Health Canada and the Public Health Agency of Canada | Santé Canada et l'Agence de la santé publique du Canada

Canada

Evaluation of the Public Health Agency of Canada's Food-borne and Water-borne Enteric Illness Activities 2017-18 to 2021-22

Prepared by the Office of Audit and Evaluation
Health Canada and the Public Health Agency of Canada

September 2022

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List of Acronyms

AMR	Antimicrobial resistance
AMU	Antimicrobial use
CIPARS	Canadian Integrated Program for Antimicrobial Resistance Surveillance
CFIA	Canadian Food Inspection Agency
CPHLN	Canadian Public Health Laboratory Network
FDASD	Food-Borne Disease and Antimicrobial Resistance Surveillance Division
FIORP	Food-borne Illness Outbreak Response Protocol
GRDI	Genomics Research and Development Initiative
IDPB	Infectious Diseases Programs Branch
MOA	Memoranda of Agreement
NESP	National Enteric Surveillance Program
NMLB	National Microbiology Laboratory Branch
PAIFOD	Publicly Available International Food-borne Outbreak Database
PHAC	Public Health Agency of Canada
PHN	Public Health Notice
PNC	PulseNet Canada
OICC	Outbreak Investigation Coordinating Committee
OMD	Outbreak Management Division
OS	Outbreak Summaries
SE	*Salmonella* Enteritidis
US CDC	United States Centers for Disease Control and Prevention
WGS	Whole genome sequencing
WHO	World Health Organization

Executive Summary

Background

Food/water-borne enteric illnesses affect millions of people in Canada each year. People become ill when they consume contaminated food or water, and contamination of food can happen at various stages of the "farm-to-fork" continuum. An outbreak is an incident in which two or more persons experience a similar illness, and there is evidence of a common exposure. Risks related to food/water-borne enteric illness are expected to increase in the future due to factors such as climate change and antimicrobial resistance.

The Public Health Agency of Canada (PHAC) is one of many players in the overall Canadian food safety system, which also includes local public health authorities, provincial and territorial governments, and other federal partners. PHAC's Infectious Diseases Programs Branch and the National Microbiology Laboratory Branch deliver food/water-borne enteric illness prevention, detection and response activities. PHAC's planned spending on food/water-borne enteric illness activities for the period of the evaluation was approximately $96.65 million.

The purpose of the evaluation was to examine the performance and efficiency of PHAC's food/water-borne enteric illness activities from 2017-18 to 2021-22.

Conclusions and Recommendations

Overall, PHAC's food/water-borne enteric illness activities are functioning effectively. PHAC is providing information, tools, and expertise to support the work of stakeholders to prevent, detect, and respond to food/water-borne illnesses. There is evidence that PHAC's work has contributed to decision making and led to policy and regulatory changes that ultimately help protect people in Canada. For example, there has been a consistent decline in cases of *Salmonella* infection in Canada, one of two leading food-borne illnesses in the country. This is partly because of improvements in outbreak detection and source identification due to PHAC's implementation of whole genome sequencing technology. This work influenced a federal industry directive that supported changes in industry practices related to frozen raw breaded chicken products.

In light of the evolving food/water-borne illness environment, continued work is needed to address new emerging pathogens, as well as antimicrobial resistance and antimicrobial use in food sources. In addition, although PHAC has provided timely information

for Canadians, the evaluation noted that the clarity and accessibility of public communications could be improved, particularly with regard to Public Health Notices.

This is the third evaluation over the past decade outlining that PHAC has an efficient and effective approach for food/water-borne enteric illness activities. Guiding documents and processes are well developed, clarify mandates, define roles and responsibilities, and provide guiding practices. To ensure that this program continues to be successful in the future, addressing challenges associated with Information Management (IM)/Information Technology (IT) barriers and inadequacies will be important. Furthermore, maintaining human resource capacity, and using fully the operational business support provided to navigate cumbersome staffing and procurement processes will also be important to increase efficiency and resource use.

The findings from this evaluation have resulted in the recommendations listed below.

Recommendation 1:
Examine public communications activities, including Public Health Notices, with a view to implement best practices to optimize accessibility, usefulness and understanding of public health messaging.

Recommendation 2:
Identify, prioritize and implement options to address operational challenges related to:

- improving IM/IT systems and support for the program, including for existing initiatives (e.g., interactive data visualization), and finding a replacement for Bionumerics software; and
- procurement and staffing, including optimizing use of business operations support provided to the program.

Recommendation 3:
Identify and prioritize options to expand surveillance activities to provide stakeholders with the data, information and tools to better address:

- emerging enteric pathogens, which are likely to become an increasing risk due to climate change; and
- ongoing increases in foodborne antimicrobial resistance and options to reduce the need for antimicrobial use in animals in Canada.

Management Response and Action Plan

Evaluation of PHAC's Food-borne and Water-borne Enteric Illness Activities

Recommendation 1				
Examine public communications activities, including Public Health Notices, with a view to implement best practices to optimize accessibility, usefulness and understanding of public health messaging.				
Management response *(Identify whether program management agrees, agrees with conditions, or disagrees with the recommendation, and why)*				
Management agrees with the spirit of this recommendation.				
Action Plan *(Identify what action(s) program management will take to address the recommendation)*	Deliverables *(Identify key deliverables)*	Expected Completion Date *(Identify timeline for implementation of each deliverable)*	Accountability *(Identify Senior Management and Executive (DG and VP level) accountable for the implementation of each deliverable)*	Resources *(Describe the human and/or financial resources required to complete recommendation, including the source of resources (additional vs. existing budget))*
Conduct an assessment of user readability and a plain language review of the PHN template and content.	Formulate recommendations for updated web content, PHN format and language, for partner review and input. Year 2: Implement revised web content and updated PHN and other communication tools.	August 2023 April 2024	IDPB – VP CFEZID – DG CPAB – ADM	To be completed with existing resources.

Recommendation 2				
Identify, prioritize and implement options to address operational challenges related to: • improving IM/IT systems and support for the program, including for existing initiatives (e.g., interactive data visualization), and prioritizing finding a replacement for Bionumerics software; and • procurement and staffing, including optimizing use of business operations support provided to the program.				
Management response				
Management agrees with the spirit of this recommendation.				
Action Plan	Deliverables	Expected Completion Date	Accountability	Resources
Conduct an assessment to identify, prioritize and provide recommendations to improve IM/IT systems that support program initiatives (e.g., interactive data visualization).	In consultation with the Corporate Data and Surveillance Branch: • Develop a report of prioritized recommendations of IM/IT systems to support current and planned future program initiatives. • Assess the feasibility of adopting or implementing prioritized IM/IT systems.	Fall 2023 Spring 2024	IDPB – VP CFEZID – DG	To be completed with available funds and successful new funding. To be completed with existing resources.
Identify and prioritize finding a replacement for Bionumerics software	Conduct a scan to identify options for replacing Bionumerics software, and prioritize options based on program needs.	May 1, 2023	NMLB – VP	To be completed with existing resources.

	Assess the feasibility of implementing the top choice for replacement of Bionumerics and outline steps and resources required to transition to the recommended replacement.	December 31, 2024		
Identify and implement strategies for improved engagement with procurement/contracting. Identify and implement opportunities to better utilize business operations support.	In consultation with PHAC contracting, develop recommendations for process improvement related to procurement/contracting. Implement recommendations to improve procurement and contracting processes. Assess program activities to identify areas where business operations support can be more fully utilized. Engage with appropriate business operations on support for identified program activities.	Fall 2023 Spring 2023 Fall 2023 Spring 2023	IDPB – VP CFEZID – DG NMLB – VP	To be completed with existing resources.

Recommendation 3				
Identify and prioritize options to expand surveillance activities to provide stakeholders with the data, information and tools to better address: • emerging enteric pathogens, which are likely to become an increasing risk due to climate change; and • ongoing increases in foodborne antimicrobial resistance and options to reduce the need for antimicrobial use in animals in Canada.				
Management response				
Management agrees with the spirit of this recommendation.				
Action Plan	Deliverables	Expected Completion Date	Accountability	Resources
Identify and prioritize funding opportunities to strengthen existing programs to support the identification and prioritization of: • expanded surveillance activities to better address emerging enteric pathogens, due to climate change; and • activities to identify and better understand ongoing increases in foodborne antimicrobial resistance and options to reduce the need for antimicrobial use in animals in Canada	Through PHAC Medium Term Planning (MTP), develop recommendations and supporting funding envelop required to implement proposed expansion of existing programming.	March 31, 2023	IDPB – VP CFEZID – DG	Planning and prioritization to be completed with existing resources. Implementation of program enhancements dependant on new, dedicated funding.

Identify limitations and gaps associated with current laboratory tools and data and propose steps to improve outputs and expand laboratory activities to climate-affected pathogens	Conduct a gap assessment to identify situations where research, laboratory tools, or scientific knowledge are lacking for enteric pathogens that may be affected by climate change.	April 1, 2024	NMLB – VP	To be completed with existing resources.

1. Program Description

Context

Food/water-borne enteric illnesses affect millions of people in Canada each year. People become ill when they consume contaminated food or water. While usual symptoms are nausea, vomiting, abdominal cramps, and diarrhoea, these illnesses can result in hospitalization and death.

Food contamination can happen at various stages of the "farm-to-fork" continuum, for example, on farms, in production and processing, in retail settings, and in food preparation. Contaminants can include bacteria, viruses, fungi, and parasites. The most common causes of food/water-borne enteric illness in Canada are norovirus, *Clostridium perfringens*, *Campylobacter*, *Salmonella*, *Listeria monocytogenes* and *Escherichia coli (E. coli)*[1].

An outbreak of food/water-borne enteric illness is an incident in which two or more persons experience a similar illness and there is evidence of a common exposure. An outbreak is identified through laboratory surveillance, or by observing an increase in illness that is unusual in terms of time or geography. An outbreak is confirmed through laboratory and/or epidemiological evidence.

Risks related to food/water-borne enteric illness are expected to increase in the future due to factors such as climate change and antimicrobial resistance (AMR). Climate variables, including temperature and precipitation patterns, extreme weather events, as well as ocean warming and acidification can affect the entire food chain. As climate change continues and intensifies, it will increase the risk of adverse effects on food safety in Canada[2]. AMR is also a potential food-borne risk. There is growing evidence that antimicrobial use and resistance in animals can lead to similar resistance in humans[3], as resistant bacteria can be transferred to humans through the food chain and direct contact. As such, AMR is an increasing risk to global health and is recognized by the World Health Organization (WHO) and the United Nations as one of the top ten global health threats facing humanity[4].

Program Profile

The Public Health Agency of Canada (PHAC) is one of many players in the overall Canadian food safety system, which also includes local public health authorities, provincial and territorial governments, and other federal partners such as Health Canada and the Canadian Food Inspection Agency (CFIA). Health Canada is responsible for setting the regulations and standards for the safety of food sold in Canada, and is responsible for food safety messaging and resources outside of food-borne illness outbreaks. In addition, Health Canada is also responsible for the human safety evaluation of veterinary antimicrobial products. The CFIA delivers all federal inspection and enforcement services related to food, and contributes to the investigation and control of food-borne illness outbreaks by conducting food safety investigations, testing, and recall activities, as well as through its regulatory compliance and enforcement activities.

The ultimate goal of PHAC's food/water-borne enteric illness activities is to protect people in Canada from food/water-borne enteric illnesses. Objectives include:

- Stakeholders have access to evidence-informed knowledge, including laboratory science public health intelligence, on infectious diseases of food/water-borne origin, and access to tools, protocols, and expertise to respond to outbreaks of food-borne and water-borne illnesses;
- Stakeholders take informed actions to prevent and respond to food/water-borne enteric illnesses and food/water-borne antimicrobial resistance; and
- People in Canada are aware of food/water-borne enteric illnesses and preventative measures, and take informed actions to protect themselves from food/water-borne illnesses, including antimicrobial-resistant infections.

PHAC's food/water-borne enteric illness prevention, detection and response activities are delivered by the Infectious Diseases Programs Branch (IDPB) and the National Microbiology Laboratory Branch (NMLB).

IDPB KEY ACTIVITIES

- conducts national surveillance for enteric illnesses and food/water-borne antimicrobial resistance;
- collaborates with international surveillance activities;
- coordinates multi-jurisdictional food-borne illness outbreaks involving more than one province or territory, or involving Canada and another country or countries where appropriate;
- provides consultation and content expertise in other food-borne outbreak investigations as requested;
- interprets and comments on the weight of epidemiologic evidence collected during investigations of enteric illness outbreaks originating from a food source; and
- provides training in enteric outbreak investigation methods[5].

NMLB KEY ACTIVITIES

- provides reference services for strain identification and characterization;
- provides national laboratory-based surveillance;
- disseminates information through PulseNet Canada and the National Enteric Surveillance Program; and
- is the usual first point of contact for provinces and territories sharing strain identification data and the detection of clusters of strains that are occurring in more than one province or territory[6].

PHAC's planned spending on food/water-borne enteric illness activities for the evaluation period was approximately $96.7 million (M).

Table 1: Planned spending on relevant activities, by division (2017-18 to 2021-22)

Division	Planned Spending
IDPB - Food-Borne Disease and Antimicrobial Resistance Surveillance Division (FDASD)	$28.1M
IDPB - Outbreak Management Division	$18.1M
NMLB - Division of Enteric Diseases	$38.3M
NMLB - Public Health Risk Sciences Division	$6.3M
NMLB - AMR	$5.8M

Source: Chief Financial Officer and Corporate Management Branch

2. Evaluation Description

Evaluation Scope

The purpose of the evaluation was to examine the performance and efficiency of PHAC's food/water-borne enteric illness activities from 2017-18 to 2021-22. The evaluation used multiple lines of evidence, both qualitative and quantitative, to ensure triangulation of findings (see Annex A for detailed methodology, limitations and mitigation strategies).

Given that the need to address food/water-borne enteric illness in Canada and PHAC's role in addressing this need are well established, the evaluation did not focus on program relevance. Instead, attention was given to achievement of results, including progress towards planned outcomes, and efficiency, including factors that have facilitated or hindered the program's activities. Detailed evaluation questions are below.

1

Results:

What progress has been made towards planned outcomes?

- Stakeholders have access to evidence-informed knowledge, including laboratory science public health intelligence, on infectious diseases of food/water-borne illnesses, and access to tools, protocols, and expertise to respond to outbreaks of food-borne and water-borne illnesses;
- Stakeholders take informed actions to prevent and respond to food/water-borne illnesses and antimicrobial resistant infections; and
- People in Canada are aware of food-borne and water-borne illnesses and preventative measures, and take informed actions to protect themselves from food-borne and water-borne illnesses.

2

Efficiency:

How efficient is the current approach?

- Has funding dedicated to addressing food/water-borne enteric illness been spent as intended?
- What factors have facilitated or hindered the program's activities? How have the COVID-19 pandemic and PHAC's organizational changes impacted the program's activities?
- How could program efficiency be enhanced?
- Does the program adequately recognize and address the possibility of differential health impacts of food/water-borne illnesses across different population groups?

3. Evaluation Findings

Question 1 – Effectiveness

To assess progress on results, the evaluation looked at the achievement of planned outcomes related to PHAC's food/water-borne enteric illness activities.

Information, tools, protocols, and expertise for stakeholders to prevent, detect and respond to food/water-borne Illnesses

PHAC has supported Canada's food safety system by providing laboratory expertise, managing multiple national surveillance systems, coordinating outbreak response, sharing scientific expertise, and generating new research. PHAC's information and tools have informed outbreak response and investigations, as well as food safety interventions made by stakeholders.

Diagnostics and testing

The NMLB provides diagnostic and testing services for food/water-borne pathogens in human-clinical isolates. This includes identification and serotyping (classifying by group of closely related organisms) for *Listeria*, *Salmonella*, *E. coli*, and other pathogens to assist in the detection of illness outbreaks.

Provincial public health laboratories regularly access NMLB's laboratory services and expertise. This information sharing occurs primarily through national networks like the Canadian Public Health Laboratory Network (CPHLN) and PulseNet Canada, both coordinated by the NMLB. For instance, every year, the NMLB sequences around 6,000 to 8,000 *Salmonella* isolates sent from provincial public health laboratories through the CPHLN. PHAC also shares laboratory test results with other federal stakeholders. However, several internal and external interviewees spoke about challenges in sharing laboratory test results between the various provincial and federal laboratories involved in enteric illness surveillance. These challenges related to different information technology (IT) requirements between the laboratories, misaligned workflow between the different laboratories, and data inaccessibility.

Throughout 2017 and 2018, PHAC did a phased implementation of whole genome sequencing (WGS) for detection and surveillance of *Listeria, Salmonella, Shigella*, and *E. coli*. According to interviewees, the rollout of WGS has been a "game changer" because it greatly enhances PHAC's ability to detect and address food-borne enteric illnesses. Given the higher accuracy and objectivity of WGS, as compared to previous molecular typing techniques, WGS has improved PHAC's ability to detect outbreak clusters, to understand a pathogen's ability to cause disease, to attribute and trace to the contaminated food source, and to detect antimicrobial resistance. For example, in the fiscal year 2018-19, a year after the complete implementation of WGS for key enteric pathogens, PHAC was involved in around 20% more outbreak

events than in 2017-18, when WGS was partially implemented, and 115% more events than in 2016-17, which was prior to implementation of WGS. As there were no additional funds or resources assigned to the implementation of WGS, the operationalization of WGS for this program was largely thanks to the grassroots efforts of NMLB scientists.

During WGS implementation, PHAC also helped provincial public health laboratories increase their own genome sequencing capabilities by offering technical support, analysis, and training. Internal planning documents identified a continued need for knowledge sharing with provincial laboratories and epidemiologists about WGS.

Surveillance information

PHAC monitors food/water-borne enteric illness through various public health surveillance systems. These systems are used to detect outbreaks, monitor disease trends, and identify risk factors. Effective public health surveillance systems should provide timely intelligence on factors affecting the health of the population, and provide useful and evidence-based information so public health professionals can take action to address emerging and ongoing issues.[7]

PHAC uses data from different surveillance systems to monitor cases of food/water-borne illness

- **Canadian Notifiable Disease Surveillance System (CNDSS)** - collects annual numbers of illnesses reported to provincial and territorial public health authorities for a set of nationally notifiable diseases.
- **National Enteric Surveillance Program (NESP)** - collects weekly numbers on select bacteria, parasites and viruses from provincial laboratories at the subtype and species level.
- **Enhanced National Listeriosis Surveillance** - collects detailed information on invasive listeriosis cases in participating provinces and territories.
- **FoodNet Canada** – collects information on cases of infectious gastrointestinal illness and sources of exposure at four sentinel sites across the country.
- **Provincial and Territorial Reportable Disease Surveillance System** – collects the number of laboratory-confirmed illnesses reported by local public health units and authorities for a set of diseases.
- **National Studies on Acute Gastrointestinal Illness (NSAGI)** - collects information from population surveys on vomiting and diarrhea.
- **PulseNet Canada (PNC)** - is comprised of a network of public health laboratories across Canada linked by databases; it uses genomic science to detect outbreaks that may have cases occurring anywhere in Canada.
- **Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)** - integrates, analyzes, and communicates trends in antimicrobial use in animals and crops, and in antimicrobial resistance in food-borne bacteria from humans, animals, and retail food across Canada (a component of the Canadian Antimicrobial Resistance Surveillance System (CARSS).
- **Outbreak Summaries (OS)** - is a web-based communication platform/database that allows public health professionals to document, query, and generate reports on the results of outbreak investigations.

PHAC regularly shares surveillance data and associated reports with other federal government departments, provincial and territorial partners, and international and industry partners. Overall, partners interviewed were positive about the usefulness and timeliness of PHAC's surveillance and outbreak data, and indicated that they use it to inform their work. This has included updating federal or provincial policies or guidelines related to food safety, modifying food industry practices to reduce illness, and informing enteric illness prevention and response activities in Canada and abroad. While it is evident that information is available to stakeholders when they need it, the evaluation identified some challenges in deploying interactive data visualization of surveillance information and in publishing surveillance reports, although these delays were due in part to conflicting priorities with the COVID-19 pandemic response.

In addition, there are opportunities for PHAC to improve the standardization, coordination, and integration of data across surveillance systems, in order to improve outbreak detection and response. For instance, the various national laboratory-based surveillance systems that generate WGS data follow different data agreements, which creates barriers for data sharing. Additionally, many external interviewees, mostly from other federal departments, spoke about how PHAC's databases and resources are not necessarily well known, particularly for those without prior connections to PHAC staff, and they voiced a desire for PHAC to make its data more easily accessible via publicly available databases.

For more information on the various surveillance systems associated with this program, please refer to Annex B.

Outbreak coordination and response

PHAC is responsible for leading a coordinated response to food-borne outbreaks in Canada involving more than one province or territory, or another country (i.e., multi-jurisdictional outbreaks). PHAC uses the Food-borne Illness Outbreak Response Protocol (FIORP) to guide a coordinated response to such outbreaks in collaboration with affected partners. The FIORP was developed in 1999 by PHAC, Health Canada, and CFIA, in consultation with provincial and territorial partners, to enhance collaboration and response effectiveness during multi-jurisdictional food-borne outbreaks. It is updated on an ongoing basis to reflect lessons learned, and was most recently updated in 2017. The FIORP sets out key guiding principles and operating procedures to enhance collaboration and coordination among partners, establish clear lines of communication, and improve the efficiency and effectiveness of a response. Many internal and external partners described the FIORP as a best practice.

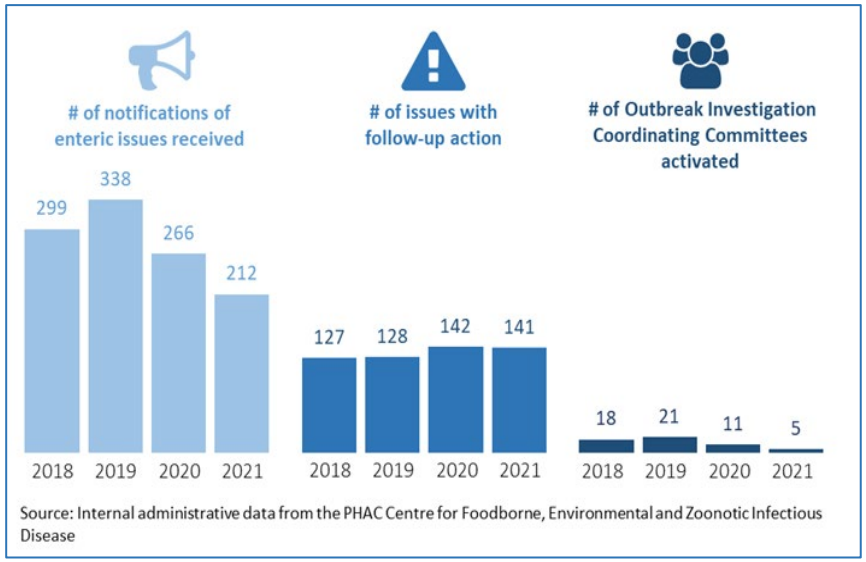
PHAC's Outbreak Management Division (OMD) is usually the first point of contact for notification from partners of issues related to actual or potential food-borne illness outbreaks and requests for content expertise and support for food-borne outbreak investigation. The NMLB provides reference services for strain identification and characterization, surveillance, and information dissemination through PulseNet Canada and the National Enteric Surveillance Program (NESP). Strain

identification data and the detection of clusters of strains are essential in indicating the potential for multi-jurisdictional food-borne outbreaks. Microbiological data collected through various PHAC surveillance systems is analyzed in an integrated way to support outbreak detection and investigation.

Over the last five years, PHAC, in collaboration with other Health Portfolio partners, has responded to a variety of food-borne illness outbreaks, even in the face of demands and uncertainty stemming from the COVID-19 pandemic. During this time, PHAC has successfully coordinated and led major outbreak investigations. From January 2018 to December 2021, PHAC received 1,115 notifications of enteric issues, of which 538 required follow-up action by PHAC's epidemiologists (see Figure 1). According to program performance data, PHAC responded to 98% of food-borne illness outbreaks within 24 hours of notification in 2019-20, 91% in 2018-19 and 95% in 2017-18 (exceeding the 90% target).

An Outbreak Investigation Coordinating Committee (OICC) is activated when a multi-jurisdictional enteric illness outbreak is detected for which a co-ordinated response would be beneficial. Each committee brings together affected partners to coordinate a multi-agency response to the outbreak. From 2018 to 2021, PHAC activated 55 OICCs under the FIORP. Conducting post-outbreak debriefs is an essential part of the outbreak response process. During these debriefs, partners identify challenges associated with the outbreak investigation, and recommendations for future investigations. Post-outbreak debriefs are systematically conducted promptly after an outbreak investigation is closed. Internal and external interviewees were supportive of these debriefs, indicating that they are a best practice, and noting that PHAC is very effective at following up to ensure recommendations are addressed. A review of recommendations and actions resulting from a sample of post-outbreak debriefs from within the evaluation period showed that these debriefs have led to improvements over time. For example, there has been an increase in the involvement of US partners in OICC calls for outbreaks common to both countries. This change was based on lessons learned through past post-outbreak debriefs.

Figure 1. Enteric Illness Outbreak Notifications Received and Actioned by PHAC, 2018-21



Source: Internal administrative data from the PHAC Centre for Foodborne, Environmental and Zoonotic Infectious Disease

Example of Outbreak Detection and Response in Action: Outbreak of *Salmonella* from red onions from the US

Investigation summary: From mid-July to late August 2020, PHAC led a multi-jurisdictional outbreak investigation of *Salmonella* Newport infections that involved cases in seven provinces, for 515 total confirmed cases. Outbreak investigators identified contaminated red onions imported from the US as the likely source. This was the largest multi-provincial *Salmonella* outbreak in recent Canadian history involving a novel food and pathogen combination.

Cluster of *S.* Newport cases
Multiple provinces begin reporting high number of *Salmonella* Newport cases.

OICC activated for multi-jurisdictional outbreak
Multi-jurisdictional outbreak is declared after cases from two provinces and the US are linked via WGS. PHAC activates Outbreak Investigation Coordinating Committee (OICC) with federal, provincial and US partners in accordance with national protocol.

First public health notice
PHAC publishes first public health notice (PHN) on the investigation.

Food source investigation
PHAC conducted case interviews to obtain more specific exposure data. In parallel, provincial partners and the CFIA conducted food sampling and trace-back investigation.

Suspected source identified
PHAC issues updated PHN specifying red onions from US as likely cause of illness and advising against their consumption until further notice.

Red onions recalled
PHAC issues another updated PHN determining probable source of contaminated red onions from the US. CFIA publishes associated recall warnings.

Final public health notice
After nine PHNs, PHAC publishes final notice stating the outbreak appears over and investigation has closed.

Post-outbreak OICC debrief
OICC conducts procedural post-outbreak debrief.

Tools and expertise for outbreak response and surveillance

PHAC is also responsible for providing Canadian and international partners with tools and expertise for outbreak response and surveillance. Key examples below:

- PHAC's OMD collaborated with the National Collaborating Centre for Infectious Diseases and the National Collaborating Centre for Environmental Health to develop an "Outbreak Toolkit"[8]. The Toolkit contains resources and tools for public health practitioners involved in enteric outbreak investigations. The tool was launched in December 2017.
- In 2018-19, OMD provided 17 presentations, webinars, or training sessions to various audiences. Topics included Outbreak Summaries, WGS, and enteric outbreak investigations.
- In 2019-20, PHAC developed 24 knowledge transfer products related to food-borne illness and presented them to over 600 partners.
- OMD served as surge capacity for provinces and territories during the pandemic, when they had reduced capacity to conduct outbreak investigations in their own jurisdictions.

Research information

PHAC conducts and shares novel research about food/water-borne enteric illnesses through publications, journal articles, and presentations to interested partners, including academia, industry groups, stakeholder groups and subject matter experts. For example, from 2017 to 2021, PHAC published 19 FoodNet Canada articles, 15 Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) articles, and 27 CIPARS-affiliated articles. These research articles covered a range of topics, such as antimicrobial resistance and antimicrobial use along the food chain, epidemiology of *Salmonella* and *E. coli* in Canada, the importance of WGS, and climate change impacts on food-borne diseases.

In 2015, PHAC published the first **Foodbook** study report based on a national survey, focussing on the food consumption patterns of people in Canada to inform investigation of and response to future food-borne illness outbreaks. Though the original study was conducted outside of the evaluation period, findings from this study continue to be useful for public health practitioners and researchers. For example, there were 1,111 downloads of the Foodbook report in the fiscal year 2017-18 alone. There is wide interest from partners for an updated Foodbook study. PHAC is currently working on such an update, but efforts have been hindered by the COVID-19 pandemic, as well as contracting delays due to procedural challenges and issues with security and privacy. While PHAC initiated work in May 2021 to implement a contract for conducting a new study, the contract was still not finalized as of March, which was the end of the period in scope for this evaluation.

Since 2016, PHAC has collaborated with four other federal departments and agencies on the Government of Canada's Genomics Research and Development Initiative (GRDI) projects on AMR. This work has produced numerous tools and insights related to prevention and action on AMR in Canada.

These include ways to reduce environmental AMR exposure in agricultural production, and the creation of a government-wide database for the sharing of bacterial genetic information. According to a recent evaluation of the GRDI, these projects increased knowledge transfers between participating departments and agencies, and with knowledge end-users and the broader scientific community[9].

Information for people living in Canada to protect themselves from food/water-borne illness

PHAC provided information to people living in Canada to help them protect themselves from food-borne illness during multi-jurisdictional outbreaks. There are opportunities to improve the clarity and accessibility of this information, in particular with regard to Public Health Notices.

PHAC, Health Canada, and CFIA share responsibility for communicating about food safety to people living in Canada. During multi-jurisdictional food-borne illness outbreaks, including international events, PHAC is responsible for leading public communications related to human illnesses and public health measures. Health Canada is responsible for leading public education related to safe food handling, and CFIA leads food recall communications. The evaluation found that there has been some overlap between PHAC's and Health Canada's communications efforts related to food safety. However, in December 2021, PHAC, Health Canada, CFIA, and Agriculture and Agri-Food Canada signed an updated Memoranda of Understanding (MOU). The new MOU is expected to address the issue of duplication of efforts as it outlines key responsibilities for risk communication.

PHAC provides timely information related to food/water-borne enteric illness for people living in Canada, primarily through social media and Public Health Notices (PHN). In addition, PHAC creates online content for canada.ca websites related to food safety. While PHAC communications are generally aligned with international guidance for food-borne outbreaks[10], there are areas where PHAC could improve its approach to public communications in order to make its messages more accessible and easier to understand. The evaluation found several areas for improvement, in particular for PHNs:

- Information for the public could be more concise and easier for consumers to understand. For example, PHNs could use more plain language and deliver the message to consumers at the beginning of the document, rather than at the end. Several interviewees pointed to the United States Centers for Disease Control and Prevention's (US CDC) approach to PHNs and other communications products as better approaches.
- The risk communications approach for PHNs could better acknowledge the challenges and limitations associated with pinpointing the source of a food-borne outbreak. For example, PHNs could be clearer about limitations when information is inconclusive in order to avoid potential confusion for consumers and undue impacts on food retailers or producers. Many interviewees discussed PHNs

related to a *Salmonella* outbreak where PHAC initially identified "fresh fruit or vegetables" to be the likely cause of the outbreak, and later revised the cause to be frozen corn. Some interviewees questioned whether a PHN related to something as broad as "fresh fruit or vegetables" was useful information for the public. They suggested that PHAC should review the decision-making criteria for how much information is needed before issuing a PHN or be more explicit in the PHNs about what is still *unknown*.

These public communication issues related to food-borne illness are not new and some were identified in the previous evaluation[11]. To help improve communications for people living in Canada, PHAC, in cooperation with Health Canada, planned a review on consumer behaviour and food safety. This review was to look at existing consumer behavior education initiatives and explore opportunities to address gaps through collaboration with various partners. Results from this review were planned to be released in winter 2019, but were delayed and then put on hold due to the COVID-19 pandemic.

Protection of people in Canada from food-borne and water-borne illnesses

In the past five years, there has been a consistent decline in cases of Salmonella infection in Canada. It is thought that this decline has been influenced by a combination of improvements in outbreak detection and source identification, and subsequent policy implementation. This came after PHAC implemented whole genome sequencing technology, in parallel with continued data availability throughout the pandemic. Still, antimicrobial resistance in food sources continues to grow and poses a risk to the health of people in Canada.

The ultimate goal of PHAC's food/water-borne enteric illness activities is to protect people in Canada from these illnesses. While multiple players in the food safety system share this goal, the evaluation found that PHAC is doing its part in protecting people in Canada.

Rate of enteric illness infections

The key indicator used to measure progress on this goal is rates per 100,000 of key infectious diseases, such as *Salmonellosis*. Cases of *Salmonella* infection in Canada have decreased since 2016, particularly the *Salmonella* Enteritidis (SE) serotype, which accounts for nearly a third of human *Salmonella* infections in Canada. Between 2017 and 2020, human cases of SE have decreased by 59% to 3.74 per 100,000 people. This surpassed targets set by the Joint Government-Industry Working Group on the Control of *Salmonella* and *Campylobacter* in Poultry, of which PHAC is a member, to

reduce new infections to 5.36 per 100,000 by 2024. Preliminary surveillance data for 2021 indicate a sustained decrease in SE illnesses nationally.

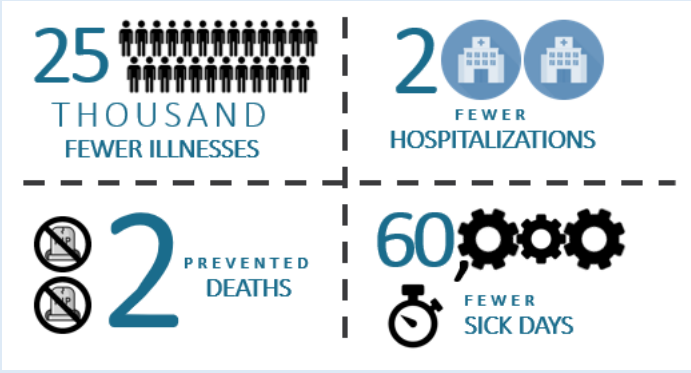
In 2020, the first year of the COVID-19 pandemic, FoodNet Canada found 28% fewer enteric illness infections when compared with annual rates between 2017 and 2019, with decreases recorded for all major pathogens tested in the surveillance system. These lower numbers could be due to several causes, including the implementation of stronger public health measures and a significant reduction in travel-related cases. The decreased rates could also be due in part to fewer surveillance testing and sampling activities during the pandemic, and fewer visits to doctors or emergency rooms due to stay-at-home measures. Preliminary data from FoodNet Canada 2020 did not show changes in the proportion of patients who were hospitalized or who received antibiotic prescriptions, as compared to the three previous years.

As previously described, implementation of WGS for enteric illness surveillance contributed to improved outbreak detection and source identification, and consequently, provided greater opportunities to protect people in Canada from enteric illnesses. The NMLB estimates that use of WGS for PulseNet Canada data to detect and respond to enteric illness outbreaks has led to decreased burden of illness, with a projected $40M in health care cost savings every year.

Spotlight on how WGS led to industry changes for frozen raw breaded chicken products

Poultry has been shown to be a major cause of *Salmonella* infection in people in Canada, especially of the *Salmonella* Enteritidis serotype. Frozen raw breaded chicken products have been a known risk factor for *Salmonella* infection for well over a decade. However, prior to the use of WGS in 2017, PHAC had only conducted one national outbreak investigation associated with exposure to frozen raw breaded chicken products (FRBCP). Once WGS was implemented, PHAC was able to identify *Salmonella* clusters related to these products more accurately, and to attribute FRBCP as the cause of illnesses, leading to 16 national outbreak investigations between May 2017 and May 2019 for this single commodity. PHAC used WGS to identify 584 laboratory-confirmed cases, which could represent an estimated 15,242 undiagnosed cases, according to PHAC estimates. This evidence led to 14 related food recalls and warnings by the CFIA between 2017 and 2019.

Furthermore, using the investigation findings, PHAC was able to demonstrate that a significant number of *Salmonella* infections could be prevented if product changes were made. In March 2018, CFIA announced a new industry directive, implemented in April 2019, to reduce *Salmonella* levels in FRBCP. Subsequently, the salmonellosis incidence rate decreased by approximately a third (33%) from 2017 to 2019. Compared to the previous five years, in 2019 there were an estimated:



Antimicrobial use and resistance in enteric bacteria

While new cases of *Salmonella* in Canada are decreasing, CIPARS surveillance data shows that the proportion of *Salmonella* isolates that are antimicrobial resistant is increasing. Importantly, though the number of isolates are still small, the proportion of *Salmonella* isolates that are resistant to six or seven of the seven antimicrobial classes tested have increased to record levels. Illnesses caused by antimicrobial resistant bacteria are much more difficult, if impossible, to treat, and antimicrobial resistance is accelerated by the inappropriate use of antibiotics. Several internal interviewees noted there is not enough attention on addressing food-borne AMR in Canada, including insufficient funding for appropriate AMR and AMU surveillance. Expanding AMR and AMU surveillance would provide more data for the development and implementation of interventions to address increasing AMR and AMU in food production and among other animals.

Protecting people facing health inequities

PHAC's activities to address groups facing health inequities or higher risk of food/water-borne enteric illness have focused on time-limited and small-scale projects. For example, a water safety project in northern communities in 2018, and the addition of targeted questions to some surveillance questionnaires. The majority of interviewees felt there was minimal or no data available to understand the different impacts of food/water-borne enteric illness on different population groups. Many people cited lack of disaggregated data provided by provincial or regional health authorities, while a few others noted the lack of data collection in northern Canada, though these data limitations extend beyond food/water-borne illness. Furthermore, a 2019 publication of an investigation of a *Salmonella* outbreak suggested opportunities for PHAC to improve the cultural relevance of its outbreak investigations and food consumption surveys, such as the inclusion of more diverse dishes on food questionnaires and collaboration with community members from various ethno-cultural and linguistic groups[12].

Question 2 – Efficiency

PHAC's approach for food/water-borne enteric illness is well developed, efficient, and effective. It includes clear and well-defined mandates, roles and responsibilities, and guiding practices. There are opportunities to expand surveillance in light of emerging pathogens. The program also faces challenges associated with IM/IT, human resource capacity, and procurement processes.

The evaluation explored efficiency in terms of the program's approach, including factors that have facilitated or hindered the program's activities, and impacts of the COVID-19 pandemic and PHAC's recent organizational changes.

Program Approach

As has been documented in previous evaluations, PHAC continues to have an efficient and effective approach for food/water-borne enteric illness activities. Guiding documents and processes are well developed; they clarify mandates, define roles and responsibilities, and provide guiding practices. Furthermore, the NMLB's Division of Enteric

Diseases has a formal quality control environment. Its labs are ISO 17025 accredited, follow PulseNet international benchmarking, and serve as a World Organisation for Animal Health reference laboratory. Several partners interviewed noted PHAC's approaches to food/water-borne surveillance and outbreak management are best practices. PulseNet Canada was used as a model for other laboratories, and CIPARS was used as a model for integrated food-borne AMR and AMU surveillance in multiple countries. The FIORP was also seen as a best practice by internal and external interviewees. It clearly defines mandates, roles, and responsibilities for partners. It also has a built-in continuous improvement process through formal post-outbreak debrief meetings.

The evaluation also found recent improvements to PHAC's program approach, including:

- integration of surveillance systems and data by combining food/water-borne enteric pathogen data from various sources, including FoodNet Canada, CIPARS, PulseNet Canada, and NESP to better identify outbreak sources and inform action; and
- changes to OMD's approach to assessing, prioritizing and investigating multi-jurisdictional clusters of enteric illness, including the development of new criteria for assessing clusters at the national level.

The evaluation found strong evidence of good internal engagement between IDPB's Food-Borne Disease and Antimicrobial Resistance Surveillance Division (FDASD) and OMD, and NMLB groups. The success of these collaborations can be credited to longstanding relationships and regular formal and informal communication across groups for their day-to-day work. The evaluation found that recent organizational changes within PHAC, such as National Microbiology Laboratory becoming a branch, restructuring within a division at NMLB, and the creation of the new Corporate Data and Surveillance Branch, have had minimal impact on the program's ability to meet its various objectives.

One area identified as a potential gap in PHAC's approach is that its surveillance systems are not designed for emerging diseases; rather they are designed to detect changes over time in existing pathogens. This is a growing concern, as climate change is expected to increase the risk of emerging diseases related to food/water-borne enteric illness. There is evidence that COVID-19 wastewater surveillance activities could contribute to detection of emerging pathogens, along with new collaborations related to the One Health approach (an approach to designing and implementing programs, policies, legislation, and research in which multiple sectors communicate and work together to achieve better public health outcomes). PHAC recognizes the One Health approach as being critical for addressing food safety challenges, and it is one of the principles guiding PHAC's climate change actions. To address this gap, NMLB planning documents have suggested that ongoing resources be allocated to fostering expertise and knowledge in explorative research to prepare for future needs. Presently this work is only being pursued through short-term projects.

Impacts of the COVID-19 Pandemic

The COVID-19 pandemic has had a variety of impacts on program activities. The most notable effect was on staff resourcing, as some team members were temporarily reallocated from food safety files to assist with the pandemic response or left permanently to fill new positions that were created with pandemic funding. Within NMLB's Division of Enteric Diseases, 60% of staff were partially or fully deployed for the COVID-19 response, which put the ability to provide core reference services or outbreak detection and response functions at risk. A similar proportion of IDPB's FDASD staff were deployed to the Health Portfolio Operations Centre and other COVID response activities, such as modelling. According to internal interviewees, COVID-related human resource challenges led to higher workloads and, in some cases, feelings of burn out for remaining staff.

In addition, NMLB saw laboratory capacity for routine activities significantly diminished in order to accommodate COVID-19 needs. More than 50% of enteric-related laboratory space in Winnipeg and Guelph was reallocated to the COVID-19 response, which meant that staff did not have enough space to do their regular work. This was further exacerbated by physical distancing measures. NMLB labs also received increased requests from external partners for support with testing and sequencing for surveillance and outbreak response. Given that the COVID-19 response overwhelmed provincial public health laboratories, many were instead sending isolates to NMLB for sequencing.

The demands related to COVID-19 led to some food safety files being put on hold or scaled back. Types of projects affected include:

- longer-term research projects;
- modelling and evidence reviews on food safety issues;
- some sample collection, especially retail food, for AMR monitoring in enteric bacteria;
- enteric wastewater surveillance;
- drafting the Pan-Canadian Action Plan on AMR;
- data entry, data management, and validation;
- OMD annual reports, FoodNet Canada annual reports, and CIPARS annual reports;
- some operational activities (e.g., suspension of retail, farm and water sampling, reduced case follow-up from health units);
- an initiative to review consumer behaviour related to food safety; and
- implementing Foodbook 2.0 for updated national food exposure data.

However, despite COVID-19 pandemic pressures, PHAC was able to maintain its core food safety functions. PHAC continued to investigate and respond to major food-borne illness outbreaks and maintain disease surveillance systems. Some adjustments had to be made to the FoodNet Canada water sampling activities in the British Columbia and Ontario sentinel sites due to COVID-19 pandemic public health measures and local public health staff resources being diverted to COVID-19 response. However, surface water sampling for verotoxigenic *E. coli* was piloted at the QC

sentinel site in 2021, which expanded water surveillance activities to all sentinel sites contributing to FoodNet Canada.

The pandemic also led to some positive impacts on the program, including lessons learned and increased attention on genomics technology used for detection of variants of concern. Scientific learnings, advancements in data manipulation, analysis, sharing, modelling and visualization, and public health capacity built during the pandemic are expected to provide valuable lessons, platforms and relationships that can be leveraged for food safety programming. In addition, COVID-19 work was seen to have increased expertise among laboratory technicians and epidemiologists in the program. Finally, the pandemic highlighted importance of coordination at the federal level and timely and ongoing communication with agri-food stakeholders to address new and emerging issues.

Information Management and Information Technology

Information management and information technology (IM/IT) has been a facilitator for food/water-borne enteric illness activities, as it allows for organization, management, analysis, manipulation, modelling, and visualization of complex data sets. In addition, web-based platforms enable communication and data sharing between partners. For example, Canadian Network for Public Health Intelligence allows provincial public health laboratories to submit data electronically and for NMLB to generate and share reports with partners on a weekly basis.

However, the evaluation also found that IM/IT issues have presented a variety of challenges for the program. There is a critical need to modernize some IT tools to help ensure that core functions can continue and to keep up with evolving science. Internal interviewees from various divisions described how some current software programs are outdated or unsuitable for their needs, including for key activities like data management, model development, and data visualization.

Another significant concern relates to a commercial application called Applied Maths Bionumerics, which the PulseNet surveillance system depends on for managing and analyzing microbiological data. The developer for Bionumerics is ending support for the product as of December 31, 2024 and no replacement software exists that would meet NMLB's needs. External partners using the software, including the US CDC, also face this challenge. According to internal interviewees, PHAC has the personnel with the skills and knowledge to develop a replacement software in-house, provided they have adequate time and resources to do so.

IM/IT challenges have also hampered the program's work to make interactive data visualizations more accessible to partners. Other concerns related to IM/IT include the inadequacy of some data management systems for the type and volume of data associated with food/water-borne activities, and challenges in acquiring the necessary hardware and software for program activities.

Program documentation identified that there is an "extremely high risk" of PulseNet Canada collapsing in three to five years due in part to aging analytics infrastructure. In terms of evolving science, the program has noted a need to develop and implement metagenomics[a] to help ensure there continues to be useable public health data for outbreak detection and emergency response. In addition, there is the potential to explore the use of new disruptive technologies for surveillance, such as machine learning, artificial intelligence, and social media data mining.

Internal interviewees were positive about PHAC's highly specialized internal IT support. For example, one interviewee described how the bioinformatics section was able to simplify complicated workflows in a way that allows NMLB scientists to run those workflows with a single push of a button. However, they also noted gaps in general IT support, such as timely support, and an unclear procurement process for IT hardware and software. In addition, a few interviewees noted that, although NMLB has a critical surveillance system, it lacks dedicated IT support; instead, all requests are routed through the central helpdesk. Associated delays can make it difficult to meet turnaround times for information requests from stakeholders, and have sometimes required staff to upload data manually. Many internal interviewees noted that the program could benefit from a dedicated IT advisor to receive more timely and appropriate support.

Human Resource Capacity

A key strength of PHAC's food/water-borne enteric illness activities is its highly skilled and committed staff. Many internal and external interviewees noted the value of longstanding relationships, which allow for effective formal and informal engagement with partners within and outside of PHAC.

The evaluation noted challenges with human resource capacity, including hiring and retaining skilled employees. These challenges are related to building adequate and appropriate capacity so that the program can function efficiently and be better prepared to respond to any type of public health event. This includes the need to hire and retain staff with specialized skills, to provide backup during departures, to keep up with evolving science, and to have additional staff with business, information technology or administrative skills to provide non-scientific support.

Interviewees specified that the complex and time-consuming human resources recruitment process, including new security requirements, and a lack of indeterminate positions, combined with a limited pool of candidates with the necessary

[a] Metagenomics the analysis of genetic material obtained directly from environmental samples, as opposed to cultures cultivated in a laboratory, which could contain DNA from multiple organisms rather than DNA from a single organism.

skillsets, have made it difficult for the program to hire and retain qualified staff. Several internal interviewees believe that building in administrative support for human resource activities would be beneficial, to supplement support provided by the Chief Financial Officer and Corporate Management Branch (CFOCMB), rather than having staff with specialized science capacity doing such work at the expense of work on food/water-borne illness.

Several internal interviewees also indicated that human resource capacity could be improved within NMLB by developing a larger number of permanent positions. Hiring and training skilled staff for short-term positions lacks efficiency and leads to retention challenges. Several PHAC interviewees also discussed the importance of building and recruiting new talent through graduate student programs, a strategy that is seen to have been successful in the past.

Procurement

The evaluation also identified challenges with navigating cumbersome procurement processes as an impediment to program efficiency. This challenge affected a variety of program areas and deliverables, but the most commonly cited impact was on FoodNet Canada Memoranda of Agreements (MOAs) with provinces to operate sentinel sites. Financial contract authority limits hindered the ability of the program to put agreements in place for sentinel sites. For example, in order to avoid additional service fees from Public Services and Procurement Canada to manage the MOAs, the program had to adapt its contracting approach, including using short-term MOAs that needed to be renewed every year. Some multi-year MOAs were reached using a "Request for Proposal" competitive process; however, this approach was time consuming and complicated. According to internal interviewees, there have been some recent improvements in this regard, as contract authority limits have increased.

Challenges with procurement were also identified for contracting related to the Foodbook study, acquisition of IT software and hardware, laboratory materials and supplies, and staffing. As with FoodNet Canada MOAs, there was concern about the proportion of time some specialist team members spent on procurement processes, as opposed to their areas of expertise.

Program Spending

For the period of 2017-18 to 2021-22, the overall variance for food/water-borne enteric illness activities was only about one percent. IDPB spent approximately 91% of the planned budget, and NMLB overspent by about 6% (see table below). Underspending in 2020-21 and 2021-22 was reportedly due to delays caused by COVID restrictions, which affected planned projects and contracts, and budget reallocations to support other, higher-priority activities during the pandemic. NMLB's variance in earlier years was largely due to internal budget transfers resulting from business cases.

Table 2: Planned versus actual spending (2017-18 to 2021-22)

TOTAL				
Fiscal Year	**Planned Spending ($)**	**Actual Spending ($)**	**Variance ($)**	**% of Planned Budget Spent**
2017-18	18,837,037	20,045,715	1,208,678	106.4%
2018-19	18,611,350	18,995,648	384,297	102.1%
2019-20	19,622,011	21,266,949	1,644,938	108.4%
2020-21	20,282,680	18,515,257	-1,767,423	91.3%
2021-22	19,301,804	16,584,127	-2,717,677	85.9%
TOTAL	**96,654,882**	**95,407,696**	**-1,247,186**	**98.7%**
IDPB				
2017-18	8,894,177	8,748,662	-145,515	98.4%
2018-19	9,098,265	8,286,218	-812,048	91.1%
2019-20	9,487,689	9,569,242	81,553	100.9%
2020-21	9,614,358	8,190,328	-1,424,029	85.2%
2021-22	9,167,482	7,288,466	-1,879,016	79.5%
TOTAL	**46,261,970**	**42,082,916**	**-4,179,055**	**91.0%**
NMLB				
2017-18	9,942,860	11,297,053	1,354,193	113.6%
2018-19	9,513,085	10,709,430	1,196,345	112.6%
2019-20	10,134,322	11,697,706	1,563,384	115.4%
2020-21	10,668,322	10,324,929	-343,393	96.8%
2021-22	10,134,322	9,295,661	-838,661	91.7%
TOTAL	**50,392,912**	**53,324,780**	**2,931,868**	**105.8%**

Source: Chief Financial Officer and Corporate Management Branch

Conclusions and Recommendations

Conclusions

Overall, PHAC's food/water-borne enteric illness activities are functioning effectively. PHAC is providing information, tools, and expertise to support the work of stakeholders to prevent, detect, and respond to food/water-borne illnesses. There is evidence that PHAC's work has contributed to decision making and led to policy and regulatory changes that ultimately help protect people in Canada. For example, there has been a consistent decline in cases of *Salmonella* infection in Canada, one of two leading food-borne illnesses in the country. This is partly because of improvements in outbreak detection and source identification due to PHAC's implementation of whole genome sequencing technology. This influenced a federal industry directive that supported changes in industry practices related to frozen raw breaded chicken products.

In light of the evolving food/water-borne illness environment, continued work is needed to address new emerging pathogens, as well as AMR and AMU in food sources. In addition, although PHAC has provided timely information for Canadians, the evaluation noted that the clarity and accessibility of public communications could be improved, particularly with regard to Public Health Notices.
This is the third evaluation over the past decade outlining that PHAC has an efficient and effective approach for food/water-borne enteric illness activities. Guiding documents and processes are well developed, clarify mandates, define roles and responsibilities, and provide guiding practices. To ensure that this program continues to be successful in the future, addressing challenges associated with IM/IT barriers and inadequacies will be important. Furthermore, maintaining human resource capacity, and using fully the operational business support provided to navigate cumbersome staffing and procurement processes will also be important to increase efficiency and resource use.

Recommendations

The findings from this evaluation have resulted in the recommendations listed below.

Recommendation 1: Examine public communications activities, including Public Health Notices, with a view to implement best practices to optimize accessibility, usefulness and understanding of public health messaging.

While PHAC has provided information to Canadians to help them protect themselves from food-borne illness in the event of multi-jurisdictional outbreaks, the clarity and accessibility of some of this information could be enhanced, in particular with regard to Public Health Notices. The information contained in Public Health Notices should be presented in easily understood language and format. Further, the notices should provide information that benefits people reading them and does not lead to confusion.

Recommendation 2: Identify, prioritize and implement options to address operational challenges related to:

- **improving IM/IT systems and support for the program, including for existing initiatives (e.g., interactive data visualization), and finding a replacement for Bionumerics software; and**
- **procurement and staffing, including optimizing use of business operations support provided to the program.**

Overall, PHAC's approach to food/water-borne enteric illnesses is efficient and effective, and skilled and committed staff are a program strength. However, the evaluation found that there have been some challenges that have impeded program efficiency. These include IM/IT barriers and inadequacies, challenges in maintaining human resource capacity and navigating cumbersome procurement processes. Addressing these challenges would improve program function and better allow staff to use their specialized knowledge for core work. Furthermore, modernizing IT tools with input from programs will help ensure that core functions can continue and better enable the program to keep up with evolving science.

Recommendation 3: Identify and prioritize options to expand surveillance activities to provide stakeholders with the data, information and tools to better address:

- **emerging enteric pathogens, which are likely to become an increasing risk due to climate change; and**
- **ongoing increases in foodborne antimicrobial resistance and options to reduce the need for antimicrobial use in animals in Canada.**

Although PHAC's food/water-borne illness surveillance systems effectively detect existing pathogens, these systems are not designed for emerging diseases. This is becoming more of a priority due to the impacts of climate change on food/water-borne illnesses. The program should work to improve surveillance of emerging pathogens, building on work done for COVID-19 wastewater detection. In addition, AMR is an increasing threat to global health, and there is an opportunity to increase attention on AMR and AMU surveillance.

Annex A – Evaluation Methodology

The scope of the evaluation included PHAC activities related to food/water-borne enteric illnesses from April 2017 to March 2022. The evaluation was designed to address the intended outcomes of PHAC's food/water-borne enteric illness activities, and provide insight on the evaluation questions.

The evaluation team collected data using various sources and methods, including:

Document and File Review
Program staff at the Infectious Diseases Programs Branch (IDPB) and National Microbiology Laboratory Branch (NMLB) provided documents for evaluators for review. In total, the evaluation team reviewed 247 documents.

Interviews
Evaluators conducted interviews with 43 interviewees. This included 19 interviewees internal to PHAC and 24 external stakeholders. External stakeholders came from the following categories: other federal government partners, provincial partners, NGOs and industry associations, international partners, as well as academics and experts. The evaluators used NVIVO qualitative analysis software to identify emerging themes from interviews.

Financial Data
PHAC's Chief Financial Officer and Corporate Management Branch provided financial data on planned and actual program expenditures for the period of the evaluation.

Academic and Grey Literature
A focused review of academic and grey literature was conducted to inform evaluation findings.

Performance Measurement Data
PHAC provided performance measurement data, which the evaluation team analyzed to look for key trends and outcomes.

The evaluation team used triangulation to analyze data collected by these various methods in order to increase the reliability and credibility of the evaluation findings and conclusions. Still, most evaluations face constraints that may affect the validity and reliability of evaluation findings and conclusions.

The table below outlines the limitations encountered during the implementation of the selected methods for this evaluation, and the mitigation strategies put in place to ensure that evaluation findings are sufficiently robust.

Limitation	Potential Impact	Mitigation Strategy
Interviews are retrospective in nature, providing only a recent perspective on past events.	This can affect the validity of assessments of activities or results that may have changed over time.	Triangulation with other lines of evidence substantiated or provided further information on data captured in interviews. Document review also provided corporate knowledge.
Some interviewees were not available for interviews due to pressures associated with the COVID-19 pandemic.	Some potential interviewees were unable to contribute their insight.	Contacted other potential interviewees from the same category to ensure that there was representation from the range of stakeholders and partners with which PHAC works.
PHAC performance measurement data was limited to a small number of indicators.	Assessment of progress towards outcomes that do not have associated performance measurement indicators can be more challenging.	Triangulation of other lines of evidence was used to provide further information where there were gaps in performance measurement data.
Financial data structure is not linked to outputs or outcomes.	There is a limited ability to assess efficiency quantitatively.	Used other lines of evidence, including interviewee interviews and document reviews, to assess efficiency qualitatively.
There was limited data related to awareness and use of information among people in Canada.	Assessment of progress towards related outcomes is challenging.	The evaluation focused more on other outcome areas, and used triangulation of other lines of evidence to the extent possible.

Annex B – Food/water-borne enteric illness surveillance systems

FoodNet Canada is a multi-partner sentinel site surveillance system that conducts continuous and episodic surveillance activities across four components (human, retail, on-farm, and water) in collaboration with public health jurisdictions and provincial public health laboratories. It collects data that would otherwise not be available through passive surveillance activities to support further epidemiological investigations. FoodNet Canada is linked to both PulseNet Canada and the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS). It was used by the US as a model for their own system. FoodNet Canada data is available online through publication of annual reports and infographic summaries. Due to competing COVID-19 pandemic priorities, the latest report posted is from 2018. However, the program shared its 2019 Tables and Figures report with FoodNet Canada partners via email. FoodNet Canada also distributes preliminary quarterly data summaries to provide timely surveillance information to regional and provincial public health partners. FoodNet Canada surveillance information is also shared with industry partners. A key achievement was the addition of a fourth sentinel site in Quebec in July 2019. Still, the implementation of the fourth site met with some administrative challenges due to procurement limits (this issue is discussed further under Efficiency). The program's four sentinel sites, located in British Columbia, Alberta, Ontario, and Quebec, are representative of 13% of annual enteric illness cases in Canada and of 7.2% of the population of Canada, which is slightly below the program's target of 10% population representation. To improve representation further, the program is exploring the addition of a fifth site in the Atlantic region. A site in Northern Canada was also discussed, as northern populations are underrepresented in current surveillance data, but there are logistical challenges, given the vast geography of the North.

PulseNet Canada (PNC) is a national food-borne illness outbreak surveillance network and surveillance system. The PNC surveillance system provides a central electronic database of real-time pathogen WGS data that provides the "DNA fingerprint" of illness-causing organisms. Data is submitted by participating federal and provincial public health and food regulatory agency laboratories. PNC also serves as a communication hub, where stakeholders involved in food-borne outbreak investigation and response can be notified of laboratory findings, including outbreak clusters, in real time. This communication hub is highly active, with over 20,000 messages on the PNC Discussion Board, and typically hundreds of views on high-priority posts. The PNC system is critical for national food-borne outbreak detection and response, and has therefore remained fully operational throughout the COVID-19 pandemic. PNC also contributes to food-borne illness detection globally, as PNC has a data-sharing agreement with PulseNet United States, is a member of the international PulseNet network, and shares WGS data publicly via the International Nucleotide Sequence Database Collaboration. These international data-sharing agreements have helped to identify many cross-border food-borne outbreaks, such as those in US and Canada caused by *Salmonella* in chocolate from the UK, onions from the US, and tahini products from Israel.

The **Enhanced National Listeriosis Surveillance (ENLS)** collects detailed information, including risk factors, food history, and laboratory data, on invasive listeriosis cases in Canada, which is used to inform cluster/outbreak investigations as well as national surveillance and public health policy.

The **National Enteric Surveillance Program (NESP)** collects and analyzes laboratory-confirmed cases of enteric disease in Canada, and has been in operation since 1997. PHAC assesses data from NESP on a weekly basis, along with PNC data, to identify clusters of food/water-borne enteric disease, leading to the detection of, and response to, multi-jurisdictional outbreaks. These NESP weekly reports are shared with and used by partners. In addition, partners can get real-time data analysis for their jurisdictions through webNESP. PHAC also publishes annual NESP summary reports; the latest report was published in January 2022 for 2020 data.

The **Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)**, collects, analyzes, and communicates trends in antimicrobial use (AMU) and antimicrobial resistance (AMR) for enteric and zoonotic bacteria. CIPARS largely follows a One Health[2] approach by testing bacteria isolated from samples collected from humans, animals, and retail meat sources from across Canada. CIPARS is a component of the Canadian Antimicrobial Resistance Surveillance System (CARSS) and is operationally linked to FoodNet Canada and PulseNet Canada. CIPARS supports measures to contain the emergence and spread of drug-resistant bacteria in animals, food, and people. CIPARS data not only helps ensure animal health and the effectiveness of antimicrobial medications for animals, but also supports antimicrobial stewardship among livestock producers. CIPARS has been used as a model for integrated food-borne AMR surveillance system development in other countries. Still, there are opportunities to improve surveillance of food-borne AMR and address knowledge gaps related to risks of AMR associated with food through AMR burden of illness estimation and risk analysis. Improved surveillance can also be achieved through expansion of AMR and AMU surveillance in animals (e.g., aquaculture, companion animals, horses, laying hens, veal calves, sheep, early production phases in the major commodities such as piglets and broiler breeders), food (e.g., veal, lamb, eggs, dairy, produce), water and food-borne pathogens not included in the current system (e.g. *Clostridiodes difficile*, *Staphylococcus aureus*), and geographic locations not represented or under-represented in the current system (e.g., Atlantic Canada, the North).

Publicly Available International Food-borne Outbreak Database (PAIFOD) is a repository that contains international outbreak data collected from multiple surveillance systems and sources. It is the only database known to capture this information. Clients from academia and from federal, provincial, and territorial governments use information from PAIFOD to develop their evidence briefs, risk summaries, risk assessments, outbreak analyses, and other research projects. As of February 2020, the database contained more than 13,000 entries spanning over 20 years. A 2021 evaluation of PAIFOD indicated that reports were meeting the needs and expectation of sampled users, but that an open-access online platform could improve timeliness and data access.

The **Outbreak Summaries (OS)** surveillance system is a secure, web-based communication platform and database of Canadian outbreak investigations. It allows public health professionals to document, query, and generate reports on the results of outbreak investigations. Eleven provinces and territories use the platform to document and report enteric outbreaks within their respective jurisdictions in a standardized manner. From this data, PHAC generates annual and multi-year reports on outbreaks, and responds to queries from public health and academic partners. The OS surveillance system is seen by partners as an efficient way to receive timely outbreak data.

Annex C – End Notes

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