

### Methods Used in 1999 Estimates

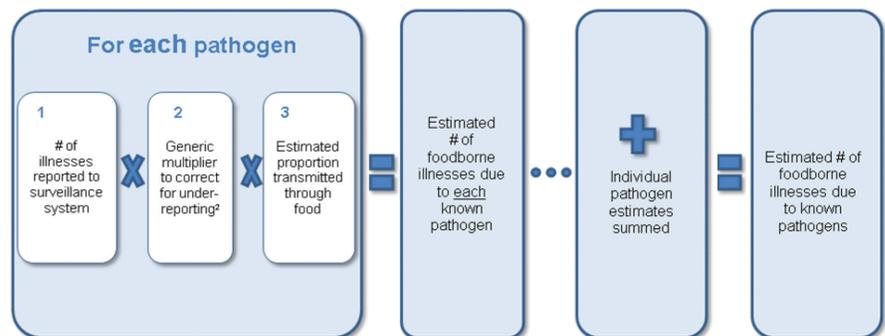
In 1999, Mead et al. estimated the overall burden of foodborne illnesses caused by known and unknown agents<sup>1</sup>. This analysis included 28 pathogens known to cause foodborne illness and unknown agents that cause acute gastroenteritis illnesses (AGI). Mead et al. also estimated the number of hospitalizations and deaths caused by these illnesses.

#### Estimating foodborne illnesses due to *known* foodborne pathogens

For the pathogens with surveillance data available, Mead et al. gathered data on the number of illnesses reported to surveillance systems. They corrected for underreporting<sup>2</sup> using generic multipliers based on the similarity of symptoms for several known pathogens, and then estimated the total number of illnesses (both reported and unreported) that occurred in the population. To that figure, they applied the estimated proportion of illnesses transmitted by food, rather than by some other route of transmission. Finally, they added the estimates for each of the pathogens to arrive at a grand total estimate for foodborne illnesses from known pathogens (Figure 1).

Because of a lack of surveillance information, Mead et al. did not include specific estimates for some pathogens only occasionally transmitted by food nor did they develop specific estimates for known noninfectious foodborne agents (e.g., mushrooms, marine biotoxins, metals, or inorganic toxins).

Figure 1. Estimating illnesses due to pathogens known to cause foodborne illness, 1999

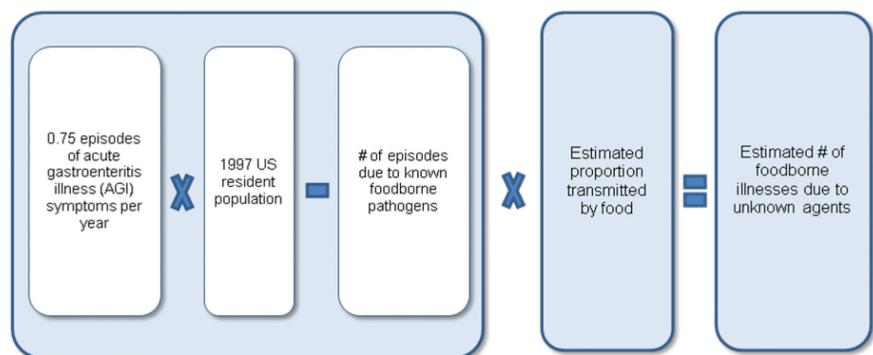


#### Estimating foodborne illnesses due to *unknown* agents

Unknown agents fall into four general categories:

- Agents with insufficient data to estimate 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

Figure 2. Estimating foodborne illnesses due to unknown agents, 1999



To estimate foodborne illnesses from unknown agents, Mead et al. used symptom-based data from three surveys to estimate the total number of acute gastroenteritis illnesses (AGI) and then subtracted the number of cases accounted for by known gastroenteritis pathogens. Finally, they multiplied this number by the proportion of illnesses attributed to foodborne transmission, using the relative frequency of foodborne transmission for known gastroenteritis pathogens as a guide (Figure 2).

<sup>1</sup> In the 2011 estimates of the burden of foodborne illnesses, Scallan et al. use the term *unspecified agents* instead of *unknown agents*.

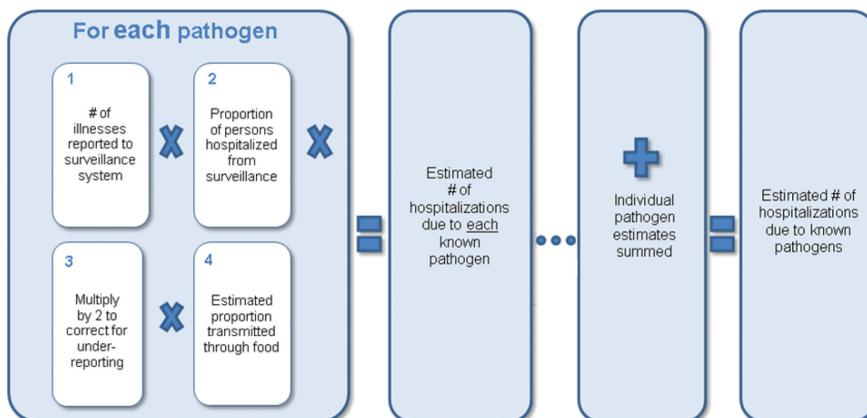
<sup>2</sup> In the 2011 estimates of the burden of foodborne illnesses, Scallan et al. refer to underreporting and under-diagnosing. Mead et al. did not differentiate between underreporting and under-diagnosis and used the term *underreporting* to describe both processes.

# Methods Used in 1999 Estimates

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

For each known pathogen with surveillance data available, Mead et al. multiplied the number of reported illnesses by the pathogen-specific hospitalization rate from surveillance data, surveys, and outbreak data. The product was doubled to correct for underreporting. They multiplied the adjusted number by the proportion of illnesses transmitted by food (described previously). Finally, the estimates for all pathogens were added for a total number of hospitalizations. Deaths were calculated in the same way (Figure 3).

Figure 3. Estimating hospitalizations and deaths\* from foodborne illnesses due to known pathogens, 1999

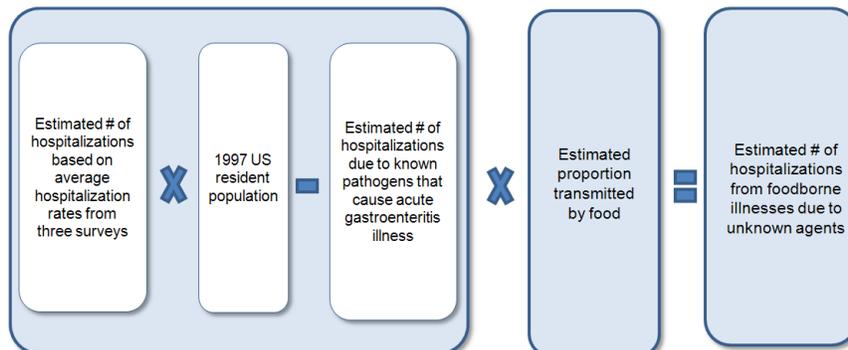


\*Process for estimating hospitalizations was repeated for deaths.

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

Mead et al. used the average hospitalization rate for acute gastroenteritis illness, derived from three national surveys, to estimate the total number of acute gastroenteritis hospitalizations. They then subtracted the estimated number of hospitalizations due to known gastroenteritis pathogens. Finally, they multiplied the adjusted number by the proportion of illnesses transmitted by food (described previously). Deaths were estimated in a similar way, with the death rate derived from multiple-cause-of-death data (from death certificates) and in-hospital death data (Figure 4).

Figure 4. Estimating hospitalizations and deaths\* from foodborne illnesses due to unknown agents, 1999



\*Process for estimating hospitalizations was repeated for deaths using multiple-cause-of-death data and in-hospital death data.

## Data Sources for the 1999 Estimates

Mead et al. used five general types of data sources to create the 1999 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)
  - » Public Health Laboratory Information System
  - » Gulf Coast States Vibrio Surveillance System
- **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)
  - » Tecumseh study
  - » Cleveland study
- **Vital (Government) Statistics**
  - » Multiple-cause-of-death data (from US death certificates)
  - » US Census

Tables 5a and 5b provide detailed information about these data sources.

**Table 5a. Data sources used to estimate illnesses, hospitalizations, and deaths due to known foodborne pathogens in the United States, 1999 (from Mead et al.)**

Data source	Data	Pathogen(s)	Geographic coverage	Time frame	Adjustments
Foodborne Diseases Active Surveillance Network (FoodNet)	Number of laboratory-confirmed illnesses, proportion hospitalized, proportion who died	<i>Campylobacter</i> spp.; <i>Cryptosporidium parvum</i> ; <i>Cyclospora cayetanensis</i> ; Shiga toxin-producing <i>Escherichia coli</i> O157:H7; <i>Listeria monocytogenes</i> ; non-typhoidal <i>Salmonella</i> ; <i>Shigella</i> spp.; <i>Vibrio</i> , other spp.; and <i>Yersinia enterocolitica</i>	FoodNet sites <sup>1</sup>	1996–1997	Geographical coverage
Foodborne Disease Outbreak Surveillance System (FDOSS)	Number of foodborne outbreak-associated illnesses	<i>Bacillus cereus</i> ; <i>Clostridium perfringens</i> ; <i>Staphylococcus aureus</i> ; and <i>Streptococcus</i> spp., Group A	United States	1988–1992 (1983–1987 for <i>Staphylococcus aureus</i> )	Underreporting
	Proportion hospitalized and proportion who died in foodborne outbreaks	<i>Bacillus cereus</i> ; <i>Brucella</i> spp.; <i>Clostridium botulinum</i> ; <i>Clostridium perfringens</i> ; <i>Staphylococcus aureus</i> ; <i>Streptococcus</i> spp., Group A; and <i>Trichinella spiralis</i>	United States	1988–1992	Underreporting
Gulf Coast States <i>Vibrio</i> Surveillance System	Number of case-patient reports, proportion hospitalized, proportion who died	<i>Vibrio cholera</i> and <i>Vibrio vulnificus</i>	4 Gulf Coast states	1989	Underreporting
National Electronic Telecommunications System for Surveillance (NETSS)	Number of case-patient reports	<i>Trichinella spiralis</i>	United States (not all states report to NETSS; those that don't report through Public Health Laboratories Information System)	1995–1998	Underreporting
National Health and Nutrition Examination Survey (NHANES)	Seroprevalence	<i>Toxoplasma gondii</i>	United States	1994	Rate of infection over time and percentage symptomatic
National Notifiable Diseases Surveillance System (NNDSS) <sup>2</sup>	Number of case-patient reports	<i>Clostridium botulinum</i> ; <i>Brucella</i> spp.; Hepatitis A, <i>Salmonella</i> Typhi	United States	1992–1997	Underreporting
Various acute gastroenteritis data sources (see Table 5b)	Acute gastroenteritis illnesses, hospitalizations, and deaths	Norovirus	See Table 5b	See Table 5b	Fraction of acute gastroenteritis attributable to norovirus

<sup>1</sup> FoodNet conducts population-based active surveillance for selected foodborne infections in 8 sites with a total population catchment area of 20.5 million Americans.

<sup>2</sup> Passive surveillance data reported by physicians and laboratories.

## Data Sources for the 1999 Estimates

**Table 5b. Data sources used to estimate illnesses, hospitalizations, and deaths due to acute gastroenteritis foodborne pathogens in the United States, 1999 (from Mead et al.)**

Data source	Data	Definition	Geographic coverage	Time frame
FoodNet Population Survey	Rate of illnesses	Average annual rate of diarrheal illness derived by multiplying the average monthly prevalence by 12, where an episode of acute diarrheal illness was defined as diarrhea ( $\geq 3$ loose stools in 24 hours) lasting $>1$ day or resulting in restricted daily activities or vomiting in the past month.	FoodNet sites <sup>1</sup>	1996–1997
Monto & Koopman, 1980	Rate of illnesses	Vomiting and respiratory symptoms	850 households in Tecumseh, Michigan	1965–1971
Dingle et al., 1964	Rate of illnesses	Vomiting and respiratory symptoms	86 families in Cleveland, Ohio	1948–1957
National Hospital Discharge Survey (NHDS)	Hospitalization rate	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).	Nationally representative sample of discharge records from ~475 US hospitals	1992–1996
National Ambulatory Medical Care Survey (NAMCS); National Hospital Ambulatory Medical Care Survey (NHAMCS)	Hospitalization rate	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); and 558.9 (other and unspecified noninfectious gastroenteritis and colitis) and reason for visit classification (RVC) codes 1595, 1530, 1540, for diarrhea, vomiting, and gastroenteritis, respectively.	Nationally representative sample of US clinical settings	1996
Multiple-cause-of-death data from the National Vital Statistics System	Death rate	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 and gastroenteritis of presumed infectious origin); and K52.9 (noninfectious gastroenteritis and colitis, unspecified)	United States	1998

<sup>1</sup> FoodNet conducts population-based active surveillance for selected foodborne infections in 8 sites with a total population catchment area of 20.5 million Americans.