



CORE

Public Health Functions for BC

Evidence Review:
Food Safety

Population Health and Wellness
BC Ministry of Health

March 2006

This is a review of evidence and best practice that should be seen as a guide to understanding the scientific and community-based research, rather than as a formula for achieving success. This review does not necessarily represent ministry policy, and may include practices that are not currently implemented throughout the public health system in BC. This is to be expected as the purpose of the Core Public Health Functions process—consistent with the quality improvement approach widely adopted in private and public sector organizations across Canada—is to put in place a performance improvement process to move the public health system in BC towards evidence-based best practice. Health authorities will develop public performance improvement plans with feasible performance targets and will develop and implement performance improvement strategies that move them towards best practice in the program component areas identified in the Model Program Paper. These strategies, while informed by the evidence in this review, will be tailored to local context.

This Evidence Review should be read in conjunction with the accompanying Model Core Program Paper.

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EXECUTIVE SUMMARY

A significant number of cases of foodborne illness occur annually in BC. The estimated number of cases in BC ranges from 208,980 to 652,248 annually. Based on these estimates, between 1 in 19 and 1 in 6 residents will experience foodborne illness every year.

The estimated cost of foodborne illness is \$988 per case. Based on the estimated number of cases of foodborne illness in BC (208,980 to 652,248), the cost of foodborne illness in BC ranges from \$206,472,240 to \$644,421,020 annually, or between 0.14 percent and 0.45 percent of the 2003 provincial GDP.

The primary source of contaminated food is from food service establishments, followed by private residences. A significant factor in determining whether a food will be contaminated is related to food handling practices. Certain practices, if done incorrectly, can lead to a higher risk of food contamination. Food handling practices are generally controlled by decisions made by individuals.

In order to reduce the number of cases of foodborne illness and the associated costs to society, a comprehensive food safety strategy is necessary. There are three key elements to a food safety strategy:

- Food premises inspection program.
- Foodborne illness outbreak investigations and food recall programs.
- Food safety education programs:
 - to industry.
 - to the public.

Research indicates that the combination of these three programs can effectively lower the incidence and likelihood of occurrence of foodborne illness cases.

1.0 OVERVIEW/ SETTING THE CONTEXT

In 2005, the British Columbia Ministry of Health released a policy framework to support the delivery of effective public health services. The Framework for Core Functions in Public Health identifies food safety as one of the 21 core programs that a health authority provides in a renewed and comprehensive public health system.

The process for developing performance improvement plans for each core program involves completion of an evidence review used to inform the development of a model core program paper. These resources are then utilized by the health authority in their performance improvement planning processes.

This evidence review was developed to identify the current state of the evidence based on the research literature and accepted standards that have proven to be effective, especially at the health authority level. In addition, the evidence review identifies best practices and benchmarks where this information is available.

2.0 METHODOLOGY

This paper was based on a. earlier document entitled *The Evidence Base for a Core Program in Food Safety*, prepared by a Working Group with representation from the BC Centre for Disease Control, health authorities, Health Officers Council, the Canadian Institute of Public Health Inspectors and the Ministry of Health. Members of the Working Group collaborated on assembling evidentiary information related to food safety and food safety programs, and then on drafting the various sections of the paper. The Working Group then reviewed the draft sections, made changes as appropriate and assembled the sections into the final paper.

3.0 FOODBORNE ILLNESS IN BRITISH COLUMBIA

According to Bryan (1982), more than 200 known diseases are transmitted through food. Food may be contaminated with a variety of contaminants. These include pathogenic organisms such as bacteria, viruses and parasites, as well as natural toxins and chemical and physical contaminants. Contaminated foods are a known source of illness in British Columbia (Provincial Health Officer 2002). Contaminated food can lead to serious illness, often in a large number of people (Todd 1989).

The overall goal of a food safety strategy is to minimize the incidence of foodborne illness in the community. This review of the evidence thus begins with a discussion of:

- The estimated incidence of foodborne illness in BC,
- The cost of foodborne illness in BC, and
- The sources of contaminated food.

3.1 Incidence of Foodborne Illness in British Columbia

There are a variety of reporting mechanisms that can be used to calculate the estimated number of cases of foodborne illness in BC. These mechanisms are as follows:

- a) Reported cases of confirmed foodborne illness in BC are forwarded to the Bureau of Microbial Hazards, Health Canada, in Ottawa, Ontario. In their latest summary published in 2001, Todd reported that 1,705 cases of confirmed foodborne illness in BC were reported to the Bureau of Microbial Hazards in 1995.

Todd (1989) estimates that for each confirmed case reported to the Bureau of Microbial Hazards, the number of foodborne illness cases must be multiplied by a factor of 350. Based on this conversion factor, the estimated number of cases of foodborne illness in BC in 1995 would have been 596,750. Based on a 9.3 per cent increase in population between 1995 and 2003 (BC Stats, Population and Demographics, n.d.), the estimated number of foodborne illness cases in 2003 would be 652,248, or approximately 1 in every 6 residents.

Also in Todd (1989), it is estimated that in the period 1978 to 1982, there were 2.2 million cases of foodborne illness in Canada annually. At that time, BC's proportion of the Canadian population was approximately 11.2 per cent (BC Stats, Population and Demographics, n.d.). As such, based on this proportion of the Canadian population, BC would have been estimated to have 246,400 cases annually of foodborne illness during this time period. Again, allowing for population increases between this time period and 2003 (BC Stats, Population and Demographics, n.d.), the number of estimated cases of foodborne illness in BC in 2003 would be 370,339, or approximately 1 in every 10 to 11 residents.

- b) A second approach to illustrate the magnitude of foodborne illness in BC is to review the reported, laboratory-confirmed cases of selected enteric pathogens that are thought to be carried primarily in food. The BC Centre for Disease Control (2002) reported 2,045 cases of Campylobacteriosis, 140 cases of Verotoxigenic E.coli (VTEC) infection, 711 cases of Salmonellosis, 26 cases of Vibrio Parahemolyticus and 601 cases of Yersiniosis. While not reported as foodborne illness, these selected enteric pathogens are thought to be mainly spread by food (Mead et al. 2000). These selected enteric pathogens represent a total of 3,523 laboratory-confirmed cases.

Chalker and Blaser (1988) estimate that for each case of salmonellosis reported under the United States Center for Disease Control's surveillance system, 39 human cases of salmonellosis are not reported. The literature range in their study was reported to be between 3.8 and 7,326. Based on this under-reporting factor of 39, the estimated number of Campylobacteriosis, VTEC, Salmonellosis, Vibrio Parahemolyticus and Yersiniosis cases in BC would be 137,397 in 2002. These figures do not include foodborne illnesses caused by other foodborne pathogens. Using the best estimates of the annual cases for the other specific types of foodborne diseases in the United States (Council for Agricultural Science and Technology 1994), the total number of estimated annual cases of foodborne illness in BC is between 208,980 and 532,825.

Based on available data, the estimated annual number of cases of foodborne illness in BC is between 208,980 and 652,248, or between 1 in 19 and 1 in 6 residents.

3.2 Cost of Foodborne Illness in BC

There are a number of costs associated with foodborne illness. Todd (1989) reports that these can include direct costs such as medical care, travel, investigation of illness complaints and legal action. Indirect costs are reported to include loss of productivity, loss of business, emotional loss due to pain, loss of leisure time and death.

A difficult cost to measure is the occurrence of chronic sequelae that may be associated with infections from foodborne pathogens. The incidence of sequelae after foodborne illness is unknown but is reported to be probably less than 5 per cent (Council for Agricultural Science and Technology 1994). Depending on the foodborne infection, types of sequelae can include ankylosing spondylitis, cardiac manifestation, chronic incapacitating diarrhea, Guillain-Barré syndrome, reactive arthritis, Reiter's syndrome, rheumatoid arthritis and septic arthritis.

A number of studies have attempted to estimate the total cost of each case of foodborne illness. Todd (1989) estimates that the cost per estimated case of foodborne illness in Canada is \$988 (adjusted to 2003 Canadian dollars). Studies of similarly developed countries show the cost per case to range from \$373 (New Zealand) to \$1,420 (United States). The average cost per case of the three international comparisons is \$788 (Table 1).

Table 1: Estimates for Costs of Foodborne Illness Cases (adjusted to 2003 Canadian dollars)

Study	Country	Cost per Case*
Todd (1989)	Canada	\$988**
Scott et al. (2000)	New Zealand	\$373**
Lindquist et al. (2001)	Sweden	\$570**
Todd (1989b)	United States	\$1,420**

* Cost per case is adjusted to 2003 Canadian dollars.

** Calculations for conversion into 2003 Canadian dollars can be found in Appendix 1.

The variability in the costs from the four studies is explained as the methodologies varied in each study, and different items were included in their cost estimates. Examples of methodology variations and differences include:

- Each study was based on the rates of various foodborne diseases in each country. The estimated rates of the various foodborne diseases vary between countries. Because costs vary between the different foodborne diseases, the final costs per case of foodborne illness varied between countries and studies.
- Some studies attached costs to certain items while other studies did not. For example, the Canadian and United States estimates included items such as investigation of illness, emotional loss (of patients), loss of business (of patients) and legal action. The New Zealand and Swedish studies did not include these costs in their estimates.

Based on earlier estimates of the estimated number of foodborne illness in BC (208,980 to 652,248), using the Todd (1989) Canadian cost estimates per case (\$988 per case), the cost of foodborne illness in BC ranges from \$206,472,240 to \$644,421,020 annually, or between 0.14 per cent and 0.45 per cent of the 2003 provincial GDP (BC Stats, BC GDP, n.d.). As a comparison, the total economic burden (direct and indirect) of physical inactivity in BC in 1999 was recently estimated to be \$422 million annually, and the economic cost of obesity in BC was estimated to be between \$730-830 million annually.

3.3 The Sources of Contaminated Food

In order to design and implement an effective food safety strategy, it is important to ascertain the manner in which the community might be exposed to the source of contaminated food, both the locations or settings of contaminated food and the risk factors associated with how food is contaminated.

3.3.1 Locations or Settings of Contaminated Food

A number of studies have assessed which locations are commonly implicated in foodborne illness. They are as follows:

- a) Based on a series of reports by Todd (1994, 1997, 1998, 2001) regarding cases of confirmed foodborne illness in Canada reported to the Bureau of Microbial Hazards, Health Canada, Table 2 summarizes the principal settings where contamination is known to have occurred.

Table 2: Settings where food contamination occurred, as a percentage, Canada, 1987 – 1995

Year	Food Service* Establishments	Food Processing Establishments	Homes	Others **
1987 ²⁰	83.5	1.6	4.8	10.1
1990 ²¹	55.3	4.6	5.8	34.2
1991 ²¹	63.0	3.8	16.9	16.3
1992 ²²	83.4	0.0	15.0	1.6
1993 ²²	82.1	0.6	8.9	8.4
1994 ²³	73.7	3.6	12.7	10.1
1995 ²³	72.7	2.2	1.2	23.9
AVERAGE	73.4	2.3	9.3	14.9

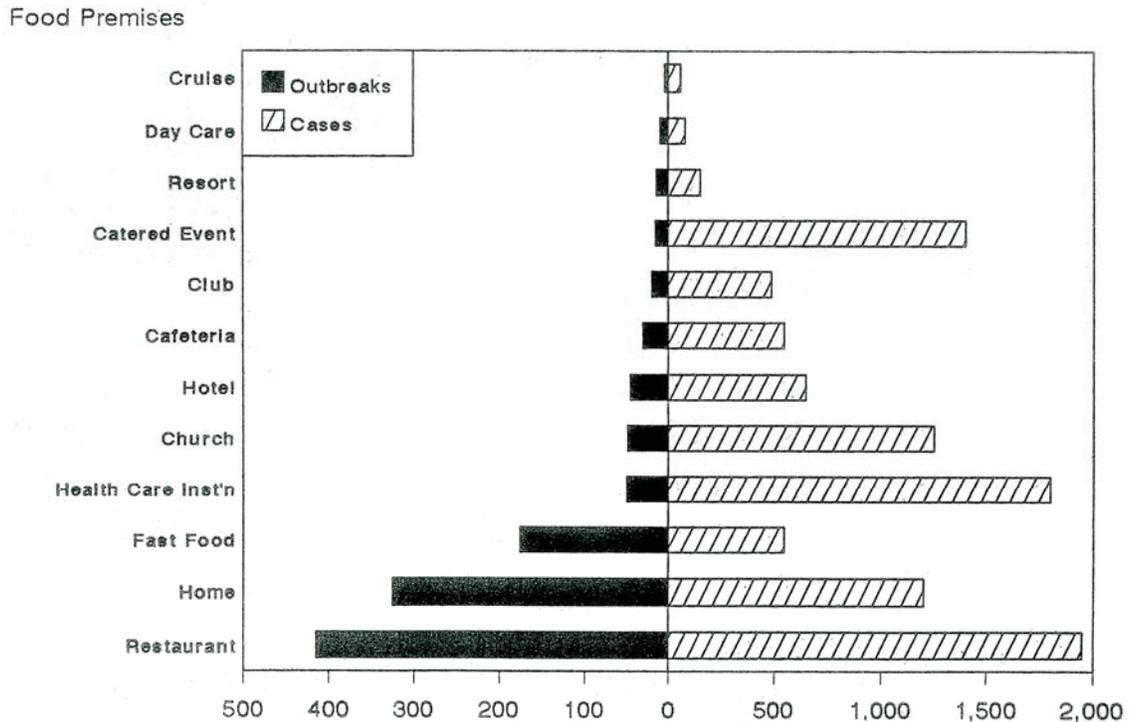
* Includes food service establishments, retail food establishments and delicatessens.

** Includes wholesalers, farm/dairies, out-of-doors and other.

As indicated in Table 2, food service establishments comprise the majority of cases where the place where the food was mishandled was known. Of the 7 years studied, the proportion of cases originating from food service establishments ranges from 63.0 per cent to 83.5 per cent, with an average of 73.4 per cent.

- b) Studies from Ontario also indicate that food service establishments account for a high proportion of cases of foodborne illness.
- Based on an analysis of Ontario outbreak data from 1982 to 1989 (Leber, Styliadiass, and Bradsky 1989), and on the number of foodborne illness outbreaks and cases, restaurants are the most common source of foodborne illness. With regard to the number of cases, this is followed by (in descending order) by health care institutions, catered events, church events and in the home. This is shown in Figure 1.

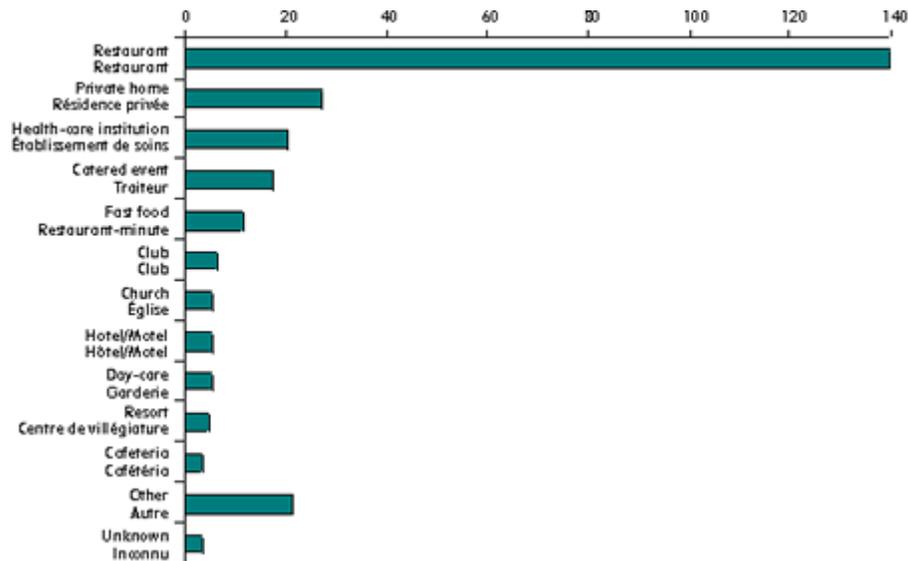
Figure 1. Food-borne Outbreaks/Cases
 (By Food Premises Ontario, 1982 to 1989)



Source: LeBer et al, 1989

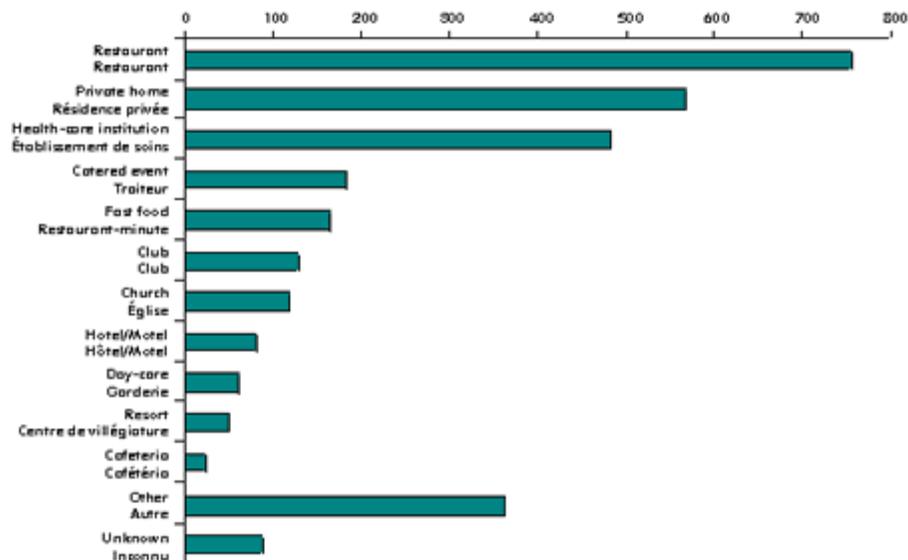
- In Isaacs, LeBer, and Michel (1998), a more recent analysis of the Ontario Reportable Diseases Information System (RDIS) examined the cases of foodborne diseases that were reported between 1993 and 1996. Figures 2 and 3 show the distribution of the risk setting of the 280 outbreaks and the 3,057 cases associated with those outbreaks reported in that time period. Based on this analysis, restaurants were the most common source of foodborne illness outbreaks and cases. This was followed by (in descending order) private homes, health care institutions, catered events, and fast food venues:

Figure 2: Distribution of Foodborne Disease Outbreaks by Risk Setting, Ontario, 1993 to 1996



(Source- Isaacs et al. 1998)

Figure 3: Distribution of Cases of Foodborne Disease Associated with Outbreaks by Risk Setting, Ontario, 1993 to 1996



(Source- Isaacs et al. 1998)

- c) Studies from the United States also show similar trends. A total of 2,751 foodborne disease outbreaks were reported and studied during 1993 to 1997 (Olsen et al. 2000). A summary of where the contaminated food was eaten is presented in Table 3. Again, food service establishments were identified as the primary source of the contaminated food in the outbreaks studied, followed by private residences.

Table 3: Source of Contaminated Food, United States, 1993 – 1997

Year	Place Where Food Was Eaten				
	Private Residence	Food Service Establishment*	Organized Event**	Other	Unknown Place
1993	17.8	45.8	8.8	25.8	1.8
1994	19.9	39.7	8.9	28.3	3.2
1995	23.4	45.9	5.9	20.5	4.3
1996	22.6	41.5	9.0	22.9	4.0
1997	22.4	42.9	7.3	22.8	4.6
Average	21.2	43.2	8.0	24.1	3.6

* Includes delicatessen, cafeteria, and restaurant.

** Includes school, picnic, church, and camp.

3.3.2 Risk Factors Associated with How Food Is Contaminated

Understanding the risk factors for how food is contaminated is also important in designing a food safety strategy. The greatest risk to food safety arises from microbial hazards. Todd's studies (1994, 1997, 1998, 2001) of foodborne incidents in Canada identify microbial hazards as the primary source of contamination where the etiology was known. Among microbial hazards, bacterial pathogens appear to be the most common cause of foodborne illness (Council for Agricultural Science and Technology 1994). Bacterial pathogens accounted for 66 per cent of outbreaks and 87 per cent of individual cases in the United States in the period 1973 to 1987 (Bean and Griffin 1990).

An analysis of outbreaks of foodborne illness in the United States from 1973 to 1982 indicates that temperature abuse (at food service establishments) was the most common factor that increased the hazard of food. The most common causes of temperature abuse were: improper cooling of food by storage in large containers in refrigerators; the lapse of 12 or more hours between preparation and eating; inadequate reheating; and improper holding of food (Bryan 1990). Other significant factors associated with foodborne illness were: incorporation of raw foods into foods that received no further cooking; inadequate cooking, canning or heat processing; foods from unsafe sources; and cross-contamination (Bryan 1988). These studies indicate that a significant factor in determining whether a food will be contaminated relates to the food processing and food handling practices. Certain practices, if done incorrectly, can lead

to a higher risk of food contamination. Food processing and food handling practices are generally controlled by the decisions made by the food workers.

Certain types of foods also appear to be at higher risk of being involved in foodborne incidents. High protein foods cause the majority of foodborne incidents. High protein foods include meat, marine foods, poultry, eggs and dairy foods. Todd (2001) reports that in Canada in 1993 to 1995, where the etiologic agent was known, these high protein foods were the cause of 56 per cent (1993), 56 per cent (1994), and 67 per cent (1995) of total cases.

Based on Canadian, Ontario and United States data, food service establishments are identified as the most significant and common cause of foodborne illness. This is followed by private homes/residences. The greatest risk to food safety arises from microbial hazards. Certain food processing practices create a higher risk that the resulting food will be contaminated. Decisions regarding food-processing practices are generally made by food workers. High-protein foods are the cause of a high proportion of foodborne incidents.

3.4 Conclusion

Foodborne illness is a significant health problem in BC. The number of estimated cases of foodborne illness annually in BC ranges from 208,980 to 652,248. Based on Canadian studies, which are comparable to international studies, the cost of foodborne illness in BC ranges from \$206,472,240 to \$644,421,020 annually.

The primary source of contaminated food is from food service establishments, followed by private residences. The risk factors involved with contaminated food are associated with certain processing practices. Incorrect decisions made by food workers regarding food-processing practices will more likely result in contaminated food. High protein foods are also at higher risk of being associated with foodborne incidents.

In order to lower the number of cases of foodborne illness in the community and the costs of foodborne illness to society, a modern comprehensive food safety strategy is necessary. There are three key elements to a food safety strategy:

- a) A food inspection program which includes a risk assessment/risk-based inspection system as well as Hazard Analysis Critical Control Point (HACCP)-based requirements for food premises.
- b) Foodborne illness outbreak investigations and food recall programs.
- c) Food safety education programs, both for the food industry and the public.

These three elements are discussed in the remaining sections of this report.

4.0 FOOD PREMISES INSPECTION PROGRAM

The purpose of a food premises inspection is to improve the health of the population by reducing the incidence of foodborne illness from food premises. This is accomplished by conducting inspections, educating the operators and food workers on food safety during those inspections and enforcing the British Columbia Food Premises Regulation. The British Columbia Food Premises Regulation (1999) defines a “food premises” as “...any place where food intended for public consumption is sold, offered for sale, supplied, handled, prepared, packaged, displayed, served, processed, stored, transported or dispensed.”

4.1 Description of a Food Premises Inspection Program

Public health inspectors educated in food safety practices provide food premises inspection programs. The inspection ensures compliance with legislated health and safety standards and is a regulatory requirement to issue operating permits.

Since 1998, public health inspectors have been using a risk-based inspection approach in the inspection of food premises. The risk-based inspection approach is based on the principles of the Hazard Analysis Critical Control Point (HACCP) system (described in Section 4.3). The approach uses the Ministry of Health (1997) manual entitled *The Risk-Based Inspection Approach: A HACCP Guide to Food Safety*, as its primary guidance document. The locations where food are likely to be contaminated as well as the risk factors associated with how food is contaminated (identified in Section 1 of this paper) are important aspects of the risk-based inspection approach. As such, risk assessment, hazard rating and food safety management are key components of this approach.

As part of the risk-based inspection approach, an inspector conducts unscheduled routine inspections to evaluate a food premises under normal operating conditions. The primary purpose of these routine inspections is to identify any significant food safety hazards or risks. Findings are reported to the operator for corrective action or compliance. Follow-up inspections would be conducted to ensure compliance with the corrective action or recommendations from the last inspection.

The focus of a food premises inspection should be the food processing and worker sanitation. The inspector should observe the areas and operations recognized as food handling practices that are at highest risk of contributing to foodborne illness. Identification of known risks associated with certain food preparation practices, food types and menu items should guide the allocation of time and focus during the inspection. Foods that have been more frequently implicated in foodborne illness, such as high protein foods, should receive higher priority. Foods prepared in large volumes and foods requiring manual assembly prior to service should also be closely observed during inspections.

The inspection should also concentrate on the complex food processes, which involve multiple ingredients being assembled or mixed, cooking of potentially hazardous food, foods which are prepared and held for several hours before service, foods which must be cooled and reheating of foods. These are the practices and risk factors known to cause the majority of foodborne

illnesses. In addition, the inspector also assesses the level of control the premises has over those practices and risk factors.

Scheduled inspections are also conducted. Generally, the inspector sets up an appointment with the operator to conduct a scheduled inspection. This gives the inspector the opportunity to discuss the food safety management plan with the operator (described in Section 4.3). The effectiveness and application of the food safety management plan is examined and any deficiencies in the plan are discussed with the operator for correction and follow-up.

Health authorities across the province do not have a standardized food premise inspection program per se. While the training of public health inspectors is standardized across BC and Canada by the Canadian Institute of Public Health Inspectors, the principles of the risk-based inspection system are used to guide the inspectors in their inspections of food premises, to prioritize and focus their resources on the high-risk practices and foods in the food premise.

Another component of the food premise inspection program involves foodborne illness investigations. These are conducted at facilities associated with any suspected outbreaks or complaints of foodborne illness. Foodborne illness investigations also use the risk-based inspection approach for guidance. However, these investigations tend to focus on the handling and processing practices of the suspect food (if known).

Identification of all regulatory violations should be noted during the inspection. A progressive enforcement scheme should be used in the case where chronic violations are noted on repeated inspections. As part of the inspection follow-up, operators must be educated on safe food handling procedures, and repeated violations should result in further legal action. In BC, the inspector can issue a violation ticket for specific violations observed at the time of the inspection.

As per the risk-based inspection approach, inspection frequency is based upon risk assessment and categorization, as described below.

4.2 Risk Assessment and Categorization

As per the risk-based inspection approach, food premises should be rated using a common risk assessment tool to categorize the food premise by potential risk of causing a foodborne illness. Risk assessments should be used to determine the frequency of routine inspection, with higher risk facilities routinely inspected more frequently than lower risk facilities. Annual reviews of the facility risk assessments should be conducted to ensure processes have not been modified that would create a significant health risk.

Risk categorization allows establishments to be ranked by considering risk factors and creating variable inspection frequencies for each category. Inspection frequencies range from a single routine inspection annually for low-risk premises to four routine inspections annually for high-risk premises. For example, food premises that serve only prepackaged, non-potentially hazardous food with limited preparation would be considered low-risk. High-risk premises are those that perform extensive handling of raw ingredients; use preparation processes that include the cooking, cooling and reheating of potentially hazardous foods; or use a variety of processes

that require hot and cold holding of potentially hazardous food; or whose food processes include advance preparation for next day service. High-risk premises would also include those facilities whose primary service population is immunocompromised (United States Food and Drug Administration [USFDA] 1999). Inspection frequency should also be based upon the historical compliance of the premise to recommendations of corrective action from previous inspections by the public health inspector.

In BC, a risk assessment tool was developed to categorize food premises based on six operational areas:

- Use of a food safety management plan.
- Nature of food preparation.
- Management effectiveness.
- Staff qualifications.
- Inherent food hazard.
- Historical level of compliance.

However, the inspection frequencies based on the risk assessment and classifications have not been developed.

In BC, food premise operations are commonly given a high, moderate or low hazard inspection risk rating. These ratings are subjective and based on the number and type of hazards identified at the time of the inspection. This hazard rating would determine inspection frequency and re-inspection date.

Food safety risks identified during an inspection can be defined as critical and non-critical hazards. Critical hazards are those food handling practices that are the most common causes of foodborne illness, while non-critical hazards include sanitation and maintenance risks where a loss of control would not pose a significant health risk.

4.3 Food Safety Management

A key requirement of the British Columbia Food Premises Regulation (1999) is that the operator must develop a written food safety management plan for the processes and foods produced in the food premises. The food safety management plan is based on risk and uses the Hazard Analysis Critical Control Point (HACCP) principles. HACCP, as a risk management system for the production or preparation of food products, has been reported to be effective for the prevention of foodborne diseases (Kato et al. 2004). In HACCP, the structure of the control system is based on seven principles:

- Food safety hazards are identified.
- The critical control points are determined.
- The critical limits are set.

- Methods are put in place to monitor critical limits.
- Corrective actions are identified.
- Records are kept and reviewed.
- The HACCP system is periodically audited.

In British Columbia, the food safety management plan is used to monitor food-handling practices. It requires every operator of a food service establishment to have written procedures to ensure that a health hazard does not occur in the operation of the establishment. The written procedures required must include: identification of all critical control points; critical limits for those critical control points; the procedures to be followed to ensure adherence to the critical limits; and the actions to be taken in the event that the critical limits are not adhered to. The primary food safety outcome of using a food safety management plan is that the operator will have better control over the food safety risks associated with his or her operation.

Two other key food safety requirements of the BC Food Premises Regulation (1999) require operators to develop a sanitation plan, and have operators trained in food safety:

- Sanitation plans require every operator to identify how chemicals are handled, and define the cleaning and sanitizing procedures for key food equipment and utensils used in the food establishment.
- Food safety training is required and every operator of a food service establishment must hold a certificate, issued by a public health official, for the successful completion of the food handler-training program known as FOODSAFE, or its equivalent. If an operator is absent from the food service establishment, at least one employee present in the establishment must also be trained in FOODSAFE or its equivalent. A more complete description of the FOODSAFE program is provided in Section 4 of this paper.

4.4 Evidence that Food Premise Inspection Programs Result in a Lowering of Foodborne Illness Rates

For the purposes of this review, we have identified published research relating to successful food safety intervention strategies from multiple perspectives. There is a need for ongoing research in this area, as many of the articles and reports reviewed refer to the same research documents.

Evidence supports the food safety risk categorization of food premises from a food safety management viewpoint. Risk categorization of food premises allows for better management of resources, which health departments can then use to target or focus their inspection resources on those food premises which have the highest risk of causing a foodborne illness outbreak (Collins 1995). Campbell et al. (1998) also concluded that there was some evidence to support an annual risk assessment for each premises.

A report of the Australian Institute of Environmental Health (2003) recommends categorizing food establishments based on the risk of causing a foodborne illness. The report recommends inspection frequencies ranging from inspecting high-risk facilities four times per year to

inspecting low-risk facilities every eighteen months. The inspection frequency would increase or decrease based on the seriousness of the infractions noted at the time of inspection.

With regard to evidence that food premises inspection programs result in a positive outcome, a Seattle-King County study (Irwin et al. 1989) identified that food premises inspection programs resulted in a lowering of foodborne illness rates. The study also found that restaurant inspection scores can predict foodborne outbreaks.

The inspection reporting system used in Seattle-King County identified 42 types of violations classified as critical and non-critical (See Appendix 2 for listing of the 42 types of violations). Critical violations are thought to have a direct impact on foodborne disease. Non-critical items are thought to play a minor role in foodborne illness. Critical violations incur a debt of 4-5 points from a perfect inspection score of 100, whereas non-critical violations incur a debt of 1-2 points.

An inspection score of 86-100 indicates a satisfactory result. A score of 70-85, or a violation of any critical item, indicates an unsatisfactory result requiring timely correction of violations. A score of less than 70 points warrants a permit suspension and restaurant closure. The study found that restaurants with poor inspection scores (less than 86 points) and those with violations of proper temperature controls of potentially hazardous foods were, respectively, five and ten times more likely to have outbreaks than restaurants with better results. The study also identified other factors that increase the risk of an outbreak including any improper food protection practice, improper storage and handling of equipment, and any critical violation. The restaurants with an increased risk of a foodborne outbreak, or poor inspection score, required more regulation to prevent outbreaks from occurring.

With regard to inspection frequencies, Allwood, Lee, and Borden-Glass (1998) measured the impact of restaurant health inspections by comparing mean inspection areas. They found that inspection scores decreased significantly among those establishments that were inspected at a lower frequency. This finding, combined with Irwin et al. (1989), concludes that less frequent inspections would result in a higher risk of foodborne illness. In addition, Allwood et al. (1998) found a significant increase in the mean number of food temperature violations in restaurants inspected less frequently. Abuses in food temperature are a known risk factor in the cause of foodborne illness.

Campbell et al. (1998) concluded that one routine inspection per food service premises per year is likely to reduce the risk of foodborne illness. The study did not preclude additional inspections but did not make recommendations for the optimal inspection frequency.

Mathias et al. (1995) also evaluated inspection frequencies of restaurants with relation to inspection scores. They found that the longer the time since the last inspection, the lower the inspection score. Inspections at a frequency of less than one year were not different from each other, but inspections done at a frequency of over one year had significantly worse violation rates. Again, this finding combined with the conclusions from Irwin et al. (1989), provides evidence that restaurant inspections done on a regular basis should lower rates of illness.

The Riben et al. (1994) study of inspection frequencies also made conclusions regarding inspection frequencies. They stated that routine restaurant programs should occur and they concluded that an effective number of inspections is between one and two per year. They also concluded that the emphasis in routine inspections should be on the critical points which have been identified as being responsible for foodborne outbreaks, rather than those points less likely to be responsible for outbreaks, such as the structure of the facility.

Mann et al. (2001) reviewed a number of studies with regard to food safety interventions. Their recommendations for practice were that public health departments should provide routine inspections of restaurants, as routine inspections were effective in enhancing inspection compliance. They did, however, comment that much of the evidence they reviewed was of moderate methodological quality. Despite this, they did further comment that it was important to recognize that the lack of good quality studies does not mean that the interventions evaluated were not effective.

The United States Food and Drug Administration (1999) Food Code recommends that routine inspections include a full review of the premise operations and facilities, and their impact on food safety. This includes:

- Assessment of food employee and management health practices, knowledge and practice of food safety.
- Food flows, source, storage, thawing, preparation, (including cooking temperatures and times) and post-preparation processes.
- Equipment and facility construction.
- Cleaning and sanitizing processes.
- Water sources.
- Sewage disposal.
- Vermin control.

Routine inspection frequency should be at least once every six months, unless the premise is operating under an approved HACCP plan.

4.5 Conclusion

The research indicates that effective interventions for food premises inspection programs should include risk categorization of food premises. Routine food premises inspections should be conducted, as the evidence suggests that inspections do lower the likelihood that food safety risk factors will occur, and this should lower the risk of foodborne illness. Food premises inspections should include inspection of critical points that have been identified as risk factors of foodborne illness.

5.0 FOODBORNE OUTBREAK INVESTIGATIONS AND FOOD RECALLS

Foodborne illness has many causes, including intrinsic hazards such as natural toxins, and extrinsic hazards such as chemical or biological contamination (Adams and Motarjemi 1999).

Strategies to reduce the presence of such hazards involve commercial producers, farmers, market gardeners, private individuals who garden or collect food-stuffs for consumption, manufacturers and purveyors of food, and those who prepare food for consumption. If at any point in the system prevention fails, an outbreak may occur which may involve cases dispersed over a wide geographic area (Sobel et al. 2002; Levitt 2001; Roberts 2000). When a foodborne illness outbreak does occur, two key elements of a modern comprehensive food safety strategy are implemented. These are: foodborne illness outbreak investigations, and food recalls

5.1 Foodborne Illness Outbreak Investigations

A foodborne illness outbreak is defined as:

- Two or more cases of the same illness linked by epidemiological, clinical, or microbiological evidence to consumed food; or
- An increase in the observed numbers of cases of the same illness compared with the expected number during the same period (O'Brien et al. 2002; Roberts 2000).

Outbreaks are frequently discovered as a result of cases being reported by alert individuals in the medical or public health areas. On the other hand, systematic surveillance at the provincial or national level may be the only way of detecting an outbreak where cases are spread over a wide geographic area (Roberts 2000).

An outbreak investigation involves a number of important steps (Bryan et al. 1988):

- a) First of all, public health must receive notification of illnesses that might be foodborne.
- b) Case histories must then be obtained by interviewing those who are ill and persons who are at risk but who remained well.
- c) The next step is to identify epidemiological associations (person, place, and time) based on this information. These associations allow the formulation of hypotheses to explain the most likely type of illness, the foods most likely to be implicated, and where and how they became contaminated.
- d) At this point precautionary or intervening actions to stop the spread of a pathogen or prevent further exposure to a toxicant may be taken.
- e) At the same time additional investigations must be done to confirm or refute the hypotheses generated. This would include collecting clinical specimens and food samples and visiting places where suspected foods have been produced, processed, or prepared to determine the sources and modes of contamination. These additional investigations may lead to further recommendations for intervening action.
- f) Finally, it is essential that the investigation be summarized in a written report.

There are three primary objectives of a foodborne illness investigation:

- a) The immediate objective is to identify the contaminated food that is causing disease, remove it from the market, and prevent further consumption and illness (Sobel et al. 2002; Levitt 2001). At the local level, the imperative purpose of outbreak investigation is to achieve outbreak control and prevention of secondary spread (O'Brien et al. 2002; Levitt 2001; Roberts 2000; Keene 1999). A properly conducted investigation can provide the rationale for advice concerning the clinical management of cases, exclusion from work or school, and institutional interventions such as ward closures and cleaning regimens.
- b) The second objective is to identify the gap in manufacturing or handling that allowed contamination of the food, so that preventive measures to render the food supply safer can be implemented (Sobel et al. 2002). Retrospective analysis of foodborne outbreaks has provided a wealth of information on risk factors and potential critical control points of value in developing and maintaining HACCP systems (Panisello et al. 2000). However it is necessary to capture information (define the epidemiology) from common outbreaks as well as the unusual outbreaks often described in the literature (Daniels et al. 2002; O'Brien et al. 2002). To do this, central reporting of all outbreaks using a standard minimum dataset allows an examination of trends in the characteristics of all general gastrointestinal outbreaks (O'Brien et al. 2002). Outbreak investigation can also provide a robust evidence base for identifying high-risk foods, practices, or behaviours, and high-risk populations. This evidence base allows the development of policies that will protect public health in the medium-and long-term (Daniels et al. 2002; O'Brien et al. 2002; Roberts 2000).
- c) The third objective is to augment scientific understanding of agent host and environment. Most agents that cause foodborne illness have been discovered in the course of outbreak investigations, as well as information about their reservoirs and routes of transmission (Sobel et al. 2002; Levitt 2001; Keene 1999).

Given the impact that outbreaks can have on food safety policy, the quality of outbreak investigation becomes very important. The quality will depend upon the preparedness and expertise of the investigation team and their ability to respond rapidly when an outbreak is identified. Most outbreaks occur in premises where food is rarely kept for more than a few days. Therefore, investigators must rely heavily on analytical epidemiological methods, including cohort and case control studies (Palmer et al. 2000). Critical importance must be given to immediate response when an outbreak is reported. Delays in response or a limited response will reduce the chance that the investigation will identify vehicles, reservoirs, and contributory factors (Guzewich, Bryan and Todd 1997).

Alternatively, an outbreak investigation program that is adequately resourced and staffed with properly trained personnel can quickly identify the source of an outbreak and facilitate successful intervention strategies, resulting in an absence of negative economic events. An example of a rapid and successful investigation involved an outbreak of botulism in hazelnut-flavored yogurt in England. As a result of the investigation, interventions occurred which identified the source of the infection and removed it from the marketplace. It was estimated that the interventions in this example saved a total of 4-10 million British pounds (\$9.64-26.51 million CDN [in 2003

dollars]). The investigation was estimated to cost not more than 6,000 British pounds (\$14,482 CDN [in 2003 dollars]) including the cost of the removed product (Roberts 2000).

In conclusion, successful outbreak investigation programs require trained and dedicated public health workers and adequate support resources (Keene 1999).

5.2 Food Recalls

A food recall is the removal from further sale or use of a product for which there are reasonable grounds to believe that it poses a risk to public, animal, or plant health. Recalls may be initiated by ministerial order under the *Canadian Food Inspection Agency Act* (mandatory recall), or by a company that initiates and carries out the recall on its own (voluntary recall).

Food recalls are classified on the basis of the risk posed to the health of users of the recalled product. A “Class 1” recall involves a situation where there is a reasonable probability that use of the product will cause serious adverse health consequences or death. A “Class 2” recall involves a product that may cause temporary adverse health consequences, or where the probability of serious adverse health consequences is remote. A “Class 3” recall involves a product that is not likely to cause any adverse health consequences. A recall may be conducted to different tiers in the product distribution system (consumer, retail, and distributor) (Canadian Food Inspection Agency [CFIA] 2001a). In general, Class 1 and Class 2 recalls involve public notification.

Food safety problems that result in a recall may be identified by the product manufacturer, importer, consumers, the CFIA, or as a result of a foodborne illness investigation conducted by public health staff (CFIA 2001b; Guzewich et al. 1997).

In the United States, about 35 per cent of food recalls are the result of microbiological contamination, and another 24 per cent are due to the presence of one or more of 8 common allergens (Wong et al. 2000; Vierk et al. 2002). Canadian statistics on food recalls are somewhat similar. In 2003, 24 per cent of the food safety alerts posted on the CFIA website were a result of microbiological contamination, and 61 per cent were due to the presence of an allergen (CFIA 2004).

Depending on the severity of the food safety risk, an important aspect of food recalls is public notification about the details of a food recall. Public notification is generally done through the media in the form of press releases and other similar methods. There are two main purposes in notifying the public about food recalls:

- To inform consumers that, if they have consumed the recalled product and are experiencing associated symptoms, they can inform their physicians about the possible cause, resulting in a higher likelihood of a correct diagnosis and successful treatment outcome.
- To ensure that consumers immediately cease consuming any of the recalled product that may still be in storage in households, in order to reduce the number of new cases.

There is evidence that public notification of food recalls is effective in reducing the number of new cases. In 2002, The BC Centre for Disease Control investigated a listeriosis outbreak

associated with mold-ripened cheese. In that outbreak, 48 of the cases had consumed the contaminated product prior to the public recall. Only 2 of the cases consumed the contaminated product after the public recall (unpublished data).

5.3 Conclusion

When a foodborne illness outbreak occurs, two elements of a food safety strategy are generally implemented: a foodborne illness investigation and a food recall. The evidence suggests that these actions are effective in protecting public health through the reduction of new outbreaks both in the short and long term.

6.0 FOOD SAFETY EDUCATION PROGRAMS

Food safety education programs fall into two broad categories: those intended for the food industry and those intended for the general public.

6.1 Communicating Food Safety to the Industry

In British Columbia, under the old Sanitation and Operation of Food Premises Regulation, there was a requirement for the operator to demonstrate adequate knowledge to run a food services establishment. This requirement was later removed. When the Food Premises Regulation was introduced in 1999, it made FOODSAFE training, or its equivalent, mandatory.

Across Canada, there are several different courses to train food handlers, which are offered by employers, private agencies, and public facilities. In British Columbia, the officially recognized course is FOODSAFE, and any alternative course must be considered to be its equivalent in order to meet the requirements of the Food Premises Regulation.

6.1.1 FOODSAFE

FOODSAFE was developed in the 1980s and was taught in regional colleges and by private instructors. It is available as a Level 1 entry course, and a Level 2 manager's course. To date, close to 400,000 people in BC have taken the Level 1 course.

In the mid-1990s, a project was launched in cooperation with the Workers' Compensation Board to revise the Level 1 course. The new version was released in late 2002, incorporating updated information on foodborne illness as well as worker safety. In 1994, Level 2 also went through major revision and now covers the basics of HACCP, as well as foodborne illness in depth, staff training, and facilities maintenance.

The current Food Premises Regulation, promulgated in 1999, made FOODSAFE a requirement for operators of food service establishments. Section 10 of the regulation requires not only the operator to have FOODSAFE (or its equivalent), it also requires someone with FOODSAFE to be present at all times when the operator is not. Section 10 came into force in 2000, along with the food and sanitation safety plan requirements.

Currently, FOODSAFE is offered as part of the foods and nutrition courses at many secondary schools throughout the province as well as post-secondary institutions and through the private education sector. FOODSAFE is administered at the health authority level, incorporating the involvement of interests from the course deliverers. Records of participants are kept on a secure web-based registry.

6.1.2 Ongoing and Specific Training

FOODSAFE is the only provincial system of training for food premises operators, but individual health authorities undertake initiatives to train operators at their discretion. One example of localized training by the health authorities is instruction to the operators of food service

establishments on the writing and implementation of food safety plans. This was done to help operators comply with the requirements of Section 23 of the Food Premises Regulation.

6.1.3 Written Materials

The province and the health authorities provide written materials to the industry in the form of

- Posters: handwashing, manual ware washing, process-based food safety plans, etc.
- Information Sheets: Health Files, Fish Safety Notes, Food Safety Bulletins etc.
- Booklets: *Food Protection - It's Your Business*, and *Enhancing Food Safety the HACCP Way*.

All of the information provided is made more effective through the ongoing relationship that public health inspectors have with operators. Inspectors must keep current with new trends, innovations, regulations, and discoveries impacting food safety and the industry.

6.1.4 Food Safety Knowledge “Aids”

One way to ensure knowledge is carried from the classroom to the kitchen is to provide “reminders” to operators in the form of posters, check sheets, reviews, and booklets. Although some support is provided by the Ministry of Health Services and the BC Center for Disease Control in this regard, this is mostly left up to the health authorities. An example of an aid is the generic, process-based food safety plan employed by some health authorities. It can simplify the more complex food safety plans and be placed on a poster.

6.2 The Effectiveness of Educating the Industry

There are a number of papers that look at the effectiveness of food sanitation training. Rinke, Brown, and McKinley (1975) compared the effectiveness of self-taught (synchronized slide/tape) food safety training versus instructor-led training. They reported that there was no identifiable difference between the two methods of education. The study compared supervisors with non-supervisors and grade 12 and higher education with grade 11 and under and found no real difference in education level or in teaching technique. The sample size was small and the study did not address the overall effectiveness of training in lowering the risk of foodborne illness.

Waddell and Rinke (1985) later tested subjects to see if computer-assisted self-instruction was more useful in training food handlers than a lecture system. They found no real difference in the two systems. The study used a control group, and also a pre-test in order to measure the amount of gain in knowledge.

Riben et al. (1994a), Riben et al. (1994b), and Mathias et al. (1994) published results of a literature search and a restaurant survey, and their subsequent recommendations with regard to restaurant inspections and food handler education. With regard to education, they recommended that: “Education of food handlers should continue. Although the evidence is weak and inconsistent, the recommendation is based upon the consistency of practice across municipal, provincial and international borders. Recommendations, based on the existing literature, cannot

be made on course content, site of training, duration of the course. This area definitely requires further study to develop an effective and efficient program” (Riben et al. 1994b).

Mathias et al. (1995) subsequently reported on a study they undertook to explore the relationship between food safety training and inspection scores in restaurants in three Canadian provinces. This study is the most significant of the papers reviewed in this section for at least three reasons: it is a Canadian study that includes restaurants in BC, and therefore is more likely to be indicative of Canadian trends; the number of premises included in the study was relatively high (630); and, the test subjects were taken from a large geographic area.

Mathias et al. (1995) found that education did make a difference in the inspection rating of food service establishments, by comparing inspection ratings and training of staff. They found there was a difference in violation scores if the managers and staff had some training. Premises were scored on a rating system starting with 100 (best possible score), and demerits were subtracted for violations. The first 10 items from the premises score sheet dealing with food handling violations gave scores for the individuals. The lower the rating number for individuals, the more highly they scored (best possible score being 0).

For both the violation scores for the premises and the personal food handling scores for the individuals, scores increased with increasing food safety course lengths (although no significant improvement was noted between the 5 day training and 6 month training groups). The most significant improvements were noted in mean “food handling scores” for staff (versus managers), going from a mean of 5.0 for staff who had no training, to 2.0 for staff who had over 180 days of training, compared to 5.1 to 3.6 for managers.

Ehiri, Morris, and McEwen (1997) conducted a study comparing the gains in food safety knowledge between food handlers and an independent group. They used a pre-test and post-test system and an “intervention group” and “comparison group” for control purposes. The overall study population was 392, with 188 in the intervention group and 204 in the comparison group. The pre- and post-test scores were used to establish gains and compare them between the two groups (they concluded that the pre-test did not influence the comparison by contributing to the knowledge base of either group).

The results did not show a significant difference between the groups; that is, the intervention group did not improve appreciably in food safety knowledge with the training intervention. They also concluded that the design of food safety training courses should “take account of social and environmental influences on food safety” and that food safety training should be part of an overall strategy to provide safe food for human consumption and not be an isolated intervention.

Finally, Cotterchio et al. (1998) reported on a study undertaken to assess the inspection ratings of a sampling of premises in Boston. They compared the ratings of three groups of premises: those run by managers required to take a 15-hour food safety course; those run by managers who voluntarily took the course; and those run by managers who did not take the course. Managers were required to take the course if their premises had significant violations or if their premises had been associated with a foodborne illness.

The results were encouraging; the mean inspection ratings significantly improved for those premises that were part of the mandated training (up 14.7 points) and for those that were part of the voluntary training (up 7.5 points). These scores were noted 1 year after training, and were maintained at 2 years post-training. The control group did not see a significant change in inspection scores. The study did incorporate controls, but the sample size was quite small, assessing only 23 premises in the ‘mandatory’ group; 31 in the ‘voluntary’ group; and 40 in the control group.

6.3 Communicating Food Safety to the Public

Public health inspectors maintain an educational and advisory relationship with the public (unlike their educational and regulatory relationship with the industry). As part of the environmental health ‘strategy’ to reduce morbidity due to contaminated food, there is an outreach to the general population.

6.3.1 FOODSAFE

Although FOODSAFE is offered to the public, it is usually more than most people are interested in. The cost of the course averages about \$75 and the time commitment—about 8 hours—is significant for many people. However, FOODSAFE is especially suitable for volunteers involved in food preparation for events, fundraising, and emergency operations.

6.3.2 Specific, Localized Courses

Health authorities will also offer specific courses intended for volunteers. The availability of courses is often dependent on the availability of environmental health staff to deliver them.

There is also a course that was developed in the 1990s, intended for small residential care facilities (6 beds or less) that do not require food service permitting (and therefore, do not require the FOODSAFE course specifically).

6.3.3 Written and Electronic Materials

Materials such as the Health Files, Food Safety Bulletins, and Fish Safety Notes are also available to the public in hard copy and through the Internet. One such website is operated by the Canadian Partnership for Consumer Food Safety Education, a government/non-governmental organization partnership aimed at helping the general public become aware of food safety issues. Their message is simple, breaking food safety down into four categories:

- Clean: Thoroughly clean hands, food contact surfaces, and utensils.
- Separate: Don’t cross-contaminate; keep raw foods and ready-to-eat foods separate.
- Cook: Cook all foods thoroughly.
- Chill: Refrigerate foods promptly, whether after cooking or bringing groceries home.

The Partnership’s website is at <http://www.canfightbac.org>

In addition to these resources, some health authorities post restaurant inspection results on their website for the public's edification. This must be done carefully to be fair and as objective as possible. For example: a hazard rating for a food service establishment is quite subjective and can be open to interpretation. It is simpler to actually post the inspection results.

6.3.4 Media Releases

Each health authority takes responsibility to do public service announcements and media releases pertaining to seasonal and emergent issues, as well as regular, general messaging around food safety. "Themed" monthly messaging can also be undertaken, as is the case in Interior Health, with December being food safety month.

The Canadian Food Inspection Agency is the lead agency for notifying the public about food recalls and alerts. The BC Centre for Disease Control also has a role in distributing this information to the health authorities as well as notifying the public on food-related health hazard alerts. Food recalls and health hazard alerts are generally distributed using press releases. While the main purpose of these messages is to immediately alert the public about a specific health risk (i.e., a certain food is contaminated, so do not consume it if it is in your home, dispose of it, etc.), many of these messages are also used for educational purposes (i.e., ground meat should always be cooked to destroy all disease-causing organisms, etc.).

6.4 The Effectiveness of Educating the Public

Woodburn and Raab (1997) reported that during an Oregon survey of households in December 1995 and January 1996, there was an increase in knowledge about foodborne illness, although there were gaps. This was following media coverage of a large outbreak of foodborne illness due to hemorrhagic *E. coli*.

The study reported that understanding of what foods are higher risks had increased, but there remained some hesitation on what could be done to make those foods safe to eat. Conversely, there was a decrease in the number of households that felt they had experienced foodborne illness, and there was an increase in the number of safe practices. It was noted that awareness of the experience of foodborne illness was limited to illness that came on no more than one day after consumption of the suspect food. Food infections with lengthy incubation periods would have been ignored.

In this study, there was a lack of knowledge about which populations were at high risk for contracting foodborne illness. Therefore Woodburn and Raab recommended focusing education on those high risk groups. They also acknowledged that younger populations should be the focus of education efforts, and those efforts should stress specific practices to make food safe to eat. The study's findings were somewhat limited in the smaller size of the sample (100) and the overrepresentation of women in the responders. There was also some question around the acceptability of the baseline data since they were taken from a portion of an Food and Drug Administration study of a much larger sample size, although some or all of the questions were similar. This limits the assessment of gains in knowledge.

Audits International (1999) conducted a study of 121 households in 82 North American cities (only 2 of which were in Canada; averaging less than 1.5 households per city). The study compared results with the same survey conducted 2 years earlier. Their results were encouraging, showing a decrease in major and critical violations per household. They assessed such factors as time/temperature abuses, personal hygiene, cross-contamination, and maintenance.

Audits International's survey showed an increase in the percentage of households meeting the criteria from 4 per cent in 1997 to 26 per cent in 1999. The frequency of households receiving at least one critical violation decreased from 96 per cent in 1997 to 69 per cent in 1999. As well, the number of critical violations per household also decreased in the time period from 2.3 in 1997, to 1.7 in 1999.

Participants in this survey indicated television, newspaper, and magazines as the top three sources of information about food safety. Importantly, the study indicated there seems to be a 'disconnect' between what people know and what they do, and that their practices need to be assessed along with their knowledge. The sample size in this study was small, and the number of households was extremely spread out.

6.5 Conclusion

It has been reported that foodborne illness is predominantly caused by hazards brought about by the behaviour and practices of food handlers. Therefore it is significant that the evidence indicates adequate and appropriate training can alter food handler behaviour.

Training of food handlers can be delivered through a variety of media and methods. Studies indicate there are details to consider in delivering education to food handlers in the industry and in the home, but in order to protect public health, it is essential that people preparing food for others be knowledgeable about the basic requirements to prevent hazards.

7.0 CONCLUSION

A high number of cases of foodborne illness occur in BC annually. The estimated number of cases in BC ranges from 208,980 to 652,248 annually. The estimated annual cost of foodborne illness in BC ranges from \$206,472,240 to \$644,421,020. As such, foodborne illness is a significant health problem in BC.

In order to lower the number of cases of foodborne illness and the costs of foodborne illness to society, a modern comprehensive food safety strategy is necessary. There are three key elements to a food safety strategy:

- Food inspection programs.
- Foodborne illness outbreak investigations and food recall programs.
- Food safety education programs.

The research indicates that these programs do lower the likelihood of occurrence of foodborne illness cases.

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APPENDIX 1: CURRENCY CONVERSIONS INTO 2003 CANADIAN DOLLARS

<p>Canada \$606 (1985) 1985 CPI = 75.0 2003 CPI = 122.3 <u>122.3</u> X \$606 = \$988 75.0</p>	<p>Sweden 2664 Sweden Krona 1998-99 1 Swedish Krona = .19 Canadian \$ = \$506 Canadian \$ <u>122.3</u> X \$506.16 = \$570 108.6</p>
<p>New Zealand \$462 (NZ) – 2000 In 2000 = \$346.5 Canadian \$ <u>122.3</u> X 346.5 = \$373 113.5</p>	<p>United States 1985 US \$ of \$670 per case 670 X 1.30 = \$871 Canadian \$ (1985) <u>122.3</u> = \$1420 75</p>

Sources for Conversion Factors: Bank of Canada (2004), Statistics Canada (2003).

APPENDIX 2: DETAILED LISTING OF 42 TYPES OF VIOLATIONS

Risk of Foodborne Outbreaks Associated with Routine Restaurant Inspection Results, by Individual Violation, Seattle-King County, Washington, January 1, 1986-March 31, 1987

Number	Violation Type†	Debit Point Value	Odds Ratio	(95 per centCI)
Food Violations				
1.	Foods from approved source, sound condition, not adulterated: no spoilage, no home canned foods†	5	3.2	(0.3, 36.6)
2.	Original container, properly labeled	1	1.0	(0.1, 18.9)
	Any food violation		2.1	(0.3, 13.1)
Food Protection Violations				
3.	Potentially hazardous foods at safe temperatures during storage, display, service, transport, hot and cold holding (45° or below or 140°F or above)†	5	10.1	(2.2, 45.7)
4.	Potentially hazardous foods properly cooked to 140°F, except pork to 150°F, poultry to 165°F, and rare roast beef to 130°F†	4		(1.2,)*
5.	Potentially hazardous foods properly cooled, 4. food depth cooled to 70°F within 2 hrs to 45°F within 4 hrs; salads made with prechilled ingredients†	5	1.4	(0.4, 5.2)
6.	Potentially hazardous foods properly reheated to 165°F†	4	1.0	(0.1, 11.0)
7.	Enough facilities to maintain proper hot and cold temperatures, properly designed, maintained, operated. Potentially hazardous foods kept under temperature control except during necessary preparation procedures†	4	8.6	(1.0, 74.9)
8.	Thermometers provided and conspicuous	1	2.0	(0.7, 5.,4)
9.	Potentially hazardous foods properly thawed	1	6.0	(0.6, 57.7)
10.	General food protection during storage, preparation, display, transportation, service; no double stacking; sneeze guards	2	2.4	(0.8, 7.2)
11.	Foods protected from cross-contamination during preparation and refrigerated storage. Foods not re-served†	4	1.7	(0.4, 7.0)
12.	Handling of food (ice) minimized; proper use of utensils	2	3.9	(0.4, 39.5)
13.	In-use food (ice) dispensing utensils properly stored	1	2.1	(0.5, 9.5)
	Any food protection violation		15.8	(2.0, 124.1)
Personnel Violations				
14.	Personnel with infections or illness restricted†	5		(0.1)*
15.	Hands washed and clean; wash hands after using the restroom; after coughing, sneezing, smoking, eating, drinking; between handling raw and cooked; or otherwise contaminating hands. Good hygienic practices†	5		(0.6)*
16.	Clean clothes, hair restraints	1	NA	
17.	Food and Beverage Workers' Permits current for all personnel	1	1.8	(0.3, 12.0)
	Any food protection violation		3.3	(0.6, 18.0)*
Food Equipment, Utensils Violations				
18.	Food (ice) contact surfaces: designed, constructed, maintained, installed, located	2	1.5	(0.4, 5.0)
19.	Nonfood contact surfaces: designed, constructed, maintained, installed, located	1	0.2	(0.04, 1.1)
20.	Food contact surfaces of equipment and utensils clean	2	1.8	(0.6, 5.4)
21.	Nonfood contact surfaces of equipment and utensils clean	1	0.6	(0.2, 2.2)
22.	Proper storage and handling of clean, sanitized equipment and utensils	1	14.9	(2.6, 85.4)
23.	Single-service articles properly stored and dispensed. No reuse of single-service articles	1	1.7	(0.2, 12.2)
	Any food equipment or utensils violation		1.8	(0.6, 5.8)

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Number	Violation Type†	Debit Point Value	Odds Ratio	(95 per cent CI)
Cleaning, Washing, Sanitizing Violations				
24.	Dishwashing facilities designed, constructed, maintained, located, operated (accurate thermometers, chemical test kits provided)	2	4.2	(0.8, 21.9)
25.	Equipment and utensils preflushed, scraped, soaked. Wash and rinse water clean, proper temperature	1		(0.03,)*
26.	Sanitization rinse: clean, proper temperature, concentration, exposure time. Equipment, utensils sanitized†	4	1.9	(0.6, 6.5)
27.	Wiping cloths clean, use restricted, stored in sanitizer	1	0.7	(0.2, 2.3)
	Any “cleaning, washing, sanitizing” violation		1.2	(0.5, 3.1)
Water				
28.	Approved water Source, hot and cold, under pressure; safe†	5	NA	
Sewage, Plumbing Violations				
29.	Sewage and waste water disposed sanitarly. No cross-connection, back siphonage, backflow†	5	2.0	(0.1, 32.0)
30.	Plumbing installed, maintained	1	2.0	(0.4, 9.9)
	Any sewage and plumbing violation		1.5	(0.3, 6.7)
Toilet, Hand-Washing Facilities Violations				
31.	Number, convenient, accessible, designed, installed†	4	3.6	(0.7, 19.9)
32.	Toilet rooms enclosed, self-closing doors, fixtures in good repair, clean; hand cleanser, sanitary towels/hand-drying devices provided, proper waste receptacles	2	1.5	(0.5, 4.1)
	Any toilet and hand-washing facilities violation		1.6	(0.6, 4.2)
Garbage, Refuse Disposal Violations				
33.	Containers/receptacles covered, adequate number, insect and rodent proof, pick-up frequency, clean	1	0.7	(0.1, 6.4)
34.	Outside storage area enclosures properly constructed, clean	1	4.0	(0.4, 44.1)
	Any garbage and refuse disposal violation		1.0	(0.2, 5.5)
Insect, Rodent, Animal Control Violations				
35.	Presence of insects/rodents. No birds, turtles, or other animals†	4	6.5	(0.8, 51.1)
36.	Outer openings protected from flying insects/rodent proof	1	3.9	(0.4, 39.5)
	Any insect, rodent, animal control violation		3.8	(0.9, 16.1)
Floors, Walls, Ceilings Violations				
37.	Floors constructed, clean, good repair, covered	1	1.5	(0.5, 4.6)
38.	Walls, ceiling, attached equipment: constructed, good repair, clean, smooth	1	2.0	(0.6, 6.8)
	Any floors, walls, ceilings violation		1.1	(0.4, 3.2)
Lighting, Ventilation				
39.	Lighting provided as required, fixtures shielded. Rooms and equipment vented as required	1	1.2	(0.3, 5.0)
Other Operations				
40.	Toxic items properly stored, labeled, used†	4	1.9	(0.5, 7.4)
41.	Premises maintained free of litter, unnecessary articles; living/sleeping quarters separate; authorized personnel; dressing rooms, lockers	1	0.8	(0.2, 3.0)
42.	Clean, soiled linen properly stored	1		(0.1,)*
Any "Critical" Violation†			6.3	(1.8, 22.5)

* Odds ratio was indeterminate in matched and unmatched analyses; only the lower 95 per cent confidence interval could be calculated in the matched analysis.

† “Critical” violations are numbers 1, 3-7, 11, 14, 15, 26, 28, 29, 31, 35, and 40.

NA - No restaurants had this violation.

Source: Irwin et al., 1989