



An Online Cost Calculator for Estimating the Economic Cost of Illness Due to Shiga Toxin- Producing *E. coli* (STEC) O157 Infections

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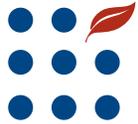
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An Online Cost Calculator for Estimating the Economic Cost of Illness Due to Shiga Toxin-Producing *E. coli* (STEC) O157 Infections

Paul D. Frenzen

Abstract

Shiga toxin-producing *E. coli* (STEC) O157 is a significant cause of foodborne illness in the United States. ERS estimated the economic cost of illness due to this pathogen—\$405.2 million (in 2003 dollars)—using the most recent estimate (1997) of the annual number of STEC O157 cases by the Centers for Disease Control and Prevention (CDC) and medical and cost data from the Foodborne Diseases Active Surveillance Network. CDC is currently updating its estimate of annual cases. As new information becomes available, the ERS online Foodborne Illness Cost Calculator enables users to review and modify the assumptions underlying the STEC O157 cost estimate, such as the number of cases, and then recalculate the cost, adjusted for inflation for any year from 1997 to 2006. The potential utility of the calculator was demonstrated by assuming that the incidence of STEC O157 had declined and then estimating the cost for a smaller number of cases.

Keywords: Foodborne illness, foodborne pathogens, food safety, Shiga toxin-producing *E. coli* O157, *E. coli* O157:H7, enterohemorrhagic *E. coli*, economic cost of illness, value of statistical life, morbidity, mortality.

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Summary

Foodborne pathogens are a significant cause of illness and death in the United States. ERS estimates the annual economic cost of illness due to several important foodborne pathogens, including Shiga toxin-producing *E. coli* (STEC) O157. These cost estimates allow policymakers to rank the risks from different pathogens and prioritize government spending on food safety. ERS has also created an online Foodborne Illness Cost Calculator (www.ers.usda.gov/data/foodborneillness/) that enables policymakers and others to review and modify the assumptions underlying the STEC O157 cost estimate and then recalculate the cost. The cost estimate can be adjusted for inflation for any year from 1997 through 2006.

What Is the Issue?

The most recent estimate of the annual number of STEC O157 cases in the United States by the Centers for Disease Control and Prevention (CDC) is for 1997. ERS relied on the CDC estimate of annual cases to calculate the cost of STEC O157. Other information from the Foodborne Diseases Active Surveillance Network (FoodNet) indicates that the annual incidence of laboratory-diagnosed STEC O157 infections has changed over time, decreasing substantially from the 1996-98 baseline during 2003 and 2004 and then returning to the baseline in 2006, following several multistate outbreaks of STEC O157 associated with fresh produce. Although the FoodNet surveillance sites were not selected to be representative of the entire United States, the FoodNet data suggest that the CDC estimate of annual STEC O157 cases may be outdated.

What Did the Study Find?

The potential utility of ERS's Foodborne Illness Cost Calculator was demonstrated by changing the number of STEC O157 cases and then recalculating the cost. The new number of cases was obtained by assuming that the national trend in the incidence of STEC O157 was the same as the downward trend in the incidence of laboratory-diagnosed STEC O157 infections in the FoodNet surveillance sites through 2005, before the multistate outbreaks of STEC O157 associated with fresh produce. Under this assumption, the annual number of STEC O157 cases decreased from 73,480 in 1997 to 56,911 in 2005. When the number of cases was changed to 56,911 in the calculator without altering any other assumptions, the annual cost of STEC O157 in 2005 was estimated at \$333.5 million (in 2005 dollars), or \$97.9 million less than the cost if the number of cases had not decreased.

How Was the Study Conducted?

ERS used the online Foodborne Illness Cost Calculator to change the annual number of STEC O157 cases and recalculate the cost of illness from this pathogen. The new estimate of cases was obtained by assuming that the trend in the incidence of STEC O157 in the United States through 2005 was the same as the downward trend in the incidence of laboratory-diagnosed STEC O157 cases in the FoodNet surveillance sites. No other assumptions about the distribution of STEC O157 cases by severity or the costs per case were changed in this example.

Introduction

Shiga toxin-producing *E. coli* (STEC) O157 is a significant cause of food-borne illness in the United States. Estimates of the economic cost of illness due to this pathogen enable policymakers to rank different risks to the food supply and prioritize government spending on control measures. This bulletin summarizes the updated ERS estimate of the annual cost of illness due to STEC O157 and illustrates how the ERS online Foodborne Illness Cost Calculator can be used to modify the assumptions underlying the cost estimate and then recalculate the cost.

STEC O157 is a strain of *E. coli* bacteria (formerly classified as *E. coli* O157:H7) that lives in the intestines of healthy cattle and other ruminants. Humans infected by this pathogen often have bloody diarrhea and may develop a life-threatening form of acute kidney failure known as hemolytic uremic syndrome (HUS). Most infections are due to the consumption of food contaminated by STEC O157 during improper food processing or handling. Outbreaks of illness caused by STEC O157 have been associated with a variety of foods, including raw beef, unpasteurized milk products, sprouts, lettuce, spinach, and unpasteurized apple juice and cider.

Estimation Methods

ERS prepared the STEC O157 cost estimate in collaboration with the Foodborne Diseases Active Surveillance Network (FoodNet) sponsored by the Centers for Disease Control and Prevention (CDC), the U.S. Food and Drug Administration (FDA), and USDA. FoodNet gathers information about laboratory-diagnosed infections by selected foodborne pathogens, including STEC O157. ERS used data from FoodNet and other sources to estimate the distribution of STEC O157 cases by severity and the average amount of health care and time lost from work per case classified by severity. These estimates were used to calculate the annual cost of medical care, lost productivity, and premature deaths. The ERS cost estimate excluded other costs such as government and business expenditures in response to STEC O157 outbreaks.

According to the most recent estimate by CDC, STEC O157 caused 73,480 illnesses in the United States in 1997, resulting in 2,168 hospitalizations and 61 deaths. ERS based the STEC O157 cost estimate on the CDC estimate of annual cases. The incidence of laboratory-diagnosed STEC O157 infections in the FoodNet surveillance sites has changed over time, decreasing substantially during 2003 and 2004 and then returning to the 1996-98 baseline in 2006 following several multistate outbreaks of STEC O157 associated with fresh produce.¹ Because the FoodNet sites were not selected to be representative of the entire United States, it is unclear whether the trend in STEC O157 in the FoodNet sites was the same as the trend for the United States. Still, the FoodNet data suggest that the CDC estimate of annual STEC O157 cases may be outdated.

ERS expanded the CDC estimate of annual STEC O157 cases into seven severity categories ranging from cases who did not visit a physician to cases who died. Data from FoodNet surveys of persons with acute diarrhea and patients with laboratory-diagnosed STEC O157 infections were used to estimate the average number of physician office visits, emergency room visits, hospitalizations, outpatient medications, and days lost from work per case classified by severity. Data from other sources were used to determine the national average cost of physician and emergency room visits, medications, hospitalizations due to STEC O157 infections and HUS, and days lost from work. The lifetime costs of medical care and lost productivity for HUS cases who experienced complete kidney failure, a condition known as end-stage renal disease (ESRD), were estimated using data on ESRD patients.²

ERS estimated the cost of premature deaths due to STEC O157 infections or ESRD using a modified value of a statistical life approach that took age at death into account. The value of a statistical life, which reflects individual attitudes about risk, was assumed to be the midpoint of published estimates derived from the wage differentials for jobs with higher mortality risks, or \$6.9 million (in 2003 dollars) at age 40.³ After adjusting for age at death, the estimated value of a premature death ranged from \$9.3 million for an infant under age 1 to \$1.8 million for an adult age 85 or older.

¹The CDC estimate of annual STEC O157 cases is reported in Mead et al. (1998) and was based on data from the first 2 years of FoodNet surveillance. The trend in laboratory-diagnosed STEC O157 infections in the FoodNet surveillance sites is described in Vugia et al. (2006; 2007) and was estimated using a log-linear Poisson regression model to account for the increase in the number of sites over time and the variation in the infection rate between sites.

²The data sources are discussed in more detail in Frenzen et al. (2005) and included National Health Accounts estimates of physician expenditures, American Medical Association data on physician visits, data from the Medical Expenditure Panel Survey on the cost of prescription medications, commercial estimates of the average wholesale price for nonprescription medications adjusted for retail markups, Nationwide Inpatient Sample estimates of community hospital discharges, Current Population Survey estimates of average hourly earnings adjusted to include employer costs of benefits, and information from the U.S. Renal Data System on ESRD patients and expenditures.

³This sum was treated as if it were the value of a fixed annual annuity paid over the average U.S. lifespan at an interest rate of 3 percent. The cost of a death at any particular age is therefore the present value of life expectancy at that age.

Cost of STEC O157 Infections

Based on the official CDC estimate of the number of STEC O157 cases in 1997, the estimated annual cost of illness due to STEC O157 infections was \$405.2 million (in 2003 dollars) (table 1). Most of the cost (\$370.0 million) was attributable to premature deaths. The remainder was due to medical care (\$30.2 million) and lost productivity (\$5.0 million). The average cost per STEC O157 case varied greatly by severity category, ranging from \$26 per case for those who did not visit a physician to nearly \$6.2 million per case for those who developed HUS and died. Fewer than one in every thousand STEC O157 infections resulted in ESRD or death (fig. 1), but these severe cases accounted for 93 percent of the total cost (fig. 2).

Because premature deaths account for such a large proportion of the cost of illness due to STEC O157, alternate assumptions about the value of a statistical life could affect the estimated cost. For example, the FDA assumes that the value of a statistical life is \$5.0 million, or \$1.9 million less than the value assumed by ERS. If ERS had used the lower FDA value, then the estimated cost of STEC O157 infections would have been reduced by 25 percent, or \$101 million.

The CDC has estimated that 85 percent of STEC O157 infections are food-borne in origin. (The other sources of infection include contaminated water, person-to-person transmission, and contact with infected farm animals.) If foodborne infections were as severe as other infections, then the annual cost of STEC O157 infections due to contaminated food would be about \$344 million.

Table 1

Annual economic cost of illness due to Shiga toxin-producing *E. coli* (STEC) O157

Severity category	Estimated annual STEC O157 cases ¹	Estimated annual economic cost ²	Estimated average cost per case ²
	<i>Number</i>	<i>Million dollars</i>	<i>Dollars</i>
Nonfatal cases			
1. Not hospitalized, did not see a physician	57,656	1.5	26
2. Not hospitalized, saw a physician	13,656	6.0	441
3. Hospitalized, did not have HUS	1,797	10.1	5,599
4. Hospitalized, had HUS but not ESRD	300	9.3	30,998
5. Hospitalized, had HUS and ESRD	10	51.7	5,173,594
Fatal cases			
6. Did not have HUS	23	92.0	3,998,265
7. Had HUS	38	234.7	6,175,500
Total	73,480	405.2	5,515

Notes: HUS = hemolytic uremic syndrome. ESRD = end-stage renal disease.

¹Derived from the CDC estimate of the annual number of STEC O157 cases, hospitalizations, and deaths in 1997. See Frenzen et al. (2005).

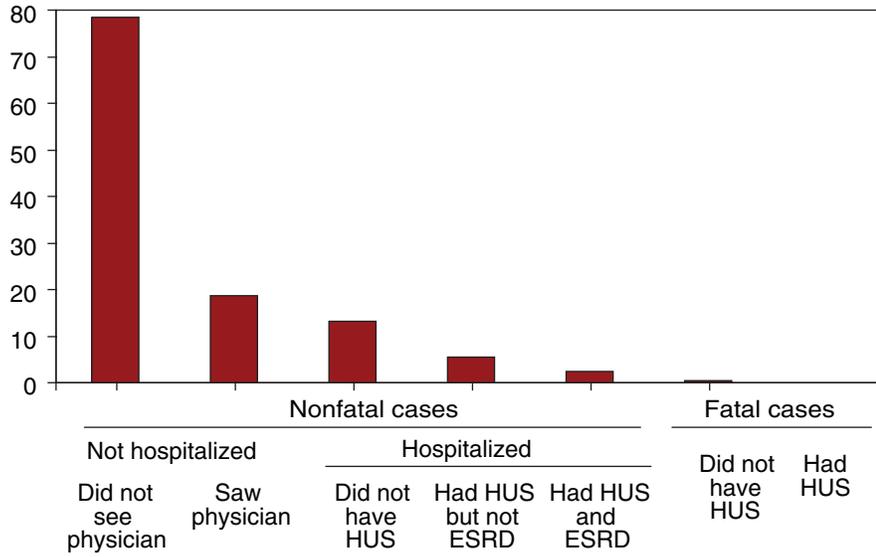
²2003 dollars. The average cost per case was calculated from unrounded totals.

Source: USDA, ERS using data from Frenzen et al. (2005).

Figure 1

Distribution of annual STEC O157 cases by severity

Percent of total cases

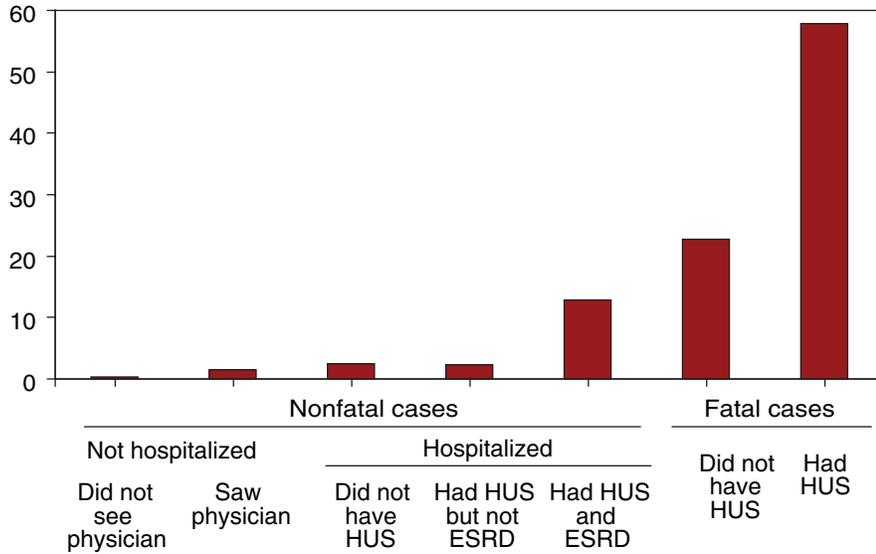


Source: USDA, ERS estimate based on FoodNet data, reported in Frenzen et al. (2005).

Figure 2

Distribution of annual economic costs of STEC O157 by severity

Percent of total costs



Source: USDA, ERS estimate reported in Frenzen et al. (2005).

Revising the Cost Estimate

The ERS Foodborne Illness Cost Calculator allows users to review and easily modify the assumptions underlying the STEC O157 cost estimate and then recalculate the cost. The assumptions that can be changed include the total number and distribution of STEC O157 cases by severity, the average amount of medical care and time lost from work per case classified by severity, and the average cost per unit of medical care, work day, and premature death. The revised estimate can be adjusted for inflation for any year from 1997 to 2006. The calculator is available on the ERS Web site at: www.ers.usda.gov/data/foodborneillness/.

The potential utility of the Foodborne Illness Cost Calculator was demonstrated by changing the number of STEC O157 cases and then recalculating the cost in 2005 dollars. The new number of cases was obtained by assuming that the national trend in the incidence of STEC O157 was the same as the downward trend in the incidence of laboratory-diagnosed STEC O157 infections in the FoodNet surveillance sites through 2005, before the multistate outbreaks of STEC O157 associated with fresh produce. It is important to note that this assumption may not be accurate because the FoodNet sites are not representative of the entire United States, and also because the proportion of STEC O157 cases that were laboratory-diagnosed might have changed over time. Under this assumption, the annual number of STEC O157 cases decreased from 73,480 in 1997 to 56,911 in 2005.

ERS entered the assumed number of STEC O157 cases in 2005 into the calculator without changing any other assumptions about medical care, lost productivity, the average cost of a premature death, or the distribution of cases by severity. After the number of cases was changed, the cost of illness due to STEC O157 in 2005 was estimated at \$333.5 million (in 2005 dollars).

ERS also used the calculator to estimate the cost of illness due to STEC O157 in 2005 if the number of cases had not decreased by changing the assumed number of cases back to 73,480. The estimated cost of illness under this assumption was \$431.4 million (in 2005 dollars). Comparison of the two cost estimates indicates that the economic benefits in 2005 due to the assumed decrease in the annual number of STEC O157 cases were \$97.9 million.

Conclusions

The most recent CDC estimate of the annual number of STEC O157 cases in the United States refers to 1997. The ERS estimate of the cost of illness due to STEC O157 based on the CDC case estimate is \$431.4 million (in 2005 dollars). Most of the cost was due to the small proportion of cases resulting in ESRD or death. The CDC case estimate may be outdated because the annual incidence of laboratory-diagnosed STEC O157 cases in the FoodNet surveillance sites has changed over time. The potential utility of the ERS online Foodborne Illness Cost Calculator was demonstrated by assuming that the trend in STEC O157 cases in the United States was the same as the downward trend in laboratory-diagnosed cases observed in the FoodNet surveillance sites before 2006. After the annual number of STEC O157 cases was revised downwards in accord with the FoodNet data, the calculator indicated that the annual cost of STEC O157 in 2005 was \$333.5 million (in 2005 dollars).

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