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Food Safety Issues Arising at Food Production in a Global Market

Michael P. Doyle

Foodborne illness is a major public health concern in the United States, with an estimated 76 million cases occurring annually. More than 90% of foodborne illnesses of known causes are of microbial origin. Animals used for foods and their manure are leading sources of foodborne pathogens. Recent advances in the investigation of foodborne outbreaks using genetic fingerprinting techniques enable epidemiologists to identify outbreaks and sources of implicated foods that heretofore were undetected. Tracebacks of outbreaks to the point of production place greater liability and responsibility on food producers. Implementation of Hazard Analysis Critical Control Point (HACCP) systems at the point of production is essential to increasing the safety of foods of animal and plant origin.

Key Words: food safety, foodborne illness, foodborne pathogens, HACCP

Prevalence of Foodborne Illness

Foodborne illness is a major cause of enteric disease in the United States. Best estimates indicate that approximately 76 million Americans annually acquire a foodborne illness (Mead et al., 1999). This means that more than one in four persons in the U.S. each year become ill from eating contaminated food.

Most foodborne illnesses of known causes are of microbiological origin, with more than 90% of cases attributed to microbial pathogens or the toxins they produce. A primary source of those pathogens that are most frequently responsible for foodborne illness (e.g., *Campylobacter jejuni* and *Salmonella*), and those pathogens responsible for serious manifestations of illness (e.g., *Escherichia coli* O157:H7 and *Vibrio vulnificus*) are foods of animal origin. The principal reservoir or major hosts of most of these pathogens are animals used in the production of food (Doyle, Beuchat, and Montville, 1997).

Sources of Foodborne Pathogens

Poultry, beef, pork, and eggs are leading vehicles of foodborne pathogens and have been directly associated with both outbreaks and sporadic cases of foodborne illness.

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Surveys have determined that 70% to 90% of retail broilers are contaminated with *Campylobacter jejuni* [U.S. Department of Agriculture (USDA), 1995]. This pathogen is the leading cause of acute bacterial gastroenteritis in the U.S., and poultry is a leading vehicle of infection.

Most recently, fresh produce and associated products have been identified as vehicles of outbreaks of human illness (U.S. Food and Drug Administration, 1998). Although the original source of contamination of implicated produce has seldom been identified, manure from farm animals has been highly suspect as a leading vehicle of pathogen transmission. Contaminated manure can contact produce directly through its use as a soil fertilizer or indirectly through infiltration of irrigation water or water used to wash produce. Conditions used for growing and processing fresh produce can vary greatly among countries. Investigation of a recent outbreak of shigellosis associated with chopped parsley grown and processed in Mexico revealed that nonpotable water was used to wash the parsley (Crowe et al., 1999).

Scientific Advances in Outbreak Investigations

The introduction of genetic fingerprinting of foodborne pathogens has revolutionized the identification and investigation of outbreaks of illness. This technology has been implemented within the past five years by the Centers for Disease Control and Prevention (CDC) and many state health departments, thereby enabling the recognition of foodborne outbreaks that heretofore would have been undetected. Highly perishable foods such as sprouts, unpasteurized apple cider, and other types of produce are becoming increasingly identified as vehicles of foodborne illness through the genetic fingerprinting-based PulseNet program introduced by CDC (CDC, 1999).

These new tools for outbreak investigations, combined with new technologies for tracking foods, will enable epidemiologists in the near future to trace back to their origin foods that were vehicles of illness. Such tracebacks will allow public health officials to identify problems that may occur at the point of production so that corrective measures can be implemented to minimize the potential for future outbreaks.

Food Producers' Responsibility in Food Safety

A major impediment to advancing the safety of raw foods is the failure of producers/farmers to consider their products as foods rather than as agricultural commodities. Beef, poultry, pork, eggs, fruit, vegetables, and even alfalfa seeds (used in sprout production) must be perceived as edible by humans, and may receive minimal or no heat treatment prior to consumption. Producers frequently

do not understand the food safety hazard associated with their edible products. They need to be educated not only in the hazards that exist, but also in approaches to prevent or control pathogen contamination. Incentives are needed to encourage producers to implement Hazard Analysis Critical Control Point (HACCP) systems at the farm.

Implementation of HACCP on the Farm

Food safety experts have determined that the most effective approach to enhancing the safety of foods, especially those that are minimally processed or consumed uncooked, is implementation of HACCP systems from the point of production throughout the food continuum, including at the point of consumption (International Commission on Microbiological Specifications for Foods, 1988). Although this approach is theoretically the best opportunity for reducing foodborne illness, a major limitation is the lack of available critical control points (CCPs) that are effective in killing pathogens or preventing their transmission on the farm.

A major investment in research to develop effective on-farm CCPs for pathogen intervention is needed. Examples of promising CCPs include probiotics or competitive exclusion microorganisms that prevent human pathogens from being carried by asymptomatic animals, innovative vaccines that may be genetically engineered into feed to stimulate immune responses that purge pathogens from the animal's gastrointestinal tract, and identification of dietary factors that influence the carriage and shedding of pathogens in manure. CCPs are also needed to eliminate pathogens from manure and to prevent manure contamination of irrigation, processing, and drinking water. An estimated 1.36 billion tons of manure are produced annually in the United States, of which approximately 90% is generated by cattle (U.S. Senate Agriculture Committee, 1998).

Safety Concerns for Imported Foods

Protecting the safety of domestically grown food is a formidable challenge, but ensuring the safety of imported foods, on which there is a growing reliance, is an even greater task. It is not certain that imported food, as a class, is a greater risk than domestically grown produce. However, many recent outbreaks of foodborne illness associated with imported produce have raised concerns regarding the ability of U.S. regulatory agencies to ensure the safety of foods grown beyond our borders. *Cyclospora* in Guatemalan raspberries, hepatitis A virus in Mexican-grown strawberries, *Salmonella* in Mexican-produced fresh orange juice, and *Shigella* in Mexican-processed chopped parsley are recent examples of imported produce responsible for major outbreaks of foodborne illness in the United States (U.S. Food and Drug Administration, 1998).

Affordable Foods Cannot Be Risk-Free

Considering the widespread distribution of food-associated pathogens in animals and the farm environment, it is not realistic to suggest that foodborne pathogens should be eradicated from the production environment. We must accept that there will be some incidence, preferably at a low level, of foodborne pathogens in production areas and subsequently in foods that are not further processed. Determining a science-based, tolerable threshold of pathogens in such foods will be essential.

A current example for which there are international differences of opinion is the occurrence of *Listeria monocytogenes* in ready-to-eat foods (Madden, 1994). Several countries have established criteria of tolerable limits for this bacterium in certain foods, whereas others, including the United States, have policies of “zero tolerance” for *L. monocytogenes* in all ready-to-eat foods. Microbiologists understand that regulatory policies of zero tolerance for this pathogen in all ready-to-eat foods are unrealistic and unenforceable considering that *L. monocytogenes* is present at low levels in a large percentage of most types of ready-to-eat foods.

Conclusions

There are no easy solutions considering the complex nature of foodborne illness. However, many of the dominant pathogens responsible for foodborne illness emanate from the production environment, which to this point in time has been largely overlooked or ignored. There are several approaches that collectively implemented could have a major impact on enhancing the safety of the U.S. food supply. These include:

1. Educate producers on the hazards associated with the foods they produce and on methods (critical control points) to reduce contamination. This will require a change of philosophy in that producers must consider their products to be foods rather than commodities.
2. Develop through research effective and practical critical control points that can easily be implemented at the production level.
3. Introduce at the farm Hazard Analysis Critical Control Point systems that include effective critical control points to reduce pathogen carriage and transmission.
4. Conduct risk-assessment studies of foodborne pathogens to identify production points or practices of greatest risk and to determine tolerable limits for specific foods. Include in the risk analysis a cost analysis to enable practical-based decision making.
5. Establish standards of equivalency for growing, harvesting, and processing practices that address the microbiological safety of imported foods.

Presently, there are no “magic bullets” for eliminating foodborne pathogens from all foods, especially fresh, minimally processed foods that do not receive a heat treatment before consumption. Hence, it is the responsibility of everyone in the food continuum, starting at the point of production, to implement critical control points that will reduce the risk of pathogen transmission.

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