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Inside this issue: Foodborne illness and more

CCDR will now be publishing monthly on the third Thursday of every month and will have an additional supplement on a theme issue most months. In this issue learn about a prompt multi-province response to an outbreak that occurred over the December holidays, and read about a new approach to determining when to initiate a provincial investigation of an enteric outbreak. See our latest links to guidelines, webinars, upcoming conferences, and summaries of recently published articles—such as three cases of botulism in Canada.

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October 28, 2014: Antimicrobial Resistant Gonococcal Infections in Canada
https://gts-ee.webex.com/gts-ee/onstage/g.php?d=550460514&t=a

November 17, 2014: Launch of the Public Health Agency of Canada AMR Awareness Campaign -
https://gts-ee.webex.com/gts-ee/onstage/g.php?d=553761831&t=a

November 20, 2014: Antimicrobial Use and Resistance in Canada - Surveillance Update - https://gts-ee.webex.com/gts-ee/onstage/g.php?d=556860062&t=a

Upcoming conferences

November 13-15, 2014: Family Medicine Forum, Quebec City, Quebec. College of Family Physicians of Canada
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Outbreak of *E. coli* O157:H7 associated with lettuce served at fast food chains in the Maritimes and Ontario, Canada, Dec 2012

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Abstract

Background: Identification and control of multi-jurisdictional foodborne illness outbreaks can be complex because of their multidisciplinary nature and the number of investigative partners involved.

Objective: To describe the multi-jurisdictional outbreak response to an *E. coli* O157:H7 outbreak in Canada that highlights the importance of early notification and collaboration and the value of centralized interviewing.

Methods: Investigators from local, provincial and federal jurisdictions, using a national outbreak response protocol to clarify roles and responsibilities and facilitate collaboration, conducted a rapid investigation that included centralized re-interview of cases, descriptive methods, binomial probability, and traceback findings to identify the source of the outbreak.

Results: There were 31 laboratory confirmed cases identified in New Brunswick, Nova Scotia, and Ontario. Thirteen cases (42%) were hospitalized and one case (3%) developed hemolytic uremic syndrome; there were no deaths. Due to early notification a coordinated investigation was initiated before laboratory subtyping was available. Re-interview of cases identified 10 cases who had not initially reported exposure to the source of the outbreak. Less than one week after the Outbreak Investigation Coordinating Committee was formed, consumption of shredded lettuce from a fast food chain was identified as the likely source of the illnesses and the implicated importer/processor initiated a precautionary recall the same day.

Conclusion: This outbreak investigation highlights the importance of early notification, prompt re-interviewing and collaboration to rapidly identify the source of an outbreak.

Introduction

Verotoxigenic *Escherichia coli* (*E. coli*) infection is a potentially serious infectious disease that can be spread through contaminated food products. In Canada, there are an estimated 13, 000 domestically acquired foodborne cases of *E. coli* O157 per year, although the majority of these cases go unreported (1). Produce, including leafy greens, is an increasingly recognized source of *E. coli* O157 infections (2−5).

On December 31, 2012, the New Brunswick Department of Health notified the Public Health Agency of Canada of a cluster of five cases of gastrointestinal illness, three of which were confirmed as *E. coli* O157. Two days later, the Public Health Agency was notified of seven cases of *E. coli* O157 in Nova Scotia. Illness onset dates for the cases in New Brunswick and Nova Scotia were tightly clustered. All infections appeared to be locally acquired, were geographically dispersed in both provinces, and many cases reported dining at fast food restaurants.

This report describes the joint federal and provincial investigation to identify the source of this outbreak and highlights the importance of early notification and collaboration in outbreak investigations.

Outbreak investigation

An Outbreak Investigation Coordinating Committee was established on January 4, 2013, between public health and food safety partners to coordinate a national investigation, as set out in the *Food-borne Illness Outbreak Response Protocol* (FIORP) (6). The Outbreak Investigation Coordinating Committee members included representatives from: Public Health Agency of Canada, Health Canada, Canadian Food Inspection Agency, New Brunswick Department of Health, Nova Scotia Department of Health and Wellness, Nova Scotia Department of Agriculture, and Prince Edward Island Health and Wellness. Cases subsequently identified in Ontario resulted in the further expansion of the investigative team to include Public Health Ontario, Ontario Ministry of Health and Long-Term Care, and Ontario Ministry of Agriculture and Food.

Case finding and data collection activities

A confirmed case was defined as a resident of, or visitor to, Canada with a laboratory confirmed *E. coli* O157 infection, the pulsed field gel electrophoresis (PFGE) outbreak pattern combination, and symptom onset or laboratory confirmation on or after December 12, 2012.

A probable case definition was also developed to support early case finding. A probable case was defined as a resident of, or visitor to, the Maritime provinces with laboratory confirmation of *E. coli* O157, PFGE pattern pending, and symptom onset or laboratory confirmation on or after December 12, 2012.

Public health alerts were issued on the Canadian Network for Public Health Intelligence by both New Brunswick and Nova Scotia on January 3, 2013, to alert public health officials across the country of the recent increase in cases and to facilitate further case finding. Following the establishment of a national outbreak investigation committee, a third alert was posted by the Public Health Agency of Canada on January 4, 2013.

Cases were initially interviewed by local public health investigators within each region using a jurisdiction-specific follow-up form to document their clinical history, food consumption history, and other risk factors. Exposure histories collected by local public health jurisdictions during initial case follow-up were collated centrally to assess common exposures within each province and subsequently by the Public Health Agency of Canada following activation of the Outbreak Investigation Coordinating Committee. Based on this initial information, a focused questionnaire was then developed. Cases were re-interviewed with the focused questionnaire by one of two interviewers from the Public Health Agency of Canada's Canadian Field Epidemiology Program who were mobilized to assist with the investigation. Interviews were conducted by telephone from a central Public Health Agency office, and interviewers discussed results after each interview.

Environmental investigation

A food safety investigation was coordinated by the Canadian Food Inspection Agency in collaboration with local public health investigators. Traceback of commonly reported foods were initiated on January 3, 2013, to determine whether they originated from a common source. Food samples collected were tested at a Canadian Food Inspection Agency laboratory.

A health risk assessment was completed by Health Canada with input from the Public Health Agency of Canada, the Canadian Food Inspection Agency and the provincial organizations (7).

Laboratory methods

All cases were laboratory confirmed for *E. coli* O157:H7 in each province where the case was diagnosed. The PulseNet Canada surveillance network was used to confirm *E. coli* O157 cases with matching and/or related outbreak genetic fingerprint patterns by PFGE. PFGE testing was conducted at the provincial labs in New

Brunswick and Ontario, and at the Public Health Agency of Canada's National Microbiology Laboratory. A second genetic typing method, multi-locus variable number tandem repeat analysis, was used to provide further characterization of the outbreak strain. All multi-locus variable number tandem repeat analysis testing was completed at the National Microbiology Laboratory.

Public health measures

Public communications were coordinated nationally and within each affected province, following the establishment of the Outbreak Investigation Coordinating Committee. Public health messages were distributed through public health notices and media press releases by both federal and provincial public health bodies.

Statistical analysis

A descriptive analysis was conducted on exposure information to identify hypotheses on the source of the outbreak. Following focused re-interviews, the proportion of ill people who reported patronizing specific fast food restaurants and consuming particular food items was compared with reference values obtained from previous population-based observational studies from the United States Centers for Disease Control and Prevention (CDC) (8,9), and the Waterloo Food Consumption Survey (10). Exact probability testing was used to measure the statistical significance of the proportion of cases who reported patronizing fast food Chain A or Chain A/B and the CDC reference values (11).

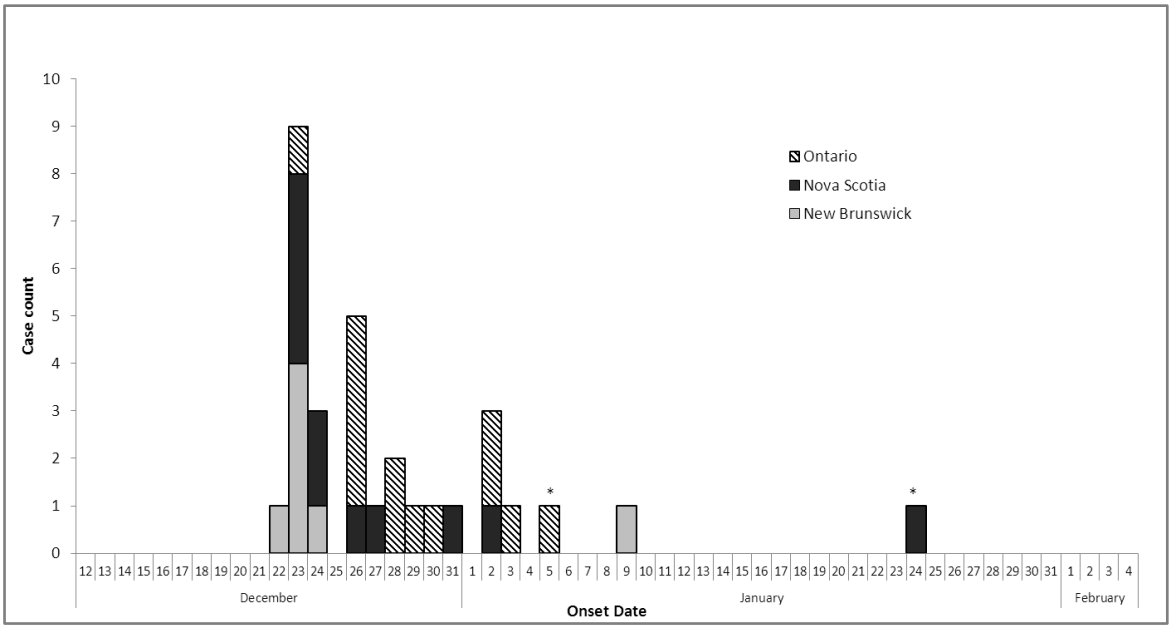
Results

Descriptive epidemiology

There were 31 laboratory confirmed cases identified between December 2012 and January 2013 in three provinces: New Brunswick (n=7), Nova Scotia (n=11) and Ontario (n=13). One case was a permanent resident of Prince Edward Island, but a temporary resident of New Brunswick and had been exposed there. All probable cases were subsequently confirmed or excluded on the basis of non-matching PFGE pattern combinations. Twenty-seven cases had the main PFGE outbreak pattern combination, while the remaining four cases had distinct, but highly related variant PFGE patterns. The high degree of similarity observed between the variant PFGE patterns and the outbreak pattern was confirmed by multi-locus variable testing. All 31 cases had an identical multi-locus variable number tandem repeat analysis profile.

Thirteen cases (42%) were hospitalized, and one case (3%) of hemolytic uremic syndrome (HUS) was reported in a senior; no deaths were reported. The median age was 21 years (range 1−83 years), and 16 cases (52%) were male. Secondary transmission of infection could not be ruled out for two confirmed cases. Symptom onset dates, excluding two possible secondary cases, ranged from December 22, 2012, to January 9, 2013. Seventeen cases (57%) reported illness in a four-day window from December 23 to 26, 2012 (**Figure 1**).

Figure 1. Number of confirmed outbreak cases of *E. coli* O157:H7 by symptom onset date and province, Dec 2012−Jan 2013 (n=31)



*Secondary transmission cannot be ruled out for these cases.

Exposure history

During initial case follow-up, many cases reported patronizing a number of fast food restaurants, including Chain A and joint Chain A/B restaurants. The subsequent focused questionnaire was completed for 29 (94%) of 31 confirmed cases. One case could not be reached for re-interview and one secondary case was not contacted for re-interview. All re-interviews were conducted over a one-week period, with a median time from Public Health Agency of Canada notification to re-interviewing of four days (range zero to eight days). Of these 29 cases, 25 (86%) reported eating at a Chain A or a Chain A/B location. Only one case reported eating at a Chain B location. In comparing these findings with available reference values of fast food consumption, they significantly exceeded expected baseline rates ($p < 0.0005$), whereas all other chains were within or less than the reference range (**Table 1**). Multiple locations of Chain A and Chain A/B were identified by cases, suggesting the source of illness was a food product distributed broadly to these restaurants.

Table 1. Fast food vendor exposures among confirmed cases re-interviewed with focused questionnaire (n=29)

Fast food vendor	Ate/probably ate at vendor	% of cases	Reference value [8]
Chain A, or Chain A/B	25	86%	7.92−16.48% (Chain A) 14.53−20.62% (Chain B)
Chain B	1	3%	
Chain C	6	21%	11.88−26.60%
Chain D	10	34%	41.58−54.70%
Chain E	8	28%	—
Chain F	6	21%	22.77−29.17%

On the basis of the frequency and type of food items consumed, food preparation methods and temporal clustering of cases, lettuce was considered to be the likely food vehicle. While the majority of cases were exposed to lettuce at Chain A, two additional cases were identified who consumed lettuce at a Chain A/B location (**Table 2**). In addition, three cases who did not report consuming lettuce at a Chain A or a Chain A/B location did report consuming lettuce during their exposure period.

Table 2. Summary of lettuce exposures among confirmed cases re-interviewed with focused questionnaire (n=29)

Exposure	Ate/probably ate (% of cases)	Reference value
Any lettuce	27 (93%)	84% [10]
Any sandwich/burger garnished with lettuce	24 (83%)	41% [9]
Lettuce from Chain A, or Chain A/B	24 (83%)	—

Environmental investigation

Local inspections of the implicated fast food establishments and traceback to source for the suspect products were conducted. All inspected premises were reported as satisfactory by food safety specialists. The Nova Scotia Department of Agriculture collected several lettuce samples from Chain A and Chain A/B locations commonly reported by cases in the province, and submitted them for analysis. The samples were representative of the product that was available for consumption by the ill cases. *E. coli* O157:H7 was not detected in any of the samples.

Through traceback from case food histories, the Canadian Food Inspection Agency identified certain common lots of shredded lettuce (iceberg and romaine), packed and distributed to Chains A and B by Importer/Processor X. An investigation was launched at Importer/Processor X to collect processing, sanitation and distribution records. Product and water samples taken at Importer/Processor X for laboratory analysis were all negative for the presence of *E. coli* O157:H7. The implicated lettuce was determined to be originally imported from the United States; however, the root cause of the contamination was not identified.

Public health measures

Several public health actions were taken to prevent further disease transmission. These included ruling out potential sources of the bacteria within food service facilities, including ill food handlers, as well as educating cases on appropriate measures to prevent secondary transmission of infection.

Public health messages were issued by New Brunswick and Nova Scotia prior to activation of the Outbreak Investigation Coordinating Committee. The Public Health Agency of Canada issued a Public Health Notice on its website concurrent with the recall of the implicated lettuce. Updates were provided by both provincial and national communication teams as the investigation progressed and lettuce was implicated as the source of the illnesses.

A health risk assessment for shredded lettuce served at Chains A and B was requested by the Canadian Food Inspection Agency on January 10, 2013. Upon conducting the assessment, Health Canada assigned “a Health Risk 1” to the implicated lettuce, meaning that there was a reasonable probability that consumption would lead to adverse health consequences (7). That same day, Importer/Processor X initiated a precautionary recall for shredded lettuce products shipped to Chain A and Chain B restaurants, even though it was unlikely that any contaminated product would still be available given its short shelf life. The recall was further expanded on January 13, 2013, to include additional products produced by Importer/Processor X with the same lots of implicated lettuce.

Discussion

This outbreak emphasizes the important role of collaboration in early detection of national outbreaks. New Brunswick and Nova Scotia provided early notification of increases in *E. coli* cases within their respective jurisdictions. As a result, the Public Health Agency of Canada and provincial public health staff were able to convene very quickly for an initial assessment of available epidemiologic evidence. This assessment took place six days before PFGE laboratory subtyping results were available to link the provincial clusters—this was early compared to other national investigations that are usually detected by laboratory subtyping methods.

Very early in the investigation, astute local and provincial public health investigators identified an increased proportion of cases reporting exposure to fast food restaurants; in one province, Chain A exposures were reported at a high frequency. The fast food and Chain A hypothesis was further strengthened with the use of a focused questionnaire, centralized re-interviewing, and central collation and analysis of exposure information. Prompt re-interview of cases helped to optimize recall and obtain good quality exposure information. By centralizing the re-interview process and having only two individuals conduct the interviews; trends were identified as the interviews took place. The probing nature of the focused questionnaire ensured that a complete history of fast food exposures was taken. The interviewers were also able to prompt cases to review bank and credit card statements to help with food history recall; in several cases it was only after checking their financial statements that the fast food exposure was remembered. This process resulted in six additional cases being identified who ate at Chain A or Chain A/B but had not originally reported this exposure. Furthermore, four cases re-interviewed by local public health who originally had not reported Chain A exposure subsequently identified eating there with re-interview. This additional exposure information was critical in identifying the source of the outbreak and led to subsequent public health actions.

Federal public health staff (Canadian Field Epidemiology Program) were mobilized through national surge capacity to provide additional support to the investigation. These two staff members concentrated primarily on conducting case interviews and were able to complete the majority of focused interviews in a two-day timeframe. This reduced the resource burden at the local and provincial levels and enabled timely re-interviewing of cases. Centralized interviewing also increased the speed at which centralized analysis could occur. The centralized interview approach is scalable and may be adapted to the location in which cases are occurring, be it locally, provincially or nationally. Cases were interviewed by the Public Health Agency of Canada in this outbreak because of the national scope and availability of mobilized staff; however, any of the investigative partners could take the role of the centralized interviewer, provided all other partners are in agreement.

Well-designed analytical studies, including case control studies, are considered the gold standard for generating epidemiologic evidence in outbreak investigations; however, there can be significant challenges in timely selection and recruitment of controls. In situations like this outbreak, where there is strong descriptive epidemiologic evidence to identify the source of the illnesses, analytical studies are often not conducted, and population-based reference data to calculate binomial probabilities can be extremely useful in corroborating source identification, thus leading to earlier public health action (11). Reference values were obtained from the United States and, although not directly comparable, these provided additional evidence to support lettuce as the source of the outbreak. The availability of Canadian reference values for restaurant and food exposure would have provided a more representative comparison and should be pursued to assist in future investigations.

Successful investigation and response to multi-jurisdictional foodborne illness outbreaks in Canada requires close collaboration amongst several organizations at multiple levels of government. Canada's *Food-borne Illness Outbreak Response Protocol* has helped to define processes to support collaboration among investigative partners (6). Timely risk communication and consistent public messaging continues to be a challenge, especially during fast-paced outbreaks such as this one.

Although *E. coli* O157:H7 was not detected in the lettuce, the weight of epidemiologic and traceback evidence was strong in implicating lettuce as the likely source of this outbreak, resulting in a recall of lettuce products from Importer/Processor X. In recent years, fresh produce has become recognized as an important transmission vehicle for *E. coli* O157:H7. In Canada, six reported *E. coli* O157:H7 outbreaks attributed to produce, including lettuce/salad, onions and spinach, were reported between 2001 and 2009 (2). More recently, in the spring of 2012, there was an outbreak of 23 cases of *E. coli* O157:H7 in New Brunswick and Québec that was traced back to lettuce (April Hexemer, Public Health Agency of Canada, personal communication, June 2012). As a result of this increasing trend, public health professionals should consider lettuce and other produce items as plausible sources when investigating *E. coli* outbreaks.

The severity of illness associated with outbreaks of *E. coli* O157:H7 requires swift public health action to identify the source and implement control measures. This outbreak was marked by early notification and the rapid development of a strong hypothesis. The initial public health action was based primarily on the epidemiological evidence and the use of centralized re-interviewing with dedicated interviewers was instrumental to the successful outcome of this investigation.

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Conflict of interest

No conflicts of interests to declare.

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Establishing criteria to initiate enteric outbreak investigations in British Columbia

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Abstract

Objective: To establish and evaluate criteria to initiate provincial enteric outbreak investigations based on characteristics of alerts, clusters and successful outbreak investigations.

Methods: We tracked all enteric disease alerts and clusters reported to the British Columbia Centre for Disease Control (BCCDC) in 2011 and 2012. Information was collected on etiology, number of cases, geographic spread, dates reported, and method of notification. Actions were classified as no further action, review/report or investigation. Outbreak investigation outcome was classified as solved/not solved. 2011 data were used to identify characteristics of alerts and clusters more likely to lead to outbreak investigations and of solved outbreaks to establish criteria. Criteria for initiating an outbreak investigation were evaluated retrospectively using 2011 data and then implemented in 2012.

Results: In 2011, 251 alerts/clusters of enteric diseases were reported. Fourteen (5.6%) led to an outbreak investigation and nine (64.3%) of the outbreaks were solved. Analyzing the data retrospectively, criteria were identified from the alerts and clusters that led to outbreak investigations and successful outbreak investigations: pathogen specificity, timely notification, a common source or event, and multi-regional outbreaks or outbreaks reported by other agencies. After applying these criteria prospectively in 2012, we took action on a smaller proportion of the 244 alerts and clusters (32.0% compared to 44.6% in 2011) and 66.7% of them were solved (compared to 64.3% in 2011).

Conclusion: Continued evaluation will identify whether this will improve outbreak investigations and use of resources in British Columbia.

Introduction

The goal of enteric disease outbreak investigations (includes foodborne, waterborne, and those spread through person-to-person or animal contact) is to identify the source of illness in order to control the outbreak, limit the number of cases and identify recommendations to prevent future outbreaks. Identifying a source also provides information on high-risk products, modes of transmission and effective interventions (1). However, the proportion of solved enteric disease outbreaks (where a source is identified) is low (2, 3). In British Columbia (BC), we have previously taken steps to improve outbreak investigations by determining enteric diseases to be routinely investigated, using standard case investigation forms, and maintaining collaborative relationships between epidemiologists and laboratory staff.

Outbreak investigations are expensive and resource intensive. Responding to alerts that do not develop into outbreaks (false alarms) and unsuccessful investigations lead to a waste of scarce public health resources. Improving the ability to solve and control outbreaks by identifying and focusing on those which have the greatest chance of a successful outcome so that resources could be used most appropriately would be valuable to public health professionals. In addition, use of a consistent and transparent approach to initiate outbreak investigations creates a standard practice and increases partner confidence in the process.

In BC, population 4.5 million (4), the British Columbia Centre for Disease Control (BCCDC) is responsible for provincial surveillance and the coordination of outbreak investigations that span multiple local health regions.

BCCDC also participates in national outbreak investigations and provides assistance for outbreaks in single local health regions when requested. In 2009 and 2010, there was an average of 225 enteric disease alerts and clusters reported each year to BCCDC; 10 of 19 (52.6%) outbreak investigations undertaken were solved. During this time there were no criteria for initiating an investigation and the decision to investigate was made based on investigators' experience and judgment. To our knowledge, there are no criteria used in Canada to initiate enteric outbreaks investigations.

The objectives of this work were to: 1) identify the characteristics of enteric alerts and clusters that we investigated; 2) identify the characteristics of successful enteric outbreak investigations in 2011 to establish criteria to initiate provincial enteric outbreak investigations; and 3) evaluate those criteria and compare outbreak investigations in 2011 and 2012.

Methods

A systematic process was used to track all incoming notifications of enteric disease alerts and clusters from a variety of sources between January 1, 2011, and December 31, 2012. Alerts with two or more cases caused by the same pathogen and clusters where two or more unrelated cases with similar illness were epidemiologically linked were included. The only exception to this was botulism, where one case was considered an outbreak, and hepatitis A that was excluded because it is investigated by a separate group at BCCDC. All clusters and alerts had to be reported to or identified by BCCDC epidemiologists. Sources of reported clusters included local health regions, the BC Public Health Microbiology and Reference Laboratory, other provinces/territories, federal agencies (e.g., Canadian Food Inspection Agency, Public Health Agency of Canada), and international agencies (e.g., U.S. state Departments of Health).

The source of alerts was the provincial reportable diseases database. BCCDC runs an automated aberration detection system on reportable diseases on a weekly basis. The data inputs include five years of reportable disease at genus level and five years of lab information (at serotype/species level and phage type (*S. Enteritidis*, *S.* Heidelberg) or PFGE (PFGE) (*E. coli* O157, *S*. *Typhimurium*, *S. sonnei*). A time series analysis identifies weekly aberrations (alerts) taking seasonal and temporal trends into consideration. Alerts are produced when the disease count is significantly above that expected over time periods of 7, 14, 21 and 28 days, at provincial or local levels.

Information on alerts and clusters was collected in a prospective fashion at the time of notification. Each alert or cluster that met the inclusion criteria was captured and information was collected on etiology, including level of subtyping, number of cases, geographic spread, initial date reported, previous knowledge of alert or cluster, and initial method of notification. Furthermore, the action taken by a BCCDC epidemiologist for each alert or cluster was documented. Actions were classified into three categories:

- **No further action taken.**
- **Review/Report— We used existing reportable disease data or laboratory data to assess for commonalities or we reported information to public health partners but did not require further investigation.**
- **Outbreak investigation— We used a coordinated approach to investigate or respond to an outbreak. This usually involved requesting and reviewing case exposure information from local health regions and using additional investigative methods (e.g., re-interviews, site investigations, environmental sampling) to identify and control the source.**

Of the alerts and clusters that led to an outbreak investigation, we classified them as solved if a source was identified based on an analytical study, laboratory detection of the pathogen in the source or a combination of case exposure information and trace back to a potential common source.

The 2011 data were used to establish criteria for initiating an outbreak investigation based on information about the pathogen, number of cases, time period between notification and most recently reported case using the earliest of available dates (report date, collection date or onset date), geography and available exposure information. The criteria were established by comparing alerts and clusters that led to an outbreak investigation to those that did not and outbreak investigations which were solved to those that were unsolved. The 2011 data

were used to retrospectively evaluate the criteria. The criteria were used throughout 2012 and data were used to prospectively evaluate the criteria by comparing the number and proportion of alerts and clusters that were investigated, solved and controlled compared to 2011 to assess the impact of implementing the criteria. MS Excel® was used for data collection and analysis. Chi-square tests were calculated using SAS and Epi Calc 2000 to compare proportions and medians. A p-value of <0.05 was considered significant.

Results

Assessment of alerts, clusters and investigations

In 2011, a total of 251 alerts and clusters were reported. Fourteen (5.6%) led to an outbreak investigation (**Table 1**). Alerts and clusters which led to an outbreak investigation were significantly different from those we did not investigate; they had a higher proportion with PFGE (p=<0.001), they were more likely to involve multiple local health regions (p=0.002) and a higher proportion were reported by other agencies (p=<0.001). The median number of cases was higher, although not significantly so and the time between most recent case and notification was similar (**Table 1**).

Table 1. Characteristics of enteric disease alerts and clusters reported to BCCDC by type of action taken, BC, 2011 (N=251)

Characteristics at time of notification	Conducted outbreak investigation (N=14)	Reviewed data and/or reported to partners (N=98)	No further action taken (N=139)	P value
Proportion of total	5.6%	39.0%	55.4%	Not applicable
Number (%) with pulsed field gel electrophoresis (PFGE)	6 (42.8%)	13 (13.3%)	4 (2.9%)	< 0.001
Median number of cases; range	6 (1−30)	3 (1−106)	3 (1−68)	0.630
Median number (and range) of days between notification and most recently reported case	4 (1−30)	3 (1−47)	Not assessed	0.710
Number (%) with multiple local health regions involved	5 (35.7%)	22 (22.4%)	15 (10.8%)	0.002
Number (%) notified by other agency	10 (71.4%)	14 (14.3%)	0	< 0.001

In 2011, nine (64.3%) of the outbreaks were solved. Solved outbreaks were more likely to involve a rare pathogen/subtype, be notified by another agency and have less than two weeks between most recent case and

notification. None of the differences were statistically significant. A common event/location and indication of source at time of notification were only identified in solved investigations (**Table 2**).

Table 2. Characteristics of solved and unsolved enteric disease outbreak investigations, BC, 2011 (N=14)

Characteristics at time of notification	Solved outbreak* (N=9)	Unsolved outbreak** (N=5)
Proportion of total	64.3%	35.7%
Pathogen Specificity		
Number and % with pulsed field gel electrophoresis (PFGE)	2 (22.2%)	4 (80.0%)
Number and % with a rare pathogen/subtype	6 (66.7%)	2 (40.0%)
Timeliness		
Median number (and range) of days between notification and most recently reported case	3 (1−30)	16 (1−21)
Number (%) with less than two weeks between onset, report, collection date of last case and notification	8 (88.9%)	2 (40.0%)
Median number of cases; (range)	5 (1−30)	6 (1−9)
Number (%) with multiple local health regions involved	3 (33.3%)	2 (40.0%)
Number (%) notified by other agency	7 (77.8%)	3 (60.0%)
Number (%) with indication of source	4 (44.4%)	0
Number (%) with common event/location	4 (44.4%)	0

***** Solved outbreaks included: diarrhetic shellfish poisoning (DSP) associated with cooked mussels (5); botulism associated with watermelon jelly; *E. coli* O157:H7 associated with veal liver; *S. Kingabwa* associated with pet lizards; *S. Enteritidis* associated with eggs; two norovirus investigations in a resort; *S. Agbeni* associated with a food handler (6); *S. Infantis* associated with a food handler.

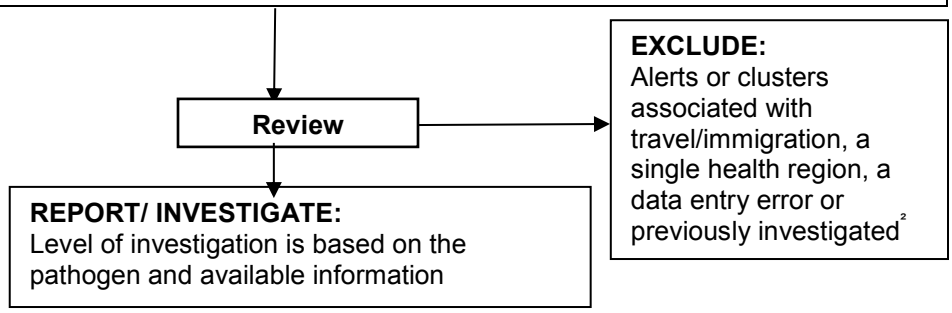
** Unsolved outbreaks included: one *Campylobacter* investigation in the community; one *E. coli* O157:H7 investigation in the community; and three *S. Enteritidis* investigations in the community.

Establishment of criteria

Pathogen-specific criteria were established to identify alerts and clusters to review and investigate (**Table 3**). The criteria include a minimum number of cases based on the pathogen and specificity, a maximum timeframe between most recent case occurrence and notification, a requirement for multi-regional distribution or epidemiological link or investigations initiated by other agencies.

Figure 1. Criteria for the review of provincial enteric disease alerts and clusters[1]

Minimum number of cases	Pathogen with common serotype/species with further typing or rare serotype/species (e.g., *E. coli* O157 with the same PFGE, *Listeria monocytogenes*): Range of 2−5 cases Pathogen with common genus/serotype/species without further typing (e.g., *S.* Heidelberg without molecular typing, *Campylobacter jejuni, Giardia*): Range of 10−20 cases AND
Maximum timeframe	Earliest of available dates (report date, collection date or onset date) of most recent case within 14 days of notification date AND
Geographic distribution	Multi-regional or unknown
OR • Single case of botulism OR • Any number of cases with earliest of available dates (report date, collection date or onset date) within 14 days of notification date with an epidemiological link to each other, a food or common source OR • Any number of cases associated with investigations initiated by other jurisdictions	



[1]Note: The criteria are subject to change over time as part of ongoing work and evaluation.
[2]If new information became available on the same cases or new cases were reported, the criteria would be applied using the new level of information.

The number of cases among alerts/cluster investigated and solved outbreaks varied by pathogen. Specificity of the pathogen assisted with both identification and solving of outbreaks. The level of specificity required varied based on the pathogen; while common pathogens required serotype or PFGE (e.g., *E. coli* O157 and *S. Enteritidis*), rarer pathogens or syndromes did not (e.g., DSP). We set thresholds for the minimum number of cases required at notification considering levels of specificity which varied from two (e.g., listeriosis) to 20 (e.g., giardiasis). For pathogens with greater pathogen specificity, the minimum number of cases required was lower.

Among the 2011 successful outbreak investigations, seven (77.8%) had less than seven days between the most recent case onset and notification (data not shown) and eight (88.9%) had less than fourteen days. We selected a 14-day period criterion to include most of the solvable outbreaks while acknowledging the need for timely action.

To meet the BCCDC provincial mandate, our criteria required that alerts and clusters affect multiple local health regions or have an unknown geographic spread at time of notification.

An indication of source at notification and epidemiological links between cases or to a common event or location were common among solved outbreaks. These characteristics likely also indicate a temporal clustering of cases and potentially more timely notification.

Evaluation of criteria

The 14 outbreak investigations from 2011 were evaluated using the criteria. Eleven (78.6%) outbreaks met the criteria for further investigation. Of the three that did not, one was conducted in a single local health region and two had most recent cases occur earlier than 14 days prior to notification (28 and 30 days). The investigation in the single local health region was solved. Neither of the outbreaks with a longer time period was solved, suggesting that our criteria would appropriately exclude such events. In addition, two events that were not investigated in 2011 would have met the criteria for initiating an investigation. Both were caused by *Salmonella* (one with a rare serotype, one with a common serotype but matching PFGE) and had four cases reported over a seven- and a fourteen-day period. Retrospective review of laboratory and available case information did not identify commonalities.

In 2012, the criteria were implemented prospectively. A total of 244 alerts and clusters were reported. Only three (1.2%) led to outbreak investigations; two were solved. In 2012, fewer alerts and clusters led to review/report (30.7% compared to 39.0%) and a larger proportion had no further action taken (68.0% compared to 55.4%) than in 2011. No known outbreaks were missed.

Throughout 2012, adjustments were made to the criteria because new laboratory methods (e.g., change in shiga toxin detection) were implemented, pathogens not previously considered were identified, and some thresholds within criteria were found to be too sensitive.

Discussion

Criteria that identified outbreaks which were more likely to be solved included characteristics of pathogen specificity, timeliness and known linkages between cases or a possible source at the time of notification. The use of our criteria in 2012 led to a 21.3% decrease in the number of clusters and alerts that were reviewed. This was largely due to no longer reviewing alerts affecting a single local health region (48.4%). This likely led to a concomitant reduction in use of resources both provincially and locally as less time was spent locating, reviewing, sharing, and centrally analyzing data. The retrospective evaluation of our criteria identified two clusters in 2011 that met our criteria but were not investigated, likely because of limited case information to indicate relatedness.

Some of our criteria are compatible with those used in other jurisdictions and some are unique.

In Minnesota, an evaluation of *Salmonella* outbreaks suggested greatest success with three cases notified to the state public health agency within seven days of each other (7). In a similar evaluation of *E. coli* O157:H7 outbreaks, the shorter the time period in which the first two isolates were received, the greater the likelihood was of solving the outbreak. Although our measure of time was different, this suggests that having a sufficient number of cases reported close in time to each other and recently notified to a public health agency helps identify solvable outbreaks. It may also indicate a common event or location. Evaluations focused on a single pathogen have demonstrated greater success in investigating *Salmonella* and *E. coli* O157:H7 PFGE clusters with four or more and three or more cases, respectively (7,8). For PFGE clusters of *Salmonella* (N=3) and shiga toxin producing *E. coli* (N=3), the number of cases needed in BC was similar to what Rounds et al. found (7,8). Use of pathogen subtyping such as PFGE has been shown to be of value in detecting outbreaks, particularly dispersed outbreaks (2,7). Incorporation of pathogen specificity information into our criteria is important for detection of provincial outbreaks which are often more dispersed.

Other similar evaluations have employed a retrospective review of clusters using laboratory data or outbreaks reported to an electronic surveillance system or summarized by the jurisdiction (7−9). Our method was unique in that it employed prospective data collection of information available at the time of notification to document decisions and set criteria which could be used and useful at this point in the assessment process. Our proportion of solved investigations is higher than or similar to other published examples (2,3,7−9) likely because we included only clusters and alerts we classified as outbreaks after initial steps were taken to review them, or based on our classification of solved.

There are a number of limitations to this study. A prospective method provided fewer years of data for assessment. Because we were aware of our process we had the ability to modify our actions over time. This awareness may have led to a bias in the selection of clusters and alerts more likely to be solved prior to criteria establishment. Although this affects our assessment of the proportion of outbreaks solved, it should not affect the determination of the criteria for initiation of an investigation. Our criteria will likely identify outbreaks associated with acute point sources, continuous sources and person-to-person transmission in a common location. It is possible that they will miss small and/or intermittent outbreaks with cases that occur over a longer period of time. We will require additional methods of notification to detect these and will rely on pathogen subtyping to identify links. Our criteria may be relevant to other jurisdictions but the levels within the criteria may need to be adjusted based on availability of case information, willingness and resources available to investigate, and laboratory subtyping capacity.

Future efforts are underway to further develop and refine these criteria. The criteria need to be flexible so that changes can easily be made over time. Ongoing data collection and analysis are planned in order to assess the proportion of investigations solved and controlled over time, to allow for updates to the criteria and to identify whether outbreaks are missed.

We undertook this work in order to improve outbreak investigation processes and outcomes. This process has improved our understanding of the elements that can lead to successful outbreak investigations. Over time we hope to improve the proportion of outbreaks solved and controlled to decrease the morbidity associated with enteric illness and improve the use of resources.

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Conflict of interest

No conflicts of interests to declare.

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NA

ID news briefs

Outbreak of type E foodborne botulism linked to traditionally prepared salted fish in Ontario, Canada.

On April 17, 2012, two adult females presented to a hospital with symptoms of botulism. Patient A displayed shortness of breath, increasing lethargy, ptosis, and fixed and dilated pupils, and was intubated after admission. Patient B presented with shortness of breath, vomiting, and stridor. Both patients consumed a meal consisting of a traditionally prepared salted fish, fesikh, two days before to celebrate Sham el-Nessim, an Egyptian holiday marking the beginning of spring. Foodborne botulism was suspected and antitoxin was administered to both patients. Another attendee of the same gathering (Patient C), who had also consumed the implicated food, developed symptoms .Clinical specimens from all three symptomatic attendees tested positive for either *Clostridium botulinum* or type E *botulinum* neurotoxin. Fesikh remaining from the shared meal contained both type E botulinum neurotoxin and *C. botulinum* type E organisms. Unsold fesikh shad and fesikh sardines tested positive for *C. botulinum* type E. After consultation, all fesikh products were voluntarily withheld from sale by the manufacturer, preventing further cases. This is the first documented outbreak of foodborne botulism associated with fesikh to occur in Canada.

Walton RN, Clemens A, Chung J, Moore S, Wharton D, Haydu L, de Villa E, et al. Foodborne Pathog Dis. 2014 Sep 4. [Epub ahead of print]

Novel microbiological and spatial statistical methods to improve strength of epidemiological evidence in a community-wide waterborne outbreak.

Failures in the drinking water distribution system cause gastrointestinal outbreaks with multiple pathogens. A water distribution pipe breakage caused a community-wide waterborne outbreak in Vuorela, Finland, in July 2012. We investigated this outbreak with advanced epidemiological and microbiological methods. A total of 473 of 2,931 inhabitants (16%) responded to a web-based questionnaire. Water and patient samples were subjected to analysis of multiple microbial targets, molecular typing and microbial community analysis. Spatial analysis on the water distribution network was done and we applied a spatial logistic regression model. The course of the illness was mild. Drinking untreated tap water from the defined outbreak area was significantly associated with illness (RR 5.6, 95% CI 1.9−16.4) increasing in a dose response manner. The closer a person lived to the water distribution breakage point, the higher the risk of becoming ill. Sapovirus, enterovirus, single *Campylobacter jejuni* and EHEC O157:H7 findings as well as virulence genes for EPEC, EAEC and EHEC pathogroups were detected by molecular or culture methods from the faecal samples of the patients. EPEC, EAEC and EHEC virulence genes and faecal indicator bacteria were also detected in water samples. Microbial community sequencing of contaminated tap water revealed abundance of *Arcobacter* species. The polyphasic approach improved the understanding of the source of the infections, and aided in defining the extent and magnitude of this outbreak.

Jalava K, Rintala H, Ollgren J, Maunula L, Gomez-Alvarez V, Revez J, Palander M, et al. PLoS One. 2014 Aug 22;9(8):e104713.

Current perspectives on viable but non-culturable (VBNC) pathogenic bacteria.

Under stress conditions, many species of bacteria enter into starvation mode of metabolism or a physiologically viable but non-culturable (VBNC) state. Several human pathogenic bacteria have been reported to enter into the VBNC state under these conditions. The pathogenic VBNC bacteria cannot be grown using conventional culture media, although they continue to retain their viability and express their virulence. Though there have been debates on the VBNC concept in the past, several molecular studies have shown that not only can the VBNC state be induced under in vitro conditions but also that resuscitation from this state is possible under appropriate conditions. The most notable advance in resuscitating VBNC bacteria is the discovery of resuscitation-promoting

factor (Rpf), which is a bacterial cytokines found in both Gram-positive and Gram-negative organisms. VBNC state is a survival strategy adopted by the bacteria, which has important implications in several fields, including environmental monitoring, food technology, and infectious disease management; hence it is important to investigate the association of bacterial pathogens under VBNC state and the waterborne/foodborne outbreaks. In this review, we describe various aspects of VBNC bacteria, which include their proteomic and genetic profiles under the VBNC state, conditions of resuscitation, methods of detection, antibiotic resistance, and observations on Rpf.

Ramamurthy T, Ghosh A, Pazhani GP, Shinoda S. Front Public Health. 2014 Jul 31;2:103.