Burden of Foodborne Diseases – the United States Perspective

WHO Foodborne Disease Burden Epidemiology Reference Group (**FERG**)

December 16, 2015

Antonio Vieira, DVM, MPH, PhD

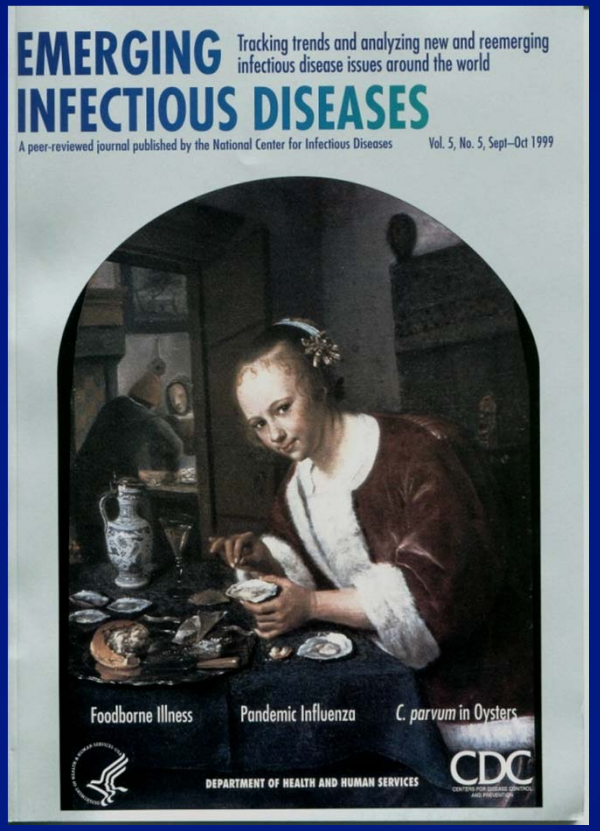
Enteric Diseases Epidemiology Branch
Division of Foodborne, Waterborne, and Environmental Diseases
Centers for Disease Control and Prevention (CDC)

Burden of Foodborne Diseases

- **Estimates of illnesses, hospitalizations, deaths, and disability-adjusted life years are essential for directing food safety policy**
- **To make estimates, strong surveillance systems are needed**
  - data for decision-making
  - identify new and persistent food safety threats
- **Ongoing revisions of estimates are essential for assessing the effectiveness of interventions**

Foodborne Illness Estimates, United States

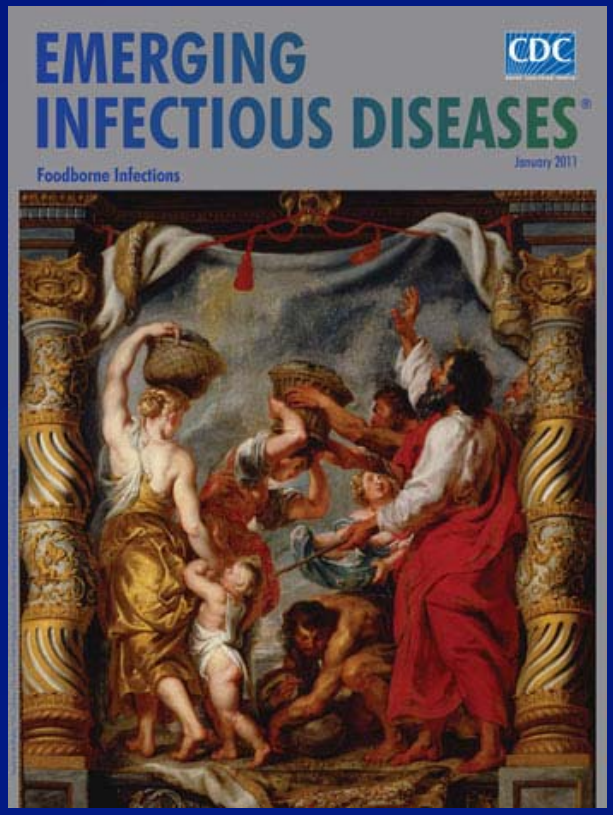
- **1999: CDC published first comprehensive estimates**



Mead PS, et al. Food-related illness and death in the United States. Emerg Infect Dis 1999 Sep–Oct;5(5); 607–25.

Foodborne Illness Estimates, United States

- **1999: CDC published first comprehensive estimates**
- **2011: CDC revised estimates using improved data sources**
  - Created new, refined methods
  - Focused on domestically acquired illnesses
  - Calculated 90% credible intervals for all point estimates



Scallan E, et al. Foodborne illness acquired in the United States—major pathogens. Emerg Infect Dis. 2011 Jan;17(1):7–15.

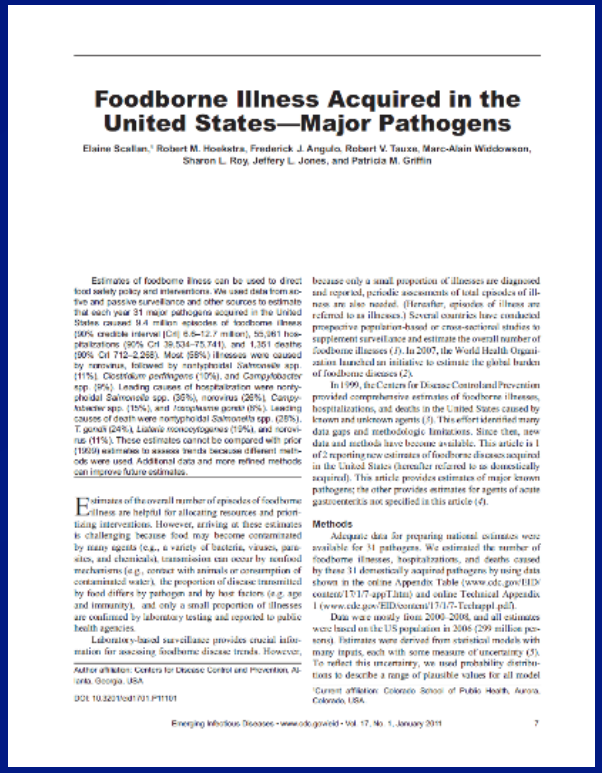
2011 Foodborne Illness Estimates, United States

- **Provide the most accurate picture yet of which pathogens are causing the most illnesses in the United States, as well as estimating the number of foodborne illnesses without a known cause**
- **CDC estimates that each year domestically acquired foodborne disease causes**
  - 9.4 million illnesses due to 31 known pathogens
  - 48 million total illnesses (1 in 6 people)
  - 128,000 hospitalizations
  - 3,000 deaths

2011 Foodborne Illness Estimates, United States

31 known pathogens causing domestically acquired foodborne illness

- Norovirus, *Salmonella*, *Campylobacter*, *Toxoplasma*, *E. coli* O157, *Listeria* and *Clostridium perfringens* cause 90% of illnesses, hospitalizations, and deaths due to known pathogens



Foodborne Illness Acquired in the United States—Major Pathogens

Elaine Scallan,[1] Robert M. Hoekstra, Frederick J. Angulo, Robert V. Tauxe, Marc-Alain Widdowson, Sharon L. Roy, Jeffery L. Jones, and Patricia M. Griffin

Estimates of foodborne illness can be used to direct food safety policy and interventions. We used data from active and passive surveillance and other sources to estimate that each year 31 major pathogens acquired in the United States caused 9.4 million episodes of foodborne illness (90% credible interval [CrI] 6.8–12.7 million), 55,961 hospitalizations (90% CrI 39,534–75,741), and 1,351 deaths (90% CrI 712–2,268). Most (68%) illnesses were caused by norovirus, followed by nontyphoidal *Salmonella* spp. (11%), *Clostridium perfringens* (10%), and *Campylobacter* spp. (9%). Leading causes of hospitalization were nontyphoidal *Salmonella* spp. (35%), norovirus (26%), *Campylobacter* spp. (15%), and *Toxoplasma gondii* (8%). Leading causes of death were nontyphoidal *Salmonella* spp. (28%), *T. gondii* (24%), *Listeria monocytogenes* (19%), and norovirus (11%). These estimates cannot be compared with prior (1999) estimates to assess trends because different methods were used. Additional data and more refined methods can improve future estimates.

Estimates of the overall number of episodes of foodborne illness are helpful for allocating resources and prioritizing interventions. However, arriving at these estimates is challenging because food may become contaminated by many agents (e.g., a variety of bacteria, viruses, parasites, and chemicals), transmission can occur by nonfood mechanisms (e.g., contact with animals or consumption of contaminated water), the proportion of disease transmitted by food differs by pathogen and by host factors (e.g. age and immunity), and only a small proportion of illnesses are confirmed by laboratory testing and reported to public health agencies.

Laboratory-based surveillance provides crucial information for assessing foodborne disease trends. However, because only a small proportion of illnesses are diagnosed and reported, periodic assessments of total episodes of illness are also needed. (Hereafter, episodes of illness are referred to as illnesses.) Several countries have conducted prospective population-based or cross-sectional studies to supplement surveillance and estimate the overall number of foodborne illnesses (*1*). In 2007, the World Health Organization launched an initiative to estimate the global burden of foodborne diseases (*2*).

In 1999, the Centers for Disease Control and Prevention provided comprehensive estimates of foodborne illnesses, hospitalizations, and deaths in the United States caused by known and unknown agents (*3*). This effort identified many data gaps and methodologic limitations. Since then, new data and methods have become available. This article is 1 of 2 reporting new estimates of foodborne diseases acquired in the United States (hereafter referred to as domestically acquired). This article provides estimates of major known pathogens; the other provides estimates for agents of acute gastroenteritis not specified in this article (*4*).

Methods

Adequate data for preparing national estimates were available for 31 pathogens. We estimated the number of foodborne illnesses, hospitalizations, and deaths caused by these 31 domestically acquired pathogens by using data shown in the online Appendix Table (www.cdc.gov/EID/content/17/1/7-appT.htm) and online Technical Appendix 1 (www.cdc.gov/EID/content/17/1/7-TechAppI.pdf).

Data were mostly from 2000–2008, and all estimates were based on the US population in 2008 (299 million persons). Estimates were derived from statistical models with many inputs, each with some measure of uncertainty (*3*). To reflect this uncertainty, we used probability distributions to describe a range of plausible values for all model

Author affiliation: Centers for Disease Control and Prevention, Atlanta, Georgia, USA

[1]Current affiliation: Colorado School of Public Health, Aurora, Colorado, USA.

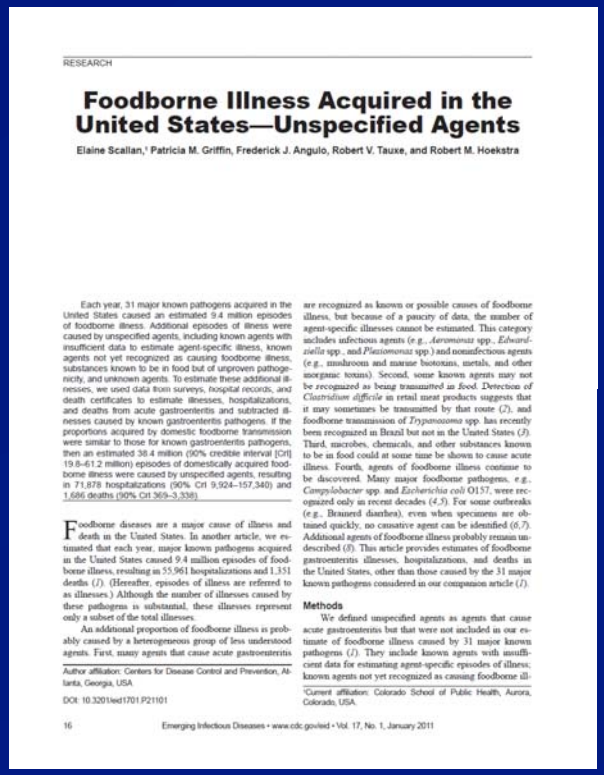
DOI: 10.3201/eid1701.P11101

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 17, No. 1, January 2011 7

2011 Foodborne Illness Estimates, United States

Unspecified agents causing domestically acquired foodborne illness

- **Agents that cause acute gastroenteritis but that were not included in our estimate due to**
  - Insufficient data;
  - Not yet recognized as causing foodborne illness;
  - Microbes, chemicals, or other substances for which pathogenicity is unproven;
  - Agents not yet described
- **Unspecified agents comprise 80% of all estimated foodborne illnesses and 56% of all hospitalizations and deaths**



RESEARCH

Foodborne Illness Acquired in the United States—Unspecified Agents

Elaine Scallan,[1] Patricia M. Griffin, Frederick J. Angulo, Robert V. Tauxe, and Robert M. Hoekstra

Each year, 31 major known pathogens acquired in the United States caused an estimated 9.4 million episodes of foodborne illness. Additional episodes of illness were caused by unspecified agents, including known agents with insufficient data to estimate agent-specific illness, known agents not yet recognized as causing foodborne illness, substances known to be in food but of unproven pathogenicity, and unknown agents. To estimate these additional illnesses, we used data from surveys, hospital records, and death certificates to estimate illnesses, hospitalizations, and deaths from acute gastroenteritis and subtracted illnesses caused by known gastroenteritis pathogens. If the proportions acquired by domestic foodborne transmission were similar to those for known gastroenteritis pathogens, then an estimated 38.4 million (90% credible interval [CrI] 19.8–61.2 million) episodes of domestically acquired foodborne illness were caused by unspecified agents, resulting in 71,878 hospitalizations (90% CrI 9,924–157,340) and 1,686 deaths (90% CrI 369–3,338).

Foodborne diseases are a major cause of illness and death in the United States. In another article, we estimated that each year, major known pathogens acquired in the United States caused 9.4 million episodes of foodborne illness, resulting in 55,961 hospitalizations and 1,351 deaths (*1*). (Hereafter, episodes of illness are referred to as illnesses.) Although the number of illnesses caused by these pathogens is substantial, these illnesses represent only a subset of the total illnesses.

An additional proportion of foodborne illness is probably caused by a heterogeneous group of less understood agents. First, many agents that cause acute gastroenteritis are recognized as known or possible causes of foodborne illness, but because of a paucity of data, the number of agent-specific illnesses cannot be estimated. This category includes infectious agents (e.g., *Aeromonas* spp., *Edwardsiella* spp., and *Plesiomonas* spp.) and noninfectious agents (e.g., mushroom and marine biotoxins, metals, and other inorganic toxins). Second, some known agents may not be recognized as being transmitted in food. Detection of *Clostridium difficile* in retail meat products suggests that it may sometimes be transmitted by that route (*2*), and foodborne transmission of *Trypanosoma* spp. has recently been recognized in Brazil but not in the United States (*3*). Third, microbes, chemicals, and other substances known to be in food could at some time be shown to cause acute illness. Fourth, agents of foodborne illness continue to be discovered. Many major foodborne pathogens, e.g., *Campylobacter* spp. and *Escherichia coli* O157, were recognized only in recent decades (*4*,*5*). For some outbreaks (e.g., Brainerd diarrhea), even when specimens are obtained quickly, no causative agent can be identified (*6*,*7*). Additional agents of foodborne illness probably remain undescribed (*8*). This article provides estimates of foodborne gastroenteritis illnesses, hospitalizations, and deaths in the United States, other than those caused by the 31 major known pathogens considered in our companion article (*1*).

Methods

We defined unspecified agents as agents that cause acute gastroenteritis but that were not included in our estimate of foodborne illness caused by 31 major known pathogens (*1*). They include known agents with insufficient data for estimating agent-specific episodes of illness; known agents not yet recognized as causing foodborne ill-

Author affiliation: Centers for Disease Control and Prevention, Atlanta, Georgia, USA

[1]Current affiliation: Colorado School of Public Health, Aurora, Colorado, USA.

DOI: 10.3201/eid1701.P21101

Foodborne Illness Estimates, United States and WHO FERG

- **Expert elicitation**
- **Both studied 31 foodborne hazards, but**
  - Agents varied somewhat
    - USA included only infectious agents
  - USA focused on domestically acquired illnesses
- **United States also estimated illnesses caused by unspecified agents**
- **Use of Disability Adjusted Life Year (DALY)**

Plan to Revise U.S. Foodborne Illness Burden Estimates

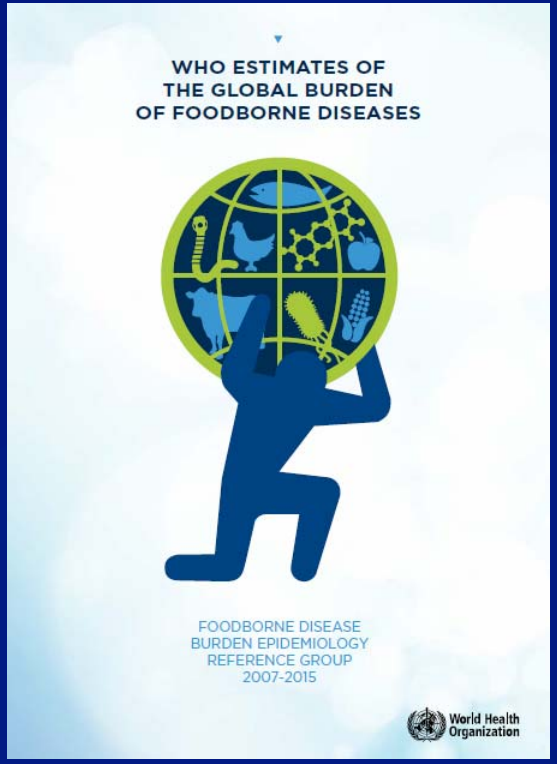
- **Learn from the WHO FERG methods, e.g.,**
  - Expert elicitation to estimate foodborne illness percentage for each agent
  - Add other agents
- **Conduct population survey about diarrheal illness in 2017**
- **Improve method for estimating hospitalizations and deaths**
- **Use additional data sources and new methods**

Improving U.S. Foodborne Illness Estimates: Interagency Food Safety Analytics Collaboration (IFSAC)

- **IFSAC is a collaboration among**
  - Centers for Disease Control and Prevention
  - US Department of Agriculture Food Safety and Inspection Service
  - US Food and Drug Administration
- **Current goal: Identify, plan, and conduct analyses on foodborne illness source attribution**

WHO FERG Goal: Using the Estimates

Encourage countries to use burden of foodborne disease estimates for cost-effective analyses of prevention, intervention and control measures.



World Health Organization (WHO). WHO estimates of the global burden of foodborne diseases, Foodborne diseases burden epidemiology reference group 2007–2015. Geneva, 2015.

Using Foodborne Illness Estimates in the United States

- **Estimates are providing a foundation for priority setting, policy development, research, education, and advocacy**
- **CDC is using burden estimates to**
  - Estimate the burden due to specific foods
- **Regulatory agencies are using these estimates to**
  - Develop risk assessments
  - Develop metrics for food safety programs
  - Estimate the cost of illnesses
  - Assess the outcome of interventions
  - Provide justification for food safety programs

FDA

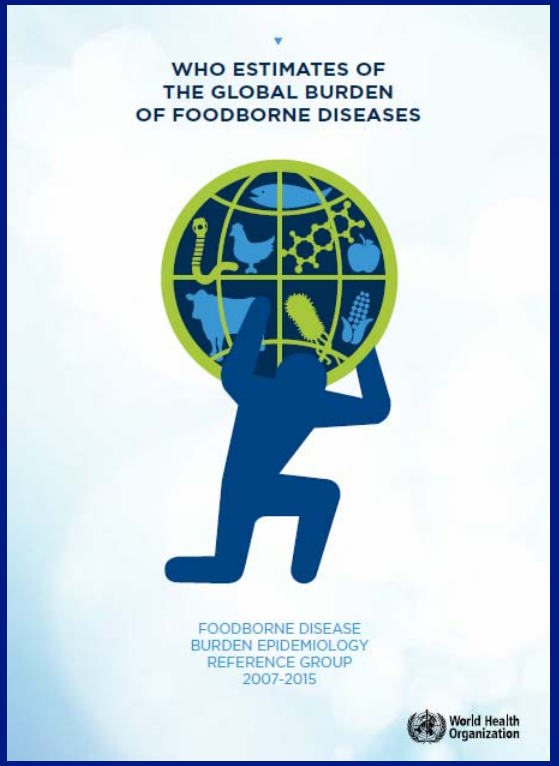
USDA
United States Department of Agriculture

Using Foodborne Illness Estimates in the United States

- Industry and academic institutions are using the estimates to inform research programs and food safety activities
- Other public health officials and consumer groups are using the estimates to target education and improve advocacy

WHO FERG Goal: Strengthening Capacity

Strengthen the capacity of countries in conducting burden of foodborne disease assessments, and to increase the number of countries that have undertaken a burden of foodborne disease study.



Strengthening Capacity

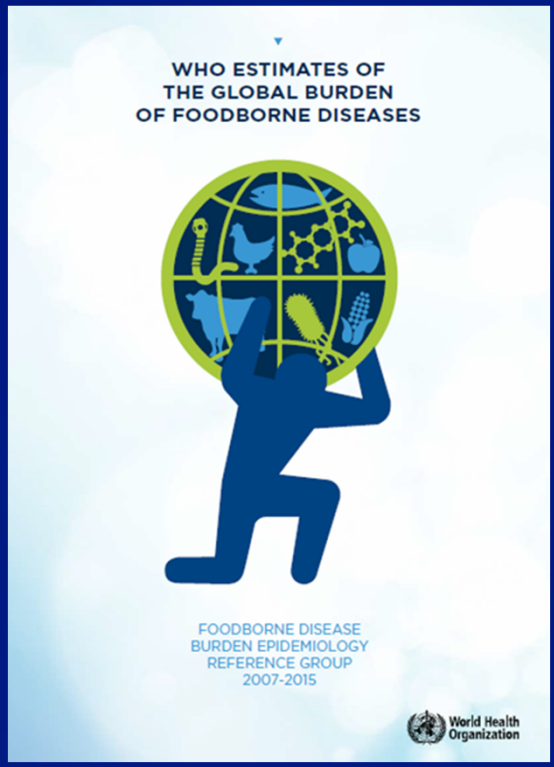
- **To conduct burden of disease assessments, countries need sustained and enhanced**
  - Public health laboratory capacity
  - Surveillance systems
  - Epidemiologic surveys, studies, and analyses

Strengthening Capacity: Global Health Security Agenda

- **CDC seeks to accelerate progress toward a world safe and secure from infectious disease threats and to promote global health security**
  - In partnership with U.S. government sister agencies, other nations, international organizations, and public and private stakeholders
- **CDC's Global Acute Diarrheal Disease (GADD) program aims to build capacity for foodborne and waterborne disease surveillance and outbreak detection and response by responding to invitations from countries to assist in**
  - Assessing capacity for enteric disease detection and surveillance
  - Building capacity
  - Creating frameworks to sustain and improve surveillance and outbreak detection

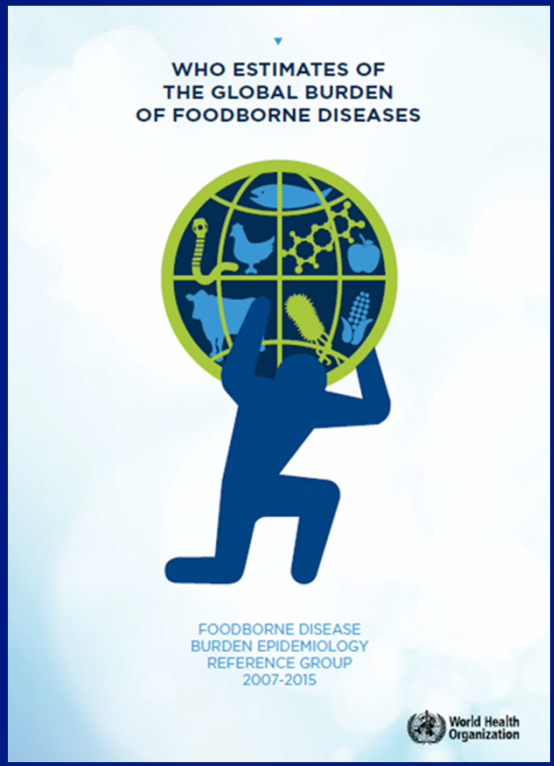
Burden of Foodborne Disease Estimates: Final Thoughts

- **Burden estimates represent a critical key step in fostering the work and focus needed to decrease foodborne illness worldwide**
  - Although getting data for estimates can be difficult, especially from regions with limited resources
  - Our experience indicates that estimates are of great value in influencing policy



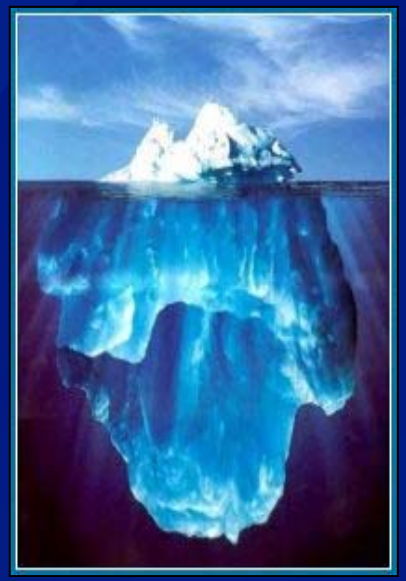
Burden of Foodborne Disease Estimates: Final Thoughts

- Countries can use these first WHO estimates to make the case for strengthening foodborne disease surveillance and control programs
- Create the surveillance, evaluation, and investigation systems needed to evaluate progress toward decreasing the burden of foodborne diseases



Thank You

www.cdc.gov/foodborneburden



1600 Clifton Road NE, Atlanta, GA 30333
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: http://www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

National Center for Emerging and Zoonotic Infectious Diseases
Division of Foodborne, Waterborne, and Environmental Diseases