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PEER-REVIEWED ARTICLE

Food Protection Trends, Vol 40, No. 2, p. 95–100

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Outbreak of Disease Caused by *Salmonella* Typhimurium Associated with an Online Meal Subscription Service in Toronto, Canada, 2016

ABSTRACT

Online food retail is an emerging business model that presents unique food safety challenges and potential risks. An outbreak of disease caused by *Salmonella* Typhimurium was detected in Toronto, Canada in July 2016. All six confirmed outbreak-associated cases had matching pulsed-field gel electrophoresis (PFGE) patterns and reported exposure to chicken meals obtained from an online meal subscription service. Food safety inspections and a Hazard Analysis Critical Control Point (HACCP) audit at the kitchen where meals were prepared revealed inadequate cooling and cold-holding of meals prior to delivery to customer pickup points. Samples from control poultry meals were elevated for total coliforms and Gram-negative counts, consistent with time and temperature abuse at the food preparation kitchen. Almost 1,500 meals were voluntarily discarded by the manufacturer as a result of the audit, and production was halted. Given the potential for high-volume multi-jurisdictional online food sales and the associated risk of foodborne disease outbreaks, coordinated action is required to address this emerging issue and prevent future illness.

INTRODUCTION

Online food retail, an emerging business model around the world, includes a wide range of services such as online grocery shopping from supermarkets or third-party commerce platforms; on-demand ordering of restaurant food through third-party couriers; subscription services of individual food items, meal kits, or prepared meals; and informal sale of home-cooked ready-to-eat meals through social media. Because online food sales present diverse and unique challenges for food safety regulators, controls over them tend to be scanty and have not kept pace with the rate of innovation *(10)*. In Canada, where annual e-commerce sales in the food services and drinking subsector grew by 68.8% between 2016 and 2017 to $2 billion (Canadian dollars) *(15)*, food safety regulations pertaining to local health authorities continue to focus on brick-and-mortar food premises *(7)* and do not specifically address these alternative business models.

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On July 26, 2016, a Toronto Public Health investigator identified four cases of salmonellosis (including two household members), with the same online meal subscription service reported as a common exposure. The cause of three of these cases was subtyped as *Salmonella* Typhimurium on July 28, 2016, the same day that a fifth case of salmonellosis with exposure to the same online meal subscription service was identified.

The objectives of this outbreak report are to describe a community outbreak of disease caused by *Salmonella* Typhimurium involving an online meal subscription service in Toronto, Canada and to increase awareness among food safety professionals about consumers' exposure to this increasingly popular business model.

MATERIALS AND METHODS

Case finding and data collection

Laboratory-confirmed cases of salmonellosis are routinely reported to Toronto Public Health under the Province of Ontario's *Health Protection and Promotion Act (7)*. Case information, including exposure histories, is obtained through telephone interviews, using a standardized provincial investigation tool for salmonellosis cases *(13)*. Components of the questionnaire include symptoms and onset, hospitalization and complications, behavioral and social risk factors, a three-day food history including names of visited food premises, and involvement in high-risk settings such as child care centers. Data are entered into Ontario's Integrated Public Health Information System (iPHIS). Toronto Public Health and the provincial public health agency, Public Health Ontario, queried iPHIS to identify any additional cases of *S.* Typhimurium infection in Toronto and neighboring health authorities served by the online meal subscription service. Descriptive analyses were conducted using Microsoft Excel 2010.

Laboratory testing

Clinical diagnostic laboratories in Ontario forward isolates of *Salmonella* to the Public Health Ontario (PHO) Laboratory for serotyping and provincial enteric illness surveillance purposes. Clinical isolates of *Salmonella* were serotyped according to recognized laboratory serotyping slide agglutination protocols *(5, 8)*. Pulsed-field gel electrophoresis (PFGE) was also performed according to standardized PulseNet Canada protocols *(1)* for clinical isolates of *Salmonella* Typhimurium for surveillance purposes and to support the investigation. The PFGE pattern designations were provided by the National Microbiology Laboratory in Winnipeg in order to identify isolates that were considered to be genetically related.

Food samples submitted to PHO Laboratory for analysis were tested according to the food type and reason for testing, as submitted by the health unit. Testing for control samples included analysis for indicator organisms in order to perform a microbiological assessment of the ready-to-eat food samples as well as testing for bacterial pathogens *(14)*.

Outbreak case definitions

- *Confirmed case:* Toronto resident with laboratory-confirmed *Salmonella* Typhimurium, PFGE patterns STXAI.0193 and STBNI.0753, with onset of symptoms on or after July 1st, 2016, who consumed food from the online meal subscription service on or after July 1st, 2016.
- *Probable case:* Toronto resident with laboratory-confirmed *Salmonella* Typhimurium, PFGE patterns STXAI.0193 and STBNI.0753, reported to Toronto Public Health on or after July 1st, 2016, but where exposures could not be ascertained.

Reported salmonellosis cases who had traveled outside Canada for the entire duration of the incubation period (3 days prior to onset of symptoms) were excluded.

Food safety investigation

Toronto Public Health conducted food safety inspections of the commercial food premises identified by the outbreak cases through the food history questionnaire, including the online meal subscription service and pickup locations. The public health inspector also conducted a Hazard Analysis Critical Control Point (HACCP) audit, following the meal preparation process for the implicated meal type at their base kitchen from meat delivery through steps of handling, preparation, cooking, cooling, cold holding, storage and delivery. Samples of uneaten food from the online meal subscription service and control food samples from the base kitchen and centralized pickup locations were submitted for laboratory testing.

RESULTS

Descriptive epidemiology

A total of six confirmed cases and one probable case were reported to Toronto Public Health between July 18 and August 4, 2016. Stool specimen collection dates ranged from July 13 to 29, 2016. The epidemic curve *(Fig. 1)* was consistent with a point-source outbreak. Six of the seven cases (86%) were male. Cases' median age was 28 years (range: 1–55 years). All of the cases were identified as Toronto residents.

Among the confirmed cases, the most common signs and symptoms were diarrhea (6/6, 100%), fever (4/6, 67%), and abdominal pain (4/6, 67%). Two of the confirmed cases and the probable case were reported to have had bloody diarrhea. Three of the confirmed cases (50%) also experienced vomiting. Mean duration of symptoms was 7.6 days (range 6–10 days). Three of the seven (43%) outbreak cases sought care at a hospital emergency department, while the remainder (57%) went to an outpatient clinic. None of the cases were hospitalized, and there were no deaths.

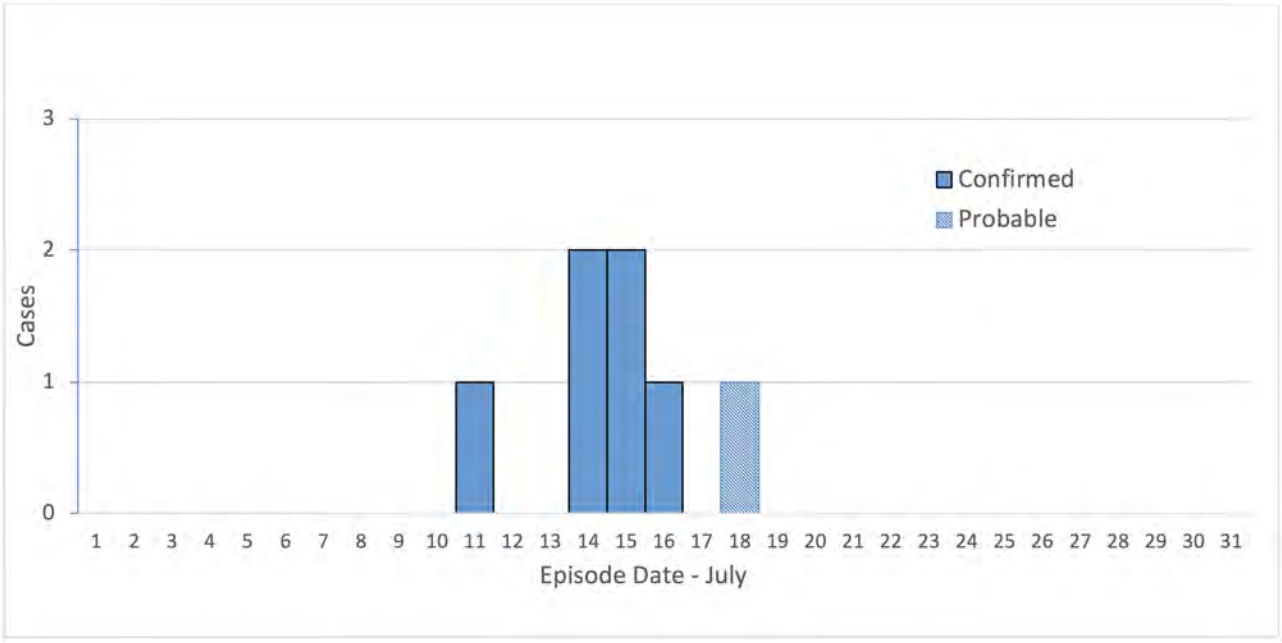

Figure 1. Number of persons infected with the outbreak strain of *Salmonella* Typhimurium associated with an online meal subscription service, by date of illness onset, Toronto, Ontario, July 2016 (N = 7)

Exposure history

The case investigation revealed that all six confirmed cases interviewed had eaten food from the same online meal subscription service within the three days preceding symptom onset. The confirmed cases had one online meal subscription service batch date in common (July 11), and one meal option in common (poultry). Two of the cases lived in the same household; however, because both consumed the poultry meal on July 11 and fell ill on July 15, a common source exposure was considered to be more likely than person-to-person transmission.

Food safety investigation

Toronto Public Health inspected commercial food premises identified by the outbreak cases through the food history questionnaire. The outbreak cases were able to name the online meal subscription service, but did not know where the food was produced, as there was no store-front. The business had not previously identified itself to the Medical Officer of Health prior to commencing operations, as per provincial food premises regulations *(7)*, and therefore had not been previously inspected by Toronto Public Health.

The online meal subscription service began operating in January 2015, with food preparation taking place in a rental kitchen. Food preparation moved to a commercial kitchen in April 2016 to accommodate a rapidly expanding number of subscribers. Typically, meal preparation for five different meal options (poultry, beef, pork, and two vegetarian) occurred in a single batch over three consecutive days. Delivery to centralized customer pickup locations or directly to the subscriber occurred on the fourth day. The prepared meals were labelled with only a symbol indicating poultry, beef, pork, or vegetarian, without production or "best before" dates or re-heating instructions present on the package. Meal contents and nutritional labelling were available online only.

At the time of the outbreak, the online meal subscription service was preparing approximately 1,700 meals twice weekly at a commercial base kitchen. Of those, 1,100 meals were being delivered to four designated downtown Toronto locations for centralized pickup by subscribers. Food delivery to pickup locations were made by an employee of the online meal subscription service, using cooler bags without ice packs. Each pickup location was a food premise, such as a coffee shop, with a sublease contract with the online meal subscription service. An upright refrigerator owned by the online meal subscription service was used to store meals at the pickup location. Subscribers personally accessed the refrigerator and chose their meals at the time of pickup; there was no record of who took what meals when; only the number of meals taken was recorded. All six of the confirmed cases in this outbreak picked up their meals, three from pickup location A and three from pickup location B.

The other 600 meals were delivered directly to subscribers' home or workplace by a third-party delivery service. For those deliveries, the meals were packaged in coolers with ice packs. Depending on the subscribers' preference, the coolers

containing the meals could be delivered to a house porch or condo/workplace reception area and potentially remain there for an extended period of time. As of May 2016, the delivery area covered five public health authorities in the Greater Toronto Area (York, Peel, Halton, Durham and Toronto). None of the outbreak cases used the home/workplace delivery option.

Toronto Public Health inspected the base kitchen, as well as the two locations where cases had picked up their meals. Location A was inspected on July 26. Refrigerator temperatures and temperature logs were within acceptable limits; no control food samples were collected. Location B was inspected on July 26; refrigerator temperatures and temperature logs were within acceptable limits. Three control food samples from the July 25 batch (poultry, beef, and pork meals) were taken and sent for laboratory testing. Inspection of the base kitchen on July 27 revealed that the designated handwashing sink lacked running hot water and paper towels; employees were using the dishwashing sink or washroom sink to wash their hands, or using gloves without proper hand hygiene. Employees were also observed to be putting hot prepared meals in the refrigerator for overnight storage, without first cooling them properly. An inspection "conditional pass" was therefore issued. There were no prepared meals or raw ingredients remaining from the July 11 batch, but control samples from the latest batch of poultry and pork meals were taken and sent for laboratory testing on July 27. The base kitchen was re-inspected on July 29; because the handwashing sink had been repaired and the incorrect use of disposable gloves had ceased, an inspection "pass" was issued.

On August 2 and 3, an HACCP audit focusing on production of the poultry meal was conducted. The audit revealed inadequate cooling and cold-holding of ready-to-eat meals at the base kitchen. Under provincial food premises regulations *(7)*, potentially hazardous foods cannot be maintained or stored at temperatures above 4 degrees Celsius or below 60 degrees Celsius for more than two hours. The public health inspector observed that after cooking the poultry at 340 degrees Celsius for 40 minutes, the poultry was cooled using a fan in front of the cooling rack for 30 minutes. Meals intended for staff delivery to pickup locations were then placed into insulated bags without ice packs (up to 50 meals per bag) before being placed in the refrigerator. The refrigerator at the base kitchen was also of inadequate size to sufficiently cool the volume of prepared meals produced in one batch. Internal temperatures after refrigeration for more than eight hours ranged between 8 and 12 degrees Celsius for the poultry meals. Similarly, internal temperatures of the beef, pork and vegetarian meals prepared concurrently with the poultry meal ranged between 7 and 15 degrees Celsius. As a result of the audit findings, the operator voluntarily discarded all 1,484 meals scheduled to be delivered on August 4 and closed the food premise pending process revisions.

On August 16, Toronto Public Health was informed that the online meal subscription service tested the production of a sample batch and were not successful at reducing the internal temperature of the meals to below 4 degrees Celsius in the recommended time frame; they therefore decided to halt all production. A follow-up inspection was not conducted, as the base kitchen was permanently closed and their refrigerators were removed from the pickup locations.

Laboratory findings

All six confirmed cases and one probable case tested positive for *Salmonella* Typhimurium, PFGE pattern STXAI.0193 and STBNI.0753. Because of the time delay between the suspected exposure and reporting to public health (7–12 days), neither prepared meals nor raw ingredients from the suspected batch were available for laboratory testing at the time of the investigation. None of the control food samples submitted for testing were positive for *Salmonella*. However, the control samples taken from both the base kitchen and pickup location B showed evidence of inadequate cooling and cold-holding; total coliforms and total Gram-negative counts were elevated in all nine samples, and the *Bacillus cereus* count was elevated in four of nine samples.

DISCUSSION

Although *Salmonella* Typhimurium is a common serotype among salmonellosis cases in Ontario *(12)* and the pathogen was not isolated from the implicated food item, the epidemiologic evidence and findings of the food safety investigation strongly support the conclusion that the outbreak was associated with this online meal subscription service. The weight of evidence *(11)* points toward a common source for the outbreak: all seven outbreak-associated cases shared matching PFGE patterns, and all six confirmed cases reported eating the poultry dish during their incubation period. Results from the inspection of the food production facility, HACCP audit, and laboratory testing of other prepared meals at the base kitchen and at the centralized pickup points revealed significant food safety issues, specifically time and temperature abuse, as the root cause of the outbreak. The last symptom onset date among confirmed cases was July 18, and no further cases were reported to Toronto Public Health after August 4.

The outbreak investigation had several limitations. The investigation focused exclusively on cases confirmed through laboratory testing. Cases who did not have illness diagnosed through a health care provider would not have been reported to Toronto Public Health. Case-finding among potentially-exposed customers was not conducted, because the online meal subscription service did not keep a record of what meals were purchased or picked up by its subscribers and because of the self-limiting nature of the infection. The delay of 7 to 12 days between the suspected exposure and *Salmonella* case reporting to public health resulted in the suspect meals being

completely consumed or discarded by the time the outbreak was reported. Therefore, no sample/leftover of the suspected dish or its ingredients were available for laboratory testing. A consumer health warning was not issued, as there was no ongoing risk to human health from available product, but this may have also limited additional case-finding.

This investigation highlights the unique food safety challenges of online food retail. Purchasing food online is still an emerging business model in Canada, with persons who are more technologically savvy being more likely to adopt this trend *(3)*. The median age of the cases in this outbreak was 28 years, which reflects changing meal consumption patterns in Canada. Survey data show that an estimated 20% of meals eaten by Canadians ages 16 to 30 years of age are prepared outside the home, with self-reported poor cooking skills and work/life pressures significant barriers to cooking and preparing meals *(2, 19)*. Convenience and price tend to be the most important factors to consumers of online food products, with food safety being of lower priority *(4)*.

Likewise, many online food retailers may be falling short on a variety of food safety measures, including undergoing mandatory inspections prior to commencing operations; providing information to consumers about safe handling, storage or cooking on their website or on product packaging; providing accurate information about time frames for the freshness of a product; ensuring that time spent in transit without adequate temperature controls is minimized; and prompt refrigeration after delivery *(9, 17)*. Indeed, one previous outbreak associated with an online food retailer has been reported in the literature; in this outbreak, 324 cases of salmonellosis among persons from seven administrative divisions in north and south Taiwan were linked to the distribution of more than 5,145 sandwiches from a bakery in central Taiwan. The sandwiches, containing bread, mayonnaise, and thin omelet, were sorted at a central hub and delivered by a logistics company within one to two days of production. Both *Salmonella* Enteriditis and *Salmonella* Virchow were isolated from samples from sandwiches, patients, and food handlers at the bakery *(18)*. This further supports the assumption that this emerging issue may be under-recognized and has the potential for impacting large numbers of people over a wide geographical area.

This outbreak also emphasizes broader food safety regulatory issues. A recent survey of European Union Member States demonstrated that official controls over food sold online were limited and focused on registered food business operators. The online marketplace allows retailors to enter, exit and change their digital identities rapidly; without ad hoc surveys or systematic proactive internet searches, non-registered retailors can be overlooked. Recently, food standards authorities in the United Kingdom and Ireland have issued guidance for local authorities and food premise operators regarding food sold over the internet. These guidance documents address issues unique to this retail model, such as determining the business' legal identity from their website; obtaining product samples through anonymous online ordering; informing consumers about product recalls through customer online order details; and closing down a business' online sales presence *(6, 17)*.

The outbreak reported in this paper resulted from the convergence of the many issues of online food retail. The online food retailer did not notify the local Medical Officer of Health prior to commencing operations, as required under provincial food premise regulations *(7)*, and therefore an inspection was not conducted until the retailer was identified as an exposure by several *Salmonella* cases, and after operating for more than a year. Large quantities of prepared meals with potentially hazardous ingredients were subject to time and temperature abuse between production at the base kitchen and delivery at multiple customer pickup points. The company's website lacked any food safety information, and prepared meals were not labelled with either re-heating instructions or production or "best-before" dates for the consumer.

After the outbreak, food safety information for consumers on Toronto Public Health's website was updated to include tips for purchasing food online, such as visiting the location where food is prepared and checking its inspection status on the DineSafe inspection disclosure portal *(16)*. When Toronto Public Health becomes aware of an online food retailer operating within city limits, including those based in private dwellings, public health inspectors attend the address of the business to inform the operator of their obligations under provincial food premises regulations *(7)*. However, there are currently no regulations or guidance documents specific to online food sales at the provincial or national level.

CONCLUSION

This outbreak caused by *Salmonella* Typhimurium in Toronto highlighted some of the challenges associated with ensuring food safety in an online food retail model. Given the increasing potential for multi-jurisdictional outbreaks associated with high-volume online food sales, coordinated action is required to address this emerging issue through guidance to operators, regulation and enforcement by food safety authorities, and consumer awareness of the potential problems associated with buying food online.

ACKNOWLEDGMENTS

The authors thank the following Toronto Public Health staff who participated in this outbreak investigation: Anne Arthur, Dana Al-Bargash, Rob Colvin, John Fernando, Esther Johnson, Marius Mihai, Dr. Herveen Sachdeva, Ada Shing, and Sylvanus Thompson. The authors also thank Public Health Ontario Laboratory personnel in the Enteric, Environmental and Molecular Surveillance sections. There are no conflicts of interest to declare.

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