National Collaborating Centre for Environmental Health
Centre de collaboration nationale en santé environnementale

JUNE 2014

# Risk Factors and Surveillance Systems for Foodborne Illness Outbreaks in Canada

*Annie Lukacsovics,[1] Megan Hatcher,[2] and Andrew Papadopoulos[3]*

evidence review

## Summary

- Risk factors for foodborne illness in Canada span along the "farm-to-fork continuum."
- Human risk factors include personal hygiene, cross-contamination, temperature control and unsafe food sources.
- Surveillance and food safety systems at the regional (or local), provincial/territorial, and federal levels are designed to function collaboratively.
- The efficiency of surveillance systems to produce complete datasets with pathogen-specific risk factor information is challenged by inconsistent disease reporting and insufficient information sharing.
- Recommendations include standardizing reportable disease lists and procedures for reporting (case and outbreak-related) and encouraging participation of all jurisdictions in information sharing using electronic systems.

## Introduction

A foodborne illness outbreak is defined as an incident in which two or more persons experience a similar illness from consuming a common food.[1] A well-known example was the listeriosis outbreak in the summer of 2008. The consumption of contaminated deli meats sickened a total of 57 Canadians in seven provinces and claimed 23 lives.[2] Procedures for reporting suspected cases and the routine surveillance of laboratory-confirmed cases are important mechanisms for detecting foodborne illness outbreaks and triggering outbreak investigations.[3,4] Surveillance also elucidates risk factors that may contribute to foodborne illness cases in order to inform public health policies and interventions. In Canada, foodborne illness surveillance is a shared responsibility between the federal, provincial/territorial (P/T), and regional (or local) levels of government. The federal government sets food safety standards and policies, develops and maintains surveillance systems, initiates food recalls, and develops national strategies for managing food safety risks.[5] Provincial and territorial governments each have a public health mandate that includes food safety surveillance, investigations, and compliance inspections.[6]

This review aims to summarize pertinent literature about the risk factors for foodborne illness outbreaks in Canada. Outbreak investigation procedures, with an emphasis on the role of surveillance, will also be assessed in order to determine if any improvements can be made to help establish a more complete dataset for reporting risk factors specific to Canada. Appendix A describes relevant terms used in this document.

[1] MPH Program, University of Guelph
[2] MPH Program, University of Guelph
[3] University of Guelph

## Methodology

Multiple databases, including ProQuest LLC, PubMed, Web of Science and Google Scholar were used to search for relevant peer-reviewed articles. Key word searches for article titles and abstracts were conducted using the primary search terms: foodborne, outbreaks, and risk factors. Combinations of these primary search terms were combined with: food safety, food handling, food inspection, incidence, common, and prevalence. Specific etiological agents were also searched for including: *Salmonella, Campylobacter, Escherichia coli (E. coli), Listeria,* norovirus*,* rotavirus*, Clostridium perfringens (C. perfringens), Staphylococcus aureus (S. aureus), Bacillus cereus (B. cereus), and Shigella* spp*.* Grey literature, such as consumer reports, government reports, and government websites were also used, especially for information on surveillance systems (regulations and protocols). Documents on surveillance were searched for using Google, with the terms provincial, territorial, Canada, and province/territory names in combination with reportable diseases, communicable diseases, public health act, public health laboratories, health authorities, health regions, surveillance, outbreak response, foodborne illness, case follow-up forms and protocols. Appendix B provides further details on the literature search strategy.

## Canadian Foodborne Illness Outbreaks and Microbial Causative Agents

In 2009, Ravel et al. published the most extensive study to date of 6,908 recorded foodborne illness outbreaks in Canada, spanning from 1976 to 2005.[7] An analysis of 3,476 outbreaks with data on etiological agents indicated that the most frequent microorganisms identified were *Salmonella* (33%), *S. aureus* (15%), *B. cereus* (12%), *C. perfringens* (11%), and *E. coli* (10%).[7] Although pathogens such as *Salmonella*, *B. cereus, Campylobacter, E. coli, and S. aureus*, were linked to all or almost all food categories, more frequent associations seemed to exist with the respective food categories of produce, poultry, and beef (Table 1).[7] Among the 5,745 outbreaks with identified food vehicles, the most prevalent associated food vehicles were multi-ingredient foods (34%), meat (26%), and meals (22%).[7] Food categories with a broad spectrum of pathogens include ‘‘produce,’’ ‘‘seafood,’’ and ‘‘multi-ingredient foods.’’ Other food categories such as ‘‘eggs,’’ ‘‘meat: wild game,’’ and ‘‘dairy: milk’’ were associated with a relatively narrow spectrum of pathogens.[7]

Outbreaks associated with the food category “produce” have been increasing in occurrence in Canada. Kozak et al.’s review of produce-related outbreaks reported 27 outbreaks including an estimated 1,549 cases of illness from 2001 through 2009.[8] Fifty percent of these outbreaks were linked to *Salmonella* as the causative agent, followed by *E. coli* (33%) and *Shigella* (17%). Outbreaks due to bacterial infection represented 66% of the total, seven outbreaks were parasite-associated, and foodborne viruses were implicated in two outbreaks.[8]

## Potential Risk Factors Contributing to Outbreaks in Canada’s Food System

Foodborne illness outbreaks are a result of an error or series of errors along the “farm-to-fork” continuum where pathogens are introduced, efforts to eliminate pathogens fail, or improper handling allows pathogens to multiply. An outbreak could be attributed to activities at the primary production (or farm level) due to pre-harvest sources or from post-harvest contamination.[9] Food manufacturers and processors can also introduce hazards into the food supply by inadequately addressing the risks of contaminants.[5] Retailers and wholesalers are gatekeepers to the food supply for most Canadians: their storage, packaging, and handling practices are significant determinants of food safety outcomes.[5]

Risk factors associated with foodborne illness outbreaks found in the later stages of the farm-to-fork continuum can be divided into non-human and human risk factors.[10] Non-human risk factors are related to the physical environment and are present when there is poor design or maintenance of facilities. Human risk factors are the most critical variables that food handlers have control over such as various food preparation techniques and ethnic or cultural preferences. Food safety knowledge and behaviour influence the likelihood of introduction and/or growth of pathogens. The following sections are based mostly on United States (US) and international research, as there are relatively few relevant Canadian studies.

### *Poor personal hygiene*

Poor hygiene and handling food while infected with an enteric pathogen have been significant risk factors for foodborne illness.[11] In numerous instances, investigators

attributed the failure of properly washing hands to the lack of adequate hand hygiene supplies or facilities.

Maintaining personal hygiene is the first and most pervasive risk factor for foodborne outbreaks.[12] The estimated annual incidence of infections from pathogens associated with personal hygiene control factors is about 9.3 million cases in the US at a cost of $8.2 billion (USD).[13] Infections from bacteria such as *Salmonella* spp. and *Shigella flexneri*, viruses such as Hepatitis A and norovirus, and parasites such as *Giardia lamblia* have been documented to be transmitted via food due to poor personal hygiene.[13-17]

### *Cross-contamination*

Inadequate food preparation practices, including cooking and cross-contamination factors, are associated with approximately 3.5 million cases at a cost of 4.3 billion USD, annually.[13] Pathogenic and nonpathogenic organisms are continually introduced into the home by people, and the persistence of microorganisms and the potential spread of microbial contaminants from contaminated foods in the home have also been reported.[18] A study found significant bacterial contamination of domestic kitchens with fecal coliforms, *E. coli, Campylobacter,* and *Salmonella.*[18]

Dufrenne et al. found that the most likely mode of *Salmonella* or *Campylobacter* infection was cross-contamination of ready-to-eat products directly with raw poultry, or indirectly via contaminated surfaces or niches in the household kitchen.[19] Additionally, earlier studies indicated that cross-contamination of foods not subjected to further cooking from raw products via hands, cleaning cloths or sponges, and utensils contributed to the occurrence of outbreaks of foodborne salmonellosis in the US.[20]

### *Improper time / temperature control*

Inadequate cooking or holding temperatures for foods was a contributing factor in 19% of outbreaks analyzed by Todd et al.[11] After contamination by food handlers, temperature abuse by undercooking, or improper cooling or storage was seen to enhance growth and multiplication of bacteria in the implicated products. Temperature abuse was a common factor in all outbreaks caused by bacterial pathogens, but not those caused by viruses or protozoan parasites.

*Campylobacter jejuni* has a minimum growth temperature of about 31$^{o}$C and therefore does not normally grow in foods, but it has a low infectious dose, highlighting the importance of microbial survival, not only growth, as a risk factor.[21,22] Additionally, microorganisms cannot grow in dried foods and frozen foods, but they can survive in these foods for long periods with only a slight decrease in numbers still sufficient to cause illness, or may proliferate when conditions become suitable (i.e., pH, temperature, and moisture).[21] The pathogens primarily associated with inadequate control of refrigeration and hot holding—*S. aureus, C. perfringens,* and *B. cereus*—cause relatively mild foodborne illness, and it is estimated that in the US there are almost 500,000 illnesses per year from these three pathogens with a cost of 142 million USD.[13]

### *Unsafe food sources*

Unsafe food sources, such as raw (unpasteurized) milk and raw-milk cheeses, have been associated with outbreaks caused by numerous etiological agents such as *Salmonella spp., Campylobacter spp., E. coli, Listeria monocytogenes (L. monocytogenes),* and *S. aureus.*[13,23] Improperly made home-canned foods have long constituted a major source of botulism, while ready-to-eat meats are most commonly linked to outbreaks of *Listeria*. The estimated annual incidence of illness associated with the consumption of foods from unsafe sources in the US is only 10,000 cases but with a substantial cost of 30 million USD since the pathogens can cause severe illness.[13]

## Current Federal Surveillance Systems

Regional authorities, P/T governments, the Public Health Agency of Canada (PHAC), and other federal government organizations, including the Canadian Food Inspection Agency (CFIA) and Health Canada, are all involved in the overall food safety system that works to prevent foodborne illness in Canada.[3] The food safety system includes foodborne illness surveillance and outbreak investigations involving disease reporting, laboratory testing (case specimens), case follow-up, and information sharing between various agencies and affected jurisdictions.

### *Provincial/territorial surveillance*

Provincial Reportable Disease Surveillance Systems (PRDSS) collect the number of laboratory-confirmed illnesses reported to regional and provincial public health authorities.[24,25] Each province and territory has its own list of reportable diseases which include important foodborne pathogens (Table 2).[26-38] Reporting is

mandated by P/T public health laws that specify the requirements of communicable disease control (Figure 1 and Table 3).[25,29,37,39-52]

Regional health officials, with assistance from other departments such as Agriculture, lead investigations of outbreaks that are detected through the PRDSS and are within provincial or territorial boundaries.[4] Case follow-up forms and Foodborne Illness Outbreak Response Protocols (FIORP) are standardized within provinces and territories (Table 3).[4,31,53-62] Jurisdictions use electronic platforms (such as the integrated Public Health Information System or iPHIS) to report information on reportable disease case follow-up to P/T health authorities and PHAC (Table 3).[63]

### *National surveillance and coordinated response*

Regional and affiliated P/T authorities voluntarily report nationally notifiable diseases, data which supports the PHAC-coordinated Canadian Notifiable Disease Surveillance System.[64,65] Select foodborne pathogens are also reportable to PulseNet Canada, the National Enteric Surveillance Program (NESP), and FoodNet Canada (Table 2).[66-69]

The National Microbiology Laboratory (NML) coordinates laboratory (national and participating P/T) and epidemiological surveillance (national) to inform PulseNet Canada and NESP.[3] The NML and Centre for Food-borne, Environmental and Zoonotic Infectious Diseases (CFEZID) jointly compile and analyze data from PulseNet Canada and NESP to identify foodborne illness outbreaks as efficiently as possible for investigation and public health intervention (Figure 2).[3,4,70-72] Additionally, CFEZID houses FoodNet Canada which works to identify the risk factors for enteric illness (including foodborne illness) through integrated surveillance.[73] The program uses enhanced questionnaires at their sentinel sites to collect the level of detail they need to study the risk factors of enteric illness in Canada.

Provinces and territories all have access to the Canadian Network of Public Health Intelligence's forum known as Public Health Alerts: Enteric Alerts, which facilitates the early notification of outbreaks, thereby encouraging a collaborative response to multi-jurisdictional enteric outbreaks.[74] For multi-provincial or international cases, PHAC (i.e., CFEZID) usually leads the response to such incidences using Canada's FIORP (Table 3).[4,75] Outbreak investigations are also accomplished through the activities of CFIA, which include food safety investigations, testing and recall activities, and regulatory compliance and enforcement activities.[4] P/T departments usually lead responses to cases within P/T boundaries or if the majority of cases reside in a single P/T. The risk factor information collected for multi-jurisdictional outbreak investigations is similar to what is collected by the US Centers for Disease Control and Prevention, and is housed in an online repository called Outbreak Summaries.[76-78] Regional, P/T, and national public health authorities are also able to publish their outbreak summaries here.[78]

## Gaps in the Literature and Surveillance Systems

Assessment of risk factors in relation to consumers remains the least studied in the farm-to-fork continuum. A considerable amount of food preparation and handling occurs in the domestic environment; therefore, research regarding the risk of unsafe food-handling practices is an essential element towards prevention of foodborne disease.

Foodborne illness is vastly underreported in Canada, a trend consistent in other countries.[79] The role of transmission via food is additionally obscured by the fact that many foodborne pathogens are also spread through water or from person-to-person. A recent study by Thomas et al. estimated that approximately 1.6 million annual cases of domestically acquired foodborne illnesses are attributable to "known pathogens" in Canada, while 2.4 million are attributable to "unspecified agents."[67] The inability to specify organisms is another hindrance for establishing accurate source attribution values. These challenges put further pressure on Canadian foodborne illness surveillance systems and outbreak detection and response mechanisms to be efficient. Greater efficiency allows for the timely collection of important human risk factor information by increasing the opportunities to collect food samples and reducing case-recall bias for information on risk behaviour and food consumption (risk factors).

There are approximately 30 specified pathogens known to cause foodborne illness.[67] Many of these pathogens are tracked by public health systems that monitor cases of illness. However, reportable disease lists and disease definitions are not consistent between the various public health authorities in Canada, which could make the task of amalgamating the data more challenging (Table 2). Additionally, it is not mandatory for regional authorities within provinces and territories to report disease cases to

agencies beyond the P/T level.[64]

The process of reporting within provinces/territories is fairly consistent (with the exception of pathogen reporting urgency; refer to Table 2). On the other hand, case follow-up forms for surveillance are not consistent between P/T authorities: some jurisdictions use pathogen-specific forms while others use general enteric illness forms.

Public health authorities at all levels do not use the same electronic platforms for information sharing (Table 3). For example, not all jurisdictions use the same systems to upload case follow-up forms for routine surveillance. In terms of outbreak detection and investigations, participation in programs like PulseNet Canada, and uploading outbreak alerts to Public Health Alerts: Enteric Alerts and investigation summaries to Outbreak Summaries, does not necessarily occur across the board.

Better communication is needed at federal, provincial, and municipal levels to apply the data from the food safety system to inform programs and educational activities involving food service employers and employees as well as everyday consumers.

## Conclusion

Despite gaps apparent in the surveillance of foodborne illness in Canada, there have been notable improvements in the system. For example, norovirus outbreaks became notifiable to NESP in 2009, and *L. monocytogenes* was added to the list of organisms included in NESP in 2012 and was adopted by all provinces/territories.[80,81] An impressive network of agencies coordinates the movement of large amounts of data at both provincial/territorial and federal levels on an ongoing basis. Some refinements in the system are still required, however, to improve foodborne illness surveillance and outbreak detection and response. International foodborne illness surveillance data, especially from the US, continue to be used to draw parallels to the Canadian situation. However, generating and analyzing a comprehensive dataset of foodborne outbreaks in Canada would assist in accurately identifying contributing factors for foodborne illness in the context of Canada's food safety systems, agencies, and programs. Suggested enhancements to food safety systems in Canada at the regional, P/T, and national levels include:

- adopting consistent reportable disease lists and procedures for reporting to facilitate the efficient collection of all available data at the national level;
- using consistent methods to gather information in the event of a foodborne outbreak to enhance reporting and learning from past outbreaks;
- using databases (such as iPHIS) that can be shared across jurisdictions to document case interviews of foodborne illness to facilitate information access and sharing;
- participating in uploading investigation summaries in Outbreak Summaries to build a single database on Canadian outbreaks;
- using Public Health Alerts: Enteric Alerts to notify other jurisdictions of outbreaks to encourage collaboration;
- streamlining the reporting process to avoid duplication of services.

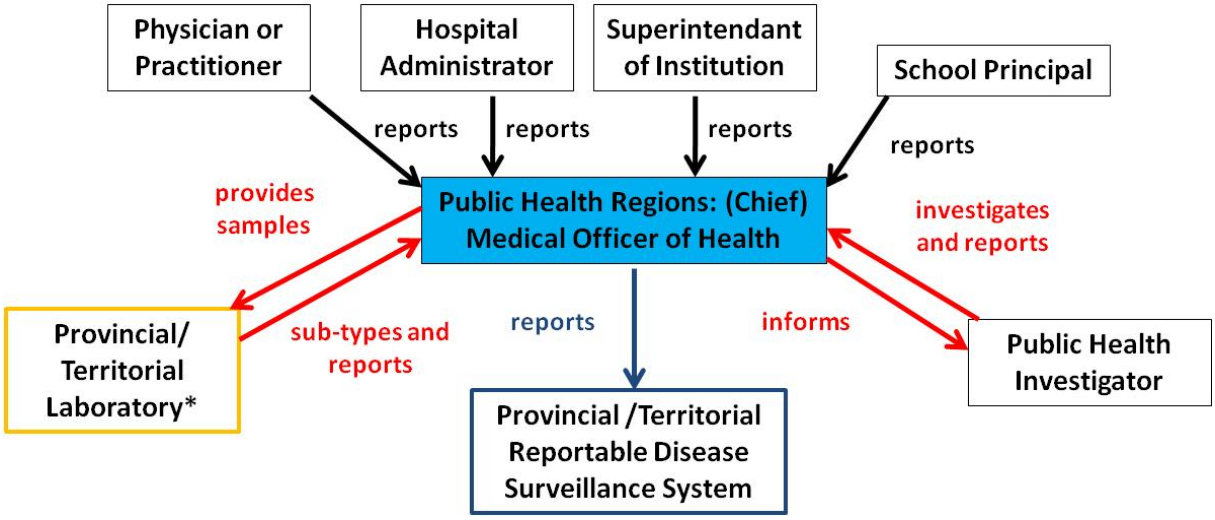
An enriched data set could reflect the importance of certain sources and modes of contamination, pathogen survival, and pathogen proliferation in association with specified etiological agents and can be used identify priority areas in food safety. Comparative analysis of consistent data sets would help determine trends in foodborne illness and provide information on the progression of food safety initiatives.

## Acknowledgements

We would like to thank Daniel Fong, Helen Ward, Nelson Fok, and Michael Duncan for their valuable input and review of the draft document.

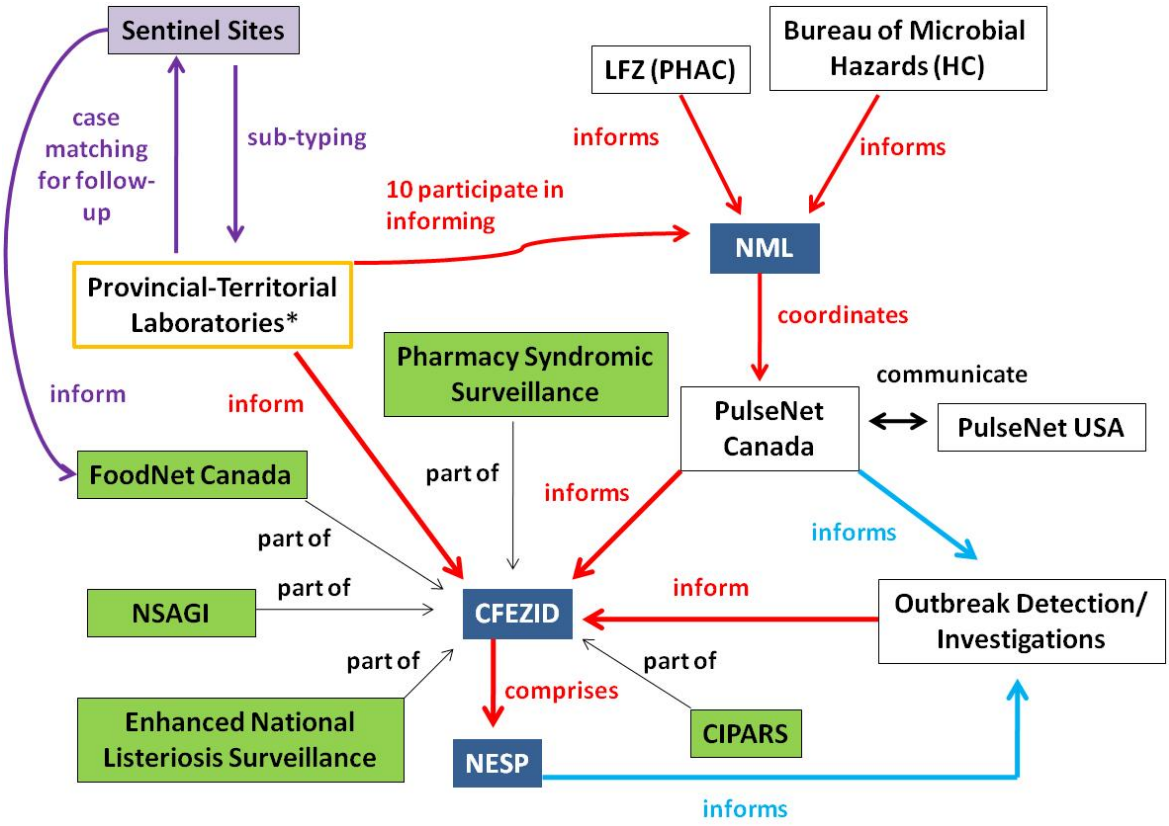
## Figures

**Figure 1**. Model of reporting foodborne illness cases and outbreaks at the provincial level[25]




CFEZID: Centre for Food-borne, Environmental and Zoonotic Infectious Diseases; CPHLN: Canadian Public Health Laboratory Network; CIPARS: Canadian Integrated Program for Antimicrobial Resistance Surveillance; HC: Health Canada; LFZ: Laboratory for Foodborne Zoonoses; NESP: National Enteric Surveillance Program; NSAGI: National Studies on Acute Gastrointestinal Illness; NML: National Microbiology Laboratory; PHAC: Public Health Agency of Canada

**Figure 2**. Federal surveillance of foodborne illness cases and outbreak detection[3,4,70-72]



# Tables

**Table 1**. Foodborne illness outbreaks in Canada from 1996 to 2005, by etiological agent and vehicle of transmission (highest attributions)

| Pathogen (total number of outbreaks) | Transmission Vehicle | Percentage of outbreaks |
|---|---|---|
| ***Salmonella enterica***[76] | Produce | 29% |
| | Poultry | 15 % |
| | Meat other than poultry, pork, and beef | 15% |
| ***Campylobacter***[32] | Poultry | 56% |
| | Dairy products other than fluid milk | 22% |
| ***Escherichia coli***[74] | Beef | 37% |
| | Cooked multi-ingredient dishes | 23% |
| | Meat other than beef, poultry, and pork | 11% |

Adapted from Ravel et al.[7]

**Table 2**. Summary of reportable foodborne illnesses for federal surveillance programs and P/T surveillance systems

| | Federal Surveillance Programs | | | | Provincial Surveillance Systems | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reportable Diseases** | **NESP** (67,68) | **CNDSS** (65) | **FoodNet Canada** (69) | **PulseNet Canada** (66) | **AB** (26) | **BC** (27) | **MB** (28) | **NB** (29) | **NL** (30) | **NT** (31) | **NS** (32) | **NU** (33) | **ON** (34) | **PE** (35) | **QC** (36) | **SK** (37) | **YT** (38) |
| **Adenovirus** | X | | | | | | | | | | | | | | | | |
| **Astrovirus** | X | | | | | | | | | | | | | | | | |
| ***Bacillus cereus*** | | | | | | | X | | | | | | | | | | |
| **Botulism** | | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Brucellosis** | | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Calicivirus** | | | | | X | | | | | | | | | | | | |
| **Campylobacteriosis** | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Cholera** | | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| ***Clostridium perfringens*** | | | | | | | X | | | | | | | | | | |
| **Cryptosporidiosis** | X | X | X | | X | X | X | X | X | X | X | X | X | X | | X | X |
| **Cyclosporiasis** | X | X | X | | X | X | X | X | X | X | X | X | X | X | | X | X |
| ***Escherichia coli*, pathogenic** | X | | | | | | | X | | | | | | | | | |
| **Foodborne illness, all causes** | | | | | | X | | X | X | X | | X | X | X | X | X | X |
| **Gastroenteritis epidemic (bacterial, parasitic, viral)** | | | | | | X | | X | | X | | X | X | X | X | | X |
| **Giardiasis** | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Hepatitis A** | | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Listeriosis** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | X |
| **Norovirus** | X | X | | | | | | | X | | | | | X | | | X |
| **Paralytic Shellfish Poisoning** | | X | | | | X | | X | X | | X | | X | X | | | |
| **Paratyphoid** | X | X | | | X | X | | | X | X | X | X | X | | X | X | X |
| **Rotavirus** | X | | | | X | | | | X | | | | | X | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Salmonellosis** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Sapovirus** | | | | | | | | | | | | | | | | | |
| **Shigellosis** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| ***Staphylococcus aureus* intoxication** | | | | | X | | X | X | | | | | | | | X | |
| **Toxoplasmosis** | | | | | | | X | | X | X | X | X | | | | X | |
| **Trichinosis** | | | | | X | | X | | X | X | X | X | X | | X | X | X |
| **Typhoid** | X | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| ***Vibrio parahaemolyticus*** | X | | | | X | | X | | | | | | | X | | | |
| ***Vibrio* spp.** | X | | | | | | | X | | | | | | | | | |
| ***Vibrio vulnificus*** | X | | | | | | | | | | | | | | | | |
| **VTEC O157** | X | | | X | X | | | | | | | | | | | | |
| **VTEC, non-O157** | X | | | | | | | | | | | | | | | | |
| **VTEC, all** | | X | X | | | | X | | X | X | X | X | X | X | X | X | X |
| **Yersiniosis** | X | | X | | X | X | X | X | X | | X | | X | X | X | X | X |

**X = immediate notification**

**Table 3**. Provincial regulations for communicable disease reporting and available Foodborne Illness Outbreak Response Protocols at the federal and provincial/territorial level

| **Province/ Territory** | ***Public Health Acts* for communicable disease regulation** (39) | **Citation for *Public Health Acts*** | **Examples of foodborne illness outbreak response protocols and/or case follow-up forms** | **Case follow-up recording** (63) |
|---|---|---|---|---|
| **AB** | Communicable Diseases Regulation, Alberta Regulation 238/1985 – *Public Health Act*, P-37 RSA 2000. | (40) | Alberta Foodborne Illness and Risk Investigation Protocol (53);<br><br>Notifiable disease guidelines and related documents (54) | iPHIS |
| **BC** | Health Act Communicable Disease Regulation, BC Reg 4/83 – *Public Health Act*, SBC 2008, c 28. | (41) | British Columbia Foodborne Illness Outbreak Response Protocol<br>(BC FIORP) – Guide to Multi-Agency Response in British Columbia (55);<br><br>Surveillance Forms – Enteric, Food & Waterborne (56) | iPHIS |
| **MB** | Part 4, Disease Control – *The Public Health Act*, CCSM, c P210. | (42) | Enteric Illness Protocol (57) | iPHIS* |
| **NB** | New Brunswick Regulation 2009-136 -*Public Health Act*, SNB 1998, P-22.4. | (29) | | |
| **NL** | *Communicable Diseases Act*, RSNL 1990, C-26. | (43) | Newfoundland and Labrador Disease Control Manual (58) | iPHIS |
| **NS** | Reporting of Notifiable Diseases and Conditions Regulations, NS Reg 195/2005 – *Health Protection Act*, 2004, c 4, s. 1.; Communicable Diseases Regulations, NS Reg 196/2005 – *Health Protection Act*, 2004, c 4, s. 1. | (46); (47) | Nova Scotia Communicable Disease Manual – Enteric, Food, and Waterborne Diseases (59) | |
| **NT** | Reportable Disease Control Regulations, NWT Reg 128-2009 – *Public Health Act*, SNWT 2007, c 17; Disease Surveillance Regulations, NWT REG 096-2009 – *Public Health Act*, SNWT 2007, c 17. | (44); (45) | Government of the Northwest Territories Communicable Disease Manual (31) | iPHIS |

| | | | | |
|---|---|---|---|---|
| **NU** | Communicable Diseases Regulations, RRNWT (Nu) 1990 c P-13 – *Public Health Act*, RSNWT 1988, c P-12; Communicable Diseases Regulations, RRNWT (Nu) 1990 c P-13 – *Disease Registries Act,* RSNWT (Nu) 1988, c 7 (Supp). | (49) | | |
| **ON** | Part IV Communicable Diseases – *Health Protection and Promotion Act*, RSO 1990, c H.7. | (25) | Ontario's Foodborne Illness Outbreak Response Protocol (ON-FIORP) (60);<br><br>Annexes to Ontario's Foodborne Illness Outbreak Response Protocol (ON-FIORP) (61) | iPHIS |
| **PE** | Notifiable Diseases and Conditions and Communicable Diseases Regulations, PEI Reg EC560/13 – *Public Health Act*, RSPEI 1988, c P-30.1. | (50) | | |
| **QC** | Chapter VIII, Reportable Intoxicants, Infections and Diseases - *Public Health Act*, RSQ, c S-2.2. | (51) | | |
| **SK** | Disease Control Regulations, RRS c P-37.1 Reg 11 – *The Public Health Act*, 1994, SS 1994, c P-37.1. | (37) | Communicable Disease Control Manual – Section 3: Enteric Illness (62) | iPHIS |
| **YT** | Communicable Diseases Regulations, YCO 1961/48 – *Public Health and Safety Act*, RSY 2002, c 176. | (52) | Canada's Food-borne Illness Outbreak Response Protocol (FIORP) 2010: To guide a multi-jurisdictional response (4) | iPHIS |
| **Federal/ Provincial/ Territorial Collaboration** | | | Canada's Food-borne Illness Outbreak Response Protocol (FIORP) 2010: To guide a multi-jurisdictional response (4);<br><br>F/P/T Detailed Roles and Responsibilities (75) | Outbreak Summaries (78)**<br>Public Health Alerts: Enteric Alerts (74)** |

*Not entire province

**Participation not mandatory

AB: Alberta; BC: British Columbia; MB: Manitoba; NB: New Brunswick; NL: Newfoundland and Labrador; NT: Northwest Territories; NS: Nova Scotia; NU: Nunavut; ON: Ontario; PE: Prince Edward Island; QC: Quebec; SK: Saskatchewan; YT: Yukon

# Appendix A

**Relevant Terms:**

a. Surveillance is the systematic process of collecting, analyzing, interpreting, and communicating health-related data to reduce disease rates and mortality.
b. The study conducted by Ravel et al. used the most comprehensive sets of Canadian outbreak data, spanning from 1976 to 2005, generating the most up-to-date Canadian food attribution values for microbial causative agents and temporal trends.
c. Multi-ingredient foods include pasta dishes, baked goods, salad, sandwiches, sauces, etc.
d. Meals include multiple/various foods, buffets, etc.
e. The "farm-to-fork" continuum describes the series of opportunities for contamination and pathogen multiplication from growing animals and plants for food, to processing agricultural products, manufacturing and transporting foods, preparing foods for consumption, and eating foods.
f. Pre-harvest sources include soil, feces, irrigation water, reconstituted pesticides, dust, pests, inadequately composted manure, wild or domestic animals, and human handling.
g. Post-harvest contamination can be contributed by human handling along with harvesting equipment, transport containers, pests, dust, rinse water, ice, transport vehicles, and processing equipment.
h. Unsafe food sources can have a wide variety of meanings, depending upon where the focus is in the farm-to-fork continuum. However, with respect to the important risk factors that occur at the final stages of the farm-to-fork continuum, unsafe sources can be ready-to-eat foods that are produced or processed in a way that does not kill pathogens, and therefore leave consumers unknowingly at risk.
i. Case follow-up forms are used by public health investigators to interview laboratory confirmed cases of foodborne illness (those that are reportable to the province or territory), and are also used to inform foodborne illness outbreak investigations through the collection of risk factor information.
j. The integrated Public Health Information System (iPHIS) is an electronic database which houses case follow-up information for provincial/territorial and national reportable diseases, and is managed by the Canadian Integrated Public Health Surveillance Collaborative. It facilitates rapid information sharing between public health jurisdictions.
k. The Canadian Notifiable Disease Surveillance System (CNDSS) collects the number of laboratory confirmed illnesses that are reported to local public health units/regions, provincial public health authorities, and national level authorities.
l. PulseNet Canada is a national laboratory outbreak investigation network of federal, provincial, and territorial laboratories coordinated by the NML. It allows for information on pathogens to be exchanged in real time, and is linked to the US PulseNet system, allowing information sharing across North America.
m. National Enteric Surveillance Program (NESP) collects aggregate counts of laboratory isolates of select enteric pathogens (species and subtype) reported through the provincial laboratories on a weekly basis.
n. FoodNet Canada collaborates with local public health units (sentinel sites) to conduct enhanced, integrated surveillance of enteric pathogens within regionally representative communities as a way of informing the source attribution of enteric illness in Canada. It currently has three sentinel sites in Alberta, British Columbia, and Ontario.
o. National Microbiology Laboratory (NML) provides federal level laboratory-based surveillance through reference services that allow for strain identification and characterization. This information can then be disseminated to Canada's foodborne surveillance programs, PulseNet Canada, and NESP.
p. The Centre for Food-borne, Environmental and Zoonotic Infectious Disease (CFEZID) conducts national surveillance and targeted studies of enteric illness, cases, and outbreaks. It houses various programs including Pharmacy Syndromic Surveillance, FoodNet Canada, and the Canadian Integrated Program for Antimicrobial Resistance Surveillance, and facilitates burden of illness work. PHAC's enteric illness Outbreak Management Division also exists under the umbrella of CFEZID.
q. Public Health Alerts: Enteric Alerts is a secure, web-based application developed by the Canadian Network for Public Health Intelligence (CNPHI), and is used to improve the identification of multi-jurisdictional outbreaks. Information is posted by regional health authorities, provinces/territories, and PHAC about current and potential enteric outbreaks in their jurisdiction, allowing various other public health authorities to view the information.
r. Outbreak Summaries is a portal where public health authorities, of all jurisdictions in Canada, can document enteric disease investigations in a standard and systematic way. It is managed by CNPHI. Participating members can access any of the outbreak information in the system to identify trends, create annual reports, and inform policy development and planning. Outbreak Summaries went live in 2008 and its membership is still growing.

# Appendix B

**Literature Search Strategy: *Foodborne illness outbreaks and microbial causative agents***

*Search Tools*

The literature search employed the following search tools (databases/indices): *ProQuest LLC, PubMed, Web of Science, Google Scholar.*

*Search Terms*

Utilizing the proposed databases, key word searches for article titles and abstracts were conducted using the primary search terms: foodborne, outbreaks, and risk factors. Combinations of these primary search terms were combined with: food safety, food handling, food inspection, incidence, common, and prevalence. Specific etiological agents were also searched for including: *Salmonella*, *Campylobacter*, *E. coli*, *Listeria*, norovirus, rotavirus, *Clostridium perfringens*, *Staphylococcus aureus*, *Bacillus cereus*, *Shigella* spp.

*Inclusion Criteria*

All papers, identified by the search, were screened for relevance using the title and/or abstract. The United States of America, the United Kingdom, and Australia engage in similar food safety practices and standards as Canada, and so were included due to scarce literature specific to Canada.

*Exclusion Criteria*

Literature was restricted to only those written in the English language, and literature published prior to 1970 was excluded.

***Current surveillance systems***

*Search Tools*

The document search employed the following search engines: *Google*

*Search Terms*

Grey literature, primarily government documents, was searched for using a combination of the terms: national, federal, provincial, territorial, Canada, province/territory names; and reportable diseases, communicable diseases, notifiable diseases, public health act, public health laboratories, health authorities, health regions, surveillance, outbreak response, foodborne illness, case follow-up forms, and protocols.

**Literature Management:**

Bibliographic data for the electronic literature obtained through the above methods was entered and stored in RefWorks, an online reference manager (www.refworks.com).

# References


1. Centers for Disease Control and Prevention. Guide to confirming a diagnosis in foodborne disease. Atlanta, GA: U.S. Health and Human Services; [updated 2013 Nov; cited 2014 Jun]; Available from: http://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/confirming_diagnosis.html.

2. Weatherill S. Report of the Independent Investigator into the 2008 Listeriosis outbreak. Ottawa, ON: Government of Canada; 2009 Jul. Available from: http://www.cmc-cvc.com/sites/default/files/files/ListeriaIndependentInvestigatorReport_July212009.pdf.

3. Public Health Agency of Canada. Evaluation of food-borne enteric illness prevention, detection and response activities at the Public Health Agency. Ottawa, ON: PHAC; 2012 Mar. Available from: http://www.phac-aspc.gc.ca/about_apropos/evaluation/reports-rapports/2011-2012/feipdra-pdimeoa/index-eng.php.

4. Public Health Agency of Canada. Canada's Food-borne Illness Outbreak Response Protocol (FIORP) 2010: To guide a multi-jurisdictional response. Ottawa, ON: PHAC; [updated 2013 Mar; cited 2014 Jun]; Available from: http://www.phac-aspc.gc.ca/zoono/fiorp-mitioa/index-eng.php.

5. Munro D, Le Vallee JC, Stuckey J. Improving food safety in Canada: toward a more risk- responsive system. Ottawa, ON: Conference Board of Canada; 2012 Feb. Available from: http://www.conferenceboard.ca/e-library/abstract.aspx?did=4671.

6. Food and Agriculture Organization of the United Nations and World Health Organization. The Food Safety Segulatory System in Canada. FAO/WHO Regional Conference on Food Safety for the Americas and Caribbean; Dec 6-9; San Jose, Costa Rica: FAO and WHO; 2005. Available from: ftp://ftp.fao.org/docrep/fao/meeting/010/af190e.pdf.

7. Ravel A, Greig J, Tinga C, Todd E, Campbell G, Cassidy M, et al. Exploring historical Canadian foodborne outbreak data sets for human illness attribution. J Food Prot. 2009;72(9):1963-76.

8. Kozak GK, MacDonald D, Landry L, Farber JM. Foodborne outbreaks in Canada linked to produce: 2001 through 2009. J Food Prot. 2013;76(1):173-83.

9. Beuchat LR, Ryu J. Produce handling and processing practices. Emerg Infect Dis. 1997;3(4):459-65.

10. Choung J. An analysis of restaurant food safety violations: human factors, non-human factors, and food-borne illness. Las Vegas, CA: University of Nevada; 2009. Available from: http://digitalscholarship.unlv.edu/cgi/viewcontent.cgi?article=1015&context=thesesdissertations.

11. Todd E, Greig J, Bartleson C, Michaels B. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 3: Factors contributing to outbreaks and description of outbreak categories. J Food Prot. 2007;70(9):2199-217.

12. Hedberg CW, White KE, Johnson JA, Edmonson LM, Soler JT, Korlath JA, et al. An outbreak of Salmonella enteritidis infection at a fast-food restaurant: implications for foodhandler-associated transmission. J Infect Dis. 1991;164(6):1135-40.

13. Medeiros L, Hillers V, Kendall P, Mason A. Evaluation of food safety education for consumers. J Nutr Educ. 2001;33(S1):S27-S34.

14. Hedberg C. Food-related illness and death in the United States. Emerg Infect Dis. 1999;5(6):840-1.

15. Dunn RA, Hall WN, Altamirano JV, Dietrich SE, Robinson-Dunn B, Johnson DR. Outbreak of Shigella flexneri linked to salad prepared at a Central Commissary in Michigan. Public Health Rep. 1995;110:580-6.

16. Sundkvist T, Hamilton GR, Hourihan BM, Hart IJ. Outbreak of hepatitis A spread by contaminated drinking glasses in a public house. Comm Dis Public Health. 2000;3:60-2.

17. Quick R, Paugh K, Addiss D, Kobayashi J, Baron R. Restaurant-associated outbreak of giardiasis. J Infect Dis. 1992;166(3):673-6.

18. Redmond EC, Griffith CJ. Consumer food handling in the home: a review of food safety studies. J Food Prot. 2003;66(1):130-61.

19. Dufrenne J, Ritmeester W, Delfgou-van Asch E, Van Leusden F, De Jonge R. Quantification of the contamination of chicken and chicken products in The Netherlands with Salmonella and Campylobacter. J Food Prot. 2001;64(4):538-41.

20. Bryan FL. Risks of practices, procedures and processes that lead to outbreaks of foodborne diseases. J Food Prot. 1988;51(8):663-73.

21. National Disease Surveillance Centre. Preventing foodborne disease: a focus on the infected food handler. Dublin, Ireland: NDSC; 2004 Apr. Available from: https://www.hpsc.ie/A-Z/Gastroenteric/FoodborneIllness/Publications/File,871,en.pdf.

22. Hazeleger WC, Wouters JA, Rombouts FM, Abee T. Physiological activity of Campylobacter jejuni far below the minimal growth temperature. Appl Environ Microbiol. 1998;64(10):3917-22.

23. Oliver SP, Jayarao BM, Almeida RA. Foodborne pathogens in milk and the dairy farm environment: food safety and public health implications. Foodborne Pathog Dis. 2005;2(2):115-29.

24. Public Health Agency of Canada. Estimates of food-borne illness in Canada. Ottawa, ON: PHAC; [updated 2014 Jan; cited 2014 Jun]; Available from: http://www.phac-aspc.gc.ca/efwd-emoha/efbi-emoa-eng.php.

25. Government of Ontario. Health Protection and Promotion Act. Part IV: Communicable Diseases. (2011). Available from: http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90h07_e.htm#BK24.

26. Alberta Health and Wellness. Notifiable disease list. Edmonton, AL: Government of Alberta; 2008 Jun. Available from: http://www.health.alberta.ca/documents/Notifiable-Disease-List.pdf.

27. British Columbia Centre for Disease Control. List of reportable comunicable diseases in BC. Vancouver, BC: BCCDC; 2009 Jul. Available from: http://www.bccdc.ca/NR/rdonlyres/261E1CF3-7D31-4DEB-AE13-968D330C91BC/0/Epid_Guidelines_reportable_diseases_British_Columbia_July2009.pdf.

28. Government of Manitoba. The Public Health Act. Reporting of Diseases and Conditions Regulation. (2009). Available from: http://web2.gov.mb.ca/laws/regs/pdf/p210-037.09.pdf.

29. Government of New Brunswick. New Brunswick Regulation 2009-136 under the Public Health Act. (2009). Available from: http://laws.gnb.ca/en/ShowPdf/cr/2009-136.pdf.

30. Newfoundland and Labrador Department of Health and Community Services. Notifiable disease list. St. John's, NL: Government of Newfoundland and Labrador; 2013 Jun. Available from: http://www.health.gov.nl.ca/health/publichealth/cdc/notifiable_disease_list.pdf.

31. Northwest Territories Department of Health and Social Services. Communicable disease manual. Yellowknife, NWT: Government of the Northwest Territories; 2007. Available from: http://www.hss.gov.nt.ca/sites/default/files/cdcmanfulldoc.pdf.

32. Nova Scotia Department of Health and Wellness. It's the law. Reporting notifiable diseases and conditions. Halifax, NS: Government of Nova Scotia; 2013. Available from: http://novascotia.ca/dhw/cdpc/documents/06026_ItsTheLawPoster_En.pdf.

33. Nunavut Department of Justice. Current consolidated statues and regulations. Public Health Act, Consolidation of. Iqaluit, NT: Government of Nunavut; 2012. Available from: http://www.justice.gov.nu.ca/apps/authoring/dspPage.aspx?page=CURRENT+CONSOLIDATIONS+OF+ACTS+AND+REGULATIONS&letter=*.

34. Government of Ontario. Health Protection and Promotion Act. Ontario Regulation 559/91. Specification of Reportable Diseases. (2013). Available from: http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_910559_e.htm.

35. Government of Prince Edward Island. Chapter P-30. Public Health Act. Notifiable and Communicable Diseases Regulations. (2013). Available from: http://www.gov.pe.ca/law/regulations/pdf/P&30-06.pdf.

36. Quebec Ministere de la Sante et des Services Sociaux. Liste des maladies, infections et intoxications - declaration obligatoire (MADO). Quebec City, QC: Government of Quebec. Available from: http://publications.msss.gouv.qc.ca/acrobat/f/documentation/preventioncontrole/03-268-05.pdf.

37. Government of Saskatchewan. Disease Control Regulations, RRS c P-37.1 Reg 11. (2007). Available from: http://www.canlii.org/en/sk/laws/regu/rrs-c-p-37.1-reg-11/latest/rrs-c-p-37.1-reg-11.htm.

38. Yukon Department of Health and Social Services. Yukon reportable diseases. Whitehorse, YK: Government of Yukon; 2013.

39. Canadian HIV/Aids Legal Network. Public health laws. Provincial websites: law and regulations. Toronto, ON: Canadian HIV/Aids Legal Network; 2012. Available from: http://www.aidslaw.ca/EN/community-kit/documents/Chapter9.1-ENG.pdf.

40. Government of Alberta. Public Health Act. Communicable Diseases Regulation. (2014). Available from: http://www.qp.alberta.ca/1266.cfm?page=1985_238.cfm&leg_type=Regs&isbncln=9780779744657.

41. Government of British Columbia. Health Act Communicable Disease Regulation, BC Reg 4/83. (2013). Available from: http://www.bclaws.ca/Recon/document/ID/freeside/12_4_83.

42. Government of Manitoba. The Public Health Act. Part 4 Disease Control. (2014). Available from: http://web2.gov.mb.ca/laws/statutes/ccsm/p210e.php.

43. Government of Newfoundland and Labrador. Communicable Diseases Act. Chapter C-26. (2007). Available from: http://www.assembly.nl.ca/legislation/sr/statutes/c26.htm.

44. Government of the Northwest Territories. Reportable Disease Control Regulations, NWT Reg 128-2009. (2012). Available from: http://www.canlii.org/en/nt/laws/regu/nwt-reg-128-2009/latest/nwt-reg-128-2009.html.

45. Government of the Northwest Territories. Disease Surveillance Regulations, NWT Reg 096-2009. (2012). Available from: http://www.canlii.org/en/nt/laws/regu/nwt-reg-096-2009/latest/nwt-reg-096-2009.html.

46. Government of Nova Scotia. Reporting of Notifiable Diseases and Conditions Regulations, NS Reg 195/2005. (2012). Available from: http://www.canlii.org/en/ns/laws/regu/ns-reg-195-2005/latest/ns-reg-195-2005.html.

47. Government of Nova Scotia. Communicable Diseases Regulations, NS Reg 196/2005. (2005). Available from: http://www.canlii.org/en/ns/laws/regu/ns-reg-196-2005/latest/ns-reg-196-2005.html.

48. Government of Nunavut. Communicable Diseases Regulations, RRNWT (Nu) 1990 c P-13. (2012). Available from: http://www.canlii.org/en/nu/laws/regu/rrnwt-nu-1990-c-p-13/latest/rrnwt-nu-1990-c-p-13.html.

49. Government of Nunavut. Reportable Diseases Order, RRNWT (Nu) 1990 c D-3. (2006). Available from: http://www.canlii.org/en/nu/laws/regu/rrnwt-nu-1990-c-d-3/latest/rrnwt-nu-1990-c-d-3.html.

50. Government of Prince Edward Island. Notifiable Diseases and Conditions and Communicable Diseases Regulations, PEI Reg EC560/13. 2014. Available from: http://www.canlii.org/en/pe/laws/regu/pei-reg-ec560-13/latest/pei-reg-ec560-13.html.

51. Gouvernement du Quebec. Public Health Act. Chapter S-2.2. (2014). Available from: http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=2&file=/S_2_2/S2_2_A.html.

52. Government of Yukon. Communicable Diseases Regulations, YCO 1961/48. (2014). Available from: http://www.canlii.org/en/yk/laws/regu/yco-1961-48/latest/yco-1961-48.html.

53. Canada Alberta Partners in Food Safety. Alberta foodborne illness and risk investigation protocol. Edmonton, AL: Alberta Agriculture and Rural Development, Food Safety Alberta; 2013. Available from: http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/afs13869.

54. Alberta Health and Wellness. Notifiable disease guidelines and related documents. Edmonton, AL: Government of Alberta; [cited 2014 Jun]; Available from: http://www.health.alberta.ca/professionals/notifiable-diseases-guide.html.

55. Alvarez R, Beilhartz G, Copeland L, Galanis E, Gustafson L, Hill L, et al. British Columbia Foodborne Illness Outbreak Response Protocol (BC FIORP). Guide to multi-agency response in British Columbia. Vancouver, BC: British Columbia Centre for Disease Control; 2012 Jan. Available from: http://www.bccdc.ca/NR/rdonlyres/9891574D-98DE-4538-8B5A-ADC2EBC2C88E/0/BCFIORP2009.pdf.

56. British Columbia Centre for Disease Control. Surveillance forms. Enteric, food & waterborne. Vancouver, BC: BCCDC; 2014. Available from: http://www.bccdc.ca/dis-cond/CDSurveillanceForms/default.htm#heading2.

57. Manitoba Communicable Disease Control Branch. Enteric illness protocol. Winnipeg, MB Government of Manitoba, 2008. Available from: https://www.gov.mb.ca/health/publichealth/cdc/protocol/enteric.pdf.

58. Newfoundland and Labrador Department of Health and Community Services. Newfoundland and Labrador disease control manual. Section 2: water/food/enteric diseases. St. John's, NL: Government of Newfoundland and Labrador,; 2010. Available from: http://www.health.gov.nl.ca/health/publications/diseasecontrol/dcenterics.pdf.

59. Nova Scotia Department of Health and Wellness. Nova Scotia communicable disease manual. enteric, food, and waterborne diseases. Halifax, NS: Government of Nova Scotia. Available from: http://novascotia.ca/dhw/cdpc/documents/cdc_manual.pdf .

60. Ontario Ministry of Health and Long-Term Care. Ontario's Foodborne Illness Outbreak Response Protocol (ON-FIORP) 2013. Ottawa, ON: Government of Ontario,; 2013 Jan. Available from: http://www.health.gov.on.ca/en/pro/programs/publichealth/enviro/docs/fiorp_protocol.pdf.

61. Ontario Ministry of Health and Long-Term Care. Annexes to Ontario's Foodborne Illness Outbreak Response Protocol (ON-FIORP) 2013. Ottawa, ON: Government of Ontario,; 2013 Jan. Available from: http://www.health.gov.on.ca/en/pro/programs/publichealth/enviro/docs/fiorp_annex.pdf.

62. Saskatchewan Ministry of Health. Communicable disease control manual. Section 3: Enteric illness. Regina, SK: Government of Saskatchewan; 2012. Available from: http://www.health.gov.sk.ca/cdc-section3.

63. Integrated Public Health Information System (iPHIS) [Canada] [database on the Internet]. University of Ottawa, Population Health Improvement Research Network. 2014. Available from: http://ophid.scholarsportal.info/details/view.html?q=enter&uri=/phirn/iphis_PHIRN_e.xml.

64. Public Health Agency of Canada. Case definitions for communicable diseases under national surveillance - 2009: introduction. Ottawa, ON: PHAC; 2011. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/09vol35/35s2/index-eng.php#toc.

65. Public Health Agency of Canada. List of nationally notifiable diseases. Ottawa, ON: PHAC; [updated 2014 Apr; cited 2014 Jun]; Available from: http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/list-eng.php.

66. Public Health Agency of Canada. Surveillance. Ottawa, ON: PHAC; [updated 2014 May; cited 2014 Jun]; Available from: http://www.phac-aspc.gc.ca/surveillance-eng.php.

67. Thomas MK, Murray R, Flockhart L, Pintar K, Pollari F, Fazil A, et al. Estimates of the burden of foodborne illness in Canada for 30 specified pathogens and unspecified agents, circa 2006. Foodborne Pathog Dis. 2013;10(7):639-48.

68. Public Health Agency of Canada, Provincial Public Health Microbiology Laboratories. National Enteric Surveillance Report (NESP) annual summary 2011. Ottawa, ON: PHAC, National Microbiology Laboratory Centre for Food-borne Environmental Zoonotic Infectious Diseases; 2012.

69. Public Health Agency of Canada. C-EnterNet 2011 Short Report. Ottawa, ON: PHAC; 2012. Available from: http://publications.gc.ca/site/eng/430834/publication.html.

70. Public Health Agency of Canada. Who participates in PulseNet Canada? Ottawa, ON: PHAC; [updated 2014

May; cited 2014 Jun]; Available from: https://www.nml-lnm.gc.ca/Pulsenet/links-liens-eng.htm.

71. Public Health Agency of Canada. PulseNet overview. Ottawa, ON: PHAC; [updated 2014 May; cited 2014 Jun]; Available from: https://www.nml-lnm.gc.ca/Pulsenet/overview-apercu-eng.htm.

72. Public Health Agency of Canada. National Enteric Surveillance Program (NESP). Ottawa, ON: PHAC; [updated 2014 May; cited 2014 Jun]; Available from: https://www.nml-lnm.gc.ca/NESP-PNSME/index-eng.htm.

73. Public Health Agency of Canada. Overview. FoodNet Canada (formerly known as C-EnterNet): reducing the burden of gastrointestinal illness in Canada. Ottawa, ON: PHAC; 2013 [updated 2013 Nov; cited 2014 Jun]; Available from: http://www.phac-aspc.gc.ca/foodnetcanada/overview-apercu-eng.php.

74. Public Health Agency of Canada. Canada's Food-borne Illness Outbreak Response Protocol (FIORP) 2010: To guide a multi-jurisdictional response. Annex 4: Canadian Network for Public Health Intelligence (CNPHI): Public health alerts: enteric alerts. [updated 2013 Mar; cited 2014 Jun]; Available from: http://www.phac-aspc.gc.ca/zoono/fiorp-mitioa/ann/1-9-eng.php#ann4.

75. Public Health Agency of Canada. F/P/T detailed roles and responsibilities. Ottawa, ON: PHAC; [updated 2013 Mar; cited 2014 Jun]; Available from: http://www.phac-aspc.gc.ca/zoono/fiorp-mitioa/ann/13-eng.php.

76. Manitoba Health. Enteric outbreak summary report. Winnipeg, MB: Government of Manitoba; 2012. Available from: http://www.wrha.mb.ca/extranet/ipc/files/manuals/ltc/ManualPCH_Sec06_G_Gastro-AppendixC.pdf.

77. Centers for Disease Control and Prevention. Surveillance for foodborne disease outbreaks --- United States, 2006. Morbidity and Mortality Weekly Report (MMWR). 2009;58(22). Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5822a1.htm.

78. Canadian Public Health Association. Outbreak Summaries: a web-based application [conference abstract]. Canadian Public Health Association: CPHA; 2009. Available from: http://resources.cpha.ca/CPHA/Conf/Data/2009/A09-622ae.pdf.

79. Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, et al. Food-related illness and death in the United States. Emerg Infect Dis. 1999 Sep-Oct;5(5):607-25. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10511517.

80. Public Health Agency of Canada. Norovirus. Ottawa, ON: PHAC; [updated 2014 Jun; cited 2014 Jun]; Available from: www.phac-aspc.gc.ca/fs-sa/fs-fi/norovirus-eng.php.

81. Public Health Agency of Canada, Provincial Public Health Microbiology Laboratories. National Enteric Surveillance Program (NESP): annual summary 2010. Ottawa, ON: PHAC, National Microbiology Laboratory Centre for Food-borne Environmental Zoonotic Infectious Diseases; 2012.

This document was produced by the National Collaborating Centre for Environmental Health at the British Columbia Centre for Disease Control, June 2014.



*Production of this document has been made possible through a financial contribution from the Public Health Agency of Canada through the National Collaborating Centre for Environmental Health.*

Photo Credits: sinankocaslan; licensed through iStockphoto

ISBN: 978-1-926933-70-2



200 – 601 West Broadway
Vancouver, BC V5Z 3J2

Tel.: 604-829-2551
contact@ncceh.ca

National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

**To provide feedback on this document, please visit www.ncceh.ca/en/document_feedback**

**www.ncceh.ca**