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Microbial Foodborne Disease: Hospitalizations, Medical Costs and Potential Demand for Safer Food

by

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Introduction

Several telephone surveys have asked food shoppers what they might be willing to pay for reduced microbial contamination of food. Moss, Degner, and Zellner (1991) reported a willingness to pay 16 cents/lb. more for chicken carefully inspected for bacterial contamination, 15 cents/lb. if bacteria were destroyed by a chemical wash, and 12 cents/lb. if irradiated. Lin found great variability in whether oyster eaters were willing to pay a premium for raw oysters with a risk level reduced to 1/40 of current risks: half of the respondents were not willing to pay anything, 1/6 would pay a 25% premium, 10% a 50% premium, and a few were willing to double the price for the risk reduction. Malone reported that one-third of respondents were willing to purchase beef, pork, chicken, and fish irradiated to control microbial pathogens and were willing to pay a 15-20 cents/pound premium. Projected across the U.S. food supply and the entire population, they estimate that consumers are willing to pay $91 billion annually for a reduction in the risk of microbial foodborne disease (Shirkey, 1992), suggesting a large and profitable market for safer food.

In the absence of efforts to control food contamination, society continues to view the costs of illness from microbial pathogens. Given the under-reporting of microbial disease and the lack of consensus on the yearly incidence, placing a value on reducing foodborne disease risk is an uncertain enterprise. Researchers recognize that the reported data on illness is only a small part of the actual number of foodborne illness events and that several stages are required before illness events become part of the official statistical surveillance system. For example, the sequence of events in

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recording Salmonella involves seven stages of becoming infected, becoming ill, seeing a physician, obtaining a specimen, identification of the organism, reporting to health department, and forwarding the information to the Center for Disease Control (Chalker and Blaser, 1988). Additional information on the number and severity of microbial foodborne illnesses would 1) permit better descriptions of the actual foodborne disease risks in experimental markets and surveys and would thereby improve the accuracy of willingness-to-pay estimates, 2) improve the accuracy of cost-of-illness estimates, 3) increase the accuracy of studies examining consumer preferences for reducing foodborne disease risks through preventive actions at home or in restaurants, and 4) improve the ability to identify various intervention methods to reduce food contamination at production, processing, and consumption points from the farm to the table. Each and, collectively, all would improve the accuracy of benefit/cost analyses of possible interventions.

Roberts, using the traditional cost-of-illness approach, estimated that diseases often associated with food cost society $2.3-3.2 billion annually for medical costs and productivity losses from bacterial diseases and $2.7 billion for parasitic diseases often associated with food. However, Roberts' (1992) estimates are a mix of detailed estimates for some pathogens where the distribution of disease severities can be estimated, and of rough extrapolations for other pathogens with limited information on the distribution of disease severities.

Mauskopf et al. (1988) in an effort to value different disease severity levels, pioneered the application of health status indices to value salmonellosis, the most studied and one of the most common microbial foodborne diseases. Mauskopf's estimated the cost to society of salmonellosis illness is 5 to 9 times greater than Roberts' cost estimate because the health status indices include a value for risk aversion and compensation for pain and suffering and lost leisure time, etc.

The cost of illness analyses could target high-risk or risk-averse consumers. Steahr and McMullin (1991) have shown that social and cultural systems influence how individuals experience and value the

physical pain or debility of illness. An individual's social and cultural background could predetermine his/her willingness to purchase safer food and the premium he/she is willing to pay for safety. In addition, some persons may be at greater risk of foodborne illness because of genetics, other disease conditions, pregnancy, age, other socio-demographic variables, food consumption habits, use of antacids, etc.. Demographic analyses of subpopulations at great risk of foodborne disease will improve the identification of possible niche markets for safer food (Caswell and Roberts, 1992).

Purpose and Data Sources

The basic purpose of this research is to estimate the prevalence of foodborne illness in the U.S. by examining data on hospital patients. This data excludes foodborne disease patients visiting physician's offices but not hospitalized and those who do not visit a physician despite their illness. This report will analyze the results of the National Hospital Discharge Survey (NHDS) from 1987 to 1990. The NHDS is a continuous survey based on a sample of medical records of patients discharged from a sample of hospitals. The hospital sample includes approximately 1% of short-stay hospitals in the U.S. The survey records information on the patients' sex, age, race, marital status, date of admission and discharge. In addition, information on discharge status, diagnosis, procedures performed, and expected source of payment are collected. Finally, hospital characteristics in terms of bedsize, ownership, and region of the country are recorded. The medical information is coded following the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM). In the 1990 Survey, 265,556 medical discharge certificates were sampled from an estimated 31.7 million discharges which is a .8 percent sample of all records. Eligible for the sample frame are hospitals in the United States that are noninstitutional hospitals (excluded are federal, military, and Veterans Administration hospitals) located in all states and the District of Columbia. Only short stay hospitals (average length of stay less than 30 days) were included in the sample frame. The sampling fraction of certificates was essentially the same for the 1989 Survey and the 1988 Survey (Graves, 1991) but were slightly lower in the 1987 Survey

(Graves, 1989) which was based on a sample of 180,982 certificates, or .5 percent of approximately 33.4 million hospital discharges.

Each discharge certificate contained ICD-9-CM codes for up to seven medical conditions for each patient. The first listed code may be regarded as the principal diagnosis while the second through seventh listed conditions are other, additional diagnoses. The search for foodborne illness reflected in ICD-9-CM codes (Karaffa, 1992) included all seven lines for each discharge certificate. After identifying discharge certificates with specific codes listed, demographic characteristics, length of hospital stay, region of the nation, and other descriptors were tabulated for each survey year 1987 through 1990. The results of this research are presented in the following section.

The complexity of foodborne disease is well documented in terms of intoxications (poisonings) and infections (Cliver, 1990) causing illness and the specific pathogens responsible for each illness (Doyle, 1989; Bryan, 1982). What is more problematic is how these diseases are placed in the ICD-9-CM codes. Some of the codes are primarily, if not entirely, composed of illness due to food and/or waterborne pathogens. These recognized categories are presented as List A. Other codes are composed of a mixture of foodborne and non-foodborne pathogens responsible for that illness and these are placed on List B. If the proportions of illness in each category due to a foodborne vehicle is unknown, the ICD-9-CM should remain on List B until reliable estimates are derived.

Foodborne Illness, List A

Table 1 presents data on patients discharged from short-stay hospitals by category of foodborne illness (List A) in the United States from 1987 through 1990. Annual data not shown here were summed to construct this table showing 4 year totals. These data are the weighted statistics published by the National Center for Health Statistics, as derived from each sample survey from 1987 through 1990. For each sample, NCHS technical documentation contains procedures for calculation of standard error for estimates of percents and for aggregate estimates, but not for the combined 1987-90 period. The statistics

Table 1: Patients Discharged from Hospitals by Category of Foodborne Disease, List A, United States, 1987 through 1990.

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[1]	Additional[2]	Total Mentions
Cholera	001	146	191	337
Typhoid and ParaTyphoid Fevers	002	4,446	332	4,778
Other Salmonella Infection	003	43,445	18,188	61,633
Shigellosis	004	15,679	5,697	21,376
Other Food Poisoning	005	18,100	5,732	23,832
Amebiasis	006	4,581	2,321	6,902
Other Protozoal Intestinal Diseases	007	11,447	13,052	24,499
Intestinal Infections Due to Other Organisms (excludes food poisoning by these organisms (005.0-.9)	008	360,867	196,662	557,529
Ill-defined Intestinal Infections	009	69,583	56,143	125,726
Listeriosis	027.0	2,262	2,094	4,356
Other Diseases Due to Viruses				
Viral Hepatitis	070.	31,890	17,725	49,615
Cysticercosis	123.1	2,675	1,857	4,532
Trichinosis	124	0	525	525
Other Noninfectious Gastroenteritis and Colitis	558			
Unspecified Gastroenteritis and Colitis	558.9	1,195,103	927,654	2,122,757
Toxic Effect of Noxious Substances Eaten as Food	988	1,927	864	2,791
Toxic Effect of Other Substances	989			
Aflatoxin and other mycotoxin (food contaminate)	989.7	0	0	0
Totals		1,762,151	1,249,037	3,011,188

Source: National Hospital Discharge Survey, United States National Center for Health Statistics, Hyattsville, MD, 1987 through 1990.

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

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

Note: List A comprises only those diagnostic categories of illness due primarily to foodborne disease.

in Table 1 and subsequent tables are summations of annual sample surveys and are subject to sampling variability as well.

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 337 patients discharged from hospitals in the United States during the four-year period. Cholera may be acquired by eating improperly cooked crabs, raw oysters, mussels, or clams which have been contaminated with the pathogen Vibrio cholera (Doyle and Cliver, p. 243). Contamination of these foods often occurs when raw sewage enters the water where they are produced. Food contamination by an infected food handles or of drinking water or water used to rinse foods are other methods of disease transmission (Berkow, p. 110).

Typhoid and para-typhoid fevers, (codes 002.0-002.9), are caused by Salmonella typhi (Doyle and Cliver, p. 186) and are 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 (Doyle and Cliver, p. 187). Contamination of these foods often occurs when raw sewage enters the water where they are produced. In the United States, 4,509 hospital patients were diagnosed as having typhoid fever, with an additional 174 patients with Para-typhoid fever A.

Third on Table 1 is Other Salmonella Infection, (ICD-9-CM code 003.0-003.9), and it contains 61,633 patients during the period. The major source of infection is the ingestion of contaminated food and water by Salmonella enteritidis, S. heidelberg, S. newport, S. infantis, S. agona, S. montevid, S. saint paul, etc. (Doyle and Cliver, p. 189). Foods such as poultry, eggs, beef, and pork have been carriers. Direct person-to-person contact with individuals recovering from salmonella may result in infection since they shed the organism in their feces for weeks to months (Doyle and Cliver, p. 190). Unsanitary behavior by these persons can spread the disease. In addition, contact with infected animals may spread Salmonella, such as pet turtles. Of the total number of patients with Salmonella infection,

the majority, 43,896 or 71.2 percent, are diagnosed generally with gastroenteritis and are not diagnosed as having an infection with a particular Salmonella strain.

Shigellosis (ICD-9-CM codes 004.0-004.9) is an acute infection of the bowel caused by Shigella organisms often resulting in fever and bloody diarrhea. The feces of infected persons provide a direct source of infection via the fecal-oral route (Berkow, p. 106). Foodhandlers who are infected and do not wash their hands after defecation and then handle food may transmit the organism (Doyle, p. 207). Foods often involved are salads with potatoes, chicken, tuna, raw oysters, beans, and hamburgers (Doyle, p. 208). During the four year period under study in the United States, 21,376 patients were discharged from hospitals after treatment for shigellosis. Most of these cases, 15,416 or 72.1 percent, were diagnosed with an unspecified type of shigellosis, (ICD-9-CM code 004.9).

The next category is a collection of diseases placed into Other Food Poisoning (ICD-9-CM codes 005.0-005.9). There were 23,832 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 (Bergdoll, p. 464). Common foods involved include raw milk, cooked meat, pork, packaged sliced bacon, and pastry products (Bergdoll, pp. 474-476). From 1987-1990, there were 1,593 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, p. 817). Home-canned food is a common source but commercial foods may also be involved, such as vegetables, fish, beef, pork, and poultry (Berkow, p. 817). There were 1,581 patients discharged from hospitals in the United States after treatment for botulism. The subcategory within Other Food Poisoning with the most cases is unspecified food poisoning, with 19,894 or 83.4 percent of all discharged patients.

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 fever and bloody diarrhea (Berkow, p. 225). Direct spread is common when personal hygiene is poor. The disease may be spread indirectly via food or water. Fruits and vegetables may be contaminated when grown in soil fertilized with human feces, washed with contaminated water, or when prepared by a infected food handler. There were 6, 902 patients discharged from hospitals who were treated for this disease from 1987-1990.

Other protozoal intestinal diseases (ICD-9-CM codes 007.0-007.9) included 24,499 patients from 1987-1990, most of whom were treated for Giardiasis (Lambliasis) 20,433 or 83.4 percent). Giardiasis is an infection of the small intestine caused by Giardia lamblia and is usually asymptomatic (Berkow, p. 228). The organism is passed directly from one 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 from 1987-1990 is ICD-9-CM codes 008.0-008.9, Intestinal infections due to other organisms. Within this category, infections due to other organisms not elsewhere classified (ICD-9-CM code 008.0) contain 411,648 cases, or 73.8 percent of all 557,529 patients treated in this category. According to discussions with Patricia Griffin at CDC, many foodborne diseases in which the causative organism is not identified are placed in to this subcategory and into codes 009 and 558.9. Ill-defined intestinal infections (ICD-9-CM codes 009.0-009.3) contains 125,726 patients, the largest percent age, 57.5 of which, were diagnosed generally with infectious colitis, enteritis, and gastroenteritis (ICD-9-CM code 009.0). By far the largest category of patients on List A is ICD-9-CM code 558.9, Unspecified Gastroenteritis and colitis, with 2,122,757 patients discharged from hospitals treated for this disease. Further research is needed to define these categories and to identify specific pathogens causing the diseases.

Next on List A is Listeriosis 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, p. 98). There were 4,356 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, by fecal contamination of hands which are not washed prior to food handling (Berkow, p. 900). Eating raw shellfish from directly contaminated water also may be responsible. Viral Hepatitis A without hepatic coma was diagnosed in 24,216 patients discharged from hospitals in the United States from 1987-1990. In addition, 24,862 patients were treated for unspecified viral hepatitis without mention of hepatic coma. These two groups accounted for 49,078 or 83.1 percent of all patients in this disease category.

Taeniasis (ICD-9-CM code 123.1) is an intestinal infection caused by the cestode Taenia solium or T. saginata. The infection of the tapeworm is the result of eating improperly cooked pork or beef contains larvae of the adult worm (Berkow, p. 252). There were 4,532 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, p. 245). Table 1 shows 525 patients discharged from hospitals after treatment for Trichinosis from 1987-1990.

Toxic effect of noxious substances eaten as food (ICD-9-CM codes 988.0-988.9) includes poisoning from mycotoxins in fish, mushrooms, berries and other plants. From 1987-1990, there were 2,791 patients in hospitals treated for these illnesses, and mushroom poisoning accounted for 1,184 or 42.4 percent of all cases of this category.

Patients Costs

Table 2 summarizes the number of patients diagnosed in each category, the length of hospital stay, and the average annual costs of hospitalization. The total number of patients treated during the 4-year period for foodborne diseases from List A is 3,011,188. This figure yields an average yearly

Table 2: 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, 1987 though 1990.

Diagnostic Category and ICD-9-CM Code	Discharged Patients 1987-90	Yearly Average[2]	Total Hospital Time		Average[3] Annual Hospital Costs ($1,000)
			Days of Care	Average Length of Stay	
Cholera 001	337	84.2	2,099	6.2	360.5
Typhoid 002	4,778	1,592.7	34,761	7.3	5,970.2
Salmonella 003	61,633	15,408.2	463,599	7.5	79,623.1
Shigellosis 004	21,376	5,344.0	98,776	4.6	16,964.8
Other Food Poisoning 005	23,832	5,958.0	78,312	3.3	13,450.1
Amebiasis 006	6,902	1,725.5	57,122	8.3	9,810.7
Other Protozoal Intestinal Disease 007	24,499	6,124.8	198,043	8.1	34,013.9
Intestinal Infections Due to Other Organisms 008	557,529	139,382.2	4,177,509	7.5	717,487.2
Ill-defined Intestinal Infection 009	125,726	31,431.5	826,074	6.6	141,878.2
Listeriosis 027	4,356	1,089.0	60,589	13.9	10,406.2
Viral Hepatitis A 070	49,615	12,403.7	443,199	8.9	76,119.4
Cysticercosis 123.1	4,532	1,133.0	36,211	8.0	6,219.2
Trichinosis 124	525	131.3	3,332	6.3	572.3
Unspecified Gastroenteritis and Colitis 558.9	2,122,757	530,689.3	11,476,213	5.4	1,971,039.6
Noxious Substance Eaten as Food 988.9	2,791	697.7	8,810	3.2	1,513.1
All Conditions Above	3,011,188	752,797	17,964,649	6.0	3,085,428.5

Source: National Hospital Discharge Survey, United States National Center for Health Statistics, Hyattsville, MD, annual data for 1987, 1988, 1989 and 1990.

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

[2] Total discharged patients divided by four.

[3] 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.

number of 752,797 patients discharged from hospitals after treatment for foodborne illness. The total number of days of care for each diagnostic category is shown; the 3 million patients accumulated almost 18 million days of hospital care, an average stay of 6.0 days. The average length of hospital stay ranged from a low of 3.2 days for treatment of toxic effect of noxious substances eaten as food (primarily mushrooms) to a high of 13.9 days for treatment for Listeriosis. It should be noted that this estimate of an average hospital stay of 6.0 days is based on hospital discharge certificates with mention of foodborne illness anywhere on lines 1-7 of the certificate. If only those cases where foodborne illness is listed on line 1, the principal diagnosis, are selected for analysis, the resulting average days of treatment may be lower.

As an estimate of hospital treatment costs, the 1990 average cost per day of $687 for community hospitals in the United States was used (Statistical Abstract of the United States, 1992). The total days of hospital care from 1987 through 1990 was divided by four to yield an average annual number of hospital days of care for each diagnostic category. This was multiplied by $687 to estimate the average annual hospital costs. The range of average annual costs per disease category is large, depending on the number of patients involved and the days of care. The low is $360,500 for patients treated for cholera and the high is almost 2 billion dollars for unspecified gastroenteritis and colitis. The total average annual hospital costs to patients for all foodborne diseases contained on List A approximated 3.1 billion dollars.

Patient Demographics

Preliminary analysis of selected demographic characteristics of patients drawn from List A (data not shown here) reveals that largest concentration of cases are located in the South (34 percent) and the lowest in the West (19 percent). Only Shigellosis is not concentrated in the South but rather in the West (36 percent). In terms of age distribution, for all foodborne illness combined, 30 percent of cases occurred in 15-34 year olds. Salmonella occurred most often in infants less than one year old, with

almost 22 percent of all cases in that age group. Shigellosis cases also occur most often in those less than 5 years (33 percent of all cases). Hospital patients of foodborne illness most often consist of white persons (64 percent of all cases), except for Cholera in which 57 percent of the patients are Black. Among Shigellosis patients, about 23 percent were Black.

Foodborne Illness, List B

In addition to the 3 million mentions on hospital discharge certificates in the United States from 1987-1990 of foodborne illness presented on List A, there are 4.1 million patient discharge certificates with mention of disease categories containing an unknown proportion due to a food or water vehicle. These are contained in Table 3. For example, of the 2.7 million patients treated for bacterial infection in conditions classified elsewhere and of unspecified site (ICD-9-CM code 041), 1.4 million were diagnosed as having E. coli bacteria. However, the particular strain of e. coli, which vary greatly in disease severity, is not specified. Infections are very common and may be caused by eating undercooked beef or unpasteurized milk, but also may be transmitted directly from person to person (Berkow, p. 815). Another disease that may be mostly foodborne is toxoplasmosis, which also may be transmitted through contact with cats. More research is needed on these and other categories in Table 3 to determine the percentage of each disease that involves a food vehicle. Potentially, a very large number of cases might be added to List A, strictly foodborne, from List B.

Discussion

The cost estimates of $3 billion annually for hospitalizations for foodborne disease are based on total hospital expenses, including payroll, employee benefits, professional fees, and supplies, but may omit the costs of specialists, special procedures, and drug therapy. Inclusion of the latter categories would likely double the estimate to $6 billion annually (personal communication, Robert Pinner, CDC). During foodborne illness, outcomes other than hospitalization also occur (deaths, physician visits, and mild cases without a physician visit) which have medical costs or out-of-pocket costs for home

Table 3: Patients Discharged from Hospitals by Category of Foodborne Disease, List B, United States, 1987 through 1990.

Disease Category	ICD-9 Code	Final Diagnosis Entered on Certificate as: Principal[1]	Additional[2]	Total Mentions
Brucellosis	023	338	80	418
Rat-bite Fever	026			
Streptobacillary fever	026.1	0	42	42
Other Zoonotic Bacterial Diseases	027	637	5,940	6,577
Diseases Due to Other Mycobacteria	031	9,973	22,327	32,300
Diphtheria	032	0	1,617	1,617
Septicemia	038	541,712	807,070	1,348,782
Other Bacterial Diseases	040			
Gas gangrene	040.0	3,780	8,688	12,468
Bacterial Infection in Conditions Classified Elsewhere and of unspecified site	041	18,462	2,682,628	2,701,090
Other Diseases Due to Viruses	070	5,211	4,243	9,454
Other Rickettsioses	083			
Q fever	083.0	80	94	174
Other Cestode Infection	123	0	1,289	1,289
Other Intestinal Helminthiases	127	2,479	8,687	11,166
Other and Unspecified Helminthiases	128	837	1,061	1,898
Toxoplasmosis	130	8,282	11,689	19,971
Toxic Effect of other Metals	985	5,233	3,173	8,406
Totals		580,404	3,558,628	4,155,652

Source: National Hospital Discharge Survey, United States National Center for Health Statistics, Hyattsville, MD, 1987 through 1990..

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

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

Note: List B comprises those diagnostic categories of illness which have a foodborne illness component but is of unknown amount.

medications, transportation, day care, etc.. In addition, the productivity losses for all persons ill from microbial foodborne disease are not included here. Productivity losses are generally much greater than medical costs for foodborne disease (Roberts).

The large number of cases in the general categories, 008, 009, and 558, in List A (Table 1) suggests that further refinements in identifying these diseases may discover that some/many are not really foodborne. On the other hand, food is at least a minor, and perhaps a major, cause of disease classifications listed in List B (Table 3).

The development of niche markets for safe food may increasingly take place. Such as AIDS patients and pregnant women, may be targeted. Special populations, AIDS patients are 300 times more likely to suffer from listeriosis than the population at large. Doctors are warning pregnant women to avoid handling raw pork because of the risk of toxoplasmosis. Lovers of raw shellfish may also be targeted. The State of Florida has issued warnings about the dangers of consuming raw shellfish because of Vibrio vulnificus. Updated information on those at risk for foodborne disease will generate an increasing demand for safer raw meat, poultry, seafood, and dairy products. Informing the public of products formulated for specific populations through new labeling conventions will help speed the awareness of "safer" food products on the market. For example, USDA has just approved a label for irradiated chicken which reads, "Irradiated to control food-borne pathogens" and we can expect to see "organic" labels meeting Federal standards of food in 1993.

Bibliography

Bennett, J.V.; S.D. Holmberg; M.F. Rogers; and S.L. Solomon. 1987. "Infections and Parasitic Diseases," in R.W. Amlett and H.B. Dull (Ed.), *Closing the Gap: The Burden of Unnecessary Illness*. New York: Oxford University Press, pp. 102-114.

Berkow, R. and A. J. Fletcher (Eds.). 1992. *Sixteenth Edition of the Merck Manual of Diagnosis and Therapy*, Merck Research Laboratories, Merck and Co., Inc., Rahway, N.J.

Bryan, F. L. 1982. "Diseases Transmitted by Food: A Classification and Summary, 2nd Ed." U.S. Department of Health and Human Services, Public Health Services, Center for Disease Control, No. 00-1845, pp. 101.

Caswell, J. and T. Roberts. "Vertical Quality Control Systems: A Potential Marketing Advantage for Cooperatives." Workshop on New Strategic Directions for Agricultural Marketing Cooperatives, Boston, Massachusetts, June 24, 1992.

Chalker, R.B. and M.J. Blaser. 1988. "A Review of Human Salmonellosis: III. Magnitude of Salmonella Infection in the United States." *Rev. Infectious Diseases* 10(1):111-124.

Cliver, Dean O. (Ed.). 1990. *Foodborne Diseases*. New York: Academic Press, pp. 395.

Graves, E. J. "National Hospital Discharge Survey: Annual Summary, 1987", Department of Health and Human Services, National Center for Health Statistics, Series 13, No. 99 (April 1989).

Graves, E. J. "National Hospital Discharge Survey: Annual Summary, 1988", U.S. Department of Health and Human Services, National Center for Health Statistics, Series 13, No. 106 (September 1991).

Karaffa, N. C. (Ed.). 1992. *International Classification of Diseases, 9th Revision, 4th Edition, Clinical Modification, Volumes 1-3, 1992*. Los Angeles: Prentice Management Information Corporation, pp. 1059.

Lin, C.J. "Consumer Shellfish Safety Perceptions and Consumption Behavior." Ph.D. dissertation, University of Florida, 1991.

Malone, J.W., Jr. "Consumer Willingness to Purchase and Pay More for Potential Benefits of Irradiated Fresh Food Products." *J. of Agribusiness* Vol. 6(1990):163-178.

Mauskopf, J.A., R.W. Leukroth, M.T. French, K.D. Fisher, A.S. Ross, C.R. Hollingworth, and D.M. Maquire. 1988. "Estimating the Value of Consumer Loss from Foods Violating the FD&C Act." Prepared for the Food and Drug Administration.

Moss, S.D., & R.L. Degner, and J.A. Zellner. "Consumer Attitudes Toward Food Safety and Willingness to Accept Bacterial Control Measures for Fresh Chicken." Florida Agricultural Market Research Center Tech. Report 91-1, July 1991.

Riemann, Hans and Frank L. Bryan (eds.). 1979. "Food-Borne Infections and Intoxications," (2nd ed.), New York: Academic Press.

Roberts, T. "Estimated Foodborne Disease Risks and Costs in the United States." ASSA meetings, New Orleans, January 1992.

Shirkey, M. "Safe Food Recipe: How Much Does It Cost? Who Gets the Bill?" *Poultry and Egg Marketing*, Sept/Oct 1992, p. 20

Simmons, W. R. "Development of the Design of the NCHS Hospital Discharge Survey," National Center for Health Statistics, Vital and Health Statistics, Data Evaluation and Methods Research, Series 2, No. 39 (September 1970).

Steahr, T.E. and P. McMullin. 1991. "An Interdisciplinary Framework for the Analysis of Foodborne Disease," NE-165 Private Strategies, Public Policies, and Food System Performance, Working Paper WP-24 (September), University of Connecticut, Storrs, CT.

REGIONAL RESEARCH PROJECT NE-165
Private Strategies, Public Policy and Food Marketing Performance
Working Papers

1. Rogers, Richard T. and Julie Caswell. 1987."Strategic Management and Internal Organization of Food Marketing Firms." University of Massachusetts, Amherst, MA.

2. Roberts, Tanya. 1987. "Salmonellosis Control: Estimated Economic Benefits." ERS/USDA, Washington, D.C.

3. Lee, David R. 1987. "Labor Market Dynamics in the U.S. Food Sector." Cornell University, Ithaca, NY.

4. McLaughlin, Edward W. and Vithala R. Rao. 1987. "An Explanatory Modeling of the Decision Process of New Product Selection by Supermarket Buyers." Cornell University, Ithaca, NY.

5. Smith, M.E., E.O. VanRavenswaay and S.R. Thompson. 1987. "Sales Loss Determination in Food Contamination Incidents: An Application to Milk Bans in Hawaii." Michigan State University, East Lansing, MI.

6. Zellner, James A. 1987. "Some Causes and Consequences of Food Industry Conduct: A Simultaneous Analysis." University of Florida, Gainesville, FL.

7. Caswell, Julie A. and Ronald Cotterill. 1988. "New Theoretical Approaches to Measuring Industry Performance." University of Massachusetts, Amherst, MA.

8. Lopez, Rigoberto A. 1988. "Political Economy of the United States Sugar Policies." Rutgers University, New Brunswick, NJ.

9. Azzam, Azzeddine, Emilio Pagoulatos and John Schroeter. 1988. "Agricultural Price Spreads and Market Performance." University of Connecticut, Storrs, CT.

10. Lopez, Rigoberto A., and Daniel Dorsainvil. 1988. "The Degree and Sources of Oligopsony Power: An Application to the Haitian Coffee Market." Rutgers University, New Brunswick, NJ.

11. Caswell, Julie A. 1988. "A Model of the Intra/Interstate Impacts of State Product Regulation." University of Massachusetts, Amherst, MA.

12. Cotterill, Ronald W. and Lawrence E. Haller. 1988. "Entry Barriers, the Queue of Potential Entrants, and Entry into Food Retailing Markets." University of Connecticut, Storrs, CT.

13. Caswell, Julie A. 1988. "An Alternative Measure of Aggregate Concentration with an Application to the Agribusiness Sector." University of Massachusetts, Amherst, MA.

14. McLaughlin, Edward W. and Vithala Rao. 1989. "The Strategic Role of Supermarket Buyer Intermediaries in New Product Selection: Implications for Systemwide Efficiency." Cornell University, Ithaca, NY.

15. Azzam, Azzeddine and Emilio Pagoulatos. 1989. "Testing for Oligopoly and Oligopsony Power." University of Nebraska-Lincoln.

16. Connor, John M. 1989. "Concentration Issues in the U.S. Beef Subsector." Purdue University, W. LaFayette, IN.

17. Manalo, Alberto B. 1989. "Benefits Sought by Apple Consumers." University of New Hampshire, Durham, NH.

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19. Padberg, Daniel I. and Julie A. Caswell. 1990. "Toward a More Comprehensive Theory of Food Labeling." University of Massachusetts, Amherst, MA.

20. Loehman, Edna. 1991. "Alternative Measures of Benefit for Nonmarket Goods which are Substitutes for Complements for Market Goods." Purdue University, W. LaFayette, IN.

21. Wiliams, Jr., Richard A. and Robert N. Brown. 1991. "Health and Safety Regulation of Small, High-Risk Subpopulations." FDA, Washington, DC.

22. McLaughlin, Edward W. 1991. "The Fresh Company." Cornell University, Ithaca, NY.

23. Connor, John M. and Everett B. Peterson. 1991. "Market-Structure Determinants of National Brand-Private Label Price Differences of Manufactured Food Products." Purdue University, W Lafayette, IN. & Virginia Polytechnic Institute & State University, Blacksburg, VA.

24. Steahr, Thomas E. and Pamela McMullin. 1991. "An Interdisciplinary Framework for the Analysis of Foodborne Disease." The University of Connecticut, Storrs, CT.

25. Ding, John Y. and Julie Caswell. 1991. "A Framework for Analysis of Alternative Restructuring Strategies Employed by Large Food Manufacturers in the 1980s." University of Massachusetts, Amherst, MA.

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27. Coaldrake, Karen and Steve Sonka. 1992. "Canola as an Emerging Industry: A Processor and Producer Perspective." University of Illinois, Urbana, IL.

28. Hopkins, Yvette S. and John Connor. 1992. "Re-Examination of Event Studies Applied to Challenged Horizonal Mergers." U.S. Environmental Protection Agency and Purdue University, W. Lafayette, IN.

29. Peterson, Everett, Paul V. Preckel, Thomas W. Hertel and Anya M. McGuirk. 1992. "Impacts of Biotechnology in the Domestic Livestock Sector." Virginia Polytechnic Institute and State University, Blacksburg, VA and Purdue University, W. Lafayette, IN.

30. McLaughlin, Edward. 1992. "Strengthening the Competitive Position of Commodity Marketers." Cornell University, Ithaca, NY.

31. Cotterill, Ronald W. and Hachim M. Salih. 1992. "Testing for Risk Premiums in the Wheat-Flour Subsector." University of Connecticut, Storrs, CT.

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