Bacterial Foodborne and Diarrheal Disease National Case Surveillance

Annual Report for 2006

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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Contents

Executive Summary

The Enteric Diseases Epidemiology Branch (EDEB), Division of Foodborne, Bacterial, and Mycotic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases is responsible for surveillance of bacterial enteric pathogens. National case surveillance encompasses two systems administered outside EDEB: the National Notifiable Diseases Surveillance System (NNDSS), which is clinical case-based, and the Public Health Laboratory Information System (PHLIS), which is a laboratory isolation-based reporting system. The laboratory-based system alone includes data on important pathogen characteristics such as serotype for *Salmonella*, *Shigella*, and Shiga toxin-producing *Escherichia coli* isolates. Serotype information for these pathogens is crucial for surveillance, outbreak detection, and investigation. PHLIS also includes some pathogens that are not formally nationally notifiable, but may be notifiable at the state level. In addition, EDEB primarily collects information for botulism, typhoid fever, cholera and other *Vibrio* illnesses, as well as for Shiga toxin-producing *E. coli*, non-O157. Information in this report includes case and isolate counts in 2006, as of May 2008; the numbers may have changed compared with previous publications of 2006 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 2006; 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, 2006, and CDC Internet sites for Foodborne and Diarrheal Diseases.

This report is the fourth 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 2006 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, 2006

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	165	NA	170
E. coli O157		Yes		3,008	NA
E. coli, Shiga toxin-producing, non-O157			4,432	423	554
Hemolytic uremic syndrome		Yes	288	NA	NA
Listeriosis		Yes	884	NA	NA
Salmonella Typhi (typhoid fever)		Yes	353	413	337§
Salmonella, non-Typhi (salmonellosis)	Includes >2,400 Serotypes	Yes	45,808	40,253	NA
Shigella (shigellosis)	Includes 4 subgroups	Yes	15,503	10,336	NA
Vibrio cholerae, toxigenic	Includes O1 and O139 serotypes (that cause cholera)	Yes	9	NA	8
Other *Vibrios* (vibriosis)	Some species may not be pathogenic	No	NA	NA	718

*NNDSS (National Notifiable Diseases Surveillance System); Centers for Disease Control and Prevention. Summary of Notifiable Diseases – United States, 2006. MMWR 2007;55(53):1-94.
†PHLIS (Public Health Laboratory Information System)
‡EDEB (Enteric Diseases Epidemiology Branch)
§ Preliminary data

Botulism

A total of 170 cases of foodborne (19), wound (45), and infant (106) botulism were reported to the EDEB botulism surveillance system, including two deaths (attributed to infant [1] and wound [1] botulism) and five outbreaks (defined as two or more cases as a result of persons ingesting the same food).

Shiga Toxin-Producing *Escherichia coli* (STEC)

Escherichia coli O157:H7 was made nationally notifiable in 1994, and all Shiga toxin-producing *E. coli* in 2001.. Reported infections with the most well-known pathogen in this group, *E. coli* O157:H7, have increased annually since becoming nationally notifiable to a peak number of 3,665 in 2000. The steady increase in the number of cases was due in part to an increasing ability of laboratories to identify this pathogen. A decline in the number of cases during 2001-03 was observed. This could have been related to coordinated efforts by regulators and industry that reduced the contamination of ground beef. The incidence rose in 2004. During 2006, 3,008 *E. coli* O157 cases were reported through PHLIS.

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 2006, CDC received 554 isolates of non-O157 Shiga toxin-producing *E. coli*. Isolates originated from 42 states and included more than 50 O groups. The three most common O groups were O26 (22%), O103 (17%), and O111 (14%).

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 288 cases of HUS reported to NNDSS in 2006, most occurred in children younger than age 5 years.

***Listeria monocytogenes* (Listeriosis)**

Listeriosis has been nationally notifiable since 2000. Reports of listeriosis are submitted to the CDC through NNDSS. Forty-seven states reported at least one case to NNDSS during 2006, for a total of 884 cases. The *Listeria* Initiative began in 2004 and aids in the investigation of clusters and outbreaks. Twenty states submitted 180 case questionnaires to the *Listeria* Initiative in 2006.

***Salmonella* Typhi (Typhoid Fever)**

Infection with *Salmonella* serotype Typhi leads to typhoid fever. The number of cases of typhoid fever (353 in NNDSS during 2006) has been relatively small and constant, mostly associated with travel outside the United States. *S.* Typhi isolates are reported to CDC through the National Salmonellosis Surveillance System; 337 isolates were reported in 2006.

***Salmonella*, Non-Typhi (Salmonellosis)**

A total of 40,253 non-Typhi *Salmonella* isolates were reported in 2006, for a rate was 13.6 per 100,000 population. Similar to other years, children younger than age 5 years accounted for 24% of isolates. About 10% came from persons in each of the second through fifth decades of life, with lower proportions from persons in later decades of life.

The twenty most common serotypes of *Salmonella* in 2006 represented 70% of all *Salmonella* isolates. The four most common serotypes in 2006 (Typhimurium, Enteritidis, Newport, and Heidelberg; 45% 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 and 2006. Serotypes Typhimurium and Enteritidis have both declined substantially (28% and 30%, respectively) since 1995.

***Shigella* (Shigellosis)**

Shigella transmission most often occurs via the fecal-oral route. Most *Shigella sonnei* infections occur in young children and are often associated with crowding and poor personal

hygiene. Daycare centers have been implicated in many *S. sonnei* outbreaks.

A total of 10,336 *Shigella* isolates were reported to PHLIS in 2006. 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. Similar to previous years, children younger than age 5 years accounted for 31.1% of all *Shigella* isolates. About 32.2% came from persons aged 5–19 years, and 26.9% from persons aged 20–59, with lower proportions from persons in later decades of life.

Of the 10,336 isolates, 9,108 (88.1%) were subgrouped. The proportion of *Shigella* isolates that were subgroup D (*S. sonnei*) was 72.3%, followed by subgroup B (*S. flexneri*, 14.3%), subgroup C (*S. boydii*, 1.1%), and subgroup A (*S. dysenteriae*, 0.5%).

Cholera and Non-Cholera *Vibrio*

In 2006, eight patients with toxigenic *V. cholerae* infection were reported. Four were hospitalized and no deaths were reported. No isolates of toxigenic *V. cholerae* O139 were identified. All eight patients were infected with toxigenic *V. cholerae* serogroup O1. Infection was acquired during international travel for four isolated cases. Exposure to domestic seafood was the source of infection for four patients.

Other *Vibrio* isolates (excluding *V. cholerae* serogroup O1 and O139) were not nationally notifiable in 2006, 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 2006, 744 *Vibrio* isolates from 718 patients from 39 states were reported to the Cholera and Other *Vibrio* Illness Surveillance System. Among patients for whom information was available, 215 (32%) of 665 were hospitalized and 36 (6%) of 649 died. *V. parahaemolyticus* was isolated from 403 (56%) patients, and was the most frequently reported *Vibrio* species. Of the patients infected with *V. parahaemolyticus*, 68 (18%) were hospitalized and 1 (<1%) died. *V. vulnificus* was isolated from 99 (14%) patients; 79 (85%) were hospitalized and 31 (35%) died.

Expanded Surveillance Summaries for Selected Pathogens and Diseases, 2006

Case surveillance summaries included here for botulism and vibriosis are derived from reports already sent to state and territorial epidemiologists and public health laboratory directors and posted on the web at http://www.cdc.gov/nationalsurveillance/botulism_surveillance.html and http://www.cdc.gov/nationalsurveillance/cholera_vibrio_surveillance.html. Only select text, tables, and figures are included here from the *Salmonella Annual Summary, 2006* and the *Shigella Annual Summary, 2006*. These complete reports are available at http://www.cdc.gov/ncidod/dbmd/phlisdata. Information on national surveillance of listeriosis and Shiga toxin-producing *E. coli* infections included in this report have not been published elsewhere. Information on surveillance data from FoodNet sites where active surveillance of these pathogens is conducted in sentinel sites is available in FoodNet reports at http://www.cdc.gov/foodnet/.

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 170 cases of botulism were reported to CDC in 2006 (Tables 2-1 and 2-2). Foodborne botulism accounted for 19 (11%) cases, infant botulism for 106 (62%) cases, and wound cases for 45 (26%) cases.

The 19 cases of foodborne intoxication were reported from six states (Table 2-3). Of these foodborne cases, toxin type A accounted for 12 (63%) cases, toxin type B for 1 (5%) case, toxin type E for 1 (5%) case, and unknown toxin type for 5 (26%) cases. The median age of patients was 57 years, with a range of 6 years to 80 years; 8 (42%) cases were male and 11 (58%) were female. No deaths were reported. There were five outbreaks involving two or more cases. They were caused by commercially-produced canned chicken broth associated with two cases, commercial carrot juice caused three cases in GA and one case in FL as well as cases in Canada and led to an international product recall, home-canned carrots associated with two cases, home-prepared fermented tofu associated with two cases, and fish eggs associated with five cases in Alaska.

There were 106 cases of infant botulism reported by 23 states (Table 2-4). Toxin type A accounted for 49 (46%) cases, toxin type B for 54 (51%) cases, toxin type E for 1 (1%) case, and toxin type F for 1 (1%) case. One infant case (1%) had an isolate that produced both neurotoxin types B and A, called type Ba. The three non-A, non-B cases occurred in AZ, IA, and NV. The median age of patients was 15 weeks with a range of <1 week to 39 weeks; 43 (41%) were male and 63 (59%) were female. No deaths were reported.

There were 45 cases of wound botulism reported by five health jurisdictions (CA [41], MD [1], NYC [1], TX [1], and WA [1]) (Table 2-5). Toxin type A accounted for 41 (91%) cases and toxin type B for 4 (9%) cases. All but two cases were injection drug users; the other two cases sustained a wound from a fall or from an injury that required a cast. The median age of patients was 46 years with a range of 14 years to 62 years; 34 (76%) were male and 11 (24%) were female. One death was reported in a wound case who was an injection heroin user.

Table 2-1. Summary of cases of botulism reported to the Botulism Surveillance System, 2006

Type	Cases	Median age	Sex	Toxin type	Comments
Foodborne	19 cases (No reported deaths)	57 years (range: 6-80 years)	8 (42%) male 11 (58%) female	12 (63%) type A 1 (5%) type B 1 (5%) type E 5 (26%) not typeable	5 multi-case outbreaks
Infant	106 cases (No reported deaths; 1 without information)	15 weeks (range: <1–39 weeks)	43 (41%) male 63 (59%) female	49 (46%) type A 54 (51%) type B 1 (1%) type Ba 1 (1%) type E 1 (1%) type F	.
Wound	45 cases (1 reported death)	46 years (range: 14–62 years)	34 (76%) male 11 (24%) female	41 (91%) type A 4 (9%) type B	

Table 2-2. Cases of botulism reported to the Botulism Surveillance System, by state and type, 2006

State/District	Foodborne	Wound	Infant	Total
Alaska	6			6
Arkansas				
Arizona			5	5
California	6	41	43	90
Colorado			1	1
Connecticut				
District of Columbia				
Florida	1		1	2
Georgia	3			3
Hawaii				
Iowa			1	1
Illinois	1		1	2
Kansas				
Louisiana				
Massachusetts			1	1
Maryland		1	5	6
Michigan				
Minnesota			1	1
Missouri				
Mississippi				
Montana			1	1
Nebraska				
New Hampshire				
New Jersey			7	7
New Mexico			1	1
Nevada	2		2	4
New York			1	1
New York City		1	2	3
Ohio			2	2
Oklahoma				
Pennsylvania			11	11
South Carolina				
Tennessee			1	1
Texas		1	5	6
Utah			3	3
Washington		1	9	10
Wisconsin				
West Virginia			1	1
Wyoming			1	1
TOTAL	**19**	**45**	**106**	**170**

Table 2-3. Cases of foodborne botulism reported to the Botulism Surveillance System, by month, 2006 (N = 19)

Month	State	Age (years)	Gender	Toxin Type	Vehicle	Death
January	CA*	73	Female	A	Home-canned carrots	No
January	CA*	74	Male	A	Home-canned carrots	No
May	IL	71	Male	B	Food prepared and consumed in Poland***	No
June	CA	29	Male	A	Commercial carrot juice***	No
July	CA	36	Female	A	Commercial soup***	No
September	GA*	77	Male	A	Commercial carrot juice	No
September	GA*	57	Female	A	Commercial carrot juice	No
September	GA*	42	Female	A	Commercial carrot juice	No
September	FL*	53	Female	A	Commercial carrot juice	No
September	AK	57	Male	E	Seal oil	No
October	AK*	54	Female	Unknown**	Fish eggs***	No
October	AK*	6	Male	Unknown**	Fish eggs***	No
October	AK*	80	Female	Unknown**	Fish eggs***	No
October	AK*	76	Female	Unknown**	Fish eggs***	No
October	AK*	49	Female	Unknown**	Fish eggs***	No
November	CA*	67	Female	A	Home-prepared fermented tofu	No
December	CA*	75	Male	A	Home-prepared fermented tofu	No
December	NV*	44	Male	A	Canned chicken broth	No
December	NV*	44	Female	A	Canned chicken broth	No

*Cases involved in multi-case outbreaks
**Serum quantity not sufficient for toxin typing
***Food vehicle implicated based on epidemiologic evidence

Table 2-4. Cases of infant botulism reported to the Infant Botulism Treatment and Prevention Program, by month, 2006 (N = 106)

Month	State	Age (weeks)	Gender	Toxin Type	Death
January	CA	7	Female	B	No
January	IA	0	Female	F*	No
January	NJ	22	Female	B	No
January	NJ	22	Male	B	No
January	PA	15	Male	B	No
January	WA	34	Female	A	No
February	CA	10	Female	A	No
February	CA	14	Female	B	No
February	CA	7	Male	A	No
February	CA	31	Female	A	No
February	CA	20	Male	B	No
February	MN	5	Female	A	No
February	NYC	12	Male	B	No
February	NY	2	Male	B	No
February	PA	17	Female	B	No
February	WA	27	Male	A	No
March	AZ	1	Female	E**	No
March	AZ	14	Female	B	No
March	CA	25	Male	B	No
March	CA	22	Female	B	No
March	CA	22	Male	A	No
March	FL	22	Female	A	No
March	MD	15	Female	B	No
March	PA	15	Female	B	No
March	PA	22	Female	B	No
March	PA	8	Female	B	No
March	PA	22	Male	B	No
March	WA	21	Female	A	No
March	WA	23	Male	A	No
March	WV	8	Male	B	No
March	WY	23	Female	A	No
April	CA	16	Female	B	No
April	CA	24	Female	A	No
April	TX	2	Male	A	No

April	TX	4	Female	A	No
May	CA	12	Female	B	No
May	CA	14	Female	A	No
May	CA	10	Female	B	No
May	CA	7	Male	A	No
May	IL	24	Female	B	No
May	MD	7	Female	B	No
May	NJ	5	Female	B	No
May	PA	16	Male	B	No
May	TX	1	Female	A	No
May	WA	19	Female	A	No
June	AZ	3	Female	B	No
June	CA	8	Female	A	No
June	CA	11	Female	B	No
June	CA	28	Male	A	No
June	CA	12	Male	A	No
June	CA	12	Female	A	No
June	CA	6	Female	A	No
June	NJ	7	Male	B	No
June	NV	19	Male	Ba***	No
July	CA	11	Female	A	No
July	CA	8	Male	B	No
July	CA	5	Male	B	No
July	CA	9	Male	B	No
July	CA	25	Female	A	No
July	CA	8	Female	A	No
July	OH	7	Female	B	No
July	PA	10	Female	B	No
July	TX	17	Male	B	No
July	UT	21	Female	A	No
July	UT	2	Male	A	No
August	CA	8	Female	A	No
August	CA	12	Female	B	No
August	CA	15	Female	A	No
August	CO	15	Male	B	No
August	NV	21	Female	A	No
August	OH	22	Male	B	No
August	TN	7	Female	B	No

August	WA	29	Male	A	No
September	AZ	4	Female	B	No
September	CA	17	Male	A	No
September	CA	7	Male	A	No
September	CA	18	Female	B	No
September	MD	25	Female	B	No
September	PA	19	Female	B	No
September	UT	25	Male	A	No
September	WA	31	Female	A	No
October	AZ	19	Male	B	No
October	CA	3	Female	B	No
October	CA	5	Female	A	No
October	CA	9	Female	A	No
October	MD	27	Male	B	No
October	WA	39	Female	A	No
November	CA	26	Male	A	No
November	CA	9	Female	A	No
November	CA	3	Male	A	No
November	MA	34	Male	B	No
November	MT	20	Male	A	No
November	NJ	2	Female	B	No
November	NM	30	Male	A	No
November	NYC	24	Female	B	No
November	PA	4	Male	B	No
December	CA	20	Male	A	No
December	CA	4	Male	A	No
December	CA	25	Female	A	No
December	CA	7	Female	A	No
December	MD	8	Female	B	No
December	NJ	14	Male	B	No
December	NJ	26	Female	B	No
December	PA	27	Male	B	No
December	TX	22	Female	B	No
December	WA	18	Male	A	No

*Botulinum toxin Type F produced by *Clostridium baratii*
**Suspect *Clostridium butyricum* type E
***Dual toxin type

Table 2-5. Cases of wound botulism reported to the Botulism Surveillance System, by month, 2006 (N = 45)

Month	State	Age (years)	Gender	Toxin Type	Exposure*	Death
January	CA	57	Male	A	IDU	No
January	CA	45	Male	A	IDU	No
January	CA	37	Female	A	IDU	No
January	CA	31	Male	A	IDU	No
January	CA	43	Male	A	IDU	No
January	CA	52	Male	A	IDU	No
January	CA	56	Male	A	IDU	No
January	CA	39	Female	A	IDU	No
January	CA	38	Male	A	IDU	No
January	CA	58	Male	A	IDU	No
January	CA	52	Male	A	IDU	No
February	CA	62	Male	A	IDU	No
February	CA	57	Male	A	IDU	No
February	CA	39	Female	A	IDU	No
March	CA	51	Female	A	IDU	No
March	CA	30	Female	A	IDU	No
March	CA	38	Male	A	IDU	No
March	NYC	14	Male	B	Trauma[1]	No
April	CA	47	Male	B	IDU	No
April	CA	61	Male	A	IDU	No
April	TX	45	Male	A	IDU	Yes
May	CA	49	Male	A	IDU	No
May	CA	47	Female	A	IDU	No
May	CA	61	Female	A	IDU	No
May	CA	41	Male	A	IDU	No
May	CA	41	Female	A	IDU	No
June	CA	55	Female	A	IDU	No
June	CA	51	Male	A	IDU	No
June	CA	40	Male	A	IDU	No
June	CA	37	Male	A	IDU	No
June	CA	37	Male	A	IDU	No
June	CA	33	Male	A	IDU	No
July	CA	48	Female	A	IDU	No
July	CA	45	Male	A	IDU	No
July	CA	46	Male	A	IDU	No

July	MD	52	Male	B	Trauma[2]	No
July	WA	46	Male	B	IDU	No
August	CA	35	Male	A	IDU	No
August	CA	53	Male	A	IDU	No
August	CA	34	Female	A	IDU	No
October	CA	39	Male	A	IDU	No
October	CA	52	Male	A	IDU	No
October	CA	48	Male	A	IDU	No
November	CA	50	Male	A	IDU	No
November	CA	52	Male	A	IDU	No

*IDU = injection drug user
[1]Acquired an injury that required a cast
[2]Wound sustained from a fall

Shiga Toxin-Producing *Escherichia coli* (STEC)

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. *E. coli* O157:H7 has been nationally notifiable since 1994. National surveillance for all STEC serotypes began in 2001. Non-O157 STEC strains are also important pathogens; they have caused several U.S. outbreaks and, in some U.S. reports, they have been isolated from diarrheal stools more frequently than *E. coli* O157:H7. Reporting of non-O157 STEC has increased every year since implementation in 2001.

Nationally, reports of serotypes of STEC isolates are submitted electronically from state public health laboratories to CDC through the Public Health Laboratory Information System (PHLIS). STEC isolates are submitted by clinical diagnostic laboratories to state public health laboratories for confirmation and further characterization. During 2006, CDC received 3,617 reports of STEC isolates from 49 states through PHLIS. The national rate of reported STEC isolates was 1.21 per 100,000; this represents a 37.9% increase since 2005 (Figure 3-1). The substantial decline in the number of cases between 2000-03 was due to the decline in *E. coli* O157 infections and coincided with regulatory and industry control activities and decreased contamination of ground beef by *E. coli* O157. Starting in 2004, the incidence of human STEC infections increased. Reasons for the increases are not known and could in part be attributed to improved identification and reporting. These increases have also been observed in sentinel sites where active surveillance is conducted. Recent large, multistate outbreaks associated with leafy greens suggest that produce consumed raw is an important source of STEC infections.

Most (3,008; 83.2%) STEC isolates reported through PHLIS were *E. coli* O157 (Table 3-1). STEC incidence varied by state, with higher isolation rates in northern states (Figure 3-2). STEC was isolated most frequently from children aged < 5 years, accounting for 24% of isolates. The distribution of isolates between males and female persons was different, with a greater number of isolates from males in all age groups except 5-19 years (Figure 3-3). STEC infections were sharply seasonal, with most cases occurring during summer months (Figure 3-4).

During 2006, 423 cases of non-O157 STEC were reported through PHLIS. 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 2006, 554 non-O157 isolates were received by CDC from 42 states (Figure 3-5). The non-O157 isolates received by CDC in 2006 included more than 50 different O groups. The predominant groups were O26 (22%) and O103 (17%), followed by O111 (14%), O121 (5%), and O45 (5%). These five O groups made up 63 % of all isolates (Table 3-2). *E. coli* O26 has been the most commonly isolated non-O157 STEC since 2002. In 2001, *E. coli* O111 was the most common.

Identification of 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 identify 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.

Figure 3-1. Incidence of laboratory-confirmed STEC infection reported through PHLIS, United States, 1996-2006

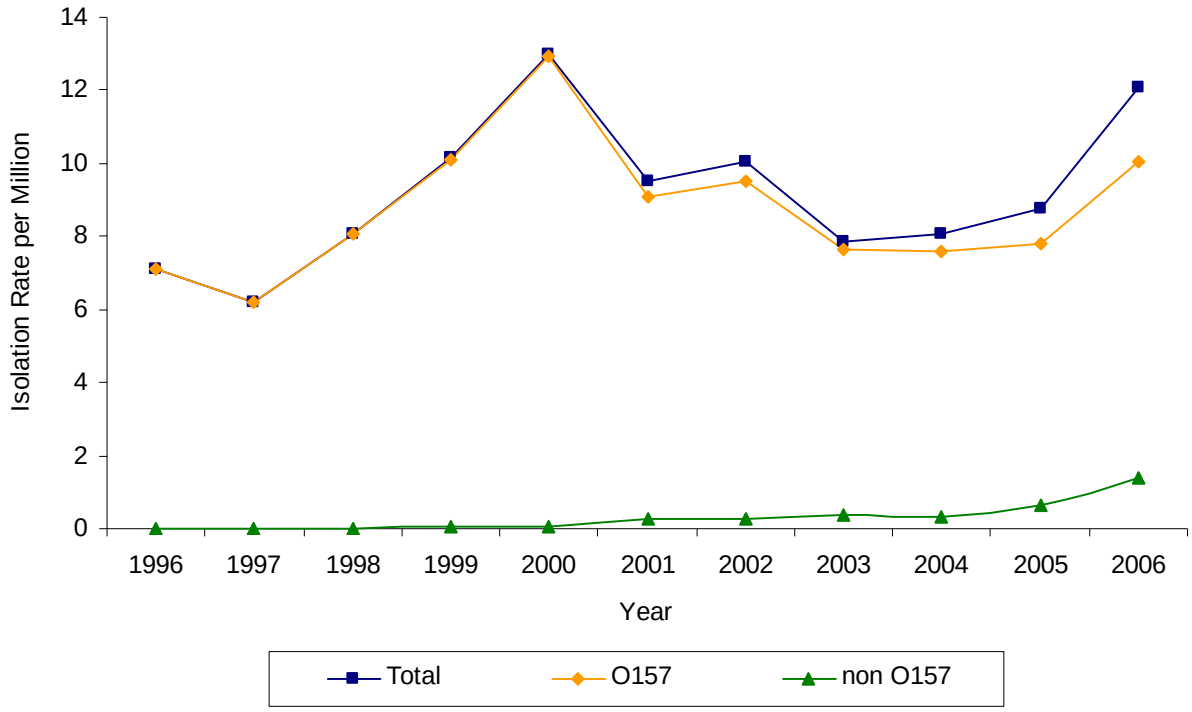


Table 3-1. STEC isolates from humans reported through PHLIS, United States, 2006

O Antigen	Number of isolates	Percent
157	3,008	83.16
26	119	3.29
103	89	2.46
111	71	1.96
45	27	0.75
121	23	0.64
145	17	0.47
118	8	0.22
165	8	0.22
177	5	0.14
28	5	0.14
128	4	0.11
156	4	0.11
179	4	0.11
69	4	0.11
76	4	0.11
3	3	0.08
777	3	0.08
91	3	0.08
43	2	0.06
79	2	0.06
Subtotal	3,413	94.36
All Other Serogroups	18	0.49
Unknown	177	4.89
Rough Isolates	9	0.25
Subtotal	204	5.64
Total	**3,617**	**100.00**

Figure 3-2. STEC isolation rate per 100,000 population, reported through PHLIS, by state, 2006

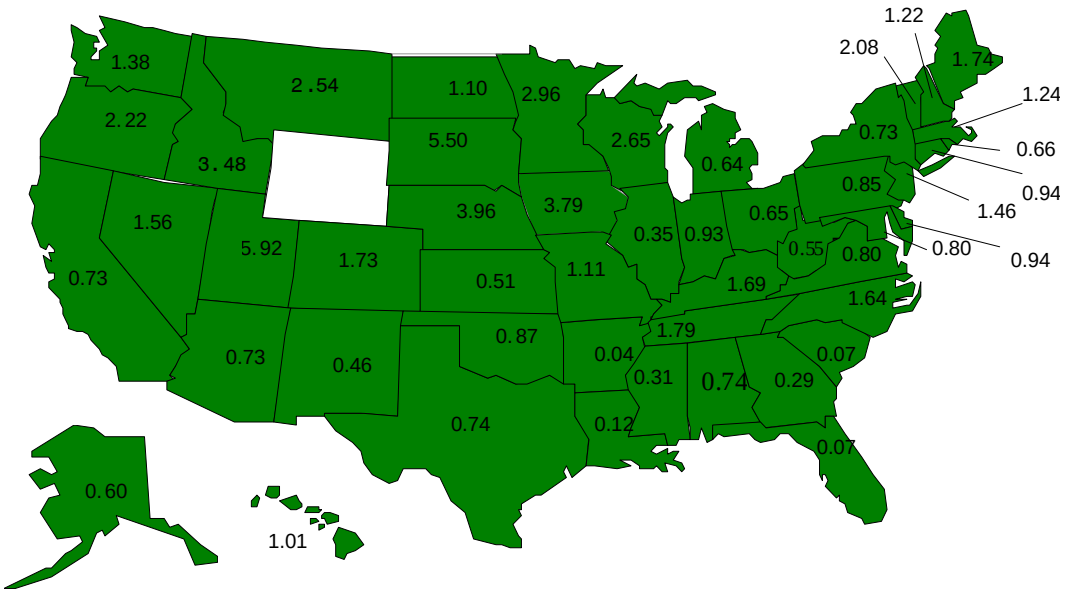


Figure 3-3. Incidence of STEC isolates, by age group and sex of patient, United States, 2006

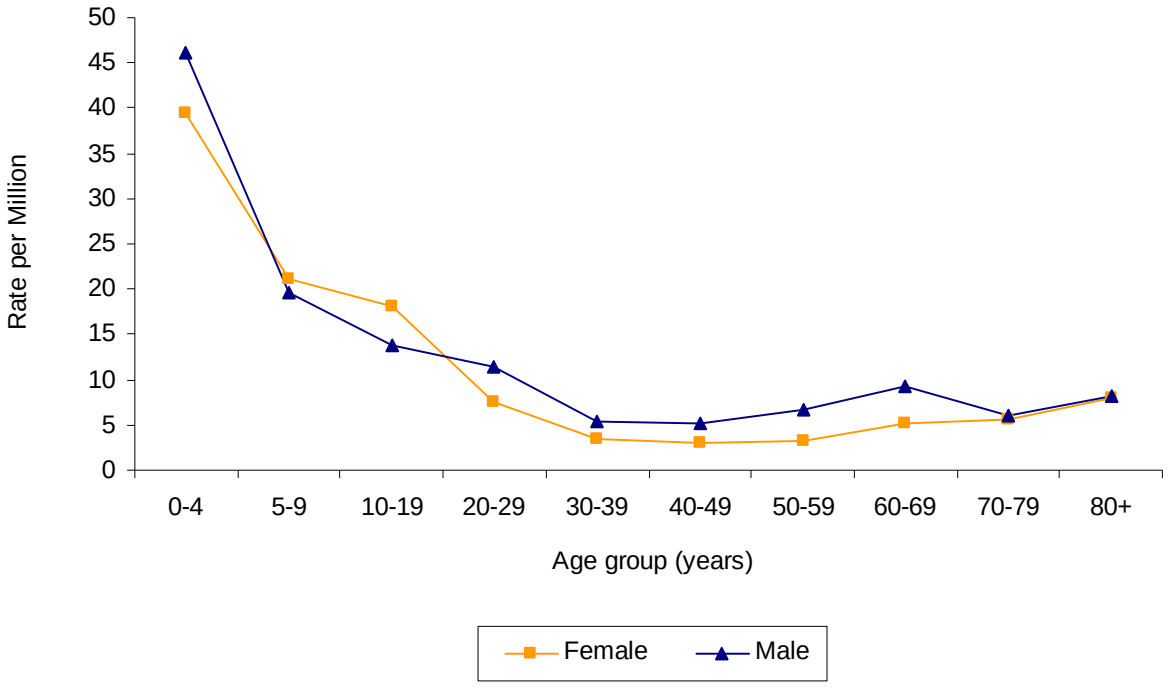


Figure 3-4. Number of STEC isolates by month of specimen collection, United States, 2006

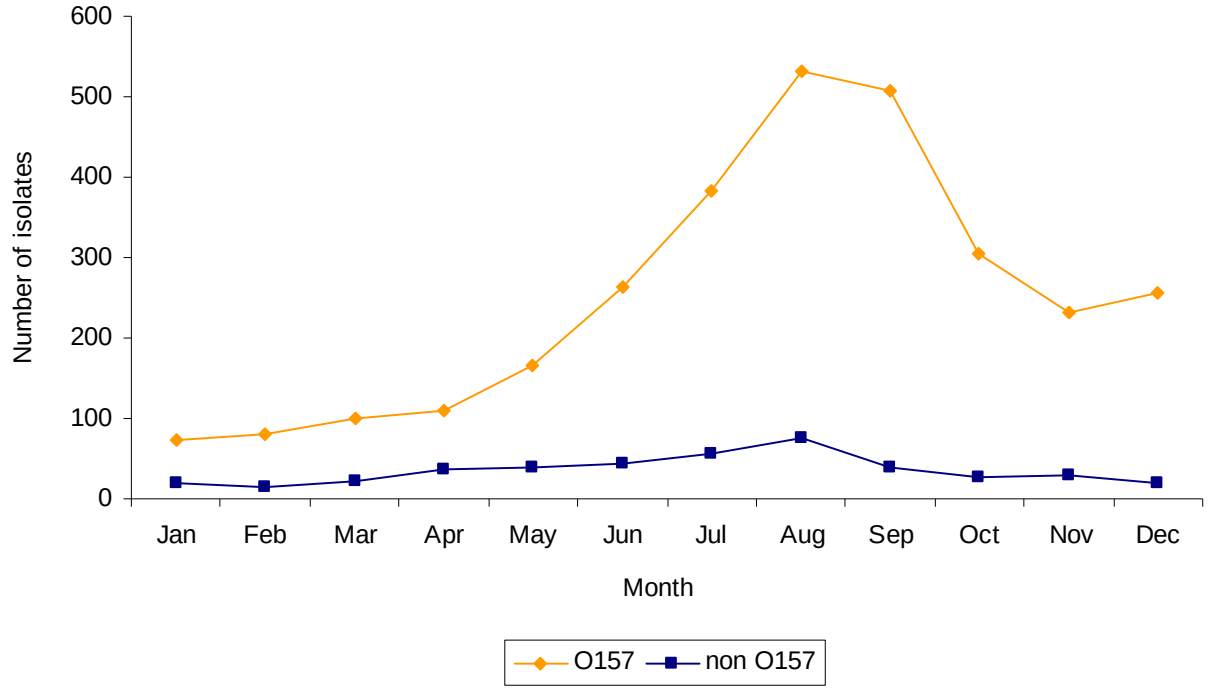
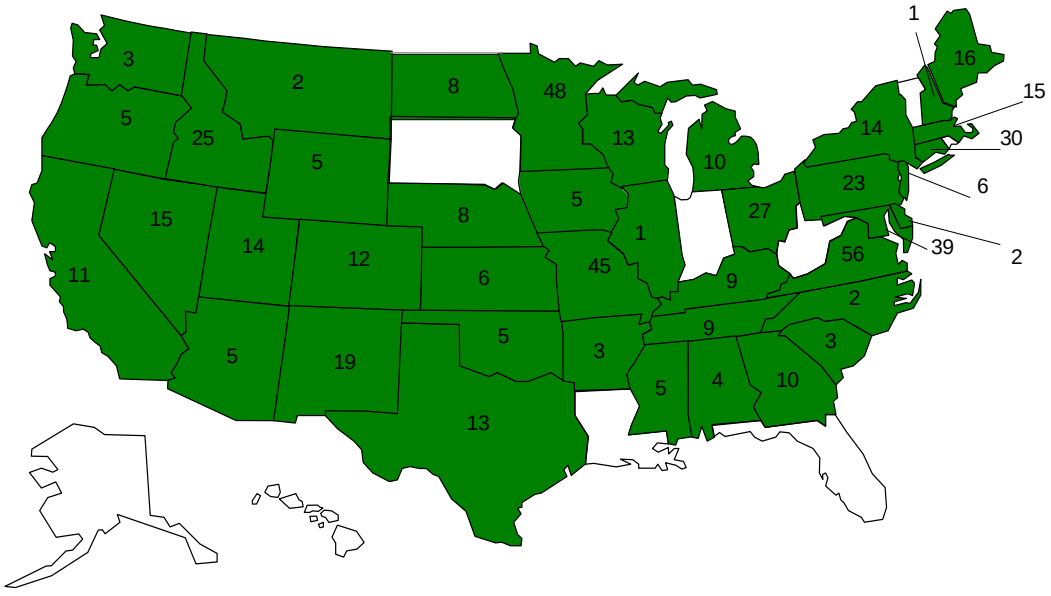


Figure 3-5. Non-O157 STEC isolates submitted to CDC, by state, 2006 (N = 42)*



* 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.

Table 3-2. Serogroup of non-O157 STEC isolates from humans sent to National *Escherichia coli* Reference Laboratory and Epidemic Investigation and Surveillance Laboratory, 2006

Serogroup	Number of isolates	Percent
26	123	22.2
103	95	17.1
111	78	14.1
121	28	5.1
45	28	5.1
145	20	3.6
118	16	2.9
69	12	2.2
91	9	1.6
165	6	1.1
177	6	1.1
76	6	1.1
123	4	0.7
153	3	0.5
174	3	0.5
28ac	3	0.5
43	3	0.5
113	2	0.4
166	2	0.4
178	2	0.4
179	2	0.4
181	2	0.4
79	2	0.4
8	2	0.4
84	2	0.4
Rough	21	3.8
Undetermined	29	5.2
Other	25	4.5
Unknown	20	3.6
Total	**554**	**100.0**

***Listeria monocytogenes* (Listeriosis)**

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, elderly, 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 notifiable disease since 2000. Reports of listeriosis are submitted to CDC through NNDSS. There were 884 cases of listeriosis reported to NNDSS during 2006 (0.3 cases per 100,000 population). Sentinel site surveillance data on listeriosis incidence rates are available in FoodNet reports at http://www.cdc.gov/foodnet/.

The *Listeria* Initiative began in 2004 as an effort to improve the investigation of *Listeria* outbreaks and clusters. It involves conducting prompt interviews of patients using an extended case form, which collects detailed information on demographics of the patient, clinical course, and food exposures. Data are maintained in a central database and are available for rapid analysis in the event that PulseNet identifies a cluster of patient isolates with the same molecular pattern. The data maintained by the *Listeria* Initiative can then be used for case-control analysis of a cluster in which people with non-matching isolates serve as controls. Prompt data collection and analysis could allow earlier public health intervention during an outbreak.

There were 180 extended case forms from twenty states submitted to CDC during 2006 (Figure 4-1). Case patients ranged in age from 0-93 years, with a median age of 66 years (Table 4-1). One hundred and seven (60%) patients were female and 17 cases (9%) were pregnancy associated. Most (91%) patients were hospitalized and 17 (13%) deaths were reported. Infection occurred most frequently in adults over 70 years of age, accounting for 43% of cases (Figure 4-2). The age distribution differed between the sexes, with a female predominance particularly evident in the 20-39 year age range.

All *Listeria monocytogenes* patient isolates 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 *Listeria* Initiative standard interview form, available at http://www.cdc.gov/nationalsurveillance/PDFs/ListeriaCaseReportFormOMB0920-0004.pdf. More information on listeriosis surveillance and the *Listeria* Initiative can be found on the National Surveillance website at http://www.cdc.gov/nationalsurveillance/listeria_surveillance.html.

Figure 4-1. Listeriosis cases reported through the *Listeria* Initiative, by state, 2006 (N=180)

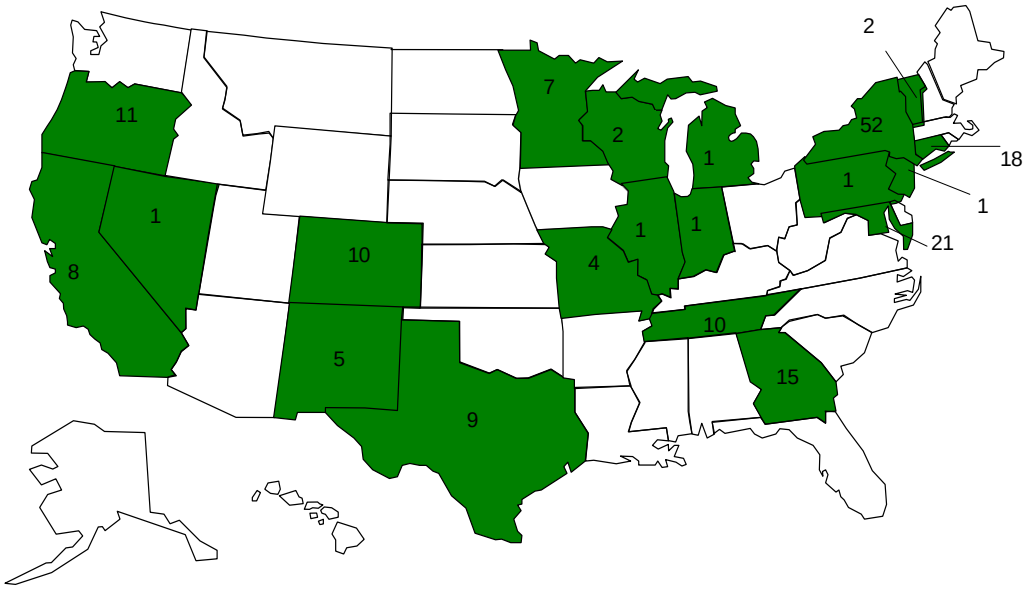
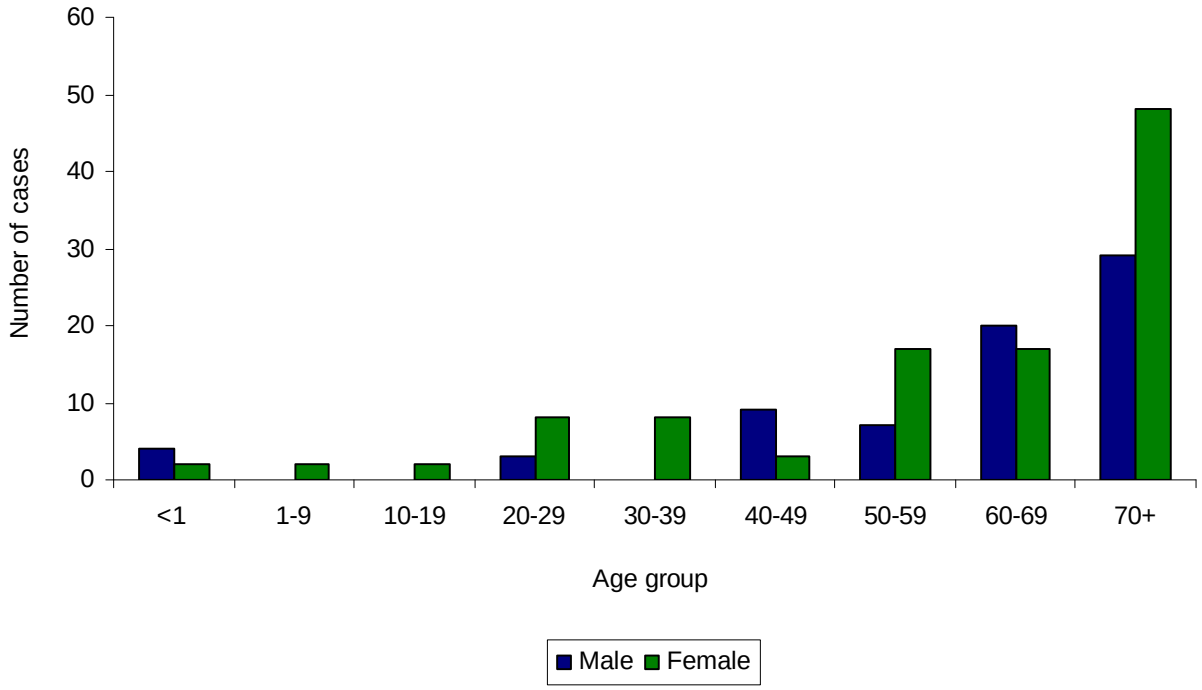


Table 4-1. Baseline characteristics and clinical course of patients interviewed using the extended case form, *Listeria* Initiative, 2006

Characteristic	
Age in Years (N=179)	
Range (median)	0-93 (66)
Gender (N=179)	
Female	107 (60%)
Male	72 (40%)
Pregnancy Associated (N=179)	
Yes	17 (9%)
No	162 (91%)
Hospitalized (N=152)	
Yes	139 (91%)
No	13 (9%)
Outcome (N=130)	
Survived	113 (87%)
Died	17 (13%)

Figure 4-2. Listeriosis cases, by age group and sex, *Listeria* Initiative, 2006 (N=179).



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. 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. Every 20th isolate is forwarded to the National Antimicrobial Resistance Monitoring System (NARMS) at CDC for susceptibility testing.[1]

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 ascertained. In addition, 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 herein should be considered a fraction of all *Salmonella* 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. For serotypes other than Typhi, only the first isolate within a thirty day period for each person is counted, if the serotype and clinical source are the same.

A total of 40,666 *Salmonella* isolates were reported from participating public health laboratories in 2006. All states and the District of Columbia reported isolates; Florida, Montana, and the District of Columbia reported partial serotype information. The number of reported isolates represents a slight increase (4.2%) compared with 1996 and a large increase compared with 2005 (12.3%); this could be attributed to increased reports from several states, including Texas and California. The national rate of reported *Salmonella* isolates in 2006 was 13.6 per 100,000 based on 2006 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 24% of isolates. Fewer 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 number of isolates from male than female infants and children and a smaller proportion of isolates from male than female adults.

The twenty most common serotypes of *Salmonella* in 2006 are listed in Table 4-1. These represent 70% of all *Salmonella* isolates. The four most common serotypes in 2006 (Typhimurium, Enteritidis, Newport, and Heidelberg; 45% 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. (During 2004, a multistate outbreak of serotype Javiana infections associated with tomatoes at a gas station deli chain affected more than 400 people in 5 states.) Typhimurium has been the most commonly isolated serotype since 1997, though Enteritidis was a very close second in 2005 and 2006 (Figure 4-1). The number of isolates of serotypes Typhimurium and Enteritidis have both declined substantially (28% and 30%, respectively) since 1996.

Among the twenty most common serotypes in 2006, Hadar has had the largest percent decline in number of isolates during the last ten years. It was the eighth most common serotype in 1996 and declined to the 20th most common in 2006, a 58% decline. Serotype Enteritidis declined 30% since 1996, although most of the decline was between 1996 and 1998. *Salmonella* Mississippi has had the most dramatic increase, 236% since 1996, most since 2002. *Salmonella* Newport had a large increase in numbers between 1997 and 2002, but then declined and has remained relatively stable since 2004. Similarly, serotype Javiana had substantial increases in 2003 and 2004, but has declined 19% from the 2004 peak.

There were 121 *Salmonella* outbreaksin 2006, causing greater than 3,300 illnesses reported to CDC Foodborne Outbreak Reporting System.[2] The most common outbreak serotypes were Enteriditis (26), Typhimurium (26), Newport (10), and Heidelberg (10). In the past, the number of Enteriditis outbreaks identified greatly exceeded the number of Typhimurium outbreaks despite Tyhpimurium's tendency to outrank Enteriditis in number of sporadic cases. This is the first year that the number of Typhimurium outbreaks has come close to the number of Enteriditis outbreaks. *Salmonella* Tennessee was a notable outbreak associated with peanut butter, which was distributed worldwide, and caused over 700 cases in 48 states.[3] In 2006, two *Salmonella* outbreaks were associated with consumption of raw tomatoes in restaurants. The first, caused by *Salmonella* Newport, caused 119 illnesses in 18 states; the Typhimurium tomato outbreak resulted in 190 cases across 21 states.[4]

References:

1. CDC. The National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS): 2004 Human Isolates Final Report. Atlanta, Georgia: U.S. Department of Health and Human Services, CDC, 2006.
2. CDC. 2006 Annual Listing of Foodborne Disease Outbreaks, United States. http://www.cdc.gov/foodborneoutbreaks/documents/2006_line_list/2006_line_list.pdf
3. CDC. Multistate Outbreak of Salmonella Serotype Tennessee Infections Associated with Peanut Butter --- United States, 2006-2007. MMWR 56:521-524.
4. CDC. Multistate Outbreaks of *Salmonella* Infections Associated with Raw Tomatoes Eaten in Restaurants --- United States, 2005-2006. MMWR 56:909-911.

Table 4-1. The 20 *Salmonella* serotypes most frequently reported to PHLIS, 2006

Rank	Serotype	Number	Percent
1	Typhimurium*	6872	16.9%
2	Enteritidis	6740	16.6%
3	Newport	3373	8.3%
4	Heidelberg	1495	3.7%
5	Javiana	1433	3.5%
6	I 4,[5],12:i:-	1200	3.0%
7	Montevideo	1061	2.6%
8	Muenchen	753	1.9%
9	Oranienburg	719	1.8%
10	Mississippi	604	1.5%
11	Saintpaul	588	1.4%
12	Braenderup	561	1.4%
13	Agona	538	1.3%
14	Infantis	491	1.2%
15	Thompson	447	1.1%
16	Paratyphi B var. L(+) tartrate+	417	1.0%
17	Typhi	413	1.0%
18	Stanley	315	0.8%
19	Tennessee	312	0.8%
20	Hadar	275	0.7%
Subtotal		**28,607**	**70.3%**
All other serotyped		6,459	15.9%
Unknown		4,042	9.9%
Partially serotyped isolates		1,448	3.6%
Rough, mucoid, and/or nonmotile isolates		110	0.3%
Subtotal		**12,059**	**29.7%**
Total		**40,666**	**100%**

* Typhimurium includes var. Copenhagen

Figure 4-1. Isolation rate per 100,000 population for the top four serotypes of *Salmonella* reported to PHLIS, 1970–2006

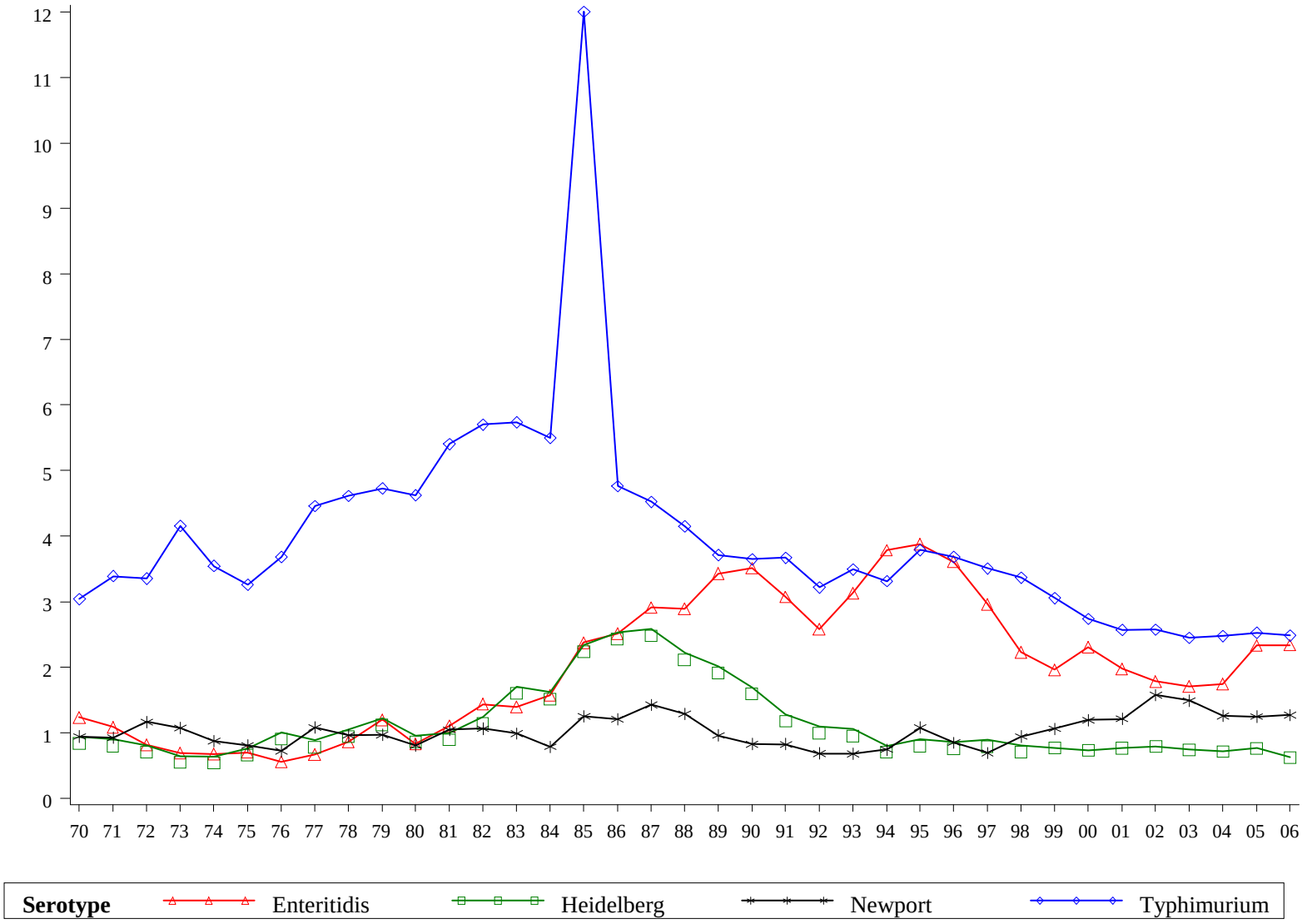
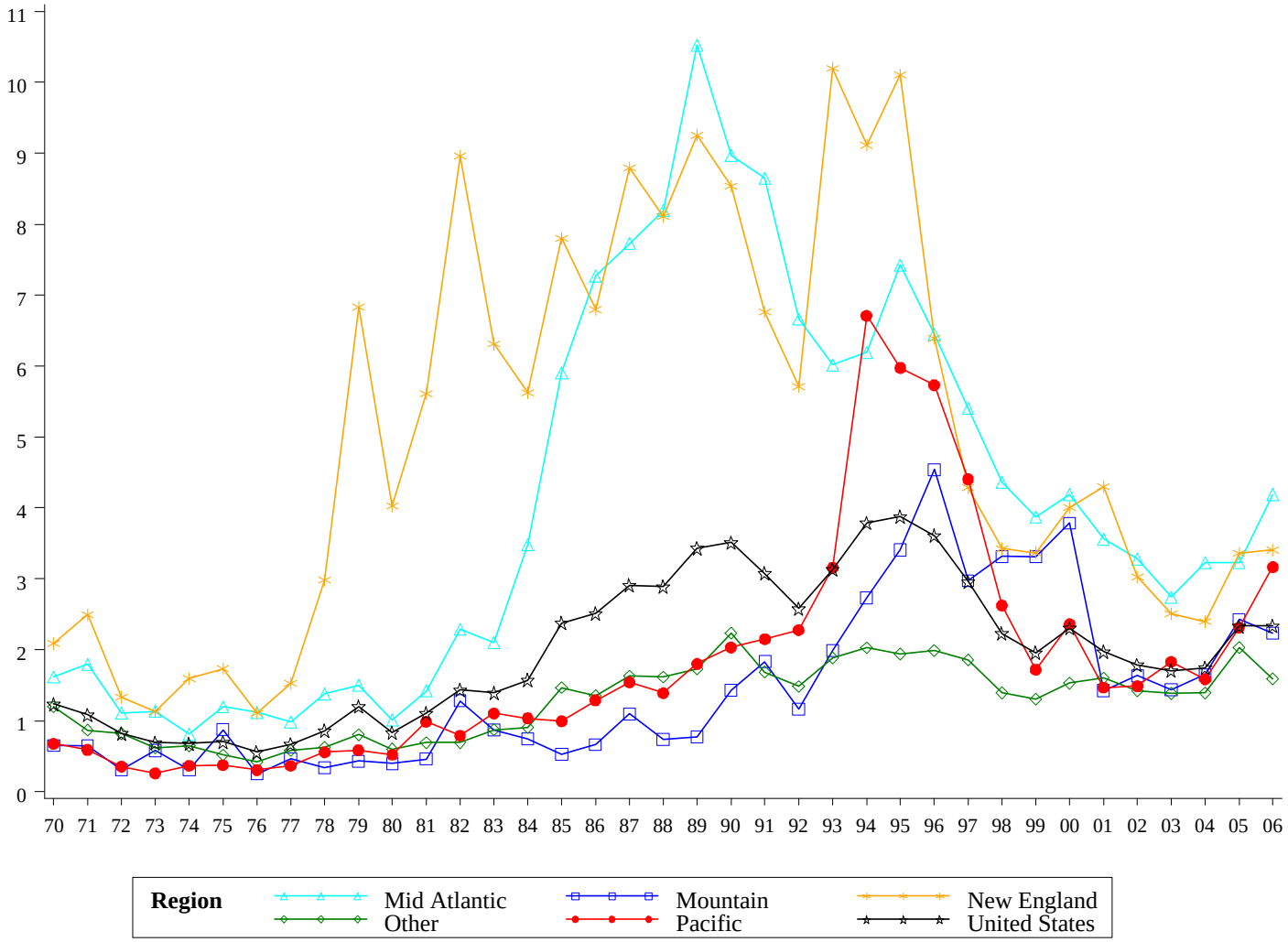


Figure 4-2. Isolation rate per 100,000 population for *Salmonella* Enteritidis reported to PHLIS, by region, 1970–2006



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 in the United States. *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 to CDC. Unusual or untypable isolates may be forwarded to the National *Shigella* Reference Laboratory at the Enterics Diseases Laboratory Branch (EDLB) at CDC for further characterization or confirmation. These results are reported back to the state laboratory by CDC.

The capture of the data concerning isolates in the National *Shigella* Surveillance System is considered to be fairly consistent. However, data on some *Shigella* isolates may not be forwarded or reported to state public health laboratories and therefore are not ascertained. 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 *Shigella* infections.

The number of isolates reported by geographical area (e.g. 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. For the Annual Summaries, duplicate records were deleted. All isolates reported herein were from infected humans.

There are four major subgroups of *Shigella*, designated A, B, C, and D, and 43 recognized serotypes. These subgroups and serotypes are differentiated from one another by their biochemical traits (ability to ferment D-mannitol) and antigenic properties. (Table 5-1).

A total of 10,336 *Shigella* isolates were reported from public health laboratories in 50 states in 2006 (Table 5-2). The national incidence of laboratory-confirmed *Shigella* was 3.5 per 100,000 population. Similar to previous years, *Shigella* was isolated frequently from children < 5 years of age, who accounted for 31.1% of all isolates. About 32.2% came from persons aged 5–19 years, and 26.9% from persons aged 20–59, with smaller percentages in older age groups. Among patients for whom gender was reported, 53.0% were female. Females accounted for more cases than males in all age groups except < 5 years (49.1% female) and 40–49 years (45.1% female). Among patients 20-29 years of age, a female predominance was particularly evident at 68% of isolates. These gender differences were most striking among patients infected with *Shigella sonnei*, where females accounted for 72.4% of patients 20-29 years of age, 63.6% of patients 30-39 years of age, 54.0% of patients 40-49 years of age, and 61.6% of patients 50-59 years of age. Among patients infected with *Shigella flexneri*, a male predominance was seen, particularly in the age groups 30–39 (66.9%), 40–49 (75.7%), and 50–59 (60.1%) years of age. Patient gender was not reported for 9.1% of all isolates and age information was not reported for 6.1% of isolates.

The frequency of subgroups and the frequency of serotypes within these subgroups for all *Shigella* isolates are shown in Tables 5-2 and 5-3. Of the 10,336 isolates, 9,108 (88.1%) were subgrouped. The proportion of *Shigella* isolates that were subgroup D (*S. sonnei*) was 72.3%), followed by subgroup B (*S. flexneri)* 14.3%), subgroup C (*S. boydii)* 1.1% and subgroup A (*S. dysenteriae)* 0.5%). Over the past decade, the numbers of *Shigella* isolates in subgroups A, B and C, and the proportions of all reported *Shigella* isolates due to these three subgroups have declined. The number (1,228) and the proportion (11.9%) of *Shigella* isolates that were not identified as belonging to a specific subgroup increased slightly.

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[a]	+	+
C	*S. boydii*	19[b]	+	-
D	*S. sonnei*	1	+	-

[a] Serotypes 1-5 are subdivided into 11 subserotypes

[b] Although the numbering scheme for serotypes extends to serotype 20, there are only 19 serotypes because *S. boydii* (now reclassified as *Escherichia boydii*) has been removed from the scheme.

Table 5-2. *Shigella* subgroups reported to PHLIS, 2006

Rank	Subgroup	Number	Percent
1	*S. sonnei*	7,471	72.3%
2	*S. flexneri*	1,477	14.3%
3	*S. boydii*	114	1.1%
4	*S. dysenteriae*	46	0.5%
Subtotal		**9,108**	**88.1%**
Unknown		**1,228**	**11.9%**
Total		**10,336**	**100.0%**

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

Rank	Serotype	Number	Percent
1	*S. sonnei*	7471	72.3%
2	*S. flexneri* unspecified	746	7.2%
3	*S. flexneri* 2 unspecified	152	1.5%
4	*S. flex*neri 2a	107	1.0%
5	*S. flexneri* 1 unspecified	102	1.0%
6	*S. boydii* unspecified	75	0.7%
7	*S. flexneri* 3 unspecified	67	0.7%
8	*S. flexneri* 6	61	0.6%
9	*S. flexneri* 4 unspecified	54	0.5%
10	*S. flexneri* 1b	38	0.4%
11	*S. flexneri* 3a	38	0.4%
12	*S. flexneri* 4a	37	0.4%
13	*S. dysenteriae* unspecified	31	0.3%
14	*S. flexneri* 2b	22	0.2%
15	*S. flexneri* variant y	22	0.2%
16	*S. boydii* 2	15	0.2%
17	*S. flexneri* 1a	12	0.1%
18	*S. boydii* 1	9	0.1%
19	*S. flexneri* 3b	7	0.1%
20	*S. boydii* 14	6	0.1%
21	*S. flexneri* 4b	5	0.1%
22	*S. dysenteriae* 2	4	0.0%
23	*S. boydii* 4	3	0.0%
24	*S. dysenteriae* 4	3	0.0%
25	*S. flexneri* variant x	3	0.0%
26	*S. boydii* 12	2	0.0%
27	*S. boydii* 18	2	0.0%
28	*S. dysenteriae* 1	2	0.0%
29	*S. dysenteriae* 12	2	0.0%
30	*S. dysenteriae* 3	2	0.0%
31	*S. flexneri* 5, unspecified	2	0.0%
32	*S. boydii* 10	1	0.0%
33	*S. boydii* 8	1	0.0%
34	*S. dysenteriae* 13	1	0.0%
35	*S. dysenteriae* 7	1	0.0%
36	*S. flexneri* 5b	1	0.0%
37	*S. flexneri* 88-893	1	0.0%
Subtotal		**9,108**	**88.2%**
Unknown		**1,228**	**11.9%**
Total		**10,336**	**100.0%**

Vibrio

The cholera and vibriosis (non-cholera *Vibrio* species) surveillance case definitions are available at http://www.cdc.gov/epo/dphsi/casedef/cholera_current.htm and http://www.cdc.gov/epo/dphsi/casedef/vibriosis.htm. Infection with toxigenic *Vibrio cholerae* serogroups 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. In addition, CDC maintains a database of reported infections with all species of *Vibrio* from humans in order to obtain reliable information on illnesses associated with the range of *Vibrio* species. 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.

The Cholera and Other Vibrio Illness Surveillance System (COVIS) was initiated by the Food and Drug Administration (FDA), CDC, and the Gulf Coast states (Alabama, Florida, Louisiana, Mississippi, and Texas) in 1988. Participating health officials collect clinical data, information about underlying illness, history of seafood consumption and exposure to seawater in the 7 days before illness, and conduct tracebacks of implicated oysters. Reporting has expanded and since 1997, many other states have also reported *Vibrio* isolates (Figure 6-1). However, only toxigenic *V. cholerae* O1 and O139 were nationally notifiable; thus the number of *Vibrio* isolates is likely greater than reported. 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.

This report summarizes human *Vibrio* infections during 2006 reported by states to CDC. Results are 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 consistency 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 or wound pathogens is less clear.

In June 2006, the Council of State and Territorial Epidemiologists adopted a resolution to add all *Vibrio* species infections (vibriosis) to the list of nationally notifiable diseases reported to the National Notifiable Diseases Surveillance System (NNDSS). Reporting of vibriosis is in addition to and distinct from reporting of cholera 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/.

An outbreak of *V. parahaemolyticus* involving a total of 177 confirmed and probable cases associated with consumption of raw shellfish occurred during the summer in 2006[1]. A total of 62 reports of confirmed *V. parahaemolyticus* outbreak-related cases were reported to COVIS from 10 states (Alaska, California, Connecticut, Georgia, New Jersey, New York, Oregon,

Texas, Utah, and Washington). Dates of onset ranged from May 30 to September 20. Of the 62 reports received, 60 (97%) cases reported consuming oysters, of which 73% reporting eating raw oysters. Among patients for whom information was known, 3% were hospitalized and no deaths were reported. Several oyster growing areas that were found to be the source of the oysters associated with illnesses were closed to oyster harvesting[1].

Isolates of toxigenic *Vibrio cholerae*

In 2006, eight patients with toxigenic *V. cholerae* O1 (cholera), two patients with toxigenic *V. cholerae* O141, and one patient with *V. cholerae* O75 were reported (Table 6-1). Of the eight cholera cases, four patients were hospitalized and no deaths were reported. Infection was acquired through international travel for four sporadic cases (three cases acquired infection while traveling in India and one case while traveling in Bangladesh). Of those who acquired infection while in India, two were vegetarians with no recreational water exposure, and the third reported eating fresh fruits and vegetables washed in local water. The patient that traveled to Bangladesh reported consuming fish while abroad. All four domestically-acquired infections occurred in residents of Louisiana who reported having eaten crab. Two of the patients obtained crab from friends or relatives who caught the crab in Louisiana. A third case purchased crab from a local distributor and the fourth could not remember where the crab was obtained. The pulsed field gel electrophoresis (PFGE) patterns of the isolates from all four patients were indistinguishable from each other by *SfiI* enzyme. When compared with the national *V. cholerae* database, these four isolates were indistinguishable from isolates previously characterized as the Gulf Coast strain by *SfiI*. Further comparison using a second enzyme, *NotI*, revealed that these four isolates and previous Gulf Coast strains differed by one to three bands.

One of the two patients with toxigenic *V. cholerae* O141 had traveled internationally to Morocco. Her symptoms began during her trip although she did not seek medical attention until returning home. No further risk information was reported. The other case ate raw oysters domestically 1 day before symptom onset. Two others who also ate the oysters reported diarrhea lasting for 1 day. Previous cases of *V. cholerae* O141 have occurred in the United States[2].

The patient infected with *V. cholerae* O75 had traveled domestically to Miami where he consumed clams and raw oysters. He presented at his primary care provider's office 4 days after onset of vomiting, diarrhea, nausea, abdominal cramps, myalgias, and headache. No treatment or hospitalization was required.

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

In 2006, 744 *Vibrio* isolates from 718 patients were reported to the Cholera and Other *Vibrio* Illness Surveillance System (Tables 6-2 and 6-3). Among patients for whom information was available, 215 (32%) of 665 were hospitalized and 36 (6%) of 649 died. *V. parahaemolyticus* was isolated from 403 (56%) patients, and was the most frequently reported *Vibrio* species. Of the patients infected with *V. parahaemolyticus*, 68 (18%) were hospitalized and 1 (<1%) died. *V. vulnificus* was isolated from 99 (14%) patients; 79 (85%) were hospitalized and 31 (35%) died.

Of the 718 cases in 2006, CDC received 164 (23%) reports of *Vibrio* illness from Gulf Coast states, 286 (40%) from Pacific Coast states, 199 (28%) from Atlantic Coast states (excluding Florida, which is included with Gulf Coast states), and 69 (10%) from inland states (Figure 6-1). The most frequent *Vibrio* species reported from Gulf Coast states were *V. vulnificus* (32%), *V. parahaemolyticus* (25%), *V. alginolyticus* (17%), and non-toxigenic *V. cholerae* (9%). The most frequent *Vibrio* species reported from non-Gulf Coast states were *V. parahaemolyticus* (65%), *V. alginolyticus* (10%), *V. vulnificus* (8%), and non-toxigenic *V. cholerae* (5%).

Among the 744 *Vibrio* isolates from all states, 446 (60%) were from stool, 89 (12%) from blood, and 128 (17%) from wounds. Thirty-six (5%) isolates were obtained from the ear, of which 30 (83%) were *V. alginolyticus*. An additional 45 isolates (6%) were from urine, sputum, or other site. *V. parahaemolyticus* was the species most frequently isolated from stool (359 [80%] of 446 isolates from stool); *V. vulnificus* was the species most frequently isolated from blood (64 [72%] of 89 isolates from blood) and *V. alginolyticus* was the species most frequently isolated from wounds (39 [30%] of 128 isolates from wounds).

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 during July for Gulf Coast states and non-Gulf Coast states.

One hundred four (14%) patients reported having a wound either before or during exposure to *Vibrio*. Of those, 97 (93%) reported having skin exposed to a body of water, 32 (31%) reported handling seafood, and 21 (20%) reported contact with marine wildlife. Excluding patients with wound infections, among the 465 for whom a food history was available, 437 (94%) reported eating seafood in the 7 days before illness onset. Among the 208 who reported eating a single seafood item (Table 6-4), 60% ate oysters (79% of whom consumed them raw), 11% ate finfish, 10% ate shrimp. International travel in the 7 days before illness onset was reported by 53 (8%) of 629 patients for whom information was available.

For reports where laboratory confirmation was available, the state public health laboratory identified 216 (98%) of 221 human *Vibrio* isolates, excluding *V. cholerae*. CDC received 147 isolates of *V. parahaemolyticus* from 141 patients. Of these, 41 (30%) from nine states were serotype O4:K12 (Alaska, Colorado, Connecticut, Georgia, Nevada, New Mexico, New York State, Oregon, and Washington); 14 (10%) isolates from eleven public health jurisdictions were of the pandemic clone serotype O3:K6 (Arizona, Colorado, Georgia, Louisiana, Maryland, Montana, New York City, New York State, Texas, Virginia, and Wisconsin); 7 (5%) isolates from six states were serotype O4:K63 (Arizona, Colorado, Mississippi, New York, Louisiana, and Washington); and the remaining 79 isolates were one of 32 serotypes. Twelve possible pandemic clones (thermostable direct homolysin positive/thermostable direct related hemolysin negative) include four 01:Kuk, two 03:Kuk, and one each of 01:K25, 03:K29, 04:K8, 04:K37, 06:K18, and 08:K41.

Recent Publications

1. *Vibrio parahaemolyticus* infections associated with consumption of raw shellfish--three

states, 2006. MMWR Morb Mortal Wkly Rep. Aug 11 2006;55(31):854-8
2. Toxigenic *Vibrio cholerae* Serogroup O141—Associated Cholera-Like Diarrhea and Bloodstream Infection in the United States. JID. Mar 1 2003;187:866-868

Table 6-1. Isolates of toxigenic *V. cholerae* reported to COVIS, 2006

State	Age	Sex	Onset	Exposure	Serogroup	Serotype
California	27	F	5/2/2006	Travel in India	*V. cholerae* O1	Inaba
Illinois	58	M	6/25/2006	Travel in India	*V. cholerae* O1	Inaba
Louisiana	39	F	6/5/2006	Domestic (seafood)-Gulf Coast	*V. cholerae* O1	Inaba
Louisiana	60	F	6/20/2006	Domestic (seafood)-Gulf Coast	*V. cholerae* O1	Inaba
Louisiana	75	F	6/27/2006	Domestic (seafood)-Gulf Coast	*V. cholerae* O1	Inaba
Louisiana	60	F	7/31/2006	Domestic (seafood)-Gulf Coast	*V. cholerae* O1	Inaba
New Jersey	15	M	7/31/2006	Travel in India	*V. cholerae* O1	Inaba
New York	46	M	5/21/2006	Travel in Bangladesh	*V. cholerae* O1	Inaba
Alabama	53	F	10/22/2006	Domestic (seafood)-Gulf Coast	*V. cholerae* O141	
Tennessee	32	F	9/24/2006	Travel in Morocco	*V. cholerae* O141	
South Carolina	34	M	08/06/2006	Domestic (seafood)-Gulf Coast	*V. cholerae* O75	

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, 2006

Vibrio Species	Patients		Complications[1]				Isolates		Site of Isolation			
			Hospitalized		Deaths							
	N	(%)	n/N	(%)	n/N	(%)	N	(%)	Stool	Blood	Wound	Other[2]
V. alginolyticus	28	(17)	2/24	(8)	0/25	(0)	28	(16)	0	1	14	13
V. cholerae (non-toxigenic)[3]	14	(8)	6/13	(46)	1/11	(9)	14	(8)	7	4	0	3
V. damsela	1	(1)	0/1	(0)	0/1	(0)	1	(1)	1	0	0	0
V. fluvialis	7	(4)	3/7	(43)	0/7	(0)	7	(4)	3	0	2	2
V. hollisae	4	(2)	4/4	(100)	0/4	(0)	4	(2)	4	0	0	0
V. mimicus	7	(4)	4/7	(57)	0/7	(0)	7	(4)	5	1	1	0
V. parahaemolyticus	42	(26)	14/37	(38)	1/39	(3)	42	(24)	22	3	15	2
V. vulnificus	53	(32)	43/49	(88)	15/45	(33)	58	(33)	6	37	13	2
Species not identified	2	(1)	0/2	(0)	0/2	(0)	2	(1)	0	0	1	1
Other	1	(1)	0/0	(0)	0/0	(0)	1	(1)	0	0	0	1
Multiple species[4]	5	(3)	4/5	(80)	0/4	(0)	12	(7)	3	0	9	0
Total	**164**	**(100)**	**80/149**	**(54)**	**17/145**	**(12)**	**176**	**(100)**	**50**	**46**	**56**	**24**

[1] Denominators indicate patients for whom information is known.
[2] Includes ear, sputum, urine, and other.
[3] Includes non-toxigenic *V. cholerae* O1 (1 isolate) and other non-toxigenic *V. cholerae* [non-O1 non-O139] (13 isolates).
[4] *V. parahaemolyticus* and *V. alginolyticus* were isolated from two patients; *V. parahaemolyticus, V. vulnificus*, and an other *Vibrio* species were isolated from one patient; *V. alginolyticus* and an unidentified *Vibrio* species were isolated from one patient; and *V. hollisae* 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, 2006

Vibrio Species	Patients		Complications[1]				Isolates		Site of Isolation			
			Hospitalized		Deaths							
	N	(%)	n/N	(%)	n/N	(%)	N	(%)	Stool	Blood	Wound	Other[2]
V. alginolyticus	54	(10)	11/49	(22)	1/49	(2)	54	(10)	0	3	25	26
V. cholerae (non-toxigenic)[3]	29	(5)	11/27	(41)	2/24	(8)	30	(5)	15	5	4	6
V. damsela	1	(0)	0/1	(0)	0/1	(0)	1	(0)	0	0	1	0
V. fluvialis	23	(4)	9/21	(43)	0/22	(0)	23	(4)	17	1	3	2
V. metschnikovii	1	(0)	1/1	(100)	0/0	(0)	1	(0)	1	0	0	0
V. hollisae	4	(1)	4/4	(100)	0/4	(0)	4	(1)	4	0	0	0
V. mimicus	5	(1)	1/5	(20)	0/5	(0)	5	(1)	4	0	0	1
V. parahaemolyticus	361	(65)	52/336	(15)	0/329	(0)	362	(64)	337	3	12	10
V. vulnificus	46	(8)	36/44	(82)	16/43	(37)	50	(9)	3	27	18	2
Species not identified	20	(4)	7/19	(37)	0/17	(0)	20	(3)	6	1	6	7
Other	3	(1)	1/3	(33)	0/3	(0)	3	(1)	2	0	1	0
Multiple species[4]	7	(1)	2/6	(33)	0/7	(0)	15	(3)	7	3	2	3
Total	**554**	**(100)**	**135/516**	**(26)**	**19/504**	**(4)**	**568**	**(100)**	**396**	**43**	**72**	**57**

[1] Denominators indicate patients for whom information is known.
[2] Includes ear, sputum, urine, and other.
[3] Includes non-toxigenic *V. cholerae* O1 (1 isolate), and other non-toxigenic *V. cholerae* [non-O1 non-O139] (28 isolates).
[4] *V. parahaemolyticus* and *V. vulnificus* were isolated from two patients; *V. alginolyticus* and an other *Vibrio* species were isolated from one patient; *V. cholerae* non-O1, non-O139, *V. cholerae* O1, and *V.cholerae* O139 were isolated from one patient; *V. alginolyticus* and *V. parahaemolyticus* were isolated from one patient; *V. fluvialis* and an other *Vibrio* species were isolated from one patient; and *V. fluvialis* and *V. parahaemolyticus* were isolated from one patient.

Figure 6-1. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*), by state, 2006 (N=718 patients in 39 states)

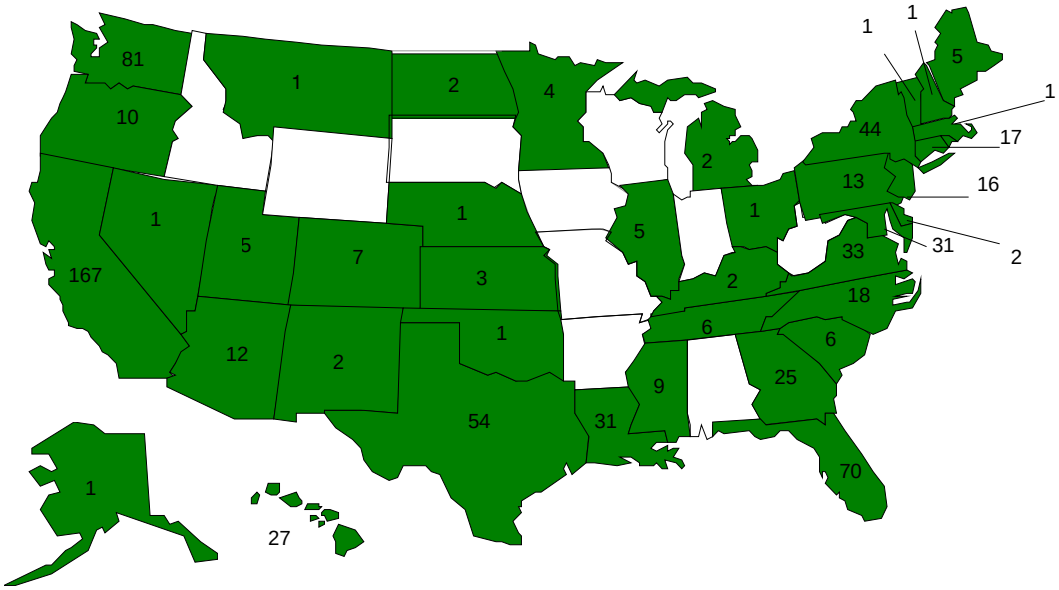


Figure 6-2. Number of patients with *Vibrio* isolates (excluding toxigenic *V. cholerae*), by month of illness onset or specimen isolation, Gulf Coast states vs. other states, 2006 (N=718).

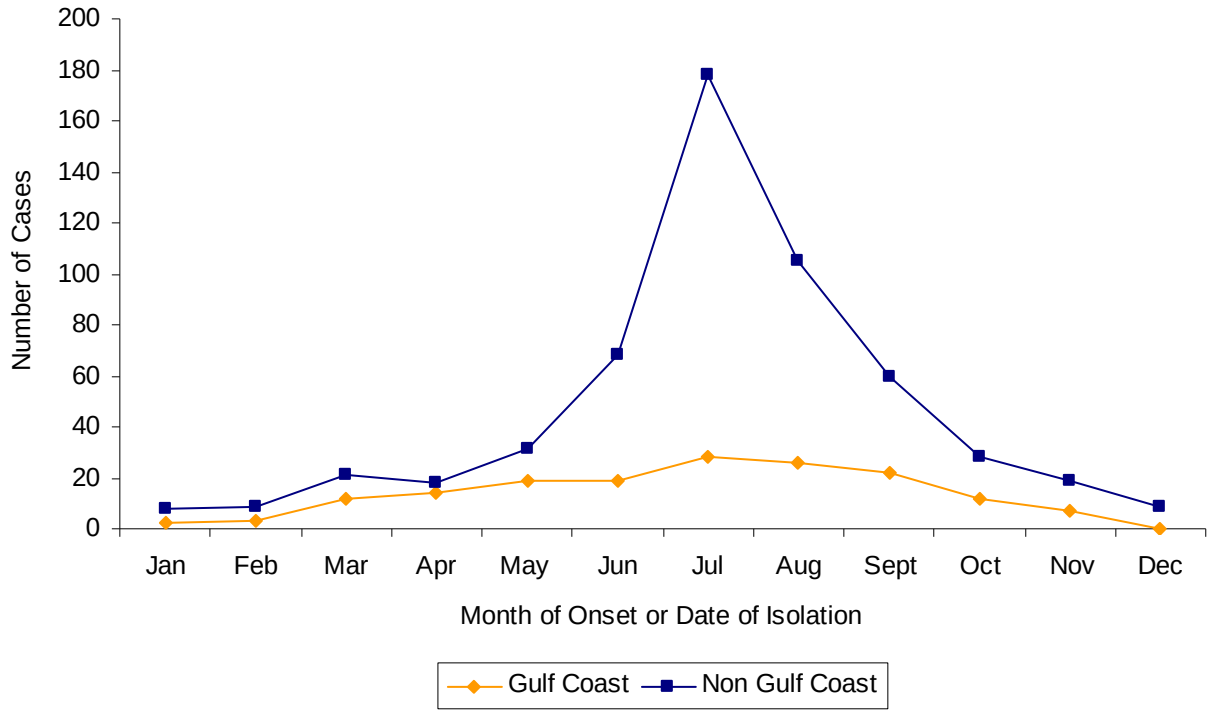


Table 6-4. Seafood exposure among patients with foodborne *Vibrio* infection (excluding toxigenic *V. cholerae*) who reported eating a single seafood item in the week before illness onset, 2006 (N=208)

	Mollusks			Crustaceans				Other Shellfish[1]	Finfish[2]	Total
	Oysters	Clams	Mussels	Shrimp	Lobster	Crab	Crayfish			
Ate (%)	138 (60)	14 (6)	2 (1)	24 (10)	3 (1%)	20 (9%)	0 (0%)	4 (2%)	26 (11%)	231
% Ate raw	79	64	50	13	0	0	0	25	11	55

[1] Other shellfish reported: prawns, squid, and sushi.
[2] Finfish reported: catfish, halibut, pomano, salmon, sushi, tilapia, and tuna

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 2006, 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.

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, BSO	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	Ryan Fagan	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, 2006

Beatty ME, Adcock PM, Smith SW, Quinlan K, Kamimoto LA, Rowe SY, Scott K, Conover C, Varchmin T, Bopp CA, Greene KD, Bibb B, Slutsker L, Mintz ED. Epidemic diarrhea due to enterotoxigenic *Escherichia coli*. Clinical Infectious Diseases; 42 (3): 329-34, 2006.

Bowen A, Fry A, Richards G, Beuchat L. Infections associated with cantaloupe consumption: a public health concern. Epidemiology and Infection; 134 (4): 675-85, 2006.

Bowen AB, Braden CR. Invasive *Enterobacter sakazakii* disease in infants. Emerging Infectious Diseases; 12 (8): 1185-9, 2006.

Braden CR. *Salmonella enterica* serotype Enteritidis and eggs: a national epidemic in the United States. Clinical Infectious Diseases; 43 (4): 512-7, 2006.

Brooks JT, Ochieng JB, Kumar L, Okoth G, Shapiro RL, Wells JG, Bird M, Bopp C, Chege W, Beatty ME, Chiller T, Vulule JM, Mintz E, Slutsker L. Surveillance for bacterial diarrhea and antimicrobial resistance in rural western Kenya, 1997-2003. Clinical Infectious Diseases; 43 (4): 393-401, 2006.

CDC. Botulism associated with commercial carrot juice--Georgia and Florida, September 2006. Morbidity and Mortality Weekly Report; 55 (40): 1098-9, 2006.

CDC. Botulism from home-canned bamboo shoots--Nan Province, Thailand, March 2006. Morbidity and Mortality Weekly Report; 55 (14): 389-92, 2006.

CDC. Human salmonellosis associated with animal-derived pet treats--United States and Canada, 2005. Morbidity and Mortality Weekly Report; 55 (25): 702-5, 2006.

CDC. Importance of culture confirmation of shiga toxin-producing *Escherichia coli* infection as illustrated by outbreaks of gastroenteritis--New York and North Carolina, 2005. Morbidity and Mortality Weekly Report; 55 (38): 1042-5, 2006.

CDC. Multiple outbreaks of gastrointestinal illness among school children associated with consumption of flour tortillas--Massachusetts, 2003-2004. Morbidity and Mortality Weekly Report; 55 (1): 8-11, 2006.

CDC. Multistate outbreak of *Salmonella* Typhimurium infections associated with eating ground beef--United States, 2004. Morbidity and Mortality Weekly Report; 55 (7): 180-2, 2006.

CDC. Ongoing multistate outbreak of *Escherichia coli* serotype O157:H7 infections associated with consumption of fresh spinach--United States, September 2006. Morbidity and Mortality Weekly Report; 55 (38): 1045-6, 2006.

CDC. Two cases of toxigenic *Vibrio cholerae* O1 infection after Hurricanes Katrina and Rita--Louisiana, October 2005. Morbidity and Mortality Weekly Report; 55 (2): 31-2, 2006.

CDC. *Vibrio parahaemolyticus* infections associated with consumption of raw shellfish--three states, 2006. Morbidity and Mortality Weekly Report; 55 (31): 854-6, 2006.

Chertow DS, Tan ET, Maslanka SE, Schulte J, Bresnitz EA, Weisman RS, Bernstein J, Marcus SM, Kumar S, Malecki J, Sobel J, Braden CR. Botulism in 4 adults following cosmetic injections with an unlicensed, highly concentrated botulinum preparation. Journal of the American Medical Association; 296 (20): 2476-9, 2006.

Chiller TM, Mendoza CE, Lopez MB, Alvarez M, Hoekstra RM, Keswick BH, Luby SP. Reducing diarrhoea in Guatemalan children: randomized controlled trial of flocculant-disinfectant for drinking-water. Bulletin of the World Health Organization; 84 (1): 28-35, 2006.

Chittick P, Sulka A, Tauxe RV, Fry AM. A summary of national reports of foodborne outbreaks of *Salmonella* Heidelberg infections in the United States: clues for disease prevention. Journal of Food Protection; 69 (5): 1150-3, 2006.

Collignon P, Angulo FJ. Fluroquinolone-resistant *Escherichia coli*: Food for thought. Journal of Infectious Diseases; 194: 8 – 10, 2006.

Cramer EH, Blanton CJ, Blanton LH, Vaughan GH, Jr., Bopp CA, Forney DL. Epidemiology of gastroenteritis on cruise ships, 2001-2004. American journal of Preventive Medicine; 30 (3): 252-7, 2006.

Dechet AM, Scallan E, Gensheimer K, Hoekstra R, Gunderman-King J, Lockett J, Wrigley D, Chege W, Sobel J. Outbreak of multidrug-resistant *Salmonella enterica* serotype Typhimurium Definitive Type 104 infection linked to commercial ground beef, northeastern United States, 2003-2004. Clinincal Infectious Diseases; 42 (6): 747-52, 2006.

Devasia RA, Jones TF, Ward J, Stafford L, Hardin H, Bopp C, Beatty M, Mintz E, Schaffner W. Endemically acquired foodborne outbreak of enterotoxin-producing *Escherichia coli* serotype O169:H41. The American Journal of Medicine; 119 (2): 168 e7-10, 2006.

Donabedian SM, Perri MB, Vager D, Hershberger E, Malani P, Simjee S, Chow J, Vergis EN, Muder RR, Gay K, Angulo FJ, Bartlett P, Zervos MJ. Quinupristin-dalfopristin resistance in *Enterococcus faecium* isolates from humans, farm animals, and grocery store meat in the United States. Journal of Clinincal Microbiology; 44 (9): 3361-5, 2006.

DuBois AE, Sinkala M, Kalluri P, Makasa-Chikoya M, Quick RE. Epidemic cholera in urban Zambia: hand soap and dried fish as protective factors. Epidemiology and Infection; 134 (6): 1226-30, 2006.

Galanis E, Lo Fo Wong DM, Patrick ME, Binsztein N, Cieslik A, Chalermchikit T, Aidara-Kane A, Ellis A, Angulo FJ, Wegener HC. Web-based surveillance and global *Salmonella distribution*, 2000-2002. Emerging Infectious Diseases; 12 (3): 381-8, 2006.

Gay K, Robicsek A, Strahilevitz J, Park CH, Jacoby G, Barrett TJ, Medalla F, Chiller TM, Hooper DC. Plasmid-mediated quinolone resistance in non-Typhi serotypes of *Salmonella*

enterica. Clinical Infectious Diseases; 43 (3): 297-304, 2006.

Gottlieb SL, Newbern EC, Griffin PM, Graves LM, Hoekstra RM, Baker NL, Hunter SB, Holt KG, Ramsey F, Head M, Levine P, Johnson G, Schoonmaker-Bopp D, Reddy V, Kornstein L, Gerwel M, Nsubuga J, Edwards L, Stonecipher S, Hurd S, Austin D, Jefferson MA, Young SD, Hise K, Chernak ED, Sobel J. Multistate outbreak of listeriosis linked to turkey deli meat and subsequent changes in US regulatory policy. Clinical Infectious Diseases; 42 (1): 29-36, 2006.

Gupta A, My Thanh NT, Olsen SJ, Sivapalasingam S, My Trinh TT, Phuong Lan NT, Hoekstra RM, Bibb W, Minh NT, Danh TP, Cam PD, Mintz ED. Evaluation of community-based serologic screening for identification of chronic *Salmonella* Typhi carriers in Vietnam. The International Journal of Infectious Diseases; 10 (4): 309-14, 2006.

Jones TF, Angulo FJ. Eating in restaurants: a risk factor for foodborne disease. Clinical Infectious Diseases; 43 (10): 1324-8, 2006.

Jones TF, Ingram LA, Fullerton KE, Marcus R, Anderson BJ, McCarthy PV, Vugia D, Shiferaw B, Haubert N, Wedel S, Angulo FJ. A case-control study of the epidemiology of sporadic *Salmonella* infection in infants. Pediatrics; 118 (6): 2380-7, 2006.

Kalluri P, Naheed A, Rahman S, Ansaruzzaman M, Faruque AS, Bird M, Khatun F, Bhuiyan NA, Nato F, Fournier JM, Bopp C, Breiman RF, Nair GB, Mintz ED. Evaluation of three rapid diagnostic tests for cholera: does the skill level of the technician matter? Tropical Medicine and International Health; 11 (1): 49-55, 2006.

Kimura AC, Mead P, Walsh B, Alfano E, Gray SK, Durso L, Humphrey C, Monroe SS, Visvesvera G, Puhr N, Shieh WJ, Eberhard M, Hoekstra RM, Mintz ED. A large outbreak of Brainerd diarrhea associated with a restaurant in the Red River Valley, Texas. Clinical Infectious Diseases; 43 (1): 55-61, 2006.

Mai V, Braden CR, Heckendorf J, Pironis B, Hirshon JM. Monitoring of stool microbiota in subjects with diarrhea indicates distortions in composition;. Journal of Clinical Microbiology. 44 (12): 4550-2, 2006.

Mead PS, Dunne EF, Graves L, Wiedmann M, Patrick M, Hunter S, Salehi E, Mostashari F, Craig A, Mshar P, Bannerman T, Sauders BD, Hayes P, Dewitt W, Sparling P, Griffin P, Morse D, Slutsker L, Swaminathan B. Nationwide outbreak of listeriosis due to contaminated meat. Epidemiology and Infection; 134 (4): 744-51, 2006.

Milstone AM, Agwu AG, Angulo FJ. Alerting pregnant women to the risk of reptile-associated salmonellosis. Obstetrics and Gynecology; 107 (2 Pt 2): 516-8, 2006.

Mintz ED. Enterotoxigenic *Escherichia coli*: outbreak surveillance and molecular testing. Clinical Infectious Diseases; 42 (11): 1518-20, 2006.

Nataro JP, Mai V, Johnson J, Blackwelder WC, Heimer R, Tirrell S, Edberg SC, Braden CR, Glenn Morris J, Jr., Hirshon JM. Diarrheagenic Escherichia coli infection in Baltimore,

Maryland, and New Haven, Connecticut. Clinical Infectious Diseases; 43 (4): 402-7, 2006.

Nsubuga P. WM, Thacker SB, Anderson MA, Blount SB, Broome CV, Chiller TM, Espitia V, Imtiaz R, Sosin D, Stroup DF, Tauxe RV, Vijayarghayan M, Trostle M. Public health surveillance: a tool for targeting and monitoring interventions. Disease control priorities in developing countries 2006; 997-1015, 2006.

Nunnery J, Angulo FJ, Tollefson L. Public health and policy. Preventive Veterinary Medicine; 73 (2-3): 191-5, 2006.

Parker AA, Stephenson R, Riley PL, Ombeki S, Komolleh C, Sibley L, Quick R. Sustained high levels of stored drinking water treatment and retention of hand-washing knowledge in rural Kenyan households following a clinic-based intervention. Epidemiology and Infection; 134 (5): 1029-36, 2006.

Qin X, Razia Y, Johnson JR, Stapp JR, Boster DR, Tsosie T, Smith DL, Braden CR, Gay K, Angulo FJ, Tarr PI. Ciprofloxacin-resistant gram-negative bacilli in the fecal microflora of children. Antimicrobial Agents and Chemotherapy;
50 (10): 3325-9, 2006.

Reller ME, Douce RW, Maslanka SE, Torres DS, Manock SR, Sobel J. Wound botulism acquired in the Amazonian rain forest of Ecuador. The American Journal of Tropical Medicine and Hygiene; 74 (4): 628-31, 2006.

Reller ME, Nelson JM, Molbak K, Ackman DM, Schoonmaker-Bopp DJ, Root TP, Mintz ED. A large, multiple-restaurant outbreak of infection with *Shigella flexneri* serotype 2a traced to tomatoes. Clinical Infectious Diseases; 42 (2): 163-9, 2006.

Rivas M, Miliwebsky E, Chinen I, Roldan CD, Balbi L, Garcia B, Fiorilli G, Sosa-Estani S, Kincaid J, Rangel J, Griffin PM. Characterization and epidemiologic subtyping of Shiga toxin-producing *Escherichia coli* strains isolated from hemolytic uremic syndrome and diarrhea cases in Argentina. Foodborne Pathogens and Disease; 3 (1): 88-96, 2006.

Scallan E, Jones TF, Cronquist A, Thomas S, Frenzen P, Hoefer D, Medus C, Angulo FJ. Factors associated with seeking medical care and submitting a stool sample in estimating the burden of foodborne illness. Foodborne Pathogens and Disease; 3 (4): 432-8, 2006.

Sivapalasingam S, Nelson JM, Joyce K, Hoekstra M, Angulo FJ, Mintz ED. High prevalence of antimicrobial resistance among *Shigella* isolates in the United States tested by the National Antimicrobial Resistance Monitoring System from 1999 to 2002. Antimicrobial Agents and Chemotherapy; 50 (1): 49-54, 2006.

Srikantiah P, Girgis FY, Luby SP, Jennings G, Wasfy MO, Crump JA, Hoekstra RM, Anwer M, Mahoney FJ. Population-based surveillance of typhoid fever in Egypt. The American Journal of Tropical Medicine and Hygiene; 74 (1): 114-9, 2006.

Steinberg EB, Henderson A, Karpati A, Hoekstra M, Marano N, Souza JM, Simons M, Kruger K, Giroux J, Rogers HS, Hoffman MK, Kadry AR, Griffin PM. Mysterious outbreaks of gastrointestinal illness associated with burritos supplied through school lunch programs. Journal of Food Protection; 69 (7): 1690-8, 2006.

Steinmuller N, Demma L, Bender JB, Eidson M, Angulo FJ. Outbreaks of enteric disease associated with animal contact: not just a foodborne problem anymore. Clinical Infectious Diseases; 43 (12): 1596-602, 2006.

Tauxe RV. The burden of illnes associated with foodborne threats to health and the challenge of prevention. Investigating Foodborne Threats, Washington DC: National Academics, 2006; 72 - 85, 2006.

Tauxe RV. Molecular subtyping and the transformation of public health. Foodborne Pathogens and Disease; 3 (1): 4-8, 2006.

Varma JK, Marcus R, Stenzel SA, Hanna SS, Gettner S, Anderson BJ, Hayes T, Shiferaw B, Crume TL, Joyce K, Fullerton KE, Voetsch AC, Angulo FJ. Highly resistant *Salmonella* Newport-MDRAmpC transmitted through the domestic US food supply: a FoodNet case-control study of sporadic Salmonella Newport infections, 2002-2003. The Journal of Infectious Diseases; 194 (2): 222-30, 2006.

Vij V, Ailes E, Wolyniak C, Angulo FJ, Klontz KC. Recalls of spices due to bacterial contamination monitored by the U.S. Food and Drug Administration: the predominance of Salmonellae. Journal of Food Protection; 69 (1): 233-7, 2006.

Vugia DJ, Abbott S, Mintz ED, Richmond J, Meshulam S, Stokes K, Lindsay A, Tsang TH. A restaurant-associated outbreak of Brainerd diarrhea in California. Clinical Infectious Diseases; 43 (1): 62-4, 2006.

Zhao S, McDermott PF, Friedman S, Abbott J, Ayers S, Glenn A, Hall-Robinson E, Hubert SK, Harbottle H, Walker RD, Chiller TM, White DG. Antimicrobial resistance and genetic relatedness among *Salmonella* from retail foods of animal origin: NARMS retail meat surveillance. Foodborne Pathogens and Disease;3 (1): 106-17, 2006.

CDC Internet sites relevant to Bacterial Enteric 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/nczved/dfbmd/

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

Enteric Diseases Epidemiology Branch
http://www.cdc.gov/ /enterics/

Enteric Diseases Epidemiology Branch, National Surveillance Team
http://www.cdc.gov/ /nationalsurveillance/

Enteric Diseases Epidemiology Branch, OutbreakNet 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 Zoonotic, Vector-borne and Enteric Diseases
http://www.cdc.gov/nczved/

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/nczved/dfbmd/disease_listing/files/botulism.pdf
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.

Voetsch AC, Angulo FJ, Jones TF, Moore MR, Nadon C, McCarthy P, Shiferaw B, Megginson MB, Hurd S, Anderson BJ, Cronquist A, Vugia DJ, Medus C, Graves LM, Hoekstra RM, Griffin PM. Reducion in the incidence of Invasive Listeriosis in Foodborne Diseases Active Surveillance Network Sites, 1996-2003. Clin Infect Dis 2007;44:513-20.

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)

CDC. *Vibrio parahaemolyticus* Infections Associated with Consumption of Raw Shellfish – Three States, 2006. MMWR 2006 ;55 :854-856.

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.

Dechet A, Yu PA, Koram N, Painter J. Nonfoodborne *Vibrio* Infections: An Important Cause of

Morbidity and Mortality in the United States, 1997-2006. Clin Infect Dis 2008;46:970-6.

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