Bacterial Foodborne and Diarrheal Disease National Case Surveillance

Annual Report, 2003

Enteric Diseases Epidemiology Branch
Division of Foodborne, Bacterial and Mycotic Diseases
National Center for Zoonotic, Vectorborne 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, Vectorborne, 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 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. The 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 and Shiga toxin-producing *E. coli*, non-O157. The 2003 case and isolate counts for nine diseases and pathogens are presented in Table 1-1. Information in this report includes case and isolate counts in 2003 as of June 2006; the numbers may have changed compared with previous publications concerning 2003 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 concerning these pathogens at the national level is variable. The Foodborne Diseases Active Surveillance Network (FoodNet) conducted more intensive surveillance in nine states in 2003; the reader is referred to their World Wide Web sites for more information (http://www.cdc.gov/foodnet/).

A still greater number of 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 may be accessed 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) is 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. For information about these documents, the reader is referred to the following sections at the end of this report: World Wide Web sites for Foodborne and Diarrheal Diseases, Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases, and Publications by the Enteric Diseases Epidemiology Branch, 2003.

This report is the first of a new annual series summarizing results from nationally notifiable bacterial foodborne and diarrheal diseases case surveillance systems. A description of the surveillance systems is included to help one understand the differences among these systems, which sometimes leads to different case counts for the same disease entity (see Data Sources and Background section). The specialized sentinel site surveillance system, FoodNet, provides complementary surveillance information for a range of foodborne infections of public health concern. It currently collects more detailed data on these infections 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 will 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 via the World Wide Web.

Table 1-1. Isolate and case counts for 9 foodborne and diarrheal diseases and pathogens, 2003*

Pathogen/Disease	Comments	Nationally Notifiable	Data Source		
			NNDSS** no. cases	**PHLIS**** no. isolates	**EDEB**** no. cases/isolates
Botulism	Includes foodborne, wound, infant and other types	YES	129	NA	126
E. coli O157:H7		YES	2,674	2,143	NA
E. coli, Shiga toxin-producing, non-O157		YES	258	166	239
Hemolytic Uremic Syndrome		YES	178	NA	NA
Listeriosis		YES	697	NA	NA
Salmonella Typhi (Typhoid fever)		YES	357	362	305
Salmonella, non-Typhi (Salmonellosis)	Includes > 2,400 Serotypes	YES	44,520	37,080	NA
Shigella (Shigellosis)	Includes 4 subgroups	YES	23,789	15,951	NA
Non-cholera *Vibrio*	Some species may not be pathogenic	NO	269	NA	479
Vibrio cholerae, toxigenic (Cholera)	Includes O1 and O139 serotypes	YES	2	NA	2

* Isolate and case counts for 2003 updated as of June 2006
**NNDSS (National Notifiable Diseases Surveillance System)
PHLIS (Public Health Laboratory Information System)
EDEB (Enteric Diseases Epidemiology Branch)

2003 Summary

Botulism: A total of 126 cases of foodborne (8), wound (30), infant (86), and other types (2) of botulism

were reported to the EDEB botulism surveillance system, including three deaths and two outbreaks (defined as two or more cases as a result of persons ingesting the same food). All deaths were attributed to foodborne (2) and wound (1) botulism.

Escherichia coli O157:H7and other Shiga toxin-producing *E. coli*: *Escherichia coli* O157:H7 has been nationally notifiable since 1994. In 2000, the Council for State and Territorial Epidemiologists passed a resolution in which all Shiga toxin-producing *E. coli* were made nationally notifiable under the name Enterohemorrhagic *Escherichia coli* or EHEC; national surveillance for EHEC began in 2001. Reported infections with the most well-known pathogen in this group, *E. coli* O157:H7, 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. After implementation of USDA measures to control infection of farm animals, reported cases of *E. coli* O157 infection have decreased. During 2003, 2,674 cases were reported through the National Notifiable Diseases Surveillance System.

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 2003, CDC received 239 isolates of Shiga toxin-producing *E. coli*, non-O157. Isolates originated from 32 states and included 32 different O groups. The three most common O groups were O26 (25%), O111 (17%), and O103 (14%). A total of 252 cases of Shiga toxin-producing *E. coli* non-O157 were reported to the Nationally Notifiable Disease Surveillance System.

Hemolytic Uremic Syndrome (HUS)- post diarrheal: HUS is a syndrome 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, though only a few persons infected with *E. coli* O157:H7 develop HUS. Of the 178 illnesses reported in the year 2003, over 65% were in children 1 to 9 years old.

Listeriosis: Listeriosis became nationally notifiable in 2000. Surveillance is conducted in the Nationally Notifiable Diseases Surveillance System. Forty-nine states listed listeriosis as reportable in 2003; 45 states reported at least one case for a total of 697 cases.

Salmonella Typhi (Typhoid fever): Infection with *Salmonella* serotype Typhi often leads to typhoid fever. The number of cases of typhoid fever (357 in the National Notifiable Diseases Surveillance System) 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 – 362 isolates were reported in 2003.

Salmonella, non-Typhi (Salmonellosis): A total of 37,442 *Salmonella* isolates were reported in 2003; 37,080 of these were *Salmonella* serotypes other than Typhi. The national rate of reported *Salmonella* isolates in 2003 was 12.9 per 100,000 population. Similar to other years, *Salmonella* was isolated most frequently from children under 5 years of age, accounting for 25% of isolates. About 10% of isolates came from persons in each of the second through fifth decades of life, with declining numbers thereafter. Specific control programs have been successful in the dramatic reduction of *Salmonella* serotype Enteritidis since 1995, which has been associated with the internal contamination of eggs. However, other serotypes, such as *S*. Mississippi, *S*. Newport, and *S*. Javiana, have increased in numbers from 1993 to 2003. Rates of antibiotic resistance among several serotypes have been increasing. For information about trends in antibiotic resistance, the reader is referred to the following sections at the end of this report: World Wide Web sites for Foodborne and Diarrheal Diseases, Sources and Contacts for Bacterial Foodborne and

Diarrheal Diseases, and Publications by the Foodborne and Diarrheal Diseases Branch, National Antimicrobial Resistance Monitoring System (NARMS).

Shigella (Shigellosis): *Shigella* transmission occurs most commonly via the fecal-oral route. The majority of *Shigella sonnei* infections in the United States 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 15,951 *Shigella* isolates were reported to PHLIS in 2003. This represents an 18% decrease compared with 1993. The national rate of reported *Shigella* isolates in 2003 was 5.4 per 100,000 population; in 1993, the national rate of reported isolates was 7.5 per 100,000. Similar to previous years, *Shigella* was isolated frequently from children under 5 years of age, who accounted for 31.3% of all isolates. Another 34% of all isolates came from persons aged 5-19 years, and 26.1% from persons aged 20-59 years.

Of the 15,951 isolates, 79% were speciated. Trends of species remained constant, with *S. sonnei* accounting for the largest percentage of isolates (66.6%), followed by *S. flexneri (*10.9%), *S. boydii* (0.9%) and *S. dysenteriae* (0.3%).

Cholera and non-cholera *Vibrio*: In 2003, toxigenic *V. cholerae* serogroup O1, the cholera agent, was identified from two patients in two states. One patient acquired the infection while traveling in Pakistan, most likely through consumption of locally prepared food. The second patient had onset of diarrhea while traveling in the Philippines. Both patients had diarrhea; the Pakistan traveler required hospitalization, and neither died.

Other *Vibrio* isolates (excluding toxigenic *V. cholerae* serogroup O1 and O139) were not nationally

notifiable in 2003 and not all states report cases. States bordering the Gulf of Mexico have a reporting agreement with the CDC; others do not but are encouraged to report cases nevertheless. In 2003, 479 other *Vibrio* isolates from 462 individual patients were reported to the Cholera and Other *Vibrios* Surveillance System. Of these 178 (39%) were from Gulf Coast states, 112 (24%) were from Pacific Coast states, 127 (27%) were from Atlantic Coast states (excluding Florida), and 45 (10%) were from inland states. Among patients for whom information was available, 189 (45%) of 417 were hospitalized and 41 (10%) of 401 died. *V. parahaemolyticus* was isolated from 158 (33%) patients and was the most frequently reported *Vibrio* species. *V. vulnificus* was isolated from 113 (24%) patients; 93% were hospitalized and 31% died.

Expanded Surveillance Summaries for Selected Pathogens and Diseases, 2003

The following bacterial foodborne and diarrheal diseases case surveillance summaries for 2003 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, 2003 and the *Shigella* Annual Summary, 2003. 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 consuming 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 anti-toxin used to treat botulism in the United States. The request for consultation and release of anti-toxin 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. For emergency consultation on cases of suspect botulism, call (770) 488-7100. For consultation on infant botulism, call the California Department of Health Services at (510) 540-2646.

A total of 126 cases of botulism intoxication were reported to CDC in 2003. Among the 8 cases of foodborne intoxication, toxin type A accounted for 5 (63%) cases and toxin type E for 2 (25%) cases and toxin type F for one (12%) case. The median age of patients was 47 years; two deaths were reported. There were two multi-case outbreaks; one in Utah, in which no food vehicle was identified, and the other in Alaska, in which the food vehicle was fermented fish heads.

There were 86 reported cases of infant botulism. Toxin type B accounted for 53 (62 %) cases and toxin type A for 32 (37%) cases, and toxin type F for one (1%) case. The median age of patients was 15 weeks; no deaths were reported.

There were 30 reported cases of wound botulism. Toxin type A accounted for 29 (97%) of cases; toxin type was not determined for one case. The median age of patients was 44 years; one death was reported. Wound botulism has been associated with the use of injected black tar heroin. Thirty of 31 cases were reported among injection drug users, and there was one multi-case outbreak of wound botulism in Washington State among injection drug users. Black tar heroin was the suspected vehicle.

There was one case of adult colonization botulism in an 83-year old man from Texas; toxin type A was identified and the patient survived. One case of treatment-related botulism was reported in a 5-year old child with cerebral palsy. The condition was caused by infection of a licensed pharmaceutical preparation of toxin type B; the child survived.

Table 2-1. Summary of reported botulism cases, 2003*

	Cases	Median age	Gender	Toxin type	Comments
Foodborne	8 cases (2 reported deaths)	47 years (range: 23 – 87 years)	3 (38%) Male	5 (63%) type A 2 (25%) type E 1 (12%) type F	2 multi-case outbreaks
Infant	86 cases (No reported deaths, 7 unknown)	15 weeks (range: 0 - 61 weeks)*	39 (45%) Male	32 (37%) type A 53 (62%) type B 1 (1%) type F	* One 61 week-old patient listed as infant botulism, although formal definition is under one year old.
Wound	30 cases (1 reported death, 3 unknown)	40 years (range: 23 –59 years)	23 (73%) Male	29 (94%) type A 1 (3%) toxin type undetermined	1 multi-case outbreak among injection drug users
Adult Intestinal Colonization	1 case (No reported death)	83 years	1 (100%) Male	type A	
Treatment-associated	1 case (No reported death)	5 years	1 (100%) Male	type B	

* Data obtained from the Botulism Surveillance System for 2003 as of June 2006

Table 2-2. Cases of botulism by state and type, 2003*

State/District	Foodborne	Infant	Wound	Other**	Total
AK	2				2
CA	2	31	21		54
CO	1	1	1		3
CT		1			1
DE		3			3
HI		1			1
IN		1			1
LA		1			1
MD		1			1
MO		1			1
MS		1			1
NJ		5			5
NM		1			1
NV		2			2
NY		3			3
NYC		1			1
OR		3	1		4
PA		16			16
TN		2			2
TX		1		2	3
UT	2	6			8
VA		1			1
WA	1	3	7		11
Totals:	**8**	**86**	**30**	**2**	**126**

* Data obtained from the Botulism Surveillance System for 2003 as of June 2006
** Adult intestinal colonization and treatment-associated

Table 2-3. Cases of foodborne botulism by month (N=8), 2003*

Month	State	Age (years)	Gender	Toxin Type	Vehicle	Death
January	WA	42	Female	A	home-canned beans and asparagus	No
February	CA	45	Female	F	unknown	No
	CO	49	Male	A	pumpkin butter	No
June	AK**	40	Male	E	fermented fish head	No
July	AK**	23	Female	E†	fermented fish head	No
October	CA	60	Female	A	commercial clam chowder	No
	UT**	87	Female	A†	unknown	Yes
	UT**	91	Male	A	unknown	Yes

* Data obtained from the Botulism Surveillance System for 2003 as of June 2006
**Cases involved in multicase outbreak
†Toxin type derived from epidemiologically-linked case

Table 2-4. Cases of infant botulism by month (N=86), 2003*

Month	State	Age (weeks)	Gender	Toxin type	Death
January	PA	9	Male	B	No
	UT	16	Female	A	unknown
	TN	12	Female	B	No
	NJ	9	Male	B	No
	UT	20	Male	A	No
	PA	10	Male	B	unknown
	CA	21	Female	A	No
	UT	24	Male	A	unknown
	WA	20	Female	A	unknown
February	UT	32	Female	A	No
	HI	12	Female	B	No
	WA	28	Male	B	No
	MS	5	Male	B	No
	NV	30	Male	A	unknown
	TX	6	Female	B	No
March	NV	15	Male	A	No
	NJ	30	Male	B	No

	CA	28	Male	A	No
	CO	20	Male	A	No
April	PA	21	Female	B	No
	NY	5	Male	B	No
	CA	28	Male	B	No
	PA	61**	Male	B	unknown
	NYC	13	Male	B	No
	PA	6	F	B	unknown
	CA	19	Female	B	No
May	CA	24	Female	A	No
	PA	6	Female	B	No
	CA	11	Male	A	No
June	UT	27	Female	A	No
	IN	42	Female	B	No
	NJ	7	Female	B	No
	PA	15	Male	B	No
	UT	10	Female	A	No
	PA	3	Female	B	No
July	NJ	9	Female	B	No
	CA	4	Female	B	No
	CA	7	Female	A	No
	CA	24	Female	B	No
	DE	4	Female	B	No
	PA	18	Female	B	No
August	MD	20	Female	B	No
	TN	8	Female	B	No
	VA	8	Female	B	No
	PA	12	Female	B	No
	CA	27	Male	A	No
	NY	10	Male	B	No
	CA	8	Female	B	No
	WA	12	Male	A	No
	NY	15	Male	B	No
	CA	15	Female	A	No
September	CA	8	Female	B	No
	NM	16	Female	A	No
	CA	24	Female	B	No

	CA	7	Female	B	No
	CA	19	Female	A	No
	CA	11	Female	A	No
	CT	14	Male	B	No
October	CA	5	Male	B	No
	OR	5	Female	A	No
	CA	0	Female	F	No
	DE	16	Male	B	No
	NY	5	Male	B	No
	PA	11	Male	B	No
November	CA	21	Male	B	No
	CA	24	Female	B	No
	CA	3	Male	B	No
	CA	19	Male	A	No
	CA	21	Male	B	No
	CA	46	Female	A	No
	OR	15	Female	A	No
	PA	14	Male	B	No
	OR	13	Female	A	No
	CA	16	Male	A	No
	CA	12	Male	A	No
	LA	11	Female	B	No
	CA	3	Female	B	No
December	CA	18	Female	A	No
	PA	15	Female	B	No
	MO	21	Female	A	No
	NJ	2	Male	B	No
	CA	17	Female	A	No
	DE	12	Male	B	No
	PA	24	Female	B	No
	PA	20	Male	B	No
	CA	12	Male	A	No

* Data obtained from the Botulism Surveillance System for 2003 as of June 2006
** Listed as infant botulism, although formal definition is under 1 year of age.

Table 2-5. Cases of wound botulism by month (N=30), 2003*

Month	State	Age (years)	Gender	Toxin Type	Exposure*	Death
January	CA	38	Female	A	IDU	Unknown
	CO	49	Male	A	IDU	No
February	CA	49	Male	A	IDU	No
	CA	35	Male	A	IDU	No
March	CA	43	Female	A	IDU	No
April	CA	53	Male	A	IDU	No
May	CA	54	Male	A	IDU	No
	CA	54	Male	A	IDU	No
	CA	34	Male	A	IDU	No
	CA	44	Male	A	IDU	unknown
June	CA	52	Male	A	IDU	No
	OR	47	Male	A	IDU	unknown
July	CA	46	Male	A	IDU	No
	CA	40	Male	A	IDU	No
	CA	54	Male	A	IDU	Yes
August	CA	54	Male	A	IDU	No
	CA	42	Female	A	IDU	No
	WA	50	Male	A†	IDU	No
	WA	38	Female	A	IDU	No
	WA	38	Male	A	IDU	No
	WA	31	Female	A†	IDU	No
September	CA	57	Male	A	IDU	No
November	CA	40	Female	A	IDU	No
	CA	41	Male	Unknown††	IDU	No
	CA	30	Female	A	IDU	No
	CA	49	Male	A	IDU	No
	CA	42	Male	A	IDU	No
	WA	44	Male	A	IDU	No
	WA	40	Male	A	IDU	No
	WA	23	Male	A†	IDU	No

* Data obtained from the Botulism Surveillance System for 2003 as of June 2006
** IDU= Injection drug use
†Toxin type derived from epidemiologically-linked case.
†† Serum quantity not sufficient for toxin typing.

Table 2-6. Cases of Adult Intestinal Colonization (N=1) and Treatment-Associated Botulism (N=1) by Month, January 1 - December 31, 2003*

Month	State	Age (years)	Gender	Type of Botulism	Toxin Type	Death
September	TX	83	Male	Adult intestinal	A	No
October	TX	5	Male	Treatment-associated**	B	No

* Data obtained from the Botulism Surveillance System for 2003 as of June 2006
** Laboratory-confirmed botulism case infected with licensed pharmaceutical preparation of toxin type B

Shiga toxin-producing *Escherichia coli* non-O157

Shiga toxin-producing *Escherichia coli* (STEC) strains cause diarrhea and 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).

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 2003, 258 cases of non-O157 STEC were reported. 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 2003, 239 isolates were received by CDC from 32 states (Figure 3-1).

In 2003, as in previous years, more (44%) non-O157 STEC isolates were collected during the warm

months, May through August, than during any other four-month period during the year. The non-O157 isolates received by CDC in 2003 included 32 different O groups. The predominant groups were O26 (25%) and O111 (17%), followed by O103 (14%), O145 (8 %) and O121 (6 %); these five O groups comprised 69 % of all isolates (Table 3-1). *E. coli* O26 was also the most commonly isolated non-O157 STEC in 2002., In 2001, *E. coli* O111 was the most common.

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

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

Clinical laboratories should add Shiga toxin testing with assays such as EIA to the microbiological tests they offer. Appropriate specimens for Shiga toxin testing include stools from persons with diarrhea, especially bloody diarrhea or HUS, and sterile-site isolates of *E. coli* from persons with HUS. Clinical laboratories can use O157 antisera to determine which STEC are O157. Identifying STEC O157 at the clinical laboratory level with rapid reporting to health departments is critical in detecting outbreaks. All Shiga toxin-positive organisms should be sent to the state public health laboratory where they are further

subtyped in real time by pulse-field electrophoresis in order to detect clusters of cases. CDC can assist state laboratories by confirming and serotyping Shiga toxin-positive *E. coli* isolates. Serotyping of non-O157 STEC is important in determining which serotypes are pathogenic in humans, defining the epidemiology of these infections, and detecting outbreaks.

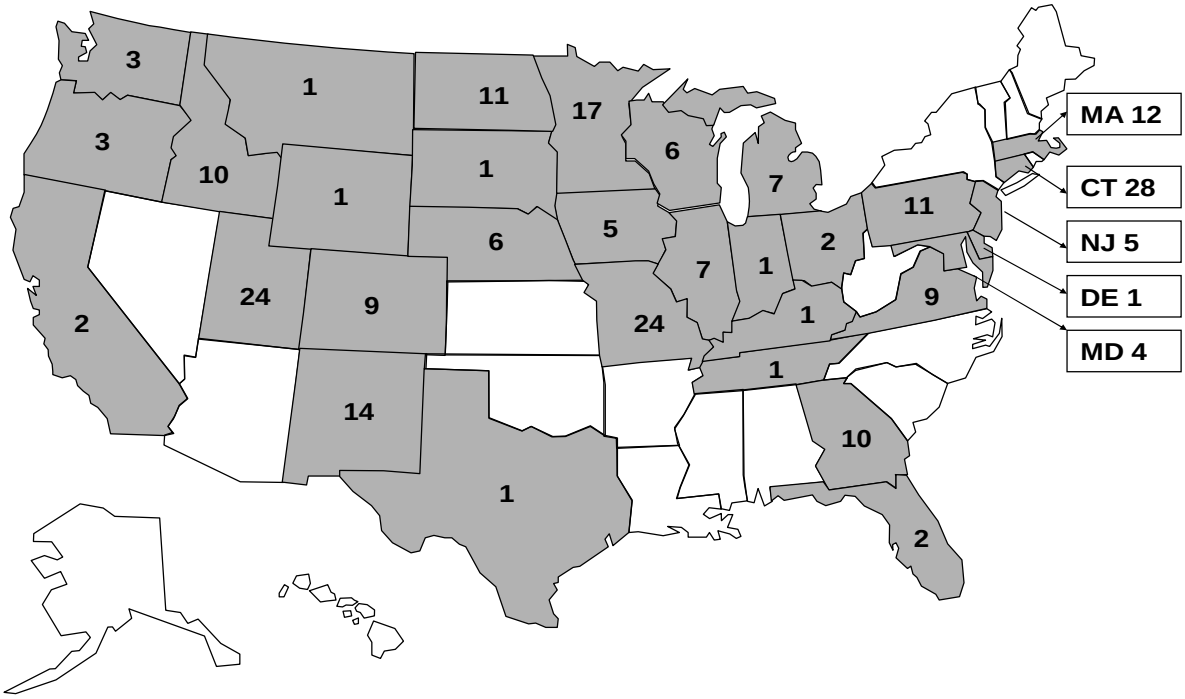
Table 3-1. Serogroup of non-O157 STEC isolates from humans sent to CDC, 2003*

Serogroup	Number	Percent
O26	60	25.1
O111	41	17.15
O103	33	13.8
O145	18	7.5
O121	14	5.9
O45	12	5
O118	6	2.5
O55	5	2.1
O76	4	1.7
O84	3	1.3
O91	3	1.3
O165	3	1.3
O174	2	0.8
O20	1	0.41
O28	1	0.41
O33	1	0.41
O38	1	0.41
O51	1	0.41
O74	1	0.41
O86	1	0.41
O113	1	0.41
O116	1	0.41
O119	1	0.41
O124	1	0.41
O130	1	0.41
O136	1	0.41
O137	1	0.41

O146	1	0.41
O153	1	0.41
O168	1	0.41
O177	1	0.41
O22,76	1	0.41
ROUGH	5	2.1
Undetermined	11	4.6
Total	239	100

* Data obtained from the National *Escherichia coli* Reference Laboratory and Epidemic Investigation and Surveillance Laboratory

Figure 3-1. States that submitted non-O157 STEC to CDC, 2003* (n=32 states)



Number indicates the number of isolates submitted
* Data obtained from the National *Escherichia coli* reference Laboratory and Epidemic Investigation and Surveillance Laboratory

Salmonella

(For *Salmonella* surveillance case definition used in NNDSS, see 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 in the United States. This information is reported electronically through the Public Health Laboratory Information System (PHLIS), to EDEB. *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 submit the data for reporting through PHLIS. Unusual or difficult isolates are forward to the National *Salmonella* Reference Laboratory at CDC for further characterization or confirmation. These results are reported back to the state laboratory, where they are reported through PHLIS. Duplicates are removed from the file at the end of the year. Every 20th isolate is forwarded to the National Antimicrobial Resistance Monitoring System (NARMS) at CDC for susceptibility testing.

The capture of isolates in the National *Salmonella* Surveillance System is considered to be fairly complete. However, some *Salmonella* isolates may not be forwarded to public health laboratories, and therefore are not reported. In addition, irrespective of the surveillance system, many cases of *Salmonella* illness are not reported because the ill person does not seek medical care, the health-care provider does not obtain a specimen for diagnosis, or the laboratory does not perform the necessary diagnostics tests. The results of surveillance reported herein 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 a year for each person is counted.

A total of 37,442 *Salmonella* isolates were reported from public health laboratories in 50 states in 2003. This represents a 1.4% increase compared with 1993 and a 14.9% increase over 2002. The national rate of reported *Salmonella* isolates in 2003 was 12.9 per 100,000 population based on 2003 census population figures for the United States.

Similar to other years, *Salmonella* was isolated most frequently from children under 5 years of age, accounting for 25% of isolates. About 10% of isolates came from persons in each of the second through fifth decades of life, with declining numbers thereafter. The distribution of isolates between the sexes was different, with a greater number of isolates from male infants and children and fewer isolates from male adults and older persons.

The 20 most common serotypes of *Salmonella* in 2003 are listed in Table 4-1. These represent 78% of all *Salmonella* isolates. Of the top 20 serotypes, the two most common serotypes, *S*. Typhimurium and *S*. Enteritidis, had substantial decreases in number compared with 1993 (24% and 39%, respectively). The incidence rates for *S.* Typhimurium (2.3 per 100,000 population) and *S.* Enteritidis (1.7 per 100,000 population) also decreased in 2003 compared to rates in 1993 (3.4 and 3.1 isolates per 100,000 respectively). The largest percent decrease in numbers compared to 1993 were *S*. Hadar (78%); the incidence rate changed from 0.5 per 100,000 population in 1993 to 0.1 per 100,000 in 2003. A dramatic increase in *S*. Mississippi (181% from 1993 to 2003, incidence rate increased from 0.06 to 0.15 per 100,000 respectively) mainly occurred before 1998, and *S*. Newport and *S*. Javiana had important increases in numbers from 1993 to 2003 as well (160% and 159% respectively, incidence rates increased from 0.6 to 1.4 and 0.25 to 0.6 per 100,000 population respectively). In 2003, *S*. Bareilly and *S*. Stanley increased in rank to be included in the top 20 serotypes, whereas *S*. Berta and *S*. Poona dropped from the top 20 serotypes compared with 2002. The newly recognized monophasic serotype I 4,[5],12:i:- ranked # 12.

The three most common serotypes of *Salmonella* in 2003 (Typhimurium, Enteritidis, and Newport, respectively) accounted for 42% of isolates. Compared with 1993, the frequency rank of *S.* Typhimurium and *S.* Enteritidis in 2003 remained first and second, respectively, though in 1994-1996 their rank was temporarily reversed. A large proportion of *S.* Typhimurium isolates were resistant to multiple antimicrobial drugs; in a 2002 national survey, 40% were resistant to one or more drugs and 21% had a 5-drug resistance pattern characteristic of a single phage type, DT104 (see NARMS site under World Wide Web sites for Foodborne and Diarrheal Diseases, http://www.cdc.gov/narms/).

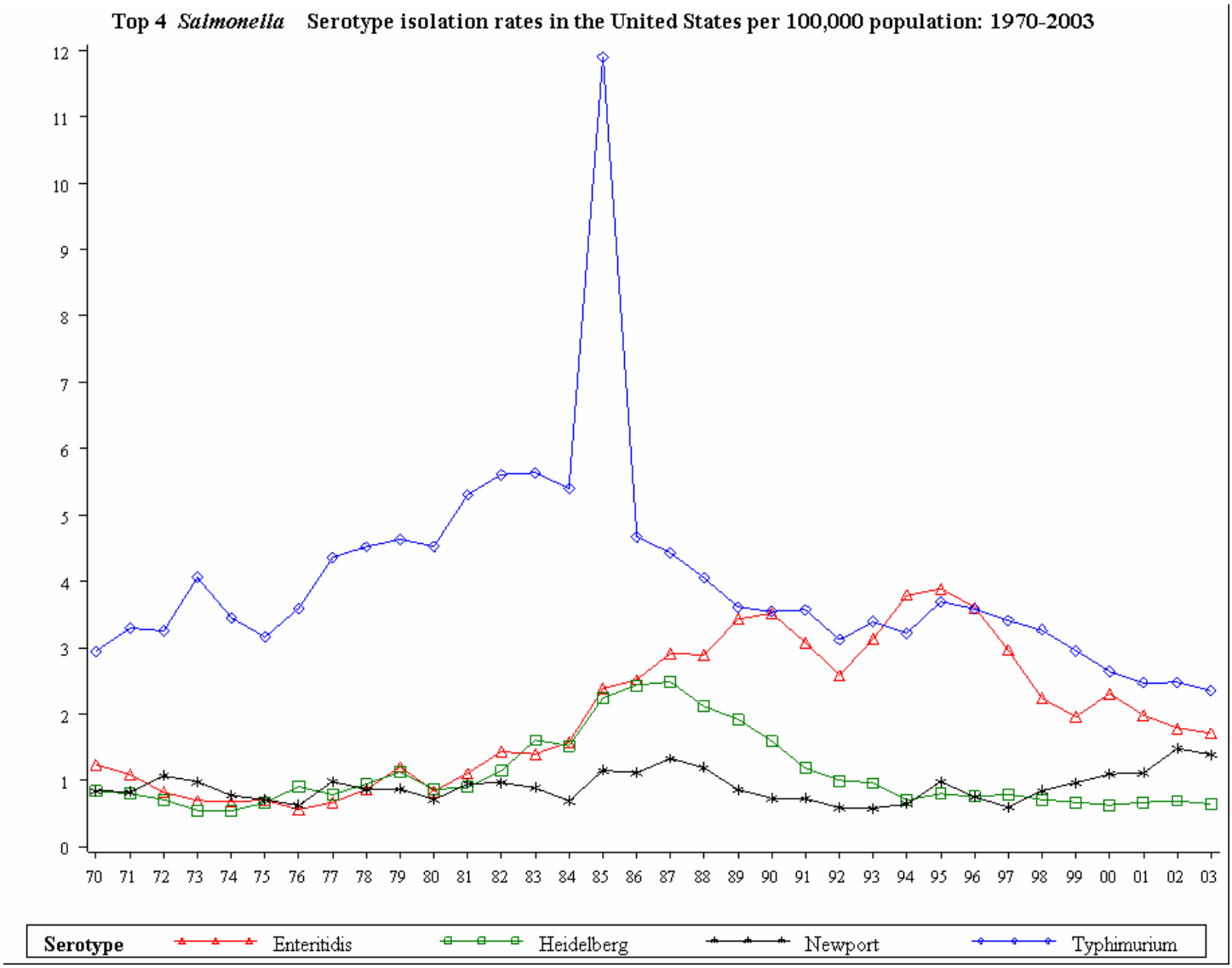
Similar to other years, there were marked regional differences in the frequency of *Salmonella* isolates among serotypes. The rate of isolations by region has been followed closely for *S.* Enteritidis as a means of assessing the impact of egg safety regulations and industry improvements. As indicated in Figure 4-2, *S.* Enteritidis rates of isolation had been relatively high in the New England, Mid-Atlantic and Pacific regions, but have shown significant decreases since 1995. Although New England had an increase in *S.* Enteritidis in 2000 and 2001 compared to 1999, the rate decreased in 2002 and 2003.

Table 4-1. The 20 most frequently reported *Salmonella* serotypes, 2003*

Rank	Serotype	Number	Percent
1	Typhimurium **	6770	18.1
2	Enteritidis	4914	13.1
3	Newport	4000	10.7
4	Heidelberg	1845	4.9
5	Javiana	1718	4.6
6	Montevideo	890	2.4
7	Saintpaul	838	2.2
8	Muenchen	795	2.1
9	Oranienburg	589	1.6
10	Infantis	570	1.5
11	Braenderup	553	1.5
12	I 4,[5],12:i:-	548	1.5
13	Agona	523	1.4
14	Thompson	509	1.4
15	Mississippi	451	1.2
16	Typhi	362	1.0
17	Paratyphi B var. L(+) tartrate+	342	0.9
18	Hadar	280	0.7
19	Bareilly	240	0.6
20	Stanley	227	0.6
Sub-total		**26,964**	**72.0**
All other serotyped		5,481	14.7
Unknown		3407	9.1
Partially serotyped isolates		1538	4.1
Rough or nonmotile isolates		52	0.1
Sub Total		**10,478**	**28.0**
Total		**37,442**	**100.0**

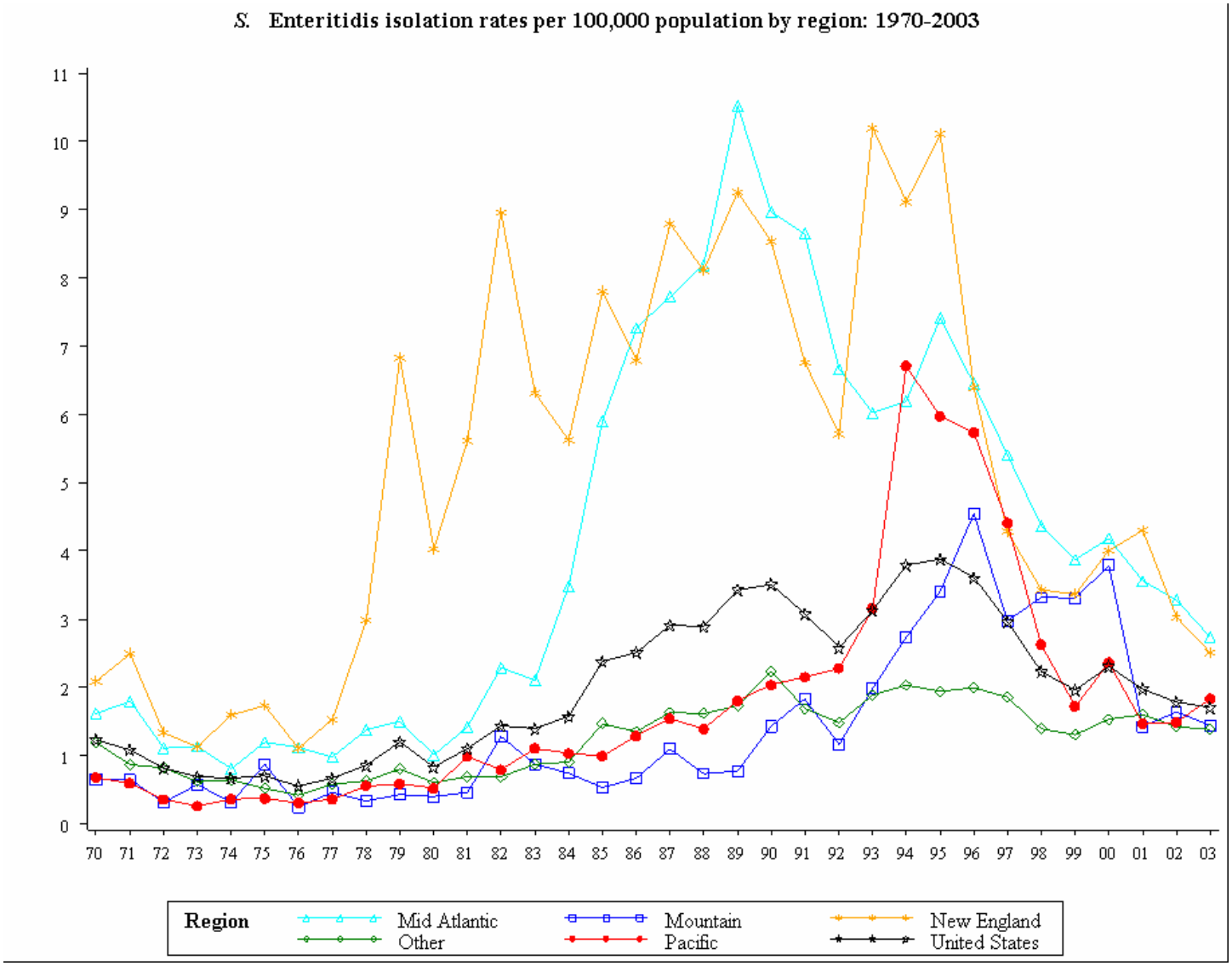
* Data obtained from the Public Health Laboratory Information System (PHLIS) for 2003 as of June 2006
** Typhimurium includes var. Copenhagen

Figure 4-1. Isolation rate per 100,000 population for top four serotypes of *Salmonella* in the United States, 1970 – 2003*



* Data obtained from the Public Health Laboratory Information System (PHLIS) for 2003 as of June 2006

Figure 4-2. Isolation rate per 100,000 population for *Salmonella* Enteritidis rates by region, United States, 1970 – 2003*



Shigella

(For *Shigella* surveillance case definition used in NNDSS, see

http://www.cdc.gov/epo/dphsi/casedef/shigellosis_current.htm)

The National *Shigella* Surveillance System collects reports of isolates of *Shigella* from every state in the United States. This information is reported electronically through PHLIS to EDEB based on data collected by state and territorial public health laboratories. *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 submit the data for reporting through PHLIS. Unusual or untypable isolates are forwarded to the National *Shigella* Reference Laboratory at CDC for further characterization or confirmation. These results are reported back to the state laboratory, where they are reported to CDC through PHLIS. Duplicates are removed from the file at the end of the year.

The capture of isolates in the National *Shigella* Surveillance System is considered to be consistent. However, some *Shigella* isolates may not be forwarded or reported to state public health laboratories and therefore are not captured. In addition, irrespective of the surveillance system, many cases of *Shigella* illness are not reported because the ill person does not seek medical care, the health-care provider does not obtain a specimen for diagnosis or the laboratory does not perform culture for *Shigella*. The results of surveillance reported herein 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 43 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 15,951 *Shigella* isolates were reported from public health laboratories in 50 states in 2003 (Table 5-2). This represents an 18% decrease compared with 1993 and a 22% increase from 2002. The national rate of reported *Shigella* isolates in 2003 was 5.4 per 100,000 population based on 2003 census population estimate figures for the United States.

Shigella was isolated frequently from children under 5 years of age, who accounted for 31.3% of all isolates. About 33.9% of all isolates came from persons aged 5-19 years, and 26.1 % from persons aged 20-59, with declining numbers thereafter. The overall distribution of *Shigella* isolates between the sexes was similar, with females accounting for 50% of persons from whom *Shigella* was isolated. The frequency of reported species, and the frequency of reported serotypes within these groups for all *Shigella* isolates are shown in Table 5-3. Of the 15,951 isolates, 12,557 (78.7%) were subgrouped. Trends of species remained constant, with *S. sonnei* accounting for the largest percentage of isolates (66.6%), followed by *S. flexneri* (14.4%), *S. boydii*, (0.9%) and *S. dysenteriae* (0.3%). Over the past decade, the numbers of reported *Shigella* isolates in species.*S. flexneri, S. boydii*, and *S. dysenteriae* and the proportions of all reported *Shigella* isolates due to these three species have declined; however, 2003 marks the first year since 1994 in which the reported numbers of *S. flexneri* isolates have increased. A very slight increase in the number of *S. boydii* was also observed. The number (3394) and the proportion (21.3%) of all reported *Shigella* isolates that were not identified as belonging to a specific subgroup also increased.

Table 5-1. Classification of *Shigella* serogroups

Subgroup	Species	Serotypes	Fermentation of D-Mannitol	Subgroup B group antigens
A	*S. dysenteriae*	15	-	-
B	*S. flexneri*	8[a]	+	+
C	*S. bodii*	20	+	-
D	*S. sonnei*	1	+	-

a- Serotypes 1-5 are subdivided into 11 subserotypes

Table 5-2. *Shigella* serogroups reported to the CDC, 2003*

Rank	Species	Number	Percent
1	*Sonnei*	10,621	66.6
2	*Flexneri*	1745	10.9
3	*Boydii*	148	0.9
4	*Dysenteriae*	43	0.3
Subtotal		**12,557**	**78.7**
Unknown		**3394**	**21.3**
Total		**15,951**	**100.0**

* Data obtained from the Public Health Laboratory Information System (PHLIS) for 2003 as of June 2006

Table 5-3. Rank and number of isolates of *Shigella* serotypes, 2003*

Rank	Serotype	Number	Percent
1	*S. sonnei*	10,621	66.6
2	*S. flexneri* Unspecified	892	5.6
3	*S. flexneri* 2 Unspecified	186	1.2
4	*S. flexneri* 3 Unspecified	113	0.7
5	*S. flexneri* 1 unspecified	100	0.6
6	*S. flex*neri 2a	95	0.6
7	*S. boydii* Unspecified	91	0.6
8	*S. flexneri* 3a	79	0.5
9	*S. flexneri* 4 Unspecified	61	0.4
10	*S. flexneri* 6	58	0.4
11	*S. flexneri* 4a	49	0.3
12	*S. flexneri* 1b	33	0.2
13	*S. boydii* 2	29	0.2
14	*S. dysenteriae* Unspecified	22	0.1
15	*S. flexneri* 2b	17	0.1
16	*S. flexneri* variant y	15	0.1
17	*S. flexneri* 3b	12	0.1
18	*S. boydii* 1	10	0.1
19	*S. dysenteriae* 2	10	0.1
20	*S. flexneri* 5 unspecified	10	0.1
21	*S. boydii* 4	9	0.1
22	*S. flexneri* 1a	6	0.0
23	*S. flexneri* 4b	6	0.0
24	*S. flexneri* variant x	6	0.0
25	*S. dysenteriae* 1	5	0.0
26	*S. flexneri* 88-893	5	0.0
27	*S. boydii* 10	2	0.0
28	*S. boydii* 8	2	0.0
29	*S. dysenteriae* 3	2	0.0
30	*S. dysenteriae* 4	2	0.0
31	*S boydii* 12	1	0.0
32	*S. boydii* 14	1	0.0
33	*S. boydii* 15	1	0.0
34	*S. boydii* 20	1	0.0
35	*S. boydii* 5	1	0.0

36	*S. dysenteriae* 14	1	0.0
37	*S. dysenteriae* 9	1	0.0
38	*S. flexneri* 4c	1	0.0
39	*S. flexneri* 5a	1	0.0
Sub total		**12,557**	**78.7**
Unknown		**3,394**	**21.3**
Total		**15,951**	**100.0**

* Data obtained from the Public Health Laboratory Information System (PHLIS) for 2003 as of June 2006

Vibrio

(For cholera surveillance case definition, see http://www.cdc.gov/epo/dphsi/casedef/cholera_current.htm). Infection with toxigenic *Vibrio cholerae* O1 and O139, the causative agents of cholera, has been a reportable disease in the United States for many years. More recently, toxigenic *V. cholerae O141* has emerged as a cause of illness, but it does not cause cholera and is not notifiable. Since 1988, CDC has maintained a database of reported *Vibrio* infections from humans in order to obtain reliable information on illnesses associated with for the range of *Vibrio spp*. 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.

This reporting system was initiated by CDC, the Food and Drug Administration (FDA), and the Gulf Coast states (Alabama, Florida, Louisiana, Mississippi, and Texas) in 1998. Since 1997, many other states have also reported *Vibrio* isolates (Figure 1). However, only toxigenic *V. cholerae* O1 and O139 are nationally notifiable; thus the true number of *Vibrio* isolates is greater than reported. 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 conduct tracebacks of implicated oysters. CDC serotypes all *V. parahaemolyticus* isolates received from state health departments, and screens for cholera toxin production and the O1, O139 and O141 serogroups in *V. cholerae* isolates.

Results are summarized from human *Vibrio* infections reported to CDC in 2003 using the "Reporting Form for Cholera and Other *Vibrio* Illnesses" and presented in two categories: *V. cholerae* isolates that produce cholera toxin (referred to as toxigenic *Vibrio 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 spp.* from a patient with illness does not necessarily indicate causation. While many *Vibrio* spp. are well-recognized pathogens, the status of *V.*

damsela, *V. furnissii*, *V. metschnikovii*, and *V. cincinnatiensis* as enteric pathogens is less clear.

Isolates of toxigenic *Vibrio cholerae*

In 2003, toxigenic *V. cholerae* O1 was identified from two patients in two states (Table 6-1). One patient acquired the infection in the Philippines, while the other acquired the infection in Pakistan. One patient was hospitalized, and neither died. No isolates of toxigenic *V. cholerae* O139 were identified. However an isolate of toxigenic *V. cholerae* O141 was identified in a Georgia resident who consumed raw oysters the day before her symptoms began. The oysters could not be successfully traced back to a specific harvest site, but the Georgia Department of Agriculture confirmed that all the oysters from the supplying facility were from Florida.

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

In 2003, 479 other *Vibrio* isolates from 462 patients were reported to the Cholera and Other *Vibrios* Surveillance System. Among patients for whom information was available, 189 (45%) of 417 were hospitalized and 41 (10%) of 401 died. *V. parahaemolyticus* was isolated from 158 (33%) patients, and was the most frequently reported *Vibrio* species. *V. vulnificus* was isolated from 113 (24%) patients; 93% were hospitalized and 31% died.

Geographic Location

In 2003, we received 178 (39%) reports of *Vibrio* illness from Gulf Coast states, 112 (24%) from Pacific Coast states, 127 (27%) from Atlantic Coast states (excluding Florida), and 45 (10%) from inland states (Figure 1). The most frequent *Vibrio* species reported from Gulf Coast states were *V. vulnificus* (37%), *V. parahaemolyticus* (26%), non-toxigenic *V. cholerae* (9%), and *V. fluvialis* (8%). The most frequent *Vibrio* species reported from non-Gulf Coast states were *V. parahaemolyticus* (39%), *V. vulnificus* (17%), non-toxigenic *V. cholerae* (14%), and *V. alginolyticus* (14%).

Anatomic Site of Isolation

Among the 479 *Vibrio* isolates from all states, 209 (44%) were from stool, 104 (22%) from blood, and 99 (21%) from wounds. In addition, 26 (5%) isolates were obtained from the ear, and 41 (9%) were from the gallbladder, urine, or other site. *V. parahaemolyticus* was the species most frequently isolated from stool (125 [60%] of 209 samples); *V. vulnificus* was the species most frequently isolated from blood (73 [70%] of 104 samples) and from wounds (41 [41%] of 99 samples).

Seasonality

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

Exposures

One hundred and eight (23%) patients reported having a wound either before or during exposure to *Vibrios*. Of those, 93% reported water activities such as swimming and boating, 25% reported handling seafood, and 26% reported contact with marine wildlife. Excluding patients from whom *Vibrio* was isolated from a wound, and among the 381 for whom a food history was available, 275 (72%) reported eating seafood in the 7 days before illness onset. Among the 113 who reported eating a single seafood item (Table 6-4), 59% ate oysters (90% of whom consumed them raw), 11% ate shrimp, and 16% ate finfish. International travel in the 7 days before illness onset was reported by 40 (9%) of patients.

Laboratory

For reports where laboratory confirmation was available, the state public health laboratory confirmed the identification of 190 (59%) of 321 *Vibrio* isolates. CDC received ninety-two isolates of *V.*

parahaemolyticus from 85 patients. Of these, 87 were viable *V. parahaemolyticus* isolates, two were not *V. parahaemolyticus*, and one was not *Vibrio*. Of the viable *V. parahaemolyticus* isolates, 14 (16%) from nine states were serotype O3:K6 (Illinois, Connecticut, Maryland, Georgia, Rhode Island, Texas, Hawaii, Pennsylvania and New York), and 13 (15%) isolates from six states were O1:K56 (Colorado, Tennessee, Hawaii, New York, Nevada, Louisiana, Massachusetts); 11 (20%) from nine states were serotype O4:K12 (Illinois, Louisiana, Tennessee, New York, Connecticut, Maryland, Rhode Island, Georgia and Virginia), and the remaining 49 isolates were one of 18 serotypes.

Table 6-1. Isolates of toxigenic *V. cholerae*, 2003*

State	Age	Sex	Onset	Suspected Exposure	Isolate	Serotype
AZ	37	F	6/02/2003	Exposure in Pakistan	*V. cholerae* O1	Ogawa
HI	12	M	12/27/2003	Exposure in Philippines	*V. cholerae* O1	Ogawa
GA	36	F	11/08/2003	Exposure in GA	*V. cholerae* O141	Not applicable

***** Data obtained from the Cholera and *Vibrio* Surveillance System

Table 6-2. Number of *Vibrio* isolates (excluding toxigenic *V. cholerae*) by species, complication and isolation site of isolation in patients from Gulf Coast states, 2003

			Complications[1]						Site of Isolation			
***Vibrio* Species**	**Patients**		**Hospitalized**		**Deaths**		**Isolates**		**Stool**	**Blood**	**Wound**	**Other[2]**
	N	**(%)**	**n/N**	**(%)**	**n/N**	**(%)**	**N**	**(%)**				
V. alginolyticus	13	(7)	8/13	(62)	1/12	(8)	14	(7)	0	1	10	3
V. cholerae-CT(–)[3]	16	(9)	9/15	(60)	0/16	(0)	17	(8)	4	7	0	5
V. fluvialis	15	(8)	10/15	(67)	1/14	(7)	15	(8)	8	2	0	5
V. hollisae	3	(2)	2/3	(67)	0/3	(0)	3	(1)	2	0	0	1
V. mimicus	6	(3)	3/6	(50)	0/5	(0)	6	(4)	3	1	2	0

V. parahaemolyticus	46	(26)	9/43	(21)	0/44	(0)	46	(25)	29	1	12	4
V. vulnificus	65	(37)	59/62	(95)	19/59	(32)	70	(36)	1	40	25	4
Other	1	(1)	1/1	(100)	0/1	(0)	1	(0)	1	0	0	0
Species not identified	12	(7)	3/11	(27)	1/10	(10)	12	(7)	3	1	1	7
Multiple species[4]	1	(1)	0/1	(0)	0/1	(0)	2	(1)	1	1	0	0
Total	**178**	**(100)**	**104/170**	**(61)**	**22/165**	**(13)**	**186**	**(100)**	**52**	**54**	**51**	**29**

[1] Denominators indicate patients for whom information is known.
[2] Includes ear, gall bladder, peritoneal fluid, sputum, urine, and unknown source.
[3] Non-toxigenic *V. cholerae.* Includes non-toxigenic *V. cholerae* O1 (2 isolates) and other non-toxigenic *V. cholerae* [non-O1 non-O139] (14 isolates).
[4] *V. parahaemolyticus* and other *Vibrio* species were isolated from the stool of one patient.

Table 6-3. Number of *Vibrio* isolates (excluding toxigenic *V. cholerae*) by species and isolation site, and complications of infection in patients from non-Gulf Coast states, 2003

			Complications[1]						Site of Isolation			
***Vibrio* Species**	**Patients**		**Hospitalized**		**Deaths**		**Isolates**		**Stool**	**Blood**	**Wound**	**Other[2]**
	n	**(%)**	**n/N**	**(%)**	**n/N**	**(%)**	**n**	**(%)**				
V. alginolyticus	39	(14)	4/30	(13)	0/30	(0)	39	(13)	2	1	16	20
V. cholerae-CT(–)[3]	41	(14)	15/38	(39)	4/39	(10)	42	(14)	25	9	4	4
V. damsela[4]	1	(0)	0/1	(0)	0/1	(0)	1	(0)	0	0	1	0
V. fluvialis	18	(6)	6/14	(43)	0/13	(0)	19	(6)	12	2	3	2
V. furnissi	1	(0)	-	-	-	-	1	0	1	0	0	0
V. hollisae	4	(1)	1/4	(25)	0/4	(0)	4	(1)	4	0	0	0
V. mimicus	3	(1)	0/3	(0)	0/3	(0)	3	(1)	3	0	0	0
V. parahaemolyticus	112	(39)	16/99	(16)	1/93	(1)	112	(38)	96	2	7	7
V. vulnificus[4]	48	(17)	37/41	(90)	11/39	(28)	53	(18)	2	33	16	2
Other	1	(0)	1/1	(100)	0/1	(0)	1	(0)	1	0	0	0
Species not identified	14	(5)	4/14	(29)	2/11	(18)	14	(5)	9	1	1	3
Multiple species[4]	2	(1)	1/2	(50)	1/2	(50)	4	(1)	2	2	0	0
Total	**284**	**(100)**	**85/247**	**(34)**	**19/236**	**(8)**	**293**	**(100)**	**157**	**50**	**48**	**38**

[1] Denominators indicate patients for whom information is known.
[2] Includes cyst, appendix, ear, peritoneal fluid, sputum, urine, sinus, and unknown source.
[3] Non-toxigenic *V. cholerae*. Includes non-toxigenic *V. cholerae* O1 (3 isolates), *V. cholerae* O139 (2 isolates) and other non-toxigenic *V. cholerae* non-O1 non-O139 (37 isolates).
[4] *V. fluvialis*, and *V.furnissi* were isolated from the wound of one patient; *V. cholerae* non-O1 non-O139 and *V. vulnificus* were isolated from the wound of one patient.

Table 6-4. Seafood exposure among patients with foodborne *Vibrio* infection who reported eating a single seafood item in the seven days before illness onset, 2003

	Mollusks			Crustaceans						
	Oysters	**Clams**	**Mussels**	**Shrimp**	**Lobster**	**Crab**	**Crayfish**	**Other Shellfish[1]**	**Finfish[2]**	**Total**
Ate (%)	67(59)	5(4)	0(0)	11(10)	0(0)	6(5)	3(3)	3(3)	18(16)	113
% Ate raw	90	100	-	13	-	20	0	50	23	60

[1] Other shellfish reported: conch, squid, “tako”
[2] Finfish reported: ceviche squid, cod, flounder, herring, salmon, sea bass, swordfish, tilapia, tuna

Figure 6-1. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*) of *Vibrio* illness by state, 2003 (N=462 patients)

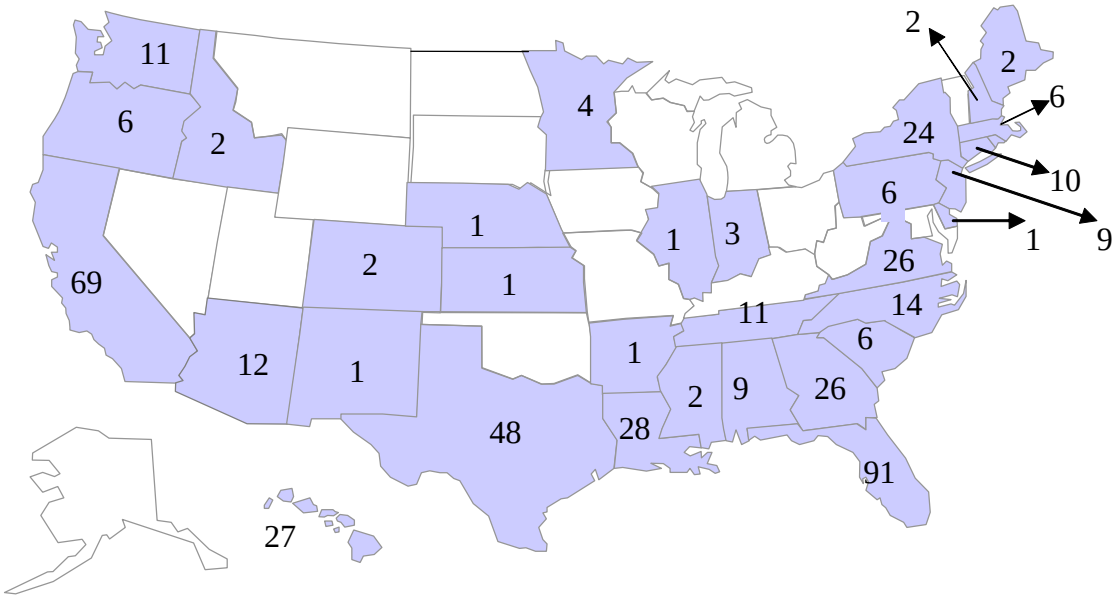
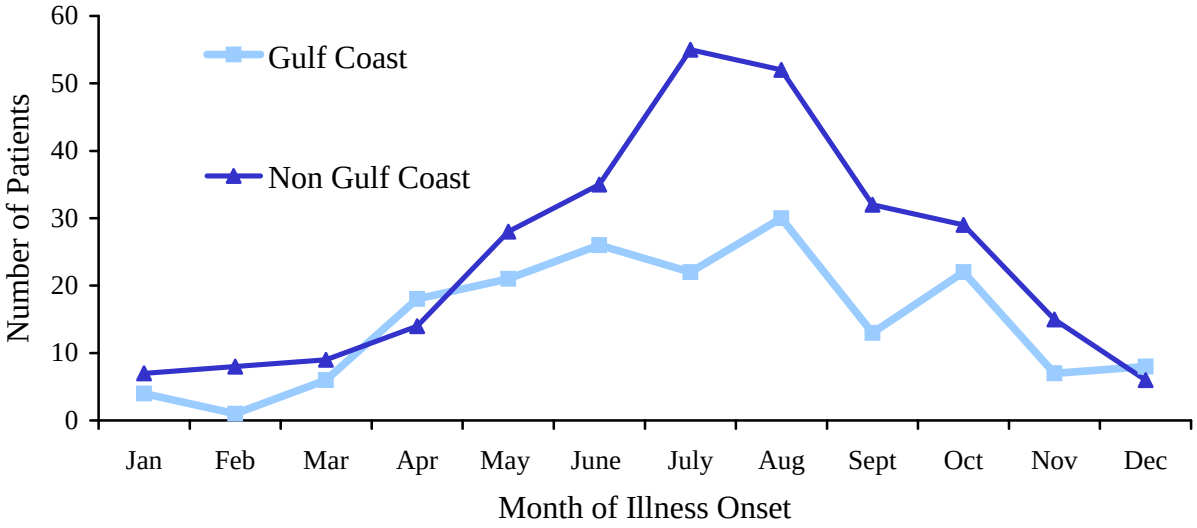


Figure 6-2. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*), by month*, Gulf Coast states vs. other states, 2003 (N=436)
*Onset date missing or unknown for 22 patients



Surveillance Data Sources and Background

The Centers for Disease Control and Prevention conducts national surveillance to define the magnitude and burden of a disease, 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 and the National Electronic Telecommunications System for Surveillance

The origins of National Notifiable Diseases Surveillance System (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. The National Electronic Telecommunications Surveillance System (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 Information Resources Management Office, CDC.

There are several sources of NETSS surveillance information for individual infections. For many diseases, public health authorities at state departments of health request or require that physicians and other health care workers report cases to the local health department, and for some, they 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, if the disease is nationally notifiable, sends the

information to CDC.

Public Health Laboratory Information System

In addition to surveillance of diagnosed cases of notifiable disease, there is additional public health benefit in sending the pathogens isolated from the patient to the public health laboratory to confirm the identity of the organism and for more detailed characterization, or subtyping. This subtyping is used to identify clusters of a specific subtype, and to link events that are in 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. Initial participation was with eight states; this grew over time to all 50 states transmitting information via an electronic network tool developed in the 1980s called Public Health Laboratory Information System (PHLIS). PHLIS collects laboratory surveillance information for a large number of pathogens (foodborne and non-foodborne). It is administered by the Biostatistics, and Information Management Branch; Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, CDC. 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. Some diseases that cause severe clinical illness are most likely to be reported accurately, if they were diagnosed by a physician. However, persons who have diseases that are clinically mild and infrequently associated with severe consequences might not seek medical care from a health-care provider, are never diagnosed or reported in surveillance systems. Even if these less severe disease are diagnosed, they are less likely to be reported.

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 diseases 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 is not performed in standard clinical laboratories. Surveillance systems cannot track infections by this common 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.

The PHLIS 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, for example 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. The specialized skills and reagents needed at the states laboratories to maintain serotyping or other subtyping methods require training and support. 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 difference 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 that depends on the locally available resources, interest and priorities. Where more than one route is available for reporting surveillance data within the public health system, states may choose to report via 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 via PHLIS, and some state epidemiology offices report infections with this organism via NETSS.

Some states may chose to submit reports on disease 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.

There are substantial real state-to-state and regional differences in the incidence of certain diseases. The PHLIS *Salmonella* surveillance system shows this well. It is a stable surveillance system that has been functioning well for several decades with full national participation. PHLIS has demonstrated that some *Salmonella* serotypes are isolated with similar frequency person in all U.S. regions, while others are highly localized.

Program specific surveillance systems

Because both NETSS and PHLIS collect little information beyond very basic patient demographics (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, which is needed for accurate monitoring and effective intervention. The diseases included are botulism, typhoid fever, and cholera and *Vibrio* spp. infections. For botulism, typhoid fever, and cholera, reporting is nation-wide. For the non-cholera *Vibrio* spp., 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, which can be fatal if untreated, and 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 U.S., only CDC has the capacity to serotype and characterize a wide variety of these isolates, hence the collection of isolates is likely representative of those isolated in the U.S. and forwarded to public health laboratories.

Surveillance in selected sites

For nine foodborne infections, the most detailed and accurate surveillance information comes from Foodborne Diseases Active Surveillance Network (FoodNet). In 2003, FoodNet included nine surveillance sites, each comprised of several counties within a state, or a whole state, and covering a population of approximately 37.6 million, or 13.8% of the U.S. population. FoodNet actively gathers information about nine infections or conditions, integrates it with available laboratory information, and collects information about the severity and outcome of the illness. FoodNet also conducts surveys of the populations to determine the burden of illness, and how many ill persons visit the physician and get tested, and surveys of clinical laboratories to determine which pathogens are sought. Because the methods of surveillance are comparable, the information from FoodNet can be used to compare the 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 virtually disappear. The list of notifiable diseases has several that were once large public health problems, and are now rarely reported, marking the success of public health efforts. The official list of nationally notifiable conditions changes in accordance with the

resolutions of CSTE.

The methods and information obtained for surveillance also continues 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, but this effort is expensive and cannot be applied everywhere. The ongoing revolution in biotechnology is bringing new subtyping or fingerprinting technologies into the state and local public health laboratories, such as pulse field gel electrophoresis (PFGE). 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 in order to identify clusters of illness caused by the same pathogen subtype. This is enhancing the capacity to detect outbreaks rapidly, to link together 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, the first of which, the Statistical Outbreak Detection Algorithm (SODA), has been in operation for *Salmonella* using PHLIS data since 1995. The effort at CDC to produce a new integrated surveillance system, which will bring information directly from the clinical laboratory into a public health database, should improve the timeliness and consistency of reporting for many diseases.

Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases

Many staff members both within and outside EDEB are responsible for 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 Unit. 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 by the National Center for Environmental Health.

Sources and Contacts for Bacterial Foodborne and Diarrheal Diseases

System	Cases Reported	Contact	Title	CDC Division
NNDSS/NETSS	Clinical-case reporting of Campylobacteriosis, Botulism, EHEC, Hemolytic Uremic Syndrome, Listeriosis, Typhoid Fever, Salmonellosis, Shigellosis, Cholera	Ruth Ann Jajosky	Epidemiologist	Information Resources Management Office
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	Foodborne, Bacterial and Mycotic Diseases
Typhoid Fever Surveillance System	Detailed case information for all U.S. typhoid fever cases	Eric Mintz	Chief, Diarrheal Diseases Epidemiology Section	Foodborne, Bacterial and Mycotic Diseases
Vibrio Surveillance System	Detailed case information for all U. S. cholera and other *Vibrio spp.* infections	John Painter	Epidemiologist	Foodborne, Bacterial and Mycotic Diseases
		Eric Mintz (Cholera)	Chief, Diarrheal Diseases Epidemiology Section	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 Preparedness 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

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We thank all those in local, state and territorial departments of public health for their time and efforts to accomplish national case surveillance for foodborne and diarrheal diseases.

List of Abbreviations

BIMB…….Biostatistics and Information Management Branch

CDC……...Centers for Disease Control and Prevention

CSTE……..Council of State and Territorial Epidemiologist

DBMD……Division of 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……..Pulse Field Gel Electrophoresis

PHILS…….Public Health Laboratory Information System

SODA…….Statistical Outbreak Detection Algorithm

STEC……..Shiga toxin-producing *Escherichia coli*

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CDC World Wide Web sites relevant to Foodborne and Diarrheal Diseases

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

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

Centers for Disease Control and Prevention
Health Topics A to Z
http://www.cdc.gov/az.do

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 Unit
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/

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

PHLIS (Public Health Laboratory Information System) Surveillance Data

http://www.cdc.gov/ncidod/dbmd/phlisdata/

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

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

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

Safe Water System
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