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Modeling the Recall and Warning Process in the Foodborne Contamination Event: Perspectives from Disaster Warnings and Crisis Communication

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Contaminated food and food contamination events occur frequently and constitute a major threat to the public. A food warning/recall is the primary method used by organizations to reduce the public's exposure when an unacceptable risk has been identified. This analysis examines the risk communication processes associated with the food warning/recall. We draw on the work of Teratanavat, Hooker and Salin (2002) and Teratanavat and Hooker (2004) regarding the dynamics of food recalls; Seeger, Sellnow, and Ulmer (2003) and Reynolds and Seeger (2005) regarding crisis communication; and Lindell and Perry (1992), Mileti and Sorensen (1990), and Mileti and Peek (2000) regarding public warning models to develop a four stage model of the communication processes associated with the food recall.

Recalls of a defective or dangerous product constitute the primary method used by organizations and government agencies to reduce the public's exposure when an unacceptable risk has been identified (Curatolo 2005). The decision to initiate a recall, a relatively dramatic action, occurs only when the potential for harm outweighs the projected, calculated costs of the recall, a sum of compromised reputation, lost product, and disruption in distribution channels. Although calculating the number of recalls in a year is difficult and not routinely done, Gibson (1997) determined that in 1997, there were 2,447 recalls in the United States (US). This amounts to about seven a day or fifty a week. Recalls included children's products, motor vehicles, appliances and tools, office furniture and tools, sports and recreational equipment, and perishable items, including food.

The recall serves as a warning and is fundamentally a form of risk communication (Salin et al. 2005). A recall includes risk identification, assessment, and management and involves coordinated communication and decision making among government agencies and industry producers and/or distributors. A recall informs different population segments ("the publics") that a particular product or commodity is mislabeled,

inoperative, and unsafe or has some other problem and advises the publics to take a particular action (Seeger, Sellnow, and Ulmer 2003).

In general, recalls occur when products are seen as creating risk of serious harm. Food products are recalled if they have a reasonable probability that the consumption of, or exposure to, them will cause serious adverse health consequences or death. To identify such risks, industry producers and processors conduct ongoing risk assessments, while several federal regulatory agencies—including the Food and Drug Administration (FDA), National Highway Traffic Safety Administration, the Consumer Product Safety Commission, US Department of Agriculture (USDA), and the Centers for Disease Control (CDC)—conduct surveillance to identify products associated with an unacceptable risk and, subsequently, recommend and/or initiate recalls (Gibson 1997).

Food recalls are actions, "taken voluntarily by food manufacturers or distributors after they determine independently or are informed by a government agency of the possibility of negative health concerns by consumers from eating their products" (Teratanavat and Hooker 2004:359). Teratanavat and Hooker (2004) describe food recalls as a form of joint risk communication and risk management. Food recalls are generally recommended by food regulatory agencies, such as the FDA and the USDA's Food Inspection and Safety Service, when they alert a food producer or distributor that a serious risk has been identified. In most cases, the government does not have the direct authority to order a recall.

This analysis examines the risk communication processes associated with the food recall. We draw on the work of Teratanavat, Hooker and Salin (2002) and Teratanavat and Hooker (2004) regarding the dynamics of food recalls; Seeger et al. (2003) and Reynolds and Seeger (2005) regarding crisis communication; and Lindell and Perry (1992), Mileti and Sorensen (1990), and Mileti and Peek (2000) regarding public warning models to develop a model of the communication processes supported by the crisis communication and disaster research and specific to the food recall. Our purpose here is to develop a conceptual framework for food recalls as a form of risk communication and ground this model in the literature on crisis communication and disaster warnings. The food recall process is a complex and tightly coupled system involving multiple agents and interdependent processes. We provide a brief case study to illustrate the model and the system it represents. This framework may guide research and better position both public and private entities in shaping and coordinating the warning/recall during a food event. Moreover, this model suggests points of intervention for improving the recall and warning system.

History of Food Recalls

The FDA and USDA seek to promote and protect the public health by assuring that the products they regulate are safe and accurately labeled. The FDA administers and enforces a number of food-related laws, primarily the Federal Food, Drug, and Cosmetic

Act. The FDA safeguards almost 80% of the nation's food supply, which includes everything but most meat, poultry, certain egg products, and foods containing 2% or more cooked, or 3% or more raw, USDA-regulated meat or poultry. The USDA regulates meat, poultry, and processed eggs (Curatolo 2005; USDA 1998).

Arguably, the first recall occurred in 1937 when 107 people across 15 states died due to a toxic medicine called Elixir Sulfanilamide. The S. E. Massengill Company of Bristol, Tennessee manufactured 240 gallons of the medicine, without any product testing, and distributed over 1500 bottles to pharmacies, salesmen, and doctors. After reports of painful suffering and miserable deaths after consumption of the elixir, the American Medical Association ordered simple animal testing of the product that proved the elixir to be poison. In response, the FDA sent its investigators and chemists throughout the country to retrieve the elixir. Approximately six months later, Congress enacted the Federal Food, Drug, and Cosmetic Act in which the FDA is required to certify the safety of new drugs (Curatolo 2005).

The first two formal food recalls occurred in 1966 and 1971. In 1966, samples of Borden Starlac, a leading brand of powdered milk, were found to contain salmonella. Although no illnesses had been attributed to Starlac, FDA recommended a recall as a precaution. After discussions with Borden, the company initiated a product recall (Borden recalls 1966). In 1971, the FDA released a public warning after learning that a New York man had died and his wife had become seriously ill from botulism after eating a can of Bon Vivant vichyssoise soup. The manufacturer, the Bon Vivant Company of Newark, New Jersey, commenced a recall of the 6,444 cans of vichyssoise soup made in the same batch as the can known to be contaminated. The event destroyed public confidence in the company's products and the Bon Vivant name. Bon Vivant filed for bankruptcy within a month of the announcement of the recall (Gellhorn 1973).

In general, the FDA has no direct or legislative authority to order a company to recall a product; it is the company who voluntarily initiates the recall. The FDA can, however, impound a product through court action and it is this authority that leverages government recommendations regarding recalls. Indeed, the FDA and the USDA play a significant role in a recall, by recommending recalls and providing warnings, guidance, monitoring, and direct assistance to the recalling company (Curatolo 2005).

Food Recalls as/and Public Warnings

In the US, unsafe foods cause an estimated 76 million illnesses and 5,000 deaths each year (Mead et al. 1999). The number of food recalls differs from year to year, yet is considerable. For example, during 2000-2003 a total of 713 recalls were initiated (Salin et al. 2005). During every food recall, an organization and federal agency confront an organizational crisis as they alert and inform the public of a foodborne contamination event. Responsibility for safe food and food regulatory authority are split among a dozen

federal agencies and 35 different statutes depending on the nature of the commodity (DeWaal, Johnson, and Bhuiya 2006).

This makes any systematic analysis of the entire food system difficult. However, investigations to assess the recall process and its effectiveness of reducing exposure and risk have been undertaken on specific commodity groups using federal data. Teratanavat et al. (2002), for example, examined meat and poultry data from Food Safety Inspection Service (FSIS) over the period of 1994-2000. They concluded that the "average amount of recalled product recovered was 50.3 percent while it took an average of 172 days to complete a recall case" (p. 8). One of the primary variables in the effectiveness of recalls was early recognition.

Recalls typically have both producer/distributor and consumer components. Recalls that remove unsafe product primarily at the distribution level, where records are available about distribution and where the product has not yet been widely purchased by consumers, rely on active (direct) notification. The producers directly communicate with distributors. These so called "stock recoveries" do not extend beyond the distributors and are generally much more effective than general consumer recalls. The communication process associated with recalls at the consumer level is generally much more passive (mediated and indirect) and carried out by commercial media outlets or through notices posted at consumer outlets. In some very rare cases, data exists that allows recalled food to be directly traced to the level of the individual consumer, which could make direct communication with exposed consumers theoretically possible.

A public warning system consists of three subsystems: a detection subsystem, a management subsystem, and a public response subsystem (Mileti and Peek 2000; Sorensen 2000). The detection subsystem consists of the processes involved in identifying a hazard and the potential for severe harm. The management subsystem refers to the decision making processes involved in weighing the risks and determining protective warnings and actions. Risk communication in the detection and management subsystems typically takes place among officials, often with little direct inclusion of the public. Risk communication in the public response subsystem includes warning the public and the resultant perceptions, processing of messages, and actions. Some of the theories that could be employed to understand the public response subsystem include Elaboration Likelihood Model, Fear Appeals, Health Belief Model, Protection Motivation Theory, and Theory of Reasoned Action. Seldom studied in the literature on public warnings, yet also an area of risk communication, are the interactions and feedback loops among the three subsystems.

The processes of risk communication for both natural hazards, such as earthquakes, and technology-based risks, such as nuclear plant accidents, have been described by Mileti and Fitzpatrick (1992) and Mileti and Peek (2000). Much of extant research examines the social-psychological response by individuals during the period of hearing a warning until acting, or choosing not to act, as a consequence. As with all

communication, the process begins with message reception and moves through interpretation and response. Mileti and Sorensen (1990) describe a process of "hear-confirm-understand-decide-respond" as fundamental to risk communication in the public response component of public warnings. Lindell and Perry (1992) describe a similar process of "risk identification-risk assessment-risk reduction-protective response." Additionally, the research examines how public behaviors in response to warning messages covary with environmental factors, social attributes, psychological attributes and their interactions (Mileti and Sorensen 1990). Environmental factors include physical and social cues, physical proximity, and time. Social factors include demographic factors and network features. Psychological factors include pre-event information and experience.

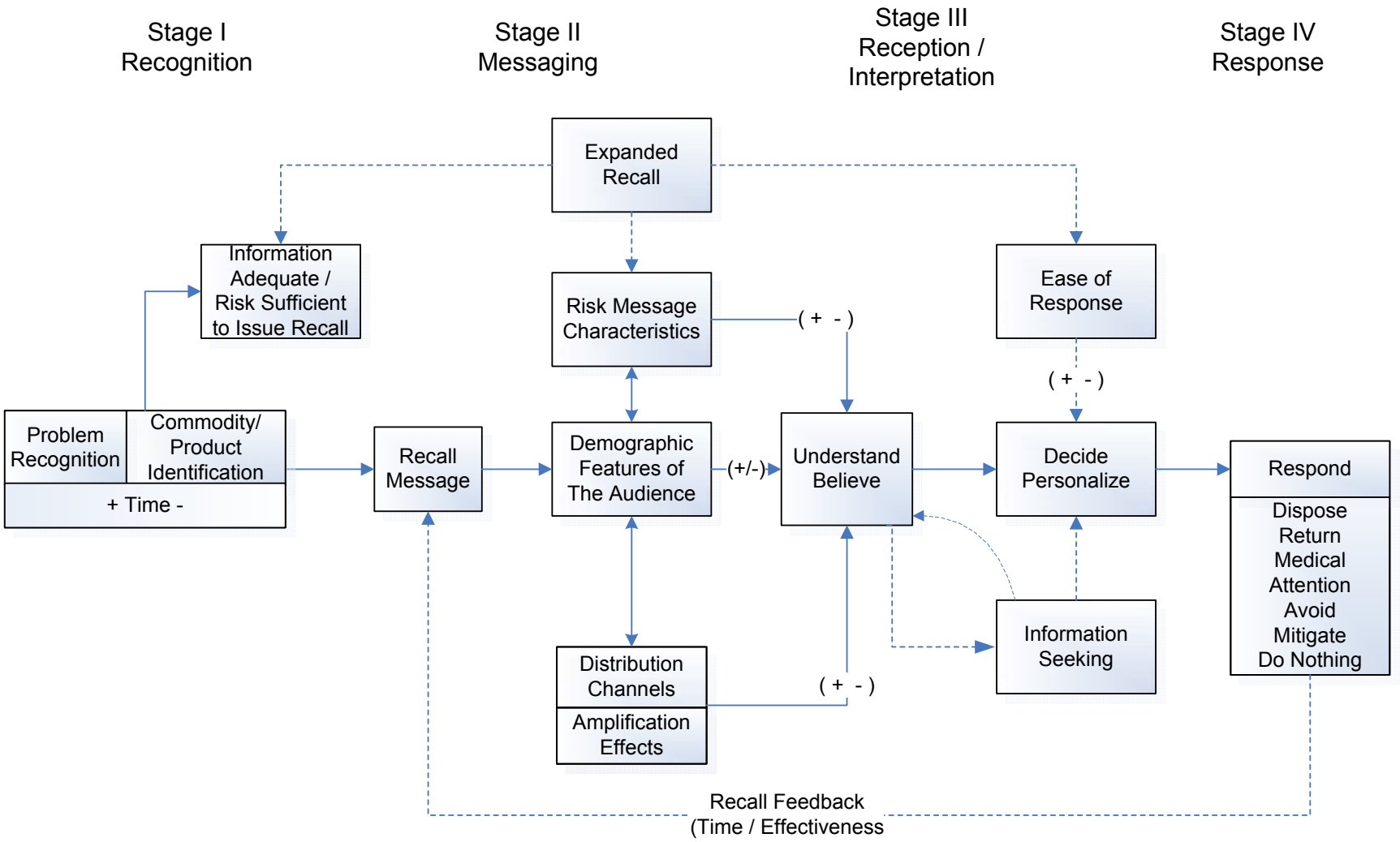
In fact the food recall process mimics a public warning system as described in the disaster literature. First, both private companies and public agencies conduct ongoing surveillance to detect a food event with crisis potential. Second, they manage information about the severity of harm and make decisions about using a food warning and/or recall. Finally, they develop and deliver messages to inform and influence the public.

An Integrated Model of the Food Recall

We describe the food recall using four stages or phases (see Figure 1). These stage models are well represented in disaster and crisis research as ways to characterize processes and distinguish key features (Lindell and Perry 1992; Mileti and Fitzpatrick 1992; Mileti and Peek 2000; Seeger et al. 2003). Stage I in this model is a recognition stage where cues accumulate regarding some harm. Cues may be generated in a number of ways, but this stage is primarily institutional or organizationally grounded. In order for a recall to be recommended and/or initiated, there must be a general recognition of harm or potential harm and there must be an identification of a commodity or product. This identification may be slower when medical authorities are confronted with novel contaminations that do not fit into expected patterns. Agencies and producers may also weigh the cost of the recall against the seriousness of the potential harm. Without specific identification of a product and expectation of a relatively serious harm, recalls generally do not happen. Time is a particularly critical variable in the recognition stage with more extended time limiting recall effectiveness (Teratanavat et al. 2002).

Stage II is a messaging stage where recall notices are distributed by regulatory agencies, produces and distributors. For stock recoveries, food producers directly communicate with and send notices to distributors, warehouses, retail outlets, and in some cases other food distributors. More often, food producers attempt to announce recalls to consumers by posting press releases on company and governmental web sites. Gibson (1997) also describes the use of direct mail, display ads, and point-of-sales messages when consumers are the intended message recipients. Since message character-

Seeger: Food Recall



istics interact with demographic elements of the audience (age, gender, and ethnic background) and channel distribution elements (width and speed of distribution), and, therefore, affect the reception and interpretation of a message, tailoring and targeting messages improves effectiveness.

Stage III involves reception and interpretation of the message by the intended audience. During this stage, the audience must "hear, confirm, and understand" the message. The process may involve collection of additional confirmatory information before the recall warning can be personalized and, thereby, lead to action. Consumers may need to hear the message from multiple sources, confirm the consistency of messages, assess if they own the product with the relevant lot numbers, and personalize the projected harm.

Stage IV is the response stage, when the intended audience takes some action as a response to the recall message. These actions vary depending on the nature of the event, the interpretation of the message, and the recommendations. Possible actions include disposing or returning the unsafe product, seeking medical attention, or simply avoiding the unsafe item. One important factor for consumer compliance may be the ease of the recommended action. Some consumers may find it easy to dispose of the product, while others may see disposal as a significant economic burden. For example, some families may readily purchase alternative foods, while others may go without, unable to bear the burden of returning to the retailer or substituting a safer product.

Throughout the model are various feedback loops representing information seeking, expanded recalls, and evaluation about the effectiveness of the recall. These loops as well as the specific elements and dynamics of the recall process are described below.

Stage I: Recognition

Problem Recognition

Problem recognition consists of a chain of events that occurs in order for one or more episodes of harm/illness/death to register within a quality assurance or public health surveillance system. For potential hazards in food processing plants, for example, the Hazard Analysis and Critical Control Points (HACCP) system is a structural approach for analyzing the potential hazards in an operation by identifying the points in the operation where hazards might occur and deciding which points must be controlled to ensure consumer safety. These critical points are then regularly monitored and remedial action, specified in advance, is taken if conditions at these points are not within safe limits (Bremer and Johnston 1996; FDA 2006; Pennington 2000). For a foodborne illness, the chain of events flows from exposure to the food, illness, visit to health care provider, specimen collection, lab tests and laboratory confirmation, and report of findings to the health department or the CDC for inclusion as data in federal surveillance systems

(Centers for Disease Control and Prevention [CDC] 2006). Upon identifying patterns in surveillance data, a governmental agency may suspect and investigate a possible foodborne illness outbreak.

Signal to noise ratio. Whether in product monitoring or public health surveillance, the identification of risk signals is challenging. For example, although technological advances in measurement have improved the detection of pathogens and contaminated product, issues of measurement error and pathogen uncertainty remain (Barnes, 1994; Renn, 2003). Similarly, public health surveillance systems struggle with ambiguity and risk diffusion. For example, an outbreak of foodborne disease that occurs among 250 people within a one-block radius is easily detected; however if the same number of people fell ill across the United States, only a highly sophisticated surveillance system could discern the risk signal of such an outbreak from the background noise of unrelated, sporadic cases of foodborne illness (Institute of Medicine [IOM] 2006).

Additionally, signals occur within complex environments in which multiple signals and noise simultaneously exist in complex mixtures of noise (IOM 2006). Factors including other issues in the organization, such as mindfulness and vigilance, structural channels, and past experiences may drown out or obscure the signal and its link in any pattern or sequence of events. In summary, risk signals may or may not lead to observed patterns of risk or harm although present

Mindfulness and vigilance. Mindfulness refers to cognitive qualities of the individual. The qualities include (a) openness to novelty, (b) alertness to distinction, (c) sensitivity to different contexts, (d) implicit, if not explicit, awareness of multiple perspectives, and (e) orientation in the present (Langer 1989a, 1989b; Langer and Moldoveanu 2000). Weick and Sutcliffe (2001) extended Langer's (1989a, 1997) concepts of mindfulness to the organizational level. They contend that organizational mindfulness results from five coexisting processes: (a) preoccupation with failures rather than successes, (b) reluctance to simplify interpretations, (c) sensitivity to operations, (d) commitment to resilience, and (e) deference to expertise (Carroll 1998; Sitkin 1996; Weick and Roberts 1993; Weick and Sutcliffe 2001). Organizations with a collective mindfulness catch the unexpected risk earlier, when it has less influence on normal operations; understand its potential importance, despite the small size of the disruption; and remove, limit, or rebound from the effects (Carroll 1998; Novak and Sellnow in press; Weick and Sutcliffe 2001).

Structural systems. Risks frequently originate or manifest themselves within organizations (Seeger et al. 2003). In the past, the majority of threats and outbreaks have been caused by unintentional mishaps somewhere along the food chain. Some risks "evolve to crisis events due to system problems in addition to individual behavioral actions or inactions" (Pidgeon et al. 1992:97). To better ensure health and safety, organizations create and implement risk management systems such as HACCP, and

thereafter expect employees to consistently comply with the more stringent operating procedures (Bremer and Johnston 1996; Reason 1998, 2000).

At the same time, compliance with these systems and norms for work behaviors usually requires only minimal processing of information relevant to tasks (Langer 1989b). Therefore, the system tends to engender an increase in mindlessness not mindfulness. Moreover, the repetition of over-learned and task-simple behaviors involved in much food processing also could lead to mindlessness (Ashforth and Fried 1988; Langer 1989a). When performing mindlessly, workers cease to sense new information about risks and thinking or behaving in a novel way rarely occurs (Langer and Piper 1987).

Seeger et al. (2003) suggested that risk communication "in the early stages is most closely associated with crisis sensing and threat assessment" (p. 202). Researchers (Mitroff and Anagnos 2001; Weick 1995; Weick and Sutcliffe 2001) purport communication among employees as key to the identification of risks and the prevention of negative outcomes. Employees active in identifying and acting on risk-related information through structural systems and mindfulness developed during pre-crisis stages are more likely to avert potential crises or to mitigate ongoing crises (Seeger et al. 2003).

CDC FoodNet system. To bolster federal regulatory activities, ongoing public health surveillance, and organizations' systems, the CDC, USDA, and FDA collaboratively developed the CDC FoodNet system. The system produces national estimates of the burden, trends, and sources of specific foodborne diseases in the US through active surveillance of 14% of the national population (CDC 2006). FoodNet personnel ascertain all laboratory-confirmed cases of foodborne illness in the catchment area and obtain information on demographics, clinical outcomes, and implicated pathogens. While the system is designed to create early recognition of a potential problem, the data are collected from only a limited number of states and do not clearly identify the specific food product (CDC 2006).

CDC PulseNet. The CDC (2009) coordinates a national network of public health and food regulatory agency laboratories which perform standardized molecular subtyping (or "fingerprinting") of foodborne disease-causing bacteria. The electronic database of contaminant fingerprints allows for rapid comparison of case clusters, early identification of common source outbreaks, and real-time communication among state, local health departments, and international partners. Improving the effectiveness of risk recognition enhances the effectiveness of subsequent processes.

Commodity/Product Recognition

Highly complex food systems and extended interdependent supply chains often make the identification of a specific contaminant very difficult to pinpoint and trace. Some food

products, for example, may be a composite of dozens of foods, food ingredients, food preservatives, food stabilizers, and chemicals (IOM 2006). In fact, the majority of US foodborne illness outbreaks involve food products with multiple ingredients (DeWaal et al. 2006). The globalization of the food industry means that the individual food components of any food product may originate from disparate parts of the world (IOM 2006). Several recent food recalls, for example, have involved food produced in Mexico, Complicating the identification of the specific contaminant even more is the great variability of record keeping and quality control standards in different countries throughout the world.

Warnings systems. Similar to product identification, the identification of the specific contaminant depends upon monitoring systems and laboratories, both governmental and private industrial (IOM 2006). Without a specifically identified contaminant and product, the costs of vague warnings and unacceptably widespread economic disruption might outweigh the projected benefits of a recall (Lindell et al. 2007). The problem of effective public health surveillance remains challenging even with important innovations, such as HACCP (Bremer and Johnston 1996; IOM 2006; Reason 1998, 2000) and the CDC's FoodNet (CDC 2006), for food safety.

Time

Timing is critical for an effective recall and differs by food product (Salin et al. 2003). The time spent in the distribution chain, the time spent on retail and consumer shelves, and the incubation time between exposure and illness all impact the ability to recover or eliminate hazardous foods and prevent harm (FSIS 1997). The further along the food chain, the more dispersed the product geographically and throughout organizations. With greater dispersion, a recall would involve a wider net of notifications and heavier reliance on passive notifications of consumers rather than active notifications of distributors Perishable food products have notably short shelf lives and the time span before product consumption is short in comparison to preserved foods. Often fresh fruits and vegetables may be at the final destination or even consumed by the time the link between a foodborne illness, pathogen, and product identification is made. Additionally, hazards differ in their incubation periods, the time between exposure and illnesses. For some pathogens, interventions of vaccinations and antibiotics post-exposure may reduce the severity of illness. The ability to determine a food product's point of time in the food supply and the point of time since exposure influences the type of recall and actions/interventions (Salin et al. 2003).

Information Adequate to Initiate Recall

The decision to recommend a recall rests with governmental regulatory and surveillance agencies along with food industry organizations (FDA 2006; USDA 2004). Both governmental agencies and food organizations calculate the benefits of a recall–-the reduction in risk and harm However, in the U.S., the final decision to implement a recall lies almost exclusively with food industry organizations (Curatolo 2005). In addition to calculating the benefits and the ethics of recalls, food organizations calculate costs such as damages associated with competence and reputation (Lindell et al. 2007; Seeger et al. 2003). The factor of time may influence the type of recall, the messages and the logistics of the recall and, thus, the effectiveness of the recall.

Although food warnings/recalls fundamentally function as risk communication for the publics, the implicated food organization(s) and the responsible regulatory agency are engaging in both risk and organizational crisis communication (Seeger et al. 2003). Advising and communicating with the public about a food contamination event calls into question the implicit trust granted to the particular company and regulatory agency to maintain the integrity and safety of the food supply. Poor and delayed risk communication during food contamination events threatens the credibility, and potentially the viability, of the organization/agency in addition to increasing the risk of morbidity and mortality.

When federal agencies and food organizations decide the risk outweighs the anticipated costs in what appears to be an evolving food contamination event, they initiate warnings/recalls. Affecting this decision making process, as described in crisis communication research (Coombs 1999; Covello 2003; Heath and O'Hair 2009; Seeger 2006; Seeger et al. 2003; Sellnow et al. 2009) is organizational preparedness, which includes strategic planning and proactive strategies operationally functioning. Seeger (2006) identifies six best practices, based on empirically grounded research, for organizations experiencing crisis: plan pre-event logistics, coordinate networks, accept uncertainty, form partnerships, listen to public concern, and be open and honest. During 2001 the anthrax event, the CDC experienced harsh critique about their poor response, which was largely a consequence of applying risk communication principles instead of an integration of risk and crisis communication principles to their response and messages (Reynolds and Seeger 2003). The ineffective response of the CDC was also grounded in a general lack of preparedness.

Stage II: Messaging

Mileti and Sorenson (1990) contend that human decision making about warnings resembles, for the most part, a sequential decision process. The process begins with hearing an initial warning. Empirical findings about *hearing* the warning reveal that an

individual's perception of a message, and specifically a warning, results from sender, message, channel, and receiver characteristics combined with cultural, environmental, and social contexts. Once the decision is made to initiate a recall, the organization takes the lead in creating the message to serve as a warning.

Recall Message

At the time as the problem/product recognition occurs and the decision to recall is made, those composing the recall message must consider the dispersal of the product in the food chain and the critical points at which intervention can occur for product removal. If the product has been distributed to consumers, for example, different message strategies will be required.

Message forms. The most common form of the recall message is the press release, typically posted on an agency web site. The release can be used as the text for the broadcast message on television or radio as well as a message that is faxed, emailed, or posted. The assumption of the recall system as currently constituted is that the messages will be picked up by media outlets and distributed widely as news. In some cases, postings and flyers may be displayed or distributed at point of sale.

Passive systems. Unless little dispersion of the food product has occurred, recall notifications need to reach many organizations at the processing, wholesaling, and retailing levels as well as individual consumers. Such notifications rely on multiple channels to maximize message availability, access, and redundancy. There is, however, currently little capacity to confirm that any one organization or any one individual actually saw/heard/acknowledged the message.

Risk Message Characteristics

Crisis and risk communication researchers have described best practices that may provide guidance for the development of warning and recall messages (Seeger 2006). Planning and the establishment of networks of coordination prior to a crisis event provide the optimal backdrop for developing and implementing messages that will meet the requisite demands of *urgency*, *credibility*, and *redundancy*. Acting as quickly as possible is always important given time's determinate role in recall effectiveness. Credibility and redundancy directly influence consumers' perception, interpretation, and responses to calls for action (Drabek 1986; Perry and Lindell 1989). Additionally, the spokesperson(s) and the organization(s) will need to demonstrate concern for and dialogue with the public, acknowledge the uncertainty, be open about the ongoing assessment and management of the risk, be available, commit to provide ongoing information, and provide clear suggestions about actions for the public to take.

Demographic Features of the Audience

A significant body of research has described the components of successful warning messages within the context of a natural disaster or terrorist event and how different audiences respond to those messages (Lindell and Hwang 2008; Lindell and Perry 2000; Mileti and Fitzpatrick 1992). These characteristics of the people who receive risk information can impact how they process the information. The characteristics include psychological characteristics, social attributes, past experiences, and environmental contexts (Mileti and Fitzpatrick 1992; Spence et al. 2006). By drawing on this information, messages can developed for multiple target audiences and distributed through media channels preferentially used by the respective audiences.

Gender. Gender differences appear consistently in the literature. Women are more likely than men to receive communications about risk and to perceive warnings as serious. Similarly, women are more likely to take protective actions. Any recall directed to consumers would increase its effectiveness by specifically targeting women, which includes passive notifications in media outlets especially accessed by women (Lindell and Perry 2000; Riad, Waugh, and Norris 2001; Spence et al. 2006). This effect may be even stronger when food is involved.

Age. Like gender, age appears to consistently influence the perception, understanding, and response to warning messages. Younger individuals and those of higher socio-economic status are more likely to attend to risk messages. The lesser influence of past experiences, where warnings may not have coincided with actual harm, and of the ability to enact the responses, since financial resources may not be a limiting factor, may attenuate or amplify the influence of age (Riad et al. 2001).

Ethnicity. The literature currently shows no consistent patterns regarding reactions to warning messages by ethnicity. Clearly, language and cultural barriers are often important to the reception of risk messages (Lindell and Perry, 2004; Mileti and Sorenson 1990; Schmidlin 2006). Spokesperson credibility, which includes dimensions of established trust, impacts the interpretation of the warnings. Also, beliefs about loci of control frequently affect response intentions and actual responses.

Distribution Channels

Distribution channels refer to the actual medium(s) used to transmit a warning or recall message. Only in instances of very early problem/product recognition and stock inventory recalls do active and direct channels, such as targeted telephone calls, faxes, or e-mails, exclusively comprise the distribution channels. More often, recalls include many channels of passive communication following the hypodermic model of communication and employing commercial media outlets.

Multiple channels. The multiple channels of passive communication include broadcast television, major networks and cable stations; radio stations of all frequencies; print journalism; Internet websites, ranging from organizational home pages to governmental consumer pages; newsletters; and postings in retail establishments. Typically, consumers report that broadcast media are the primary sources of warning reception. The specific outlet, however, varies widely by demographic variables. Notwithstanding, the more that different channels are used to disseminate warning messages, the more likely people are to receive and remember warning messages (Fishman and Casarett 2006; Guion, Scammon, and Borders 2007; Lindell and Perry 2000; Mileti and Fitzpatrick 1992; Mileti and Darlington 1995, 1997).

Media use patterns. The use of different types of media during an event tends to change over time. Television and radio appear more effective initially, whereas newspapers become increasing important in the case of long-term warnings. Most recalls take place during a short period of time, especially those associated with food products. Television is more of an immediate form of media and typically reports news in short increments. Newspapers are more likely to conduct in-depth reporting with a broader message than the recall details (Guion et al. 2007).

Width of diffusion and speed. The target audience consists of anyone recommended to take action. As time lapses between incident occurrence and problem recognition, the probability of serious harm increases. Therefore maximal diffusion and speed are pivotal. Evidence suggests that media messages tend to follow a logistic (s-shaped) pattern of dissemination (Greenberg 2002). Nevertheless, little is known about the speed at which information is disseminated and received (Lindell, Prater, and Peacock 2007).

Amplification Effects: Media Agenda, Timing, Public Perception

Messages may be amplified or attenuated pending the media agenda. The media agenda tends to set the public agenda; therefore the more prominence given a story, the more likely the public will hear the message and talk about it. Moreover, the media adds their frame and interpretation, which may heighten or dampen concern (Lindell et al. 2007). The presence of multiple food contamination events and cases of harm may serve to amplify a recall message, whereas the reverse may dilute it. Even more broadly, the presence or absence of other events unrelated to the food event will affect the competition for broadcast time.

Additionally, public perceptions of risk may amplify or attenuate risk messages. Public perceptions of risk frequently diverge from expert understandings of risk based solely on hazard calculations (Covello and Sandman 2001; Pigeon, Kasperson, and Slovic 2003). In practice, public perceptions of risk weakly correlate with experts' hazard calculations. Small hazards are as likely to trigger public concern and uproar as large hazards. The "risks that kill people" and the risks that alarm them are often

completely different (Sandman 2000: 3). An assessment of risk, both the presence of risk and its potential impact, for any individual is more complex than what technical experts have traditionally considered as risk.

Expanded/Reduced Recall

Upon initiating a recall, it is necessary to assess response effectiveness in relation to the amount of time available for prevention and mitigation action. Concurrently, ongoing surveillance may broaden or narrow forecasts about a foodborne problem, especially as increased information about the specificity of contaminated product/s becomes available. The message combined with utilized channels of distribution may be adjusted. The ongoing loop of feedback and new information make it possible to expand or narrow the scope of the recall as needed.

Stage III: Reception and Interpretation

After receiving the warning, individuals interpret the recall message (Lindell and Perry 1992; Mileti and Sorenson 1990). This involves a complex interplay of pre-existing beliefs and experiences, understanding, information seeking and confirming, assessing the ease of response, and personalizing the message in order to decide about response intentions.

Understanding and Believing

Once heard, the warning must be understood. This does not refer to correct interpretation of what is heard, but rather to the personal attachment of meaning to the message. Audiences vary widely in the interpretation of messages, particularly warning messages, based on a variety of message characteristics, as well as personal, psychological, normative, and even physical factors.

Simplicity of event/message. In general, simple messages that require limited audience recall of information are more effective. If a recall message includes complex information regarding product features, such as multiple brands, lot numbers, expiration dates, and distribution locations, the message is likely to be less effective. Similarly, confusing information about symptoms or about disposal recommendations may also reduce the effectiveness of messages.

Experience with previous events. Personal experience significantly impacts understanding and believing (Lindell and Perry 2000). Individuals usually think of warnings in personal terms – that is in terms of the implications of the risk for themselves and their families or community group. When thinking about a foodborne illness, individuals may remember a day of mild stomach upset or conjure up the experience of

an extended family member with resultant chronic health problems. These experiences are likely to impact the way in which a recall message is interpreted. Often those with previous experience underestimate the likelihood of a crisis, yet they are more likely to take recommended actions once they recognize a crisis (Drabek 1986; Schmidlin 2006).

Normative and physical factors. In addition, personal and physical factors may influence response to food recall messages. For example, income, education, and ethnicity influence risk perceptions and behaviors. (Drabek, 1986; Lindell and Perry 2000; Tierney 1999). There is evidence to suggest that income level impacts choices about crisis planning and response. It is likely that some people may view the disposal of a contaminated food item as a significant loss and may choose to accept the risk. In addition general social norms about appropriate behaviors may influence how individuals respond to food warning messages. For example, they may cook ground meat to a higher than normal temperature, assuming (based on the common belief and practice) that high temperatures kill all pathogens.

Ease of Response

A significant body of research has suggested that it is important to convey a sense of self efficacy in the warning and risk communication process. People must believe that they are capable of taking the recommended action and that the action is meaningful in some way. In addition, some research suggests that a range of actions best accommodates the distribution of risk tolerance in the public. In general, recall actions may involve disposal or return of the item. Disposal may include additional recommendations depending on the nature of the contaminant.

Confirmation/Information Seeking

During warning periods, people do not passively await the arrival of more information. Instead, most people actively seek additional information. They seek information to confirm prior information as contained in the message (Guion et al. 2007; Mileti and Fitzpatrick 1992). Often, consumers check and reconfirm an initial warning message that was heard on a television news broadcast. This may be done by watching for subsequent messages or from an active data collection process, such as an agency of company web site or a telephone hotline.

Deciding and Personalizing

Before taking a recommended protective action, people determine if the recall message is relevant to their experience (Guion et al. 2007). As an initial step in deciding and personalizing, the consumer is likely to assess if he or she owns the food in question.

Similarly, the consumer will assess whether she/he, another family member, or friend has been exposed to or eaten the contaminated food product. Consumers are motivated to act in their perceived best interests, a decision based on understanding, confirming, determining self-efficacy, and personalizing the message (Lindell et al. 2007).

Stage IV: Respond

This stage corresponds to taking action. The individual has heard the message, has interpreted and formed an understanding of the message, and decided if and how to respond. Upon the personalization of the message, the individual determines the appropriate action, which may or may not be the recommended action. In general, individuals take action according to what they believe is in their best interest (Mileti and Sorenson 1990).

Options: Return, Dispose, Seek Medical Attention, Mitigate, Avoid, Do Nothing

Response options vary according to the specific characteristics of the problem and product. Directions about the recommended options should be simple, clear, concise, and attentive to the possible barriers that consumers could encounter when carrying out the recommendations. Typically, organizations accept product returns in order to eliminate hazardous products and reimburse consumers for the costs of their purchases. When returning the product to the producer is impractical, consumers may be encouraged to use the product only under certain circumstances or, as the safest option, to simply dispose of the product.

For those potentially exposed to the hazard, warning messages usually encourage consumers to seek medical attention regardless of the presence of illness symptoms. Other response options may be directed towards avoiding the hazard or mitigating the consequences of the hazard. As previously indicated, consumers personalize the message and make the decision to respond or to do nothing.

Recall Effectiveness/Feedback

A final step in the process is a feedback loop assessing the effectiveness of the recall process. Feedback consists of monitoring the return of contaminated product and tracking the prevalence and severity of public harm. Notably, the amount of returned product provides only limited information about risk reduction because many consumers may simply dispose of the product. Additionally, some consumers return product beyond the scope of the recall in an effort to be overcautious. This feedback, in addition to new information about the problem and the identified product, provides information that can be used in decisions regarding recall expansion, reduction, and/or message modification.

Case Study Illustration

The 2008 salmonellosis outbreak provides a case study that illustrates various aspects of the food recall model. The outbreak began in mid-April and, on June 7, the CDC confirmed that 145 people in 16 states had fallen ill with 23 persons hospitalized and one dead (FDA 2008a). Eighty-five percent of those ill were infected with a rare strain of Salmonella serotype Saintpaul and reported eating fresh tomatoes (CDC 2008). Based on food history interviews, federal officials had traced the infection to three suspected types of raw tomatoes: red plum, red Roma, and round red (CDC 2008). Although the problem had been identified and a source suspected, the FDA had yet to find contaminated vegetables or confirm the source of contamination (FDA 2008a). The FDA, however, issued a national warning about the salmonella outbreak and the suspected link to consumption of certain types of raw tomatoes. The warning specifically excluded tomatoes that came from trusted sources and all types of tomatoes other than those that had been identified as suspect.

From June to mid-July, tomatoes remained the major suspect of the salmonella contamination although this had not been confirmed. Criticism mounted as time elapsed, the source remained unconfirmed, and the outbreak continued. Then, on July 17, the FDA cleared all tomatoes and issued a warning on raw jalapeno and raw Serrano peppers (FDA 2008b). According to the CDC, 1,220 persons infected with *Salmonella* Saintpaul (and the same genetic fingerprint) had been identified in 42 states, the District of Columbia and Canada (FDA 2008b). On July 21, Agricola Zaragoza, Inc. recalled jalapeno peppers distributed since June 30 based on sampling results done by the FDA and CDC, which revealed a match of *Salmonella* Saintpaul strains in the peppers and the outbreak (Agricola Zaragoza 2008). Simultaneously, the FDA warned consumers to avoid eating fresh jalapeno peppers, and foods made with them, including fresh salsa (FDA 2008c). Only on July 30 did the FDA confirm the source and revise its warning to cover raw jalapeno and Serrano peppers grown in Mexico (FDA 2008d).

The *Food Recall Model* allows us to assess the warning/recall process and highlight some of the consequences in the 2008 *Salmonella* outbreak. First as indicated in Stage I, the more rapid the recognition of the problem, the quicker and the more effective the recall. Unfortunately, recognition of the problem typically occurs after significant morbidity/mortality. The CDC, in coordination with public health departments, identifies possible outbreaks after establishing patterns of illness and confirmation of a shared source. The process includes trace back investigations and lab tests (CDC 2008). In this outbreak, the CDC was unable to confirm the outbreak until two months had elapsed and 145 people in 16 states had fallen ill with 23 persons hospitalized and one dead (FDA 2008a).

Also indicated in Stage I, the specific identification of the contaminated product is necessary for an effective warning/recall. In the 2008 Salmonella outbreak, the FDA first

issued a warning in New Mexico and Texas about certain tomatoes. The warning evolved into an nationwide warning about certain tomatoes from certain geographic locations, followed by a lifting of the tomato warning, a nationwide warning about raw jalapeno and Serrano peppers, a recall of jalapeno peppers by Agricola Zaragoza, Inc., a message clearing domestic but not Mexican grown jalapeno and Serrano peppers. Finally, there was a warning, based on contamination confirmation, about raw jalapeno and Serrano peppers grown in Mexico. Warnings that are not specific and are amended back through the recognition process compromise the perceived credibility of regulatory agencies and the effectiveness of subsequent recalls. They can also be expected to contribute to "risk fatigue" and generally undermine the public trust in the food safety system. Both the FDA and the CDC suffered harsh media critiques for their failure to swiftly identify the specific nature of the outbreak.

As the Food Recall Recall model suggests, timing is a critical factor. Stage I illustrates the time sensitive nature of foodborne contamination events as an interplay of outbreak recognition, specific source identification, contaminated product distribution, and feedback about the effectiveness of the warning/recall. In the 2008 *Salmonella* outbreak, the perishable nature of the contaminated product complicated the confirmation of the contaminated product, which, in turn, impacted the specificity and consistency of the warning and the recommended actions for producers, distributors, and consumers. The more time delays in Stage I, the other stages, or in feedback-based adjustment, the greater the morbidity and mortality. According to media reports the outbreak ultimately sickened 1,443 people and caused at least 286 hospitalizations and possibly two deaths (CDC 2008). Additionally, the tomato industry suffered a loss estimated to be between $130 million and $250 million dollars.

Because recalls have the potential to undermine the public trust in specific products, food organizations, regulatory agencies, and the food supply in general, there is pressure to be as specific as possible in identifying the suspect agent. Without specific identification of a product and expectation of a relatively serious harm, recalls generally do not happen. Time is a particularly critical variable in the recognition stage; therefore, the more extended Stage I, the less effective the recall.

As described in Stage II, effective messaging depends on purposeful tailoring and targeting so that the messages directly influence the consumers' reception and understanding. The 2008 *Salmonella* outbreak demonstrates the decreasing effectiveness of a recall when there are cascading expansions and reductions of warning/recall messages. Consumers can become confused when messages appear to change. In this case, the messages began with warnings about tomatoes, and evolved to ones about an expansion to peppers, an elimination of the tomato warning, a warning about jalapenos and Serranos, a recall for jalapenos, a message clearing domestic jalapeno and Serrano peppers, and finally a warning about all jalapeno and Serrano peppers from Mexico. Some consumers can become overwhelmed by this information and, thus, withdraw from

consuming *any* products that might be considered at risk.

These cascading warnings and inconsistent messages impacted Stage III, reception and interpretation. Consumers often need to hear the message from multiple sources, confirm the consistency of messages, assess if they own that product and check lot numbers, and personalize the projected harm. When risk messages conflict and are inconsistent, the public has more difficulty interpreting and personalizing the messages. There is some evidence to suggest that rather than avoid only those types of tomatoes identified by the FDA as suspect, consumers simply avoided all fresh tomatoes.

Stage IV response, in this case, primarily consisted of avoidance. Additionally, some retailers voluntarily removed the suspected tomatoes from stores and restaurant offerings. Later messages included specific suggestions that older consumers and those with weakened immune systems be particularly vigilant in avoiding suspect products.

Intervention Implications

The assumption of the Food Recall Model is that by withdrawing the contaminated product, consumer exposure may be averted and harm will be limited. Thus, three important factors in the effectiveness of a recall and fundamentally controlled by the organization and federal agency are speed of response, breadth of message diffusion, and message content.

The model suggests that the more quickly a contaminated food item is identified, the more quickly it can be recalled, lowering the probability it has been distributed and consumed. Although there are many variables in the process such as shelf-life and product distribution, Teratanavat, Salin, and Hooker (2005), using Food Safety and Inspection Service data, calculate that for meat products every day delay results in more consumers being placed at risk. Their analysis also suggests that scope of distribution significantly interferes with timely recalls.

Stage II highlights the features of targeting and tailoring messages in the warning/recall process. Not all consumers use traditional mass media channels upon which recall messages have historically depended. This directly impacts the breadth of recall message diffusion. The Pew Center for the Press reports that, in 2004, only about 59% of Americans turn to local televisions news for their information. About 38% reported regularly watching network news and 34% watched cable news. Daily newspaper readership was at about at 42% and about 42% of Americans reported that they regularly listened to radio news. Moreover, the speed of diffusion for mass media messages is not instantaneous. Following the 2006 recall of fresh spinach, the Food Policy Institute (Cuite et al. 2007) conducted a random national survey of 1500 adults about one month after the recall had ended. Of those surveyed, 29% reported hearing a little or nothing about the spinach recall. These results support the conclusions that a

significant proportion of the adult population simply does not receive recall messages when they are distributed through traditional news channels.

The nature, form, and level of the message are also related to the effectiveness of a warning/recall. As a rule, the more a message is tailored to a specific population segment, the more effective it will be. Recall messages, however, tend to be directed to mass audiences, and disseminated through mass media outlets. Yet, at the same time, they try to be very specific in their recommendations so as to avoid impacting the image of companies and products that are not involved. This creates an inherent tension in the recall process.

Agencies have generally focused their recall messages on very specific products, down to the level of lot number and production date. This has created conditions in some instances where recalls have been delayed. In the recent case of recalls involving peanut products, for example, very long and complex lists of products, numbering into the thousands, were identified in recall messages. These messages also required a relatively high level of literacy. In practical terms these messages could not be interpreted by a significant proportion of consumers. In contrast, a recent recall of pistachios was more generally constructed so as to encourage consumers to avoid all pistachios.

The National Assessment of Adult Literacy 2003 survey found that 14% of adult America readers have no more than the most simple and concrete level of prose literacy. Another 29% of the population functions at the level of simple and everyday literacy. Taken together, these groups comprise around 93 million consumers, or roughly one third of the population (National Center for Education Statistics 2009).

Novak and Biskup (2009) conducted an investigation of the reading level of FDA and USDA food recall press releases. The releases from both agencies were quite complex and written at a higher grade level than that of nearly half the U.S. population, which has been found to read at a “basic” or “below basic” level (National Center for Education Statistics 2009). The authors concluded that a significant proportion of the general public would not be able to process these recall messages. For those groups who could not understand the recall messages, the recall was ineffective in averting exposure.

The 2006 investigation into the recall of fresh spinach described earlier (Cuite et al. 2007) provides further support to the conclusion that recall messages are not being understood and interpreted as intended. Of those surveyed, 29% reported hearing a little or nothing about the spinach recall. Moreover, of the remaining 71%, many could not accurately describe the details of the recall. This suggests that messages were not effective in creating understanding. For example, only 64% of the respondents who reported that they were aware of the spinach recall said that they had heard that “during the recall, no fresh spinach was considered safe to eat” (p. 12). For these consumers, the recall messages did function as an effective means of averting exposure but at the cost of avoiding safe spinach as well.

Stage IV of the recall model concerns consumer response. Ineffective recall timing,

narrow diffusion of the message, and poor message design can be expected to result in poor rates of consumer compliance with recommendations. If consumers do not receive the message, receive it too late, or cannot interpret the message, they cannot be expected to comply. Survey data from 2007 and 2009 indicate that that current recalls systems have limited effectiveness. In the Food Policy Institute study described earlier (Cuite et al. 2007),

> nearly one-third (30%) of those who eat spinach and were aware of the recall say that they had fresh spinach in their homes when they first learned about it. While more than three quarters (77%) reported ultimately discarding the spinach once they learned about the recall, more than one-quarter (27%) say they consumed some or all of the spinach they had at home and 72% of these say they knew about the recall at the time they ate it. (p. 12).

A more recent survey conducted by the Food Policy Institute (Hallman, Cuite, and Hooker 2009) concluded that only about 60% of the respondents reported ever having checked to see if they had recalled food in their home. The authors suggested that consumers did not personalize the recall message or believe that the recall related to them.

Data from these food surveys and from readability studies and media use studies suggest that recall effectiveness may be 60-70% effective. Additional factors including economic constraints, inability to verify the messages, or message complexity may further limit the effectiveness of recalls. While the specific reasons these consumers did not comply with the recall are not clear, it is evident that there is an opportunity for more effective messaging.

The limited effectiveness of the recall system in averting exposure due to speed of response, breadth of message diffusion, message content, and the resulting lack of consumer response represents an opportunity for improvement that can be quantified. It is important to recognize, however, that 100% compliance with a recall message is unrealistic. One investigation of hurricane warnings found that when officials were aggressive and used very effective risk communication, it only was possible to achieve about 90% evacuation of the residents of very vulnerable barrier islands (Baker 1991). Moreover, the three factors of speed of response, breadth of diffusion, and message content are likely highly intercorrelated.

Using data from the most recent Food Policy Institute survey (Hallman 2009) suggests that at least 40% of the consuming public is not responding to recall messages in ways that would avert exposure. This is also consistent with the fact that roughly 40% of the American public does not regularly follow traditional media outlets and that recall press releases are written at a level that about half the population cannot easily

understand. We argue that timely messages, broader dissemination of the messages, and more effectively constructed messages have the potential to increase the effectiveness of recalls by 30% -40%.

Research Implications

The food recall model provides a conceptual framework for the risk and crisis communication processes associated with limiting the impact of contaminated food products. Specifically, we have drawn from the crisis communication and disaster research literature in the development of this comprehensive model which integrates empirical findings and experiences of crisis events within the two disciplines. The model extends disaster research to a new hazard with increasing social relevance for public health and enriches crisis communication research with its focus on public warnings. Arguably, these literatures have preferentially focused on Stages I and II, those stages more controlled by the organizations and their efforts to identify, assess, and manage foodborne contamination events. Organizations such as food industry companies and federal regulatory agencies issue warnings/recalls when the public is at serious risk of morbidity and mortality. In such cases, a foodborne contamination event also threatens the credibility and viability of the food company and the credibility of the federal agency.

Such a framework implicates three immediate trajectories of further research. First, the model needs to be strengthened by continuing to develop an interdisciplinary understanding of the food recall process. Clearly, other literatures such as those of social influence and health communication would contribute to a broader understanding of messages and public responses (O'Keefe, 2002).

Second, the various features within each stage of the model require more extensive descriptions combined with research-based, actionable knowledge for purposeful interventions. Third, future case studies of food contamination events and cross-comparisons of such studies need to include data collection on a) organizational strategies for determining when information is adequate to issue a warning/recall, b) message reception and interpretation specific to the food contamination event, c) message responses, and d) the mechanisms used for the collection of feedback on the responses and subsequent adjustments of the warning/recall and messages. This will require organizational access and openness to the study of the entire process associated with a foodborne contamination event. This includes examination of emergency response plans, surveillance and assessment activities, decision-making conversations and meetings, management strategies and activities, message development sessions and approvals, and feedback loops. Many of these decisions and activities are documented, so only part of the organizational study would have to take place during an evolving foodborne contamination event. However, the study of public reception, interpretation, and responses will need to be done during an evolving event.

More broadly, this model points to the systemic elements of a recall and warning system. The model identifies associations between the various stages and between the specific processes, such as messages system, information seeking, and behavioral outcomes. Efforts to characterize warning systems must embrace similar approaches in order to accommodate the multiple agents and interdependent processes involved as well as the unique context of the specific event. Other models, such as the Crisis and Emergency Risk Communication model, developed by the Centers for Disease Control and Prevention, take similar systemic approaches to understanding the complex dynamics of communicating detailed information about emerging and uncertain risks to diverse audiences through multiple and divergent channels.

Conclusion

As the United States' food system becomes more complex and global, it becomes more vulnerable and sensitive to unintentional and intentional food safety issues. Moreover, industry consolidation has created conditions where contamination at one supplier facility can impact hundreds of products in dozens of supply chains. Therefore, food safety has increasingly become a critical issue and multiple federal agencies, state agencies, and the private sector, with differing responsibility and authority, have some role in ensuring a safe food supply. Compounding the system issues secondary to complexity and globalization as well as the management issues complicated by the many organizations and many statutes is the lack of a comprehensive, conceptual framework of the food recall process in the US, even though the food recall is the primary means by which the public is warned about and protected from unsafe food and related illnesses.

The Food Recall Model explained here describes four stages: recognition, messaging, reception/interpretation, and response and suggests that, to protect the public health, a coordinated communication process among food industry organizations, government agencies, and the general publics is needed. During stages one and two, industry organizations and government agencies undergo a sequential yet dynamic decision making process similar to that of consumers in stages three and four. They detect (or receive), interpret, confirm, and act in regards to risk or risk messages.

The Food Recall Model identifies specific points at which intervention can take place to improve the effectiveness of recall messages. In this way, the effectiveness of the recall can be enhanced. For example, procedures for rapid identification of the contaminant and the commodity can be bolstered to create more timely recall messages. Recall messages can be targeted more directly to vulnerable audiences and those groups who are more receptive to risk communication. Where sufficient information is available, messaging can be targeted to the level of the individual consumer.

Although there is variation across food events, the lack of a conceptual framework compounded by the importance of time hinders food industry officials, governmental

regulators, and researchers in the analysis and management of the food event. It also hinders coordinated communication between senders and input/feedback loops among message senders and receivers. The Food Recall Model as herein elaborated fills the void by providing a comprehensive, conceptual framework that could better position public and private entities to shape the warning process through their coordination during a food event and to create effective messages deliberately delivered at identified points of intervention. This framework, then, enhances the likelihood of increasing the effectiveness of the recall system and reducing public harm.

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