two or more persons have become ill from a common source. These reported cases are only a fraction of the actual annual incidence of foodborne disease cases for many reasons:

 Symptoms typical of several forms of foodborne illness include diarrhea, vomiting, abdominal pain, and physical weakness. These symptoms are also common to a wide variety of bacterial and viral infections not generally associated with food consumption. Consequently, many treated cases of foodborne illness are generically diagnosed as non-specific gastroenteritis or "the flu" and not identified as being caused by a specific foodborne pathogen.

 Most foodborne illness is transitory and self-limiting. People often become sick within a few hours after consumption of contaminated food, suffer acute symptoms, and recover spontaneously. These people are unlikely to seek medical attention, and will not become part of the reporting database.

• While some foodborne pathogens cause illness within a few hours of food consumption (Staphylococcus aureus and Salmonella), many common pathogens cause illness after a lag of several days (E. coli O157:H7 and Campylobacter) or weeks (Listeria *monocytogenes*). The longer the lag between consumption and illness, the less likely the connection to food will be made.

 Individual cases of foodborne illness are excluded from the CDC reporting system, except for botulism, toxic fish, mushrooms, and certain chemical poisonings where one case constitutes an outbreak.

• Around half of CDC's reported outbreaks and cases are never identified with a causative pathogen.

 CDC primarily relies upon voluntary reporting from State and local health agencies which, in turn, rely on hospitals, clinics, and individual health care professionals for information. All these institutions have resource limitations and different disease reporting requirements. For example, 12 States have no surveillance staff assigned to monitor foodborne diseases.

For the 4 foodborne pathogens of greatest concern, the case and severity estimates presented here are the "best estimates" of the actual incidence of foodborne disease associated with specific pathogens, rather than the fraction of cases actually reported to CDC. Many of the "best estimates" were developed by the landmark CDC study by Bennett, Holmberg, Rogers, and Solomon, published in 1987, which used CDC surveillance and outbreak data, published reports, and expert opinion to estimate the overall incidence and case-fatality ratio for all infectious and parasitic diseases, and identified 17 as foodborne pathogens. All the estimates of bacterial foodborne disease cases in Table 3 are based on CDC data to estimate actual cases of foodborne disease caused by each pathogen. (The estimated cases for the parasitic disease, congenital toxoplasmosis, are based on various reports in the medical literature.)

TABLE 3.—REFERENCE SOURCES OF DATA FOR SELECTED HUMAN PATHOGENS, 1993

Pathogen	Foodborne illness cases (#)	Source(s) for case estimates
Bacteria:		
Campylobacter jejuni or coli	1,375,000-1,750,000	Tauxe; Tauxe et al.
Clostridium perfringens	10,000	Bennett et al.
Escherichia coli O157:H7	8,000–16,000	AGA Conference.
Listeria monocytogenes	1,616–1,674	Roberts and Pinner; Schuchat.
Salmonella	732,000–3,660,000	Helmick et al.; Bennett et al.; Tauxe & Blake.
Staphylococcus aureus Parasite:	1,513,000	Bennett et al.
Toxoplasma gondii	2056	Roberts, Murrell, and Marks.

Sources: American Gastroenterological Association Consensus Conference on E. coli O157:H7, Washington, DC, July 11-13, 1994.

Bennett, J.V., S.D. Holmberg, M.F. Rogers, and S.L. Solomon. 1987. "Infectious and Parasitic Diseases," In R.W. Amler and H.B. Dull (Eds.) *Closing the Gap: The Burden of Unnecessary Illness.* Oxford University Press, New York. Helmick, C.G., P.M. Griffin, D.G. Addiss, R.V. Tauxe, and D.D. Juranek. 1994. "Infectious Diarrheas." In: Everheart, JE, ed. *Digestive Dis-*

eases in the United States: Epidemiology and Impact.

USDHHS, NIH, NIDDKD, NIH Pub. No. 94–1447, pp. 85–123, Wash, DC: USGPO. Roberts, T., K.D. Murrell, and S. Marks. 1944. "Economic Losses Caused by Foodborne Parasitic Diseases," Parasitology Today. vol. 10, no. 11: 419-423.

Roberts, T. and R. Pinner. "Economic Impact of Disease Caused by Listeria monocytogenes" in Foodborne Listeriosis ed. by A.J. Miller, J.L. Smith, and G.A. Somkuti. Elsevier Science: Amsterdam, The Netherlands, 1990, pp. 137-149.

Schuchat, Anne, CDC, personal communication with T. Roberts at the FDA Science Forum on Regulatory Sciences, Washington, DC, September 29, 1994

Tauxe, R.V., "Epidemiology of Campylobacter jejuni infections in the United States and other Industrialized Nations." In Nachamkin, Blaser, Tompkins, ed. *Campylobacter jejuni: Current Status and Future Trends*, 1994, chapter 2, pages 9–19. Tauxe, R.V. and P.A. Blake, Salmonellosis. Chap. 12. In: Public Health & Preventive Medicine. 13th ed. (Eds: Last JM; Wallace RB; Barrett-Conner E) Appleton & Lange, Norwalk, Connecticut, 266–268.

Tauxe, R.V., N. Hargrett-Bean, C.M. Patton, and I.K. Wachsmuth, 1988, "Campylobacter Isolates in the United States, 1982–1986," Morbidity and Mortality Weekly Report, vol. 31, no. 88–2.

Data collected by CDC also show food source for foodborne illness. Food products of all types, including beef, pork, turkey, chicken, bakery products, dairy products, eggs, finfish, shellfish, ice cream, mushrooms, fruits and vegetables, are associated with

foodborne illness. Among foodborne illness outbreaks reported to CDC, the majority of those which can be identified are traced to pathogenic bacteria. The six target pathogens account for nearly all meat and poultry foodborne illness outbreaks and about

75% of total reported outbreaks caused by a bacterial agent.

B. Costs of Foodborne Illness

Table 4 shows the estimated cost of all foodborne illness to be approximately \$5.6-9.4 billion in 1993.