FoodNet
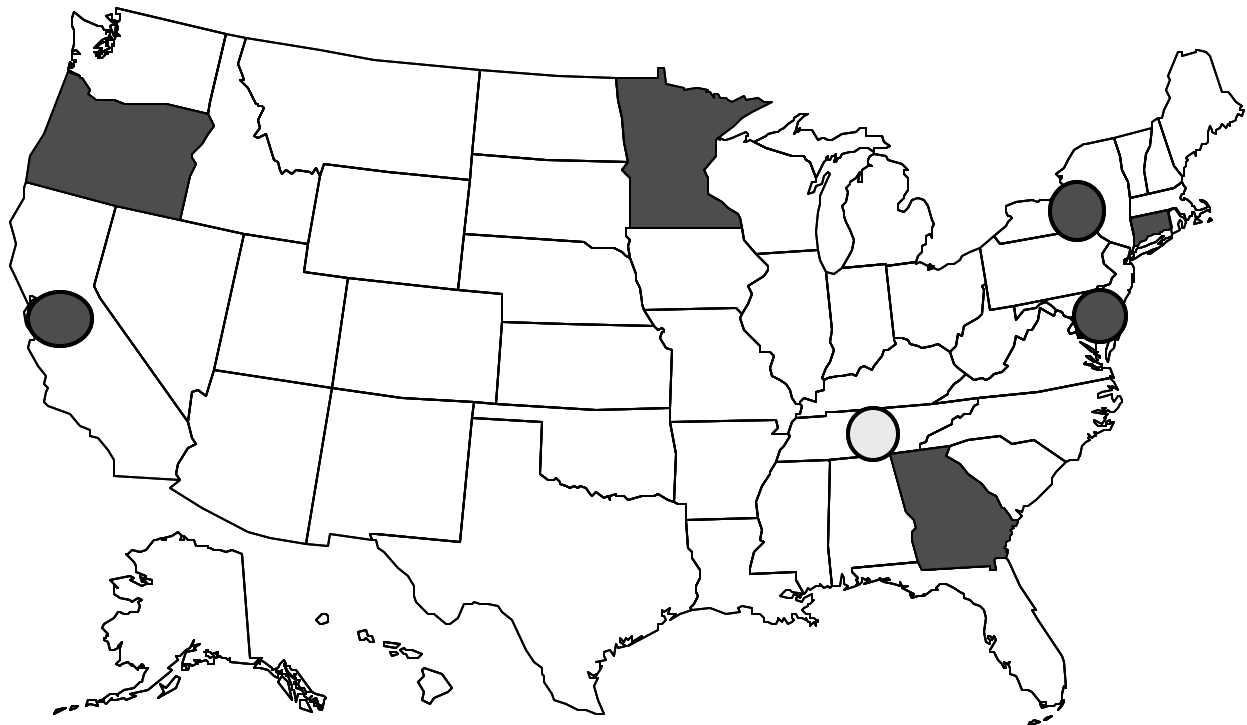## Foodborne Diseases Active Surveillance Network
CDC's Emerging Infections Program

1999 Surveillance Results
Preliminary Report

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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 eight EIP sites, the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA), and the Food and Drug Administration (FDA). FoodNet augments, but does not replace, longstanding activities at CDC, FSIS, 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 Pathogen Reduction and Hazard Analysis and Critical Control Points (HACCP) Rule, in decreasing the number of cases of foodborne diseases in the United States each year.

The following are key findings of FoodNet surveillance activities during 1999:

C   Since 1997, there has been a 19% overall decline in incidence of the bacterial foodborne infections. Although these declines might reflect simple annual fluctuations in foodborne illness, they were concurrent with several interventions, including implementation of mandated changes in meat and poultry processing plants, increased attention to "good agricultural practices" on farms, and increased consumer awareness. Much of this work has been supported by the President's Food Safety Initiative.

C   *Campylobacter* continued to decline in 1999, decreasing in incidence 19% from 1998. Poultry is the most common source of *Campylobacter* infections. This decline is likely related to changes in poultry processing plants instituted by industry and encouraged by the Pathogen Reduction and Hazard Analysis and Critical Control Points (HACCP) rule of the United States Department of Agriculture that may be leading to less *Campylobacter* contamination of poultry.

C   *Shigella* incidence demonstrated a 44% decline from 1998 to 1999. This decline follows a large outbreak of shigellosis in 1998 traced to imported parsley, which focused attention on the problems of produce-associated shigellosis and the need for improving basic sanitation on produce farms

throughout the continent. This outbreak highlighted the global nature of foodborne illness. The response to the 1998 outbreak suggests that international collaboration may lead to effective interventions.

C   The rate of *Salmonella* infections increased in 1999. However, infections due to the most common serotype, Typhimurium, remained constant, and infections due to the second most common serotype, Enteritidis, declined. The continued decline of *Salmonella* Enteritidis, an egg-associated serotype, occurred in the setting of increased farm-to-table control measures. Increases in other *Salmonella* serotypes may be related to large outbreaks associated with unpasteurized orange juice, raw sprouts, and mangos.

C   The rate of *E. coli* O157 infections decreased in 1999 to a 4-year FoodNet low. This decline occurs in the setting of improved sanitation and hygiene in slaughter and processing plants and attention to hamburger cooking temperature. Further surveillance is needed to clarify whether this new low is the beginning of a trend.

C   FoodNet completed a case-control study of *Campylobacter* infections in 1999. Ongoing analysis of the data indicates that travel and eating undercooked poultry are risk factors for the infection.

C   In FoodNet sites, *Listeria* infections were associated with the highest hospitalization rate and caused nearly half of the reported deaths. FoodNet will begin a case-control study of *Listeria* infections in 2000 to identify food sources and potential control points.

Background

Foodborne infections are an important public health challenge. The Centers for Disease Control and Prevention (CDC) estimates 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 Food and Drug Administration (FDA), and the eight 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. This mission is being accomplished through several activities including FoodNet.

Objectives   The objectives of FoodNet are to determine the frequency and severity of foodborne diseases; determine the proportion of common foodborne diseases that result from 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 HACCP Rule, in decreasing the rate of foodborne diseases in the United States each year.

Methods   In 1999, FoodNet conducted population-based active surveillance for confirmed cases of *Campylobacter*, *Cryptosporidium*, *Cyclospora*, Shiga toxin-producing *Escherichia coli* O157, *Listeria*, *Salmonella*, *Shigella*, *Vibrio*, and *Yersinia* infections in Connecticut, Georgia, Minnesota, and Oregon and selected counties in California, Maryland, and New York (total population 25.6 million). To identify cases, FoodNet personnel contact each of the more than 300 clinical laboratories serving the catchment areas, either weekly or monthly, depending on the size of the clinical laboratory. FoodNet also conducts surveillance for hemolytic uremic syndrome through pediatric nephrologists, and surveillance for foodborne disease outbreaks.

Results

Cases reported   The results contained in this report are preliminary. FoodNet attempts to finalize surveillance case-counts in late February, however, audits and additional case-finding may change the number of cases which will be published in the final 1999 Annual Report.

In 1999, a total of 10,697 confirmed cases of infections caused by the pathogens under surveillance were identified in the seven sites. Of these, 10,209 were bacterial, caused by 3794 *Campylobacter* infections, 4533 *Salmonella* infections, 1031 *Shigella* infections, 530 *E. coli* O157 infections, 163 *Yersinia* infections, 113 *Listeria* infections, and 45 *Vibrio* infections (Table 1A). Of the 4095 *Salmonella* isolates that were serotyped, the most commonly identified serotypes were Typhimurium (982 cases), Enteritidis (403), Newport (362), Heidelberg (284), and Muenchen (231). In addition, 488 cases of parasitic diseases were reported, including 474 cases of *Cryptosporidium* infection and 14 cases of *Cyclospora* infection (Table 1B).

Table 1A. Cases of infections caused by specific bacterial pathogens, reported by FoodNet sites, 1999

| Pathogen	Total
Campylobacter	3794
E. coli O157	530
Listeria	113
Salmonella	4533
Shigella	1031
Vibrio	45
Yersinia	163
Total	**10209**

Table 1B. Cases of infections caused by specific parasitic pathogens, reported by FoodNet sites, 1999

Pathogen	Total
Cryptosporidium	474
Cyclospora	14
Total	488

Seasonality

Isolation rates for pathogens showed seasonal variation; 35% of *Campylobacter*, 40% of *Salmonella*, 37% of *Shigella,* and 41% of *E. coli* O157 were isolated during June through August (Figure 1). *Yersinia* infections were more likely to have occurred in winter months with 40% of cases being reported during January, February, or December.

Figure 1. Cases of foodborne disease caused by specific pathogens, by month, FoodNet Sites, 1999
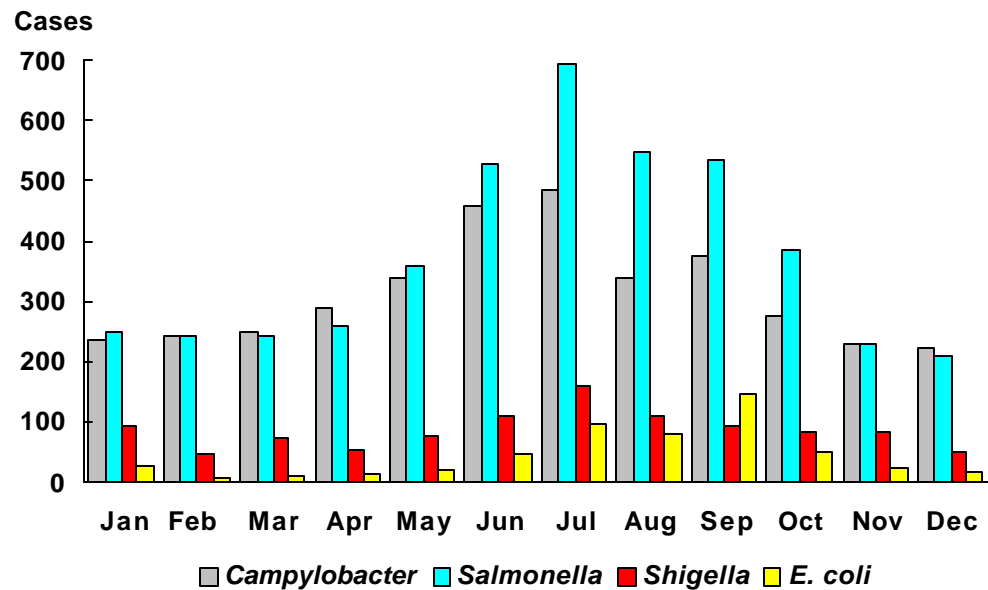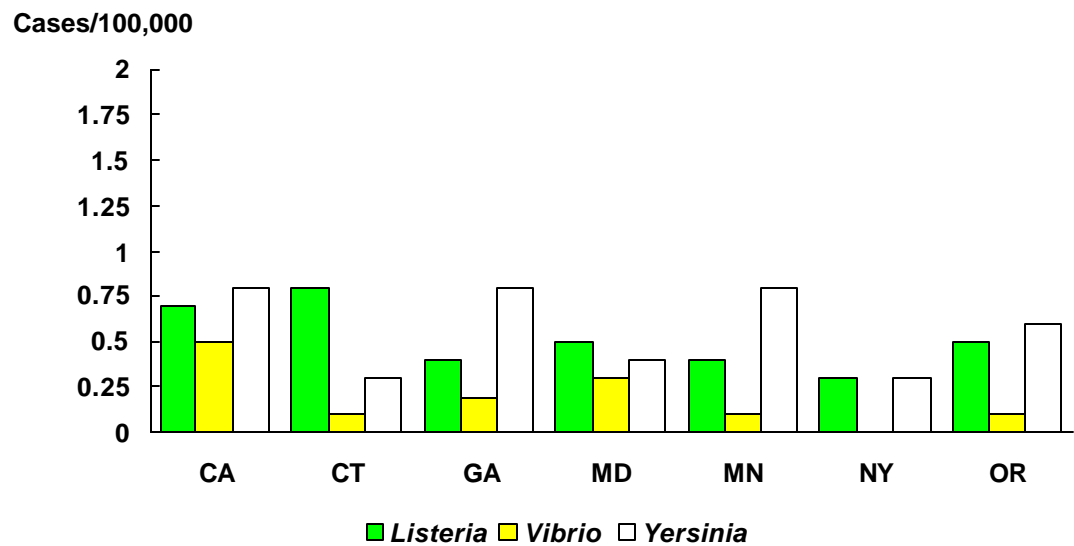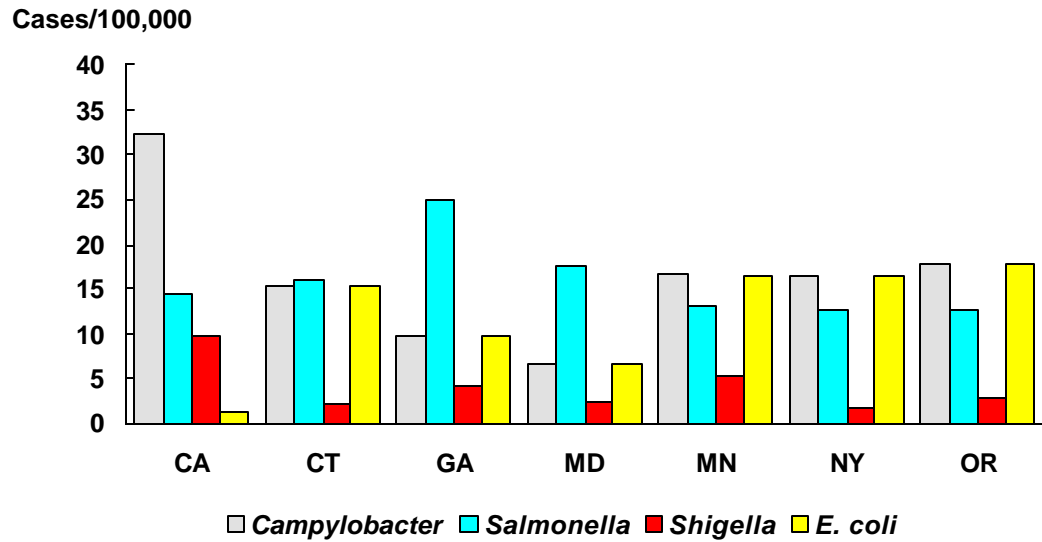
1999 Rates

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 1999 rates reported here use 1998 population estimates and are therefore considered preliminary. Final incidence data will be available once 1999 population estimates are available in mid-2000. Overall incidence rates were highest for infections with *Salmonella* (17.7/100,000 population), *Campylobacter* (14.8/100,000), and *Shigella* (4.0/100,000). Lower overall incidence rates were reported for *Cryptosporidium* (1.5/100,000), *E. coli* O157 (2.0/100,000), *Yersinia* (0.6/100,000), *Listeria* (0.5/100,000), *Vibrio* (0.2/100,000), and *Cyclospora* (0.04/100,000).

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 6.6/100,000 in Maryland to 32.5/100,000 in California and for *Shigella* infections, from 1.7/100,000 in New York to 9.7/100,000 in California. Incidence rates for aggregate *Salmonella* infections also varied among the sites, from 12.7/100,000 in New York to 25.5/100,000 in Georgia. Among the two most common serotypes of *Salmonella*, *S.* Typhimurium ranged from 2.0/100,000 in New York to 4.6/100,000 in Georgia and *S.* Enteritidis ranged from 0.7/100,000 in New York to 4.0/100,000 in Maryland. Incidence rates for *E. coli* O157 infection varied from 0.6/100,000 in Georgia to 5.8/100,000 in New York. Some New York cases are related to a large waterborne outbreak of *E. coli* O157 infections that occurred in 1999. Infections caused by *Yersinia* varied from 0.3/100,000 in New York and Connecticut to 0.8/100,000 in California, and Georgia. Incidence rates of *Cryptosporidium* cases ranged from 0.3/100,000 in Maryland to 2.3/100,000 in Georgia. Reasons for these regional differences in incidence rates are being investigated; for example, most laboratories do not test specimens routinely for all pathogens. Regional difference in *E. coli* O157 incidence are not accounted for by regional differences in laboratory practices.

Figure 2. Cases per 100,000 population of foodborne disease caused by specific pathogens, FoodNet sites, 1999

Cases/100,000

☐ *Campylobacter* ■ *Salmonella* ■ *Shigella* ☐ *E. coli*

Cases/100,000

■ *Listeria* ■ *Vibrio* ☐ *Yersinia*

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 146.5/100,000 and the rate of *Campylobacter* infection was 40.6/100,000, rates substantially higher than for other age groups.

Figure 3. Incidence of *Campylobacter* and *Salmonella* infections by age group, FoodNet sites, 1999

Cases / 100,000
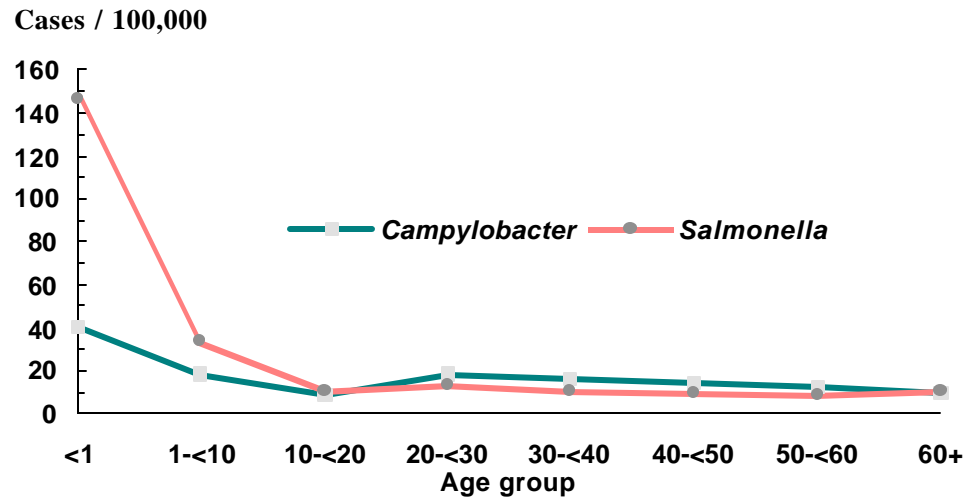
Rates by sex

Incidence rates varied by sex (Table 2). Overall, males were more likely than females to be infected with every pathogen except *Cyclospora* and *Yersinia* (for which rates were approximately equal for both sexes). Rates of *Cryptosporidium* infection were 64% higher among males, rates of *Campylobacter* infection were 21% higher among males, and rates of *Shigella* were 12% higher among males.

Table 2. Sex-specific incidence rates per 100,000 population, by pathogen, FoodNet sites, 1999

| Pathogen	Male	Female
Campylobacter	16.4	12.9
Cryptosporidium	2.2	0.8
Cyclospora	0.04	0.05
E. coli O157	2.0	2.1
Listeria	0.4	0.5
Salmonella	16.9	16.4
Shigella	4.2	3.7
Vibrio	0.2	0.1
Yersinia	0.6	0.6
Total	**42.9**	**37.2**

Rates by age and sex

The incidence rate of *Campylobacter* infection was higher for males than for females in all age groups, except for 60 and over. The incidence rate of *Salmonella* infection was higher among males for all age groups under 30 years and the age group 40-49 years compared with females.

Hospitalizations

Information on hospitalization is still being collected. Preliminary data show that overall, 19% of culture-confirmed persons were hospitalized; hospitalization rates differed markedly by pathogen (Figure 4). The rate of hospitalization was highest for persons infected with *Listeria* (88%) followed by those infected with *E. coli* O157 (37%), *Yersinia* (36%), *Vibrio* (25%), *Salmonella* (22%), *Shigella* (14%), and *Campylobacter* (11%).

Figure 4. Percentage of persons hospitalized with infections caused by specific pathogens, FoodNet sites, 1999
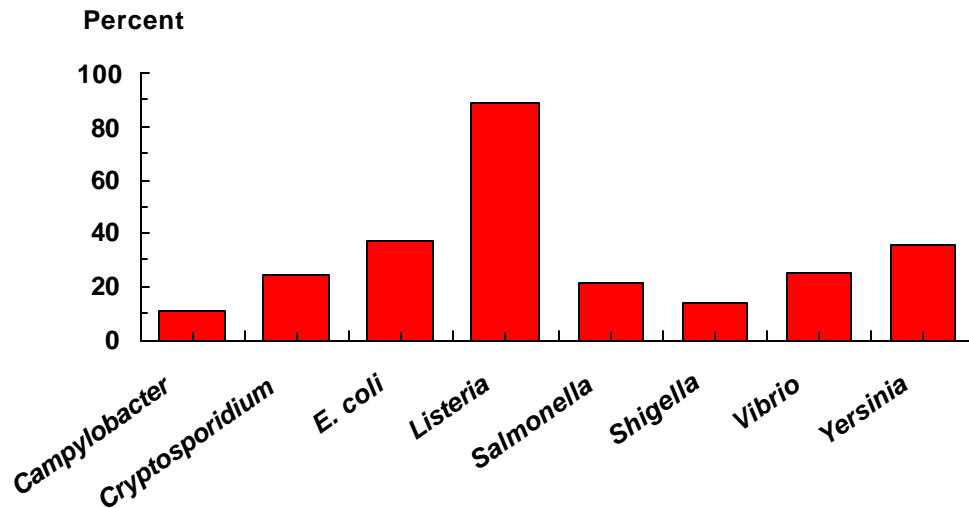
Outbreaks

Information on foodborne disease outbreaks is still being collected. A foodborne disease outbreak is defined as an incident with two or more persons ill caused by ingestion of a common food that is investigated and reported by the health department (Table 3). The overall rate of foodborne disease outbreaks in which 10 or more persons become ill reported in FoodNet sites was 3.3 outbreaks per million population, ranging from 0.9 outbreaks per million in Connecticut to 6.1 outbreaks

per million in Oregon. The variation in rates may be partly related to variation in resources and disease-surveillance activities of state and local public health agencies.

Table 3: Outbreaks reported with 10 or more persons ill, FoodNet sites, 1998-1999

	1998		1999	
Site	**Events**	**Rate / 1,000,000**	**Events**	**Rate/ 1,000,000**
California	12	5.7	3	1.3
Connecticut	7	2.1	3	0.9
Georgia	3	0.8	10	1.3
Maryland	10	4.1	12	4.9
Minnesota	24	5.1	28	5.9
New York	9	8.1	9	4.3
Oregon	12	3.6	20	6.1
Total	**77**	**3.8**	**85**	**3.3**

1996-1999 Rates For the five original sites, overall incidence rates of illness caused by pathogens under surveillance declined from 1996 to 1999 (Table 4A). Infections caused by *Campylobacter* and *Shigella* showed the largest decrease, from 23.5/100,000 and 8.9/100,000 in 1996 to 17.3/100,000 and 5.0/100,000 in 1999, representing 19% and 41% declines respectively. *E. coli* O157 infections declined 22% from 1996 to 1999, *Yersinia* infections declined 20% in the same time period, and *Cryptosporidium* infections declined 19% from 1997 to 1999. The overall incidence of salmonellosis decreased 15% from 1996 to 1998; however, the incidence increased 20% from 1998 to 1999. Compared with 1998 rates, 1999 rates for salmonellosis increased in Connecticut, Georgia, Minnesota, and Oregon, and declined in California. Rates for *S* Typhimurium, the most common serotype, were constant from 1996 to 1999 (3.9 to 3.6 respectively). SE rates declined 48% from 1996 to 1999 with a 7 % decline from 1998 to 1999 (Table 4B). From 1998 to 1999,

Salmonella infections with serotypes Muenchen, Newport, and Heidelberg increased 348%, 79%, and 44% respectively. The incidence of *Vibrio* infections, which increased substantially from 1996 through 1998, declined in 1999. Incidence rates for *Listeria* have been slightly higher in the past 2 years, in the setting of a large multistate outbreak. The incidence of illness caused by *Cryptosporidium* decreased from 2.8/100,000 in 1997 to 2.2/100,000 in 1999, and *Cyclospora* decreased from 0.09/100,000 in 1997 to 0.03/100,000 in 1999.

1997-1999 Rates   CDC estimates of the burden of foodborne illness in the United States (Mead, et al. *Emerging Infectious Diseases* 1999) are largely based on 1997 FoodNet data. In those estimates, the bacterial foodborne pathogens included in FoodNet surveillance caused an estimated 4.5 million illnesses annually. Since 1997 the aggregate incidence of these bacterial pathogens has declined 19%.

Table 4A. Rate* and percent change of selected pathogens detected by FoodNet at the five original sites, by year and pathogen, 1996-1999

Pathogen	1996	1997	1998	1999	% change		
					1996-1999	1997-1999	1998-1999
Campylobacter	23.5	25.2	21.4	17.3	-26	-31	-19
Cryptosporidium	NR§	3.0	3.4	2.9	NR§	-3	-15
Cyclospora	NR§	0.3	<0.1	<0.1	NR§	-67	0
E. coli **O157**	2.7	2.3	2.8	2.1	-22	-9	-25
Listeria	0.5	0.5	0.6	0.5	0	0	-17
Salmonella	14.5	13.6	12.3	14.8	-2	9	+20
Shigella	8.9	7.5	8.5	5.0	-44	-33	-41
Vibrio	0.1	0.3	0.3	0.2	+100	-33	-33
Yersinia	1.0	0.9	1.0	0.8	-20	-11	-20
Total	**51.2¶**	**50.3¶**	**46.9 ¥¶**	**40.7¶**	**-21¶**	**-19¶**	**-13¶**

* Per 100,000 population. ¥ Corrected from March 2000 MMWR. § Not reported. ¶ Excludes *Cryptosporidium* and *Cyclospora*.

Table 4B. Rate* and percent change of *S*. Typhimurium and *S*. Enteritidis detected by FoodNet at the five original sites, by year and serotype, 1996-1999

Pathogen	1996	1997	1998	1999	% change		
					1996-1999	1997-1999	1998-1999
Salmonella **Enteritidis**	2.5	2.3	1.4	1.3	-48	-43	-7
Salmonella Typhimurium	3.9	3.9	3.7	3.6	-8	-8	-3

* Per 100,000 population.

Burden of Illness

Cases reported through active surveillance represent a fraction of the number of cases in the community. To estimate better 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 testing for bacterial pathogens influence the number of culture-confirmed cases. Using FoodNet and other data, CDC estimates that there were 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in 1997 in the United States.

Figure 5. Burden of illness pyramid

Reported to health dept. / CDC
↑
Culture-confirmed case
↑
Lab tests for organism
↑
Specimen obtained
↑
Person seeks care
↑
Person becomes ill
↑
Population exposures

← Active surveillance

← Laboratory survey

← Physician survey

← Population survey
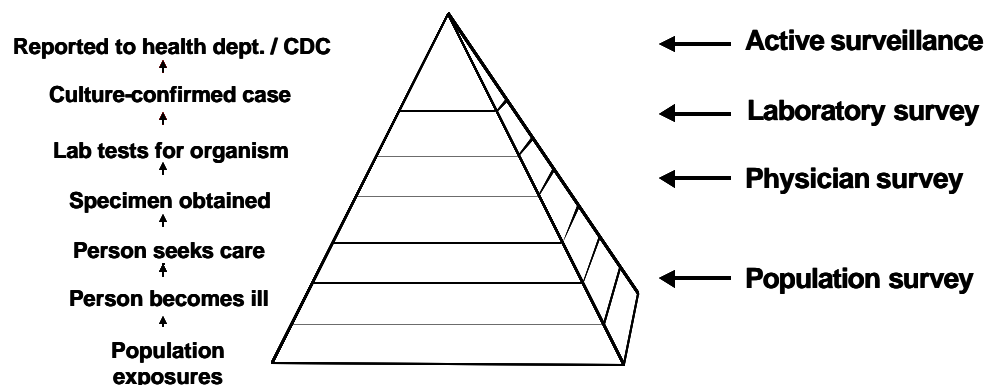
This model can be used for developing estimates of the burden of illness caused by each foodborne pathogen. For example, data from this model suggest that in 1997 there were 1,400,000 *Salmonella* infections, resulting in 113,000 physician office visits, and 37,200 culture-confirmed cases in this country. Culture-confirmed cases alone resulted in an estimated 8500 hospitalizations and 300 deaths; additional hospitalizations and deaths occur among persons whose illness is not culture-confirmed.

Causes of Foodborne Diseases

As part of FoodNet, case-control studies are conducted to determine the proportion of foodborne diseases that are caused by specific foods or food preparation and handling practices. By determining this proportion, prevention efforts can be made more specific and their effectiveness documented.

C **_E. coli_ O157 case-control studies**

A case-control study of *E. coli* O157 infections conducted at FoodNet sites in 1997 found that undercooked ground beef was the principal food source of these infections. In 1999, FoodNet concluded data collection for a follow-up *E. coli* O157 case-control study. This follow-up study will more precisely determine risk and prevention factors for *E. coli* O157 infections. Analysis of the latest study is underway.

C **_Salmonella_ case-control studies**

Eating chicken and undercooked eggs was associated with sporadic *Salmonella* Enteritidis and *Salmonella* Heidelberg infections. Antimicrobial use in the month before illness was associated with multiresistant *Salmonella* Typhimurium DT104 infections. Breast-feeding was found to be protective against infant salmonellosis. Reptile contact was associated with salmonellosis.

C **_Campylobacter_ case-control study**

In 1999, FoodNet concluded data collection for the *Campylobacter* case-control study. This study will more precisely determine risk and prevention factors for *Campylobacter* infection through analysis of more than 1200 cases and 1200 controls. Analysis is ongoing.

C **_Listeria_ case-control study**

To determine sources and risk factors for listeriosis, a FoodNet case-control study has recently began and will run for 2 years.

C **_Cryptosporidium_ case-control study**

A FoodNet case-control study to determine sources and risk factors for *Cryptosporidium* infection begun in 1999 will continue for 1 year.

Future activities

C   Continue population-based surveillance for *Campylobacter, Cryptosporidium, Listeria monocytogenes, Cyclospora, Salmonella, Shigella,* Shiga-toxin producing *Escherichia coli, Vibrio, and Yersinia enterocolitica,* infections and for hemolytic uremic syndrome (HUS).

C   Repeat the survey of the general population in the FoodNet catchment area beginning February 2000 to help determine the burden of illness and frequency of risk factors in the community.

C   Conduct surveillance for all foodborne disease outbreaks of any cause that occur within the FoodNet sites and pilot electronic reporting for outbreaks.

C   Expand the population under active surveillance by including additional counties in Tennessee in 2000 and preparing Colorado for participation starting 2001. In 2000, the population within the catchment areas will include 32.6 million persons or 12% of the U.S. population.

C   Continue analysis of *E. coli* O157 case-control study.

C   Continue *Cryptosporidium* infections case-control study.

C   Conduct a case-control study of *Listeria* infections.

C   Repeat a survey of clinical laboratories in FoodNet sites to determine changes in laboratory practices.

1999 FoodNet Working Group

CDC

Frederick Angulo
Thomas Van Gilder
Patricia Griffin
Robert Tauxe
Sudha Reddy
Malinda Kennedy
Beth Imhoff
Samantha Yang
David J. Wallace
Stephanie Wong
Nina Marano
Paul Mead
David Swerdlow
Laurence Slutsker
Cindy Friedman
Vance Dietz
Sarah Pichette
Karen Stamey
Peggy Hayes
Timothy Barrett
Bala Swaminathan
Richard Bishop
Kathleen Maloney
Mike Hoekstra
Nancy Bean
Laura Conn
Robert Pinner

California

Duc Vugia
Michael Samuel
Ben Werner
Kevin Reilly
Sharon Abbott
Sue Shallow

Gretchen Rothrock
Pam Daily
Alexander McNees
Nandeeni Mukerjee
Joelle Nadle
Mary Ann Davis
Lisa Gelling
Ben Silk

Connecticut

James Hadler
Matthew Cartter
Ruthanne Marcus
Terry Fiorentino
Gazala Kazi
Robin Ryder
Patricia Mshar
Robert Howard
Donald Mayo

Georgia

Paul Blake
Jane Koehler
Monica Farley
Susan Ray
Wendy Baughman
Suzanne Segler
Shama Desai
Matthew Sattah
Sabrina Whitfield
Molly Bardsley
Katherine Gibbs-McCombs
Laura Gilbert

Maryland

Kelly Henning
Peggy Pass
Lora Gay
Michael Carter
Dale Rohn
Jeffery Roche
Diane Dwyer
Althea Glenn
Jafar Razeq
Yongyu Wong
Alexander Sulakvelidze
J. Glenn Morris, Jr.

Minnesota

Michael Osterholm
Craig Hedberg
Julie Wicklund
Valerie Deneen
Heidi Kassenborg
Jeff Bender
Kirk Smith
John Besser

New York

Dale Morse
Perry Smith
Shelley Zansky
Nellie Dumas
Barbara Damaske
Hwa-Gan Chang
Candace Noonan
Brian Sauders
Karim Hechemy

Oregon

David Fleming
Paul Cieslak
Bill Keene
Beletshachew Shiferaw
Maureen Cassidy
Teresa McGivern
Regina Stanton
Steve Mauvais
Stephen Ladd-Wilson
Bob Sokolow
Vijay Balan

Tennessee

William Moore
Allen Craig
Timothy Jones
William Schaffner
Brenda Barnes

USDA-FSIS

Kaye Wachsmuth
Phyllis Sparling
Ruth Etzel

FDA-CFSAN

Ken Falci
Bing Garthright
Clifford Purdy

For more information on FoodNet, visit our web-page at:

www.cdc.gov/ncidod/dbmd/foodnet