Opportunities for Mitigating Foodborne Illnesses Caused by Emerging and Persistent Infectious Agents**

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Summary

Foodborne illnesses caused by infectious agents are a major, global public health concern (e.g., a recent outbreak of *E. coli* O104 infection caused more than 50 deaths). The international food trade has grown exponentially during the past decade, especially from developing countries where sanitary practices are often subpar and foodborne pathogen contamination is prevalent. In many countries, antibiotics critical to human therapy are used indiscriminately in food production, resulting in the development of multiple antibiotic resistance in foodborne pathogens. In addition, many developing countries are the principal global providers of sensitive ingredients that are sources of harmful microbes. Two critical needs to enhance the safety of the global food supply are the development of: 1) rapid methods to sample foods and detect foodborne pathogens and 2) effective treatments to kill harmful microbes while retaining the fresh-like characteristics of raw foods. Opportunities for international policies to greatly influence the mitigation of foodborne disease outbreaks include: (i) widely implementing a global surveillance and outbreak investigation system, (ii) requiring the development and implementation, by the food industry, of comprehensive food safety plans, (iii) developing and implementing robust sampling procedures and rapid methods for detecting pathogens in sensitive food ingredients and ready-to-eat foods, and (iv) globally restricting the use of antibiotics, which are important to human therapy, in agricultural production.

Current realities

Current estimates indicate that almost 50 million cases of foodborne illness occur annually in the United States, of which the infectious agents norovirus, *Salmonella*, *Campylobacter,* Shiga toxin-producing *E. coli,* and *Shigella* are the principal known causes. Produce, followed by fish, poultry, meat, and shellfish, are the leading vehicles of recent foodborne outbreaks. Fresh fruits and vegetables have become major vehicles of foodborne illnesses in the United States and Europe. About one-fourth of foodborne outbreaks reported in the U.S. in 2006 were associated with produce, and most were from leafy greens that were fresh-cut, bagged, and ready-to-eat.

Recent advances in the Centers for Disease Control and Prevention's (CDC) and U.S. state health departments' surveillance and outbreak investigation systems have led to the identification of many new vehicles of foodborne outbreaks, including bagged spinach, peanut butter, ground pepper, and jalapeno peppers. These systems have been important in identifying: (i) new foodborne pathogens, (ii) new risky food processing and distribution practices, (iii) foods or ingredients not previously recognized as high risk, and (iv) "problem" suppliers and food processors, both domestic and international (Tauxe et al., 2010). A major public health concern in the food safety net is the sensitive ingredients that are added to ready-to-consume foods that generally do not receive an additional microbial kill treatment. Foods that contain these sensitive ingredients include ice cream, nutrition bars, cooked or fermented meat products, and snack foods. Types of sensitive ingredients include peanut and nut butter/paste, chocolate, nuts, spices, herbs, flour, and vitamins. *Salmonella* contamination is the principal concern associated with sensitive ingredients; it can produce serious illness in people even when present in small numbers — less than 1 *Salmonella* organism/gram.

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Most developed countries are importing foods at unprecedented rates, largely from developing countries such as China, India, Mexico, and Brazil (Doyle, 2009). Currently, about 20% of the U.S. food supply, and many sensitive ingredients, including about 45% of tree nuts and most spices, are imported. Sanitation practices for food production and processing are not universally equivalent throughout the world, and major weaknesses occur in many developing countries. Spices, nuts, produce, and seafood are examples of food items in which *Salmonella* contamination has resulted from poor sanitary practices (Doyle and Erickson, 2008).

In addition, antibiotics, including those critical for human therapy, are extensively applied indiscriminately and inappropriately in some developing countries to prevent and control contamination of harmful microbes in livestock, poultry, and aquaculture. China has the world's most rapid growth rate of antimicrobial resistance: Resistance rose approximately 22% between 1994 and 2000. A recent study of antimicrobial resistance of *Salmonella* isolates from chickens in China revealed that more than 85% of *Salmonella* Indiana (a dominant serotype) isolates were highly resistant to 10 antibiotics, and many of these isolates were resistant to 16 antibiotics. A large proportion of these antibiotics, which the microbes are resistant to, are critical for human therapy.

Scientific opportunities and challenges

One of the greatest impediments to verifying the safety of foods is the lack of rapid (real-time) methods that would enable sampling large volumes of foods and testing them for hazardous contaminants, such as infectious agents. Pathogen tests, including molecular-based methods, typically take many hours (e.g., 24 hours) to complete, and the sample size is relatively small (e.g., 25 grams or a total of 375 grams from 60 samples). These methods are not conducive to determining the safety of large shipments of food. Reliable, sufficiently sensitive, rapid pathogen-detection methods, which preferably take less than one hour, are needed to enable more rapid test and release programs. In addition, advanced methods are needed to concentrate samples, thereby enabling testing of large volumes of foods for more meaningful results.

Fresh produce has become recognized as a leading vehicle of foodborne disease outbreaks, in part because of the lack available, cost-effective treatments (other than cooking or irradiation) that can both kill pathogens and retain the desired fresh-like characteristics of fruits and vegetables. Fresh-cut produce (e.g., lettuce, celery) is especially difficult to disinfect because most treatments degrade the quality of cut fruits and vegetables (e.g., browning, wilting), and harmful microbes can become internalized in the cut tissue where chemical treatments cannot contact them. Hence, there is a pressing need for the development of highly effective antimicrobial treatments that retain the quality of fresh and fresh-cut fruits and vegetables (e.g., sprouts).

Policy issues

- The best overall mitigation strategy for global reduction of emerging and persistent foodborne infectious disease outbreaks is to require the food industry to develop and implement food safety plans based upon approved models. These plans should include good agricultural practices for food producers, as well as hazard analysis and pathogen control points for food processors. The Food and Agricultural Organization (FAO) should be responsible for developing the model food safety plans and assisting the food industry with their implementation, especially in the developing world. The Codex Alimentarius should be responsible for establishing not only guidelines, but also global requirements for the application of food safety plans by the international food industry.

- A more widely implemented global surveillance and outbreak investigation system for human foodborne illnesses, which includes better food source attribution and traceback than currently exists, is needed to mitigate outbreaks of foodborne illness. Not all food producers and food processors are equally committed to producing safe foods given that their primary driver is generally economics/low cost. Such a system should be managed globally by the World Health Organization (WHO) and FAO working in conjunction with country health and agriculture departments. This would enable detection of otherwise unrecognized outbreaks, better identification of the vehicle (food) transmitting the outbreak strain, and more rapid implementation of control measures to minimize the number of illnesses globally.

- Development and implementation of robust sampling and rapid methods for detection of foodborne pathogens in sensitive ingredients could mitigate the risk of foodborne outbreaks. Globally, FAO should provide oversight of the development of sampling and rapid detection procedures and Codex should globally implement their usage.

- Ready-to-eat foods that do not receive an additional pathogen kill step following the addition of sensitive ingredient(s) (e.g., spices, chocolate, nuts, nut paste), as well as ready-to-eat foods considered to be of high risk to humans (e.g., sprout seeds and fresh-cut fruits/vegetables) found to be contaminated in international trade, should be reported to a global electronic portal developed and maintained by FAO or a reputable private entity.

- The use of antibiotics that are important for human therapy in agricultural production should be restricted to application by veterinarians and not made available directly to food producers. Prescribing practices among veterinarians could be improved by following electronic medical guidelines for the use of specific antibiotics, or antibiotic alternatives, for treating or preventing animal diseases. FAO and WHO should be responsible for developing prudent antibiotic use criteria and Codex should implement the rules for restricted antibiotic application by veterinarians.

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*** A policy position paper prepared for presentation at the conference on Emerging and Persistent Infectious Diseases (EPID): Focus on Mitigation, convened by the Institute on Science for Global Policy (ISGP) October 23–26, 2011, at the University of Edinburgh, Edinburgh, Scotland.*

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