Table of Contents

Part I. Narrative Report

Part II. Summary Tables and Figures

Part I

Narrative Report

Executive Summary

The Foodborne Diseases Active Surveillance Network (FoodNet) is the principal foodborne disease component of the Centers for Disease Control and Prevention's (CDC's) Emerging Infections Program (EIP). FoodNet is a collaborative project among CDC, state health departments in EIP sites, the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA), and the Center for Food Safety and Applied Nutrition of the United States Food and Drug Administration (FDA). FoodNet is a sentinel network that is producing more stable and accurate national estimates of the burden and sources of specific foodborne diseases in the United States through active surveillance and additional studies. Enhanced surveillance and investigation are integral parts of developing and evaluating new prevention and control strategies that can improve the safety of our food and the public's health.

Between 1996 and 2003 there was a substantial decline in the incidence of infections caused by *E. coli* O157. There has also been a sustained decline in the incidence of infections caused by *Yersinia*, *Campylobacter*, and *Salmonella* Typhimurium from 1996 to 2003. These declines indicate important progress toward achieving the U.S. Department of Health and Human Services Healthy People 2010 objectives of reducing the incidence of several foodborne diseases by the end of the decade.

The declines in the incidence of these infections are unlikely to be due to surveillance artifacts. FoodNet conducts several studies to monitor surveillance factors that can influence the incidence of laboratory-diagnosed foodborne diseases. These factors include the frequency with which persons with gastrointestinal symptoms seek medical care, the frequency with which diagnostic stool specimens are submitted to clinical laboratories, and the frequency with which the laboratories routinely test stool specimens for various pathogens. We are unaware of any changes in these factors that might explain the magnitude of the declines observed in the reported infections.

Food animals are a major source of *E. coli* O157, *Yersinia*, *Campylobacter*, and *Salmonella*. One contributing factor to the decline in foodborne infections caused by these pathogens is likely to be a change in the industry and regulatory approach to meat and poultry safety. Beginning in 1997, the USDA-FSIS began implementing the Pathogen Reduction/Hazard Analysis Critical Control Point (PR/HACCP) systems regulations in the meat and poultry slaughter and processing plants. The decline in the incidence of *Salmonella* Typhimurium infections in humans may be related to changes in meat processing as evidenced by a decline in the prevalence of *Salmonella* isolated from FSIS-regulated meat and poultry products reported by USDA.

However, although Typhimurium is the most common serotype causing human infections, the overall incidence of human *Salmonella* infections has not had a sustained decline, which may be related to the multifaceted sources of human *Salmonella* infections. Furthermore, substantial declines have not occurred in the incidence of infection caused by other major *Salmonella* serotypes, including Enteritidis, Newport, and Heidelberg. The incidence of *S.* Javiana infections increased markedly.

The decline in *E. coli* O157 infections in humans in 2003 occurred in the context of enhanced food safety intervention efforts. Following an October 2002 FSIS notice to manufacturers of raw ground beef products that they must reassess their HACCP plans regarding this pathogen, many beef processing plants began testing of ground beef and did not distribute production lots of ground beef unless such tests were negative for *E. coli* O157. Contemporaneously, FSIS reported declines in the frequency of *E.* coli O157:H7 contamination of ground beef for 2003.

The incidence of foodborne diseases remains high despite the important declines in the incidence for several foodborne diseases. The high incidence of foodborne diseases in infants and young children is a major concern. Additional measures are needed to further reduce the incidence of these diseases, and are particularly needed for *Salmonella* and *Vibrio* to achieve the Healthy People 2010 objectives, and to protect the public health. Efforts to reduce the incidence of foodborne diseases should include steps to reduce the prevalence of these pathogens in their respective important animal reservoirs; e.g., cattle (*Escherichia coli* O157), egg-laying chickens (*Salmonella* Enteritidis), and seafood, particularly oysters (*Vibrio*). Implementation of nationwide, consistent on-farm preventive controls for example, would reduce the risk of human illness from *Salmonella* Enteritidis-contaminated eggs.

Background

Foodborne infections are an important public health challenge. The Centers for Disease Control and Prevention (CDC) has estimated that in 1997, foodborne infections caused 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths. CDC, the Emerging Infections Program (EIP) sites, the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA), and the United States Food and Drug Administration (FDA) are actively involved in preventing foodborne diseases. In 1997, the interagency national Food Safety Initiative was established to meet the public health challenge of foodborne diseases. CDC's principal role in the Food Safety Initiative has been to enhance surveillance and investigation of infections that are usually foodborne. FoodNet has been instrumental in accomplishing this mission.

Objectives

The objectives of FoodNet are to determine the frequency and severity of foodborne diseases; monitor trends in foodborne diseases over time; and determine the association of common foodborne diseases with eating specific foods. To address these objectives, FoodNet uses active surveillance and conducts related epidemiologic studies. By monitoring the burden of foodborne diseases over time and attributing foodborne disease to sources, FoodNet can document the effectiveness of new food safety initiatives, such as the USDA Hazard Analysis and Critical Control Points (HACCP) system, in decreasing the burden of foodborne diseases in the United States.

Surveillance of Laboratory-Confirmed Infections

Methods

In 2003, FoodNet conducted population-based active surveillance for clinical laboratory isolations of *Campylobacter*, *Cryptosporidium*, *Cyclospora*, Shiga toxin-producing *E. coli* (STEC) including *E. coli* O157, *Listeria*, *Salmonella*, *Shigella*, *Vibrio*, and *Yersinia* infections in Connecticut, Georgia, Maryland, Minnesota, Oregon, and Tennessee, and selected counties in California, Colorado, and New York (total population 41.9 million). A case was defined as isolation (for bacteria) or identification (for parasites) of an organism from a clinical specimen. For simplicity, in this report all isolations are referred to as infections, although not all strains of all pathogens have been proven to cause illness in each case. To identify cases, FoodNet personnel contacted each of the more than 650 clinical laboratories serving the catchment areas either weekly or monthly, depending on the size of the clinical laboratory.

Cases reported in 2003

In 2003, a total of 15,774 laboratory-confirmed infections caused by the pathogens under surveillance were identified in nine sites. Of these, 15,278 were bacterial, including 6,040 *Salmonella* infections, 5,273 *Campylobacter* infections, 3,041 *Shigella* infections, 444 *E. coli* O157 infections, 162 *Yersinia* infections, 139 *Listeria* infections, 110 *Vibrio* infections, 47 non-O157 STEC infections, and 22 STEC O antigen undetermined infections

(Table 1A). Of the 5,615 *Salmonella* isolates that were serotyped, the most commonly identified serotypes were Typhimurium (1,115 cases), Enteritidis (761), Newport (668), and Heidelberg (349). In addition, 496 cases of parasitic diseases were reported, including 481 cases of *Cryptosporidium* infection and 15 cases of *Cyclospora* infection (Table 1B).

Table 1A. Infections caused by specific bacterial pathogens, reported by FoodNet sites, 2003

Pathogen	CA	CO	CT	GA	MD	MN	NY	OR	TN	Total
Campylobacter	**871**	**371**	**543**	**622**	**423**	**937**	**472**	**578**	**456**	**5273**
***Escherichia coli* O157**	**29**	**37**	**37**	**23**	**16**	**133**	**49**	**86**	**34**	**444**
STEC, non-O157	**0**	**2**	**25**	**2**	**0**	**12**	**1**	**3**	**2**	**47**
STEC, O Ant Undet*	**0**	**0**	**1**	**4**	**4**	**10**	**3**	**0**	**0**	**22**
Listeria	**17**	**6**	**22**	**33**	**28**	**6**	**11**	**5**	**11**	**139**
Salmonella	**474**	**249**	**401**	**2013**	**798**	**579**	**395**	**378**	**753**	**6040**
Shigella	**277**	**235**	**70**	**1146**	**467**	**103**	**238**	**104**	**401**	**3041**
Vibrio	**20**	**1**	**11**	**28**	**23**	**4**	**7**	**6**	**10**	**110**
Yersinia	**19**	**5**	**16**	**49**	**12**	**12**	**15**	**5**	**29**	**162**
Total	**1707**	**906**	**1126**	**3920**	**1771**	**1796**	**1191**	**1165**	**1696**	**15278**

*STEC (O Antigen Undetermined)

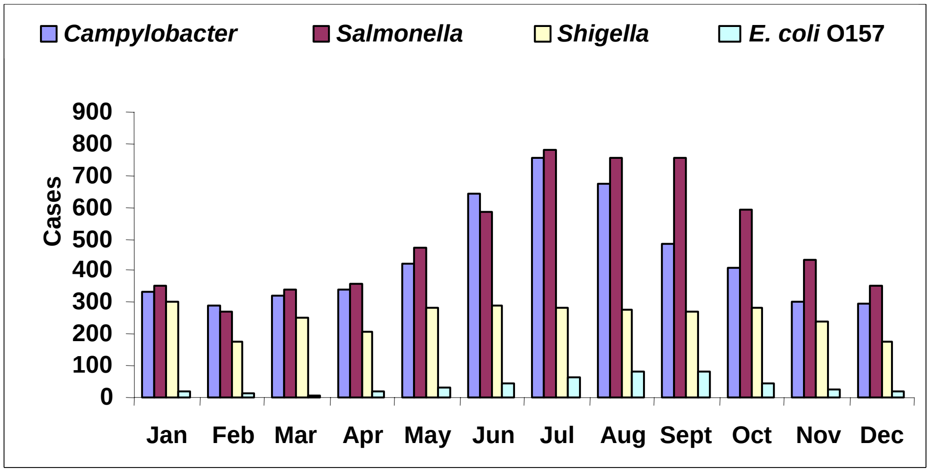
Table 1B. Infections caused by specific parasitic pathogens, reported by FoodNet sites, 2003

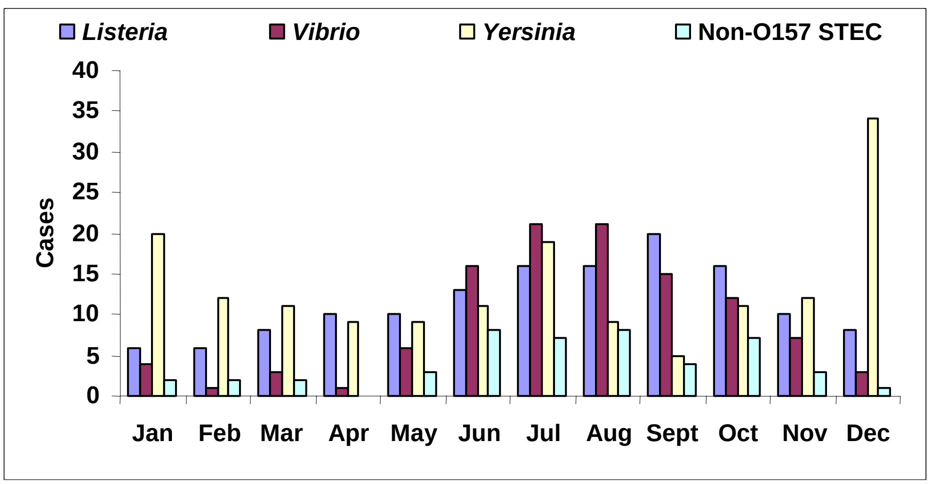
Pathogen	CA	CO	CT	GA	MD	MN	NY	OR	TN	Total
Cryptosporidium	**31**	**11**	**20**	**120**	**19**	**155**	**48**	**35**	**42**	**481**
Cyclospora	**0**	**0**	**4**	**8**	**2**	**0**	**1**	**0**	**0**	**15**
Total	**31**	**11**	**24**	**128**	**21**	**155**	**49**	**35**	**42**	**496**

Seasonality in 2003

Laboratory-confirmed infections showed seasonal variation: 53% of *Vibrio*, 49% of non-O157 STEC, 44% of *E. coli* O157, 35% of *Salmonella*, 39% of *Campylobacter*, and 28% of *Shigella* were isolated between June and August (Figure 1). *Yersinia* infections were most common in winter months, with 41% of cases being reported during January, February, or December (Figure 1).

Figure 1. Cases of foodborne disease caused by specific pathogens, by month, FoodNet sites, 2003

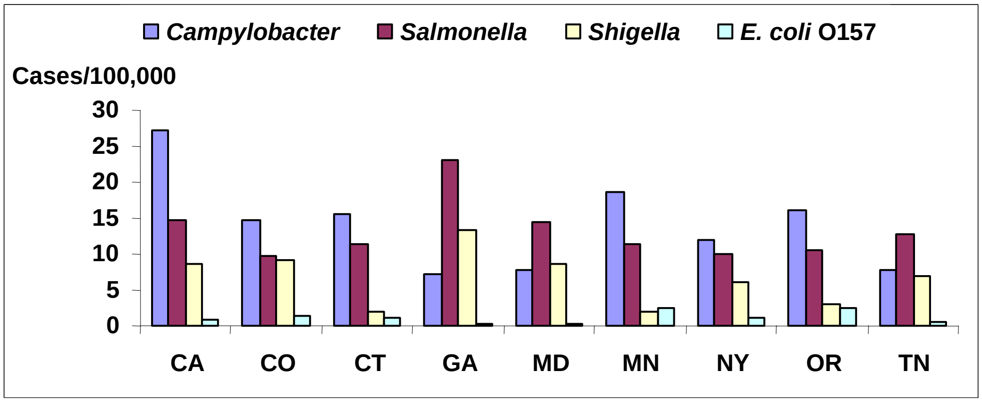


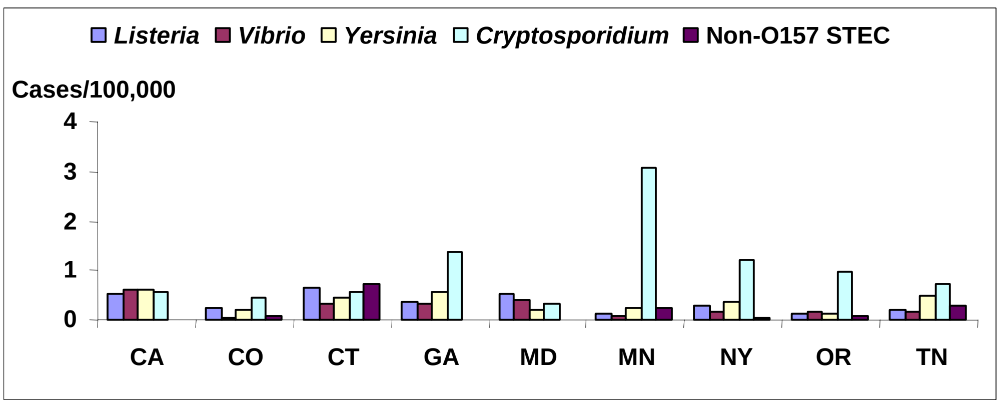


Incidence in 2003

To compare the number of laboratory-confirmed cases among sites with different populations, incidence was calculated (incidence is the number of laboratory-confirmed cases divided by the population). The 2003 incidence reported here was calculated with 2003 census population counts. Incidence was highest for infections with *Salmonella* (14.4/100,000 population), *Campylobacter* (12.6/100,000), and *Shigella* (7.3/100,000). Lower incidence was reported for *Cryptosporidium* (1.09/100,000), *E. coli* O157 (1.06/100,000), *Yersinia* (0.39/100,000), *Listeria* (0.33/100,000), *Vibrio* (0.26/100,000), *Cyclospora* (0.03/100,000), and non-O157 STEC (0.11/100,000). The 2003 incidence of foodborne diseases caused by specific pathogen, by FoodNet site in 2003, are shown in Figure 2.

Figure 2. Cases per 100,000 population of foodborne disease caused by specific pathogens, FoodNet sites, 2003

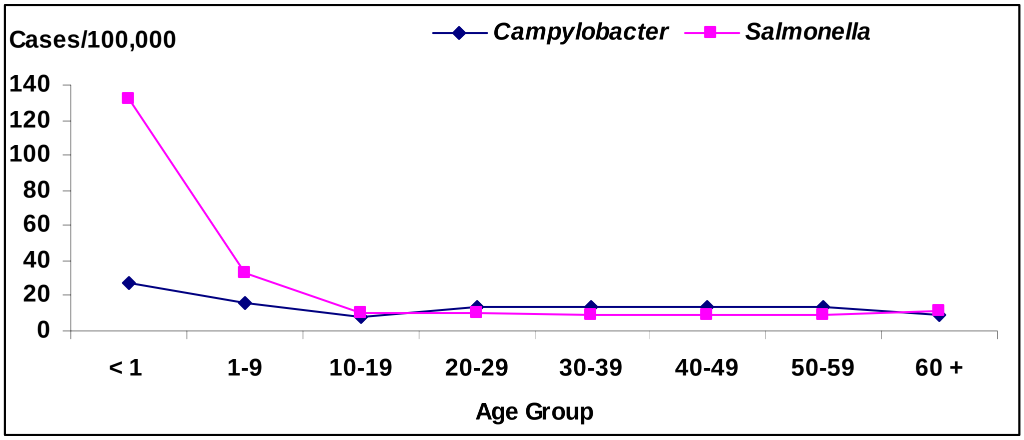




Incidence by age in 2003

The incidence of foodborne illness varied by age in 2003, especially for *Salmonella* and *Campylobacter* infections (Figure 3). For children <1 year of age, the incidence of *Salmonella* infection was 131.9/100,000 and the incidence of *Campylobacter* infection was 27.2/100,000, substantially higher than for other age groups.

Figure 3. Incidence of *Campylobacter* and *Salmonella* infections by age group, FoodNet sites, 2003



Incidence by sex in 2003

The incidence also varied by sex in 2003 (Table 2). Overall, males were more likely than females to be infected with every pathogen except *Cyclospora*, *E. coli* O157, *Listeria,* and *Salmonella.* Among males, the incidence of *Cryptosporidium* infection was 64% higher than females, *Vibrio* was 52% higher, *Campylobacter* infection was 26% higher, *Shigella* was 5% higher, and *Yersinia* was 1% higher.

Table 2. Sex-specific incidence (per 100,000 population), by pathogen, FoodNet sites, 2003

Pathogen	Male	Female
Campylobacter	14.07	11.14
Cryptosporidium	1.43	0.87
Cyclospora	0.03	0.04
***E. coli* O157**	0.99	1.13
Listeria	0.30	0.36
Salmonella	13.77	14.95
Shigella	7.43	7.06
Vibrio	0.32	0.21
Yersinia	0.39	0.39

Hospitalizations in 2003

Whether or not the patient was hospitalized was determined for 94% (14,826) of cases ascertained in FoodNet in 2003. Overall, 22% of persons with laboratory-confirmed infection were hospitalized; hospitalization rates differed markedly by pathogen. The percentage of persons hospitalized was highest for *Listeria* (91% of reported cases), followed by *E. coli* O157 (39%), *Yersinia* (34%), *Vibrio* (30%), *Salmonella* (27%), *Cryptosporidium* (25%), *Shigella* (18%), *Campylobacter* (15%), non-O157 STEC (13%), and *Cyclospora* (7%).

Deaths in 2003

Eighty-three persons with laboratory-confirmed infections in 2003 died; of those, 34 were infected with *Salmonella*, 22 with *Listeria*, nine with *Campylobacter*, seven with *Vibrio*, four with *E. coli* O157, three with *Cryptosporidium*, two with *Shigella*, and two with *Yersinia*. The pathogen with the highest case-fatality rate was *Listeria*; 17% of persons infected with *Listeria* died.

Incidence, 1996-2003

The number of FoodNet sites has almost doubled and the population under surveillance has almost tripled since FoodNet began in 1996 (Table 4). Because of substantial variation in incidence among the sites, adding new sites influences overall incidence. To account for the increased population and variation in the incidence among sites, a log-linear negative binomial regression model was used to estimate the effect of time on the incidence of various pathogens, treating time (calendar year) as a categorical variable, with 1996 as the reference year (Figures 4A to 4D). The relative change in incidence between 1996 and 2003 was estimated and confidence intervals for those changes were calculated (Tables 5A to 5B).

Between 1996 and 2003 (Table 5A), the estimated incidence of *Yersinia* decreased 51% (95% confidence interval [CI]=62% to 35% decrease), *E. coli* O157 decreased 43% (95% CI=59% to 22% decrease), *Campylobacter* decreased 29% (95% CI =36% to 20% decrease), and *Salmonella* decreased 19% (95% CI =28% to 9% decrease). Between 1996 and 2003 (Table 5B), *S*. Typhimurium decreased 39% (95% CI=49% to 27% decrease), *S*. Enteritidis decreased 28% (95% CI=50% decrease to 4% increase), *S*. Heidelberg increased 27% (95% CI= 5% decrease to 68% increase), *S*. Newport increased 12% (95% CI=29% decrease to 78% increase), and *S*. Javiana increased 224% (95% CI=64% to 540% increase) (Table 5B). A substantial decline in the incidence of *S*. Enteritidis infection between 1996 and 1999 was partially reversed by increased incidence in 2000 through 2003. Between 1996 and 2003, the estimated incidence of *Listeria* infections decreased 21% (95% CI=40% decrease to 4% increase).

The incidence of *Shigella* infections showed considerable variation by year and site. The estimated incidence in 2003 was 12% lower than in 1996 (95% CI=50% decrease to 57% increase). The incidence of *Vibrio* infections was 96% higher in 1997 than it was in 1996, reflecting the emergence of *Vibrio parahaemolyticus* O3:K6, and has not shown a consistent change since; the incidence was 113% higher in 2003 than it was in 1996 (95% CI=24% to 267% increase).

Surveillance for the parasitic pathogens *Cryptosporidium* and *Cyclospora* began in 1997. Between 1997 and 2003, the incidence of *Cryptosporidium* infections decreased 52% (95% CI=64% to 36% decrease) (Figure 4D). Although the incidence of *Cyclospora* has decreased since 1997, the statistical model could not be applied to *Cyclospora* because of the rarity of cases (170 cases between 1997 and 2001).

Healthy People 2010 objectives have been established for four pathogens under FoodNet surveillance. In 2003, the incidences of *Campylobacter*, *E. coli* O157, and *Listeria* were approaching their targets of 12.3, 1.0, and 0.25 cases per 100,000 respectively. The incidence of *Salmonella* infections in 2003, however, remained much higher than the goal of 6.8 cases per 100,000 (Table 6).

Table 4. Population under surveillance in FoodNet sites, 1996-2003

Site	1996	1997	1998	1999	2000	2001	2002	2003
California	2,087,032	2,113,195	2,142,806	2,162,359	3,181,686	3,230,038	3,228,717	3,213,848
Colorado	-	-	-	-	-	2,155,324	2,507,484	2,526,245
Connecticut	1,622,809	2,453,483	**3,272,563**	**3,282,031**	**3,411,956**	**3,434,602**	**3,460,503**	**3,483,375**
Georgia	2,720,443	3,632,206	3,744,022	**7,788,240**	**8,234,373**	**8,405,677**	**8,560,310**	**8,684,715**
Maryland	-	-	2,441,279	2,450,566	2,516,889	4,253,665	**5,458,137**	**5,508,909**
Minnesota	**4,647,723**	**4,687,726**	**4,726,411**	**4,775,508**	**4,934,248**	**4,984,535**	**5,019,720**	**5,059,375**
New York	-	-	1,105,062	2,084,453	2,111,143	2,115,056	3,330,456	3,972,809
Oregon	**3,195,087**	**3,243,254**	**3,282,055**	**3,316,154**	**3,431,137**	**3,473,441**	**3,521,515**	**3,559,596**
Tennessee	-	-	-	-	2,825,539	2,848,426	2,874,846	**5,841,748**
TOTAL	14,273,094	16,129,864	20,714,198	25,859,311	30,646,971	34,900,764	37,961,688	41,850,620
FoodNet population as % of U.S. population	5.4	6.0	7.7	9.5	10.9	12.2	13.2	14.4

Bolded indicates active surveillance was conducted statewide, including all counties within a state; otherwise surveillance was conducted in select counties.
"-" Indicates state was not a FoodNet site during indicated year.

Figure 4A. Relative rates of laboratory-diagnosed cases of *Campylobacter, Salmonella,* and *Shigella*, by year, 1996–2003

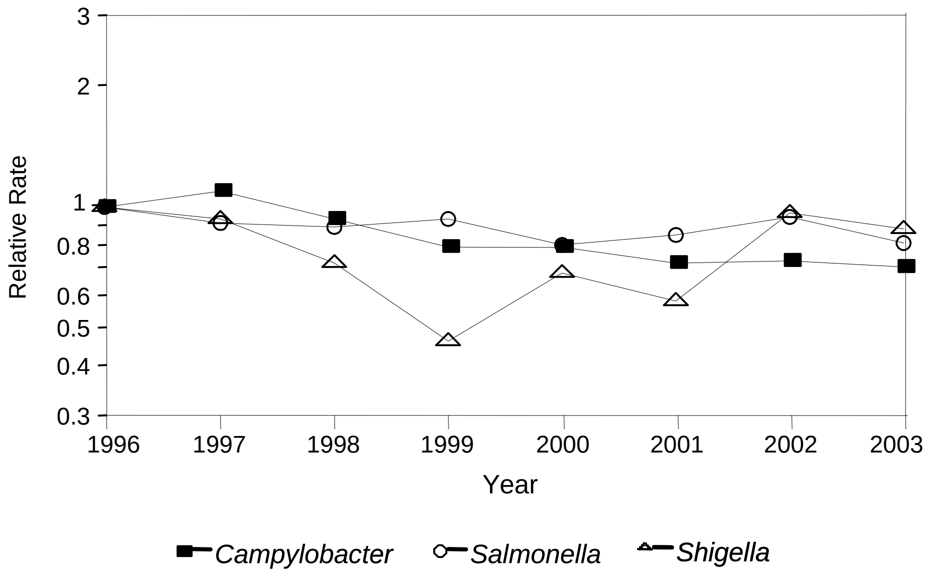


Figure 4B. Relative rates of laboratory-diagnosed cases of *E. coli* O157, *Listeria*, and *Yersinia*, by year, 1996–2003

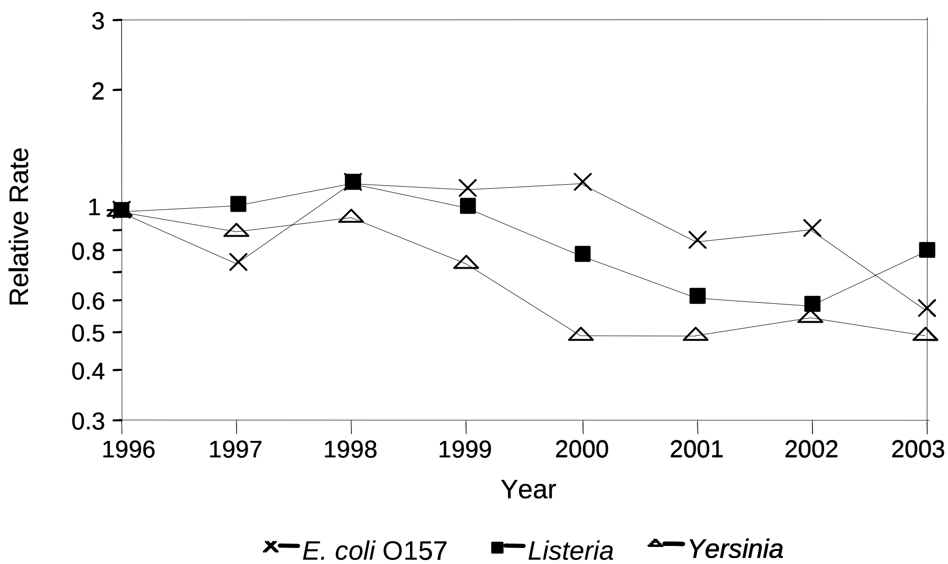


Figure 4C. Relative rates of laboratory-diagnosed cases of *Vibrio*, by year, 1996-2003

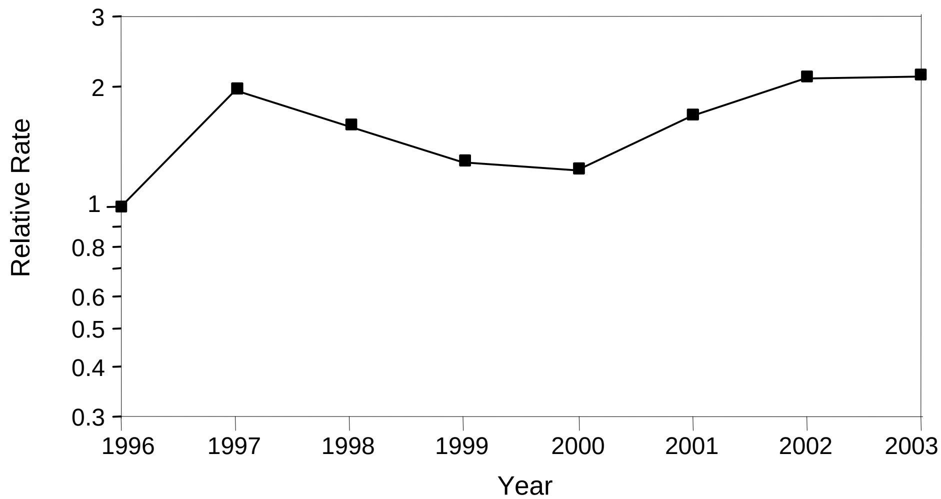


Figure 4D. Relative rates of laboratory-diagnosed cases of *Cryptosporidium*, by year, 1997-2003

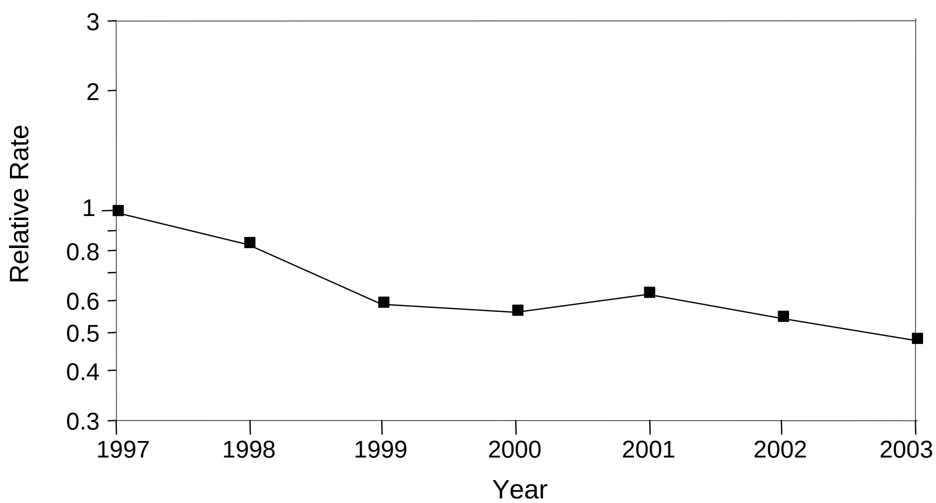


Table 5A. Percent change in incidence* of diagnosed infections for pathogens under surveillance in FoodNet, by pathogen, 1996–2003

Bacterial Pathogen	Percent Change	95% Confidence Interval
Campylobacter	-29	36% to 20% decrease
Escherichia O157	-43	59% to 22% decrease
Listeria	-21	40% decrease to 4% increase
Salmonella	-19	28% to 9% decrease
Shigella	-12	50% decrease to 57% increase
Vibrio	113	24% to 268% increase
Yersinia	-51	62% to 35% decrease

*Cases per 100,000 population

Parasitic Pathogen	Percent Change*	95% Confidence Interval
Cryptosporidium	-52	65% to 35% decrease

*1997–2001

Table 5B. Percent change in incidence* of diagnosed infections for the five most common *Salmonella* serotypes, by serotype, 1996–2003

Pathogen	Percent Change	95% Confidence Interval
Salmonella Typhimurium	-39	49% to 27% decrease
Salmonella Enteritidis	-28	50% decrease to 4% increase
Salmonella Newport	12	29% decrease to 78% increase
Salmonella Heidelberg	27	5% decrease to 68% increase
Salmonella Javiana	224	64% to 540% increase

*Cases per 100,000 population

Table 6. Comparison of 2003 incidence with the Healthy People 2010 objectives

	Incidence*	
Pathogen	**2003 Actual**	**2010 Objective**
Campylobacter	12.60	12.3
Escherichia coli O157	1.06	1.0
Salmonella	14.43	6.8
Listeria	0.33	0.25

*Cases per 100,000 population

Surveillance of Hemolytic Uremic Syndrome

Background

Hemolytic uremic syndrome (HUS) is a life-threatening illness characterized by hemolytic anemia, thrombocytopenia, and acute renal failure. Most cases of HUS in the United States are preceded by diarrhea caused by infection with STEC. *E. coli* O157 is the most easily and frequently isolated STEC, but other serotypes of *E. coli* can also cause HUS.

Methods

Active surveillance for pediatric HUS cases was established in 1997 in five FoodNet sites (Minnesota, Oregon and select counties in California, Connecticut and Georgia). Surveillance was expanded to include select counties in Maryland and New York in 1999, select counties in Tennessee in 2000, and select counties in Colorado in 2001. Active surveillance was accomplished through a network of pediatric nephrologists and infection control practitioners, who reported all cases of HUS. Data on HUS cases in adults were also collected but surveillance was passive and incomplete. Hospital discharge data were reviewed to identify any potential HUS cases that may not have been reported through the networks or passive surveillance system. Review of the hospital discharge data and validation of the diagnosis through medical chart reviews resulted in a one year lag in reporting of HUS cases.

Cases reported in 2002

In 2002, 80 HUS cases were reported (Table 7A) and death occurred in four (5%) cases. Among children less than 15 years of age, 64 HUS cases were reported and 2 (3%) died. Fifty four percent of the HUS cases were diagnosed between June and September.

Incidence, 1997-2002

A total of 372 cases of HUS were reported between 1997 and 2002 (Table 7A). Fifty-seven percent occurred in females. The median age was 4.4 years and the median length of hospitalization was 12 days. The overall incidence of HUS among children under five years of age was 1.75/100,000, and among children 5 to 14 years of age it was 0.38/100,000 (Table 7B). *E. coli* O157 was isolated from 61% of stools that were specifically tested for this pathogen (Table 7C), and Shiga toxin was detected in 70% of stools specifically tested for it. Only two non-O157 STEC were isolated, but it is unknown how rigorously they were sought. Serum samples from 34 cases were tested for antibodies to O157, O111, or O26 lipopolysaccharide (LPS); 17 cases (50%) had antibodies to O157 LPS and three cases (9%) had antibodies to O111 LPS.

Table 7A. HUS cases by site and year, 1997–2002

State	1997		1998		1999		2000		2001		2002	
	Age <15 years	Age ≥15 years	Age <15 years	Age ≥15 years	Age <15 years	Age ≥15 years	Age <15 years	Age ≥15 years	Age <15 years	Age ≥15 years	Age <15 years	Age ≥15 years
California	2	0	2	0	2	0	3	0	7	0	5	1
Colorado	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6	1	6	1
Connecticut	1	0	0	0	7	2	11	5	2	1	7	2
Georgia	2	0	8	0	3	0	14	13	10	3	7	2
Maryland	n/a	n/a	2	0	1	0	1	0	9	0	3	2
Minnesota	9	3	16	4	9	4	12	1	19	3	10	1
New York	n/a	n/a	0	0	11	5	4	3	2	3	4	3
Oregon	4	3	6	1	3	3	6	5	12	1	22	3
Tennessee	n/a	n/a	n/a	n/a	n/a	n/a	6	6	7	3	0	1
Total	18	6	34	5	36	14	57	33	74	15	64	16

Table 7B. Pediatric HUS cases, by site and age, 1997–2002

State	Age < 5 years		Age 5–14 years	
	Cases	**Rate per 100,000**	**Cases**	**Rate per 100,000**
California	12	1.15	9	0.41
Colorado* **	7	1.99	5	0.78
Connecticut	17	1.30	11	0.37
Georgia	36	1.24	8	0.14
Maryland*	8	0.70	8	0.27
Minnesota	50	2.60	25	0.58
New York*	16	2.19	5	0.34
Oregon	43	3.21	10	0.35
Tennessee**	8	1.36	5	0.21
Total	**197**	**1.75**	**86**	**0.38**

*Based only on 1999-2002 data

**Based only on 2000-2002 data

***Based only on 2001-2002 data

Table 7C. Results of microbiologic testing for STEC infection among HUS cases, 1997–2002

Diarrhea in three weeks before HUS diagnosis/ Total patients	328/372 (88%)
Stool specimen obtained/ Total patients	331/372 (89%)
Stool cultured for *E. coli* O157/ Patients with stool specimen obtained	317/331 (96%)
E. coli O157 isolated from stool/ Patients with stool cultured for *E. coli* O157	192/317 (61%)
Stool tested for Shiga toxin/ Patients with stool specimen obtained	118/331 (36%)
Stool Shiga toxin-positive/ Patients with stool tested for Shiga toxin	83/118 (70%)
Non-O157 STEC isolated from stool/ Patients with stool tested for Shiga toxin	2/118 (2%)
Stool yielding *E. coli* O157, non-O157 STEC and/or Shiga toxin/ Total patients with stool cultured for *E. coli* O157	199/331 (60%)

Comments

During 1996–2003, the estimated incidence of *Campylobacter*, *Cryptosporidium*, *E. coli* O157, *Salmonella*, and *Yersinia* infections declined substantially. The decline in *Campylobacter* and *E. coli* O157 infections demonstrates important progress towards meeting the 2010 national health objectives. Although the incidence of *Salmonella* infection has declined, among the five most common *Salmonella* serotypes, only *S.* Typhimurium demonstrated a sustained decline.

The changes in the incidence of these infections occurred in the context of control measures implemented by government agencies and the food industry, enhanced food-safety education efforts, and increased attention by consumer groups and the media. In 1997, the U.S. Department of Agriculture (USDA)'s Food Safety and Inspection Service (FSIS) implemented the Pathogen Reduction/Hazard Analysis and Critical Control Point (HACCP) systems regulations in meat and poultry slaughter and processing plants. The sharp decline in *E. coli* O157 infections in humans in 2003 occurred in the context of enhanced food safety intervention efforts following an October 2002 FSIS notice to manufactures of raw ground beef products that they must reassess their HACCP plans regarding this pathogen (1), many beef processing plants began testing of ground beef and did not distribute production lots of ground beef unless such tests were negative for *E. coli* O157 (2). Contemporaneously, FSIS reported declines in the frequency of *E.* coli O157:H7 contamination of ground beef for 2003 (3).

The decline in human *Salmonella* infections during 1996–2003 accompanies a decline in the isolation of *Salmonella* from meat and poultry by FSIS (4). The Food and Drug Administration has introduced additional interventions to prevent foodborne diseases. These include implementing HACCP regulations for the seafood industry beginning in 1997 and the juice industry beginning in 2002, publishing sprout safety guidance in 1999, publishing produce safety guidance in 1998, and

1 U.S. Department of Agriculture, Food Safety and Inspection Service. *E. coli* O157:H7 contamination of beef products. Federal Register 2002;67:62,325–34. Available at http://www.fsis.usda.gov/oppde/rdad/ frpubs/00-022n.htm.

2 M. Koohmaraie, Meat Animal Research Center, USDA, personal communication, 2004

3 Holt KG, Levine P, Naugle AL, Eckel R. Food Safety and Inspection Service Microbiological Testing Program for *Escherichia coli* O157 in Ground Beef Products, U.S., October 1994–September 2003. In: Program and Abstracts Book of the International Conference on Emerging Infectious Diseases, 2004. Atlanta, Georgia: International Conference on Emerging Infectious Diseases, 2004:100.

4 U.S. Department of Agriculture, Food Safety and Inspection Service. Pathogen Reduction/HACCP & HACCP Implementation. Available at http://www.fsis.usda.gov/oa/haccp/imphaccp.htm.

implementing regulations requiring the refrigeration and safety labeling of shell eggs in 2001 (5) .

During 1996–2003, no substantial changes were observed in the incidence of infection caused by *Listeria*, *Shigella*, and several common *Salmonella* serotypes (*S*. Enteritidis, *S*. Newport, and *S*. Heidelberg). The incidence of *Vibrio* and *S*. Javiana infections increased.

Future control measures should include mandatory, on-farm prevention efforts to reduce egg contamination with *S*. Enteritidis (6) and greater use of pasteurized eggs and irradiated ground meat. Additional targeted efforts should include further steps to reduce the prevalence of pathogens in the following animal reservoirs and the foods derived from them: broiler chickens and turkeys (*Salmonella* and *Campylobacter*); cattle and ground beef (*Salmonella* and *E. coli* O157); and seafood, particularly oysters (*Vibrio*). Efforts also should include steps to reduce contamination of fresh produce. The high incidence of several of these infections in infants and young children is of major concern. Further efforts are needed to determine risk factors for these infections and opportunities for prevention.

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5 U.S. Department of Health and Human Services, Food and Drug Administration, Center for Food Safety and Applied Nutrition. National Food Safety Programs. Available at http://www.foodsafety.gov/~dms/fs-toc.html.

6 Hogue A, White P, Guard-Petter J, et al. Epidemiology and control of egg-associated Salmonella Enteritidis in the United States of America. Rev Sci Tech 1997;16:542–53.

Limitations

The findings in this report are subject to at least four limitations. First, although the majority of foodborne illnesses are not laboratory-diagnosed, FoodNet data are limited to laboratory-diagnosed illnesses, and are thus biased by factors that affect the probability of an illness being reported. Second, illnesses reported to FoodNet might be acquired through non-foodborne sources (e.g., contaminated water, person-to-person contact, and direct animal exposure); reported incidences do not represent foodborne sources exclusively. Third, although FoodNet data provide the most detailed information available for these infections, the findings might not be generalizable to the entire U.S. population. Finally, year-to-year changes in incidence might reflect either annual variation or sustained trends; further data are needed to discern trends clearly.

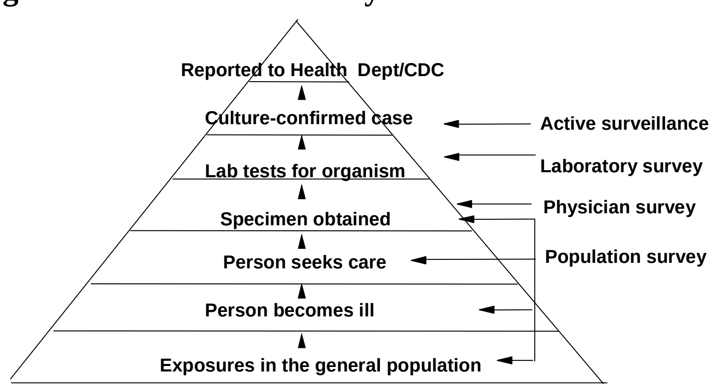
Other FoodNet Data Sources

Burden of Illness

Cases reported through active surveillance represent only a fraction of the number of cases in the community. To better estimate the number of cases of foodborne disease in the community, FoodNet conducts surveys of laboratories, physicians, and the general population in the participating EIP sites (Figure 5). Using these data, we can determine the proportion of people in the general population with a diarrheal illness, and from among those, the number who seek medical care for the illness. We can estimate the proportion of physicians who ordered a bacterial stool culture for patients with diarrhea, and we can evaluate how variations in laboratory testing for bacterial pathogens influence the number of culture-confirmed cases. Using FoodNet and other data, CDC estimated that 76 million foodborne illnesses, 325,000 hospitalizations, and 5,000 deaths occurred in 1997 in the United States (77).

This model can be used for developing estimates of the burden of illness caused by each foodborne pathogen. For example, data from this model suggest that in 1997 there were 1,400,000 *Salmonella* infections, resulting in 113,000 physician office visits and 37,200 culture-confirmed cases in this country. Laboratory-diagnosed cases alone resulted in an estimated 8,500 hospitalizations and 300 deaths; additional hospitalizations and deaths occur among persons whose illness is not laboratory diagnosed.

Figure 5. Burden of Illness Pyramid



7 Mead P, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. Emerging Infectious Disease 1999;5:607-25. Available at http://www.cdc.gov/ncidod/eid/vol5no5/mead.htm

Routes of Transmission of Foodborne Pathogens

FoodNet conducts case-control studies to determine the proportion of foodborne diseases that are caused by specific foods or food preparation and handling practices. To date, FoodNet has conducted case-control studies of *E. coli* O157; *Salmonella* serotypes Enteritidis, Heidelberg, Typhimurium, and Newport; infant salmonellosis; *Campylobacter*; *Cryptosporidium*; and *Listeria*. Case-control studies of infant *Salmonella* and *Campylobacter* infections were launched in 2002. By determining the contribution to these foodborne diseases made by specific foods or food preparation and handling practices, prevention efforts can be made more specific and their effectiveness documented.

Other FoodNet Activities in 2003

- Preliminary analysis of the *Listeria* case-control study, which enrolled 174 cases and 378 controls, began. Analysis will be completed in 2004.
- Data collection for the *Salmonella* Newport and *Salmonella* Enteritidis case-control studies was completed. The *S*. Newport study was designed to identify behavioral, dietary, and medical risk factors for and medical consequences of *S*. Newport infections, including multidrug-resistant strains of *S*. Newport. This study enrolled 215 cases and 1154 controls. The *S*. Enteritidis study was designed to identify behavioral, dietary, and medical risk factors for and medical consequences of *S*. Enteritidis infections. This study enrolled 223 cases and 742 controls. Analysis of these studies is on-going; the goal is to complete it in 2005.
- The infant salmonellosis and campylobacteriosis case-control study data collection phase was completed, enrolling 566 cases and 928 controls. This study was designed to identify behavioral, dietary, and medical risk factors for infections of infants with *Salmonella* or *Campylobacter*. The goal is to complete the data analysis in 2005.
- The data collection phase for a retrospective cohort study to evaluate the impact *Salmonella* Typhi infection with reduced susceptibility to fluoroquinolones have on clinical outcomes was completed, enrolling 57 persons.

Publications and Abstracts, 2003

Publications

1. Vanden Eng J, Marcus R, Hadler JL, et al. Consumer Attitudes and Use of Antibiotics. Emerg Infect Dis 2003; 9(9): 1128-1135.

Abstracts

1. Nelson JM, Baker N, Theriot C, et al. Increasing Incidence of Ciprofloxacin-Resistant *Campylobacter*: FoodNet and NARMS 1997-2001. Presented at the Annual Conference on Antimicrobial Resistance, Bethesda, MD, June 2003.

2. Nelson, JM, Mølbak K, Theriot C, et al. Increasing Incidence of Ciprofloxacin-Resistant *Campylobacter* infections in the United States: FoodNet and NARMS 1997-2001. Presented at the 12th Annual Workshop on *Campylobacter*, *Helicobacter* and Related Organisms, Aarhus, Denmark, September 2003.

Further information concerning FoodNet, including previous surveillance reports, *MMWR* articles, and other FoodNet publications, can be obtained by contacting the Foodborne and Diarrheal Diseases Branch at (404) 371-5465.

Materials Available On-Line

The following reports are available on the FoodNet Web site:

http://www.cdc.gov/foodnet

CDC. 1996 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 1998.
CDC. 1997 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 1998.
CDC. 1998 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 1998.
CDC. 1999 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 2000.
CDC. 2000 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 2002.
CDC. 2001 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 2002.
CDC. 2002 Final FoodNet Surveillance Report. Atlanta: Centers for Disease Control and Prevention; 2003.

The following *MMWR* articles about FoodNet are available at this Web site:

http://www.cdc.gov/epo/mmwr/mmwr.html

CDC. The Foodborne Diseases Active Surveillance Network**,** 1996. Morbidity and Mortality Weekly Report. 1997; 46:258-61.

CDC. Incidence of foodborne illness-FoodNet**,** 1997. Morbidity and Mortality Weekly Report. 1998; 47:782-86.

CDC. Incidence of foodborne illness: Preliminary data from the Foodborne Diseases Active Surveillance Network (FoodNet) – United States, 1998. Morbidity and Mortality Weekly Report. 1999; 48:189-94.

CDC. Preliminary FoodNet data on the incidence of foodborne illnesses – selected sites, United States, 1999. Morbidity and Mortality Weekly Report. 2000; 49: 201-5.

CDC. Preliminary FoodNet data on the incidence of foodborne illnesses – selected sites, United States, 2000. Morbidity and Mortality Weekly Report. 2001; 50: 241-46.

CDC. Preliminary FoodNet data on the incidence of foodborne illnesses – selected sites, United States, 2001. Morbidity and Mortality Weekly Report. 2002; 51: 325-29.

CDC. Preliminary FoodNet data on the incidence of foodborne illnesses – selected sites, United States, 2002. Morbidity and Mortality Weekly Report. 2003; 52: 340-43.

CDC. Preliminary FoodNet data on the incidence of foodborne illnesses – selected sites, United States, 2003. Morbidity and Mortality Weekly Report. 2003; 52: 338-343

The following *FoodNet News* newsletters are available at the FoodNet Web site:

http://www.cdc.gov/foodnet

FoodNet News. Volume 1, No. 1, Fall 1998
FoodNet News. Volume 1, No. 3, Fall 1999
FoodNet News. Volume 1, No. 2, Winter 1999
FoodNet News. Volume 3, No. 1, Spring 2000
FoodNet News. Volume 3, No. 2, Winter 2000
FoodNet News. Volume 4, No. 1, Fall 2002
FoodNet News. Volume 4, No. 2, Spring 2003
FoodNet News. Volume 5, No. 1, Fall/Winter 2003

A list of FoodNet publications and presentations is available at the following FoodNet Web site:

http://www.cdc.gov/foodnet/pub.htm

Additional information about the pathogens under FoodNet surveillance is available at the following Web sites:

http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodborneinfections_g.htm
http://www.cdc.gov/health/diseases.htm

FoodNet Working Group, 2003

CDC
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Carl Schroeder

FDA-CFSAN
Jack Guzewich
Eileen Parish
Patrick McCarthy
Clifford Purdy

FDA-CVM
David White

Part II

Summary Tables and Figures

Listing of Summary Tables and Figures

Annual Summaries by Pathogen*

Bacterial Pathogens

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* Each Annual Summary contains the following 3 figures:

- Incidence for 1996 through 2003, by month (Cases per 100,000 person-months)
- Percent change in incidence between 2002 and 2003, by site (All Sites) (Cases per 100,000 person-years) / Percent change in incidence between 2002 and 2003, by month (By Site) (Cases per 100,000 person-months)
- Incidence for 2002 and 2003, by age group and sex (Cases per 100,000 person-years)

Parasitic Pathogens

Frequency by Serotype or Species

Case Information by Pathogen