEC, Hemolytic Uremic Syndrome, Listeriosis, Typhoid Fever, Salmonellosis, Shigellosis, Cholera	Ruth Ann Jajosky	Epidemiologist	Integrated Surveillance Systems and Services
PHLIS	Laboratory-based reporting of STEC, *Salmonella, Shigella*	Richard Bishop	Analyst	Foodborne, Bacterial and Mycotic Diseases
National Botulism Surveillance System	Detail case information for all U.S. botulism cases, including foodborne, infant, wound, and other forms	Jeremy Sobel	Epidemiologist, EDEB	Foodborne, Bacterial and Mycotic Diseases
Typhoid Fever Surveillance System	Detailed case information for all U.S. typhoid fever cases	Liz Blanton	Epidemiologist, EDEB	Foodborne, Bacterial and Mycotic Diseases
Vibrio Surveillance System	Detailed case information for all U. S. cholera and other *Vibrio* species. infections	Martha Iwamoto (vibriosis) Liz Blanton (cholera)	Epidemiologist, EDEB Epidemiologist, EDEB	Foodborne, Bacterial and Mycotic Diseases Foodborne, Bacterial and Mycotic Diseases
National *Salmonella, Campylobacter*, and *Helicobacter* Reference Lab	Isolates received at CDC for serotyping and characterization	Patricia Fields	Chief, Enteric Diseases Laboratory Branch	Foodborne, Bacterial and Mycotic Diseases
National *E. coli, Shigella, Yersinia,* and *Vibrio* Reference Lab	Isolates received at CDC for serotyping and characterization	Nancy Strockbine	Team Lead, National *E. coli, Shigella, Yersinia,* and *Vibrio* Reference Lab	Foodborne, Bacterial and Mycotic Diseases

List of Acronyms

BSO……. . Biostatistics Office
CDC……... Centers for Disease Control and Prevention
CSTE……..Council of State and Territorial Epidemiologist
DFBMD…… Division of Foodborne, Bacterial and Mycotic Diseases
EHEC……Enterohemorrhagic *Escherichia coli*
EIA……Enzyme Immunoassays
ETEC……..Enterotoxigenic *Escherichia coli*
EDEB……Enteric Diseases Epidemiology Branch
FDA……Food and Drug Administration
FoodNet……..Foodborne Diseases Active Surveillance Network
HUS……Hemolytic Uremic Syndrome
MMWR…….. *Morbidity Mortality Weekly Repor*t
NARMS-EB……...National Antimicrobial Resistance Monitoring System for Enteric Bacteria
NCID……..National Center for Infectious Diseases
NETSS……... National Electronic Telecommunications System for Surveillance
NNDSS…….. National Notifiable Diseases Surveillance System
PCR……Polymerase Chain Reaction
PFGE……..Pulsed-field Gel Electrophoresis
PHLIS…… Public Health Laboratory Information System
SODA…….Statistical Outbreak Detection Algorithm
STEC……..Shiga toxin-producing *Escherichia coli*

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CDC Internet Sites Relevant to Foodborne and Diarrheal Diseases

For more information about foodborne disease, please visit any of the following Web sites:

Case definition for Infectious Conditions under Public Health Surveillance
http://www.cdc.gov/epo/dphsi/casedef/index.htm

Causes of Foodborne Illness
http://www.cdc.gov/foodborneoutbreaks/foodborne_az.htm

Division of Bacterial and Mycotic Diseases
http://www.cdc.gov/ncidod/dbmd/

Division of Parasitic Diseases
http://www.cdc.gov/ncidod/dpd/

DPDx (Identification and Diagnosis of Parasites of Public Health Concern)
http://www.dpd.cdc.gov/dpdx/

Division of Viral and Rickettsial Diseases
http://www.cdc.gov/ncidod/dvrd/index.htm

Division of Viral Hepatitis
http://www.cdc.gov/ncidod/diseases/hepatitis/index.htm

Epidemiology Program Office, Division of Public Health Surveillance and Informatics
http://www.cdc.gov/epo/index.htm

Foodborne and Diarrheal Diseases Branch
http://www.cdc.gov/ /foodborne/

Foodborne and Diarrheal Diseases Branch, Outbreak Response and Surveillance Team
http://www.cdc.gov/foodborneoutbreaks/

FoodNet (Foodborne Diseases Active Surveillance Network)
http://www.cdc.gov/foodnet/

NARMS: Enteric Bacteria (National Antimicrobial Resistance Monitoring System)
http://www.cdc.gov/narms/

National Center for Infectious Diseases
http://www.cdc.gov/ncidod/

PHLIS (Public Health Laboratory Information System) Surveillance Data
http://www.cdc.gov/ncidod/dbmd/phlisdata/

Public Health Practice Program Office (PHPPO)
http://www.phppo.cdc.gov/index.asp

PulseNet (National Molecular Subtyping Network for Foodborne Disease Surveillance)
http://www.cdc.gov/pulsenet/

Respiratory and Enteric Virus Branch
http://www.cdc.gov/ncidod/dvrd/revb/index.htm

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http://www.cdc.gov/safewater/

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