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## *Prologue*

This is the sixth in a series of annual reports. The FoodNet Surveillance Report for 2001 (Final Report) summarizes the data collected through FoodNet's active surveillance sites during 2001. It represents the continued efforts of numerous individuals, and the collaboration of multiple federal, state, and local public health agencies. This Final Report consists of two parts: Part I, Narrative Report; and Part II, Summary Tables and Graphs. It uses the 2000 census population counts as the denominator, and includes a small number of additional cases reported since the publication of the Preliminary Report. Therefore, Tables 1A and 1B, found in Part II of the Final Report, Summary Tables and Graphs, are updated, with recalculated incidence rates. Furthermore, surveillance data for hemolytic uremic syndrome and deaths are provided in this Final Report.

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 or via the Internet at http://www.cdc.gov/foodnet.

# *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, the nine 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). FoodNet augments, but does not replace, longstanding activities at CDC, USDA, FDA, and in states to identify, control, and prevent foodborne disease hazards.

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. Ongoing FoodNet surveillance is being used to document the effectiveness of new food safety control measures, such as the USDA–FSIS Pathogen Reduction and Hazard Analysis and Critical Control Point (PR/HACCP) systems, in decreasing the number of cases of foodborne diseases that occur in the United States each year.

The following are key findings of FoodNet surveillance activities during 2001:

- There has been a sustained decline in the incidence of infections caused by *Yersinia*, *Listeria*, *Campylobacter,* and *Salmonella* Typhimurium over the past six years. 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. However, additional measures will be needed to further reduce the incidence of these diseases to achieve our national health objectives by 2010.

- The decline in the incidence of infections caused by *Yersinia*, *Listeria*, *Campylobacter,* and *Salmonella* Typhimurium are unlikely to be due to surveillance artifacts. FoodNet conducts several studies to monitor the surveillance factors that can influence the incidence of these 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 foodborne infections.

- Food animals are a major source of *Yersinia*, *Listeria*, *Campylobacter*, and *Salmonella* Typhimurium. 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. Additional evidence of the contribution of the USDA regulations to the decline in the incidence of *Salmonella* infections in humans described in this report is the decline in the prevalence of *Salmonella* isolated from FSIS-regulated meat and poultry products.

- Enhanced surveillance and outbreak investigations have identified new control measures and focused industry attention on foodborne illness, so that control measures are more likely to be implemented. Recent interventions include egg safety programs for the prevention of *Salmonella* Enteritidis infections, increased attention to fresh produce safety through better agricultural practices on farms and food processing, regulation of fruit and vegetable juice, industry efforts to reduce food contamination, food safety education, and increased regulation of imported food.

- Although there have been important declines in the incidence of infection for several foodborne diseases, the incidence of foodborne diseases remains high. Efforts to reduce the rate of foodborne diseases might 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 would reduce the risk of human illness from *Salmonella* Enteritidis-contaminated eggs.

- The lack of a sustained decline in *E. coli* O157 infections indicates a need for increased efforts to reduce the burden of these infections. Preventing *E. coli* O157 will not be a simple task because it can be transmitted through food, water, person-to-person contact, and direct animal exposure. FoodNet studies and recent outbreaks have shown that an important route of transmission is direct contact with cattle or their environment. Strategies that reduce *E. coli* O157 on farms could decrease direct contact infection and food contamination, as well as entry into the water supply.

- The high incidence of foodborne diseases in infants and young children is a major concern. FoodNet studies have shown that breast-feeding of infants is important in preventing foodborne disease in infants. To determine other opportunities for prevention of foodborne diseases among children, FoodNet began a case-control study in 2002 of sporadic cases of *Salmonella* and *Campylobacter* among young children.

- The increase in the incidence of infections caused by *Salmonella* Newport represents an emerging challenge to public health. Many of these isolates are resistant to nine or more antimicrobial agents, including all agents approved for oral use in children. Further studies are necessary to understand and resolve these problems. FoodNet recently began a case-control study of sporadic cases of *Salmonella* Newport to assess possible risk factors and opportunities for prevention.

## *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 Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA), the United States Food and Drug Administration (FDA), and the nine Emerging Infections Program (EIP) sites 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; determine the association of common foodborne diseases with eating specific foods; and describe the epidemiology of new and emerging bacterial, parasitic, and viral foodborne pathogens. To address these objectives, FoodNet uses active surveillance and conducts related epidemiologic studies. By monitoring the burden of foodborne diseases over time, 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 rate of foodborne diseases in the United States each year.

***Methods***

In 2001, FoodNet conducted population-based active surveillance for clinical laboratory isolations of *Campylobacter*, *Cryptosporidium*, *Cyclospora*, Shiga toxin-producing *E. coli* including *E. coli* O157, *Listeria*, *Salmonella*, *Shigella*, *Vibrio*, and *Yersinia* infections in Connecticut, Georgia, Minnesota, and Oregon, and selected counties in California, Colorado, Maryland, New York, and Tennessee (total population 37.8 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 contact each of the more than 450 clinical laboratories serving the catchment areas either weekly or monthly, depending on the size of the clinical laboratory. FoodNet also conducts surveillance for foodborne disease outbreaks and hemolytic uremic syndrome (HUS), the latter principally through pediatric nephrologists.

## *Results*

***Cases reported***

In 2001, a total of 13,755 laboratory-confirmed infections caused by the pathogens under surveillance were identified in nine sites. Of these, 13,148 were bacterial, including 4,751 *Campylobacter* infections, 5,240 *Salmonella* infections, 2,219 *Shigella* infections, 560 *E. coli* O157 infections, 61 non-O157 Shiga toxin-producing *E. coli* (STEC) infections, 144 *Yersinia* infections, 94 *Listeria* infections, and 79 *Vibrio* infections (Table 1A). Of the 4,900 *Salmonella* isolates that were serotyped, the most commonly identified serotypes were Typhimurium (1,076 cases), Enteritidis (711), Newport (559), and Heidelberg (332). In addition, 607 cases of parasitic diseases were reported, including 575 cases of *Cryptosporidium* infection and 32 cases of *Cyclospora* infection (Table 1B).

**Table 1A. Infections caused by specific bacterial pathogens, reported by FoodNet sites, 2001**

| Pathogen | CA | CO | CT | GA | MD | MN | NY | OR | TN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Campylobacter*** | **999** | **343** | **495** | **614** | **300** | **954** | **248** | **586** | **212** | **4751** |
| ***Escherichia coli* O157** | **36** | **37** | **39** | **50** | **16** | **232** | **31** | **77** | **42** | **560** |
| **Non-O157 STEC** | **0** | **4** | **24** | **4** | **0** | **24** | **0** | **5** | **0** | **61** |
| ***Listeria*** | **16** | **5** | **15** | **16** | **14** | **4** | **7** | **12** | **5** | **94** |
| ***Salmonella*** | **480** | **317** | **454** | **1675** | **622** | **693** | **271** | **290** | **438** | **5240** |
| ***Shigella*** | **427** | **144** | **60** | **714** | **141** | **493** | **28** | **112** | **100** | **2219** |
| ***Vibrio*** | **16** | **5** | **9** | **24** | **13** | **3** | **2** | **5** | **2** | **79** |
| ***Yersinia*** | **17** | **9** | **9** | **50** | **12** | **19** | **6** | **12** | **10** | **144** |
| **Total** | **2051** | **878** | **1126** | **3334** | **1147** | **2620** | **608** | **1155** | **836** | **13755** |

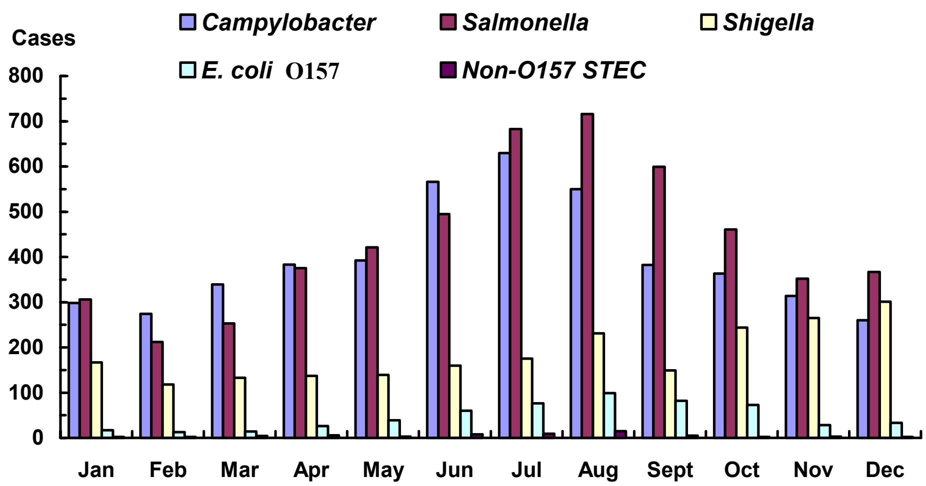
**Table 1B. Infections caused by specific parasitic pathogens, reported by FoodNet sites, 2001**

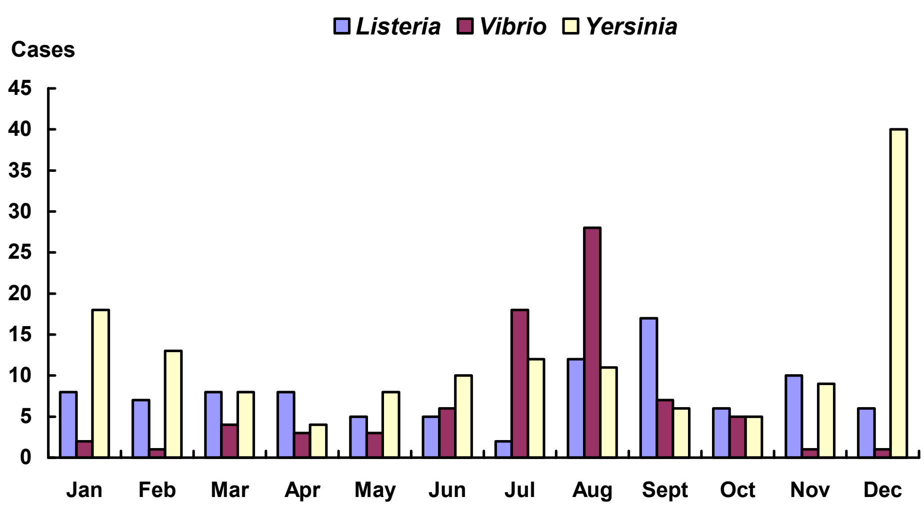
| Pathogen | CA | CO | CT | GA | MD | MN | NY | OR | TN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Cryptosporidium*** | **60** | **14** | **17** | **159** | **29** | **198** | **15** | **56** | **27** | **575** |
| ***Cyclospora*** | **0** | **0** | **4** | **28** | **0** | **0** | **0** | **0** | **0** | **32** |
| **Total** | **60** | **14** | **21** | **187** | **29** | **198** | **15** | **56** | **27** | **607** |

***Seasonality***

Isolation rates for pathogens showed seasonal variation: 42% of *E. coli* O157, 36% of *Salmonella*, 37% of *Campylobacter*, and 26% of *Shigella* were isolated between June and August (Figure 1). *Yersinia* infections were more likely to have occurred in winter months, with 49% 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, 2001**



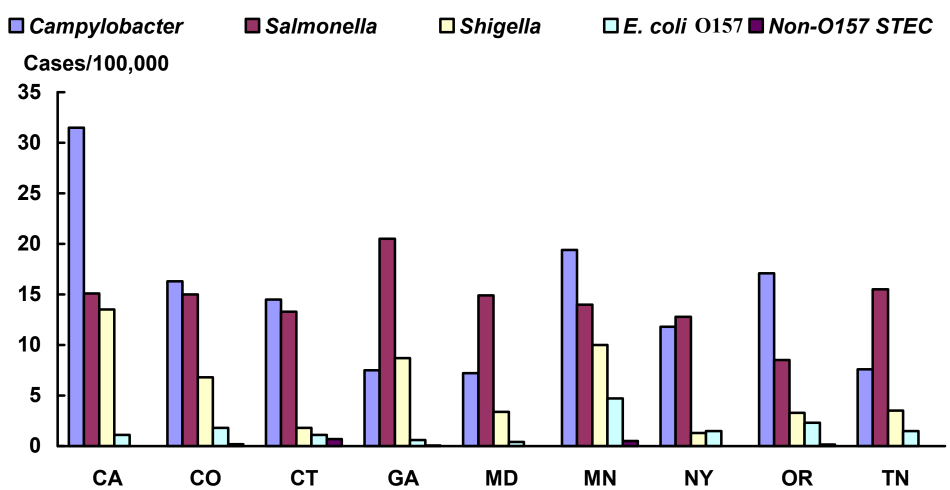

***2001 Rates***

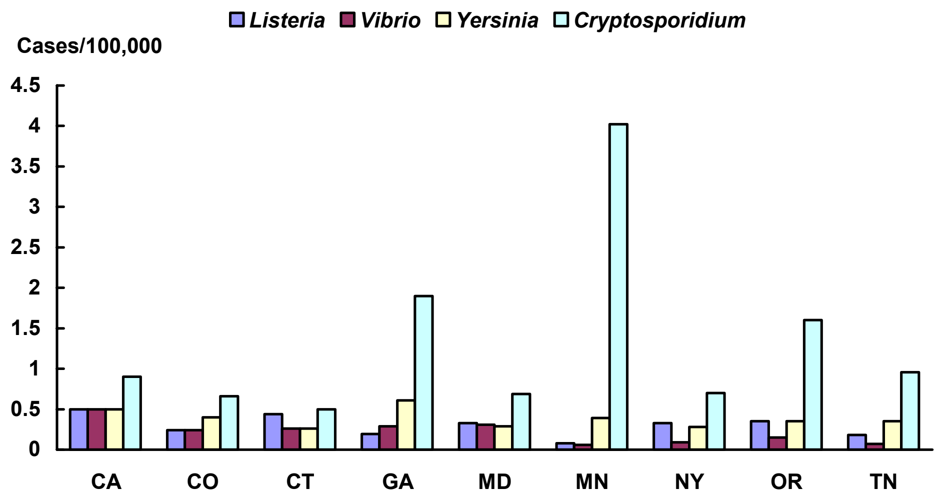
To compare the number of cases among sites with different populations, preliminary annual incidence rates were calculated. Incidence is the number of cases divided by the population. All 2001 rates reported here were calculated with 2000 census population counts. 2001 census projections were not available. Overall incidence rates were highest for infections with *Campylobacter* (13.8/100,000 population), *Salmonella* (15.3/100,000), and *Shigella* (6.5/100,000). Lower overall incidence rates were reported for *E. coli* O157 (1.6/100,000), non-O157 STEC (0.18/100,000) *Cryptosporidium* (1.5/100,000), *Yersinia* (0.42/100,000), *Listeria* (0.27/100,000), *Vibrio* (0.23/100,000), and *Cyclospora* (0.08/100,000).

***Rates by site***

Incidence rates for many of these pathogens varied substantially among the sites (Figure 2). The incidence rates for *Campylobacter* infection varied from 7.2/100,000 in Maryland to 31.5/100,000 in California, and for *Shigella* infections from 1.3/100,000 in New York to 13.5/100,000 in California. Incidence rates for aggregate *Salmonella* infection also varied among the sites, from 8.5/100,000 in Oregon to 20.5/100,000 in Georgia. Among the two most common serotypes of *Salmonella*, *S.* Typhimurium ranged from 2.0/100,000 in California to 4.1/100,000 in Tennessee and *S.* Enteritidis ranged from 0.84/100,000 in Oregon to 4.5/100,000 in Maryland. Incidence rates for *E. coli* O157 infection varied from 0.38/100,000 in Maryland to 4.7/100,000 in Minnesota. FoodNet began collecting information on non-O157 STEC in 2000; the majority of these cases were reported in Connecticut and Minnesota. Infection caused by *Yersinia* varied from 0.26/100,000 in Connecticut to 0.6/100,000 in Georgia. Incidence rates of *Cryptosporidium* infection ranged from 0.49/100,000 in Connecticut to 4.0/100,000 in Minnesota. Listeriosis ranged from 0.08/100,000 in Minnesota to 0.5/100,000 in California, and *Vibrio* infections ranged from 0.06/100,000 in Minnesota to 0.5/100,000 in California. Reasons for these regional differences in incidence rates are being investigated; for example, most laboratories do not test specimens routinely for all pathogens. However, regional differences in *E. coli* O157 incidence are only partially accounted for by differences in laboratory practices.

**Figure 2. Cases per 100,000 population of foodborne disease caused by specific pathogens, FoodNet sites, 2001**

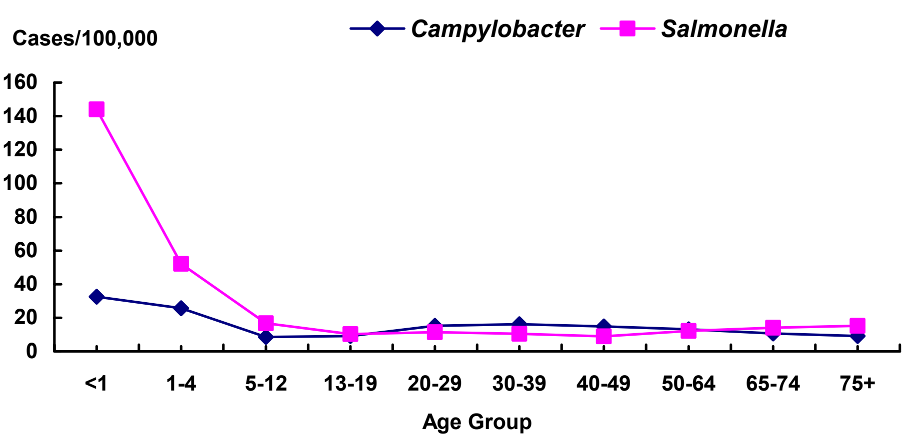





***Rates by age***

Annual incidence rates of foodborne illness varied by age, especially for *Campylobacter* and *Salmonella* infections (Figure 3). For children <1 year of age, the rate of *Salmonella* infection was 144/100,000 and the rate of *Campylobacter* infection was 32.6/100,000, substantially higher than for other age groups.

**Figure 3. Incidence of *Campylobacter* and *Salmonella* infections by age group, FoodNet sites, 2001**




***Rates by sex***

Incidence rates also varied by sex (Table 2). Overall, males were more likely than females to be infected with every pathogen except *E. coli* O157 and *Listeria.* Among males, rates of *Campylobacter* infection were 24% higher, rates of *Shigella* were 35% higher, rates of *Cryptosporidium* infection were 48% higher, and rates of *Vibrio* were 61% higher.

**Table 2. Sex-specific incidence rates per 100,000 population, by pathogen, FoodNet sites, 2001**

| Pathogen | Male | Female |
|---|---|---|
| ***Campylobacter*** | 15.3 | 12.3 |
| ***Cryptosporidium*** | 1.82 | 1.23 |
| ***Cyclospora*** | 0.08 | 0.08 |
| ***E. coli* O157** | 1.5 | 1.8 |
| ***Listeria*** | 0.26 | 0.28 |
| ***Salmonella*** | 15.3 | 14.9 |
| ***Shigella*** | 7.4 | 5.5 |
| ***Vibrio*** | 0.29 | 0.18 |
| ***Yersinia*** | 0.43 | 0.41 |

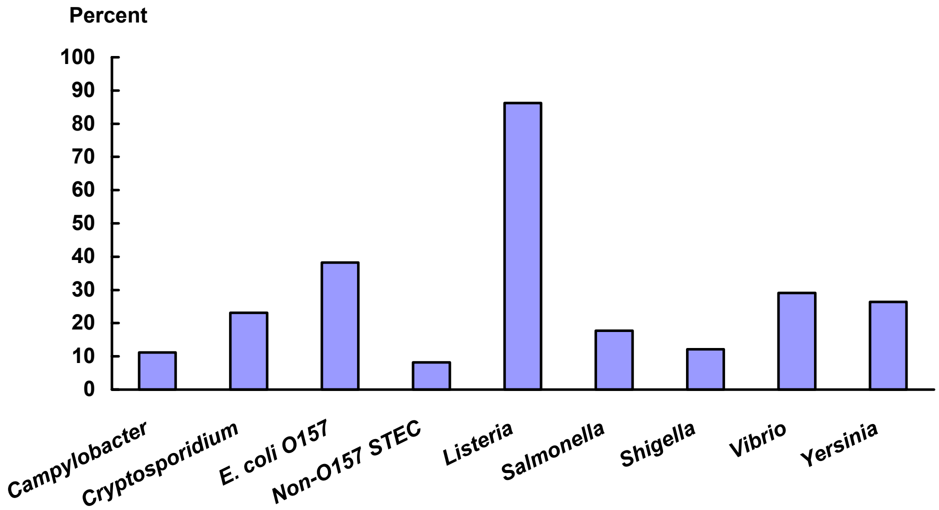
***Rates by age and sex***

The incidence rate of *Campylobacter* infection was higher for males than for females in most age groups, except for persons less than one year of age, those aged 20-29 years and those aged 65-74 years. Among persons less than 12 years of age, the incidence rate of *Salmonella* infection was higher among males than among females. Among persons more than 50 years of age, the incidence rate of *Salmonella* infection was higher among women than among men.

***Hospitalizations***

Overall, 16.2% of persons with culture-confirmed infection were hospitalized; hospitalization rates differed markedly by pathogen (Figure 4). The percentage of hospitalizations was highest for persons infected with *Listeria* (86.2% of reported cases) followed by those infected with *E. coli* O157 (38.2%), *Vibrio* (29.1%), *Yersinia* (26.4%), *Cryptosporidium* (23.1%), *Salmonella* (17.7%), *Shigella* (12.1%), *Campylobacter* (11.2%), and non-O157 STEC (8.2%).

**Figure 4. Percentage of persons hospitalized with infections caused by specific pathogens, FoodNet sites, 2001**




***Deaths***

Fifty-one persons died; of those, 19 were infected with *Listeria*, 15 with *Salmonella*, six with *Campylobacter*, four with *Vibrio*, three with *E. coli* O157, two with *Cryptosporidium* and two with *Yersinia*. The pathogen with the highest case-fatality rate was *Listeria*; 20% of persons infected with *Listeria* died.

***HUS***

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 Shiga toxin-producing *Escherichia coli* (STEC). *E. coli* O157:H7 is the most easily and frequently isolated STEC, but many other serotypes can also cause HUS.

Active surveillance for pediatric HUS cases was established in 1997 in five FoodNet sites (California, Connecticut, Georgia, Minnesota, and Oregon). Surveillance was expanded to include areas of Maryland and New York in 1999, Tennessee in 2000, and Colorado in 2001. Maryland, Tennessee, and Colorado submitted pilot HUS data in 1998, 1999, and 2000, respectively. These data were included, but were considered as outside the catchment area. Active surveillance is accomplished through pediatric nephrologists, who report all cases of HUS, including those from outside the FoodNet catchment area. Data on HUS cases in adults are also collected, but surveillance is passive and often incomplete. The primary objectives of HUS surveillance are to 1) determine the incidence of HUS, 2) monitor long-term trends in STEC infection using HUS as a marker, and

3) identify and monitor STEC strains that cause HUS over time. A total of 361 cases of HUS were reported between 1997 and 2001 (Table 3A). Sixty-one percent of reported cases occurred in females. The median age was five years and the median length of hospitalization was 12 days.

In 2001, 95 HUS cases were reported, and deaths occurred in eight (8%) of these cases. Among children less than 15 years of age, 79 HUS cases were reported and five (6%) deaths occurred. Consistent with the seasonal distribution of 2001 *E. coli* O157:H7 infections, 32 (34%) of the 2001 HUS cases were diagnosed between June and August (Figure 4).

The overall rate of HUS among children under five years of age in the nine sites from 1997 to 2001 was 1.7/100,000, and among children 5 to 14 years of age it was 0.4/100,000 (Table 3B). *E. coli* O157:H7 was isolated from 59% of stools that were specifically tested for this pathogen (Table 3C). Eight patients had stool samples that tested positive for Shiga toxin, but stool cultures did not yield *E. coli* O157:H7. Only two other STEC were identified by stool culture, but it is unclear how rigorously they were sought. A total of 28 cases had STEC serology done to identify anti-O157, O111, or O126 antibodies; 16 cases (57%) had detectable antibody to O157 and three cases (11%) had detectable antibodies to O111.

**Table 3A. HUS cases by site* and year, 1997–2001**

| **State** | **1997** | | **1998** | | **1999** | | **2000** | | **2001** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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** | 10 | 0 | 8 | 0 | 5 | 0 | 15 | 0 | 9 | 1 |
| **Colorado** | n/a | n/a | n/a | n/a | n/a | n/a | 8 | 0 | 8 | 3 |
| **Connecticut** | 1 | 0 | 0 | 0 | 8 | 2 | 11 | 5 | 2 | 1 |
| **Georgia** | 6 | 0 | 13 | 0 | 4 | 0 | 16 | 9 | 6 | 1 |
| **Maryland** | n/a | n/a | 2 | 0 | 2 | 0 | 2 | 0 | 9 | 1 |
| **Minnesota** | 9 | 3 | 17 | 3 | 9 | 4 | 12 | 1 | 19 | 3 |
| **New York** | n/a | n/a | n/a | n/a | 15 | 5 | 4 | 4 | 2 | 3 |
| **Oregon** | 6 | 3 | 6 | 1 | 3 | 3 | 6 | 5 | 12 | 1 |
| **Tennessee** | n/a | n/a | n/a | n/a | 2 | 0 | 10 | 7 | 12 | 2 |
| **Total** | **32** | **6** | **46** | **4** | **48** | **14** | **84** | **31** | **79** | **16** |

**Includes cases among persons residing outside the formal catchment area.*
*n/a means not applicable.*

**Table 3B. Pediatric HUS cases, by site† and age, 1997–2001**

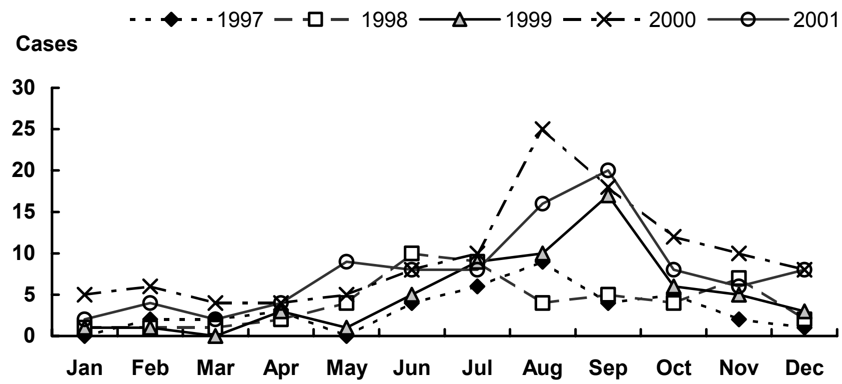
| State | Age < 5 years | | Age 5–14 years | |
|---|---|---|---|---|
| | Cases | Rate per 100,000 | Cases | Rate per 100,000 |
| **California** | 8 | 1.0 | 5 | 0.3 |
| **Colorado*** ** | 2 | 1.3 | 4 | 1.3 |
| **Connecticut** | 13 | 1.3 | 8 | 0.4 |
| **Georgia** | 28 | 1.2 | 6 | 0.1 |
| **Maryland*** | 7 | 1.1 | 6 | 0.4 |
| **Minnesota** | 45 | 2.8 | 21 | 0.6 |
| **New York*** | 12 | 3.0 | 5 | 0.5 |
| **Oregon** | 22 | 2.0 | 9 | 0.4 |
| **Tennessee**** | 7 | 1.8 | 4 | 0.5 |
| **Total** | **144** | **1.7** | **68** | **0.4** |

*†Includes cases among persons residing within catchment area only*
**Based only on 1999-2001 data*
***Based only on 2000-2001 data*
****Based only on 2001 data*

**Table 3C. Results of microbiologic testing for STEC infection among HUS cases, 1997–2001**

| | |
|---|---|
| Diarrhea in three weeks before HUS diagnosis/<br>Total patients | 329/360 (91%) |
| Stool specimen obtained/<br>Total patients | 327/360 (91%) |
| Stool cultured for *E. coli* O157:H7/<br>Patients with stool specimen obtained | 316/327 (97%) |
| *E. coli* O157:H7 isolated from stool/<br>Patients with stool cultured for *E. coli* O157:H7 | 185/316 (59%) |
| Stool tested for Shiga toxin/<br>Patients with stool specimen obtained | 111/327 (34%) |
| Stool Shiga-toxin positive/<br>Patients with stool tested for Shiga toxin | 75/111 (68%) |
| Non-O157 STEC isolated from stool/<br>Patients with stool tested for Shiga toxin | 2/111 (2%) |
| Stool yielding *E. coli* O157:H7, non-O157 STEC and/or Shiga toxin/<br>total patients with stool cultured for *E. coli* O157:H7 | 193/316 (61%) |

**Figure 5. Total cases of HUS, by year and month, 1997–2001**




***1996–2001 Rates***

The number of sites and the population under surveillance have nearly doubled since FoodNet began in 1996 (Figures 6 and 7). 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 Poisson regression model was used to estimate the effect of time on the incidence of various pathogens, treating time (i.e., calendar year) as a categorical variable, with 1996 as the reference year. The relative change in incidence between 1996 and 2001 was estimated and confidence intervals for that change were calculated.

The bacterial pathogens with the highest relative incidence during the period between 1996 and 2001 were *Campylobacter, Salmonella,* and *Shigella* (Figure 8A). Pathogens with lower incidence were *E. coli* O157, *Listeria,* and *Yersinia* (Figure 8B). The incidence of infection with most pathogens decreased between 1996 and 2001. For three pathogens (*Yersinia*, *Listeria*, and *Campylobacter*), this decrease was observed consistently over several years. During the period of 1996 to 2001, the estimated incidence of *Yersinia* infections decreased 47% (95% confidence interval [CI]=59% to 32% decrease), *Listeria* decreased 32% (95% CI=51% to 7% decrease), *Campylobacter* decreased 25% (95% CI=15% to 33% decrease), and *Salmonella* decreased 10% (95% CI=9% to 0% decrease) (Table 4A). Considerable temporal variations were observed for the five most common *Salmonella* serotypes. Betwen 1996 and 2001, *S*. Typhimurium decreased 26% (95% CI=36% to 13% decrease), *S*. Enteritidis decreased 18% (95% CI=38% decrease to 8% increase), *S*. Newport increased 34% (95% CI=20% decrease to 126% increase), *S*. Heidelberg increased 40% (95% CI=4% to 89% increase), and *S*. Javiana increased 122% (95% CI=62% to 537% increase) (Table 4B). A substantial decline in the incidence of *S*. Enteritidis infection during the period of 1996 through 1999 was partially reversed by increased incidence in both 2000 and 2001. Between 1996 and 2001, the estimated incidence of *E. coli* O157 infections decreased 17% (95% CI=39% decrease to 13% increase), but this decline reflects a decrease only for 2001.

The incidence of *Shigella* infections showed considerable variation by year and site. The estimated incidence in 2001 was 29% lower than in 1996 (95% CI=53% decrease to 10% increase). The incidence of *Vibrio* infections was 94% higher in 1997 than it was in 1996, reflecting the emergence of *Vibrio parahaemolyticus* O3:K6 (*6*), and has not shown a consistent change since; the incidence was 87% higher in 2001 than it was in 1996 (95% CI=5% to 234% increase) (Figure 8C).

Surveillance for the parasitic pathogens *Cryptosporidium* and *Cyclospora* began in 1997. Between 1997 and 2001, the incidence of *Cryptosporidium* cases decreased 6% (95% CI=48% decrease to 68% increase) (Figure 8D). Although the incidence of *Cyclospora* has decreased since 1997, the statistical model could not be applied to *Cyclospora* because of the rarity of cases (128 cases between 1997 and 2001).

Following the September 11 and anthrax attacks of 2001, public health resources were diverted to emergency response activities. To test the hypothesis that the declines in foodborne disease incidence reflect decreased surveillance activities in late 2001, we repeated the Poisson regression analysis using data collected only from January through August for each year from 1996 through 2001. We observed no change in the results compared to the models that included all 12 months; therefore these reported declines are unlikely to be caused by a surveillance artifact associated with these attacks.

**Figure 6. FoodNet surveillance area (sites indicated by black areas), 1996 (total population=14,281,096)**

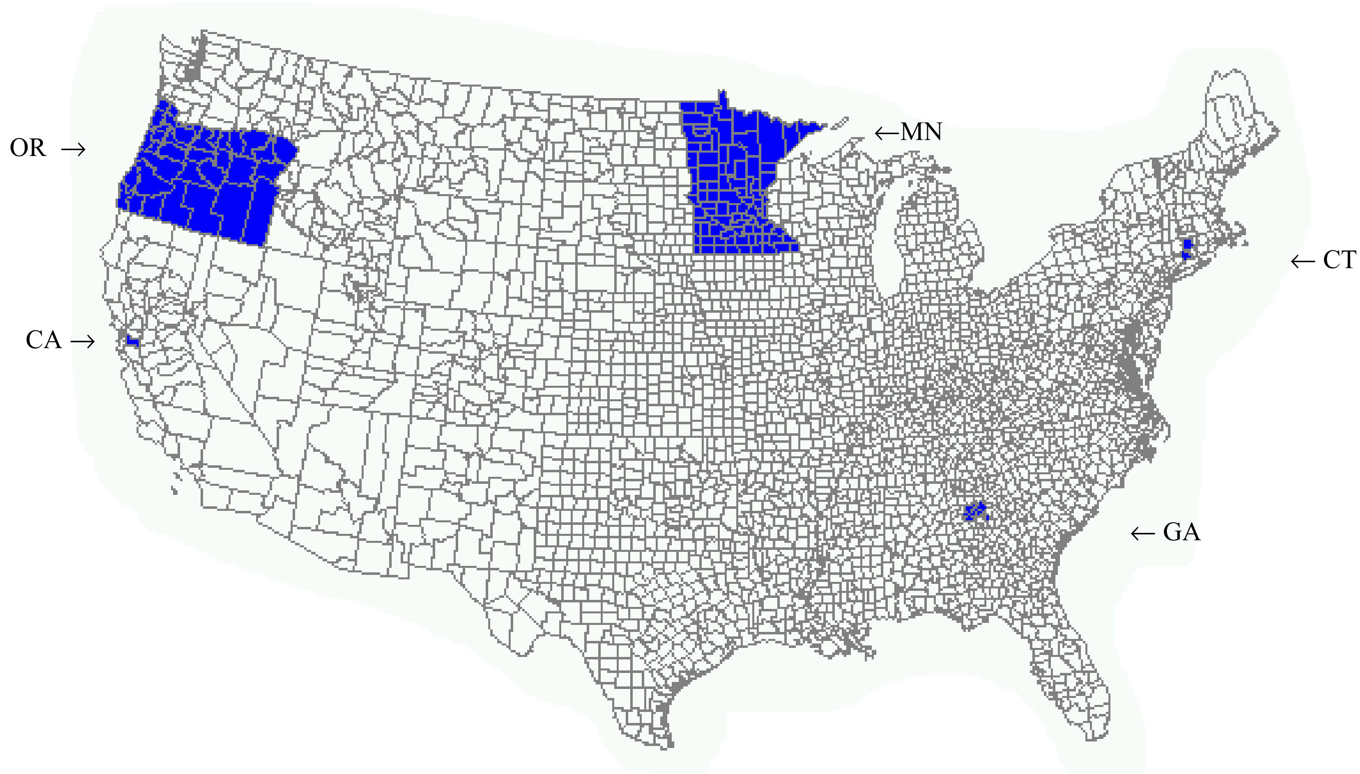



**Figure 7. FoodNet surveillance area (sites indicated by black areas), 2001 (total population=37,817,351)**

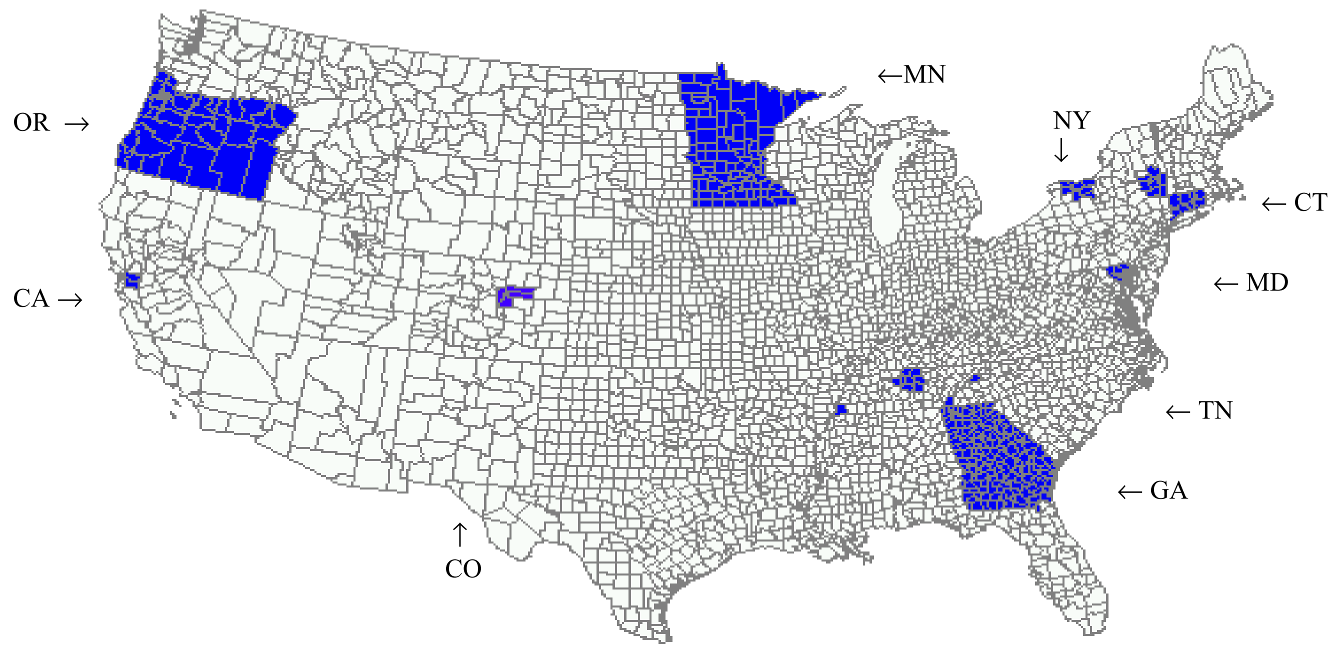


**Figure 8A. Relative rates of laboratory-diagnosed cases of *Campylobacter, Salmonella*, and *Shigella*, by year, 1996–2001**

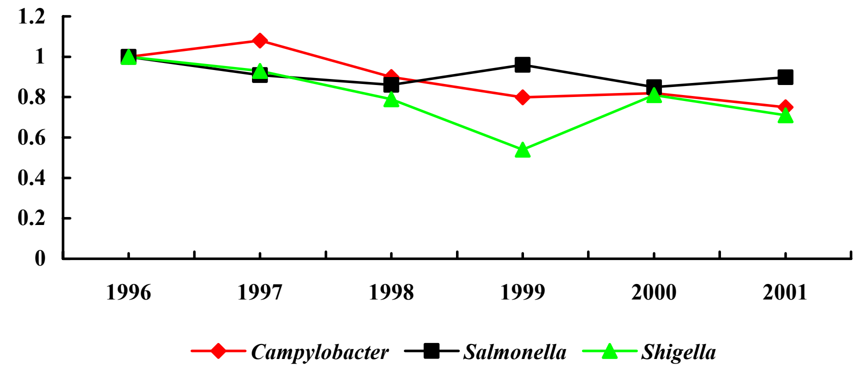



**Figure 8B. Relative rates of laboratory-diagnosed cases of *E. coli* O157*,* *Listeria*, and *Yersinia*, by year, 1996–2001**

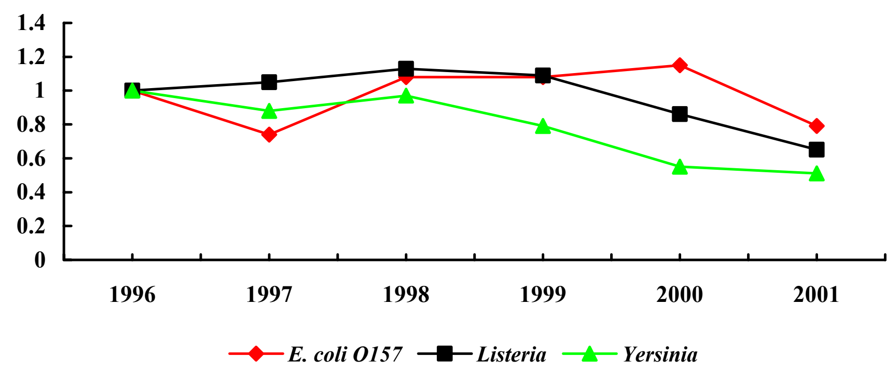


**Figure 8C. Relative rates of laboratory-diagnosed cases of *Vibrio*, by year, 1996–2001**

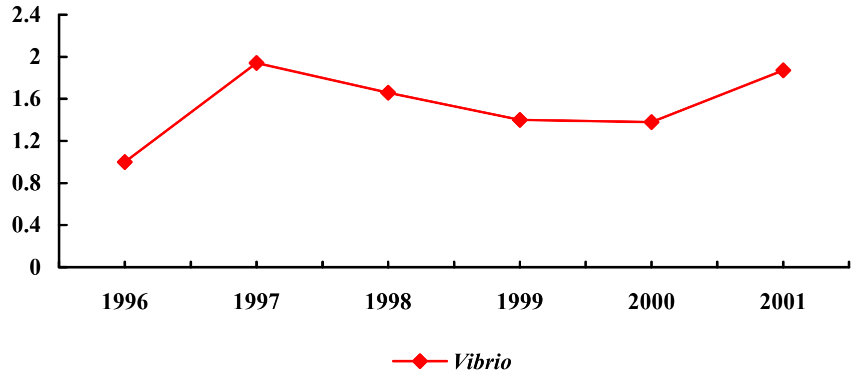



**Figure 8D. Relative rates of laboratory-diagnosed cases of *Cryptosporidium*, by year, 1997–2001**

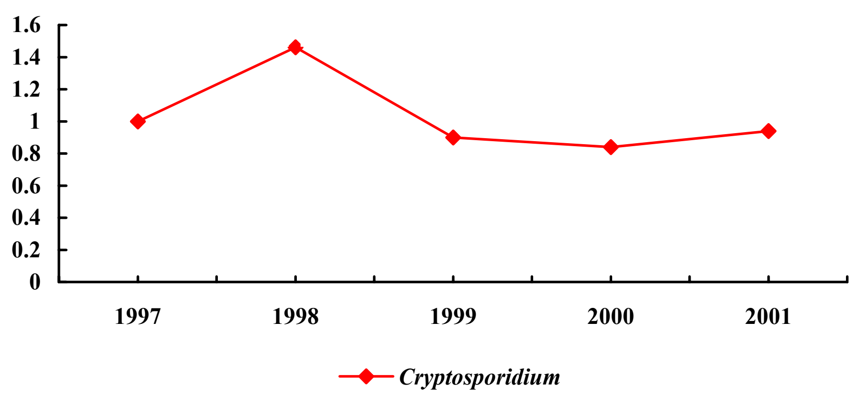


**Table 4A. Percent change in incidence* of diagnosed infections for pathogens under surveillance in FoodNet, by pathogen, 1996–2001**

| Bacterial Pathogen | Percent Change | 95% Confidence Interval |
|---|---|---|
| *Campylobacter* | -25 | 33% to 15% decrease |
| *Escherichia coli* O157 | -17 | 39% decrease to 13% increase |
| *Listeria* | -32 | 51% to 7% decrease |
| *Salmonella* | -10 | 9% decrease to 0% |
| *Shigella* | -29 | 53% decrease to 10% increase |
| *Vibrio* | +87 | 5% to 234% increase |
| *Yersinia* | -47 | 59% to 32% decrease |

*Per 100,000 population

| Parasitic Pathogen | Percent Change* | 95% Confidence Interval |
|---|---|---|
| *Cryptosporidium* | -6 | 48% decrease to 68% increase |

*1997–2001

**Table 4B. Percent change in incidence* of diagnosed infections for *Salmonella* serotypes, by serotype, 1996–2001**

| Pathogen | Percent Change | 95% Confidence Interval |
|---|---|---|
| *Salmonella* Typhimurium | -26 | 36% to 13% decrease |
| *Salmonella* Enteritidis | -18 | 38% decrease to 8% increase |
| *Salmonella* Newport | +34 | 20% decrease to 126% increase |
| *Salmonella* Heidelberg | +40 | 4% to 89% increase |
| *Salmonella* Javiana | +122 | 62% to 537% increase |

*Per 100,000 population

**Table 5. Comparison of 2001 incidence with the Healthy People 2010 objectives**

| Pathogen | 2001 Actual Incidence* | 2010 Objective Incidence* |
|---|---|---|
| *Campylobacter* | 13.8 | 12.3 |
| *Escherichia coli* O157 | 1.3 | 1.0 |
| *Salmonella* | 14.9 | 6.8 |
| *Listeria* | 0.3 | 0.25 |

*Per 100,000 population

***Comments***

Between 1996 and 2001, the incidence of infections caused by *Yersinia*, *Listeria*, and *Campylobacter* showed a substantial and sustained decline. The declines in the incidence of foodborne diseases targeted in the national health objectives indicate important progress. However, additional measures must be taken to achieve the national health objectives.

On the basis of studies conducted by FoodNet to monitor factors that can influence the incidence of foodborne diseases, changes in healthcare-seeking behaviors for persons with diarrhea or changes in laboratory testing practices are unlikely to explain the declines observed in disease incidence.[1,2] Enhanced surveillance and outbreak investigations have identified new control measures and focused attention on preventing foodborne diseases. The declines in the incidence of these foodborne infections occurred in the context of several control measures, including implementation by the U.S. Department of Agriculture's Food Safety Inspection Service (FSIS) of the Pathogen Reduction/Hazard Analysis Critical Control Point (HACCP) systems regulations in meat and poultry slaughter and processing plants. The decline in the rate of *Salmonella* infections in humans coincided with a decline in the prevalence of *Salmonella* isolated from FSIS-regulated products to levels well below baseline levels before HACCP was implemented.[3] Additional interventions include egg-safety programs for *S*. Enteritidis, increased attention to fresh produce safety through better agricultural practices, introduction of HACCP in the seafood industry, regulation of fruit and vegetable juice, industry efforts including new intervention technologies to reduce food contamination, food safety education, and increased regulation of imported food.

Although the incidence of infection has declined for several foodborne diseases, the incidence of foodborne diseases remains high. Efforts to reduce the rate of foodborne illnesses might include steps to reduce the prevalence of these pathogens in their respective important animal reservoirs: cattle (*E. coli* O157), egg-laying chickens (*S.* Enteritidis), and seafood, particularly oysters (*Vibrio*). Implementation of nationwide, consistent, on-farm preventive controls would reduce the risk for human illness from *S.* Enteritidis-contaminated eggs. The increases in infections caused by *S*. Newport, *S.* Heidelberg, and *S*. Javiana[4] and the high incidence of foodborne diseases in children, especially infants, are of major concern. To determine possible risk factors for infections and opportunities for prevention, FoodNet has initiated a case-control study of sporadic cases of *Salmonella* and *Campylobacter* in young children.

The findings in this report are subject to at least three limitations. First, FoodNet data are limited to diagnosed illnesses; though, most foodborne illnesses are neither laboratory diagnosed nor reported to state health departments. For

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[1]Hawkins M, Delong SM, Marcus R, et al. The burden of diarrheal illness in FoodNet, 2000–2001. Conference on Emerging Infectious Diseases. Atlanta, Georgia, March 2002. Available at http://www.cdc.gov/foodnet/pub/iceid/2002/hawkins_m.htm.
[2]Voetsch A, Angulo F, Rabatsky-Ehr T, et al. Laboratory practice in FoodNet sites, 1995–1999. Conference on Emerging Infectious Diseases. Atlanta, Georgia, March 2002. Available at http://www.cdc.gov/foodnet/pub/iceid/2002/voetsch_a.htm.
[3]U.S. Department of Agriculture. Pathogen Reduction/HAACP & HACCP Implementation. Available at http://www.fsis.usda.gov/oa/haccp/imphaccp.htm.
[4]CDC. Public Health Laboratory Information System surveillance data, *Salmonella* annual summaries. Available at http://www.cdc.gov/ncidod/dbmd/phlisdta/salmonella.htm.

example, although clinical laboratories in FoodNet sites routinely test stool specimens for *Salmonella* and *Shigella,* and almost always for *Campylobacter,* only about 60% routinely test for *E. coli* O157, and fewer test routinely for other pathogens. Variations in testing for pathogens could account for some of the variations in incidence, including variations by site and age. Second, because some laboratory-diagnosed illnesses reported to FoodNet also might be acquired through nonfoodborne routes (e.g., through contaminated water, person-to-person contact, and direct animal exposure), reported rates do not represent foodborne sources exclusively. Finally, although FoodNet data provide the most detailed information available for these infections, the data do not reflect the entire U.S. population.

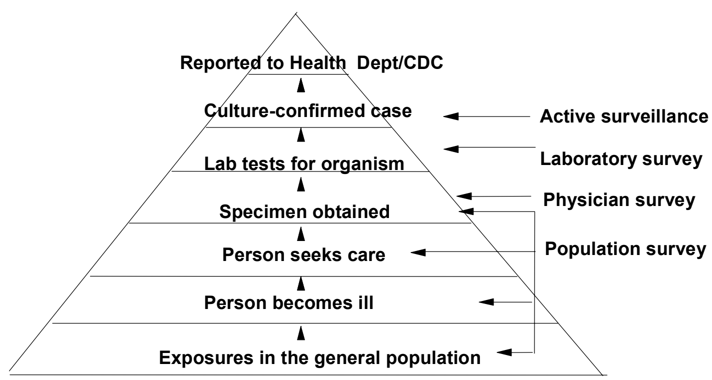
## *Other Ongoing Projects*

***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 9). 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.[5]

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 9. Burden of Illness Pyramid**




***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, and Typhimurium; infant salmonellosis; *Campylobacter*; and *Cryptosporidium*. A *Listeria* case-control study is ongoing. Case-control studies of infant *Salmonella*

5 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

and *Campylobacter* infections, *Salmonella* Newport and *Salmonella* Enteritidis 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 2001*

- The population under active surveillance was expanded in 2001 by including five additional counties in Colorado and Prince George's County and Montgomery County in Maryland.
- The third cycle of the FoodNet population survey was completed in 2001. The purpose of the survey is to estimate more precisely the burden of acute diarrheal illness in the United States. FoodNet population survey data help determine the prevalence and severity of self-reported diarrheal illness, common symptoms associated with diarrhea, the proportion of persons with diarrhea who seek care, and exposures that may be associated with foodborne illness.
- The *E. coli* O157 case-control study was completed, enrolling 333 cases and 591 controls. Preliminary analysis reported at the 2002 International Conference on Emerging Infectious Diseases can be obtained at http://www.cdc.gov/foodnet/pub/iceid/2002/kennedy_m.htm.
- The *Cryptosporidium* case-control study was completed, enrolling 281 cases and 524 controls.
- FoodNet continued collaboration with the Environmental Health Specialists Network (EHS-Net) to strengthen relationships between epidemiology, laboratory, and food protection programs and to better identify factors contributing to foodborne illness and foodborne disease outbreaks, particularly in retail establishments.

## *Future Activities for 2002*

- Continue population-based surveillance for *Campylobacter*, *Cryptosporidium*, *Cyclospora*, *Salmonella*, *Shigella*, Shiga toxin-producing *Escherichia coli* including *E. coli* O157, *Listeria*, *Yersinia*, and *Vibrio* infections, and for hemolytic uremic syndrome.
- Conduct the fourth cycle of the FoodNet population survey. Begun in 2002 in the nine FoodNet sites, it will run for 12 months and will be conducted in both English and Spanish.
- Continue the *Listeria* case-control study.
- Conduct case-control study of infant *Salmonella* and *Campylobacter* infections.
- Conduct case-control study of *Salmonella* Newport infections.
- Conduct case-control study of *Salmonella* Enteritidis infections.
- Continue collaboration with EHS-Net to better identify factors contributing to foodborne illness and foodborne disease outbreaks, particularly in retail establishments.
- Conduct cohort study to estimate the proportion of enteric infections that progress to reactive arthritis.
- Conduct Retail Food study to determine the prevalence of antimicrobial resistance among *Salmonella*, *Campylobacter*, *E. coli*, and enterococci isolated from a convenience sample of chicken, ground turkey, ground beef, and pork chops purchased from selected grocery stores in the United States.
- The population under active surveillance will be expanded in 2002 to include all counties in Maryland, Boulder, and Broomfield counties in Colorado, and Erie, Niagara, and Wyoming counties in New York.

# *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. FoodNet Surveillance Report for 1998: Final Report. Atlanta: Centers for Disease Control and Prevention; 1998.
CDC. FoodNet Surveillance Report for 1999: Final Report. Atlanta: Centers for Disease Control and Prevention; 2000.
CDC. FoodNet Surveillance Report for 2000: Final Report. Atlanta: Centers for Disease Control and Prevention; 2002.

**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.

**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

**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**

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***www.cdc.gov/foodnet***

## *Part II*
## *Summary Tables and Graphs*

## *Part II: Listing of Summary Tables and Graphs*

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## *Graphs*

Rates per 100,000 by pathogen per month
*Campylobacter*
*Cryptosporidium*
*Cyclospora*
*Escherichia coli* O157
STEC nonO157
*Listeria*
*Salmonella*
*Salmonella* Enteritidis
*Salmonella* Typhimurium
*Salmonella* Heidelberg
*Salmonella* Newport
*Salmonella* Montevideo
*Salmonella* Agona
*Shigella*
*Shigella sonnei*
*Shigella flexneri*
*Shigella dysentariae*
*Vibrio*
*Yersinia*

Age-specific rates per 100,000 distribution by pathogen for all sites
*Campylobacter*
*Cryptosporidium*
*Cyclospora*
*Escherichia coli* O157
*Listeria*
*Salmonella*
*Shigella*
*Vibrio*
*Yersinia*