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PART FOUR: Inputs to Valuation Studies

17. Determining Foodborne Illness in the United States: A Step Toward Valuation

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17

Determining Foodborne Illness in the United States: A Step Toward Valuation

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Underlying the attempt to value foodborne illness in the United States is the belief there is consensus on what is included in this category. In fact, such a consensus does not exist. Sources of problems include the assumption that foodborne illness is distinguishable from other types of illness, e.g., that pathogens using food or water as a transmission vehicle to human populations may be identified in a separate category. A second source is the assumption that a list of foodborne illness exists and provides the basis for a count of persons with these diseases. A third source of the lack of consensus is that no single data base contains all cases of foodborne illness. The intent of this chapter is to identify illness which is most likely caused by foodborne pathogens, to construct a list of these diseases using the International Classification of Disease, 9th Revision codes, and to examine several national data sets for the frequency of foodborne illness and the demographic characteristics of persons with these diseases. This approach will result in a more comprehensive view of foodborne illness from which valuation research may proceed.

One measurement of the prevalence of foodborne illness is provided by the Centers for Disease Control and Prevention. The surveillance system is based on reported outbreaks of foodborne illness. An outbreak is defined as two or more persons experiencing a similar illness after ingestion of a common food. The exceptions are botulism and chemical poisoning where one case is defined as an outbreak. While this surveillance system provides valuable information on the incidence of foodborne disease, it is limited in several ways. With the two exceptions above, all single cases of persons becoming ill due to foodborne pathogens do not qualify as outbreaks and are not reported as such. In addition, if two or more persons are involved, the original report must come from state and local health departments on standard forms. This means that reporting

outbreaks depends on patient and physician recognition, motivation to contact the local health department, the resources of laboratories to identify the pathogen, and other factors. It has been suggested that only a small fraction of foodborne disease outbreaks are reported to the Centers for Disease Control and Prevention (Bean and Griffin 1990: 85). For example, small outbreaks of infections involving mild illness from ingesting food at family gatherings, workplace picnics, and similar social events are less likely to be reported than outbreaks involving hospitalizations. Outbreaks caused by pathogens difficult to detect are also underreported (Bean and Griffin 1990).

Outbreak data also underrepresent the prevalence of foodborne illness in the United States because the types of conditions receiving the most research attention from bacteriology during the past decades have been acute conditions resulting from gastroenteritis-causing pathogens. Specific human pathogens, such as *Salmonella spp*, *Campylobacter spp*, and *Shigella spp*, have been clearly linked to foodborne illness outbreaks (Bean et al. 1990, Bean and Griffin 1990). More recently, chronic conditions which have a longer period of debility and have more complex etiology are becoming directly or indirectly connected with foodborne pathogens. For example, reactive arthritis may be activated by *Salmonella spp* (among other pathogens); diarrheal experiences during foodborne illness may increase overall morbidity by reducing nutritional and immunity levels; and the heart diseases of endocarditis and myocarditis have been associated with foodborne pathogens (Archer and Young 1988: 387-390). These and other chronic health conditions suggest that the consequences and health costs of foodborne illness extend well beyond the immediate hospital costs to treat acute events.

Microbiologists have established that foodborne disease encompasses a complex pattern ranging from a passive mode in which pathogens are transmitted to people via the eating of contaminated food acting as a simple vehicle, to an active mode in which the food supports growth of the pathogens so they replicate on food prior to eating. Moreover, foodborne disease is included within enteric or diarrheal disease and this ranks second only to respiratory diseases in prevalence in the United States. One estimate is that of all enteric disease, foodborne disease constitutes one-third of the total cases annually, or over 80 million cases (Archer and Young 1988: 378). This level of disease may be due primarily to unsanitary methods of producing food, improper methods of handling and preserving food, and unhygienic customs which allow persons to transmit their diseases via food. The complex etiology of food contamination has long been recognized (Bryan 1982).

While research at the microbial level is required to understand the etiology of specific diseases, a broader approach is necessary if the incidence and prevalence of foodborne illness in human populations is to be understood. It is recognized that the reported data on foodborne illness are only a small part of the actual number of events that take place. There are a number of cultural,

social, economic, and administrative "filters" through which illness events must pass before becoming part of the official surveillance system. Cultural factors impacting on illness events include preference for uncooked meat or fish, or for large pieces of meat that prevent cooking from killing all bacteria, or for aging food without refrigeration. Social factors include attaching a meaning to the physical experience of pain which links it to food ingestion and then seeking medical care for this condition, rather than doing nothing, or self-care only, or care from relatives or friends. Research on these factors reveals a great deal of individual and cultural variation (Foster and Kaferstein 1985, Vargas 1990, Strain 1989). Characteristics such as age, gender, education, marital status, and health status are related to attaching meaning to pain and seeking medical health care (Kaplan et al. 1987, Swedlund and Armelagos 1990, Wolinsky et al. 1989). After such health care is sought, administrative conditions must be met to include the event in the official statistics. For example, after a physician is visited, a specimen must be taken and the organism correctly identified. This finding should be reported to the health department which forwards the data to the Centers for Disease Control and Prevention (Chalker and Blaser 1988). Since some of the illness events fall out of the system at various stages, the official statistics on foodborne illness are an underestimate of actual incidence or prevalence. Moreover, relatively little is known about the demographic and geographic patterns of persons with specific types of foodborne illness.

A basic thesis of this chapter is that scientific knowledge of foodborne illness should be expanded to include the analysis of ill persons, as well as the analysis of the pathogen and how to eliminate its transmittal. Valuation research concerned with the economic impact of foodborne illness should recognize which high risk groups suffer most and what corrective action is needed to reduce this type of illness among young children, the elderly, persons with impaired immunity systems, etc. This information is required to establish trends and to document improvement following policy changes intended to ameliorate suffering from foodborne illness.

Available Data for Determining Foodborne Illness

The preceding discussion suggests that surveillance statistics on foodborne illness in the United States are only the tip of the iceberg in terms of actual numbers of illness events. In developing countries of the world foodborne illness is recognized as a widespread problem and estimates of unreported cases approach 90 percent in nonindustrialized countries (Abdussalam and Grossklaus 1991). While levels of unreported illness are lower in developed nations, there are still many cases that are not in the surveillance system. At the broadest level, persons become ill from eating a foodborne pathogen, do not seek medical treatment (or are not taken to a physician if they are children), and then return

to normal functions after symptoms disappear. Measuring the frequency of these illness events requires special purpose surveys with carefully designed questionnaires. While some survey research of this type has been accomplished, significantly more is necessary to estimate the prevalence of nonreported foodborne infection.

Beyond the initial level of unreported cases, there are official statistics which provide three sources of data on foodborne illness. One important indicator of the extent of these events is the number of persons who see a physician and are diagnosed as suffering from a foodborne pathogen. Fortunately, the National Center for Health Statistics, Public Health Service, Centers for Disease Control and Prevention, publishes such a data set. The National Ambulatory Medical Care Survey of 1990 provides data from samples of patient records selected from a national sample of office-based physicians. This sample describes the use of ambulatory medical care in the United States. In 1990 there were approximately 43,469 patient records provided by 1,684 physicians participating in the survey. Only office visits of nonfederally employed physicians classified by the American Medical Association or the American Osteopathic Association as "office-based patient care" were included. Specialties of anesthesiology, pathology and radiology were excluded. The random sample of 43,469 patient records represents the total of over 704 million physician office visits by all patients in the United States in 1990. The use of this data set to estimate the frequency of foodborne illness and determine selected demographic characteristics of the patient are discussed below.

A second indicator of the prevalence of foodborne illness is the number of patients treated in hospitals. This may be an indicator of a more serious threat to health than physician office visits. These data exist in the National Hospital Discharge Survey of 1990, also collected by the National Center for Health Statistics, Public Health Service, Centers for Disease Control and Prevention (Graves 1992). This survey began in 1988 and is taken annually. In 1990, the survey covered discharges from noninstitutional hospitals located in all states and the District of Columbia (excluded are federal, military, and Veterans Administration hospitals). Only short-stay hospitals (average length of stay less than 30 days) or children's hospitals responded to the survey. The hospital discharge certificates for sampled patients are examined for foodborne illness as diagnosed by the hospital. The socio-demographic characteristics of those patients are described below. This random sample of hospital discharge certificates includes a weighting value for each certificate in terms of characteristics of the patient, such as age, gender, race, type of illness, etc. These weights are summed for the estimate of the actual number of discharge certificates that would have been counted if a complete enumeration of all patients was taken. In other words, the data presented here are the summations of weighted sample values provided by the Centers for Disease Control and Prevention from the original computer tapes.

A third and most serious indicator of the prevalence of foodborne disease is the level of mortality caused by specific foodborne pathogens. The most recent published data are for 1986 and are contained in the National Mortality Followback Survey. This was also collected by the National Center for Health Statistics, Public Health Service, Centers for Disease Control and Prevention. The data are a national sample of approximately 1 percent of the United States resident deaths of persons 25 years and older. Each state is represented in the sample (except Oregon) and information on 18,733 deaths was taken from four sets of data: (1) information from the death certificate, (2) an informant questionnaire, (3) a nursing home, hospital, or hospice questionnaire, and (4) a facility abstract record. The final record on each death contained all of this information and socio-demographic characteristics of persons deceased with mention of foodborne pathogens. Data for these are presented below.

Determination of Foodborne Illness

As noted earlier, a list of International Classification of Disease codes identifying only foodborne illness does not exist. Various diseases may be thought of as forming a continuum from primarily foodborne to rarely foodborne. The problem is to place each code on this continuum so that accurate counts of foodborne illness may be derived. Without this step, valuation of the economic costs and impacts of those diseases are hindered by the two problems of not knowing basic frequencies and not knowing basic demographic characteristics of patients suffering from foodborne illness. The classification used here is the International Classification of Disease, 4th Edition, Clinical Modification (ICD-9-CM) (Karaffa 1992). These codes are used to provide the link between each of the three data sets described above.

An attempt to construct such a list was made based on careful reading of texts on foodborne bacteria (Doyle 1989, Cliver 1990, Riemann and Bryan 1979), by cross-checking the Merck Manual of Diagnosis and Therapy (Berkow and Fletcher 1992) for a given disease, and by reading the relevant articles in the health literature. It quickly became apparent that persons diagnosed with a given ICD-9 coded disease may or may not have contracted that illness via a foodborne or waterborne vehicle; only case by case analysis could determine a source. Direct contamination through open skin lesion is a frequent method of infection. It is not possible to determine the number of cases of a given ICD-9 disease that are caused by a foodborne vehicle without a case-specific analysis. An attempt to solve this problem was made by creating two lists of ICD-9 codes: List A and List B. List A is intended to include only those ICD-9 codes for diseases most likely the result of food- or waterborne pathogens. List B is intended to include those ICD-9 codes for diseases which may result from non-foodborne causes but which also include an unknown number of cases caused

by foodborne infection. Because the relative proportions are unknown, analysis is not performed on List B.

It should be noted that the ICD-9-CM codes included on List A and List B are approximations and not a final division without potential change. Indeed, it is likely some conditions might be dropped from List A while other conditions added to List A from List B. New conditions not presently on List B may also be included on List A.

Foodborne Illness, List A

The National Hospital Discharge Survey for 1990 is used to establish List A. Table 17.1 presents data on patients discharged from short-stay hospitals by category of foodborne illness (List A) for the United States in 1990. The hospital discharge certificate for each inpatient contained seven lines on which a diagnosis might be recorded. The first line contained the principal diagnosis for each case and lines 2-7 contained related conditions for each patient. Table 17.1 presents these separately so that the frequency of foodborne illness as the principal diagnosis may be determined. Based on numerical order of the ICD-9-CM codes, cholera is the first category. While cholera is endemic in many nations, there were only 92 patients discharged from hospitals in the United States in 1990 with it. The etiological agent is *Vibrio cholera* and may be ingested by eating improperly cooked crabs, raw oysters, mussels, or clams (Cliver 1990: 243). Cholera is also spread by drinking water or eating food contaminated by the excrement of persons with the infection (Berkow and Fletcher 1992: 110). Typhoid and paratyphoid fevers (codes 002.0-002.9) are caused by *Salmonella typhi* (Cliver 1990: 186) which is also spread by either direct human fecal contamination of food or water or by indirect contamination by a food handler who is infected and spreads *S. typhi* to food. Foods that have been involved in the transmission of this disease include raw milk, shellfish, and raw salads (Cliver 1990: 187). In the United States, 1,882 hospital patients were diagnosed as having typhoid fever, with an additional 174 patients with paratyphoid fever A.

Third on Table 17.1 is Other *Salmonella* Infection(ICD-9-CM code 003.0-003.9), which accounted for 17,984 patients during 1990. The major source of infection is the ingestion of contaminated food and water (Cliver 1990: 189). Foods such as poultry, eggs, beef, and pork have been carriers. Direct person-to-person contact with individuals recovering from salmonellosis may result in infection since they shed the organism in their feces for weeks to months (Cliver 1990: 190). Unsanitary behavior by these persons can spread the disease. In addition, contact with infected animals may spread *Salmonella*, such as was the case with pet turtles. Of the total number of patients with *Salmonella* infection, the majority, 11,490 or 63.9 percent, are diagnosed with gastroenteritis.

TABLE 17.1 Patients Discharged from Hospitals by Category of Foodborne Disease, List A, United States, 1990

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Cholera	001	92	0	92
Vibrio cholera	001.0	0	0	0
Vibrio cholera el tor	001.1	0	0	0
Cholera, unspecified	001.9	92	0	92
Typhoid and ParaTyphoid Fevers	002	2,056	0	2,056
Typhoid fever	002.0	1,882	0	1,882
Paratyphoid fever A	002.1	174	0	174
Paratyphoid fever B	002.2	0	0	0
Paratyphoid fever C	002.3	0	0	0
Paratyphoid fever, unspecified	002.9	0	0	0
Other Salmonella Infection	003	12,237	5,747	17,984
Gastroenteritis	003.0	9,404	2,086	11,490
Salmonella septicemia	003.1	1,909	1,570	3,479
Localized salmonella	003.2	50	0	50
Other specified salmonella	003.8	293	574	867
Salmonella, unspecified	003.9	581	1,517	2,098
Shigellosis	004	1,440	673	2,113
Shigella dysenteriae	004.0	220	15	235
Shigella flexneri	004.1	327	49	376
Shigella boydii	004.2	0	0	0
Shigella sonnei	004.3	268	76	344
Other specified shigella	004.8	232	0	232
Shigellosis, unspecified	004.9	393	533	926
Other Food Poisoning	005	5,121	993	6,114
Staphylococcal	005.0	308	0	308
Botulism	005.1	494	235	729
Clostridium perfringens	005.2	0	0	0

(continues)

TABLE 17.1 *(continued)*

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Other clostridia	005.3	0	0	0
Vibrio parahaemolyticus	005.4	0	0	0
Other due to Bacillus cereus	005.8	52	0	52
Food poisoning, unspecified	005.9	4,267	758	5,025
Amebiasis	006	1,011	330	1,341
Acute amebiasis, with abscess	006.0	89	231	320
Chronic amebiasis, no mention of abscess	006.1	0	0	0
Amebic nondysenteric colitis	006.2	0	0	0
Amebic liver abscess	006.3	922	0	922
Amebic lung abscess	006.4	0	0	0
Amebic brain abscess	006.5	0	0	0
Amebic skin ulceration	006.6	0	0	0
Amebic infection elsewhere	006.8	0	46	46
Amebiasis, unspecified	006.9	0	53	53
Other Protozoal Intestinal Diseases	007	1,927	2,937	4,864
Balantidiasis (B. coli)	007.0	0	0	0
Giardiasis (Lambliasis)	007.1	1,671	1,296	2,967
Coccidiosis (Isosporiasis)	007.2	256	1,416	1,672
Intestinal Trichomoniasis	007.3	0	225	225
Other protozoal intestinal diseases	007.8	0	0	0
Unspecified protozoal intestinal diseases	007.9	0	0	0
Intestinal Infections Due to Other Organisms (excludes food poisoning by these organisms (005.0-.9))	008	101,978	74,304	176,282

(continues)

TABLE 17.1 *(continued)*

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Escherichia coli	008.0	1,686	572	2,258
Paracolon bacilli	008.1	0	0	0
Aerobacter aerogenous	008.2	0	14	14
Proteus	008.3	0	205	205
Other specified bacteria	008.4	20,955	31,073	52,028
Bacterial enteritis, unspecified	008.5	2,800	1,251	4,051
Bacterial enteritis, specified	008.6	14,494	8,533	23,027
Other organisms, NEC	008.8	62,043	32,656	94,699
Ill-Defined Intestinal Infections	009	15,982	12,321	28,303
Infectious colitis, etc.	009.0	6,850	5,164	12,014
Presumed infectious colitis, etc.	009.1	6,191	2,174	8,365
Infectious diarrhea	009.2	2,460	4,892	7,352
Diarrhea presumed infectious origin	009.3	481	91	572
Listeriosis	027.0	796	452	1,248
Other Diseases Due to Viruses				
Viral Hepatitis	070.	7,523	5,287	12,810
Viral Hepatitis A, with hepatic coma	070.0	0	0	0
Viral Hepatitis A, without hepatic coma	070.1	4,407	2,236	6,643
Unspecified viral hepatitis without mention of hepatic coma	070.9	3,116	3,051	6,167
Cysticercosis	123.1	612	830	1,442

(continues)

TABLE 17.1 *(continued)*

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Trichinosis	124	0	42	42
Other Noninfectious Gastroenteritis and Colitis	558			
Unspecified Gastroenteritis and Colitis	558.9	294,818	267,229	562,047
Toxic Effect of Noxious Substances				
Eaten as food	988	308	44	352
Fish and shellfish	988.0	42	44	86
Mushrooms	988.1	109	0	109
Berries and other plants	988.2	142	0	142
Other specified	988.8	15	0	15
Other unspecified	988.9	0	0	0
Toxic Effect of Other Substances	989			
Aflatoxin and other mycotoxin (food contaminate)	989.7	0	0	0
Totals		445,901	371,189	817,090

Source: National Hospital Discharge Survey, 1990, United States National Center for Health Statistics, Hyattsville, MD.

Note: Total mentions in this table may not agree exactly with total mentions of foodborne illness on subsequent tables due to some discharge certificates reporting more than one ICD-9 code for foodborne disease. While some ICD-9 codes have no cases recorded in the 1990 data, other years may reveal foodborne illness from those diseases.

[a]Principal diagnosis on hospital discharge certificates appears on the first line.

[b]Additional diagnosis on hospital discharge certificates appears on lines 2-7.

Shigellosis (ICD-9-CM codes 004.0-004.9) is an acute infection of the bowel caused by *Shigella* organisms resulting in dysentery. A direct source of infection is feces of infected persons via the fecal-oral route (Berkow and

Fletcher 1992: 106). Of course, the amount of feces necessary to contaminate food is very small, as microbes may reside under fingernails, on body hairs, or on the surface of unwashed skin in visually undetectable amounts. Food handlers who are infected and do not wash their hands after defecation and then handle food may pass the organism on (Doyle 1989: 207). Foods often involved are salads with potatoes, chicken, tuna, raw oysters, beans, and hamburgers (Doyle 1989: 208). During 1990 in the United States, 2,113 patients were discharged from hospitals after treatment for shigellosis.

The next category is a collection of diseases placed into Other Food Poisoning (ICD-9-CM codes 005.0-005.9). There were 6,114 patients discharged from hospitals in the United States treated for these diseases. Staphylococcal food poisoning (code 005.0) is caused by toxins produced by enterotoxins, the most important of which is the *Staphylococcus aureus* species (Berkow and Fletcher 1992: 464). Common foods involved include raw milk, cooked meat, pork, packaged sliced bacon, and pastry products (Berkow and Fletcher 1992: 474-476). In 1990 there were 308 patients discharged from hospitals treated for staphylococcal infections. Foodborne Botulism (ICD-9-CM code 005.1) is caused by *Clostridium botulinum* toxin eaten in contaminated food (Berkow and Fletcher 1992: 817). Home-canned food is a common source but commercial foods may also be involved, such as vegetables, fish, beef, pork, and poultry (Berkow and Fletcher 1992: 817). There were 729 patients discharged from hospitals in the United States after treatment for botulism. The category with the most cases is unspecified food poisoning, with 5,025 or 82.2 percent of all discharged patients in the category.

Amebiasis (ICD-9-CM codes 006.0-006.9) is an infection of the colon caused by *Entamoeba hisolytica* and, while usually asymptomatic, patients may exhibit symptoms ranging from mild diarrhea to dysentery (Berkow and Fletcher 1992: 225). Direct spread is common when personal hygiene is poor or the disease may be spread indirectly via food or water. Fruits and vegetables may be contaminated when grown in soil fertilized with human feces, worked with contaminated water, or prepared by a contaminated food handler. There were 1,341 patients discharged from hospitals who were treated for this in 1990. Other protozoal intestinal diseases (ICD-9-CM codes 007.0-007.9) included more patients, 4,864, during the time period and most of these were treated for Giardiasis (Lambliasis), with 2,967 or 61.0 percent with this disease. Giardiasis is an infection of the small intestine caused by *Giardia lamblia* and is usually asymptomatic (Berkow and Fletcher 1992: 228). The organism is passed directly between an infected person to another (between children or between sexual partners) or indirectly via contaminated food or water.

The category on List A containing the second largest number of patients in 1990 is ICD-9-CM codes 008.0-008.9, Intestinal Infections Due to Other Organisms. The subcategory contained 94,699 cases, or 53.7 percent, of all 176,282 patients treated for these infections. According to discussion with the

Centers for Disease Control and Prevention, many foodborne diseases where the causative organism is not identified are placed in this category and into codes 009 and 558.9. Further research is needed to refine these estimates.

Ill-defined intestinal infections (ICD-9-CM codes 009.0-009.3) contains 28,303 patients treated for that disease. The largest percent, 42.4, were diagnosed with infectious colitis, enteritis, and gastroenteritis (ICD-9-CM code 009.0). Next on List A is Listeriosis (ICD-9-CM code 027.0) which is caused by an infection from *Listeria monocytogenes*. Outbreaks have been caused by cabbage, hot dogs, and undercooked chicken. Direct contact may be achieved by veterinarians or butchers handling infected animals (Berkow and Fletcher 1992: 98). There were 1,248 patients discharged from hospitals treated for this disease.

Other Disease Due to Viruses (ICD-9-CM codes 070.0-070.9, excluding 070.2 and 070.3) are largely Viral *Hepatitis A* without hepatic coma. Viral *Hepatitis A* spreads primarily via the fecal-oral route, with fecal shedding of the virus contaminating hands which are not washed prior to food handling (Berkow and Fletcher 1992: 900). Eating raw shellfish from directly contaminated water also may be responsible. Viral *Hepatitis A* without sepatic coma was diagnosed in 6,643 patients discharged from hospitals in the United States in 1990. In addition, 6,167 patients were treated for unspecified viral hepatitis without mention of sepatic coma.

Cysticercosis (ICD-9-CM code 123.1) is an intestinal infection caused by the cestode *Taenia solium*. The infection of the tapeworm is the result of eating improperly cooked pork which is a carrier of the adult worm (Berkow and Fletcher 1992: 252). There were 1,442 patients released from hospitals in the United States who received treatment for this infection. Trichinosis (ICD-9-CM code 124) which is a parasitic disease caused by *Trichinella spiralis*, a roundworm also found in raw or inadequately cooked pork (Berkow and Fletcher 1992: 245). Table 17.1 shows 42 patients discharged from hospitals after treatment for Trichinosis. By far the largest category of patients on List A is ICD-9-CM code 558.9, Unspecified Gastroenteritis and colitis, with 562,047 patients discharged from hospitals treated for this disease. Toxic effect of noxious substances eaten as food (ICD-9-CM codes 988.0-988.9) included poisoning from toxins produced by microtoxin in fish, mushrooms, berries, and other plants. In 1990, there were 352 patients in hospitals treated for these illnesses.

Based on hospital discharge certificate data for 1990 shown in Table 17.1, there were a total of 817,090 patients treated for specific foodborne illness. This figure is derived from the counting of the listed ICD-9-CM codes anywhere on the discharge certificate. The first line on the seven line list of diagnosis made for each patient is reserved for the principal illness treated during the hospital stay. Of the total of 817,090 mentions, 445,901 or 54.6 percent appeared as the principal diagnosis.

Foodborne Illness, List B

As explained for List A, List B presents the weighted sample estimates based on the random sample of hospital discharge certificates drawn by the National Center for Health Statistics survey. They represent the estimate of the actual number of discharge certificates by ICD-9-CM codes that would have been counted if a complete enumeration of all patient records were taken.

Disease categories which may contain infections due to food or waterborne vehicles are shown in List B (Table 17.2). Of the 692,789 patients treated for bacterial infection in conditions classified elsewhere and of unspecified site (ICD-9-CM codes 041.0-041.9), there were 349,674 diagnosed with *E. coli* bacteria. This infection can be very common and may be passed directly from person to person or by eating undercooked beef or unpasteurized milk (Berkow and Fletcher 1992: 815). More research is needed on this and other categories on List B to determine the proportion of each disease which is foodborne. Potentially, a substantial number of the 1,005,709 cases might be transferred to List A.

Patient Hospital Costs

Table 17.3 summarizes the amount of foodborne illness present in the United States in 1990 in terms of discharged patients, hospital care, and average annual hospital costs. The total number of patients treated during the period for particular diseases from List A is 815,721. There were a total of 1,369 fewer cases reported than on Table 17.1 because some sampled discharge certificates reported more than one foodborne illness and were included in this first disease count. The total number of days of care for each diagnostic category is also shown. The 815,721 patients accumulated over 5 million days of hospital care, an average stay of 6.2 days. The average length of hospital stay ranged from a low of 1.5 days for treatment of toxic effect of noxious substances eaten as food to a high of 12.8 days for treatment for Listeriosis. This is consistent with the average length of say of 6.4 days for inpatients discharged from hospitals for all causes combined in 1990 (Graves 1992).

As an estimate of patient direct costs for this hospital treatment, the 1990 average cost per day of $687 for the community hospitals in the United States is used (Statistical Abstract of the United States 1992). This was multiplied by days of care to estimate the annual hospital costs which are presented in Table 17.3. The estimated range of annual costs is large, depending on the number of patients involved and the days of care. The low is $57,700 for patients treated for trichinosis and the high is over $2 billion for unspecified gastroenteritis and colitis. The total average annual hospital costs to patients for all foodborne diseases contained on List A is estimated to be $3.5 billion.

TABLE 17.2 Patients Discharged from Hospitals by Category of Foodborne Disease, List B, United States, 1990

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Brucellosis	023			
B. melitensis	023.0	218	0	218
B. abortus	023.1	0	0	0
B. suis	023.2	0	0	0
B. canis	023.3	0	0	0
Other brucellosis	023.8	0	0	0
Brucellosis, unspecified	023.9	218	0	218
Rat-Bite Fever	026			
Streptobacillary fever	026.1	0	0	0
Other Zoonotic Bacterial Diseases	027	491	1,771	2,262
Erysipelothrix infection	027.1	0	116	116
Pasteurellosis	027.2	491	1,655	2,146
Other specified zoonotic bacterial diseases	027.8	0	0	0
Unspecified zoonotic bacterial diseases	027.9	0	0	0
Diseases Due to Other Mycobacteria	031	3,642	6,751	10,393
Pulmonary	031.0	2,295	3,710	6,005
Cutaneous	031.1	51	186	237
Other specified mycobacteria diseases	031.8	961	1,850	2,811
Unspecified mycobacteria	031.9	335	1,005	1,340
Diphtheria	032	0	278	278
Faucial diphtheria	032.0	0	0	0
Masopharyngeal diphtheria	032.1	0	0	0

(continues)

TABLE 17.2 *(continued)*

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Anterior nasal diphtheria	032.2	0	0	0
Other specified diphtheria	032.8	0	0	0
Unspecified diphtheria	032.9	0	278	278
Septicemia	038	145,395	138,572	283,967
Streptococcal	038.0	17,872	29,513	47,385
Staphylococcal	038.1	39,467	0	39,467
Pneumococcal	038.2	4,875	2,371	7,246
Septicemia due to anaerobes	038.3	2,681	2,890	5,571
Septicemia, gram negative	038.4	0	0	0
Other specified septicemia	038.8	10,099	16,772	26,871
Unspecified septicemia	038.9	70,401	87,026	157,427
Other Bacterial Diseases	040			
Gas gangrene	040.0	1,014	2,447	3,461
Bacterial Infection in Conditions Classified Elsewhere and of Unspecified Site	041	5,300	687,489	692,789
Streptococcus	041.0	2,418	136,101	138,519
Staphylococcus	041.1	2,032	180,514	182,546
E. coli	041.4	692	348,982	349,674
Unspecified	041.9	158	21,892	22,050
Other Rickettsioses	083	0	94	94
Q fever	083.0	0	94	94
Other Cestode Infection	123	0	51	51
Taenia solium	123.0	0	0	0

(continues)

TABLE 17.2 *(continued)*

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Taenia saginata	123.2	0	0	0
Taeniasis, unspecified	123.3	0	51	51
Diphyllobothriasis, intestinal	123.4	0	0	0
Sparganosis	123.5	0	0	0
Hymenolepiasis	123.6	0	0	0
Other specified	123.8	0	0	0
Cestode, unspecified	123.9	0	0	0
Other Intestinal Helminthiases	127	494	1,411	1,905
Ascariasis	127.0	0	270	270
Anisakiasis	127.1	0	0	0
Strongyloidiasis	127.2	0	40	40
Trichuriasis	127.3	0	322	322
Enterobiasis	127.4	203	779	982
Capillariasis	127.5	0	0	0
Trichostrongyliasis	127.6	0	0	0
Other specified helminthiasis	127.7	291	0	291
Mixed intestinal helminthiasis	127.8	0	0	0
Intestinal helminthiasis, unspecified	127.9	0	0	0
Other and Unspecified Helminthiases	128	0	895	895
Toxocariasis	128.0	0	895	895
Gnathostomiasis	128.1	0	0	0
Other specified helminthiasis	128.8	0	0	0
Helminth, unspecified	128.9	0	0	0
Toxoplasmosis	130	3,297	4,882	8,179
Encephalitis	130.0	1,241	1,459	2,700

(continues)

TABLE 17.2 *(continued)*

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[a]	Additional[b]	Total Mentions
Conjunctivitis	130.1	0	251	251
Chorioretinitis	130.2	0	150	150
Myocarditis	130.3	0	0	0
Pneumonitis	130.4	19	207	226
Hepatitis	130.5	0	0	0
Other specified sites	130.7	1,026	1,282	2,308
Multisystemic	130.8	78	215	293
Unspecified	130.9	933	1,318	2,251
Toxic Effect of Oher Metals	985	431	786	1,217
Mercury	985.0	0	0	0
Arsenic	985.1	333	0	333
Manganese	985.2	0	0	0
Beryllium	985.3	0	0	0
Antimony	985.4	0	0	0
Cadmium	985.5	0	0	0
Chromium	985.6	0	0	0
Other, specified	985.8	98	786	884
Unspecified metal	985.9	0	0	0
Totals		160,282	845,427	1,005,709

Source: National Hospital Discharge Survey, 1990, United States National Center for Health Statistics, Hyattsville, MD.

[a]Principal diagnosis on hospital discharge certificates appears on the first line.

[b]Additional diagnosis on hospital discharge certificates appears on lines 2-7.

The total hospital costs to the patient in 1990 of $3.5 billion may be viewed as an upper level estimate of the direct costs of foodborne illness because it includes patients whose principal diagnosis was not foodborne illness. Table 17.4 presents patients discharged from hospitals with principal diagnosis as foodborne illness, List A, in the United States in 1990. There were a total of 445,901 patients in this category and they accumulated a total of 1,794,734 days of hospital care, which is an average of 4.0 days per patient with principal

TABLE 17.3 Patients Discharged from Hospitals by Category of Foodborne Disease, List A, by Days of Care, Average Length of Stay, and Average Annual Hospital Costs, United States, 1990

Diagnostic Category and ICD-9-CM Code	1990[a] Discharged Patients	Total Hospital Time		Annual[b] Hospital Costs ($1,000)
		Days of Care	Average Length of Stay	
Cholera 001	92	368	4.0	252.8
Typhoid 002	2,056	15,448	7.5	10,612.8
Salmonella 003	17,239	139,241	8.1	95,658.6
Shigellosis 004	2,112	7,348	3.5	5,048.1
Other Food Poisoning 005	6,114	31,200	5.1	21,434.4
Amebiasis 006	1,341	8,035	6.0	5,520.0
Other Protozoal Intestinal Disease 007	4,864	51,959	10.7	35,695.8
Intestinal Infections Due to Other Organisms 008	175,779	1,361,630	7.7	935,439.8
Ill-Defined Intestinal Infection 009	28,183	226,772	8.1	155,792.4
Listeriosis 027	1,248	15,934	12.8	10,946.7
Viral Hepatitis A[c] 070	12,810	87,036	6.8	59,793.7
Cysticercosis 123.1	1,442	12,629	8.8	8,676.1
Trichinosis 124	42	84	2.0	57.7
Unspecified Gastro-enteritis and Colitis 558.9	562,047	3,097,865	5.5	2,128,233.3
Noxious Substance Eaten as Food 988	352	528	1.5	362.7
All Conditions Above	815,721	5,056,077	6.2	3,473,524.9

Source: National Hospital Discharge Survey, United States National Center for Health Statistics, Hyattsville, MD, annual data for 1990.

[a]Includes patients with mention of disease on lines 1-7 of the hospital discharge certificate.

[b]Based on 1990 national average cost per day of $687, from U.S. Bureau of Census, *Statistical Abstracts of the United States, 1992*, United States Government Printing Office, Washington, D.C., Table 170.

[c] Excludes viral Hepatitis B with or without mention of hepatic coma.

TABLE 17.4 Patients Discharged from Hospitals with Principal Diagnosis as Foodborne Disease, List A, United States, 1990

Diagnostic Category and ICD-9-CM Code	Discharged Patients 1990	Total Hospital Time		Annual Hospital Costs ($1,000)
		Days of Care	Average Length of Stay	
Cholera 001	92	368	4.0	252.8
Typhoid 002	2,056	15,448	7.5	10,612.8
Salmonella 003	12,237	61,631	5.0	42,340.5
Shigellosis 004	1,440	5,045	3.5	3,465.9
Other Food Poisoning 005	5,121	26,185	5.1	17,989.1
Amebiasis 006	1,011	5,428	5.4	3,729.0
Other Protozoal Intestinal Disease 007	1,927	12,542	6.5	8,616.3
Intestinal Infections Due to Other Organisms 008	101,978	496,443	4.9	341,056.3
Ill-Defined Intestinal Infection 009	15,982	54,241	3.4	37,263.6
Listeriosis 027	796	6,512	8.2	4,473.7
Viral Hepatitis A 070	7,523	34,360	4.6	23,605.3
Cysticercosis 123.1	612	6,809	11.1	4,677.8
Trichinosis 124	0	0	0	0
Unspecified Gastro-enteritis and Colitis 558.9	294,818	1,069,414	3.6	734,687.4
Noxious Substance Eaten as Food 988	308	308	1.0	211.6
All Conditions Above	445,901	1,794,734	4.0	1,232,982.3

Source: National Hospital Discharge Survey, United States National Center for Health Statistics, Hyattsville, MD.

diagnosis of foodborne illness. The national cost of $687 per day in a hospital yields $1.2 billion of cost to patients. This may be viewed as a minimal direct cost of foodborne illness in 1990. Omitted from both cost estimates are the costs of physician charges and drugs (which may double the estimates). In addition, the productivity losses for persons ill from microbial foodborne disease are not included and are generally much greater than medical costs (Roberts 1992, Roberts and Foegeding 1991).

Foodborne Illness: Additional Perspectives

The National Ambulatory Medical Care Survey of 1990 provides data on patient records selected in a national sample of office-based physicians. These records contained a weighting variable based on patient characteristics and other sampling considerations. The summation of these weights, as determined by the National Center for Health Statistics, represents the estimate of the number of cases of a given disease that would have been counted if all physician office visits were enumerated. Table 17.5 presents basic data on the frequency of foodborne illness as indicated by physician office visits in 1990, hospital discharge certificates in 1990, and as appears on death certificates for 1986 (the most recent year available).

Examination of the total number of cases reporting ICD-9-CM codes on List A shows the pattern one might expect; that the largest number of cases is for physician office visits (6,242,353 visits were diagnosed as involving foodborne illness), followed by hospital discharge certificates (815,721 patients) and death certificate mentions (208,384 appearances on death certificates). These figures yield ratios of 7.65 physician's office visits for every hospital treatment involving foodborne illness and 3.91 hospital discharges for every death certificate listing foodborne disease. This pattern tends to support the image of the frequency of foodborne illness as a pyramid in which the largest number of cases are unreported to physicians. Indeed, if the ratio of office visits to hospital discharge is applied to estimate the number of foodborne illness cases that are unreported, the estimate would exceed 47 million cases in the United States in 1990 (7.65 x 6.2 million = 47 million unreported cases).

There are two major exceptions to the pyramid image of disease frequency: *Listeriosis* and *Viral Hepatitis A*. In the case of *Listeriosis*, there were 1,248 hospital discharge certificates in 1990 with mention of this disease but 42,157 death certificates mentioned the disease. This disease is caused by *Listeria spp*, which are bacilli found in the environment. Infection is most common in children and the elderly and is usually the result of eating contaminated dairy products or raw vegetables (Berkow and Fletcher 1992: 98). Infection may also occur by direct contact of veterinarians with infected livestock and with butchers or workers who slaughter infected animals.

A similar pattern exists for *Viral Hepatitis A*. There were 12,810 cases with mention of this disease on hospital discharge certificates but 32,203 death certificates mentioned this disease. Food and water contaminated with the virus is a common source of infection and eating raw shellfish is sometimes involved. It is not clear why the frequency of mentions on death certificates is much higher than for hospital discharge certificates.

TABLE 17.5 Frequency of Foodborne Disease, Physician's Office Visits and Hospital Discharge Certificates for 1990 and Appearance on Death Certificate for 1986, United States

Disease Category and ICD-9-CM Code	1990 Physician's Office Visits	1990 Hospital Discharge	1986 Appears on Death Certificate
Cholera 001	0	92	0
Typhoid 002	0	2,056	0
Salmonella 003	0	17,239	79,428
Shigellosis 004	38,521	2,112	3,666
Other Food Poisoning 005	162,173	6,114	0
Amebiasis 006	0	1,341	0
Other Protozoal Intestinal Disease 007	76,451	4,864	12,376
Intestinal Infections Due to Other Organisms 008	1,238,689	175,779	0
Ill-Defined Intestinal Infection 009	246,063	28,183	14,136
Listeriosis 027	0	1,248	42,157
Viral Hepatitis A[a] 070	127,298	12,810	32,203
Cysticercosis 123.1	0	1,442	0
Trichinosis 124	0	42	0
Unspecified Gastroenteritis and Colitis 558.9	4,353,158	562,047	0
Noxious Substance Eaten as Food 988	0	352	24,418
All Conditions Above	6,242,353	815,721	208,384

Source: National Ambulatory Medical Care Survey, 1990; National Hospital Discharge Survey, 1990; and National Mortality Followback Survey, 1986, National Center for Health Statistics, Division of Vital Statistics, Hyattsville, MD.

Note: Table includes List A diseases only.

[a]Excludes viral Hepatitis B with or without mention of hepatic coma.

Foodborne Illness: Patient Demographics

Characteristics of persons suffering from foodborne illness are important to know if valuation research is to reflect the impact on youth, elderly, minority groups, etc. Identification of groups with an elevated risk of foodborne illness by geographic area where they live is necessary for effective policy to reduce

suffering from these diseases. For example, if rates of foodborne illness for specific diseases show a systematic variation by age, sex, and race, then future levels might be predicted by application of these rates to projections of population by those characteristics. Demographic analysis also provides a basis for continued epidemiological investigation. If a certain foodborne illness occurs at elevated rates within an identifiable geographic area, continued investigation within that area is necessary to explain and correct that event. Moreover, if demographic analysis reveals a concentration of a given foodborne illness among children under 1 year of age or the elderly 75 years of age or over, a different type of educational program is necessary to reduce those rates than a generalized program appealing to all age groups. In brief, disaggregation of persons suffering from foodborne illness is required to establish meaningful trends over time in selected diseases, to formulate an effective policy to deal with those trends, to document the impact of those actions on disease rates for different types of persons, and to anticipate future levels of foodborne illness.

Selected demographic characteristics of patients who visited a physician's office and were diagnosed with a foodborne illness from List A in 1990 are presented in Table 17.6. Of the more than 6 million patients, 54.6 percent were female and only 45.5 percent were male. The geographic distribution revealed the highest concentration in the South and Midwest (63.3 percent of all cases), with the Northeast region accounting for only 15.6 percent. The racial composition of this patient population was primarily white (82.7 percent) and, in terms of residence, located in metropolitan areas (71.2 percent). The age structure reveals a concentration in the younger ages, with the largest group in the 1-4 year old category, with 1.2 million or 20.1 percent of all patients. In fact, children under the age of 14 years accounted for 43.5 percent of all patient visits to physician offices. This may be the result of parents being more likely to take their children to a physician when illness occurs than they are in the event of their own illness. In brief, a typical patient would be a white, female child living in the metropolitan areas of the South or Midwest.

Demographic characteristics of patients discharged from hospitals with mention of foodborne illness from List A in 1990 are shown in Table 17.7. For the over 815 thousand discharged patients, the largest percent were women (58.8 percent). The geographic distribution was clearly concentrated in the South with 37.5 percent of all cases living there. The West had the lowest proportion with 14.2 percent. The racial composition was largely white (70.4 percent) but at lower levels than office visit data. Information on marital status revealed that single (37.8 percent) was the most frequently mentioned category. Unlike data for office visits, the age distribution of patients discharged from hospitals is not concentrated at the younger ages. In fact, the largest number and percent of all patients were in the 75 and over age group (16.9 percent). Persons 65-74 years of age accounted for 10.9 percent of all patients. Days of stay in the hospital were normally less than seven days (80.1 percent of all stays). In brief, the

TABLE 17.6 Selected Demographic Characteristics, Physician Office Visits with Foodborne Illness, List A, United States, 1990

	1990 Office Visits	
Demographic Characteristics	Number	Percent
Sex	6,242,353	100.0
Male	2,836,449	45.4
Female	3,405,904	54.6
Region	6,242,353	100.0
Northeast	972,011	15.6
Midwest	1,942,877	31.1
South	2,012,658	32.2
West	1,314,807	21.1
Race	6,242,353	100.0
White	5,159,064	82.7
Black	556,414	8.9
Other	283,450	4.5
Not stated	243,425	3.9
Residence	6,242,353	100.0
Metropolitan	4,447,185	71.2
Nonmetropolitan	1,795,168	28.8
Age	6,242,353	100.0
Under 1 yr.	745,338	11.9
1-4 yrs.	1,258,090	20.1
5-14	720,428	11.5
15-24	434,728	7.0
25-34	637,656	10.2
35-44	893,805	14.3
45-54	366,670	5.9
55-64	383,259	6.1
65-74	440,625	7.1
75+ yrs.	361,754	5.8

Source: National Ambulatory Medical Care Survey, 1990, Department of Health and Human Services, National Center for Health Statistics, Hyattsville, MD.

TABLE 17.7 Selected Demographic Characteristics, Patients Discharged from Hospitals with Foodborne Illness,[a] List A, United States, 1990

	1990 Hospital Discharge Certificate	
Demographic Characteristics	Number	Percent
Sex	815,721	100.0
Male	336,254	41.2
Female	479,468	58.8
Region	815,721	100.0
Northeast	163,392	20.0
Midwest	230,869	28.3
South	305,976	37.5
West	115,484	14.2
Race	815,721	100.0
White	574,063	70.4
Black	87,818	10.8
Other	23,132	2.8
Not stated	130,708	16.0
Marital Status	815,721	100.0
Married	185,030	22.7
Single	308,917	37.8
Widow/Divorced	88,210	10.8
Not stated	233,564	28.6
Age	815,721	100.0
Under 1 yr.	98,971	12.1
1-4 yrs.	87,066	10.7
5-14	50,636	6.2
15-24	64,561	7.9
25-34	82,629	10.1
35-44	72,490	8.9
45-54	62,051	7.6
55-64	70,519	8.6
65-74	89,097	10.9
75+ yrs.	137,692	16.9
Days in Hospital	815,721	100.0
0-7 days	653,513	80.1
8-14	96,870	11.8
15-21	30,028	3.7
22-28	14,356	1.8
29+ days	20,954	2.6

Source: National Hospital Discharge Survey, United States National Center for Health Statistics, 1990 Survey.

[a]Includes patients with mention of foodborne disease on lines 1-7 of the hospital discharge certificate.

hospital discharge data revealed the typical patient to be a white, single female in the older age categories who likely lives in the South region or the Midwest.

Demographic characteristics of persons who died with mention of foodborne illness on the death certificate from List A in the United States in 1986 are presented in Table 17.8. In terms of death data, males account for 65.6 percent

TABLE 17.8 Selected Demographic Characteristics, Deaths from Foodborne Illness[a], List A, United States, 1986

	1986 Deaths	
Demographic Characteristics	Number	Percent
Sex	208,384	100.0
Male	136,695	65.6
Female	71,689	34.4
Region	208,384	100.0
Northeast	56,421	27.1
Midwest	68,788	33.0
South	67,753	32.5
West	15,422	7.4
Race	208,384	100.0
White	172,791	82.9
Black	32,273	15.5
Other	3,320	1.6
Age	208,384	100.0
Under 1 yr.	–	–
1-4 yrs.	–	–
5-14	–	–
15-24	–	–
25-34	12,849	6.2
35-44	25,854	12.4
45-54	18,413	8.8
55-64	12,111	5.8
65-74	84,779	40.7
75+ yrs.	54,378	26.1

Source: National Mortality Followback Survey, 1986, National Center for Health Statistics, Division of Vital Statistics, Hyattsville, MD.

[a]Death data are for persons 25 years of age and over.

of all the 208,384 certificates in this year with mention of foodborne disease, a reversal of the patterns described for the previous data sets. The regional concentration is similar with 65.5 percent of all deaths occurring in either the South or the Midwest. Again the white population accounts for the majority of deaths, with 82.9 percent of the diseased classified in this category. Since this survey is restricted to persons who died after 25 years of age, the age structure is considerably older. Persons 65 years of age and over accounted for 66.8 percent of all death certificates in the sample. In brief, the death certificate data suggest the typical person who died with mention of foodborne disease to be an older, white male who resided in either the Midwest or South region.

Conclusions and Discussion

At the level of microbiology, knowledge about the extent of foodborne illness is being extended from the earlier connection with short-term, acute conditions to the recognition that foodborne pathogens may also be involved in long-term, chronic health problems. This represents a significant expansion of the health arena within which foodborne disease must be assessed. Food is becoming a major sector of acute enteric disease and of chronic diseases of unknown etiology. One may anticipate a continued expansion of the impact of microbial foodborne illness as the national population ages during the next several decades, as the number of HIV-related diseases increases, and as the ethnic composition becomes more diverse with a wide range of food-related customs.

An important conclusion from the recent recognition by microbiology that foodborne pathogens may be involved in chronic diseases as well as acute conditions, and from the recognition that social/cultural practices also contribute to foodborne illness, is that there is no single source in food production and consumption which may be held responsible. Commercially processed foods purchased in retail stores may be free of pathogens but become contaminated by people with unhygienic food handling habits. Therefore, attempts by policy makers to reduce the levels of foodborne illness in the United States must recognize the multidimensional nature of the problem and not rely on a single method to increase public protection.

In terms of data needs, it is clear that the national sample surveys taken by the National Center for Health Statistics are of critical importance in the surveillance of foodborne disease. They should be continued on an annual basis and an increase in the sample size should even be considered. Beyond these data, there is a significant need for more special purpose sample surveys asking persons about food purchases, food preparation, illness events, etc. The actual frequency of unreported cases of foodborne illness needs to be established. In addition, characteristics of persons becoming ill need documentation so that high risk groups may be determined and corrective actions suggested.

Note

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