

An Outbreak of *E. coli* O157:H7 Hemorrhagic Colitis Associated with Unpasteurized Gouda Cheese

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ABSTRACT

Background: A cluster of *E. coli* O157:H7 hemorrhagic colitis was identified in metro Edmonton, Alberta through notifiable disease surveillance in late 2002.

Methods: Environmental health officers collected food histories and clinical information from cases in the cluster. The provincial public health laboratory conducted pulsed field gel electrophoresis (PFGE) analysis on *E. coli* O157:H7 isolates from cluster cases. Public health and food regulatory agencies conducted an investigation when a food source (unpasteurized gouda cheese) was implicated.

Results: PFGE analysis revealed an "outbreak" profile in 13 cases. Onset dates for the outbreak cases ranged between October 2002 and February 2003. Two cases, aged 22 months and 4 years, developed hemolytic uremic syndrome as a result of their infection. Consumption of unpasteurized gouda cheese produced at a local dairy farm was reported by 12 of 13 outbreak cases in the 2 to 8 days prior to illness. *E. coli* O157:H7 was isolated from 2 of 26 cheese samples manufactured by the implicated producer. The cheese isolates had indistinguishable PFGE profiles as compared with outbreak case isolates. Implicated cheese was found to be contaminated with *E. coli* O157:H7 104 days after production, despite having met regulated microbiological and aging requirements.

Conclusion: To our knowledge, this is the first confirmed outbreak of *E. coli* O157:H7 infection in Canada associated with raw milk hard cheese. A review of federal legislation vis-à-vis raw milk hard cheese may be in order.

MeSH terms: *Escherichia coli* O157; hemolytic-uremic syndrome; disease outbreaks; cheese

La traduction du résumé se trouve à la fin de l'article.

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Escherichia coli (*E. coli*) O157:H7 is a virulent strain of shiga toxin-producing *E. coli* (STEC).¹ Illness caused by STEC is characterized by diarrhea (often bloody), abdominal pain and occasionally fever; late sequelae include hemolytic uremic syndrome, which develops in 5-8% of cases.² Since the first reported outbreak in 1983,³ infection with *E. coli* O157:H7 has emerged as a major public health problem since it is commonly transmitted via contaminated food and water. A major waterborne outbreak occurred in Walkerton, Ontario in 2000.⁴ We report an outbreak of *E. coli* O157:H7 hemorrhagic colitis linked to consumption of unpasteurized gouda cheese in Edmonton, Alberta.

METHODS

All cases of *E. coli* O157:H7 in Alberta are reported to the respective local public health department. A standard questionnaire is administered to all reported cases by environmental health officers. Data collected include demographic information, symptom onset date and history of exposure to potential sources. All isolates of *E. coli* O157:H7 reported in Alberta are subject to pulsed field gel electrophoresis (PFGE) analysis by the Alberta Provincial Laboratory of Public Health (Microbiology). This method, widely utilized for the sub-typing of *E. coli* O157:H7 isolates,⁵ involves the cutting of bacterial chromosomal DNA with specific enzymes and comparing the resultant fragments, which are analogous to bacterial "fingerprints". If unusual numbers or clusters of disease are noted through these surveillance activities, an outbreak investigation is initiated under the direction of the Medical Officer of Health.

RESULTS

Case series summary

An unusually high incidence of *E. coli* O157:H7 intestinal infection was identified through notifiable disease surveillance in the Capital Health region (metro Edmonton, Alberta) in December 2002. Upon follow-up with regional environmental health officers, three cases in this cluster reported consumption of unpasteurized gouda cheese, produced at a local dairy farm and purchased at a local farm-

ers' market, during the incubation period for *E. coli* O157:H7 gastroenteritis (2 to 8 days before illness onset). The *E. coli* O157:H7 isolates from cases that recalled consumption of the implicated variety of cheese had indistinguishable PFGE profiles, which were different from *E. coli* cases who did not report cheese consumption. Additional *E. coli* O157:H7 cases with this PFGE profile were identified, from which information regarding attendance at farmers' markets and foods eaten or purchased was collected. A total of 13 *E. coli* O157:H7 cases with the "outbreak" PFGE profile were identified, 12 of whom reported consumption of the implicated cheese during their incubation period. Illness onset in the cases occurred between October 2002 and February 2003. Twelve cases resided within the metro Edmonton area; one case was a resident of another province, who visited the Edmonton area during the incubation period.

Of the 12 outbreak cases who reported consumption of the implicated cheese, 4 consumed only small portions of the cheese offered as "free samples" at a local farmers' market. One case reported consuming as little as one free sample piece, an estimated 2 cm³ in size. Eight outbreak cases consumed the cheese at home; five cases purchased the cheese at local farmers' markets, two cases received the cheese as a gift, and one case purchased the cheese directly from the producer.

The predominant signs and symptoms reported by cases included diarrhea (100%) and bloody diarrhea (77%). Five cases (38%) were hospitalized as a result of their infection. In those cases for whom an incubation period could be elucidated (most cases reportedly ate the implicated cheese on multiple occasions during their incubation period), the mean was 3.4 days, with a range of 2 to 7 days. The cases ranged in age from 22 months to 73 years, with a mean and median of 34.5 and 26 years, respectively, and 77% of cases were female.

Two cases, aged 22 months and 4 years, developed hemolytic uremic syndrome. The former had a hemoglobin of 13.1 gm/dl upon admission, which dropped to 6.7 within 48 hours; her platelet count fell to 36,000, and she had proteinuria and hemoglobinuria. The hemoglobin of the latter case, 13.4 upon admission, fell to a

low of 7.1, with a platelet count of 60,000. Both cases required two transfusions prior to discharge from hospital. At discharge, the 22-month-old had a platelet count of 100,000, and the 4-year-old had a hemoglobin of 11.8 and platelet count of 213,000.

Public health investigation

Upon identification of the outbreak, the local Medical Officer of Health issued a media release, including an advisory to immediately discard cheese manufactured by the implicated producer. Production of the cheese was ceased under the supervision of the provincial regulatory body for the implicated cheese plant (Alberta Agriculture, Food and Rural Development). The Canadian Food Inspection Agency (CFIA) subsequently recalled cheese already distributed by the manufacturer. An alert regarding the outbreak was posted on a secure Health Canada-administered web-based surveillance information system (Canadian Enteric Outbreak Surveillance Centre, or CEOSC), accessed by local, provincial and federal epidemiologists.

A total of 26 cheese samples were collected from the cheese plant, from area retailers of the product or from homes of outbreak cases, 2 of which were positive for *E. coli* O157:H7. One positive sample was in the original packaging in which it had been sealed at the cheese plant. The *E. coli* O157:H7 isolates recovered from cheese samples had indistinguishable PFGE profiles as compared with outbreak case isolates. However, the investigation failed to confirm the source of the *E. coli* contamination at the farm. Samples of raw milk, well water, cow feces and environmental swabs collected at the cheese plant during the investigation were all negative for *E. coli* O157:H7. Clinical samples were not collected from plant employees, as no gastrointestinal illness was reported among employees during the outbreak period, and the duration of shedding of STEC in the stool of infected adults is typically less than 3 weeks.⁶ This is significantly shorter than the time that had elapsed following production of implicated cheese, and thus, an employee infected with STEC at the time of production would likely have tested negative during the outbreak investigation.

As per regulatory requirements, samples from each lot of cheese produced by the implicated manufacturer had been analyzed for microbiological quality under the supervision of the provincial regulator, prior to identification of the outbreak. Cheese lots had not been released for distribution by the provincial regulator until it had been confirmed that the lot sample was within allowable microbiological limits for hard unpasteurized cheese in federal and provincial legislation (see Discussion). A lot code was available for the *E. coli* O157:H7 contaminated cheese sample still in its original packaging; the lot sample that had been previously analyzed to ensure compliance with the above microbiological parameters contained 40 generic *E. coli*/gram, well within the allowable limit. However, a sample from this same lot collected during the outbreak investigation was positive for *E. coli* O157:H7 104 days after production.

Regulators were unable to verify sanitation procedures that were in place at the plant at the time the contaminated cheese was produced, as the plant operator had not previously developed a written sanitation plan. Minor sanitation infractions were observed during the investigation, although it is unknown whether these were contributing factors in this outbreak. The lack of an identified source of *E. coli* contamination resulted in the voluntary destruction of all remaining cheese at the implicated plant, jointly supervised by the provincial regulator and the CFIA.

DISCUSSION

Cheese containing unpasteurized milk has been frequently implicated as the vehicle of transmission in outbreaks of infectious intestinal disease,⁷ including *E. coli* O157:H7.^{8,9} The epidemiological evidence that implicates gouda cheese in this outbreak is strong, as all but one outbreak case reported consuming the cheese during the *E. coli* O157:H7 incubation period, and the PFGE patterns of *E. coli* O157:H7 isolates from clinical and cheese samples were indistinguishable. However, the source of *E. coli* contamination of the cheese could not be determined by this investigation. The small amount of cheese reportedly consumed by some cases may indicate significant contamination of the product, and/or a highly pathogenic organism.

Regulations pursuant to Canada's *Food and Drugs Act*¹⁰ and Alberta's *Dairy Industry Act*¹¹ currently allow the sale of unpasteurized hard cheese, if such cheese is aged a minimum of 60 days and specific microbiological parameters are met (i.e., <500 *E. coli*/gram, <1000 *Staphylococcus aureus*/gram). Most documented raw milk cheese-associated outbreaks have been linked to soft cheese. Legislated aging requirements for raw milk hard cheese, in Canada and elsewhere, are thought to be effective in eliminating pathogens that may be present in raw milk, with regulated microbiological quality requirements in the finished product acting as a further safeguard.

Based on this investigation, and other current evidence, it is clear that these regulations are in need of review. The 60-day aging requirement is based on decades-old research indicating that *Brucella abortus* is eliminated in cheddar cheese after this aging period, and a lack of documented outbreaks associated with cheese aged in this way.¹² This aging process appears inadequate for other enteric pathogens – cheese implicated in this outbreak was found to contain *E. coli* O157:H7 fully 104 days after production, consistent with a previous study in which *E. coli* O157:H7 bacteria survived 158 days in aging cheddar cheese.¹³ Compliance with regulated microbiological criteria for unpasteurized hard cheese did not prevent *E. coli* O157:H7 contaminated product from entering the food supply in this outbreak.

Two Canadian studies have reported that approximately 1% of bulk raw milk analyzed was contaminated with STEC,^{14,15} and thus it would seem likely that a significant portion of hard cheese prepared from unpasteurized milk would also contain the pathogen. Notwithstanding the apparent preference of some consumers for unpasteurized dairy products,¹⁶ from a public health perspective, a food manufacturing process that does not reliably prevent the contamination of a ready-to-eat food product with a serious enteric pathogen should be called into question.

Health Canada proposed the banning of all raw milk cheese in 1996.¹⁷ This initia-

tive was strongly supported by regulators and public health professionals, but was ultimately defeated by industry and consumer groups. Regulatory review in this area requires revisiting and further support. In the interim, from the perspective of the clinician, cases of *E. coli* O157:H7 should be questioned about consumption of unpasteurized dairy products in the days prior to illness.

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RÉSUMÉ

Contexte : Vers la fin de 2002, le système de surveillance des maladies à déclaration obligatoire a relevé une concentration de cas de colite hémorragique causés par *Escherichia coli* O157:H7 dans le Grand Edmonton, en Alberta.

Méthode : Des hygiénistes du milieu ont recueilli les antécédents alimentaires et cliniques des cas relevés. Le laboratoire provincial de dépistage sanitaire a analysé par électrophorèse sur gel en champs pulsé (EGCP) des isolats de *E. coli* O157:H7 parmi ces cas. Les organismes de santé publique et de réglementation des aliments ont fait enquête lorsqu'une source de nourriture (du gouda non pasteurisé) a été mise en cause.

Résultats : L'EGCP a révélé une séquence apparentée à une éclosion dans 13 cas. Les dates d'apparition des cas liés à l'éclosion se situaient entre octobre 2002 et février 2003. Deux cas, l'un âgé de 22 mois et l'autre de quatre ans, ont présenté un syndrome hémolytique et urémique dû à l'infection. Douze des 13 cas liés à l'éclosion ont dit avoir consommé du gouda non pasteurisé fabriqué dans une ferme laitière locale au cours d'une période de deux à huit jours avant leur maladie. On a isolé *E. coli* O157:H7 dans deux des 26 échantillons de fromage fabriqués par la ferme en question. Les séquences EGCP des isolats du fromage étaient identiques à ceux des isolats des cas liés à l'éclosion. Le fromage en question avait été contaminé, 104 jours après sa fabrication, par *E. coli* O157:H7, bien que la ferme ait respecté les exigences réglementaires en matière microbiologique et d'affinage.

Conclusion : À notre connaissance, il s'agit de la première éclosion confirmée du colibacille O157:H7 au Canada associée à du fromage au lait cru à pâte dure. Un examen de la législation fédérale sur le fromage au lait cru à pâte dure pourrait être indiqué.