Bacterial Foodborne and Diarrheal Disease National Case Surveillance

Annual Report, 2005

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 data 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 2005, as of March 2007; the numbers may have changed compared with previous publications of 2005 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. The Foodborne Diseases Active Surveillance Network (FoodNet) conducted more intensive surveillance in ten sites in 2005; 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 due to 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/. It should be noted that all surveillance reports from state and territorial departments of public health to the Centers for Disease Control and Prevention (CDC) are voluntary.

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 the Enteric Diseases Epidemiology Branch, 2005, and CDC Internet sites for Foodborne and Diarrheal Diseases.

This report is the third 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 2005 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, 2005

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	135	NA	145
E. coli O157:H7		Yes	2,621	2,368	NA
E. coli, Shiga toxin-producing, non-O157		Yes	501	224	348
Hemolytic uremic syndrome		Yes	221	NA	NA
Listeriosis		Yes	896	NA	NA
Salmonella Typhi (typhoid fever)		Yes	324	348	143§
Salmonella, non-Typhi (salmonellosis)	Includes >2,400 Serotypes	Yes	45,322	35,836	NA
Shigella (shigellosis)	Includes 4 subgroups	Yes	16,168	8,520	NA
Vibrio cholerae, toxigenic	Includes O1 and O139 serotypes (that causes cholera)	Yes	8	NA	12
Other *Vibrios* (vibriosis)	Some species may not be pathogenic	No	NA	NA	546

*NNDSS (National Notifiable Diseases Surveillance System)
†PHLIS (Public Health Laboratory Information System)
‡EDEB (Enteric Diseases Epidemiology Branch)
§ Preliminary data

Botulism

A total of 145 cases of foodborne (18), wound (28), infant (96), and other types (3) of botulism were reported to the EDEB botulism surveillance system, including three deaths (attributed to foodborne botulism [2] and unknown [1]) and four 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 (CSTE) 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 number 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 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 2005, CDC received 348 isolates of Shiga toxin-producing *E. coli*, non-O157. Isolates originated from 39 states and included 29 different O groups. The three most common O groups were O26 (24%), O103 (17%), and O111 (13%). A total of 501 cases of Shiga toxin-producing *E. coli* non-O157 were reported to NNDSS.

Hemolytic Uremic Syndrome (HUS), Post-diarrheal
HUS is defined by the triad of hemolytic anemia, thrombocytopenia, and renal insufficiency. The 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 221 cases of HUS reported in 2005, 75% occurred in children younger than age 10 years.

Listeriosis
Listeriosis became nationally notifiable in 2000. Surveillance is conducted through NNDSS. Forty-five states and one territory reported at least one case, for a total of 896 cases.

***Salmonella* Typhi (Typhoid Fever)**
Infection with *Salmonella* serotype Typhi leads to typhoid fever. The number of cases of typhoid fever (324 in 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; 348 isolates were reported in 2005.

***Salmonella*, Non-Typhi (Salmonellosis)**
A total of 35,836 non-Typhi *Salmonella* isolates were reported in 2005. The national rate was 12.2 per 100,000 population. Similar to other years, children younger than age 5 years accounted for 20% of *Salmonella* 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 thirty most common serotypes of *Salmonella* in 2005 represent 82% of all *Salmonella* isolates. The four most common serotypes in 2005 (Typhimurium, Enteritidis, Newport, and Heidelberg; 52% of all isolates) have been the most common serotypes since 1995, except for 2004 when serotype Javiana replaced Heidelberg as the fourth most common serotype. Serotype Typhimurium has been the most commonly isolated serotype since 1997, though Enteritidis was a very close second in 2005. Serotypes Typhimurium and Enteritidis have both declined substantially (28% and 34%, respectively) since 1995; the total number of *Salmonella* isolates has also declined during this period, though not as substantially as serotypes Typhimurium and Enteritidis.

***Shigella* (Shigellosis)**

Shigella transmission occurs via the fecal-oral route. Most *Shigella sonnei* infections occur in young children and are associated with crowding and poor personal hygiene. Daycare centers have been implicated in many *S. sonnei* outbreaks.

A total of 10,484 *Shigella* isolates were reported to PHLIS in 2005. This represents a stabilization of *Shigella* rates from the sharp decreases that occurred in 2004. The national rate was 3.5 per 100,000 population, based on 2005 census population estimates for the United States. Similar to previous years, children younger than age 5 years accounted for 28.2% of all *Shigella* isolates. About 34.2% came from persons aged 5–19 years, and 26.6% from persons aged 20–59, with lower proportions from persons in later decades of life.

Of the 10,484 isolates, 9,420 (89.7%) were subgrouped. The relative proportions of the different subgroups remained similar to previous years, with subgroup D (*S. sonnei*) accounting for the largest percentage of isolates (74.4%), followed by subgroup B (*S. flexneri*, 13.6%), subgroup C (*S. boydii*, 1.2%) and subgroup A (*S. dysenteriae*, 0.5%).

Cholera and Non-Cholera *Vibrio*

In 2005, 12 patients with toxigenic *V. cholerae* were reported. Five patients were hospitalized and no deaths were reported. No isolates of toxigenic *V. cholerae* O139 were identified. All 12 patients were infected with toxigenic *V. cholerae* serogroup O1. Infection was acquired during international travel for five isolated cases. Exposure to domestic seafood was the source of infection for four patients. Source of infection was unknown for three cases.

Other *Vibrio* isolates (excluding *V. cholerae* serogroup O1 and O139) were not nationally notifiable in 2005, 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 2005, 578 *Vibrio* isolates from 546 patients were reported to the Cholera and Other *Vibrio* Illness Surveillance System. Among patients for whom information was available, 232 (46%) of 506 were hospitalized and 40 (8%) of 485 died. *V. parahaemolyticus* was isolated from 218 (40%) patients, and was the most frequently reported *Vibrio* species. Of the 546 patients infected with *V. parahaemolyticus*, 23% were hospitalized and 1% died. *V. vulnificus* was isolated from 121 (22%) patients; 90% were hospitalized and 26% died.

Expanded Surveillance Summaries for Selected Pathogens and Diseases, 2005

The following bacterial foodborne and diarrheal diseases case surveillance summaries for 2005 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, listeriosis, 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 are included here from the *Salmonella Annual Summary, 2005* and the *Shigella Annual Summary, 2005*. 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 department 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 145 cases of botulinum intoxication were reported to CDC in 2005 (Tables 2-1 and 2-2). Among the 18 cases of foodborne intoxication, toxin type A accounted for 7 (39%) cases, toxin type B 1 (5%) case, and toxin type E for 10 (56%) cases (Table 2-3). The median age of patients was 35 years. Two deaths were reported. There were 4 multi-case outbreaks. They were caused by fish (type unspecified), stinkfish, stinkhead, and suspected leftovers containing several ingredients including salmon, respectively.

There were 96 reported cases of infant botulism in 2005 (Table 2-4). Toxin type B accounted for 52 (54%) cases and toxin type A for 44 (46%) cases. The median age of patients was 16.5 weeks; no deaths were reported.

There were 28 reported cases of wound botulism in 2005 (Table 2-5). Toxin type A accounted for 25 (89%) cases, toxin type B 2 (7%) cases, and unknown toxin type 1 (4%) cases. All cases occurred in injecting drug users. The median age of patients was 44.5 years; no deaths were reported.

There were 3 reported cases of botulism of other or unknown source in 2005 (Table 2-6). Toxin type F accounted for 2 (67%) cases, and type A accounted for 1 (33%) case. One toxin type F case was associated with adult intestinal colonization and exposure to gardening soil. The sources of the other type F case and the type A case were unknown. The case patients were 56, 84, and 74 years of age respectively; one death was reported.

Table 2-1. Summary of cases of botulism reported to the Botulism Surveillance System, 2005

Type	Cases	Median age	Sex	Toxin type	Comments
Foodborne	18 cases (2 reported deaths)	35 years (range: 1–82 years)	10 (56%) male	7 (39%) type A 1 (5%) type B 10 (56%) type E	4 multicase outbreaks
Infant	96 cases (No reported deaths)	16.5 weeks (range: 2–60 weeks)	53 (55%) male	44 (46%) type A 52 (54%) type B	.
Wound	28 cases (No reported deaths; 2 without information)	44.5 years (range: 28–57 years)	23 (82%) male	25 (89%) type A 2 (7%) type B 1 (4%) toxin type undetermined	
Other, unknown	3 cases (1 reported death)	74 years (range: 56–84 years)	3 (100%) male	1 (33%) type A 2 (67%) type F *(Clostridium baratii)*	

Table 2-2. Cases of botulism reported to the Botulism Surveillance System, by state and type, 2005

State/District	Foodborne	Wound	Infant	Other	Total
Alaska	8				8
Alabama			1		1
Arizona			1		1
California	3	24	42		69
Colorado			1		1
Delaware			2		2
Florida			1		1
Idaho			1		1
Illinois			1	1*	2
Kentucky			1		1
Louisiana			1		1
Massachusetts	1				1
Maryland			5		5
Michigan	1				1
Missouri			1		1
Montana				1†	1
North Carolina	1		1		2
New Hampshire			1		1
New Jersey	2		9		11
New Mexico			1		1
Nevada			1		1
New York City			4		4
Oklahoma	1		1		2
Oregon			2		2
Pennsylvania	1		11		12
Texas			1	1*	2
Utah			3		3
Virginia			1		1
Washington		4	2		6
Total	**18**	**28**	**96**	**3**	**145**

*Unknown source
†Adult intestinal; gardening soil

Table 2-3. Cases of foodborne botulism reported to the Botulism Surveillance System, by month, 2005 (N = 18)

Month	State	Age (years)	Sex	Toxin Type	Vehicle	Death
January	Massachusetts	75	Male	A	Chili with rice and lotus root	No
	Michigan	82	Male	B	Unknown†	Yes
May	California	30	Male	A	"Pruno"‡	No
July	New Jersey*	45	Male	E	Fish	No
	New Jersey*	16	Female	E	Fish	No
	Oklahoma	14	Female	A	Home-canned venison stew	No
August	Alaska*[1]	27	Female	E§	Stinkfish	No
	Alaska*[1]	33	Male	E	Stinkfish	No
	Alaska*[1]	37	Female	E§	Stinkfish	No
	Alaska*[1]	69	Male	E	Stinkfish	No
	Alaska*[2]	19	Female	E	Stinkhead	No
	Alaska*[2]	23	Female	E	Stinkhead	No
	Alaska*[2]	47	Female	E	Stinkhead	No
	Alaska*[2]	1	Male	E	Stinkhead	No
September	North Carolina	64	Female	A	Homemade nutritional juice	No
November	California*	82	Male	A	Leftovers containing salmon	Yes
	California*	17	Male	A	Leftovers containing salmon	No
	Pennsylvania	63	Male	A	History of homecanning	No

*Cases involved in multicase outbreaks
[1] Group 1 multicase outbreak in Alaska
[2] Group 2 multicase outbreak in Alaska
†Multiple suspected sources due to history of improper food storage
‡Homemade alcoholic beverage
§Toxin type derived from epidemiologically-linked case

Table 2-4. Cases of infant botulism reported to the Infant Botulism Treatment and Prevention Program, by month, 2005 (N = 96)

Month	State	Onset Age (weeks)	Sex	Toxin Type	Death
January	California	7	Male	B	No
	California	29	Male	A	No
	California	12	Female	A	No
	New Jersey	50	Female	B	No
	New York City	11	Male	B	No
	Pennsylvania	13	Female	B	No
	Pennsylvania	16	Male	B	No
	Utah	20	Female	A	No
February	California	18	Male	B	No
	California	34	Male	A	No
	California	43	Female	A	No
	New Jersey	12	Female	A	No
	Pennsylvania	28	Male	B	No
	Pennsylvania	20	Male	B	No
	Utah	16	Male	A	No
March	California	14	Male	A	No
	California	8	Male	A	No
	Delaware	39	Female	B	No
	Florida	34	Female	A	No
	Maryland	25	Female	B	No
	Oklahoma	10	Female	A	No
	Pennsylvania	20	Male	B	No
April	California	12	Female	B	No
	Pennsylvania	16	Female	B	No
May	California	24	Male	B	No
	California	6	Female	A	No
	California	3	Male	A	No
	Illinois	12	Male	A	No
	Kentucky	12	Male	B	No
	Maryland	28	Male	B	No
	Maryland	13	Male	B	No
	New Jersey	15	Female	B	No
	New Jersey	12	Male	B	No
	New York City	22	Female	B	No
	Pennsylvania	24	Male	B	No
	Pennsylvania	21	Female	B	No
	Utah	10	Male	A	No
	Virginia	21	Male	B	No
June	California	26	Male	A	No
	California	19	Male	B	No
	California	23	Female	A	No
	California	28	Female	B	No
	California	19	Male	A	No
	California	20	Male	A	No

Month	State	Onset Age (weeks)	Sex	Toxin Type	Death
	Delaware	40	Male	B	No
	Louisiana	3	Male	B	No
	Nevada	60	Female	A	No
	Pennsylvania	22	Male	B	No
July	Alabama	5	Male	B	No
	California	16	Male	A	No
	California	19	Female	B	No
	California	30	Male	A	No
	California	6	Female	B	No
	New Hampshire	17	Female	B	No
	New Jersey	21	Male	B	No
	New Jersey	17	Male	B	No
August	Arizona	13	Male	A	No
	California	4	Female	B	No
	California	20	Female	B	No
	California	16	Male	B	No
	California	10	Female	B	No
	California	20	Male	A	No
	Maryland	3	Male	B	No
	New Jersey	4	Male	B	No
	Washington	31	Male	A	No
September	California	24	Female	A	No
	California	23	Female	B	No
	California	14	Male	A	No
	California	20	Female	A	No
	California	4	Female	A	No
	Oregon	16	Female	A	No
	Oregon	19	Female	A	No
	Texas	10	Male	A	No
October	California	17	Female	A	No
	California	46	Female	A	No
	California	9	Female	A	No
	California	6	Male	A	No
	California	30	Male	A	No
	Idaho	16	Male	A	No
	New Jersey	4	Female	B	No
	New York City	19	Male	B	No
	Pennsylvania	2	Female	B	No
	Pennsylvania	17	Female	B	No
November	California	8	Female	A	No
	California	9	Female	A	No
	Colorado	8	Female	A	No
	New York City	6	Female	B	No
December	California	5	Male	B	No
	California	19	Female	B	No
	California	24	Male	A	No
	Maryland	15	Male	B	No
	Missouri	9	Female	A	No
	North Carolina	12	Male	B	No
	New Jersey	10	Male	B	No
	New Mexico	52	Male	B	No
	Washington	17	Male	A	No

Table 2-5. Cases of wound botulism reported to the Botulism Surveillance System, by month, 2005 (N = 28)

Month	State	Age (years)	Sex	Toxin Type	Exposure*	Death
January	California	38	Female	A	IDU	No
	Washington	37	Male	A	IDU	Unknown
	Washington	50	Male	A	IDU	Unknown
February	California	28	Male	A	IDU	No
March	California	47	Male	A	IDU	No
	California	43	Male	B	IDU	No
	California	57	Male	A	IDU	No
	California	43	Male	A	IDU	No
	Washington	34	Female	A	IDU	No
May	California	51	Female	A	IDU	No
June	California	40	Male	A	IDU	No
July	California	48	Male	A	IDU	No
	California	38	Male	B	IDU	No
	California	53	Male	Unknown†	IDU	No
	California	35	Male	A	IDU	No
August	California	43	Male	A	IDU	No
	California	49	Male	A	IDU	No
	California	51	Male	A	IDU	No
	California	34	Male	A	IDU	No
	California	50	Female	A	IDU	No
September	California	30	Male	A	IDU	No
	California	51	Male	A	IDU	No
	California	53	Female	A	IDU	No
	California	36	Male	A	IDU	No
October	California	56	Male	A	IDU	No
	California	36	Male	A	IDU	No
November	California	46	Male	A	IDU	No
	Washington	51	Male	A	IDU	No

*IDU = injecting drug user
† Serum quantity not sufficient for toxin typing

Table 2-6. Cases of botulism, other, reported to the Botulism Surveillance System, 2005 (N= 3)

Month	State	Age (years)	Gender	Toxin Type	Exposure	Death
March	Montana	56	Female	F (*C. baratii*)*	Adult intestinal; gardening soil	No
June	Illinois	84	Female	F(*C. baratii*)*	Unknown	Yes
September	Texas	74	Female	A	Unknown	No

*Botulinum toxin Type F produced by *Clostridium baratii*

Escherichia coli, Shiga Toxin-Producing non-O157

The surveillance case definition for Shiga toxin-producing *Escherichia coli* (STEC) 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. STEC is indicated as enterohemorrhagic *Escherichia coli* (EHEC) in the Nationally Notifiable Diseases Surveillance System (NNDSS) for 2005.

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.

During 2005, 501 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 2005, 348 isolates were received by CDC from 39 states (Figure 3-1).

The non-O157 isolates received by CDC in 2005 included 29 different O groups. The predominant groups were O26 (24%) and O103 (17%), followed by O111 (13%), O45 (8%), and O121 (7 %). These five O groups made up 69 % of all isolates (Table 3-1). *E. coli* O26 was also the most commonly isolated non-O157 STEC in 2004 and 2003. 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.

Healthcare 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.

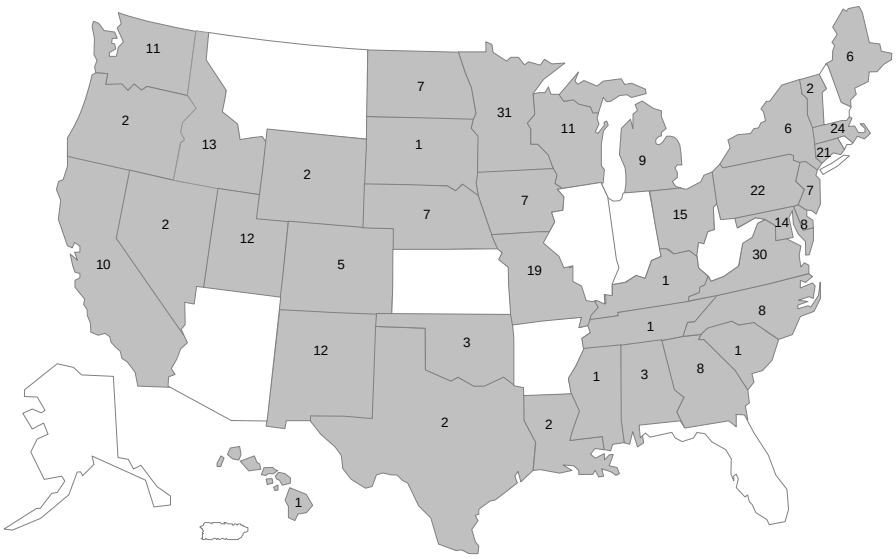
Healthcare providers should notify clinical diagnostic laboratories when STEC O157 infection is suspected so that appropriate testing methods can be applied. Clinical laboratories should strongly consider including STEC O157 in their routine bacterial enteric panel (with *Salmonella*, *Shigella*, and *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 or 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 National *Escherichia coli* Reference Laboratory and Epidemic Investigation and Surveillance Laboratory, 2005

Serogroup	Number	Percent
O26	83	23.9%
O103	58	16.7%
O111	44	12.6%
O45	27	7.8%
O121	26	7.5%
O145	12	3.4%
O91	8	2.3%
O76	5	1.4%
O177	4	1.1%
O28	4	1.1%
O118	3	0.9%
O165	3	0.9%
O112	2	0.6%
O123	2	0.6%
O153	2	0.6%
O174	2	0.6%
O63	2	0.6%
O84	2	0.6%
O22	1	0.3%
O51	1	0.3%
O69	1	0.3%
O8	1	0.3%
O87	1	0.3%
O88	1	0.3%
O116	1	0.3%
O117	1	0.3%
O126	1	0.3%
O143	1	0.3%
O181	1	0.3%
Rough	20	5.7%
Undetermined	26	7.5%
Unknown	2	0.6%
Total	348	100.0%

Figure 3-1. States that submitted non-O157 STEC isolates to CDC, 2005 (N = 39)*



* 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 and 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 896 cases of listeriosis reported to NNDSS during 2005 (0.3 cases per 100,000 population). The rate of listeriosis was highest among neonates (1.6 cases per 100,000 population), followed by adults older than age 70 years (1.5 cases per 100,000 population). 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. Data collected using a 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. During 2004–2005, there were 131 forms submitted from eleven states.

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 the PHLIS to EDEB. Unusual or difficult isolates are forwarded 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 to CDC 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 healthcare 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 36,184 *Salmonella* isolates were reported from participating public health laboratories in 2005. This represents a 12% decrease compared with 1995, and a slight increase compared with 2004 (1.4%). The national rate was 12.2 per 100,000 population.

Similar to other years, children younger than age 5 years accounted for 20% of all *Salmonella* isolates. Less than 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 thirty most common serotypes of *Salmonella* in 2005 are listed in Table 4-1. These represent 82% of all *Salmonella* isolates. The four most common serotypes in 2005 (Typhimurium, Enteritidis, Newport, and Heidelberg; 52% of all isolates) have been the most common serotypes since 1995, except for 2004 when serotype Javiana replaced Heidelberg as the fourth most common serotype (Figure 4-1). Serotype Typhimurium has been the most commonly isolated serotype since 1997, though Enteritidis was a very close second in 2005. Serotypes Typhimurium and Enteritidis have both declined substantially (28% and 34%, respectively) since 1995; the total number of *Salmonella* isolates has also declined during this period, though not as substantially as serotypes Typhimurium and Enteritidis.

Among the thirty most common serotypes in 2005, *Salmonella* Hadar has had the largest percent decline during the past decade. Serotype Hadar was the fifth most common serotype in 1995 and has steadily declined to the 21st most common serotype in 2005, a 75% decline in number of isolates. Serotype Poona has declined 63% since 1995, although most of the decline was between 1995 and 1997. *Salmonella* Mississippi has had the most dramatic increase, 184% since 1995, most since 2002. *Salmonella* Newport had a large increase in numbers between 1997 and 2002, but has been declining since then. Similarly, serotype Javiana had substantial increases in 2003 and 2004, but declined 25% in 2005.

Salmonella serotype I 4,[5],12:i:- was introduced as the 18th most common serotype in 2002 and has increased in rank to sixth in 2005. The serotype has been tracked in the National *Salmonella*

Surveillance system since 1998, though many isolates were classified as only Subspecies I or Group B in the past. 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:- based on additional data submitted. Recent efforts to correctly classify this serotype may be responsible for at least some of the increase in numbers. It is unknown how many of the 479 isolates reported as Subspecies I, Group B in 2005 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 (1). Many U.S. isolates of this serotype were characterized by pulsed-field gel electrophoresis (PFGE) and the patterns submitted to PulseNet, the National Molecular Subtyping Network for Foodborne Disease Surveillance. The PFGE patterns for most serotype I 4,[5],12:i- isolates were closely related to serotype Typhimurium PFGE patterns, indicating that they are most likely variants of serotype Typhimurium.

A large proportion of serotype Typhimurium isolates were resistant to multiple antimicrobial drugs; in a 2004 national survey, 39% were resistant to one or more drugs and 23% had a five-drug resistance pattern characteristic of a single phage type, DT104. Similarly, serotype Newport has emerged as a major multidrug-resistant pathogen. In 2004, 28 (15%) of 190 serotype Newport isolates submitted to the National Antimicrobial Resistance Monitoring System 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, serotype Enteritidis rates of isolation had been relatively high in New England, Mid-Atlantic, and Pacific regions, but have shown significant decreases since 1995. However, since 2003 all regions have had small increases in serotype Enteritidis rates of isolation.

Table 4-1. The 30 *Salmonella* serotypes most frequently reported to PHLIS, 2005

Rank	Serotype	Number	Percent
1	Typhimurium*	6982	19.3%
2	Enteritidis	6730	18.6%
3	Newport	3295	9.1%
4	Heidelberg	1903	5.3%
5	Javiana	1324	3.7%
6	I 4,[5],12:i:-	822	2.3%
7	Montevideo	809	2.2%
8	Muenchen	733	2.0%
9	Saintpaul	683	1.9%
10	Braenderup	603	1.7%
11	Oranienburg	590	1.6%
12	Mississippi	565	1.6%
13	Infantis	505	1.4%
14	Paratyphi B var. L(+) tartrate+	460	1.3%
15	Thompson	428	1.2%
16	Agona	367	1%
17	Typhi	348	1%
18	Hartford	239	0.7%
19	Stanley	224	0.6%
20	Berta	209	0.6%
21	Hadar	205	0.6%
22	Bareilly	201	0.6%
23	Anatum	197	0.5%
24	Poona	196	0.5%
25	Mbandaka	190	0.5%
26	Panama	148	0.4%
27	Litchfield	141	0.4%
28	Sandiego	138	0.4%
29	Schwarzengrund	138	0.4%
30	Brandenburg	134	0.4%
Subtotal		**29,507**	**81.5%**
All other serotyped		3,841	10.6%
Unknown		1113	3.1%
Partially serotyped isolates		1684	4.7%
Rough or nonmotile isolates		39	0.1%
Subtotal		**6,677**	**18.5%**
Total		**36,184**	**100%**

* Typhimurium includes var. Copenhagen

Figure 4-1. Isolation rate per 100,000 population for the top four serotypes of *Salmonella* reported to PHLIS, 1970–2005

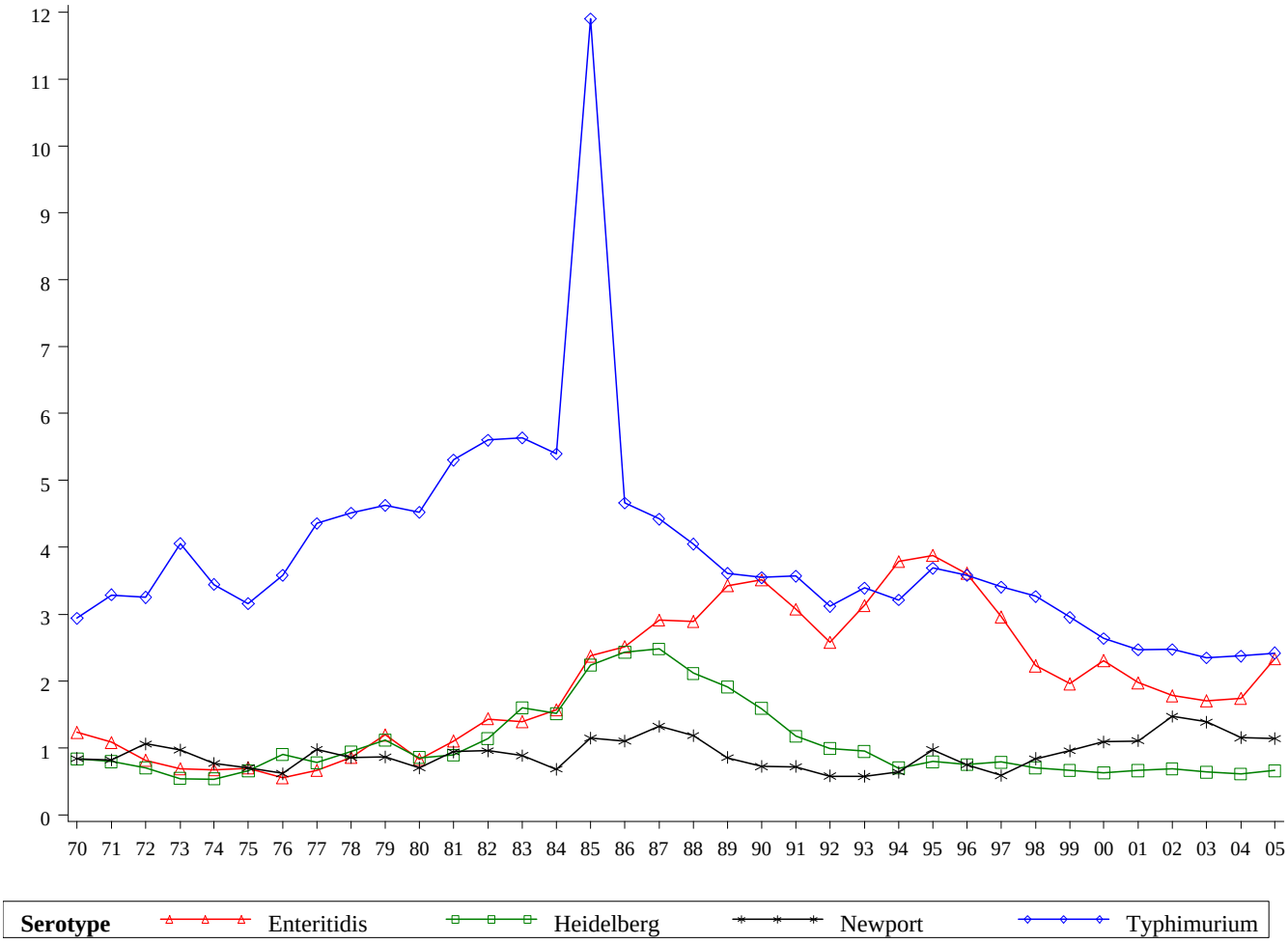
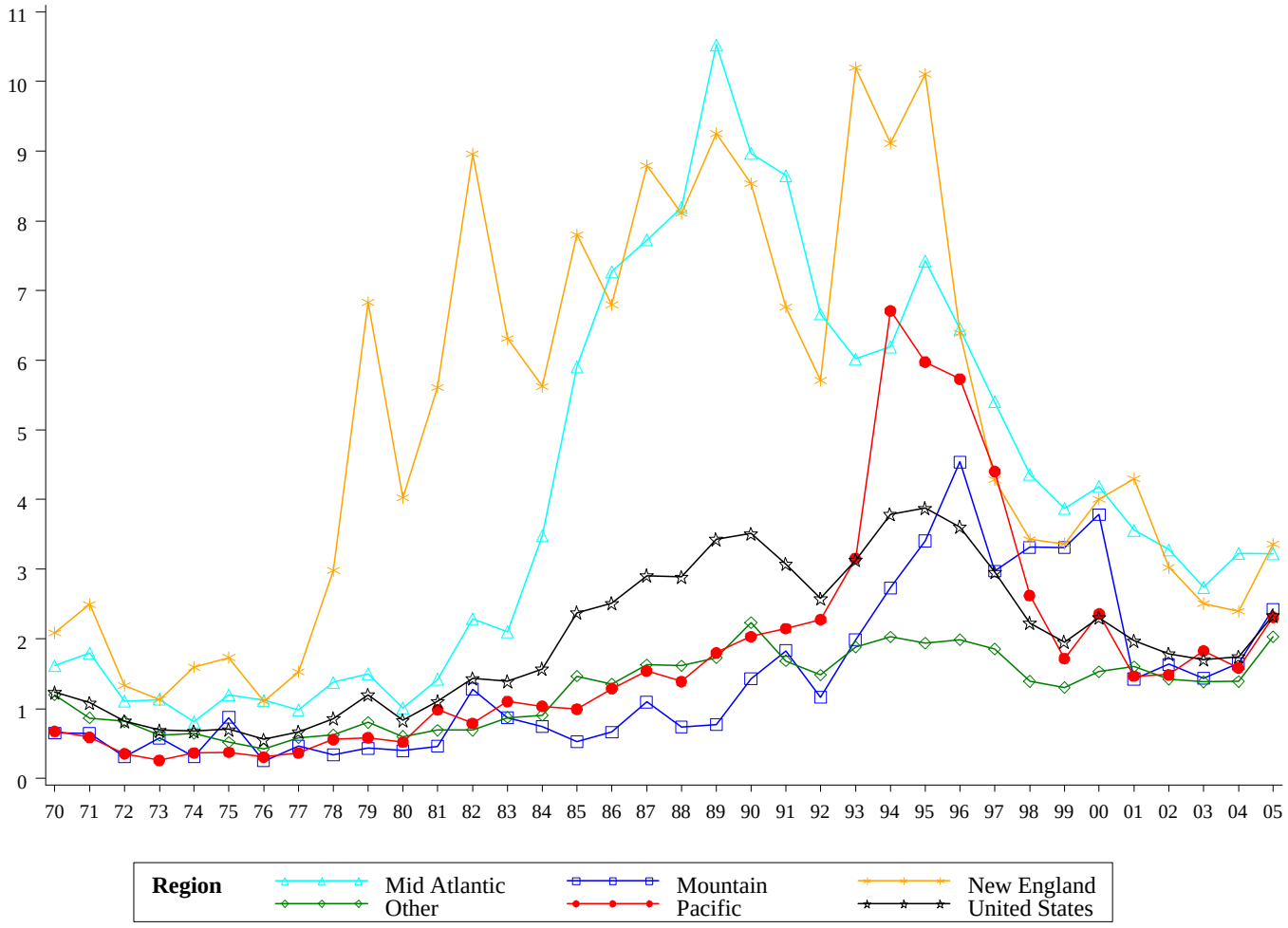


Figure 4-2. Isolation rate per 100,000 population for *Salmonella* Enteritidis reported to PHLIS, by region, 1970–2005



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 healthcare 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 10,484 *Shigella* isolates were reported from public health laboratories in 50 states in 2005 (Table 5-2). The national rate was 3.5 per 100,000 population. Similar to previous years, children younger than age 5 years accounted for 28.2% of all *Shigella* isolates. About 34.2% came from persons aged 5–19 years, and 26.6% from persons aged 20–59, with lower proportions from persons in later decades of life. The overall distribution of *Shigella* isolates between the sexes was similar, with females accounting for 53.0% of persons from whom *Shigella* was isolated. Females accounted for more cases than males in all age groups except 40–49 years (47.5% female). The female predominance was particularly evident among persons aged 20–29 years (67.7%). Among reported isolates of *Shigella flexneri*, a male predominance is seen, particularly in the age groups 20–29 (57.3%), 30–39 (68.5%), 40–49 (73.6%), and 50–59 (61.2%). Gender information was not reported for 7.0% of all isolates and age information was not reported for 5.6% of isolates.

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 10,484 isolates, 9,402 (89.7%) were subgrouped. The relative proportions of subgroups remained constant, with subgroup D (*S. sonnei*) accounting for the largest percentage of isolates (74.4%), followed by subgroup B (*S. flexneri*, 13.6%), subgroup C (*S. boydii*, 1.2%) and subgroup A (*S. dysenteriae*,

0.5%). Over the past decade, the numbers of reported *Shigella* isolates in subgroups A, B and C, and the proportions of all reported *Shigella* isolates caused by these three subgroups have declined. The number (1,082) and the proportion (10.3%) of all reported *Shigella* isolates that were not identified as belonging to a specific subgroup also decreased.

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, 2005

Rank	Subgroup	Number	Percent
1	*S. sonnei*	7,795	74.4%
2	*S. flexneri*	1,430	13.6%
3	*S. boydii*	124	1.2%
4	*S. dysenteriae*	53	0.5%
Subtotal		**9,402**	**89.7%**
Unknown		**1,082**	**10.3%**
Total		**10,484**	**100.0%**

Table 5-3. Rank and number of isolates of *Shigella* serotypes reported to PHLIS, 2005

Rank	Serotype	Number	Percent
1	*S. sonnei*	7795	74.4%
2	*S. flexneri* unspecified	838	8.0%
3	*S. flexneri* 2 unspecified	108	1.0%
4	*S. boydii* unspecified	91	0.9%
5	*S. flex*neri 2a	88	0.8%
6	*S. flexneri* 1 unspecified	86	0.8%
7	*S. flexneri* 3 unspecified	51	0.5%
8	*S. flexneri* 4 unspecified	50	0.5%
9	*S. flexneri* 4a	47	0.5%
10	*S. dysenteriae* unspecified	34	0.3%
11	*S. flexneri* 1b	34	0.3%
12	*S. flexneri* 3a	31	0.3%
13	*S. flexneri* 6	28	0.3%
14	*S. flexneri* variant y	26	0.3%
15	*S. flexneri* 2b	17	0.2%
16	*S. flexneri* 3b	17	0.2%
17	*S. boydii* 2	11	0.1%
18	*S. boydii* 1	8	0.1%
19	*S. dysenteriae* 2	5	0.1%
20	*S. boydii* 4	4	0.0%
21	*S. dysenteriae* 3	4	0.0%
22	*S. dysenteriae* 4	4	0.0%
23	*S. boydii* 14	3	0.0%
24	*S. dysenteriae* 1	3	0.0%
25	*S. flexneri* 1a	3	0.0%
26	*S. boydii* 10	2	0.0%
27	*S. boydii* 15	2	0.0%
28	*S. boydii* 20	2	0.0%
29	*S. flexneri* 5 unspecified	2	0.0%
30	*S. boydii* 8	1	0.0%
31	*S. dysenteriae* 12	1	0.0%
32	*S. dysenteriae* 3162-96	1	0.0%
33	*S. dysenteriae* 6	1	0.0%
34	*S. flexneri* 4b	1	0.0%
35	*S. flexneri* 5a	1	0.0%
36	*S. flexneri* 88-893	1	0.0%
37	*S. flexneri* variant x	1	0.0%
Subtotal		**9,402**	**89.7%**
Unknown		**1,082**	**10.3%**
Total		**10,484**	**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. Infections with toxigenic *Vibrio cholerae* O1 and O139, the causative agents of cholera, have been reportable 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 seven 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.

In June 2006, the Council of State and Territorial Epidemiologists (CSTE) adopted a resolution to add all *Vibrio* species infections (vibriosis) to the list of nationally notifiable diseases reported to NNDSS. Reporting for vibriosis is in addition to and distinct from reporting of *V. cholerae* currently conducted through NNDSS. The position statement, "National Reporting for non-cholera *Vibrio* Infections (Vibriosis)," can be found at http://www.cste.org/PS/2006pdfs/PSFINAL2006/06-ID-05FINAL.pdf. In addition to reporting through NNDSS, CDC requests that states collect information using the standard surveillance form for COVIS available at http://www.cdc.gov/foodborneoutbreaks/.

Isolates of toxigenic *Vibrio cholerae*

In 2005, 12 patients with toxigenic *V. cholerae* were reported (Table 6-1). Five patients were hospitalized, and no deaths were reported. All 12 patients were infected with toxigenic *V. cholerae* serogroup O1; no isolates of toxigenic *V. cholerae* O139 were identified. Infection was acquired during international travel in five isolated cases (three patients acquired

infection while traveling in Pakistan, and two patients traveled in the Philippines). Exposure to domestic seafood was the source of infection for four patients, two of whom were a husband and wife in Louisiana who ate crab and shrimp harvested from the Gulf Coast. The other two cases associated with domestic seafood were unrelated and occurred in patients who ate seafood acquired in Hawaii. Source of infection was unknown for three cases in Guam, of whom two patients were related, but had brief contact with each other and did not share any meals in the two weeks before illness onset. They, however, did receive drinking water from the same municipal aquifer supply and ate finfish in the week before illness. The third patient in Guam reported eating tuna fish and shrimp, in the week before illness.

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

In 2005, 578 *Vibrio* isolates, excluding toxigenic *V. cholerae*, from 546 patients were reported to the COVIS. Among patients for whom information was available, 232 (46%) of 506 were hospitalized and 40 (8%) of 485 died. *V. parahaemolyticus* was isolated from 218 (40%) patients, and was the most frequently reported *Vibrio* species. Of the patients infected with *V. parahaemolyticus*, 23% were hospitalized, and 1% died. *V. vulnificus* was isolated from 121 (22%) patients; 90% were hospitalized, and 26% died. The following sections provide further information on these non-toxigenic *Vibrio* isolates:

Geographic location: In 2005, CDC received 219 (40%) reports of *Vibrio* illness from Gulf Coast states, 143 (26%) from Pacific Coast states, 151 (28%) from Atlantic Coast states (excluding Florida), and 33 (6%) from inland states (Figure 6-1). The most frequent *Vibrio* species reported from Gulf Coast states were *V. vulnificus* (39%), *V. parahaemolyticus* (23%), *V. alginolyticus* (11%), and non-toxigenic *V. cholerae* (11%) (Table 6-2). The most frequent *Vibrio* species reported from non-Gulf Coast states were *V. parahaemolyticus* (51%), *V. alginolyticus* (12%), *V. vulnificus* (11%), and non-toxigenic *V. cholerae* (10%) (Table 6-3).

Anatomic site of isolation: Among the 578 *Vibrio* isolates, 243 (42%) were from stool, 105 (18%) from blood, and 164 (28%) from wounds. In addition, 18 (3%) isolates were obtained from the ear, and 48 (8%) were from urine, sputum, or other sites. *V. parahaemolyticus* was the species most frequently isolated from stool (150 [62%] of 243 isolates from stool); *V. vulnificus* was the species most frequently isolated from blood (68 [65%] of 105 isolates from blood) and from wounds (51 [31%] of 164 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 of cases occurred in August for Gulf Coast states and non-Gulf Coast states.

Exposures: 153 (28%) patients reported having a wound either before or during exposure to *Vibrio*. Of those, 100 (65%) reported water activities such as swimming and boating, 34 (22%) reported handling seafood, and 40 (26%) reported contact with marine wildlife. Excluding patients from whom *Vibrio* was classified as a wound, and among the 255 for whom a food history was available, 223(87%) reported eating seafood in the seven days before illness onset. Among the 86 who reported eating a single seafood item, 49% ate oysters (91% of whom consumed them raw), 10% ate shrimp, and 15% ate finfish (Table 6-4). International travel in the seven days before illness onset was reported by 41 (9%) of 449

patients, for whom information was available.

Laboratory: For reports where laboratory confirmation was available, the state public health laboratory confirmed the identification of 234 (97%) of 242 human *Vibrio* isolates. CDC received 126 isolates of *V. parahaemolyticus* from 115 patients. Of these, 111 were viable, and four were not viable. Of the viable *V. parahaemolyticus* isolates, 28 (25%) from 11 health jurisdictions were serotype O4:K12 (Colorado, Hawaii, Louisiana, Maryland, Maine, Montana, North Carolina, New York State, New York City, Oregon, and Washington); 16 (14%) isolates from seven states were serotype O3:K6 (Arizona, Colorado, Georgia, Louisiana, Maryland, New Mexico, and Washington); 13 (12%) isolates from eight states were serotype O1:K56 (Hawaii, Louisiana, Maine, Montana, Oregon, Texas, Virginia, and Washington); and the remaining 54 isolates were one of 25 serotypes.

Outbreaks: Illnesses following Hurricane Katrina were reported to COVIS from eight states (Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, and Texas). The species reported were 26 *V. vulnificus* (72%), 6 non-cholerigenic *V. cholerae* (17%), 3 *V. parahaemolyticus* (8%), and 1 (3%) unidentified *Vibrio* species. For patients with available information, 20 (91%) of 22 were considered wound infections because they reported having a wound either before or during exposure to *Vibrio*.

Table 6-1. Isolates of toxigenic *V. cholerae* reported to COVIS, 2005

State	Age	Sex	Onset	Exposure	Serogroup	Serotype
Hawaii	85	Female	4/8/2005	Domestic (seafood)	*V. cholerae* O1	Ogawa
Hawaii	34	Male	5/10/2005	Domestic (seafood)	*V. cholerae* O1	Ogawa
Montana	44	Female	8/2/2005	Travel in Pakistan	*V. cholerae* O1	Inaba
New York	44	Female	7/26/2005	Travel in Pakistan	*V. cholerae* O1	Inaba
Louisiana	43	Male	10/15/2005	Domestic (crab and shrimp) - Gulf Coast	*V. cholerae* O1	Inaba
Louisiana	46	Female	10/15/2005	Domestic (crab and shrimp) - Gulf Coast	*V. cholerae* O1	Inaba
Guam	32	Male	10/26/2005	Unknown	*V. cholerae* O1	Ogawa
Guam	29	Male	10/19/2005	Unknown	*V. cholerae* O1	Ogawa
Michigan	53	Male	11/3/2005	Travel in Pakistan	*V. cholerae* O1	Inaba
Michigan	34	Male	11/26/2005	Travel in the Philippines	*V. cholerae* O1	Ogawa
California	46	Male	12/22/2005	Travel in the Philippines	*V. cholerae* O1	Ogawa
Guam	26	Female	12/26/2005	Unknown	*V. cholerae* O1	Ogawa

Table 6-2. Number of *Vibrio* illnesses (excluding toxigenic *V. cholerae*) reported to COVIS, by species, complications and site of isolation in patients from Gulf Coast states, 2005

Vibrio Species	Patients		Complications* Hospitalized		Complications* Deaths		Isolates		Site of Isolation: Stool	Blood	Wound	Other†
	N	(%)	n/N	(%)	n/N	(%)	N	(%)				
V. alginolyticus	23	(11)	5/21	(24)	0/21	(0)	23	(10)	1	1	15	6
V. cholerae (non-toxigenic) ‡	23	(11)	12/20	(60)	3/19	(16)	23	(10)	12	5	1	4
V. damsela	3	(1)	0/2	(0)	0/2	(0)	3	(1)	0	0	3	0
V. fluvialis	11	(5)	7/11	(64)	2/11	(18)	12	(5)	5	2	4	1
V. hollisae	3	(1)	2/3	(67)	0/3	(0)	3	(1)	1	0	1	1
V. mimicus	4	(2)	2/4	(50)	1/4	(25)	4	(2)	3	0	0	1
V. parahaemolyticus	50	(23)	17/44	(39)	2/46	(4)	52	(22)	20	4	21	7
V. vulnificus	85	(39)	70/77	(91)	15/65	(23)	93	(39)	3	45	40	5
Species not identified	9	(4)	4/9	(44)	0/8	(0)	9	(4)	5	0	1	3
Multiple species§	8	(4)	4/8	(50)	1/6	(17)	18	(8)	6	4	8	0
Total	**219**	**(100)**	**123/199**	**(62)**	**24/185**	**(13)**	**240**	**(100)**	**56**	**61**	**94**	**29**

* Denominators indicate patients for whom information is known.
† Includes ear, endotracheal secretion, sputum, and urine.
‡ Non-toxigenic *V. cholerae*. Includes non-toxigenic *V. cholerae* O1 (1 isolates) and other non-toxigenic *V. cholerae* [non-O1 non-O139] (22 isolates).
§ *V. parahaemolyticus* and *V. alginolyticus* were isolated from two patients, *V. parahaemolyticus* and *V. mimicus* were isolated from one patient, *V. parahaemolyticus* and *V. fluvialis* were isolated from one patient, *V. parahaemolyticus* and an unidentified *Vibrio* species were isolated from one patient, *V. parahaemolyticus* and *V. vulnificus* were isolated from one patient, *V. vulnificus* and *V. alginolyticus* was isolated from one patient, and *V. vulnificus* and an unidentified *Vibrio* species were isolated from one patient.

Table 6-3. Number of *Vibrio* illnesses (excluding toxigenic *V. cholerae*) reported to COVIS, by species, complications, and site of isolation in patients from non-Gulf Coast states, 2005

Vibrio Species	Patients		Complications*				Isolates		Site of Isolation			
			Hospitalized		Deaths				Stool	Blood	Wound	Other†
	N	(%)	n/N	(%)	n/N	(%)	N	(%)				
V. alginolyticus	40	(12)	9/37	(24)	0/37	(0)	40	(12)	2	1	25	12
V. cholerae (non-toxigenic)[3]	33	(10)	14/31	(45)	2/28	(7)	35	(10)	19	10	4	2
V. damsela	4	(1)	3/4	(75)	0/4	(0)	4	(1)	0	0	3	1
V. fluvialis	17	(5)	8/17	(47)	1/17	(6)	17	(5)	12	2	2	1
V. furnissii	2	(0.6)	2/2	(100)	1/2	(50)	2	(0.6)	1	1	0	0
V. hollisae	4	(1)	3/4	(75)	0/3	(0)	4	(1)	4	0	0	0
V. mimicus	6	(2)	3/6	(50)	1/6	(17)	6	(2)	3	0	2	1
V. parahaemolyticus	168	(51)	29/155	(19)	0/155	(0)	168	(50)	130	3	22	13
V. vulnificus	36	(11)	31/35	(89)	10/32	(31)	37	(11)	1	23	11	2
Species not identified	10	(3)	3/9	(33)	0/9	(0)	10	(3)	6	1	1	2
Other	1	(0.3)	0/1	(0)	0/1	(0)	2	(1)	1	0	0	1
Multiple species§	6	(2)	4/6	(67)	1/6	(17)	13	(4)	8	3	0	2
Total	**327**	**(100)**	**109/307**	**(36)**	**16/300**	**(5)**	**338**	**(100)**	**187**	**44**	**70**	**37**

* Denominators indicate patients for whom information is known.
† Includes ear, peritoneal fluid, sinus, sputum, and urine.
‡ Non-toxigenic *V. cholerae*. Includes non-toxigenic *V. cholerae* O1 (3 isolates), non-toxigenic *V. cholerae* O139 (1 isolate), and other non-toxigenic *V. cholerae* (non-O1 non-O139) (29 isolates).
§ *V. parahaemolyticus* and *V. alginolyticus* were isolated from one patient; *V. parahaemolyticus* and *V. fluvialis* were isolated from two patients; *V. parahaemolyticus* and an unidentified *Vibrio* species were isolated from one patient; *V. alginolyticus* and *V. fluvialis* were isolated from one patient; and *V. cholerae* non-O1, non-O139, *V. fluvialis*, and *V. vulnificus* were isolated from one 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, 2005

	Mollusks			Crustaceans						
	Oysters	**Clams**	**Mussels**	**Shrimp**	**Lobster**	**Crab**	**Crayfish**	**Other Shellfish***	**Finfish†**	**Total**
Ate (%)	42 (49)	3 (3)	1 (1)	9 (10)	1 (1%)	13 (15%)	2 (2%)	2 (2%)	13 (15%)	86
Ate raw (%)	91	67	100	44	0	0	0	0	27	49

* Other shellfish reported: scallops

† Finfish reported: ahi poke, cat fish, flounder, perch, red snapper, rockfish filet, salmon, sunfish, sushi, tuna, yellow fin, and whiting.

Figure 6-1. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*) reported to COVIS, by state, 2005 (N = 546 patients)

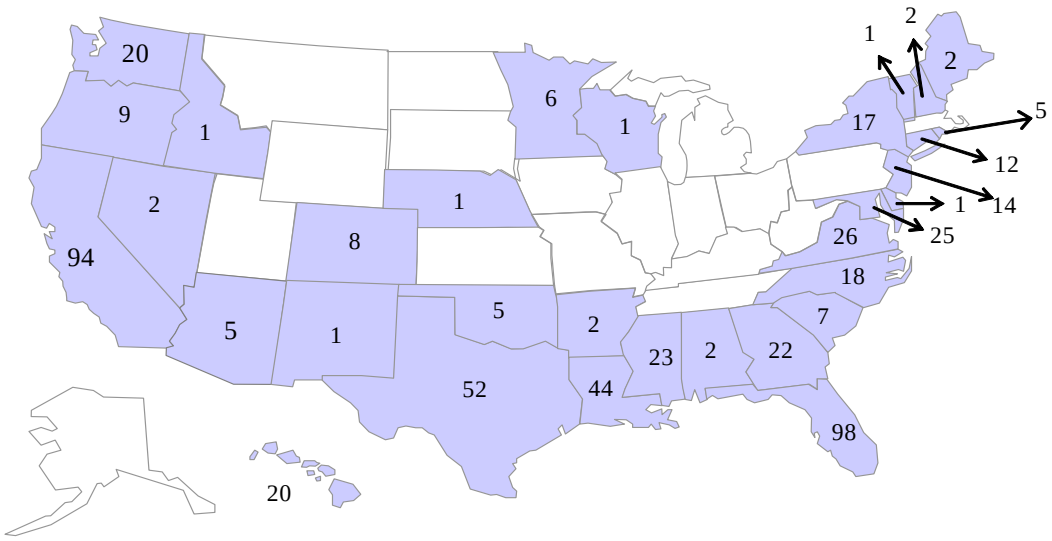
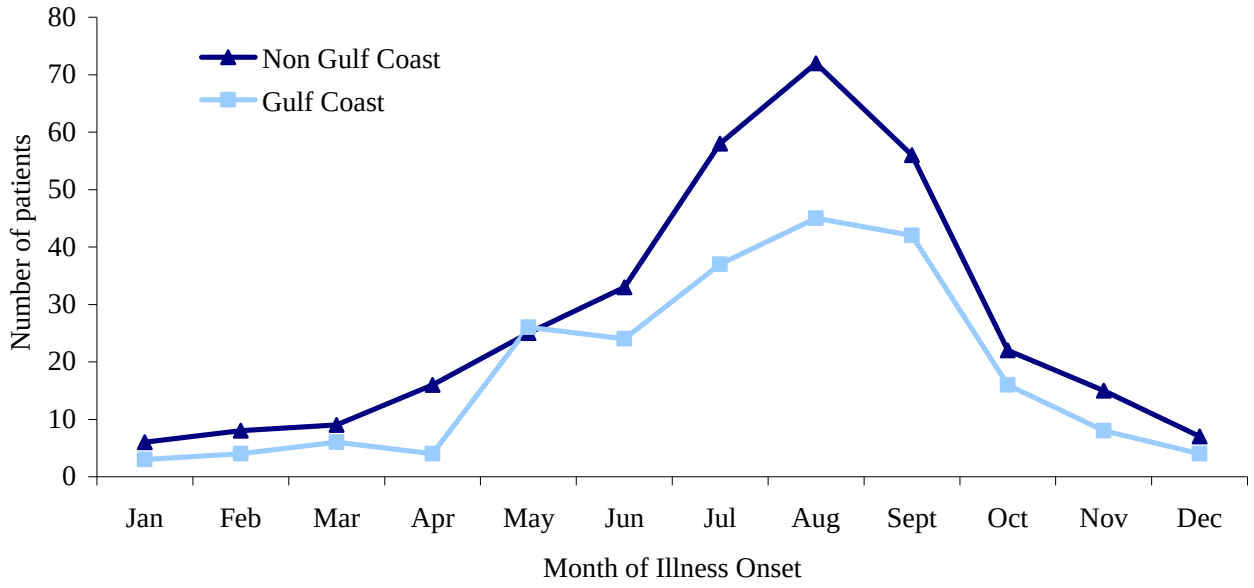


Figure 6-2. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*) reported to COVIS, by month of illness onset or specimen isolation, Gulf Coast states vs. other states, 2005 (N = 546)



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 the 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, the 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 the CDC 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 health departments 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 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 through 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 healthcare 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* (ETEC) 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 that is 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, but are not part of the nationally notifiable disease system.

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, and time) and pathogen characteristics (e.g. *Salmonella* serotype in PHLIS), EDEB collects more detailed information on individual cases for some diseases because this information is needed for accurate monitoring and effective intervention. The diseases included are botulism, typhoid fever, and cholera and *Vibrio* species infections. For botulism, typhoid fever, and cholera, reporting is nationwide. For the non-cholera *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 emergency 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 and forwarded to public health laboratories.

Surveillance at Selected Sites

For nine foodborne infections, the most detailed and accurate surveillance information comes from Foodborne Diseases Active Surveillance Network (FoodNet). In 2005, 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 also 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 Surveillance of Bacterial Foodborne and Diarrheal Diseases

Many staff members both within and outside EDEB are responsible for foodborne and diarrheal diseases national surveillance. For the purpose of this report, EDEB national case surveillance activity is considered separate from foodborne outbreak surveillance, FoodNet, and the National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS-EB). Information concerning FoodNet and NARMS is cited in the reference section. Surveillance for foodborne disease outbreaks is contained in the report from the EDEB Outbreak Response and Surveillance Team. Note also that EDEB activities concern bacterial pathogens. Surveillance information concerning viral and parasitic diseases is reported by Division of Viral and Rickettsial Diseases and the Division of Parasitic Diseases, respectively, and surveillance information regarding chemical intoxications is reported by the National Center for Environmental Health.

Sources and Contacts for Surveillance of Bacterial Foodborne and Diarrheal Diseases

System	Cases Reported	Contact	Title	CDC Division
NNDSS/NETSS	Clinical-case reporting of Campylobacteriosis, Botulism, EHEC, 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 Report

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*

Publications by the Enteric Diseases Epidemiology Branch, 2005

Anderson A, Nelson M, Baker N, Rossiter S, Angulo F. Public health consequences of use of antimicrobial agents in agriculture. In: Smulders FJM, Collins JD, eds. Food safety assurance and veterinary public health: Wageningen Academic, 2005:173–184.

Batz M, Doyle M, Morris G, et al. Attributing illness to food. Emerging Infectious Diseases 2005;11:993–999.

Brooks J, Sowers E, Wells J, et al. Non-O157 Shiga toxin-producing *Escherichia coli* infections in the United States, 1983–2002. Journal of Infectious Diseases 2005;192:1422–1429.

Burr R, Effler P, Kanenaka R, Nakata M, Holland B, Angulo F. Emergence of *Salmonella* serotype Enteritidis phage type 4 in Hawaii traced to locally-produced eggs. International Society for Infectious Diseases 2005;9:340–346.

CDC. *Escherichia coli* O157:H7 infections associated with ground beef from a U.S. military installation, Okinawa, Japan, February 2004. Morbidity and Mortality Weekly Report 2005;54:40–42.

CDC. Outbreak of multidrug-resistant *Salmonella* Typhimurium associated with rodents purchased at retail pet stores—United States, December 2003–October 2004. Morbidity and Mortality Weekly Report 2005;54:429.

CDC. Outbreaks of *Salmonella* infections associated with eating roma tomatoes—United States and Canada, 2004. Morbidity and Mortality Weekly Report 2005;54:326–328.

CDC. Rapid health response, assessment, and surveillance after a tsunami—Thailand, 2004–2005. Morbidity and Mortality Weekly Report 2005;54:61-64.

CDC. Salmonellosis associated with pet turtles—Wisconsin and Wyoming, 2004. Morbidity and Mortality Weekly Report 2005;54:223–226.

Crump J, Otieno P, Slutsker L, et al. Household based treatment of drinking water with flocculant-disinfectant for preventing diarrhoea in areas with turbid source water in rural western Kenya: cluster randomised controlled. BMJ 2005;10:1–6.

Devasia R, Varma J, Whichard J, et al. Antimicrobial use and outcomes in patients with multidrug-resistant and pansusceptible *Salmonella* Newport infection, 2002–2003. Microbial Drug Resistance 2005;11:371–377.

Doumith M, Jacquet C, Gerner-Smidt P, et al. Multicenter validation of a multiplex PCR assay for differentiating the major *Listeria monocytogenes* serovars 1/2a, 1/2b, 1/2c, and 4b: toward an international standard. Journal of Food Protection 2005;68:2648–2650.

Fischer T, Ashley D, Kerin T, et al. Rotavirus antigenemia in patients with acute gastroenteritis.

Journal of Infectious Diseases 2005;192:913–919.

Fisk T, Lundberg B, Guest J, et al. Invasive infection with multidrug-resistant *Salmonella* enterica Serotype Typhimurium Definitive Type 104 among HIV-Infected Adults. Clinical Infectious Disease 2005;40:1016–1021.

Flint J, Duynhoven YTV, Angulo F, et al. Estimating the burden of acute gastroenteritis, foodborne disease, and pathogens commonly transmitted by food: an international review. Clinical Infectious Diseases 2005;41:698–704.

Frenzen P, Drake A, Angulo F. Economic cost of illness due to *Escherichia coli* O157 infections in the United States. Journal of Food Protection 2005;68:2623–2630.

Fry A, Braden C, Griffin P, Hughes J. Foodborne disease. In: Mandell GL, Bennett JE, Dolin R, editors. Principles and practice of infectious diseases. Philadelphia PA: Churchill Livingston; 2005. p. 1286–1301.

Gerner-Smidt P, Kincaid J, Kubota K, et al. Molecular surveillance of shiga toxigenic *Escherichia coli* O157 by PulseNet USA. Journal of Food Protection 2005;68:1926–1931.

Graves L, Hunter S, Rae Ong A, et al. Microbiological aspects of the investigation that traced the 1998 outbreak of listeriosis in the United States to contaminated hot dogs and establishment of molecular subtyping-based surveillance for *Listeria monocytogenes* in the PulseNet Network. Journal of Clinical Microbiology 2005;43:2350–2355.

Green L, Selman C, Banerjee A, et al. Food service worker's self-reported food preparation practices: an EHS-Net study. International Journal of Hygiene and Environmental Health 2005;208:27–35.

Green LR, Selman C, Scallan E, Jones TF, Marcus R. Beliefs about meals eaten outside the home as sources of gastrointestinal illness. Journal of Food Protection 2005;68:2184–2189.

Gupta A, Nelson J, Barrett L, et al. Antimicrobial resistance among *Campylobacter* strains, United States,1997–2001. Emerging Infectious Diseases 2005;10:1102–1109.

Gupta A, Sivapalasingam S, Olsen S, Mintz E, Bibb W, Hoekstra R. Evaluation of community-based serologic screening for identification of chronic *Salmonella* Typhi carriers in Vietnam. International Journal of Infectious Diseases 2005;1–6.

Gupta A, Summer C, Castor M, Maslanka S, Sobel J. Adult botulism type F in the United States, 1981-2002. Neurology 2005;65:1694–1700.

Hannah EL, Angulo FJ, Johnson JR, Haddadin B, Williamson J, Matthew S. Drug-resistant *Escherichia coli*, Rural Idaho. Emerging Infectious Diseases 2005;11:1614–1617.

Helms M, Ethelberg S, Molbak K, Group DS. International *Salmonella* Typhimurium DT104

infections, 1992–2001. Emerging Infectious Diseases 2005;11:9.

Homes C, Chillers T. National Antibiotic Resistance Monitoring System for Enteric Bacteria. Emerging Infectious Diseases 2005;10:20–61.

Hunter S, Vauterin P, Lambert-Fair M, et al. Establishment of a universal size standard strain for use with the PulseNet standardized pulsed-field gel electrophoresis protocols: converting the national databases to the new size standard. Journal of Clinical Microbiology 2005;43:1045–1050.

Hyma K, Lacher D, Nelson A, et al. Evolutionary genetics of a new pathogenic *Escherichia* species: *Escherichia albertii* and related *Shigella boydii* strains. Journal of Bacteriology 2005;187:619–628.

Kretsinger K, Sobel J, Tarkhashvili N, et al. *Helicobacter pylori,* Republic of Georgia. Emerging Infectious Diseases 2005;11:780–781.

Kubota K, Barrett L, Ackers M, Brachman P, Mintz E. Analysis of *Salmonella enterica* serotype Typhi pulsed-field gel electrophoresis patterns associated with international travel. Journal of Clinical Microbiology 2005;43:1205–1209.

Luby SP, Agboatwalla M, Feikin DP, Billheimer W, Altaf A, Hoekstra RM. Effect of handwashing on child health: a randomized controlled trial. Lancet 2005;366:225–233.

Lule J, Mermin J, et al. Effect of home based water chlorination and safe storage on diarrhea among persons with human immunodeficiency virus in Uganda. AJTMH 2005;73:926–933.

MacDonald PD, Whitwam R, Boggs J, et al. Outbreak of listeriosis among Mexican immigrants as a result of consumption of illicitly produced Mexican-style cheese. Clinical Infectious Disease 2005;40:677–682.

McLaughlin J, DePaola A, Bopp C, et al. Outbreak of *Vibrio parahaemolyticus* gastroenteritis associated with Alaskan oysters. New England Journal of Medicine 2005;353:1463–1470.

Mead PS, Dunne E, Graves L, et al. Nationwide outbreak of listeriosis due to contaminated meat. Epidemiology and Infection 2005:1–8.

Mermin J, Lule J, Ekwaru J, et al. Effect of co-trimoxazole prophylaxis on morbidity, mortality, CD4-cell count, and viral load in HIV infection in rural Uganda. Lancet 2005;364:1428–1434.

Naugle A, Holt K, Levine P, Eckel R. Sustained decrease in the rate of *Escherichia coli* O157:H7 positive raw ground beef samples tested by the Food Safety and Inspection Service. Journal of Food Protection 2005;68:2504–2505.

Nelson J, Tauxe R, Angulo F. Reply to Cox. Journal of Infectious Diseases 2005;191:1566–1567.

Olsen S, Patrick M, Hunter S, et al. Multistate Outbreak of *Listeria monocytogenes* infection linked to delicatessen turkey meat. Clinical Infectious Disease 2005;40:962–967.

Rangel J, Sparling P, Crowe C, Griffin P, Swerdlow D. Epidemiology of *Escherichia coli* O157: H7 outbreaks United States, 1982–2002. Emerging Infectious Diseases 2005;11:603–609.

Rankin S, Whichard J, Joyce K, et al. Detection of a blaSHV extended-spectrum B-lactamase in *Salmonella* Newport MDR-AmpC. Journal of Clinical Microbiology 2005;43:5792–5793.

Raphael B, Pereira S, Flom G, Zhang Q, Ketley J, Konkel M. The *Campylobacter jejuni* response regulator, CbrR, modulates sodium deoxycholate resistance and chicken colonization. Journal of Bacteriology 2005;187:3662–3670.

Reller M, Nelson J, Molbak K, et al. A Large, Multiple-restaurant outbreak of infection with *Shigella flexneri* serotype 2a traced to tomatoes. Clinical Infectious Diseases 2005;42:163–169.

Sanchez TH, Brooks JT, Sullivan P, et al. Bacterial diarrhea in persons with HIV Infection, United States, 1992-2002. Clinical Infectious Diseases 2005;41:1621–1627.

Scallan E, Majowicz S, Hall G, et al. Prevalence of diarrhoea in the community in Australia, Canada, Ireland, and the United States. International Journal of Epidemiology 2005;34:454–460.

Schroeder C, Naugle A, Schlosser W, et al. Estimate of illnesses from *Salmonella* Enteritidis in eggs, United States, 2000. Emerging Infectious Diseases 2005;11:113–115.

Sobel J. Botulism. Clinical Infectious Diseases 2005;41:1167–1173.

Sobel J. Food and beverage sabotage. Encyclopedia of Bioterrorism Defense 2005:215–220.

Sobel J, Mixter C, Kolhe P, et al. Necrotizing enterocolitis associated with *Clostridium perfringens* type A in previously healthy North American adults. J Am Coll Surg 2005;201:48–56.

Sobel J, Painter J. Illnesses caused by marine toxins. Clinical Infectious Diseases 2005;41:1290–1296.

Srikantiah P, Bodager D, Toth B, et al. Web-based investigation of multistate salmonellosis outbreak. Emerging Infectious Diseases 2005;11:610–612.

Srikantiah P, Charles M, Reagan S, et al. SARS clinical features, United States, 2003. Emerging Infectious Diseases 2005;11:135–138.

Swaminathan B, Gerner-Smidt P, Barrett L. Foodborne disease trends and reports. Foodborne Pathogens and Disease 2005;2:189–191.

Tauxe R. Linking illnesses to foods: a conceptual framework. In: Hoffmann SA, Taylor MR, eds. Toward Safer Food Perspective on Risk and Priority Setting. Washington, DC, 2005:47–63.

Tauxe R, Khabbaz R, Cameron D, Feinman L. International Conference on Emerging Infectious Diseases. Emerging Infectious Diseases 2005;10:2037–2038.

Varma J, Greene K, Ovitt J, Barrett L, Medalla F, Angulo F. Hospitalization and antimicrobial resistance in *Salmonella* outbreaks, 1984 - 2002. Emerging Infectious Diseases 2005;11:4.

Varma J, Rossiter S, Hawkins M, et al. Antimicrobial-resistant nontyphoidal *Salmonella* is associated with excess bloodstream infection and hospitalization. Journal of Infectious Diseases 2005;19:554–561.

Vora G, Meador C, Bird M, Bopp C, Andreadis J, Stenger D. Microarray-based detection of genetic heterogeneity, antimicrobial resistance, and the viable but nonculturable state in human pathogenic *Vibrio* spp. PNAS 2005;102:19109–19114.

Whichard J, Joyce K, Fey P, Nelson J, Angulo F, Barrett T. B-lactam resistance and *Enterobacteriaceae*, United States. Emerging Infectious Diseases 2005;11:1464–1466.

Widdowson M, Sulka A, Bulens S, et al. Norovirus and foodborne disease, United States, 1991–2000. Emerging Infectious Diseases 2005;11:95–102.

Woodward D, Clark C, Caldeira R, et al. Identification and characterization of *Shigella boydii* 20 serovar nov., a new and emerging *Shigella* serotype. Journal of Medical Microbiology 2005;54:741–748.

Wright J, Tengelsen L, Smith K, et al. Multidrug-resistant *Salmonella* Typhimurium in four animal facilities. Emerging Infectious Diseases 2005;11:1235–1242.

CDC Internet sites relevant to Foodborne and Diarrheal Diseases

For additional information about foodborne disease, please visit any of the following web sites:

Case Definitions for Infectious Conditions under Public Health Surveillance
http://www.cdc.gov/EPO/DPHSI/casedef/case_definitions.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/

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

Safe Water System
http://www.cdc.gov/safewater/

Bibliography

Botulism

Angulo FJ, St. Louis ME. Botulism. In: Evans AS, Brachman PS, eds. Bacterial Infections of Humans. New York: Plenum,1998:131–53.

CDC. Botulism in the United States, 1899–1996: Handbook for epidemiologists, clinicians, and laboratory workers. Atlanta, GA: US Department of Health and Human Services, Public Health Service, CDC, 1998. Available at http://www.cdc.gov/ncidod/dbmd/diseaseinfo/botulism_g.htm

CDC. Infant botulism—New York City, 2001–2002. MMWR 2003;52:21-4.

Shapiro RL, Hatheway C, Becher J, Swerdlow DL. Botulism surveillance and emergency response: a public health strategy for a global challenge. JAMA 1997;278:433–5.

Shapiro RL, Hatheway C, Swerdlow DL. Botulism in the United States: A clinical and epidemiologic review. Ann Intern Med 1998;129:221–8.

Sobel J, Tucker N, McLaughlin J, Maslanka S. Foodborne botulism in the United States, 1999–2000. Emerg Infect Dis 2004;10:1606–12.

Sobel J. Botulism. Clin Infect Dis 2005;41;1167–73.

Cholera

Mintz ED, Tauxe RV, Levine MM. The global resurgence of cholera. In: Noah ND, O'Mahony M, eds. Communicable disease epidemiology and control. Chichester, England: John Wiley & Sons, 1998:63–104.

Steinberg EB, Greene KD, Bopp CA, Cameron DN, Wells JG, Mintz ED. Cholera in the United States, 1995–2000: Trends at the end of the millennium. J Infect Dis 2001;184, 799–802.

Mahon BE, Mintz ED, Greene KD, Wells JG, Tauxe RV. Reported cholera in the United States, 1992-1994: a reflection of global changes in cholera epidemiology. JAMA 1996;276:307–12.

World Health Organization. Guidelines for cholera control. Geneva, Switzerland: World Health Organization, 1993.

Escherichia coli O157 and other Shiga toxin-producing *E. coli*

Bender JB, Hedberg CW, Besser JM, et al. Surveillance for *Escherichia coli* O157:H7 infections in Minnesota by molecular subtyping. N Engl J. Med 1997;337:388–94.

Brooks JT, Sowers EG, Wells JB, Greene KD, Griffin PM, et al. Non-O157 Shiga toxin-producing *Escherichia coli* infections in the United States, 1983–2002. J Infect Dis 2005;192:1422–9.

Crump JA, Sulka AC, Langer AJ, et al. An outbreak of *Escherichia coli* O157:H7 among visitors to a dairy farm. N Engl J Med 2002;347:555–60.

Griffin PM, Mead PS, Sivapalasingam S. *Escherichia coli* O157:H7 and other enterohemorrhagic *E. coli*. Chapter 42. In: Blaser MJ, Smith PD, Ravdin JI, Greenberg HB, Guerrant RL, eds. Infections of the gastrointestinal tract. Philadelphia: Lippincott Williams & Wilkins, 2002:627–42.

Mead PS, Griffin PM. *Escherichia coli* O157:H7. Lancet 1998;352:1207–12.

Hemolytic uremic syndrome

Banatvala N, Griffin PM, Greene KD, et al. The United States National Prospective Hemolytic Uremic Syndrome Study: microbiologic, serologic, clinical, and epidemiologic findings. J Infect Dis 2003;183(7):1063–70.

Mahon BE, Griffin PM, Mead PS, Tauxe RV. Hemolytic uremic syndrome surveillance to monitor trends in infection with *Escherichia coli* O157:H7 and other Shiga toxin-producing *E. coli* (Letter). Emerg Infect Dis 1997;3:409–12.

Listeria

Gottlieb SL, Newbern EC, Griffin PM, et al. Multistate outbreak of listeriosis linked to turkey deli meat and subsequent changes in US regulatory policy. Clin Infect Dis 2006;42:29–36.

Mead PS, Dunne EF, Graves L, Wiedmann M, Patrick M, et al. Nationwide outbreak of listeriosis due to contaminated meat. Epidemiol Infect 2006;134:744–51.

Mead PS, Slutsker L, Dietz V, McCaig L, Bresee J, Shapiro C, Griffin P, Tauxe R. Food-related illness and death in the United States. Emerg Infect Dis 1998;5(5):607–25.

Olsen SJ, Patrick M, Hunter SB, et al. Multistate outbreak of *Listeria monocytogenes* infection linked to delicatessen turkey meat. Clin Infect Dis 2005;40(7):962–7.

Slutsker L, Evans MC, Schuchat A. Listeriosis. In: Scheld WM, Craig WA, Hughes JM, eds. Emerging Infections, 4th ed. Washington DC; American Society for Microbiology, 2000:83–106.

Slutsker L, Schuchat A. Listeriosis in humans. In: Ryser ET and Marth EH, eds. *Listeria*, Listeriosis, and Food Safety, Second Edition. New York, NY: Marcel Dekker, Inc. Little, Brown and Company;1999:75–95.

Tappero J, Schuchat A, Deaver K, Mascola L, Wenger J, for the Listeriosis Study Group. Reduction in the incidence of human listeriosis in the United States: Effectiveness of prevention efforts. JAMA 1995;273(14):1118–22.

Salmonella

Braden CR. *Salmonella enterica* serotype Enteritidis and eggs: a national epidemic in the United States. Clin Infect Dis 2006;43;512–17.

Mahon BE, Slutsker L, Hutwagner L, et al. Consequences in Georgia of a nationwide outbreak of *Salmonella* infections: what you don't know might hurt you. Am J Public Health 1999;89:31–5.

Olsen SJ, Bishop R, Brenner FW, et al. The changing epidemiology of *Salmonella*: trends in serotypes isolated from humans in the U.S., 1987–1997. J Infect Dis 2001;183:756–61.

Voetsch AC, Van Gilder TJ, Angulo FJ, et al. FoodNet estimate of burden of illness caused by nontyphoidal *Salmonella* infections in the United States. Clin Infect Dis 2004;38(Suppl 3):S127–34.

Shigella

CDC. Shigellosis outbreak associated with an unchlorinated fill-and-drain wading pool, Iowa, 2001. MMWR, 2001;50:797–800.

CDC. Outbreaks of multidrug-resistant *Shigella sonnei* gastroenteritis associated with day care centers—Kansas, Kentucky, and Missouri, 2005. MMWR 2006;55:1068–71.

CDC. Outbreaks of *Shigella sonnei* infection associated with eating fresh parsley—United States and Canada, July–August 1998. MMWR 1999;48:285–9.

Gupta A, Polyak CS, Bishop RD, Sobel J, Mintz ED. Laboratory-confirmed shigellosis in the United States, 1989–2002: epidemiologic trends and patterns. Clin Infect Dis 2004;38:1372–7.

Mohle-Boetani JC, Stapleton M, Finger R, et al. Community-wide shigellosis: control of an outbreak and risk factors in child daycare centers. Am J Public Health 1995;85:812–6.

Shane A, Crump J, Tucker N, Painter J, Mintz E. Sharing *Shigella*: risk factors and costs of a multi-community outbreak of shigellosis. Arch Pediatr Adolesc Med 2003;157:601–3.

Sobel J, Cameron DN, Ismail J, et al. A prolonged outbreak of *Shigella sonnei* infections in traditionally observant Jewish communities in North America caused by a molecularly distinct bacterial subtype. J Infect Dis 1998;177:1405–8.

Typhoid

Ackers ML, Puhr ND, Tauxe RV, Mintz ED. Laboratory-based surveillance of *Salmonella* serotype Typhi infections in the United States: antimicrobial resistance on the rise. JAMA 2000;283:2668–73

Crump J, Barrett TJ, Nelson JT, Angulo FJ. Reevaluating fluoroquine breakpoints for *Salmonella enterica* serotype Typhi, and for non-Typhi *Salmonellae*. Clin Infect Dis 2003;37:75–81.

Mermin JH, Townes JM, Gerber M, Dolan N, Mintz ED, Tauxe RV. Typhoid fever in the United States, 1985–1994: changing risks of international travel and increasing antimicrobial resistance. Arch Intern Med 1998;158:633–8

Olsen SJ, Bleasdale SC, Magnano AR, et al. Outbreaks of typhoid fever in the United States, 1960–1999. Epidemiol Infect 2003;130:13–21.

Reller M, Olsen SJ, Kressel A. Sexual transmission of typhoid fever: a multi-state outbreak among men who have sex with men. Clin Infect Dis 2003;37:141–4.

Steinberg EB, Bishop RB, Dempsey AF, et al. Typhoid fever in travelers: who should be targeted for prevention? Clin Infect Dis 2004;39:186–91.

Vibrio Infections (non-cholera)

Daniels NA, Ray B, Easton A, Marano N, et al. Emergence of a new *Vibrio parahaemolyticus* serotype in raw oysters. A prevention quandary. JAMA 2000;284:1541–1545.

Daniels NA, MacKinnon L, Bishop R, Altekruse S, et al. *Vibrio parahaemolyticus* infections in the United States, 1973–1998. J Infect Dis 2000;181:1661–1666.

McLaughlin JB, DePaola A, Bopp CA, Martinek KA, Napolilli NP, Allison CG, Murray SL, Thompson EC, Bird MM, Middaugh JP. Outbreak of *Vibrio parahaemolyticus* gastroenteritis associated with Alaskan oysters. N Engl J Med 2005;353(14):1463–70.

Shapiro RL, Altekruse S, Hutwagner L, et al. The role of gulf coast oysters harvested in warmer months in *Vibrio vulnificus* infections in the United States, 1988–1996. J Infect Dis 1998;178:752–759