CDC Estimates of Foodborne Illness in the United States

Methods Used in 2011 Estimates

In 2011, Scallan et al. estimated the overall burden of foodborne illness caused by known and unspecified agents[1]. This analysis included 31 pathogens known to cause foodborne illness and unspecified agents that cause acute gastroenteritis illnesses (AGI). Scallan et al. also estimated the number of hospitalizations and deaths caused by these illnesses.

Estimating US foodborne illnesses for 31 *known* foodborne pathogens

For each pathogen[2], we gathered data from surveillance systems and corrected for underreporting and under-diagnosis. We then multiplied the adjusted number by the proportion of illnesses that was acquired in the United States (that is, not during international travel) and the proportion transmitted by food to yield an estimated number of illnesses that are domestically acquired and foodborne. Then, we added the estimates for each of the pathogens to arrive at a total, and used an uncertainty model to generate a point estimate and 90% credible interval (upper and lower limits) (Figure 1).

### Estimating US foodborne illnesses for *unspecified* agents

Unspecified agents fall into four general categories:

- Agents with insufficient data to estimate agent-specific burden
- Known agents not yet recognized as causing foodborne illness
- Microbes, chemicals, or other substances known to be in food whose pathogenicity is unproven
- Agents not yet described

To estimate foodborne illnesses from unspecified agents, we used symptom-based data from surveys to estimate the total number of AGI and then subtracted the number of illnesses accounted for by known gastroenteritis pathogens. We then multiplied this number by the proportion of domestically acquired illnesses and of illnesses attributable to food, just as we did for the known agents. Finally, again as with the known-pathogens estimate, we used an uncertainty model to generate a point estimate and 90% credible interval (upper and lower limits) (Figure 2).

Foodborne illnesses due to chemicals that cause acute gastroenteritis are included in the estimate of illnesses due to unspecified agents. However, chemicals or unspecified agents that do *not* cause acute gastroenteritis are not included in the estimates.
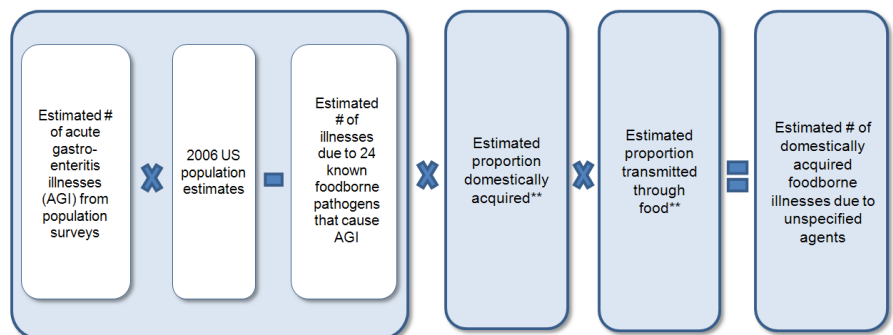
Figure 1. Estimating illnesses for pathogens known to cause foodborne illness, 2011*
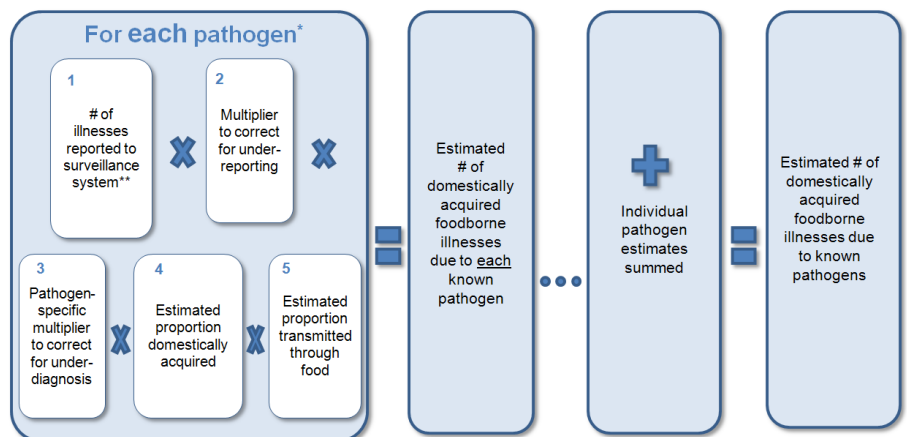
*Probability distributions were used to model uncertainty in each of the data inputs. Point estimates were bounded by a 90% credible interval.
**For six of the 31 pathogens, no routine surveillance data were available so alternative approaches were used to estimate illnesses.

Figure 2. Estimating foodborne illnesses due to unspecified agents, 2011*

*Probability distributions were used to model uncertainty in each of the data inputs. Point estimates were bounded by a 90% credible interval.
**Estimated proportions were based on the 24 known pathogens that cause acute gastroenteritis illnesses

---

[1] In the Mead et al. paper, unspecified agents were referred to as *unknown* agents.

[2] For 6 of the 31 known pathogens, no routine surveillance data were available so alternative approaches were used to estimate illnesses.

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

Methods Used in 2011 Estimates

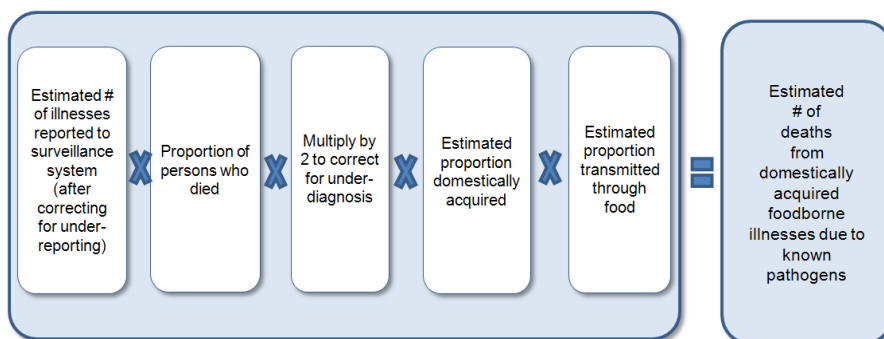**Estimating hospitalizations and deaths from US foodborne illnesses due to *known* pathogens**

For each known pathogen with surveillance data available, we multiplied the estimated number of reported illnesses (after correcting for underreporting) by the pathogen-specific hospitalization and death rate from surveillance data, surveys, or outbreak data. Because some people with illnesses that were not laboratory-confirmed would also have been hospitalized and died, we doubled the estimates to correct for under-diagnosis. We multiplied the adjusted hospitalization and death estimates by the proportion of illnesses that were acquired within the United States (vs. international travel-related) and the proportion transmitted by food. Finally, we used an uncertainty model to generate a point estimate and 90% credible intervals for both hospitalizations and deaths (Figures 3 and 4).

Figure 3. Estimating hospitalizations from foodborne illnesses due to known pathogens, 2011*
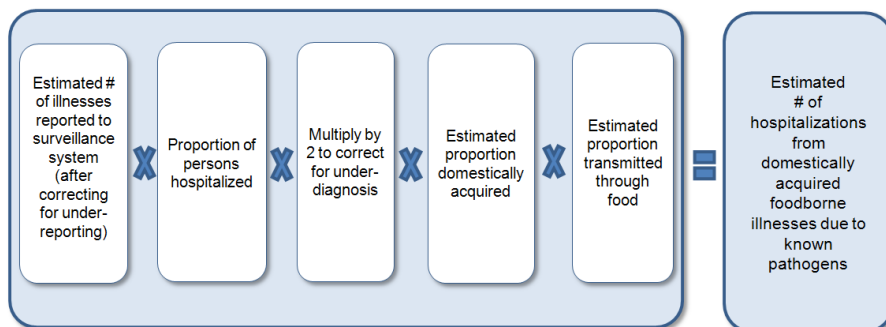
* Probability distributions were used to model uncertainty in each of the data inputs. Point estimates were bounded by a 90% credible interval.

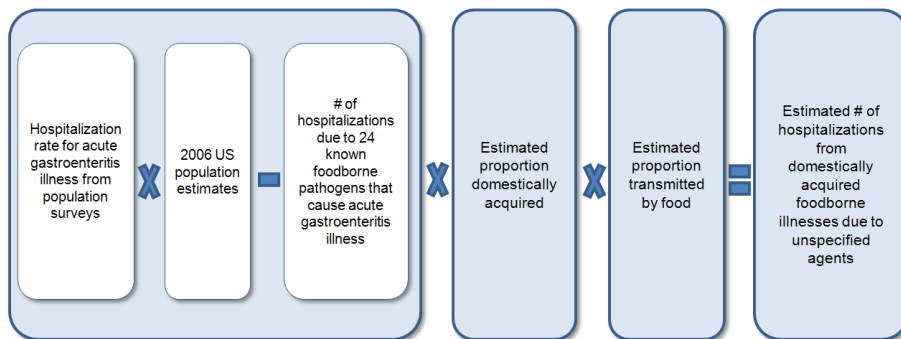**Figure 4. Estimating deaths from foodborne illnesses due to known pathogens, 2011***

*Probability distributions were used to model uncertainty in each of the data inputs. Point estimates were bounded by a 90% credible interval.

Methods Used in 2011 Estimates

## Estimating hospitalizations and deaths from US foodborne illnesses due to *unspecified* agents

To estimate hospitalizations, we applied the average hospitalization rate for all AGI, determined from survey data for 2000–2006, to 2006 US population estimates and subtracted the estimated number of hospitalizations caused by the 24 known pathogens that cause AGI. For deaths, we determined the death rate for acute gastroenteritis illnesses from US death certificates (specifically, multiple-cause-of-death data) for 2000–2006 and applied that rate to the 2006 US population estimate. We then subtracted the estimated number of deaths from the 24 known gastroenteritis pathogens. For both hospitalizations and deaths, we multiplied the overall number by the proportion of hospitalizations and deaths from the 24 known gastroenteritis pathogens that was domestically acquired and foodborne. Finally, we used an uncertainty model to generate a point estimate and 90% credible intervals (Figures 5 and 6).

Figure 5. Estimating hospitalizations from foodborne illnesses due to unspecified agents, 2011*

*Probability distributions were used to model uncertainty in each of the data inputs. Point estimates were bounded by a 90% credible interval.

Figure 6. Estimating deaths from foodborne illnesses due to unspecified agents, 2011*
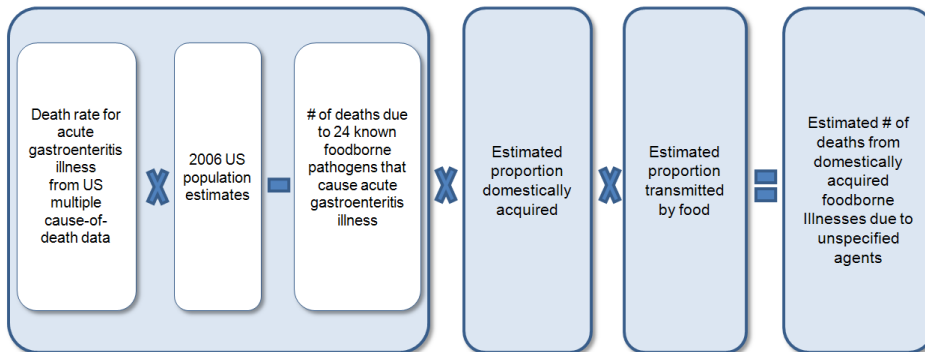
*Probability distributions were used to model uncertainty in each of the data inputs. Point estimates were bounded by a 90% credible interval.

Data Sources for the 2011 Estimates

We used five general types of data sources to create the 2011 estimates:

- **Active surveillance** (public health officials actively gather data from state and local health departments, laboratories, hospitals, etc.)
  - » Foodborne Diseases Active Surveillance Network (FoodNet)
- **Passive surveillance** (public health officials rely on state and local health departments, laboratories, hospitals, etc. to report data to surveillance systems)
  - » National Notifiable Diseases Surveillance System (NNDSS)
  - » National Tuberculosis Surveillance System (NTSS)
  - » Public Health Laboratory Information System
  - » Cholera and other *Vibrio* Illness Surveillance System (COVIS)

- **Outbreak surveillance**
  - » Foodborne Disease Outbreak Surveillance System

- **Surveys**
  - » FoodNet Population Survey
  - » FoodNet Laboratory Survey
  - » National Ambulatory Medical Care Survey (NAMCS)
  - » National Hospital Ambulatory Medical Care Survey (NHAMCS)
  - » National Hospital Discharge Survey (NHDS)
  - » National Health and Nutrition Survey (NHANES)
  - » Nationwide Inpatient Sample (NIS)

- **Vital (Government) Statistics**
  - » Multiple-cause-of-death data (from US death certificates)
  - » US Census

Tables 6a and 6b from Scallan et al. provide detailed descriptions of the data sources.

Table 6a. Data sources used to estimate illnesses, hospitalizations, and deaths due to known foodborne pathogens in the United States, 2011 (from Scallan et al.)

Data source	Data	Pathogen(s)	Geographic coverage	Time frame	Adjustments
Cholera and Other *Vibrio* Illness Surveillance System (COVIS)*	Number of case-patient reports, proportion hospitalized, proportion who died	*Vibrio cholerae,* toxigenic; *Vibrio vulnificus*; *Vibrio parahaemolyticus*; other *Vibrio* spp.	United States	2000–2007	Underreporting; Under-diagnosis
Foodborne Diseases Active Surveillance Network (FoodNet)	Number of laboratory-confirmed illnesses, proportion hospitalized, proportion who died	*Campylobacter* spp.; *Cryptosporidium spp.; Cyclospora cayetanensis;* Shiga toxin–producing *Escherichia coli* O157; Shiga toxin-producing *E.coli* non-O157; *Listeria monocytogenes;* non-typhoidal *Salmonella; Salmonella* serotype Typhi; *Shigella* spp.; *Yersinia enterocolitica*	FoodNet sites‡	2005–2008	Geographical coverages§; Under-diagnosis
Foodborne Disease Outbreak Surveillance System (FDOSS)	Number of foodborne outbreak-associated illnesses	*Bacillus cereus; Clostridium perfringens;* Enterotoxigenic *Escherichia coli; Staphylococcus aureus; Streptococcus* spp., Group A	United States	2000–2007; (*Streptococcus* spp., Group A 1996–2007)†	Underreporting; Under-diagnosis
	Proportion hospitalized and proportion who died in foodborne outbreaks	*Bacillus cereus; Clostridium perfringens;* Enterotoxigenic *Escherichia coli; Staphylococcus aureus; Streptococcus* spp., Group A; *Clostridium botulinum; Trichinella spp.*	United States	2000–2007; (*Streptococcus* spp., Group A 1981–2007)†	Under-diagnosis

Table 6a. Data sources used to estimate illnesses, hospitalizations, and deaths due to known foodborne pathogens in the United States, 2011 (from Scallan et al.) *continued*

Data source	Data	Pathogen(s)	Geographic coverage	Time frame	Adjustments
Nationwide Inpatient Sample (NIS)	Hospitalization rate	*Giardia intestinalis* (ICD-9-CM code 007.1), *Toxoplasma gondii* (ICD-9-CM codes 130.0-9)	Sample of discharge records from US hospitals	2000–2006	Weighted to give national estimates according to Healthcare Cost and Utilization Project (HCUP) criteria; Under-diagnosis (*Giardia intestinalis* and *Toxoplasma gondii*)
	Death rate	*Giardia intestinalis* (ICD-9-CM code 007.1), *Toxoplasma gondii* (ICD-9-CM codes 130.0-9)	Sample of discharge records from US hospitals	2000–2006	Under-diagnosis
National Health and Nutrition Examination Survey (NHANES)	Seroprevalence	*Toxoplasma gondii*	United States	1999–2004	Rate of infection over time and percentage symptomatic
National Notifiable Diseases Surveillance System (NNDSS)	Number of case-patient reports	*Brucella* spp.; *Clostridium botulinum* (foodborne); *Trichinella spp.*; Hepatitis A; *Giardia intestinalis*	United States	2000–2007 (2002–2007 for *Giardia intestinalis*)#	Underreporting; Under-diagnosis
	Hospitalization rate	Hepatitis A	United States	2000–2007	Under-diagnosis
National Tuberculosis Surveillance System (NTSS)	Number of tuberculosis case-patient reports, proportion who died	*Mycobacterium bovis*	United States	2004–2007	Percentage of tuberculosis cases attributable to *M.bovis*; under-diagnosis
US Census	Population estimates	Astrovirus, rotavirus, sapovirus	United States	2006	75% of children experience an episode of clinical illness by 5 years of age
Various acute gastroenteritis data sources *(see Table 6b)*	Acute gastroenteritis illnesses, hospitalizations, and deaths	Norovirus	*See Table 6b*	*See Table 6b*	Fraction of acute gastroenteritis attributable to norovirus

* Passive surveillance from COVIS was used in preference to active surveillance from FoodNet for *Vibrio* spp. because most illnesses are reported by Gulf States (Florida, Alabama, Louisiana, Texas) that are not included in the FoodNet surveillance area.

‡ Beginning in 2000, there were 10 FoodNet sites. In 2008, the population of these sites was 46 million persons, 15% of the US population.

§ Incidence of laboratory-confirmed illnesses in FoodNet from 2004 to 2007 was applied to the 2006 US Census population estimates.

† Data from FDOSS on *Streptococcus* spp., Group A were included from 1996 to 2007 for illnesses and from 1981 to 2007 for hospitalizations and deaths because of a paucity of data (Appendix 1 and 3).

\# *Giardia intestinalis* became nationally notifiable in 2002.

Data Sources for the 2011 Estimates

Table 6b. Data sources used to estimate illnesses, hospitalizations, and deaths due to acute gastroenteritis in the United States, 2011 (from Scallan et al.)

Data source	Data	Definition	Geographic coverage	Time frame
FoodNet Population Survey	Rate of illness	Average annual rate of acute gastroenteritis was derived by multiplying the average monthly prevalence by 12, where an episode of acute gastroenteritis was defined as diarrhea (≥3 loose stools in 24 hours) or vomiting in the past month with both lasting >1 day or resulting in restricted daily activities. Persons with a chronic condition in which diarrhea or vomiting was a major symptom and persons with concurrent symptoms of cough or sore throat were excluded.	FoodNet sites‡	2000–2001, 2002–2003, 2006–2007
Death certificates -- Multiple-cause-of-death data from the National Vital Statistics System	Death rate	Norovirus; Acute gastroenteritis deaths were identified from the underlying or contributing cause of death classified by ICD-10 diagnostic codes A00.9–A08.5 (infectious gastroenteritis of known cause); A09 (diarrhea & gastroenteritis of presumed infectious origin); and K52.9 (noninfectious gastroenteritis and colitis, unspecified); excluding A04.7 (enterocolitis due to *Clostridium difficile*) and A05.1 (botulism) ¶.	United States	2000–2006
National Ambulatory Medical Care Survey (NAMCS); National Hospital Ambulatory Medical Care Survey (NHAMCS)	Hospitalization rate	Norovirus; Acute gastroenteritis hospitalizations were identified from patient visits to clinical settings, including physician offices, hospital emergency and outpatient departments with a diagnosis of infectious enteritis (ICD-9-CM diagnostic codes 001–008 (infectious gastroenteritis of known cause); 009 (infectious gastroenteritis); 558.9 (other and unspecified noninfectious gastroenteritis and colitis), or 787.9 (other symptoms involving digestive system: diarrhea); [excluding 008.45 (*Clostridium difficile* colitis) and 005.1 (botulism) ¶] or reason for visit classification codes for diarrhea (1595) or gastrointestinal infection (1540) resulting in hospitalization ¶.	Nationally representative sample of US clinical settings	2000–2006
Nationwide Inpatient Sample (NIS)	Hospitalization rate	Norovirus; Acute gastroenteritis hospitalizations were identified from discharges with one of the first three listed diagnoses classified by ICD-9-CM diagnostic codes 001–008 (infectious gastroenteritis of known cause); 009 (infectious gastroenteritis); 558.9 (other and unspecified noninfectious gastroenteritis and colitis), or 787.9 (other symptoms involving digestive system: diarrhea); excluding 008.45 (*Clostridium difficile* colitis) and 005.1 (botulism) ¶ .	Sample of discharge records from US hospitals	2000–2006
National Hospital Discharge Survey (NHDS)	Hospitalization rate	Norovirus. Acute gastroenteritis hospitalizations were identified from discharges with one of the first three listed diagnoses classified by ICD-9-M diagnostic codes 001–008 (infectious gastroenteritis of known cause); 009 (infectious gastroenteritis); 558.9 (other and unspecified noninfectious gastroenteritis and colitis), or 787.9 (other symptoms involving digestive system: diarrhea); excluding 008.45 (*Clostridium difficile* colitis) and 005.1 (botulism) ¶.	Nationally representative sample of discharge records from US hospitals	2000–2006

‡ Beginning in 2000, there were 10 FoodNet sites. In 2008, the population of these sites was 46 million persons, 15% of the US population.

¶ Codes for other and unspecified noninfectious gastroenteritis and colitis were included because infectious illnesses of unknown etiology are sometimes coded as noninfectious.