

# WTP ESTIMATES OF THE SOCIETAL COSTS OF U.S. FOOD-BORNE ILLNESS

TANYA ROBERTS

The U.S. federal government has a prominent role in regulating food safety. Estimates of the societal costs of food-borne illness are an important input for regulators setting risk-reduction priorities and designing programs. For example, the Economic Research Service's (ERS's) estimates of the cost of food-borne illness for selected pathogens were used in the U.S. Department of Agriculture's (USDA's) Benefit/Cost Analysis of the Food Safety and Inspection Service's (FSIS's) proposed Pathogen Reduction/Hazard Analysis and Critical Control Point regulations (1995, p. 6781). A key question is, how much food safety is society demanding? Estimation of the societal costs of missing food safety information and of information as a public good is critical for government priority setting and decision making about food safety (Unnevehr 2006). I highlight the exceedingly small probability of a company's product being linked to a human illness, underscoring the important role of the federal government in assuring food safety.

Next I examine advances in valuation methods and use Willingness to Pay (WTP) estimates for food-borne illnesses. WTP is endorsed in the literature as the valuation method most consistent with economic theory (Viscusi and Aldy 2003; Haninger and Hammitt 2007). Hammitt and Haninger (2007) have surveyed consumers on their WTP for a "safer" meal. This paper uses the Hammitt and Haninger estimates of WTP for safer food and

FoodNet data on the age distribution for various severities of illness to provide preliminary estimates of the societal WTP for acute food-borne illnesses. Different values are used for children, adults, and the elderly in either the morbidity and/or mortality estimates. Because these cost estimates include all seventy-six million food-borne illnesses (Mead et al. 1999) and use different valuation techniques, the values are higher than previous estimates of the cost of food-borne illness by ERS and FDA based on only a handful of pathogens.<sup>1</sup>

## Pathogen Information and Victim Compensation

The occasional settlement in court cases associated with a well-publicized outbreak sends the signal that food-borne illness victims are compensated. Because bacterial and viral pathogens cannot be seen by the consumer, a negative externality of a food-borne illness can occur without sufficient information to earn compensation. I examine the evidence on victim compensation and the limits imposed by information and transactions costs.

In 1990s, FoodNet was created to call U.S. laboratories and increase the recording of pathogen test results (figure 1). Mead et al. (1999) find that 0.04% of all estimated

---

<sup>1</sup> The first estimate of costs of food-borne illness, for selected bacterial pathogens, was published in the *American Journal of Agricultural Economics* in 1989 by Roberts. The human capital method was used to value mortality and the cost of illness method for morbidity. While the USDA's Economic Research Service and the Environmental Protection Agency continue to use various cost of illness methods for morbidity, the Food and Drug Administration uses Quality Adjusted Life Years. Today, all three agencies use the WTP method to value mortality, based on labor market risks.

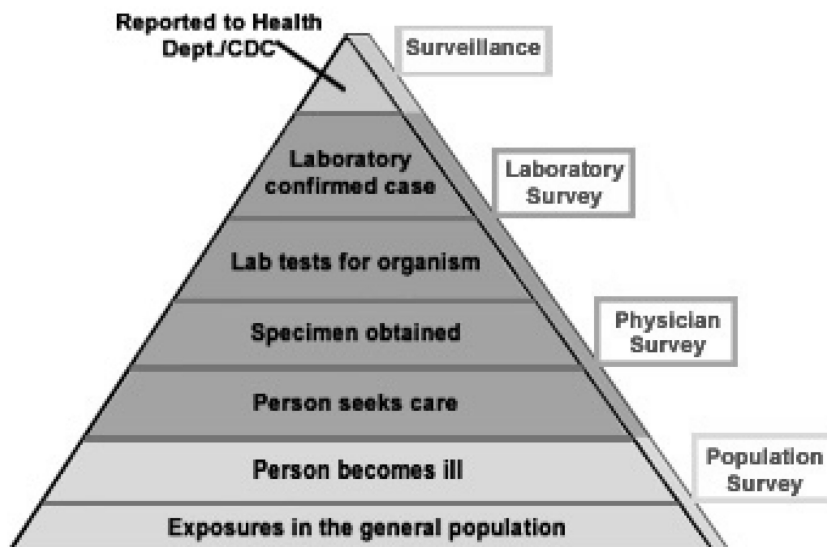
Previous ERS morbidity estimates use the Cost of Illness method, along with disease outcome trees for each pathogen laboriously built from medical data to indicate the probability of different acute illness and chronic disease outcomes over a lifetime. The limitation, however, was that only a handful of diseases were included in the ERS food-borne illness cost estimates. The WTP approach used in this paper has the benefit of including all acute food-borne illnesses, but excludes costly chronic complications that can last a lifetime, such as kidney failure, paralysis, arthritis, and mental retardation.

---

Tanya Roberts is Economist with the Economic Research Service, United States Department of Agriculture. I thank James K. Hammitt, Harvard University, and Jason F. Shogren, University of Wyoming, for insightful discussions and access to the literature on valuation. David Zorn, Food and Drug Administration, and Chris Dockins and Kelly Maguire, Environmental Protection Agency, provided useful information on valuation methods used for morbidity and mortality in their agencies.

The views expressed in this paper are those of the author and do not reflect the views of the Economic Research Service or the U.S. Department of Agriculture.

This article was presented in a principal paper session at the AAEE annual meeting (Portland, OR, July 2007). The articles in these sessions are not subjected to the journal's standard refereeing process.



Source: Centers for Disease Control and Prevention (CDC).

**Figure 1. The US food-borne disease databases from CDC**

food-borne illnesses can be linked, via a test, to the specific pathogen causing the illness.<sup>2</sup> The remaining illnesses are identified by symptoms in the gastrointestinal tract,<sup>3</sup> as reported by physicians or the patients in two FoodNet surveys (figure 1).

The next information problem is linking the pathogen and the food, which is most likely to happen in a food-borne disease outbreak. Illnesses identified in an outbreak average 5,800 cases per year, or 0.008% of the total seventy-six million U.S. food-borne illnesses (Mead et al. 1999). Illnesses not part of an outbreak have higher information hurdles for identifying the causative pathogen, the food containing the pathogen, and the company producing the food.

Suing and winning compensation for a food-borne illness are even lower probability events with high transactions costs, such as time invested, cost of hiring a lawyer, and emotional

costs of revisiting the illness. Buzby, Frenzen, and Rasco (2001) found that very few food-borne illnesses end up in court—on average eighteen jury trials per year or 0.000024% of all illnesses. Only 30% of the cases win in a jury trial. For the winners, the median award is \$25,600 and increases to \$55,000 if the pathogen can be identified. Other cases are settled out-of-court and require that the award be kept secret. This secrecy decreases the probability that other ill persons will take legal action against the company and suppresses news stories associating food-borne illness with the company and its products. The out-of-court settlement is partly an agreement to keep information from others who might be ill and able to build on this court case, partly savings on legal fees by all parties, and partly compensation for the illness. In sum, the probabilities of a positive pathogen test, of identifying the food contaminated with the pathogen, and of winning compensation are exceedingly small.<sup>4</sup>

<sup>2</sup> Mead et al. (1999) list that 19% of food-borne illnesses are identified by pathogen. This number is based on two multiplication factors. First, FoodNet sites with active pathogen surveillance are only 7.5% of the U.S. population. Second, most cases with a positive pathogen test were multiplied by 38 to adjust for the other cases where the ill person did not seek medical care, where the physician did not ask for a stool sample, where the test did not give a positive result even though the patient was positive, and where the positive test was reported to the CDC. The 0.04% result of actual, known positive tests is Mead's 0.19, multiplied by the population fraction that FoodNet covers (0.075) and divided by 38.

<sup>3</sup> FoodNet survey instruments for physicians and the general population define an illness as "...  $\geq 3$  loose stools in 24 hours with impairment of daily activities or duration of diarrhea of more than a day" (Jones et al. 2006).

<sup>4</sup> The information problem is illustrated by salmonellosis, an infection with a bacterium called *Salmonella*. This bacterium lives in the gastrointestinal tracts of mammals, birds, and reptiles. It is one of the most common causes of human food-borne illness and results in diarrhea, fever, and abdominal cramps 12–72 hours after food consumption (CDC 2007). Many different kinds of illnesses can cause diarrhea, fever, or abdominal cramps. Determining that *Salmonella* is the cause of the illness depends on laboratory tests that identify *Salmonella* in the stools of an infected person. The diversity of foods contaminated and the delay before illness strikes make linking the pathogen to the food difficult, unless there is a well-documented outbreak where people are surveyed about what

Table 1. Hammitt and Haninger’s Willingness to Pay Values for Safer Food

Severity of Symptoms <sup>a</sup>	Duration of Illness	Value per Child Case	Value per Adult Case <sup>b</sup>
Moderate/no medical care	1 day	\$28,000	\$11,100
Moderate/see physician, no test	3 days	\$30,400	\$11,700
Moderate/see physician, +test	7 days	\$26,500	\$14,400
Severe/hospitalized cases	7 days	\$26,700	\$16,100

Source: Hammitt and Haninger (2007). Estimates are median WTP values to avoid morbidity caused by food-borne pathogens. <sup>a</sup>Moderate Symptoms—You will have an upset stomach, fever, and will need to lie down most of the time. You will be tired and will not feel like eating or drinking much. Occasionally, you will have painful cramps in your stomach. In addition, you will have some diarrhea and will need to stay close to a bathroom. While you are sick, you will not be able to go to work or do most of your regular activities. Severe Symptoms—You will have to be admitted to a hospital. You will have painful cramps in your stomach, fever, and will need to spend most of your time lying in bed. You will need to vomit and will have severe diarrhea that will leave you seriously dehydrated. Because you will be unable to eat or drink much, you will need to have intravenous tubes put in your arm to provide nourishment. <sup>b</sup>Adult values are those for the more numerous category of “households without children.”

Historically, pathogen information first became a problem with the export of U.S. hog bellies to Europe. In the 1860s, some European countries began using the trichinae scope to detect the parasite, *Trichinella*. When countries found the parasite in U.S. hog bellies, they closed their markets in the 1870s and 1880s. United States companies exporting to Europe lobbied the federal government for meat inspection in order to regain access to overseas markets. In 1890, voluntary federal inspection became available for exporting companies. In 1891, U.S. companies could request inspection for the domestic market. In 1906, federal inspection was mandated for beef and pork transported across state lines. In 1957, poultry was added. These examples illustrate the increased federal involvement in regulating and assuring food safety.

In 1996, a new system, called the Pathogen Reduction/Hazard Analysis Critical Control Point system, was implemented. Federal inspection of final products by the FSIS was replaced by federal inspection of meat and poultry companies’ systems to control food-borne hazards. The most serious hazards are bacteria, viruses, parasites, and prions that may enter the food supply chain from the farm to the kitchen. Federal intervention leads to the question, how costly is the current level of U.S. food-borne illness? The next section develops estimates of the societal cost of human food-borne illness using results from consumer surveys to estimate WTP for safer food.

they ate in the days before the illness. Human salmonellosis illnesses usually last four to seven days, and most persons recover without treatment. Sometimes the diarrhea is so severe that the patient needs to be hospitalized. In these patients, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness. (See CDC (2007) for details.)

Societal Costs of Acute Food-Borne Illness

The ERS funded two consumer surveys to update valuation methods for morbidity and mortality risks attributed to food-borne pathogens. The first two papers in this session report the WTP findings from these consumer surveys. Hammitt and Haninger (2007) conduct a stated-preference survey of WTP to reduce risk of food-borne illness. I use their values for children and adults for morbidity valuation in four categories: hospitalized cases, those who see a physician and test positive for a pathogen, those who see a physician but do not have a test taken, and those who do not seek medical care (table 1).

FoodNet uses four survey instruments to collect data on age for three severities of illness: persons who visited a physician and had a positive test for a pathogen, patients who were hospitalized, and patients who died (figure 1). In table 2, the distribution of cases by disease severity is shown for three age groups: children (0–14), adults (15–69), and the elderly (70+). I chose these age groups because the economic literature has shown valuation varies with age (Viscusi and Aldy 2003; Blomquist 2004).

Mortality risk valuation has a long history examining risk premiums in labor markets, while valuation of mortality risk is more recent in the environmental literature. Typically, researchers compare small differences in mortality risk in different occupations or in different industries with the accompanying differences in wages, after adjustment for skill level and other factors. The mortality risk and associated risk premium in wages are used to estimate the Value of a Statistical Life (VSL). Blomquist’s review of studies finds that VSLs are generally greater for children than adults, while VSLs for those over seventy years of age are about 30% lower than other adults (2004). Viscusi and Aldy’s review of the labor market

**Table 2. Illnesses, Hospitalizations, and Deaths in FoodNet, by Age, 2001–2005**

Case Severity/Age	0–14		15–69		70+		Total Cases
	#	%	#	%	#	%	
Illness confirmed by pathogen test	25,821	41%	35,263	55%	2,338	4%	63,422
Cases that require hospitalization	4,828	31%	8,444	55%	2,148	14%	15,420
Food-borne illness caused deaths	36	10%	158	43%	174	47%	368

Note: The illness severity categories are mutually exclusive. Data from FoodNet, Ida Rosenblum, April 2007 email.

literature finds estimates of \$4 million to \$9 million per VSL (2003).

#### *Food-Borne Illnesses by Severity*

Mead et al. (1999) estimate that there are seventy-six million U.S. food-borne illnesses each year, that 325,000 result in hospitalization, and that 5,200 result in death from the acute illness. Subtracting the hospitalizations and deaths leaves 75,669,800 remaining milder cases. These cases can be parsed into subgroups of differing severity. Mead et al.'s estimates were based on cases that tested positive for a pathogen. Scallan et al. (2006) find that physicians only ask for pathogen tests if the patient has bloody diarrhea or is quite ill. Salmonellosis is the most studied food-borne pathogen, and for each case with positive test there are thirty-eight milder cases with either no test or a negative test. Using salmonellosis as a guide, I estimate the number of patients who test positive for a pathogen at 1,991,311 (75,669,800/58).

Scallan et al. (2006) estimate that 80% of all FoodNet cases do not visit a physician. This means that of the seventy-six million cases, 60,800,000 never seek medical care, primarily because they have a mild case of illness. The remainder of the cases are persons who do see a physician, but the physician does not request a pathogen test or the test is negative, or 12,878,489 cases.

In summary, the estimated annual seventy-six million cases of food-borne illness are now separated into five mutually exclusive severity categories:

- 5,200 deaths
- 325,000 cases that average 5.8 days in the hospital (Voetsch et al. 2004)
- 1,991,311 cases who are ill enough to see a physician and test positive for a specific pathogen
- 12,878,489 cases who see a physician but have no test or a negative test
- 60,800,000 cases who do not seek medical care

#### *Valuation of Severity Categories*

For the four categories of morbidity, I use Hammitt and Haninger's values in table 2. The survey instrument was designed to elicit separate adult and child values, namely what the parent is willing to pay to protect his or her child from a food-borne illness.

For mortality values, I use different values for adults, children, and the elderly. Adults are valued at \$7 million each, based on Viscusi and Aldy's 2003 review of the VSL literature where the range is \$4 million to \$9 million. The midpoint, accounting for some inflation, is roughly \$7 million today. The elderly, 70+, are valued at 30% less, or \$5 million, based on Blomquist's review (2004). Children are valued more highly, based on Hammitt and Haninger's ratio for hospitalized cases. Here the child value is around 70% higher than the adult value, or \$26,700 divided by \$16,100. Consequently, the death of a child from a food-borne illness is valued at \$12 million.

Mead et al. estimate that there are 5,200 deaths caused by acute food-borne illness annually (1999). I use the age breakdown of food-borne illness deaths, based on the FoodNet data from 2001 to 2005 (table 2). Children (0–14) account for 10% of the deaths, adults (15–69) account for 43%, and the elderly (70+) account for 47%. The total value for all deaths is \$34 million; the age breakdown is \$6.2 million for children, \$15.7 million for adults, and \$12.2 million for the elderly (table 3).

The societal cost contribution of each of the five severity categories is markedly different from ERS traditional estimates, largely because of the valuation method. In table 3, WTP estimates are used for both deaths and milder cases. Traditionally, the ERS has used WTP only for deaths and has valued less-severe cases with the Cost of Illness method, grounded in medical costs and productivity losses. The ERS's use of the Cost of Illness method omits values for lost leisure time, pain and suffering, and disruption of daily life that are captured in WTP values. In the traditional ERS estimates, deaths and chronic

**Table 3. U.S. Societal Annual Costs of Acute Food-Borne Illness Based on Willingness to Pay Values from Hammitt and Haninger (2007) and Viscusi and Aldy (2003)**

Severity/Age	Adult Cases <sup>a</sup>		Child Cases (0–14)		Total Cases/Costs	
	#	\$/Case	#	\$/Case	#	\$(Billion)
No medical care	35,800,000	\$11,100	25,000,000	\$28,000	60,800,000	1,098
See physician, no + test	7,600,000	\$11,700	5,280,000	\$30,400	12,878,489	249
See physician, +test	1,175,000	\$14,400	816,000	\$26,500	1,991,311	39
Hospitalized	220,000	\$16,100	105,000	\$26,700	325,000	6
Death	4,680	\$7 million	520	\$12 million	5,200	34
Total					76 million	\$1,426 billion

<sup>a</sup>Elderly, defined as 70+, are valued with other adults in the morbidity valuations. Elderly are valued separately for deaths, at 70% of the other adult value, or \$5 million.

complications are the largest contributors to the costs of human illness. In contrast, the leading cost component in the WTP estimates is cases where no medical care is received. This severity category contains 80% of the illness cases and contributes over \$1 trillion to the societal WTP cost estimate. A WTP estimate for twenty-four hours of food-borne illness with moderate symptoms (table 1) is \$11,100 for an adult case and \$28,000 for a child's case. One interpretation of the high value for twenty-four hours of illness is that consumers surveyed are intolerant of food-borne illness and expect that the government and industry will protect them from food-borne illness.

Another difference in WTP versus traditional ERS estimates is that for the first time all seventy-six million cases of acute food-borne illness are included. Previous estimates examined only a few specific pathogens. This estimate of the societal costs of food-borne illnesses totals \$1.4 trillion, compared to the last ERS estimate of \$6.9 billion for five pathogens causing food-borne illness (Crutchfield and Roberts 2000).

### Sensitivity Analyses and Discussion

Since WTP survey results are typically not very sensitive to differences in severity or duration of illness, a sensitivity analysis is performed for the estimated societal costs of food-borne illness (tables 1 and 3). In table 1, the duration of illness varies from one to seven days. Another method to estimate WTP to avoid one day of illness is to start with Hammitt and Haninger's estimate for seven days of illness and divide by seven. This forces each day's value to be identical within a severity category. For example, if the moderate symptoms are forced to

be linear, the adult one-day value of illness becomes \$2,060 and the child one-day value of illness becomes \$3,786. The total cost of illness estimate becomes \$269 billion for those not seeking medical care. For those who see a physician but do not have a positive test, the three days of illness are now valued at \$6,170 per adult and \$11,360 per child and total \$107 billion for this severity category. These linear estimates dramatically lower the total societal costs of food-borne illness from \$1.4 trillion to \$455 billion annually.<sup>5</sup>

Recent food-borne illness outbreaks have led to a decline in the percentage of shoppers confident about the safety of supermarket food from 82% in 2006 to 66% in 2007, according to the Food Marketing Institute's annual survey (Feedstuffs FoodLink 2007). Consumer confidence in restaurant food is even lower at 43%. The intensity of current public concern about food safety dates back to the early delegation of food safety inspection to the federal government. In 1906, public outrage over slaughterhouse practices chronicled by Upton Sinclair in *The Jungle* and over chemicals added to foods and drugs pushed Congress and the President to mandate federal inspection for meat crossing state lines and to create the Food and Drug Administration. However, enforcement remains an issue, which is not unusual for a public good with moral hazard properties. For example, the FSIS does not have the authority

<sup>5</sup> Another method for forcing linearization is to assume the one-day values are the most accurate and multiply the one-day value by the number of days in each severity category. This method will dramatically increase the estimate above the \$1.4 trillion Societal Costs of Food-borne Illness. I also calculate a third sensitivity analysis, based on Hammitt and Haninger's concluding statement: "Our stated-preference estimates suggest that WTP to reduce risk of short-term morbidity from food-borne pathogens is on the order of \$10,000 per statistical case avoided for adults and twice as large for children" (2007). This result is \$1.2 trillion annually.

to order recalls or impose fines on companies producing contaminated products. FSIS does not post pathogen test data by company on the web, but instead provides very general test data by type of product.

## Conclusion

The high societal costs estimated for food-borne illness and the high level of consumer concern about food safety in supermarkets and restaurants contrast sharply with the exceedingly low probability of consumers' ability to identify the food, pathogen, and company that made them ill and to win compensation. Although food safety has been delegated to the federal government, enforcement tools are limited, which can hinder the attainment of the level of food safety preferred by consumers.

## References

- Blomquist, G.C. 2004. "Self-Protection and Averting Behavior, Values of Statistical Lives, and Benefit Cost Analysis of Environmental Policy." *Review of Economics of the Household* 2:89–100.
- Buzby, J.C., P.D. Frenzen, and B. Rasco. 2001. *Product Liability and Microbial Foodborne Illness*. Economic Research Service, AER 799, available at [www.ers.usda.gov/publications/aer799/](http://www.ers.usda.gov/publications/aer799/).
- Centers for Disease Control and Prevention (CDC)'s salmonellosis page accessed 4/13/2007: Available at [www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis.g.htm](http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis.g.htm).
- Crutchfield, S.R., and T. Roberts. 2000. "Food Safety Efforts Accelerate in the 1990S." *FoodReview* 23(3):44–49, Available at [www.ers.usda.gov/publications/foodreview/septdec00/FRsept00h.pdf](http://www.ers.usda.gov/publications/foodreview/septdec00/FRsept00h.pdf).
- Feedstuffs FoodLink. 2007. May 14, Available at [feedstuffsfoodlink@feedstuffsfoodlink.com](mailto:feedstuffsfoodlink@feedstuffsfoodlink.com).
- Hammitt, J.K., and K. Haninger. 2007. "Willingness to Pay for Food Safety: Sensitivity to Duration and Severity of Illness." *American Journal of Agricultural Economics* 89(5): 1170–1175.
- Haninger, K., and J.K. Hammitt. 2007. "Willingness to Pay for Quality-Adjusted Life Years: Empirical Inconsistency Between Cost-Effectiveness Analysis and Economic Welfare Theory." Working paper draft, Harvard Center for Risk Analysis.
- Jones, T.F., M.B. McMillian, E. Scallan, P.D. Frenzen, A.B. Cronquist, S. Thomas, and F.J. Angulo. 2006. "A Population-Based Estimate of the Substantial Burden of Diarrhoeal Disease in the United States; FoodNet, 1996–2003." *Epidemiology Infect* 135:293–301.
- Mead P.S., L. Slutsker, V. Dietz, L.F. McCaig, J.S. Bresee, C. Shapiro, P.M. Griffin, and Robert V. Tauxe. 1999. "Food-Related Illness and Death in the United States." *Emerging Infectious Diseases* 5(5):607–625, Available at [www.cdc.gov/ncidod/eid/vol5no5/pdf/mead.pdf](http://www.cdc.gov/ncidod/eid/vol5no5/pdf/mead.pdf).
- Roberts, T. 1989. "Human Illness Costs of Food-borne Bacteria." *American Journal of Agricultural Economics* 71(2):468–74.
- Rosenblum, I., and E. Scallan. 2007. FoodNet data from CDC, emails, conversations, and tables provided in the spring of 2007.
- Scallan, E., T.F. Jones, A. Cronquist, S. Thomas, P. Frenzen, D. Hoefler, C. Medus, F.J. Angulo, and The Foodnet Working Group. 2006. "Factors Associated with Seeking Medical Care and Submitting a Stool Sample in Estimating the Burden of Foodborne Illness." *Foodborne Pathogens and Disease* 3(4):432–38.
- United States Department of Agriculture, Food Safety and Inspection Service. 1995. "Pathogen Reduction: Hazard Analysis and Critical Control Point(HACCP) Systems; Proposed Rule." *Federal Register*:6773–6889.
- Unnevehr, L.J. 2006. "Food Safety as a Global Public Good: Is There Underinvestment?" Plenary Paper, International Association of Agricultural Economists Conference, Australia, August 12–18.
- Viscusi, W.K., and J.E. Aldy. 2003. "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World." *Journal of Risk and Uncertainty* 27(1):5–76.
- Voetsch, A.C., T.J. Van Gilder, F.J. Angulo, M.M. Farley, S. Shallow, R. Marcus, P.R. Cieslak, C. Deneen, and R.V. Tauxe. 2004. "Food-Net Estimate of the Burden of Illness Caused by Nontyphoidal *Salmonella* Infections in the United States." *Clinical Infectious Diseases* 38(Suppl.3):S127–S34.