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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).

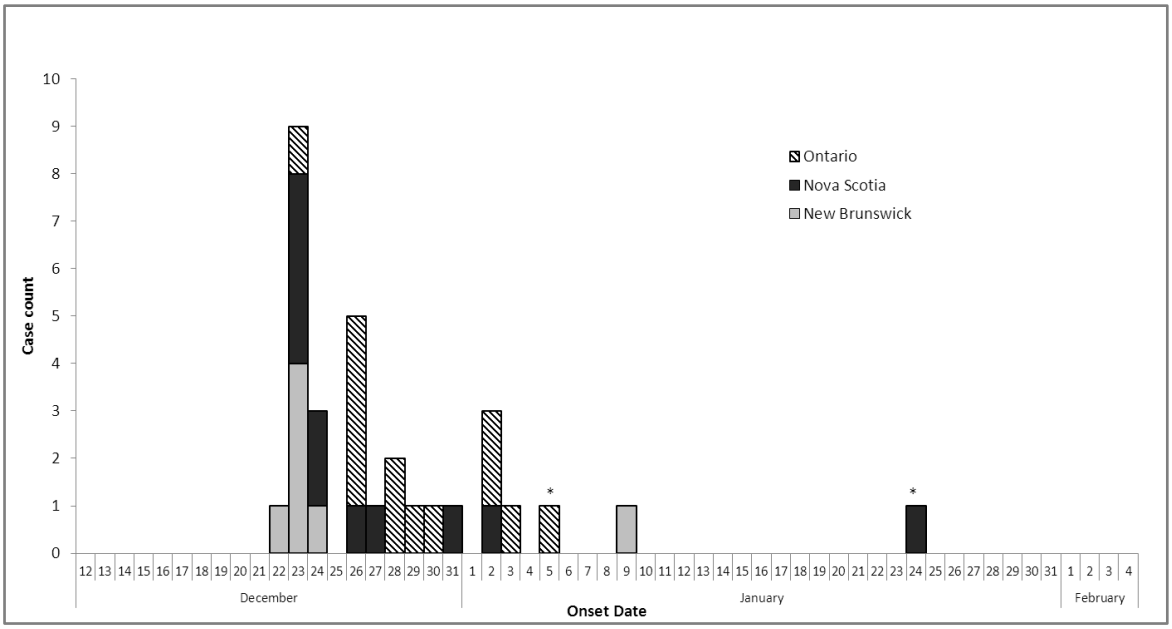
Results

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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