

The 'farm to plate' approach to food safety – Everyone's business

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DG Allard. The 'farm to plate' approach to food safety – Everyone's business. *Can J Infect Dis* 2002;13(3):185-190.

Food safety is growing in importance as a public health concern for health practitioners and the general public. The Canadian public is exposed more extensively than ever before to exotic foods and pathogens via international travel, changing lifestyles and domestic contact with fresh foodstuff that is imported from faraway lands. Global warming, changing microbial ecology and resistance, and reduced host immunity are also having their effect in increasing the risk. To manage the risk adequately, interventions must be implemented at every point of the food supply chain, from production and processing to distribution, preparation and consumption, at home and in retail food service establishments. The role of government is explained, and the roles of other stakeholders, including physicians, are reviewed briefly.

Key Words: *Foodborne illness; Foodborne risk factors; Foodborne risk management*

La méthode “ de la ferme à l'assiette ” pour assurer la salubrité des aliments - C'est l'affaire de tous

RÉSUMÉ : Les dispensateurs de soins et le grand public accordent de plus en plus d'importance à la salubrité des aliments en santé publique. Le public canadien est exposé plus que jamais à des aliments et à des pathogènes exotiques en raison des voyages internationaux, de l'évolution des modes de vie et du contact indigène avec des denrées importées de pays lointains. Le réchauffement de la planète, l'évolution de l'écologie et de la résistance microbiennes et la diminution de l'immunité des hôtes ont également un effet sur l'augmentation des risques. Pour prendre le risque en charge de manière pertinente, il faut implanter des interventions à chaque point de la chaîne d'approvisionnement alimentaire, de la production et de la transformation à la distribution, à la préparation et à la consommation, à domicile et dans les établissements de restauration au détail. Le rôle du gouvernement est expliqué et celui d'autres intervenants, y compris les médecins, fait l'objet d'un bref examen.

FOODBORNE ILLNESS – AN IMPORTANT HEALTH PROBLEM

Food safety is growing in importance as a public health concern for health practitioners and the public. There is growing evidence that pathogenic *Escherichia coli* (especially 0157:H7) is becoming more common as a source of foodborne illness from an expanding number of food products, while multidrug-resistant salmonellae (eg, *Salmonella typhimurium* DT104) are causing concerns about reduced treatment options for severe human cases. The European community is embroiled in 'Mad Cow Disease' and its human consequence, the new variant Creutzfeld-Jakob

Disease. And what of the scare over genetically modified foods? Food safety is foremost in Canadian consumers' minds. A recent survey showed that 68% of Canadians are concerned about the safety of the food that they eat (1).

Based on Health Canada statistics and estimates, approximately 30 Canadians die every year as a result of foodborne illness; thousands are hospitalized or consult the health care system; and up to two million suffer unpleasant symptoms and inconvenience from foodborne illness (2-4). American statistics and estimates are similarly compelling (5), and the number and variety of outbreaks are not abating (6). Many determinants are responsible for this state of affairs (Table 1).

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Received for publication December 13, 2001. Accepted February 1, 2002

TABLE 1
Determinants that contribute to the increased occurrence of foodborne illness

Aging population
Immunodeficient individuals
International migration and travel
Demand for imported, exotic foodstuffs
Meals eaten outside the home more frequently (changing lifestyles)
Laxity of food-handling hygiene (transient workforce, lack of time)
Global distribution of foodstuffs (multinational, fewer food processors)*
Increased prevalence of insect vectors (climate change)
Pathogen virulence (changing ecology)
Antimicrobial resistance of pathogens (intensive animal production)
Toxin contamination (environmental pollution, product misuse)
Enhanced surveillance†
Improved laboratory methodology†

*Results in larger outbreak and wider spread; †Contributes to increased detection and recognition of foodborne illness

FACTORS RESPONSIBLE FOR THE HIGH LEVEL OF FOODBORNE ILLNESS

The aging of the population and improvements in health care have led to a larger proportion of individuals in the population surviving, but also being at higher risk of illness from, communicable diseases (7). Many people (for example, cancer and AIDS patients, the very old, premature infants) have weak immune systems that make them prone to foodborne and/or waterborne infections (eg, *Listeria monocytogenes*) with higher rates of complication (8-10).

More extensive international travel increases the likelihood of a traveller bringing into Canada infections that are transmitted easily to others via food or water (eg, salmonellosis, hepatitis A), and this transmission occurs even before the traveller becomes symptomatic (11,12). Immigrant and refugee populations, as potential carriers of infectious agents that are transmissible through food (eg, typhoid), have also increased the challenge of communicable disease control (13). The expanding public awareness of, and contact with, various cultures and exotic foods (eg, melons) have increased the demand for imported products, which are not easily regulated, and are often produced under less hygienic conditions than domestically grown products (14).

Global warming is affecting insect vectors, permitting them to harbour new human pathogens (eg, West Nile virus) or to re-introduce others (eg, malaria) (15-19). Pathogens are also changing – becoming more virulent (eg, *E coli* 0157) due to changing ecology or acquiring antimicrobial resistance (eg, *Salmonella typhimurium* DT104) that is facilitated by intensive animal food production practices (20-22). Better epidemiological surveillance, bolstered with enhanced laboratory methodology, points increasingly to viruses (eg, *caliciviridae*) as significant causal agents for outbreaks of enteric illness (23,24), and to protozoae (cyclospora, cryptosporidium) as the culprits in foodborne outbreaks from a variety of fresh produce (25-28). Environmental pollution (eg, dioxins,

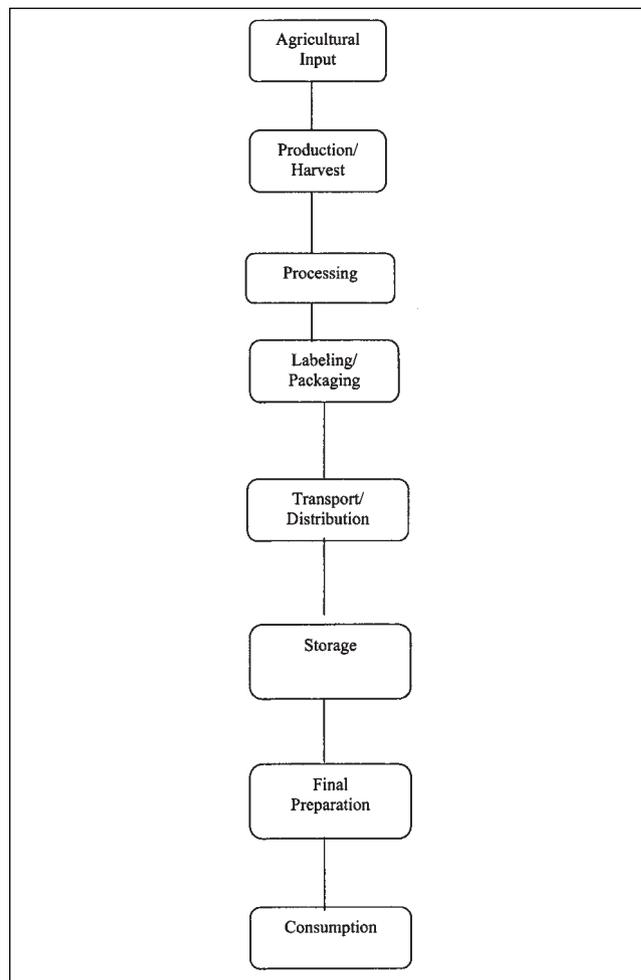


Figure 1 'From farm to plate' – The food supply chain

polychlorinated biphenyls) and pesticide misuse also contribute occasionally to foodborne hazards (29-31). As science and technology improve, pathogen detection and identification allow a better understanding of the routes of transmission, often pointing the finger at food and drinking water.

Changing lifestyles, with less time for meal preparation at home, and more meals eaten at restaurants and fast-food establishments or from take-out/delivery outlets, with laxity in food-handling practices at home and in food service establishments, also contribute to the increased risk of the spread of foodborne infections and the complexity of their prevention and control (32-34). A more global distribution of foodstuff by a shrinking pool of food processors has greatly augmented the ability of any foodborne infection to spread rapidly to masses of consumers over large geographic areas (35-38).

Today, in view of the complex interaction of factors potentially affecting the risk of foodborne illness, there is no fail-proof way to ensure that all food is kept free from potential sources of contamination, entirely safe until it is consumed. All that can be done is to improve food safety incrementally by systematically concentrating on reducing the risks of contamination at every point of the food supply chain (Figure 1), from production and processing to distri-

bution, preparation and consumption, at home and in retail food service establishments. Although previous technological advances such as pasteurization and refrigeration, and more recent improvements such as the conception and implementation of Hazard Analysis Critical Control Point (HACCP) systems (39,40) (Table 2), which was conceived in the 1960s by the Pillsbury Company and the United States government to help ensure safe food for NASA astronauts, have reduced the likelihood of foodborne diseases, the risks to consumers remain significant. The considerable burden of foodborne illness on Canadian society deserves the attention of governments at all levels, the food industry, and the consumers themselves, who, in the final analysis, are their own last line of defense against foodborne hazards.

The process of ensuring the safety of the food supply needs to be dynamic and flexible, permitting it to adapt to constant change in the types of food consumed, the geographic origins of food products and the ways in which different foods are processed (41).

ADDRESSING FOOD SAFETY

The contribution of science and technology

To understand and control all of the major factors that affect food safety 'from farm to plate', it is necessary to integrate more effectively the various disciplines (veterinarians, botanists, molecular biologists, microbiologists, inspectors, physicians, etc) that are involved in the study, investigation and control of foodborne disease – on the farm where food is produced; at the plant where it is processed; during its distribution to final points of sale; and at food service establishments and in the home, where it is consumed.

The first step in tackling any problem is to identify correctly its components and to understand better their extent and contribution. To grasp better the burden of foodborne illness and the factors that affect its incidence, and to monitor progress in addressing this challenge, a good surveillance system is needed. At this time, there is, unfortunately, a large discrepancy between reported cases of foodborne disease and actual incidence of community illness. This under-reporting is due to a variety of reasons, including infected individuals not accessing the health care system for diagnosis and treatment, and physicians missing a foodborne etiology, not ordering specific stool tests or not notifying the public health authorities, etc. The Centers for Disease Control and Prevention (CDC) in the United States have initiated a surveillance system, called FoodNet, at various levels of the illness continuum, which has started to provide the needed information (42). Canada would benefit from implementing a similar program. Canadian laboratories are also becoming partners in another CDC initiative, a bacterial molecular subtyping database called PulseNet, which makes it possible to match otherwise apparently isolated cases of foodborne illness and associate a likely food source to those illnesses (43).

Equally important is an adequate assessment of the level of risk caused by various pathogens when they are present on a variety of foods, some of which are eaten raw, while

TABLE 2
Seven steps of the Hazard Analysis Critical Control Point (HACCP) process

1. Conduct hazard analysis
2. Determine critical control points
3. Establish critical limits
4. Establish monitoring protocol
5. Establish corrective action scheme
6. Establish verification procedures
7. Establish documentation and record-keeping system

others are processed extensively. This risk assessment comprises four components: hazard identification, hazard characterization (dose-response assessment), exposure assessment and risk characterization. It must be sound, must be based on the latest scientific knowledge and expert judgment, must acknowledge areas of uncertainty, and must explicitly state assumptions. The power of desktop computers has made it easier to reach more realistic estimates with the use of a probabilistic analytical approach such as the Monte-Carlo simulation (44).

Looking at efforts to reduce microbial contamination of foodstuff, the use of conventional thermal processes (eg, pasteurization) is no longer sufficient to deal with these emerging challenges, which necessitates continued investment in research and the development of new technologies such as high pressure treatment, pulsed electric field processing, ozonation, irradiation and so on (45).

A better understanding of the genetics, physiology and virulence of foodborne pathogens, as well as how microbes, humans and animals interact is needed to provide a scientific and technological foundation for designing new pathogen control programs and for developing effective disease prevention strategies. More sensitive methods for detecting and categorizing foodborne pathogens need to be found, and more advanced information technology systems for enhanced surveillance need to be designed to allow investigators to detect and trace outbreaks more rapidly and precisely. Advances in risk assessment methodology now make it possible to integrate information from the various stages in the food production process. This new capability can be used to identify particular steps in the food supply system for targeted intervention to control hazards and prevent disease.

THE ROLE OF GOVERNMENT

In the sector of human health and food safety, the Canadian constitution assigns different areas of legislative authority to federal and provincial governments. This poses a challenge to moving to better-integrated and complementary food safety systems. Even where it might be convenient to do so, it is not possible to exchange jurisdictional responsibilities. Currently, there are more than 70 provincial and federal food-related acts, administered by a variety of departments (Canadian Food Inspection Agency [CFIA], Agriculture, Health, Fisheries, Environment, Natural Resources).

Governments have the responsibility to set and enforce standards pertaining to health and safety, based on sound scientific risk assessment and management principles; to ensure that product information provided by industry is sufficient and accurate; to provide health and safety information to consumers; and, at the federal level, to interact internationally to represent the interests of Canadian consumers and producers.

In Canada, the responsibility for food safety policy, nutritional quality, standard setting, risk assessment, analytical testing research and audit remains with Health Canada. The creation of the CFIA in April 1997 integrated the food inspection functions of four federal government departments: Health Canada, Agriculture and Agri-Food Canada, Fisheries and Oceans, and Industry Canada. The CFIA is responsible for enforcing 13 various acts and 34 sets of regulations. Food safety regulations and existing standards cover various commodities such as fish and shellfish, meat and poultry, dairy products, eggs, fruits and vegetables, maple syrup, and honey, including retail manufactured and imported foods. One of the tasks given to the new agency at its inception was to harmonize as much as possible the Canadian food inspection system, from the federal level to the provincial plane.

Provincial governments and, in some provinces, municipalities also have a large role to play, with local or regional health authorities providing inspection services for food retail, food service establishments, hospitals, nursing homes, community kitchens, food banks and so on. Many jurisdictions have started to require enhanced training and certification for food handlers.

Federal-provincial, and in some cases municipal, collaboration is essential to ensure a comprehensive regulatory and enforcement coverage of the 'farm to plate' food safety continuum. A variety of forums are available to discuss inter-jurisdictional harmonization and cooperation issues; these forums include the Federal-Provincial-Territorial Committee on Food Safety Policy, the Canadian Food Inspection System Implementation Group and the Federal-Provincial-Territorial Agri-Food Inspection Committee. Discussions at such forums include strategies for standardizing HACCP programs for processing plants, collaboration with on-farm food safety programs, agreements on more uniform standards, and procedures and practices for the delivery of inspection programs. On a one-to-one level, the CFIA has negotiated bilateral cooperative inspection agreements or service contracts in recent years with many of its provincial counterparts, aiming at more seamless, collaborative and efficient working relationships for the benefit of Canadian consumers.

THE ROLE OF OTHER STAKEHOLDERS

The food industry also has a role to play in improving food safety. It is responsible for the safety and quality of its products, and for information that is provided to the consumer via labelling. Industry should benefit from involving itself in food safety as a primary requirement for maintaining marketability and competitiveness. Recently, the drastic

impact on business from the loss of consumer confidence in certain food commodities (eg, red meat in Europe as the result of Mad Cow scare) or specific brand names has been witnessed, not counting the potentially costly litigation that might come from affected consumers. The implementation of quality assurance systems such as HACCP at the processing plant and on the farm can help industries mitigate any risk that is inherent to the production and processing of foodstuff. The prudent use of antimicrobials, principally in animal husbandry practices, is also important and should help to reduce the progress of antimicrobial resistance among foodborne pathogens.

Food retailers and food service establishments need to follow food safety principles and guidelines when preparing, handling, packaging, distributing, storing and serving food products. Staff need training in food preparation and handling techniques, and a better understanding of the occurrence of foodborne hazards. Also, they need to be provided with the equipment (eg, dependable refrigerators and sanitizers) and hygienic facilities necessary to apply these guidelines adequately.

Trade associations can do much to promote the adoption of food safety standards throughout their industry, facilitating the transfer of information to the public via adequate labelling, Web-based documents, sponsoring of educational events and other activities.

In the health care sector, physicians must keep up-to-date on emerging foodborne pathogens and the human diseases that they generate to be in a position to diagnose and treat them quickly. They should also recognize the importance of reporting early any suspicion of a foodborne outbreak to public health authorities to help limit the scope of the outbreak and the spread of the pathogen. They, too, have a role to play in mitigating the increase in antimicrobial resistance of foodborne pathogens by collaborating with the veterinary medicine community, promoting the prudent use of antibiotics and adhering to established professional guidelines for antimicrobial use in this regard.

Many health professional associations (physicians, veterinarians, microbiologists, etc) can play important parts in enhancing food safety. First, they can educate their own constituents on foodborne health risks and ways in which they can help mitigate them and propose practice guidelines to address them. They can also collaborate and try to integrate their actions in the interest of efficiency and synergy. Many professional associations need to be community minded and must help to develop educational material for the general public and groups that are at special risk.

The mass media also have a contribution to make. Setting aside the sensationalism and scandal-seeking that they are, unfortunately, too often known for, the media should make an honest attempt to be reliable and balanced sources of useful information for consumers and the public in general. All forms of mass media, including television, radio, print and the Web, should take some responsibility in educating their viewers, listeners and readers on what they can do to protect themselves from foodborne and waterborne health risks. For

TABLE 3
A summary of the emerging and needed practices and tools aimed at further improving the food safety system

Area	Emerging and/or needed practices and tools
Surveillance	<ul style="list-style-type: none"> • Community surveys on food hygiene and foodborne illness (eg, FoodNet) • Molecular-level bacterial subtyping (eg, PulseNet)
Risk assessment	<ul style="list-style-type: none"> • Better defined and standardized methodology • Computing power and models (eg, Monte-Carlo) permitting more realistic estimates
Food processing technology	<ul style="list-style-type: none"> • Innovative nonthermal processes to reduce and eliminate microbial contamination on food stuff
Government	<ul style="list-style-type: none"> • Better coordinated, complemented and harmonized or equivalent standards and programs across the country
Food industry	<ul style="list-style-type: none"> • Implementation of Hazard Analysis Critical Control Point (HACCP) systems and equivalent safety assurance systems for most food commodities • Prudent use of antimicrobials in the production of animals raised for food
Food retail and food service	<ul style="list-style-type: none"> • Enhanced foodhandler training • Increased availability of reliable and proven equipment (eg, refrigeration, hot-holding)
Trade associations	<ul style="list-style-type: none"> • Enhanced promotion of good practices, education to members and information for the public
Health care practitioners	<ul style="list-style-type: none"> • Improved access to prompt diagnosis and effective treatment • Faster and more complete reporting to public health services • Prudent use of antibiotics, aimed at reducing development of resistance
Health professional associations	<ul style="list-style-type: none"> • Enhanced education of their members and the general public • Development and promotion of practice guidelines
Mass media	<ul style="list-style-type: none"> • Becoming a more reliable resource of useful information • Notable contribution to public education via radio and television programming
School system	<ul style="list-style-type: none"> • Child and parent education regarding best food handling practices
Consumer association	<ul style="list-style-type: none"> • Stronger advocacy and representation of consumer interests • Regular information and educational activities
Consumers	<ul style="list-style-type: none"> • The public's acceptance of responsibility for self-education • Increased adherence to food handling guidelines

example, hosts of nutrition or cooking television programs should make a point of practicing and promoting simple rules of food preparation and personal hygiene.

School systems also have a role to play in facilitating the provision of educational sessions and/or material to their students, either by the inclusion of food preparation and food hygiene information in the regular curriculum or by delivery in special sessions during the lunch period (eg, via closed circuit television in the cafeteria) or at other pertinent moments or events. Educational material can also be delivered effectively to the home environment (caretaker, parents) via the child.

Consumers' associations can play a variety of roles in assuring food safety. In general, in terms of food safety, Canadian-based consumer associations have not been very visible thus far. With time, it is hoped that they will represent the interest of a majority of consumers or of specific risk groups, and will provide needed comment on governments' food safety policy and regulatory proposals. They have some responsibility in educating consumers about ways to enhance food safety and in increasing consumers' understanding about the risks associated with food.

Consumers are the end point in the food chain, and should take on some responsibility for the safety of the food

that they eat, buy and prepare for their families. Recent surveys and observational studies have shown food-hygiene practices at home to be lacking (46). To do a better job, people need access to accurate and useful information on food safety, including safe food handling and preparation guidelines, food recall advisories, and nutrient and/or allergen content information. Using these facts and applying the guidelines, parents will be better equipped to pass onto their children good practices that will help mitigate health risks from food to themselves and to future generations. The FightBAC program (47), a consumer education partnership of the federal government and industry, and health and environmental organizations has been helpful in educating the public in this regard.

Table 3 summarizes some of the emerging and needed practices and tools that are discussed in the present article, and which are aimed at further improving the food safety system.

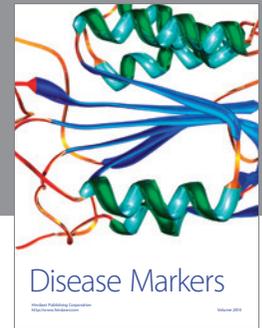
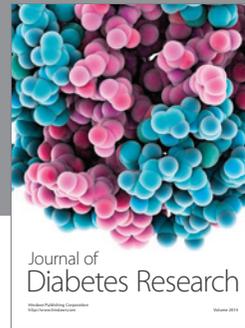
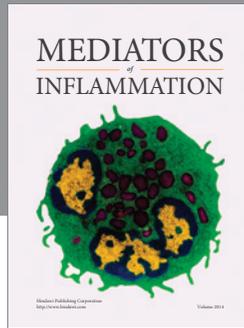
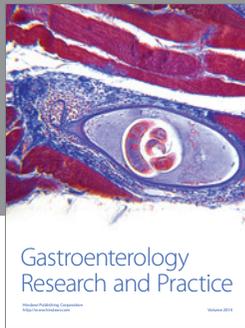
VISION FOR THE FUTURE – COLLABORATION AND COMPLEMENTARITY OF ACTION

Today, Canadians expect the food that they eat to be safe, regardless of its source. To achieve this public expectation and worthy objective, an enhanced integration and comprehensiveness in the food safety system is necessary. First,

this requires a greater clarity and acceptance of the role and responsibilities of each of the partners in this enterprise, including governments, industry, health professionals, educators, the mass media and, finally, the consumers. Second, it will require the complementary resolve and action of all stakeholders in making their necessary and timely contributions to the effort.

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