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PRIVATE STRATEGIES, PUBLIC POLICIES & FOOD SYSTEM PERFORMANCE

AN INTERDISCIPLINARY FRAMEWORK FOR THE ANALYSIS OF FOODBORNE DISEASE

by

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WP-24 September 1991

WORKING PAPER SERIES

A Joint USDA Land Grant University Research Project

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INTRODUCTION

The prevalence and severity of illness from any cause is of serious concern to persons and agencies responsible for the protection and improvement of public health. A critical element in the formation of public health policy is information provided by scientific research on specific forms of disease. As a result of this need for knowledge, much of the previous and current research is justifiably concerned with the etiological agent causing the disease, in terms of its growth and transmission throughout a population. While this important work is necessary and needs to be continued, the thesis of this paper is that scientific knowledge should be expanded to include economic and social factors relating to illness. Research on the social and cultural variables related to sickness, including foodborne disease, should be encouraged. The economic costs and consequences of death and illness needs scientific investigation. To accomplish this goal, a general interdisciplinary framework is offered which will organize existing work and suggest areas of future research for a more complete understanding of illness in our society.

EXISTING MODELS FOR DISEASE ANALYSIS

Epidemiologists, physicians, economists, and others interested in deaths and illness from disease have developed increasingly sophisticated conceptual frameworks within which empirical investigation may be classified. An excellent statement of these approaches is provided by Frank L. Bryan (Riemann and Bryan, 1979). He observes that the presence of an etiologic agent, as in contaminated food, will not usually cause illness because several other factors are required before foodborne disease occurs. The various models developed to specify the relations that cause disease include a) the chain of infection model, b) the epidemiologic triangle, c) the web of causation approach, and d) the ecosystem view (Riemann and Bryan, p. 13).

Note: *Thanks is due to the Food Marketing Policy Center, University of Connecticut for providing financial support for this research project.*

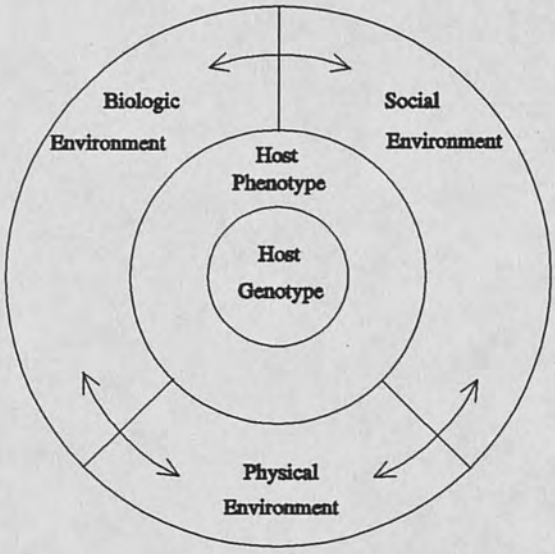
Briefly, the chain of infection posits the existence of a sequence of factors before persons become infected. With reference to foodborne disease, the causal sequence is, first, the existence of etiologic agent in the food production environment. Then there must be a source or reservoir in which the infection can normally live and multiply. Given these conditions, the etiologic agent must be transmitted from the source to the food. Once transmission occurs, the food must be able to support the additional growth (in terms of water levels, pH ranges, nutrients). Contaminated food then must remain within the temperature range long enough to allow the agent to grow enough to cause infection or cause toxin reactions. Finally, the amount of food eaten must have enough organisms to exceed the level of sensitivity of the person eating the food. The final step, illness resulting from eating contaminated food, is actually the result of the several previous causal stages.

The epidemiologic triangle model is more general in that it is comprised of relationships between three elements - the agent, the host, and the environment. Illness is the result of the presence of the microorganism when it can grow and multiply in its usual manner outside the host. There are a variety of features of the host which affect the resistance to the agent. Such features or characteristics as sex, age, and race are biological while others may include social variables like religion, education, and occupation. The environment is a factor which impacts on either the growth of the microorganism or its transmission to the host. Illness is the end result of the interaction of these three basic elements.

The web of causation approach is basically a flow-diagram view of the various developmental steps resulting in illness. These diagrams attempt to include every important step in the development of an illness and is illustrated by Bryan in the analysis of clostridium perfringens (Riemann and Bryan, p. 16-17). To summarize this approach, foodborne illness from this anaerobic bacterium may be viewed in a series of steps beginning with the feed given

to animals used for food, the possible contamination during slaughter in processing of the meat, threats during storage and transportation, the problems during the cooking process and the reheating process prior to ingestion of the food. Each of these major stages allow for proliferation of additional variables such as equipment problems, worker contamination, soil and dust contamination, etc.. Illness is the result of a complex web of causal factors occurring in the environment.

The ecosystem model, as discussed by Bryan (Riemann and Bryan, pp. 16-32), and shown in Figure 1, is composed of three basic elements; the genotype (the genetic basis of a person) and the phenotype (the social basis of a person) which together define the host, and the environment which is subdivided into biologic, physical and social components. The infectious agent is placed into the biologic component of the environment which also includes reservoirs, sectors, plants, animals, and people. The physical environment includes weather, light, heat, air, water, radiation, noise, atmospheric pressure and chemical agents. The social environment is defined as the overall socioeconomic and political organization of a society or social institution to which persons belong. The ecosystem model has the advantage of being compatible with each of the other three models while not overemphasizing the role of the etiologic agent. Several elements of the social environment are recognized as importantly related to foodborne illness, such as family gatherings, ethnic food preferences, job-related gatherings, and other social activities, but less effort has been made toward an organized elaboration of the social environment factors. This report will propose an elaboration of the social environmental factors in the ecosystem model.



The Ecosystem Model
(from H. Rieman and F.L. Bryon)

Figure 1

The Social Environment

An early and influential attempt to organize knowledge about the social factors associated with illness is provided by Edward A. Suchman (1965). He divided the sequence of medical patterns into five stages: 1) the symptom experience stage, 2) assumption of the sick role stage, 3) medical care contact stage, 4) the dependent-patient role stage, and 5) the recovery or rehabilitation stage. This is presented in Figure 2.

The first stage of symptom experience involves the physical experience (the pain or debility of the illness), the cognitive aspect (the interpretative meaning of these symptoms), and the emotional response (fear or anxiety) to the first two conditions. This developmental sequence helps organize findings that a given symptom may be differentially perceived,

Stages of Illness Model
(from Edward A. Suchman)

Figure 2

evaluated and acted or not acted upon by persons with selected characteristics (Mechanic, 1961). The first stage of symptom experience suggests that pain or some disability must be experienced for illness to be recognized and that illness is unlikely to be recognized in the absence of pain. Problems with this view occur when people react differently to pain or other symptoms (ranging from pain denial to immediate action), when the illness has no dramatic recognizable symptoms (such as hypertensive illness), and when the symptoms take years to become manifest (cancer due to environmental toxic agents).

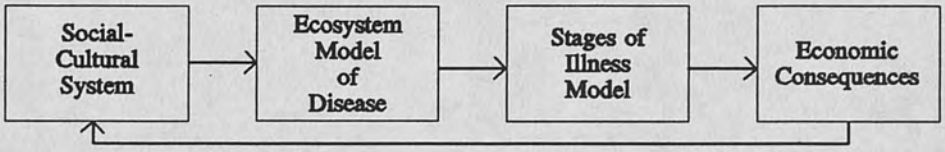
The passage into the second stage, occupying the sick role (the decision that one is sick and needs professional care), involves seeking treatment for the illness and temporary suspension of performance of normal obligations and activities. The third stage is medical care contact (acquiring professional medical care) and entry into both of these stages is found to vary significantly by age, sex, marital status, education, employment status, and family size for the

ethnic groups of Puerto Rican, Cuban, Mexican, Black and Anglo (Wolinsky, et.al., 1989; Strain, 1989). The likelihood of seeking professional health care services to cure illness is not equal for every person since many rely on folk-medicine or family care and support.

When the sick individual actually becomes a patient and accepts the physician's diagnosis and prescriptions, the fourth stage of the dependent-patient role is entered. Given this development, the passage into the fifth and final stage of recovery or rehabilitation (removal from the patient role) is possible. It may take considerable time before normal activities are fully resumed and, depending on the nature of the illness, long-term rehabilitation may be necessary.

In summary, the ecosystem model of the disease complex provides a means for organizing existing research on the infectious agent itself, on the individual host, and social environment within which the host lives. A conceptual refinement of the social component is accomplished by viewing illness as going through five stages. Both the ecosystem model and the developmental model are based on the individual person as the primary unit of analysis. This is appropriate since illness affects an individual but we propose two additional analytical variables to broaden the overall view: the prior sociocultural system of which the individual is a part and the economic consequences resulting from the illness. Diagrammatically this is presented in Figure 3:

The social-cultural system of the individual is known to influence disease and nutrition levels (Swedlund and Armelagos, 1990), the location in the social stratification system affects medical utilization and illness reporting (Koos, 1954; Kaplan, et. al., 1987) and ethnic group identification impacts on illness and health care system utilization (Saunders, 1954). The economic consequences resulting from illness impacts on the individual in terms of income lost which, in turn, may affect the speed of movement through the five stages of illness. Ultimately,



Social and Economic Framework
Figure 3

the economic factors impact on the larger social-cultural system by altering normative behavior patterns that relate to health. All of these categories are interrelated which emphasizes the system dependency view of disease.

FOODBORNE ILLNESS

While the previous discussion is primarily in terms of all types of illness resulting from various diseases, this section will illustrate how existing research on foodborne diseases may be organized. It is not the intention to provide an exhaustive review of this literature but rather to select some examples for each of the major categories. In addition, the framework will be used to suggest directions for future research and areas of additional data needs.

Social-Cultural System

This category includes the most broadly defined variables that may influence the incidence of foodborne disease. Community based studies in Cleveland, Ohio; Tecumsah, Michigan; Charlottesville, Virginia; and elsewhere have provided estimates of activity restriction,

physician consultation levels and hospitalizations resulting from intestinal infectious diseases (Garthright, et.al., 1988). In addition, the ways in which food is rendered unsafe for human consumption or the ways food safety may be increased are a reflection of social and cultural patterns. In some social groups there may be a 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, or other culture-specific practices (Foster and Kaferstein, 1985).

Also included in this category are underlying changes in demographic characteristics, lifestyle patterns, and consumer behavior. The population of the United States will change demographically over the next twenty years. Projections show a rapid increase in the elderly population 65 years and over, an increase in racial and ethnic minority groups, and a large increase in the 40-50 year old group as the baby-boom generation ages forward (Witrogan, 1985). Population trends and changes in lifestyle patterns due to increasing numbers of working women result in alterations in eating patterns and nutritional habits. Also related to food consumption patterns are changes in food retailing practices, advertising and packaging of food items (Senauer, 1990).

These and other macro-system level variables strongly suggest that illness from foodborne causes is imbedded in the social-cultural system (Vargas, 1990) and that more research by social scientists is needed. More specifically, analysis of food production, transportation, marketing, storage, preparation, and consumption is needed for different cultural systems (Foster and Kaferstein, 1985).

The Ecosystem Model - Stages of Illness

The category includes the ecosystem model of the host (phenotype and genotype) and the biologic, physical, and social environment (Bryan, 1979). Research on genetic factors would include an individual's inability to digest certain foods (favism) or allergic reaction to selected

foods. Research on phenotype characteristics related to foodborne illness would include sex and age specific illnesses (Finlay and Falkow, 1989). The biologic environment as a category would include the very large number of studies on etiologic agents (Riley, et.al., 1984), reservoirs, and sectors that interact with the host. An excellent summary of such work is provided by Cliver (1990). The physical environmental factors include studies of patterns of disease (Bennett, et.al., 1987; Garthright, 1988), the geographic distribution and longitudinal trends (Bean and Griffin, 1990) and basic descriptive surveillance reports (Bean, et.al., 1990). It is at this level of secondary data collection by national agencies that the need for improvements have been recognized. Better data are needed on the incidence and severity of foodborne disease from microbial, chemical, and natural elements in food (Roberts and Smallwood, 1991). Improvements in the structure of the national data collection system are needed to increase our understanding of foodborne disease and to increase preventive measures to reduce illness frequency.

The social environmental factors of the ecosystem model were elaborated to include the stages of illness model by Suchman (1965). As previously described, the first stage of symptom experience is composed of three separate parts: 1) the physical experience of pain or debility, 2) the meaning attached to the physical experience, and 3) the emotional response to steps one and two. Research falling into the first category of the physical experience of pain or discomfort shows a great deal of individual and cultural variation (Foster and Kaferstein, 1985; Vargas, 1990; Mechanic, 1961). It is clear that the presence of the symptoms themselves does not explain the actions people take, rather the social context must be considered. The second and third steps of attaching some meaning to the recognition of pain and then experiencing an emotional response are related to but distinct from the first step. An excellent example of work in steps two and three is provided by L. A. Strain (1989) in which she looks at illness behavior

from symptoms awareness to resolution for persons 60 years of age and older. She identified multiple pathways to health care which involved doing nothing, professional care only, self-care only, consulting, lagged consulting, and simultaneous self-care and professional care. Characteristics of the individual, such as age, gender, education, marital status, income and health status were related to attaching meaning to pain and seeking care. Recognition of foodborne illness may vary by length of the incubation, from less than one hour to over 96 hours, and by severity of the symptoms, e.g., vomiting, nausea, diarrhea (Bean and Griffin, 1990; Riemann and Bryan, 1979; Cliver, 1990) as well as other factors.

The second stage of illness involves the assumption of the sick role, the recognition that one is ill and needs professional care. An important element in this stage is seeking lay advice and agreement that illness exists and is the basis for being excused from normal obligations. In the case of foodborne illness, an example of the assumption of the sick role would be children who ingested contaminated food seeking advice and direction from adults who, upon confirming illness, release them from their normal activities. The data collected by Suchman, over 5,000 randomly drawn persons in the Washington Heights community of New York City, showed that three fourths of the subjects discussed their illness with someone prior to seeking medical attention. Research on the elderly by Laurel A. Strain (1989) revealed consultations with family members and friends both within and outside the household.

The third stage of medical contact (seeking professional care) is complex as well. The person must actively seek professional help, although lay advice and self-help methods also may be used. Interview data collected by Suchman revealed that persons would seek professional care if the symptoms were seen as serious and if hospitalization was possible. Research on the severity of symptoms of foodborne illness suggests a similar relationship but more research in this area is necessary. It is at this stage that resources (income, health insurance, etc.) are

crucial. Without them, medical contacts will be delayed, thus probably producing a much more serious, if not lethal, situation.

The fourth stage of dependent-patient and the fifth stage of recovery (giving up the patient role) occur as the final two stages. Becoming a patient means that the data collection process shifts to health care system based data. Now the physician sees the patient, makes a diagnosis of likely cause, obtains a specimen for analysis, has the lab identify the organism and reports the results to required official agencies. These important national data sets on deaths and illness published by several agencies, such as the Multiple Cause Death Data, the National Hospital Discharge Survey, and the National Mortality Followback Survey, have been evaluated for additional research on foodborne disease, (Roberts and Smallwood, 1991). Estimates of the incidence of foodborne disease in the United States have ranged between 8 million cases per year to 324 million cases per year (Garthright, et.al., 1988). Other published research compares five different estimates of foodborne disease based on different data sources (Todd, 1989). Additional evaluation of these data sets is needed to judge their strengths and limitations for analytical studies of foodborne illness and death.

The fifth stage of recovery involves giving up the patient role and resuming the normal duties as a well member of society. Most patients express concern over economic matters during the period of convalescence, such as fear of loss of job or wages, but patients with different characteristics had different experiences. The convalescent period is more likely to be enjoyed by younger persons than older persons; upper socioeconomic groups are less likely to enjoy their convalescence; and men are more likely than women to be concerned about returning to normal duties following illness (Suchman, 1965). It may be hypothesized that the number of times a person passes through these stages of illness will affect the perception of one's health and the likelihood of future involvement in or sensitivity toward illness behavior.

Economic Consequences

The economic consequences of death and illness from foodborne disease is treated as a separate category because of the complexity of the subject. Estimates of medical and productivity costs in the United States from these diseases are in the billions of dollars annually (Roberts, 1989; Roberts and Frenkel, 1990). The economics of foodborne illness and food safety issues received extensive attention in a volume edited by Julie A. Caswell (1991). This compendium presented research on modeling consumer demand for food safety, on the application of risk assessment methodology to food safety, on the measurement of consumer response to health information, and on the analysis of the supply of food safety. A total of fifteen research reports organized around these topics illustrate the complexity of the economic consequences. Other reports, ranging from studies on consumer willingness to pay increased costs for irradiated food (Malone, 1990) to attempts to develop a theory of food labeling and food purchasing (Padberg and Caswell, 1990), also demonstrate the magnitude of this category. While it is not the intent of this paper to provide a complete review of the economic literature, it should be noted that relatively little research on the economics of food safety and foodborne illness had been accomplished up to the mid-1980's (Caswell, 1991, p. vii).

In addition to a traditional investigation of economic variables, the model presented previously suggests a feedback between the economic consequences and the larger social-cultural system as it impacts on the ecosystem model of disease. Interdisciplinary research involving economists, anthropologists, sociologists, psychologists and other behavioral scientists is needed to map completely the incidence of foodborne disease and to develop cost and health effective intervention programs to improve the quality of life.

CONCLUSIONS

The preceding discussion provides a framework for classifying existing research and suggests areas of additional research, particularly including the social-cultural variables. Primary data collection derived from community based longitudinal studies dealing with specific types of foodborne disease is needed to fully identify social-cultural practices affecting food safety. Information about these important variables cannot be obtained from existing secondary data sets published by federal health agencies. Primary data must be collected by direct interviewing, telephone interviewing, direct observations, or other available methods and particular ethnic groups, such as Hispanics, Blacks, and Asians, be examined for health habits and food practices which impact on food safety.

Given the observation that different population groups have different risks of foodborne illness, additional research at the social-cultural level should include demographic analysis of past cases of illness and death. Characteristics of persons with differential risks, such as age, sex, education, ethnic status, marital status, income, and occupation, needs documentation so that trends over time may be isolated. Demographic projections of future populations with those characteristics could establish various demand levels for health care services under different projection assumptions. More innovative demographic analysis might involve the utilization of life table techniques to quantify the number of person years lost in a population due to deaths and illness from foodborne disease. These might provide a basis for estimating the total cost to a population from these causes.

The social-cultural level also suggests that comparative, cross-cultural research on foodborne disease is required. Current anthropological and economic knowledge shows significant differences between societies in food production, transportation, marketing, storage, preparation, and consumption. However, much additional international research is needed if

ethnocentric conclusions about foodborne illness are to be avoided. In the long-run, interdisciplinary longitudinal research in a variety of cultural systems is the only approach which will provide complete theoretical understanding of the processes of this disease.

The second major analytical step involves the ecosystem model of disease. The majority of the current literature may be placed within this framework. Examples include studies on the etiologic agent and its environment, studies of individual factors (genetic and social) related to illness, and studies of the physical environmental factors related to illness. The social environment within which sickness occurs is given refinement with the stages of illness model. Since the presence of symptoms cannot explain the actions people take, additional research is needed on how different persons respond to symptoms of foodborne illness, i.e. the elderly, children, AIDS victims, and persons with other health conditions. Primary data collection is the most appropriate methodology for this purpose. Closely related are studies of the types of persons who assume the sick role in response to symptoms of foodborne illness. More research is needed at this stage as well as the following stages of medical contact, dependent-patient, and final recovery. Of particular relevance would be multi-disciplinary studies of different cultural systems' response to foodborne illness.

The final category of economic consequences of foodborne illness and death includes a rapidly growing body of literature by economists on a wide range of subjects from studies of food production to studies of willingness-to-pay for food protection. While research with this theme should be encouraged, special attention should be given to the feedback economic consequences have on the larger social-cultural system. Are the costs of foodborne illness, in terms of lost wages and lower productivity, distributed equally throughout a population? Again, multi-disciplinary research in a variety of cultural systems will provide the most rewarding framework for the analysis of foodborne disease.

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PRIVATE STRATEGIES, PUBLIC POLICIES & FOOD SYSTEM PERFORMANCE

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