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Foodborne illness outbreaks: Recommendations for collaborative investigations

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Key Messages

- Foodborne illness (FBI) outbreak investigations are becoming more complex, requiring collaboration between individuals from a wide range of disciplines.
- Environmental public health professionals (EPHPs) have unique skill sets that are an essential part of collaborative FBI outbreak response.
- Key informants identified challenges faced by EPHPs during FBI outbreak investigations.
- There is a need for mentoring, practical experience, and training in FBI outbreak investigations, particularly for emerging EPHPs.
- Information silos within and between health authorities can disrupt communication and coordination during FBI outbreak investigations.
- A centralized repository of FBI outbreak investigation resources and templates can support standardization and timely information sharing.
- Outbreak summaries can be used to share lessons learned and to generate resources and training for emerging EPHPs.

Glossary

Term	Definition
Environmental Public Health Professional (EPHP)	A person working in the field/science/profession of environmental public health who holds the CPHI(C) credential.
Environmental assessment	This involves inspecting food production, processing, and preparation facilities to identify potential sources of contamination and assess compliance with food safety regulations. This may include interviews with food handlers, owners, and operators. Emphasis is on the identification of the source of foodborne illness.

Emerging EPHP	EPHPs with limited to no experience in foodborne illness outbreak investigations. Includes students in accredited EPHP programs, recent graduates, uncertified public health inspectors, and newly certified inspectors not routinely involved in outbreaks.

Introduction

The food system today is rapidly evolving.[1] Increasingly, food is global in origin and distributed through emerging systems such as e-commerce. This poses challenges for identifying, investigating, and controlling foodborne illness (FBI) outbreaks in the 21st century.[1] To respond to these challenges, public health needs faster, streamlined, and more coordinated investigations to identify and remove contaminated food from the market.[2]

Environmental Public Health Professionals (**EPHPs**, commonly known as public health inspectors and environmental health officers) are crucial members of collaborative FBI outbreak investigation teams. During typical FBI outbreak investigations, EPHPs conduct **environmental assessments** of food establishments, collect samples for laboratory testing, conduct case and contact interviews, and use outbreak data and investigation findings to guide outbreak control measures. However, investigating and controlling FBI outbreaks require the involvement of many disciplines, including clinical medicine, epidemiology, laboratory analysis, food microbiology, and risk management.[3] As such, EPHPs require a working knowledge of many food safety disciplines and strong collaborative skills to perform effective FBI outbreak investigations. In particular, **emerging EPHPs** may require more practical training and experience in these areas.

This is the third of three documents that explore the collaborative investigation of FBI outbreaks in Canada, emphasizing the role of EPHPs. The first document focused on the role of emerging technologies to support FBI outbreaks and investigations,[4] and the second explored FBI roles and responsibilities during collaborative outbreak investigations.[5] The second document introduced EPHP core competencies for FBI investigations, identified challenges related to communication silos in public health program delivery, emphasized the importance of post-outbreak response, and listed existing FBI outbreak tools. Here, additional FBI outbreak and communicable disease resources and training materials are added to that list of tools based on the recommendations of key informants.

This document highlights current challenges in FBI outbreak response and identifies several opportunities that can be leveraged to support EPHPs during outbreak investigations. Although it focuses primarily on the needs of EPHPs, there are examples, challenges, and opportunities discussed that could benefit a broad spectrum of public health professionals engaged in FBI outbreak investigations.

Methodology

This document analyzes 20 key informant interviews (KIIs) conducted between October 2022 and January 2023 with public health experts from federal, provincial, and local health authorities experienced in FBI outbreak investigations. These recorded Zoom interviews explored the various FBI outbreak investigation challenges and opportunities from local to international outbreaks. Key informants were recruited at the Canadian Institute of Public Health Inspectors (CIPHI) National Annual Education Conference, followed by a promotional campaign through the NCCEH September newsletter, the CIPHI National listserv, and snowball sampling.[6] At the start of the interview, participants provided written consent via a Microsoft Forms link. Participant confidentiality was maintained in the final, anonymized transcripts using coding such as [P2, P14] instead of names. To identify and interpret concepts related to FBI outbreak investigation challenges and opportunities, inductive thematic analysis[7] was used to analyse the transcripts. Analysis was facilitated by qualitative research software ATLAS.ti Web version 4.9.0 (ATLAS.ti Scientific Software Development GmbH © 2023). Further details of the methods used for the environmental scan, survey, and key informant interviews, including participant selection, interview conduct and transcription, are described in the previous documents in this series.[5] Full search terms and methodology for the environmental scan are available upon request.

Results

The key informants worked for local public health authorities (n=13), provincial public health agencies (n=4), First Nations health authorities (n=1), and federal public health agencies (n=2). Most participants were certified public health inspectors (PHI) from Ontario, Alberta, and British Columbia. Non-PHI participants included a registered nurse and four senior epidemiologists. Job titles included: PHI, environment health officer (EHO), communicable disease PHI/EHO, manager, senior EHO, senior epidemiologist, and communicable disease consultant. Over half of the participants reported working in more than one capacity (e.g., PHI and manager, generalist, and specialist EPHP) during their careers. All

participants reported experience with FBI outbreaks across one or more categories (local to international).

Unique skills and competencies of EPHPs

Most participants highlighted the nature of EPHPs accredited education, practical training, and field experience that makes them uniquely qualified to support FBI outbreak investigations. *Foodborne illness outbreaks: roles and responsibilities*[5] highlighted that EPHPs are critical to successful outbreak response because they are embedded in the local community. As one key informant stated, they are the "boots on the ground" [P9] that provide unique context to FBI outbreak investigations. A second key informant [P12] echoed this sentiment, noting that "understanding and ongoing learning about the population you're serving, I think, it [sic] is pretty important" [P12]. Participants identified that EPHPs are unique in their environmental public health focus, understanding of food safety and source attribution, and establishing community connections.

> "*Public health inspectors are infinitely more suited to be doing these types of investigations…because their whole focus and scope of everything have always been environmental; it's never been patient-focused.*" [P12]

Further, participants identified that established community connections help break down barriers, liaise with community partners, and extract needed information during outbreak investigations.

> *"[EPHPs] have a better ability to break down those barriers of communication in case there's a fear of authority… [EPHPs] are going to be able to act as a better liaison to their connections in partnerships with the communities, due to the relationships that we have*." [P14].

Despite these unique skills, it was also noted that EPHPs were occasionally left out of the FBI outbreak investigation process. For example, one participant stressed that EPHPs, "who are trained [in] source attribution, should be doing enteric diseases, and so I find it increasingly frustrating that [EPHPs] are being sidelined in these investigations" [P2].

Professional development needs of emerging EPHPs

Several FBI outbreak investigation competencies were identified by participants, deemed essential for emerging EPHPs' success. First, participants noted that emerging EPHPs need to be taught communicable disease and outbreak investigation techniques in school, that experience matters, and emerging EPHPs

need training and mentoring (see Table 1). Additionally, participants identified several resources and training materials to support professional development and training (see Table 2).

EPHPs need a strong food safety foundation and keen awareness of emerging food safety trends

Participants stressed that EPHPs need a strong foundation in "food safety" [P7], "foodborne illnesses" [P12], and "knowledge of communicable diseases, the typical pathogens that would be present in foods and how they are transmitted" [P8]. Further, EPHPs must develop an awareness of "novel food safety items responsible for outbreaks" [P1]. One participant noted that EPHPs should possess an "intermediate level of epidemiology" [P18].

EPHPs need to know now to conduct environmental assessments

Participants identified strong investigation skills, particularly the ability to conduct **environmental assessments** as well as good note taking and risk assessment as vital to successful outbreak response. Distinguishing between compliance food safety inspections and environmental assessments was noted by several participants, for example:

> "*Not understanding the nuances between a routine inspection and a investigation [environmental assessment] for an outbreak; so a lot of times it's literally completing the checklist and saying whether or not this premise is in compliance when [in an outbreak] it is a lot of interviewing, a lot of actual investigation, and how that differs from inspection, because inspection is really about observing what you see at the time; but you know, in that outbreak [assessment] you're trying to create the picture of what happened*" [P2].

Experience matters — emerging EPHPs need training and mentoring

Participants highlighted the importance of practical experience, formal education, and professional development for emerging EPHPs. However, the loss of experienced EPHPs through retirement, redeployment, or turnover because of demands related to COVID-19 response has resulted in a lack of mentorship and coaching opportunities.

> "*We had our internal food safety training before, that our staff used to take. But now there's really no training. It's all sort of passed down word of mouth. And we lost a lot of those experienced staff through the pandemic, where they took other opportunities or retired"* [P3].

Participants also highlighted personal characteristics that should be fostered in emerging EPHPs. They identified that EPHPs need to be comfortable "living in the grey" [P19], as their role requires flexibility and adaptability to changing environments during outbreak investigation. It is also helpful to develop a

"dogged determination" [P19] to continue to chase leads. Participants also noted that FBI outbreaks are complex events that require a variety of skills and expertise. As such, all FBI investigators, including EPHPs, need to accept "the fact that they're going to need to ask for help" [P8]. This highlights the importance of a coordinated approach and "strong collaboration skills, because [during] outbreaks you're working within a multidisciplinary team" [P14] to conduct investigations as part of an effective FBI outbreak response.

Challenges in current FBI outbreak response

Challenges identified through the KIIs are presented in full in Table 3. The following sections discuss the key themes that emerged regarding current challenges for EPHPs in FBI outbreak response.

Structure of local public health

Several participants identified outbreak communication and coordination issues related to information silos within the public health workforce. Specifically, participants identified challenges in communication between food safety and communicable disease (CD) EPHPs:

> "*Part of it is about the infectious disease team communicating with the food safety team*" [P2].

> "*Sometimes a lot of the regular [environmental health EPHPs], they're not as familiar with what the CD [EPHP] role is, or what we actually do*" [P10].

> *"[The] CD program would do the outbreak management for community food investigations, where environmental health, they would go in and look at the kitchen*" [P5].

Differences in approaches and expectations between health authorities was identified as a significant coordination challenge, including between neighboring health units, for example:

> "*So, their expectation is when any one individual calls in and says, 'I think I got sick from eating at this one place', if they live in our jurisdiction, they call and expect us to run out and drop off a stool sample kit. We don't have the resources to do that for one case; if it's two or more that's related to a setting, we absolutely will prioritize it*" [P7].

> "*I think you have a lot of health departments doing their own thing, and if you had something more standardized, then you can bring it to the schools and teach it, and then they're familiar with it*" [P5].

Merging conflicting lines of evidence

An interesting challenge identified through KIIs is the juxtaposition between environmental, epidemiological, and laboratory evidence that can occur in an investigation. While information gathered from the public can be invaluable, it can also be challenging to interpret due to a lack of public knowledge about FBIs. For example:

> "*The reluctance of participants…example, little kid with E. coli, his mom will say, 'no [his illness] has nothing to do [with an exposure at home], he's never been close to any animals,' and then, all of a sudden, you'll find out, 'yes, dad actually runs a feed lot'*" [P11].

> "*I'm surprised, but it's like people's lack of awareness for what foodborne illnesses are, and then the first question they always ask is, 'What can I take?' They always want a medication*" [P16].

It can also be challenging to weigh different sources of evidence against each other, as well as determine the level of evidence needed to act:

> "*So, I interviewed these people, and I had been hearing over and over again that [example] was a food that they loved, and I never heard people mention that they loved [example] so many times, and so over the course of about two months, I had attended a number of interprovincial teleconferences, where I had been saying that it's [example], and we'd actually had another agency that had done trace back at distribution and it said that actually it couldn't be [example]. But then, about a week later, they actually realized it certainly could be so. It took a couple of months to actually convince people that it was likely [example], and then we actually put out an alert that we didn't know the source of the [food item]…that was kind of a frustrating process to try to convince people because also [those] statistics didn't support [example]*" [P8].

Additionally, participants identified the lack of clinical samples as challenges in outbreak response. "Well, they went to the doctor, and the doctor said they got food poisoning, but then" [P18], "probably ninety percent of clinicians that see someone with classic foodborne illness symptoms are not going to collect a sample" [P7].

It was also noted by participants that it is rare to successfully identify the source and/or causative agent of an FBI outbreak:

> "*The chances of succeeding in a lot of these outbreaks is lower than you would typically expect, even when you have dozens and dozens of cases, especially with the disease we follow up, you*

know where it could be, you know a billion different foods, honing that in or getting enough data to prove that a certain food item [is the source]" [P8].

As noted in the first document in this series,[4] many clinical and some public health laboratories are switching to rapid, non-culture tests, meaning there may be fewer (or no) isolates from patients with FBIs. This highlights a critical limitation in using laboratory testing results for foodborne outbreak investigations. It also stresses the ability to connect environmental, food, and clinical samples, forcing investigators to potentially rely on epidemiological evidence only, and information from the food safety investigation, without the corroborating laboratory confirmation.

Decentralized outbreak resources, templates, and inconsistent data collection

Participants identified several themes related to outbreak data, including issues with collection, consistency of interview tools, and securing consent for follow-up calls. The importance of quality data was stressed by most participants, for example: "One challenge is data quality…quality is poor, which impacts our ability to do cluster and outbreak detection because often we're missing a lot of information" [P1].

Many participants noted a lack of awareness about the about the Enteric outbreak toolkit from the National Collaborating Centre for Infectious Disease (NCCID) and the National Collaborating Centre for Environmental Health (NCCEH) and other outbreak resources, relying instead on internal documents rather than published materials. This emphasizes differing approaches to FBI outbreak response. One participant indicated, "I don't think I'm overly familiar with the ones that you [listed]. I think we normally just use our internal documents" [P10]; another said, "It's one thing to have these great tools, but if they're not being used, if people aren't being trained on them, then they become useless" [P2].

However, participants did express interest in having access to more standardized and easily accessible resources. One participant relayed the centralization of pandemic data as an example for FBI outbreak resources to mimic:

"*For COVID, I go to the [provincial] website; all my documents, my guidance, like everything's right there. It's a one-stop shop…there needs to be something similar*" [P5].

Lack of sharing lessons learned

Participants identified the need to explore opportunities to share experiences in outbreak response, especially at the local level. The interprovincial and international outbreaks tend to get written up and

shared. Here, participants identified several barriers to creating and sharing outbreak summaries. One of the most important barriers identified was the need to allocate time and resources to developing outbreak summaries, publishing, and sharing lessons learned:

> "*I don't have a lot of time to write up my foodborne outbreaks every time. I'm like this would be a really good one to write up… it's still sitting in my inbox from like six seven years ago to write up*" [P7].

> "*It would be great if we had more resources…so that we could get more attention as [EPHPs] to write up all these great things that we do, so that there's more awareness in the public realm…because we do a fantastic job*" [P9].

> "*It's interesting because when we're finishing investigation tools…once we've inputted the information, we get a lab back, and it'll subtype it sometimes…we just update that, and that's where we leave it. We don't ever follow up with the person and be like this is exactly what you ended up with, and this is where [it came from], because we know that certain subspecies are more prevalent with certain foods...*" [P16].

Foodborne illness outbreaks: roles and responsibilities[5] outlined the importance of risk communication and sharing of lessons learned during outbreaks stressed in many outbreak policies and manual. The KIIs also identified that outbreak debriefs are an important learning tool, especially for emerging EPHPs:

> *"…because as a collective, as a group, we learn from those debriefs. I think maybe people that are seasoned and veterans, and so forth, maybe they don't think it's really necessary because they are already aware of the information. But I think it's important for up-and-coming people in the public health field to learn from the whole process, and for their experience to hear a collective of voices*" [P9].

Staying on top of emerging food safety trends

As new trends in food are constantly emerging, staying on top of food safety implications of these trends is an additional challenge for EPHPs performing FBI outbreak investigations. As one participant noted, "How do you keep on top of these novel emerging food items that are responsible for outbreaks?" [P1]. Participants also noted increase home catering as a food safety risk, and the overall diversity of food sources, adding complexity to source attribution and outbreak investigations: "It's not farm to fork as much anymore; what you are eating could be sources from multiple countries" [P2].

Discussion

EPHPs are uniquely qualified to actively contribute to FBI outbreak investigations

The key informants highlighted that EPHPs are integral members of FBI outbreak investigation teams. They bring an educational background focused on environmental public health as well as practical training and field experience. Further, EPHPs are critical to successful outbreak response because they are embedded in local communities and have a keen understanding of food safety and source attribution. EPHPs need to develop and maintain FBI outbreak investigation competencies to continue to support all three phases of investigations: (1) environmental health; (2) epidemiology; and (3) laboratory.[5,8] This will require continued and coordinated efforts between the accredited academic programs, CIPHI, and EPHP employers to ensure that the education and training needs of EPHPs performing FBI investigations are supported.

Professional competencies for emerging EPHPs in FBI outbreak response

Participants identified the difficulty in getting emerging EPHPs experience in outbreaks, due to the infrequency of outbreaks, especially in smaller health authorities. Additionally, outbreaks may not align with the timing of professional placements. Key informants noted the need for emerging EPHPs to develop specific outbreak skills, including case and operator interviewing, guided interviews, and environmental assessments. This is consistent with findings from the study by Torok et al. that identified several training priorities for environmental health professionals, namely, environmental assessments, interview skills, observation and record review, and critical thinking.[9] Here, given the complexity of outbreak response, one of the most important skills identified is the ability to acknowledge the need for help and to ask for it.

In this study, participants identified a need to incorporate more FBI outbreak learning opportunities, including case studies and simulations into schooling and field training for all individuals involved in FBI outbreak response, particularly EPHPs. There is a need to incorporate outbreak competencies into the curricula of all public health programs, especially those that are EPHP accredited.[9,10]

Studies of FBI outbreak investigators identified the need for additional training resources related to outbreak investigations.[9,11] This includes training on interviewing, standardized interviewing tools,

strategies to address cultural and language barriers, and the implementation of the single interviewer approach.[11] Currently, there are several interview training resources available (see Table 2). One example is case interviewing and enteric illness outbreak investigation training (e.g., tabletop exercises) for schools and public health authorities from the Public Health Agency of Canada's (PHAC) Outbreak Management Division, available upon request. Outbreak simulations and table-top exercises can help support skills development and collaborative response.[3] Another example is the Foodborne Outbreak Challenge, hosted by the Colorado Integrated Food Safety Center of Excellence at the Colorado School of Public Health,[12,13] which could be adapted by schools or employers as outbreak skills development opportunities.

Fieldwork is an opportunity for students to apply academic knowledge in a real-world setting. Students would benefit from opportunities to work with EPHPs on foodborne outbreak investigations, providing hands-on experience in outbreak identification, investigation, and response. Public health authorities should strive to provide FBI outbreak experience for emerging EPHPs, during practicum placements and early in their careers, including the development of mentoring programs. Where outbreaks are scarce, training organizations could provide mock outbreak simulations as discussed above and have students complete outbreak training modules as outlined in Table 2.

Participants also noted examples of provincial and federal agencies facilitating training to support EPHPs in outbreak response, including understanding of laboratory techniques and developing tools related to specific commodities. Some examples include the BC Centre for Disease Control (BCCDC) flow chart to assist in assessment of seafood-related illness by symptoms and food[14] and Vibrio infection case report form.[15] These trainings came in response to requests from the field of practice for enhanced skill development. Local public health authorities and professional associations (e.g., CIPHI) should continue to work with provincial and federal public health partners to identify needs and facilitate delivery of training for outbreak investigators.

Opportunities to support collaborative FBI outbreak investigations

Investigation of FBI outbreaks must be collaborative because they are complex, requiring a variety of professional skill sets and strengths. There are a few challenges related to communication, data collection and standardization, and information sharing that may hamper an effective collaborative FBI response. The following sections discuss these challenges and present opportunities to support EPHPs to participate in effective and collaborative FBI outbreak investigations.

Local public health structure

Effective communication and collaboration among public health officials, industry, and other stakeholders is essential for identifying and responding to foodborne outbreaks. Risk communication should include exchange of information with all stakeholders. However, this can be challenging due to competing interests and different levels of expertise among the various stakeholders involved.

It is beyond the scope of this work to analyze the public health program delivery models used by different health units. However, it highlights that specialized (siloed) program delivery models can pose challenges to collaborative FBI outbreak investigations. These challenges can be addressed through strong policy, communication, and coordination.[8,9,11] Health authorities deploying specialized program delivery may benefit from periodic rotations and/or cross training to ensure EPHPs FBI investigation competencies are maintained, and capacity is available to support outbreaks regardless of other demands (e.g., future pandemics, staff turnover).

Data collection and standardization

There is currently a lack of standardization in the methods used for the identification, investigation, and response to foodborne outbreaks. Successful investigations require strong communication and coordination.[2,9] The lack of standardization can negatively impact data collection and impede the timely sharing of data between health authorities, slowing outbreak response and impairing implementation of control measures. Several resources are presented in Table 2, to support development of outbreak investigators and provide guidance and standardization in outbreak response, particularly the PHAC outbreak toolkit.[16] Further, Health Canada's *Weight of evidence: Factors to consider for appropriate and timely action in a foodborne illness outbreak investigation*,[17] provides guidance assessing evidence obtained from the microbiological, epidemiological and food safety investigations. Although intended primarily for a federal audience, similar criteria can be considered by investigators for all levels of foodborne outbreak response.[17]

Despite the breadth of resources available, the coordination and sharing of these resources is often ad hoc, with no mechanism currently available to vet resources and promote consistent and standardized approaches across health authorities. Moving forward, public health would benefit from a curated list of FBI outbreak resources housed on a publicly available website and updated regularly. The CIPHI National or the NCCEH websites would be optimal sites for such a list. Given CIPHI's mandate to "advance the profession and field of environmental public health,"[18] this is a project that CIPHI should consider undertaking with support from the accredited academic institutions, NCCEH, PHAC, and other public health partners. Accredited institutions should then consider incorporating these resources into their curricula to develop the knowledge and FBI outbreak investigation skills for emerging EPHPs.

Sharing lessons learned

Sharing lessons learned is a valuable part of routine outbreak response, as previously noted in this series.[5] Outbreak summaries should be broadly communicated and openly shared with public health and community partners as well as the public.[3] Here, the allocation of time and resources for outbreak summaries was identified as a key barrier to sharing lessons learned. To address this, outbreak summaries should be considered part of regular outbreak response, with appropriate allocation of time and resources. Successful outbreak summaries and sharing of lessons learned requires the collection and retention of information throughout the outbreak investigation to document all relevant outbreak management steps. During every FBI outbreak investigation, records should be kept related to:

- Relevant tracing information,
- Descriptive epidemiology,
- Hypotheses, and
- Investigation findings, including inspection, environmental assessment and regulatory actions.[3]

To facilitate effective data sharing, templates and standard tools should be developed in advance and included in FBI outbreak procedures for all parties to use.[3] Currently, the PHAC outbreak toolkit[16] provides guidance and templates for outbreak investigations, including standardized questionnaire(s) and outbreak summaries. Given the general lack of awareness and use of the toolkit identified by participants, PHAC's Outbreak Management Division should consider surveying public health authorities to identify ways to increase the awareness of and use of the toolkit and any additional outbreak or training needs.

Successes in sharing lessons learned and providing FBI outbreak professional development opportunities

Beyond existing means for publishing, investigators should continue seeking opportunities to share lessons learned, through communities of practice, webinars, conferences, curated lists of outbreak summaries, and blog posts. For example, CIPHI hosts a National Annual Educational Conference, and several provincial CIPHI branches also host their own annual educational conferences. Additional public health conferences and education series include: The Ontario Public Health Conference, and International Association of Food Protection annual general meeting. These conferences present opportunities to share lessons learned and provide excellent professional development for EPHPs and other public health professionals. Conferences can also support this information sharing by adding an outbreak summary session to all public health related conferences. Outbreak summaries could also be shared on a blog site, similar to the Worms and Germs blog from the University of Guelph's Centre for Public Health & Zoonoses.[19] With a standardized template, investigators could quickly share redacted FBI outbreak summaries focused on lessons learned. Short, redacted outbreak summaries should reduce the time

needed to prepare them, an issue identified here as a barrier to information sharing. Ideally, outbreak summaries and the sharing of lessons learned would include information on the most notable successes and challenges that occurred during the outbreak response, as well as what could be improved upon for similar outbreaks.[3] This sharing of information will help raise awareness of the importance of FBIs and the roles of various public health partners, and identify prevention measures.[2]

Limitations

There are several limitations to this work. First, the qualitative research methods used are not intended to be fully generalizable. Due to the sampling approach and small sample size, the participants in this study may not be representative of all EPHPs or public health authorities in Canada. Given that authority and responsibility for FBI outbreak investigations occurs at multiple government levels, it is difficult to account for all outbreak experiences, challenges, and needs. Nevertheless, the findings from the KIIs identify important challenges and opportunities related to foodborne outbreak response. Second, the environmental scan used in the study did not include a review of public health authorities' internal FBI documents or policies. The delivery of public health programing, especially environmental health and communicable diseases, varies significantly across provinces and health authorities, making it impossible to generalize tools, recommendations, or guidance applicable to all organizations and outbreak situations. The findings of this report are intended raise awareness of issues that impact FBI outbreak response and to complement existing outbreak tools, policies, and guidelines.

Summary

FBI outbreaks are complex events that require a variety of skills and expertise to investigate and respond to collaboratively. EPHPs are critical to successful outbreak response, given their unique EPH focus, the fact they are embedded in local communities, and their keen understanding of food safety and source attribution. Participants identified a clear need for mentoring, practical experience, and training in FBI outbreak investigations, particularly for emerging EPHPs. Experience, especially with environmental assessments and interviews, was identified as a key need for EPHPs, especially given recent loss of expertise in many authorities due to staff turnover, linked to retirements and COVID-19. There is a need to incorporate outbreak competencies into public health curricula, to better prepare emerging EPHPs. Lastly, participants identified the need to explore opportunities to share experiences in outbreak

response and lessons learned to enhance professional development, improve outbreak response, and increase awareness of foodborne illness outbreaks and their impacts.

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Table 1. Themes, codes, and exemplar quotes under the theme "Emerging EPHPs need knowledge and skills in outbreak response," derived from key informant interviews of 20 foodborne illness outbreak experts (October 2022 – January 2023)

Theme	Code	Exemplar quote
Emerging EPHPs need to be taught communicable disease and outbreak investigation techniques in school	Communicable diseases interview and investigation skills need to be taught in schools.	*But nobody comes out of school really prepared to do the CD [communicable disease] stuff, and people are usually hesitant...because [they] don't feel prepared for it.* [P2]
	EPHP students may not be taught the skills to conduct FBI interviews and investigations.	*But where's the bar across Canada set for, for how these investigations are done, or what you need to know, or the skills you need to do them? I don't think it's that well covered in school.* [P12]
	EPHP students may not be taught the skills to conduct FBI interviews and investigations.	*Kind of giving that training or school with how to do a good investigation, or how to write something down right. Like we're taught how to inspect, but not necessarily [how to] conduct an interview*. [P5]
Experience matters, emerging EPHPs need training and mentoring	Summer practicums may offer little experience in foodborne outbreak investigations.	*It's a hard place in the summer for students, when they're going through their training, to get training for maybe in school some more mock [outbreak experience].* [P5]
	Emerging EPHPs may be overwhelmed during their first outbreak experiences.	*There have been times when we've had staff that look like they've seen a ghost, so you know, once you've dealt with this before, and you kind of know the steps to start with, you're less worried*. [P8]
	Emerging EPHPs need experienced mentors to	*Who's coaching them and giving them feedback?* [P13]

	support their development.	
	Emerging EPHPs need to know when to ask for help.	*The perspective of a fairly new inspector, recognizing when you don't know something, you need to help someone.* [P6]
	EPHPs level of experience matters.	*The level of training of the investigators matters*. [P12]; *maybe new people shouldn't be involved in large outbreaks.* [P8]
	Foodborne outbreaks may not be common in some health authorities.	*They may not have ever seen a foodborne outbreak. In fact, we've had regular [EPHPs] who have worked for years and may never encounter a foodborne illness outbreak that they have to investigate.* [P8]
	Training and mentorship is often informal (i.e., word of mouth).	*It is about resources because I'm one of the few [EPHPs] left that were trained on how to do this, and [training] has all been word of mouth.* [P3]

Table 2. FBI outbreak and communicable disease resources and training material derived from key informant interviews of 20 foodborne illness outbreak experts (October 2022 – January 2023)

Tool	Description
Public Health Agency of Canada Outbreak toolkit	Offering a one-stop resource for epidemiologists, EPHPs, public health nurses and other practitioners involved in enteric outbreak response.[16]
Canada's Foodborne Illness Outbreak Response Protocol (FIORP)	Offers a guide to multi-jurisdictional enteric outbreak response.[20]
Centers for Disease Control and Prevention, Environmental Assessment Training Series (EATS)	A resource for EPHPs on how to interview food handlers and how to do an environmental assessment (not a routine inspection).[21] Environmental assessments should cover all aspects of the production, storage, transport, handling, distribution, and consumption to substantiate if it is possible that the food source or the production conditions are the source of the outbreak.[3]
The Integrated Food Safety Center of Excellence (Washington state)	Applied outbreak investigation training resources.[22]
Ontario's Public Health Inspector's (PHI) Guide to Environmental Microbiology Laboratory Testing	An evergreen guide created by Public Health Ontario that is designed to support effective public health practice, ensuring that EPHPs have timely information on laboratory environmental microbiology services and expertise.[23]
World Health Organization's Codex Alimentarius Commission's Proposed Draft Guidance on the Management of Biological Foodborne Outbreaks	The guidelines address preparedness, detection, and outbreak response, and include recommendations on the appropriate use of new analytical technologies, e.g., genetic typing methods in outbreak investigations.[3]
International Association for Food Protection's Procedures to Investigate Foodborne Illness guide	A guide for investigating foodborne illness outbreaks based on epidemiological principles, laboratory techniques, and environmental health assessments.[24]

Council to Improve Foodborne Outbreak Response (CIFOR) Guidelines for Foodborne Disease Outbreak Response	A comprehensive source of information on foodborne disease investigation and control for local, state, and federal health agencies. It describes model practices for foodborne disease outbreaks, and outlines the roles of key organizations in foodborne disease outbreaks.[25]
CDC National Outbreak Reporting System (NORS) Dashboard	Launched in 2009, the NORS dashboard is used by local, state, and territorial health departments in the United States to report all waterborne and foodborne disease outbreaks and enteric disease outbreaks transmitted by contact with environmental sources, infected persons or animals, or unknown modes of transmission to CDC.[26]
Marler Clark the Food Safety Law Firm's website	Includes links to cases that changed food policy and a searchable outbreak database.[27]
Oregon Health Authorities' Outbreak Interview Strategies training videos	Oregon Health Authority presents a training video on disease outbreak interviewing techniques to train staff and volunteers. The video outlines the 10 cardinal rules of effective interviewing.[28]
Public Health Agency of Canada's Introduction to Case Interviewing	This course provides a general introduction to interviewing best practices and aims to leave you feeling comfortable conducting public health interviews. As protocols, procedures, and tools vary by jurisdiction, this course should be accompanied by jurisdiction-specific orientation and training.[29] Need to register for an account. Then select "Health Emergency Management," then "Contact Tracing Training," then "Introduction to Case Interviewing."

Table 3. Themes, codes and exemplar quotes under the theme "Current foodborne outbreak responses present several challenges," derived from key informant interviews of 20 foodborne illness outbreak experts (October 2022 – January 2023)

Theme	Code	Exemplar quote
Data collection and sharing	Lack of communication between agencies can hinder outbreak response.	*There's a disconnect there, in communication and understanding, which has hindered more than one outbreak investigation.* [P12]
	There is a need to collect and share quality data in a timely manner to support outbreaks.	*Making sure that that information is being collected and making sure that it's being shared amongst the group, so it's almost like a puzzle; I see it like everybody is a different piece, and you're collecting information to bring the picture together.* [P16]
Differences in resources dedicated to FBI outbreak investigations	Centralization of communicable disease cases may impact depth of investigation.	*They've taken away the ability to basically do much in the local geography...the model that they'd switch to in [province]. You are more of a call centre type person.* [P11]
	Staff turnover.	*At the local level, one of the biggest issues, and it sort of is like the step before the outbreak, is that training is a huge one. So right now we have significantly novice staff that are on the team, but before the pandemic, we had staff that had been there for many, many years. We were very seasoned, and so there wasn't a lot of training that was happening.* [P3]
	Staffing issues can impact ability to investigate.	*I mean the staff turnover, one and the like. All of the changes that have come post-pandemic are huge because some of those issues were there before the pandemic, so they're not really surprising. I wouldn't say to me, but they're concerning, I guess, for being able to manage the outbreaks.* [P3]

Outbreak investigations can vary between neighboring health authorities and between provinces	Outbreak investigations can vary between neighboring health authorities.	*Even working with multiple health units with differing approaches, differing expectations on the level of investigation.* [P7]
	Variation in data collection.	*But there are lots of differences in, and I mean in just the data collection on any pathogen; some people might have different collection timeframes — they may only collect the last three days versus the last seven days of food histories.* [P7]
	Variation in data collection between provinces.	*Again, it tends to be one of the challenges, again back to reportable diseases. Not all the diseases in province A are the same reportable diseases in other provinces*. [P7]
Resources to FBI outbreak investigations	Some public health partners have more resources and time to dedicate to FBI outbreaks than others.	*The farther up it goes, the more resources we say we tend to get, especially when it gets into interprovincial and international, where you know, PHAC and CFIA resources come into play...They have people where they can dedicate hours of time to follow up a single person, whereas we couldn't possibly do that with the regular cases follow up. So I find that when we get up into some of those, it actually kind of gets easier.* [P8]
Structure of public health teams can impact FBI investigations	Siloed.	*In investigations, it would be the actual district [EPHPs] who go out to the implicated premises, to do any investigations like check menu items, see if there's any staff that have been ill, see if there's left over food to collect... all those sorts of things; they'll be there, the boots on the ground, to do whatever it needs to be done, and get information back to us [the CD team].* [P9]
	Siloed.	*We're divided here between infectious disease and environmental health, and two separate groups, so*

		coordinating with environmental health to do site inspections. [P18]
Timeliness of response	Delays in receiving notifications impact ability to collect meaningful data.	*By the time people have reported or found out that their friends that they attended the same dinner at or whatever have similar symptoms. We're always up against the clock. And so a large proportion of our investigations, the food has been disposed of, there's nothing left to test, and the individuals are no longer symptomatic.* [P7]

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