N EWP

WP-2

NE-165

PRIVATE STRATEGIES, PUBLIC POLICIES & FOOD SYSTEM PERFORMANCE

Salmonellosis Control:
Estimated Economic Benefits

by

Tanya Roberts

WP-2 September 1987

WORKING PAPER SERIES

A Joint USDA Land Grant University Research Project

Salmonellosis Control:
Estimated Economic Benefits

by

Tanya Roberts

WP-2 September 1987

The views expressed in this paper are not official policy of the U.S. Department of Agriculture. An earlier version of the paper was presented at the Poultry Science Association annual meetings in Corvallis, Oregon in August 1987 and is forthcoming in the Journal of Poultry Science.

The author is an agricultural economist, E.R.S. - room 1108, 1301 New York Ave. N.W., Washington, D.C. 20005-4788 (telephone: 202-786-1864).

<u>Salmonellosis Control: Estimated Economic Benefits</u>

Tanya Roberts (202-786-1864)

<u>Abstract</u>

Salmonellosis, a common human intestinal disorder primarily caused by contaminated meats and poultry, attacks an estimated two million Americans annually. Using a cost of illness approach, the medical costs and productivity losses alone were estimated to cost around one billion dollars in 1987. If pain and suffering, lost leisure time, and chronic disease costs could be quantified, the estimate would increase significantly. Other procedures for calculating the value of life could either raise or lower the estimated economic benefits of reducing human salmonellosis.

Incorporating losses to farmers, whose animals have reduced feed efficiency, reduced weight gain, or deaths because of chronic salmonellosis, would also increase the estimates. Also excluded were costs of food safety regulatory programs and costs to the industry for product recalls and plant closures due to foodborne salmonellosis outbreaks.

The National Academy of Sciences has endorsed risk assessment as a necessary method to evaluate and improve food safety regulatory programs, especially as applied to <u>Salmonella</u> contamination of poultry. Understanding the costs of salmonellosis is an important part of risk characterization since a key benefit of regulatory programs is reducing human salmonellosis.

Key words: <u>Salmonella</u>, salmonellosis, foodborne disease costs, economic costs, risk assessment, risk characterization

Introduction

Foodborne disease, such as the intestinal disease salmonellosis, results when two events occur: 1) Food is contaminated by organisms pathogenic to humans, and 2) These pathogens are not killed by cooking, salting, or some other means and their numbers may actually be increased by insufficient cooking or insufficient refrigeration (Bryan). Foods containing animal or seafood proteins are more likely to contain human pathogens than fruits and vegetables, consequently the meat industries must be alert to the potential contamination in their products.

The possibility of a poor quality product, such as contaminated food, does not by itself indicate a problem that cannot be corrected by the marketplace. Product quality is one of the market parameters. If you don't like the performance of the product, you can either ask for your money back or ask for a replacement---actions firmly supported by the legal system. Or you can change your purchasing or use patterns. For example, consider remedies to stawberries which mold the day after purchase: you can refuse to buy the product in the future (give up strawberries) or change your use practices (buy strawberries only when you plan to use them that day) or change stores (maybe another store buys fresher berries and handles them to extend shelf-life) or switch to a higher quality product or another product (frozen strawberries) that will perform to your satisfaction. All these actions are market solutions to the problem of inferior products and result in sales signals sent back to producers.

The problem with contaminated food is information about product performance. You cannot always tell whether what you ate or something else made you sick. 1) Most of the people in salmonellosis outbreaks think they have the stomach flu, not salmonellosis (R. V. Tauxe, 1987, personal communication). 2) If you do make the connection to a foodborne illness, you cannot always identify which food made you sick. For example, the average time until onset of disease for campylobacteriosis (another intestinal disease associated with poultry) is 3-4 days, and it may be up to a week before you become ill. 3) Even if you do know what food is likely to have made you ill, most of the time it has been eaten or thrown out and is not available for testing for contaminants. (Epidemiological surveys may be able to track down the disease source, but only at great expense).

Because the connection between food and disease is difficult to make, corrective market signals are not sent back to producers. In fact, producers get signals that they don't need to correct the problem ! After a foodborne disease episode, people do not stop purchasing what made them ill (because they don't know what it is). Quantities and prices of the foods causing illness do not fall. Grocery stores and restaurants seldom receive complaints. Less frequently does a beef, chicken, or pork slaughter plant hear about diseases their products may have caused. Farmers raising these animals hear even less frequently. This lack of communication does not mean a lack of foodborne disease. It means a lack of an understanding of the seriousness of foodborne disease. It means a lack of incentives to change production and handling practices to minimize contamination of food with human pathogens such as Salmonella, Campylobacter, Trichinella, Toxoplasma, Taenia, Staphylococcus, Bacillus, and Clostridium (National Research Council, 1985). Food safety is a classic example of a market failure due to imperfect information: consumers become ill but producers do not see a fall in purchases. Consequently, producers do not change their practices and foodborne disease is not reduced.

This lack of information has another dimension. Consumers cannot easily take preventive actions and avoid contaminated products. They cannot look at a chicken leg in a grocery store, a chicken salad sandwich in a delicatessen, or chicken kiev in a restaurant and choose only those products which will not make them ill. Because of the information problem, as a society we have delegated food safety regulation to federal and state governments. Even the regulators have trouble detecting microscopic pathogens as the National Academy of Sciences pointed out (National Research Council, 1987).

Methodology

Risk assessment, the backbone of the Hazard Analysis at Critical Control Points system recommended by the National Research Council of the National Academy of Sciences (1983, 1985, 1987), has not been systematically applied to salmonellosis caused by food. Risk assessment includes examining the potential entry points of Salmonella into food from farm to table and estimating the hazards to humans in terms of exposure, illness, and resulting costs.

Foodborne illness arises out of a market activity such as purchasing meat or poultry at a supermarket or a restaurant and consuming it (Fig. 1). This exposes the individual to a risk or hazard, namely the possibility of acquiring a foodborne illnes. Only some of the exposed persons become ill.

The costs associated with the illness include costs imposed on the parties in the market transaction--the person becoming ill from buying and consuming the product and the firm selling the product (Fig. 1). The monetizable costs include lost wages and medical costs for the sick person and lost sales, product recall and costs associated with legal liability suits for the restaurant or supermarket. In addition, there are the nonmonetizable costs such as the pain and inconvenience of the ill person who purchased the food.

Other costs are imposed on parties outside of the market transaction; they did not buy and consume the food and did not become ill. An example of a monetizable cost is the expense of travel to visit a hospitalized family member or friend. Again the most obvious nonmonetizable cost is the stress and disruption of having an ill family member.

The cost of illness approach used here is limited to evaluating two components of human illness costs: medical costs and lost productivity. Omitted from the analysis are estimates of the costs of pain and suffering, reduction of leisure time choices, and other costs to individuals (Fig. 1). Industry costs of reduced animal performance or product recall and plant cleanup during a foodborne disease outbreak are also omitted as well as the cost of the public health surveillance system.

Three estimates of human salmonellosis cases are available from the Centers for Disease Control (CDC) in Atlanta:

1) Outbreak data for all foodborne diseases which are primarily reported by state health departments: salmonellosis typically has around 50 outbreaks and around 2,000 associated cases annually.

2) Salmonellosis Surveillance Activity which are reported by private and public health workers: averages about 40,000 cases annually.

3) Extrapolations from the outbreak and surveillance data by CDC to estimate the "true" incidence of salmonellosis which ranges from 400,000 to 4,000,000 human cases annually (Cohen and Tauxe, 1986).

Both outbreak data and surveillance data are clear underestimates. Infection may not be suspected, cultured, diagnosed or reported for a variety of reasons. Community surveys during outbreaks suggest that the proportion of actual infections reported are between 1 in 10 and 1 in 100. Thus CDC estimates that between 400,000 and 4,000,000 cases may occur annually (Cohen and Tauxe, 1986). CDC's "best estimate" is 2 million salmonellosis cases annually (Bennett, Holmberg, Rogers, and Solomon, 1987).

Individuals vary greatly in their susceptibility to salmonellosis depending partly on the virulence of the organism (there are over 1,500 Salmonella serotypes) and partly on the individual's immune system along with other factors. As few as 10 Salmonella cells per gram or milliliter of food have caused human illness (Mulder, 1982). Typically, Salmonellacaused disease in humans is limited to salmonellosis, an acute gastroenteritis which appears 12 to 74 hours after eating contaminated food. Salmonellosis may cause only mild abdominal discomfort with minimal diarrhea lasting less than a day. More acute symptoms of disease include nausea, stomach ache, vomiting, diarrhea, cold chills, fever, and exhaustion. The symptoms of disease normally persist for 2 to 6 days, but in exceptional cases for several weeks. A small percentage of the people who contract salmonellosis die from it. Those most vulnerable are the sick, those taking antibiotics, infants, and the elderly. In rare cases Salmonella, like many other bacterial and parasitic infections, can cause chronic disease syndromes (Mossel, 1984; Cohen and Tauxe, 1986; Archer, 1984, 1985).

Because of the variety of severities for salmonellosis cases, the estimated two million cases are divided into four categories: deaths, hospitalizations, persons seeing a doctor but not hospitalized, and those not seeking medical attention. Both a high and a low estimate are calculated for all four severity categories. One estimate is based on Salmonella outbreak data and the other estimate based on Salmonella surveillance data.

Costs estimates for the three illness severities (excluding deaths) are taken from Cohen et. al.'s study (1978) and updated using various price indices for medical care and wages published by the Bureau of Labor Statistics, U.S. Department of Labor (Table 2). I do not know how representative these costs are, but they are the only costs in the literature.

To be consistent with consumer behavior theory, public programs for reducing risks of premature death should determine what people are willing to pay to reduce the risk of death. However, economists are still debating how to measure this. Fisher, Chestnut, and Violette (1986) reviewed six surveys where people were asked how much they would be willing to pay to have less risk in their jobs. From their replies a monetary value for risk reduction was calculated. Fisher, Chestnut, and Violette concluded that the results were relatively consistent with each other and indicate a value of a statistical life saved of

\$1.6 to \$8.4 million. However, Gerking's research (1987) indicates that people give overestimates in such surveys compared to actual market purchases. Because of the lack of consensus, I am not using this method.

The time-honored method of valuing the actuarial loss of someone's death is the human capital method pioneered by Dorothy Rice. An individual is valued by the wages they would have received over the remainder of their lifetime. The courts have used this method extensively to make the family whole, i.e. replace the lost earnings of a family member. Recently the cost of housekeeping services that would have been performed by the deceased person (such as the cost of a cleaning service) have been added to the estimates.

Landefeld and Seskin (1982) have adjusted the human capital method to make it more consistent with individual preferences and what people are willing to pay to reduce risk. Income available to pay for risk reduction is expanded to include non-labor income, such as earnings from real estate and stocks and bonds, as well as wages. The interest rate reflects the individual's (not society's) opportunity cost of investing in risk reducing activities, such as buying smoke alarms, and is estimated at 3%. A risk aversion factor is added since studies have shown that households are willing to pay more than their actuarial loss for other household risks, for example fire insurance. The risk aversion factor used by Landefeld and Seskin increases the estimates by 60%. The adjusted human capital value of life formula is:

$$\text{value of life} = \left[\sum_{t=0}^{T} Y_t/(1 + r)^t\right]\alpha$$

where T = remaining lifetime
t = a particular year
Y_t = after-tax income including labor and nonlabor income
r = household's opportunity cost of investing in risk-reducing activities
α = risk aversion factor

Landefeld and Seskin's adjustments increase the value of avoiding death estimates roughly fourfold for salmonellosis deaths when compared to the unadjusted human capital method (Roberts, 1985). Because Landefeld and Seskin only include financial losses associated with death and omit psychic costs such as pain and suffering and the value of lost leisure time, the value of life lost is underestimated. Because I use their estimates, the value of life in this paper is also underestimated.

Human Salmonellosis Cost Estimates

Total costs depend upon disease severity. The salmonellosis cases are divided into four severity classes: deaths, hospitalized cases, cases in which a doctor is consulted either in their office or an emergency room (but not admitted to the hospital), and mild cases averaging a couple days of illness which may include some time off work but no doctor visit.

Deaths: Death certificate data showed only 79 deaths due to salmonellosis in 1979 (Public Health Service, 1984). Death certificate information is very inaccurate for two reasons. They are filled out within hours of death and not updated with laboratory tests showing the causative organism. Even autopsy data is not subsequently entered on the death certificate.

CDC estimates actual deaths from salmonellosis in two ways. One method uses the salmonellosis surveillance data. A stratified sample of counties have periodically been surveyed for more detailed information. In the 1979-80 survey 1.4% died and in the 1984-5 survey 1.3% died which provides an estimate of 500 deaths per year for the 40,000 reported cases (Cohen and Tauxe, 1986). Since the 40,000 reported cases are only a fraction of the estimated 2 million cases that occur, the number of deaths is doubled to an estimated 1,000 annually (R.V. Tauxe, 1987, personal communication).

The other method uses data from outbreaks of foodborne disease due to salmonellosis. In outbreaks where virtually all cases have been identified, typically 1/1,000 cases dies. Multiplying this ratio by the estimated 2 million cases results in an estimated 2,000 deaths annually (Bennett, Holmberg, Rogers, and Solomon, 1987).

Most of reported deaths are elderly people and a few infants (Public Health Service, 1984). Assuming this reported age distribution is representative for all estimated salmonellosis deaths, then it can be combined with Landefeld and Seskin's numbers to estimate the benefits of reducing health risks from salmonellosis. Updated to August 1987 values using the Average Weekly Earnings Index, todays' value for the stream of productivity lost for each premature salmonellosis death is $354,600. Multiplied times the 1,000 to 2,000 estimated deaths, the loss due to premature death is estimated to range from $355 million to $709 million annually (Table 1).

Hospitalized cases: Again the two methods for estimating the number of people hospitalized are extensions of the national salmonellosis surveillance data and foodborne outbreak data. Cohen and Tauxe (1986) report that an estimated 18,000 of the 40,000 reported salmonellosis surveilance cases are hospitalized annually. Again because the 40,000 reported cases are only a fraction of the estimated actual 2,000,000 cases, the number of hospitalized cases is doubled to estimate 36,000 hospitalizations for salmonellosis annually (R.V. Tauxe, 1987, personal communication).

Outbreak data estimation comes from the 1985 Illinois salmonellosis outbreak due to pasteurized milk. Hospitalized cases numbered 2,777. The hospitalization rate for the outbreak is 2,777 hospitalizations divided by the 183,186 total estimated cases for the Illinois outbreak, or 1.52% (Ryan et al., 1987). Multiplying this percentage by the U.S. annual estimated cases of salmonellosis results in an estimated 30,000 hospitalized cases (.0152 x 2,000,000 = 30,000 rounded to the nearest thousand).

Costs are not yet available from the Illinois outbreak so Cohen et al.'s costs (1978) are updated to October 1987 values using the Hospital Room component of the Consumer Price Index (Table 2). The cost for hospitalized cases is estimated to be $4,350. Multiplied times the number of hospitalizations results in these cases costing an estimated $131 to $157 million annually (Table 1). As Cohen et. al. reported, most of the cost is for hospital expenses followed by productivity loss during absence from work.

Ill enough to see a doctor: Again the two methods are extensions of the surveillance data and the outbreak data. The two studies of a sample of reported salmonellosis surveillance cases in 1979-80 and 1984-5 found that 22,000 of the 40,000 cases saw a doctor without being hospitalized (Cohen and Tauxe, 1986). Extending these results to the estimated 2 million U.S. salmonellosis cases annually, the number of cases is doubled to estimate that 44,000 people see a doctor (1987, personal communication).

From the Illinois outbreak data the estimates are more complicated and still preliminary. Six hundred people were randomly selected from the 16,000 culture-confirmed cases and sent a questionnaire asking about their illness. (318 of the 600 answered the questionnaire). Of the respondents 63% reported seeing a physician either in the emergency room or private office (C. Ryan, 1987, personal communication). Assume that 63% of the 16,000 confirmed cases saw a physician and that none of the remaining 183,186 cases saw a physician. (This conservative assumption was suggested by Caroline Ryan, CDC, to offset the higher than average rate of people seeking medical attention because of the publicity and the possibility of litigation against the dairy). The rate of doctor visits then is 5.04% for the whole Chicago outbreak, or (16,000 x .63)/200,000. Multiplying 5.04% times the U.S. 2 million estimated cases, results in an estimated 101,000 doctor visits for salmonellosis annually.

Costs for the doctor visits are again updated from Cohen et al. (Table 2). This time the Physician Services component of the Consumer Price Index is used to update the numbers to October 1987 values. The average estimated cost for persons consulting a physician for salmonellosis is $680. Multiplied times the estimated cases, the estimated costs for these cases range from $30 to $69 million annually. While physician expenses and laboratory tests were the key costs cited by Cohen et al., productivity loss is also included in the estimate.

Mild cases: I assume that the remainder of the estimated 2 million cases are mild cases: 1,191,000 cases using extensions of salmonellosis surveillance data and 1,906,000 cases using extensions of the outbreak data. Cohen et al. roughly estimated costs for these people, although their sample size was small. Updated to April 1987 dollars using the change in Average Weekly Earnings since the bulk of the cost is time away from work, the costs for the mild cases are roughly estimated at $221 apiece (Table 1). The total costs for mild cases are estimated to range between $421 and $424 million annually.

In summary, the human illness costs of salmonellosis are substantial. Medical costs and lost productivity add up to a low estimate of $966 million annually using salmonellosis surveillance data and a high estimate of $1.3 billion annually using outbreak data for salmonellosis cases (Table 2). The difference between the low and high estimates reflects the two different methods of allocating cases into disease severity categories.

Discussion

What is the reliability of the above estimates ? The costs for the four severity levels are relatively rough. The three illness categories are based on a survey of 234 people in an outbreak of Salmonella heidelberg contaminated cheddar cheese in Colorado (Cohen et al., 1978). Several sources of bias are possible: the disease severity may be higher or lower than average depending on the Salmonella serotype, the number of Salmonella ingested, and the age and sex composition of the people affected. To the extent this outbreak is not a "typical" salmonellosis outbreak, there is the possibility of bias. Of particular concern is the cost estimate for the mild cases because so few of these cases were in the sample and because the large numbers of cases make these cases the first (surveillance data) or second (outbreak data) largest component in the estimates.

The costs for the deaths are reasonably reliable, yet economists still differ on the best methodology. The human capital method evaluated at a 10% interest rate is one-fourth of the adjusted Landefeld and Seskin method used here, and the willingness to pay surveys suggest a value more than four times higher.

This paper contributes to the epidemiological literature on salmonellosis by reporting two methods for dividing cases into different severity groups: one based on surveillance data and the other on outbreak data. Future work will refine the methods for estimating the number of cases that belong in the severity categories and hopefully increase the number of severity categories. Refinement of the estimated deaths is particularly important because of their large contribution to total estimated costs.

The one billion dollar salmonellosis cost estimate excludes several factors which may be significant (Fig. 1). Chronic medical conditions resulting from salmonellosis are excluded from the estimates. Salmonellosis is occasionally followed by chronic disease such as rheumatoid syndromes, heart disease, meningitis, colitis, blood poisoning, thyroiditis (Archer, 1984, 1985; Cohen and Tauxe, 1986; Mossel, 1984). What we don't know is the likelihood of occurance. Archer has estimated that 2% of salmonellosis patients will end up with reactive arthritis, an inflammation of the joints which lasts from a few days to 6 months (1985). A fraction of these cases will continue to have episodes of arthritis. Rheumatoid arthritis sufferers were willing to pay 22 percent of household income to be rid of arthritis in a recent survey (Thompson, 1986). With better incidence data, costs of these chronic medical conditions could be added into the estimate.

Other costs to individuals are excluded. For example, a Canadian economist, Leo Curtin, estimated that the loss of leisure time was greater than the loss of worktime due to salmonellosis (1984). Estimates using his methodology of valuing leisure time at the prevailing wage rate would more than double the cost of salmonellosis estimates presented here.

An estimate for inconvenience, pain, and other relatively intangible costs to individuals could be approximated by the compensation approved by Circuit Judge John Breen, Jr. for the Chicago salmonellosis victims but still subject to appeal (Food Chemical News, 1987). Those sick three to four days are to receive $1,000 plus compensation for medical expenses and lost work time. Those sick one or two days will receive $800 plus the compensation. Individual settlements are to be negotiated for those sick longer than four days.

Salmonellosis can affect the productivity of poultry thru deaths (McCapes, 1987) or reduced feed efficiency and reduced weight gain (Krug, 1985). Other industry costs of salmonellosis disease outbreaks include plant cleanups and product recalls. Ewen Todd found that readily measurable costs associated with salmonellosis outbreaks in the food service industry ranged from $60,000 to $700,000 per outbreak (1985b) while costs to food processors ranged from $36,000 to $3.3 million per salmonellosis outbreak (1985a).

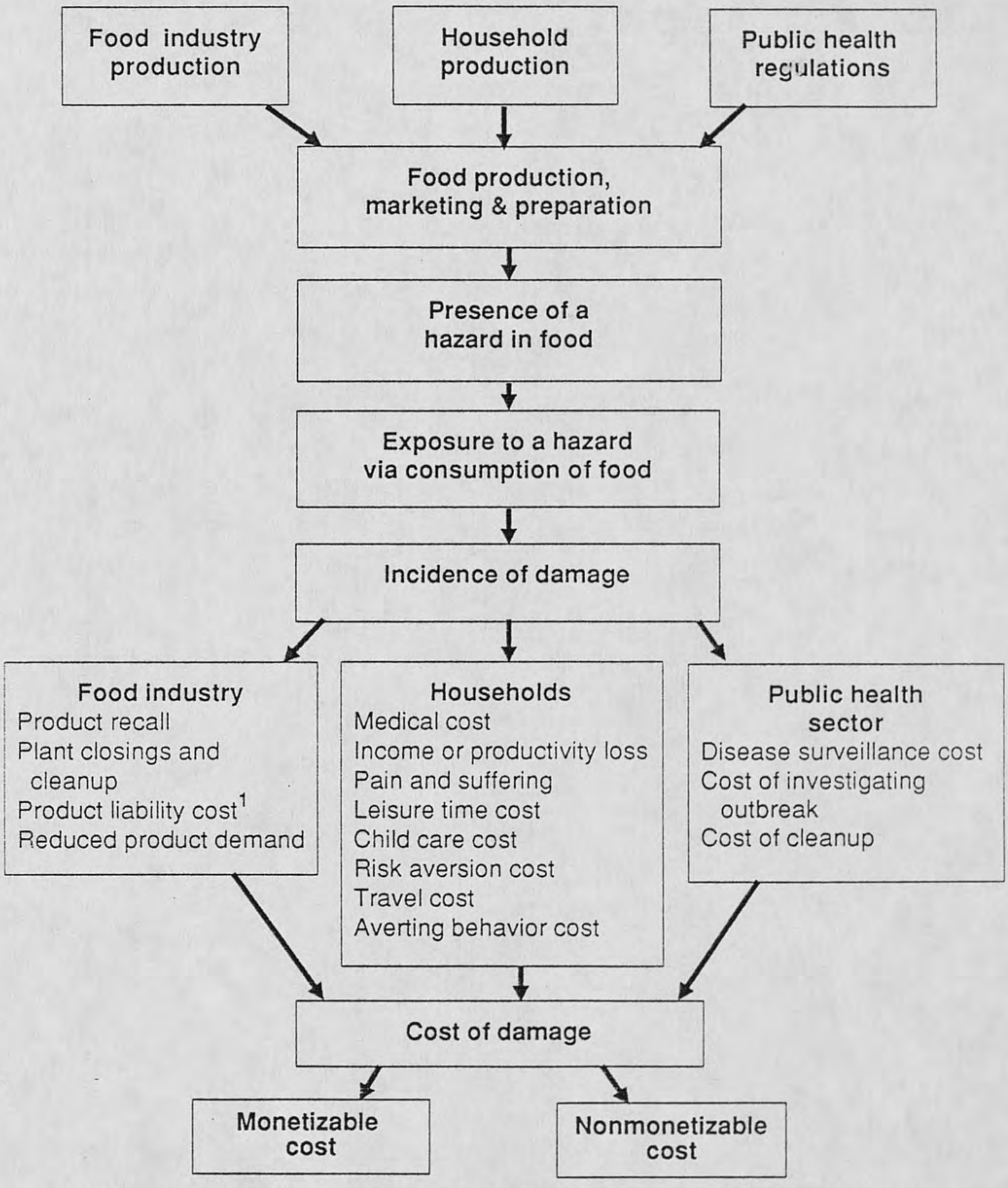
Most human cases of salmonellosis come from foodborne sources (Bryan, 1980; Cohen and Tauxe, 1986). It is encouraging that several producer groups, such as the Southeastern Poultry and Egg Association, the National Broiler Council, and the American Meat Institute are in the process of developing good manufacturing practices to reduce Salmonella contamination levels.

Researchers also need to follow the charge of the National Academy of Sciences to conduct rigorous risk assessments to better quantify the economic tradeoffs for controlling salmonellosis. Reducing pathogen contamination in foods costs money. It may require changing animal husbandry practices, purchasing

Salmonella-free feed, installing better refrigeration in meat coolers, reducing cross-contamination along the slaughter line, throwing out over-age food sooner in grocery stores and restaurants, training food preparers on proper food handling and sanitation techniques, or implementing new technologies such as irradiation of packaged poultry to kill Salmonella (Curtin, 1984; McCapes, 1987; Roberts, 1985). We don't know yet which combination of strategies will have the greatest payoff in reducing foodborne salmonellosis.

Acknowledgements. Helpful review comments on various drafts of the paper were received from Masao Matsumoto, David Smallwood, and Lee Christensen, all at the Economic Research Service, United States Department of Agriculture; two anonymous reviewers in the Animal and Plant Health Inspection Services, USDA; and two anonymous reviewers from the NE-165 Cooperative Regional Research Project, "Private Strategies, Public Policies and Food System Performance". I am indebted to Robert Tauxe and Caroline Ryan, both at the Centers for Disease Control, for the estimations of cases in the four disease severity categories.

Fig. 1. Costs from exposure to foodborne disease



[1] In adding up costs, care must be taken to assure that product liability cost to firms is not already counted in the estimated pain and suffering cost to individuals.

TABLE 1. U.S. salmonellosis medical costs and productivity losses, 1987

Salmonellosis severity categories	Estimated cases: Surveillance data	Estimated cases: Outbreak data	Updated costs per case	Total costs: Surveillance data	Total costs: Outbreak data
	--number--		dollars	million dollars	
Deaths[1]	1,000	2,000	354,600	355	709
Hospitalized cases	36,000	30,000	4,350	157	131
Only saw doctor	44,000	101,000	680	30	69
Mild cases (residual)	1,920,000	1,869,000	221	424	413
Total				$966 million to $1.3 billion	

[1]Deaths are also assumed to be hospitalized cases. The value of premature death is updated from Landefeld and Seskin using BLS' Average Weekly Earnings Index.

TABLE 2. Updated costs per case by salmonellosis severity in Cohen *et al.*

Case severity category	1976 costs	1987 costs	Index used to update
	--dollars--		
Hospitalized cases	1,750	4,350	Hospital Rooms/CPI
Only doctor visit	222	680	Physicians Services/CPI
Ill but no doctor visit	125	221	Average Weekly Earnings

Note: All updating indexes are published by the Bureau of Labor Statistics, US Department of Labor.

References

Archer, D. L., 1984. Diarrheal episodes and diarrheal disease: acute disease with chronic implications. J. Food Protection. 47:321-328.

Archer, D. L., 1985. Enteric microorganisms in rheumatoid diseases: causative agents and possible mechanisms. J. Food Protection. 48:538-545.

Archer, D. L., 1987. Testimony, Senate Committee on Agriculture, Nutrition, and Forestry, Full Committee Hearing on "Foodborne illnesses and deaths in the United States," Washington, DC, June 4.

Bennett, J. V., S. D. Holmberg, M. F. Rogers, and S. L. Solomon, 1987. Infectious and parasitic diseases in Closing the gap: the burden of unnecessary illness. R.W. Amler and H. B. Dull, ed. Oxford Univ. Press, New York.

Bryan, F. L., 1980. Foodborne disease in the United States associated with meat and poultry. J. Food Protection. 43:140-150.

Cohen, M. L. and R. V. Tauxe, 1986. Drug-resistant Salmonella in the United States: an epidemiological perspective. Science. 234:964-969.

Cohen, M. L., R. E. Fountaine, R. E. Pollard, et. al., 1978. An assessment of a patient related economic costs in an outbreak of salmonellosis. New England J. Medicine. 299:459-460.

Cohen, M. L. and E. J. Gangarosa, 1978. Nontyphoid salmonellosis. Southern Medical Journal. 71:1540-1545.

Cooper, B. S., and D. P. Rice, 1976. The economic cost of illness revisited. Social Security Bulletin. Feb:21-36.

Curtin, L., 1984. Economic study of salmonella poisoning and control measures in Canada. working paper no. 11/84, Marketing and Economics Branch, Agriculture Canada, Ottawa.

Fisher, A., L. Chestnut, D. Violette, 1986. "New information on the value of reducing risk", draft.

Food Chemical News, 1987. Judge approves settlement plan for Salmonella victims. Nov 30: 37.

Gerking, S., 1987. Environmental Law Institute/Environmental Protection Agency seminar, Washington, DC.

Krug, W., 1985. Social costs of Salmonella infections in humans and domestic animals in Proceedings of the International Symposium on Salmonellosis. H. G. Snoyenbos, ed. American Asociation of Avian Pathologists, Kennett Square, Pennsylvania.

Landefeld, J. S., and E. P. Seskin, 1982. The economic value of life: linking theory to practice. Amer. J. Public Health. 72:555-566.

McCapes, R. H., 1987. Why the crisis ? Poultry Processing. August: 24-30.

Miller suggests new FDA inspection approach, 6 July 1987. Food Chemical News. 29:18-21.

Mossel, D. A. A., 1984. Intervention as the rational approach to control diseases of microbial etiology transmitted by foods. J. Food Safety. 6:89-104.

Mulder, R. W. A. W., 1982. Salmonella radiciation of poultry carcasses. PhD dissertation. Agricultural University, Wageninen, The Netherlands.

National Research Council, 1983. Risk-assessment in the federal government: managing the process. National Academy Press, Washington, DC.

National Research Council, 1985. Meat and poultry inspection: the scientific basis of the nation's program. National Academy Press, Washington, DC.

National Research Council, 1987. Poultry inspection: the basis for a risk-assessment system. National Academy Press, Washington, DC.

Orskov, F., and I. Orskov, 1982. Gram negative rods: enterobacteriaceae in Microbiology: Basic Science and Medical Applications. A. I. Braude, ed. W.B. Saunders, Co., Philadelphia.

Public Heath Service, U.S. Dept. of Health and Human Services, 1984. Vital statistics of the United States, 1979: vol II-mortality, part A. National Center for Health Statistics, Hyattsville, Maryland.

Roberts, T., 1985. Microbial pathogens in raw pork, chicken, and beef: benefit estimates for control using irradiation. Amer. J. Agricultural Economics. 67:957-965.

Ryan, C. A., M. K. Nickels, N. T. Hargrett-Bean, M. E. Potter et al., 11 Dec. 1987. Massive outbreak of antimicrobial-resistant salmonellosis traced to pasteurized milk. J. Amer. Med. Ass. 258:3269-3274.

Thompson, M.S., 1986. Willingness to pay and accept risks to cure chronic disease. Amer. J. Public Health. 76:390-396.

Todd, E. C., 1985a. Economic loss from foodborne disease and non-illness related recalls because of mishandling by food processors. J. Food Protection. 48:621-633.

Todd, E. C., 1985b. Economic loss from foodborne disease outbreaks associated with foodservice establishments. J. Food Protection. 48:169-180.

NE-165

PRIVATE STRATEGIES, PUBLIC POLICIES & FOOD SYSTEM PERFORMANCE

Working Paper Series

Purpose: The NE-165 Working Paper Series provides access to and facilitates research on food and agricultural marketing questions. It is intended to be a publication vehicle for interim and completed research efforts of high quality. A working paper can take many forms. It may be a paper that was delivered at a conference or symposium but not published. It may be a research report that ultimately appears in full or abbreviated form as a journal article or chapter in a book. Using the working paper series enables a researcher to distribute the report more quickly and in more extensive detail to key research users. A working paper may also be an end product in itself, for example, papers that collate data, report descriptive results, explore new research methodologies, or stimulate thought on research questions.

Procedures: Working papers may address any issues in the food and agricultural marketing area as described in the NE-165: Private Strategies, Public Policy and Food System Performance, project statement. This research agenda is available from Professor Ronald Cotterill, Executive Director of NE-165 at the address given below. A prospective working paper should be forwarded to the Executive Director who will coordinate a review of the paper by two research peers. Alternatively authors may submit two independent peer reviews with their paper. Based upon independent reviewer comments the Executive Director may accept, accept with revisions, or reject the submission. If accepted the Executive Director will issue working paper covers, and a mailing list to the author who shall have responsibility for preparing and distributing copies to all persons and organizations on the mailing list. Additional copies of working papers are available from the author or from the office of the Executive Director at The University of Connecticut.

Professor Ronald W. Cotterill, Executive Director NE-165
Department of Agricultural Economics and Rural Sociology
Box U-21
The University of Connecticut
Storrs, Connecticut 06268