

From the Field

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Outbreaks of *Salmonella* illness associated with frozen raw breaded chicken products in Canada, 2015–2019

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Abstract

Frozen raw breaded chicken products (FRBCP) have been identified as a risk factor for *Salmonella* infection in Canada. In 2017, Canada implemented whole genome sequencing (WGS) for clinical and non-clinical *Salmonella* isolates, which increased understanding of the relatedness of *Salmonella* isolates, resulting in an increased number of *Salmonella* outbreak investigations. A total of 18 outbreaks and 584 laboratory-confirmed cases have been associated with FRBCP or chicken since 2017. The introduction of WGS provided the evidence needed to support a new requirement to control the risk of *Salmonella* in FRBCP produced for retail sale.

Nontyphoidal salmonellosis is a leading cause of gastroenteritis illness in Canada and has been estimated to cause over 1 00 000 illnesses per year [1]. *Salmonella* Enteritidis is the most common serovar in Canada accounting for approximately 45% of human salmonellosis cases followed by Typhimurium and Heidelberg at 8% and 6%, respectively [2]. The rates of *Salmonella* Enteritidis have been rising over the past several years. However, due to the highly clonal nature of this serovar traditional genotyping methods such as pulsed field gel electrophoresis (PFGE) and phage typing lack sufficient discriminatory power to confirm genetic relatedness of isolates [3]. As a result, very few discrete, genetically related clusters were historically identified at the national level resulting in few national outbreak investigations.

Investigations into sustained increases of *Salmonella* Heidelberg and Enteritidis in Canada have previously identified frozen raw breaded chicken products (FRBCP) as risk factors for infection [4–6]. In Canada, most FRBCP (e.g. nuggets, strips, burgers) available for sale in the marketplace are raw; however, they are par-fried before being frozen which gives them a cooked appearance. Because of this cooked appearance, it has been estimated that 40% of consumers consider these products to be precooked [6].

In 2015, a cluster of *Salmonella* Enteritidis with a new PFGE pattern was identified and a national outbreak investigation was conducted. In total, 51 cases were linked to this outbreak over a 6-month period; 45% of these cases were hospitalised. The source of the outbreak was determined to be FRBCP [7]. Frozen raw breaded chicken burgers, strips and nuggets produced at a single facility on the same day were recalled from the marketplace [8]. This was the first national outbreak investigation linked to FRBCP in Canada. As a result of this outbreak investigation, regulators recommended that industry strengthen messaging to consumers that FRBCP are raw and need to be fully cooked and that packaging instructions provide explicit instructions about not microwaving products.

In May 2017, PulseNet Canada began using whole genome sequencing (WGS) for analysis of all clinical *Salmonella* isolates in Canada. WGS provided increased resolution of genetic relatedness among *Salmonella* isolates, which was especially true for common serovars such as Enteritidis. With this increased resolution, clusters of highly genetically related isolates could be identified, thereby allowing epidemiologists to conduct outbreak investigations based on the principle that genetically related isolates are more likely to have originated from a common source. In addition, WGS was also instituted for food isolates collected through the existing FoodNet Canada sentinel site surveillance system, and for food samples collected during outbreak investigations. Food isolates are analysed in real-time and results are combined with clinical results, allowing for comparison and in some instances, providing microbiologic evidence of an association between clinical and food isolates.

The implementation of WGS resulted in an increase in the number of *Salmonella* clusters identified. Collating human and food isolate sequencing data resulted in many clusters that included both human and food isolates. Often this provided an initial hypothesis that could

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Table 1. National Outbreaks of *Salmonella* associated with chicken, including frozen raw breaded chicken products (FRBCP) and associated product recalls, Canada, 2015–2019

Case onset date range	Serotype	Number of Cases	Source	Product recalled ^a
January–July 2015	Enteritidis	51	Frozen raw breaded chicken products (FRBCP)	Chicken burgers, strips and nuggets [15]
March–October 2017	Braenderup	51	Chicken	No recall
April–July 2017	Enteritidis	25	Chicken including FRBCP	No recall
April–June 2017	Enteritidis	13	FRBCP	Chicken nuggets
April–July 2017	Heidelberg	9	FRBCP	No recall
April–August 2017	Enteritidis	46	Chicken	No recall
June 2017–October 2017	Enteritidis	22	FRBCP	Chicken burgers and popcorn chicken
April–December 2017	Enteritidis	54	Chicken including FRBCP	No recall
May 2017–March 2018	Enteritidis	33	Chicken including FRBCP	Chicken nuggets
March 7–26 July 2018	Enteritidis	90	Chicken including FRBCP	Chicken burgers
November 2017–February 2018	Enteritidis	12	FRBCP	No recall
June–August 2018	Enteritidis	27	FRBCP	Chicken fries
June–Sept 2018	Enteritidis	55	FRBCP	Chicken nuggets
July–September 2018	Enteritidis	12	FRBCP	Chicken fries
December 2017–September 2018	Enteritidis	26	FRBCP	Chicken strips and chicken burgers
June 2018–March 2019	Enteritidis	64	FRBCP	Chicken nuggets (2)
December 2018–March 2019	Enteritidis	30	FRBCP	Chicken nuggets
February 2019–April 2019	Enteritidis	4	FRBCP	Chicken nuggets
September 2018–April 2019	Enteritidis	11	FRBCP	Chicken strips

^aAll recalled products were comminuted chicken products.

be investigated using traditional epidemiological methods. Many clusters were found to be associated with chicken, including FRBCP exposure.

In total, 12 outbreaks and 285 cases of *Salmonella* have been investigated and found to be associated with FRBCP exposure in Canada since May 2017 (Table 1). An additional four outbreaks and 202 cases of *Salmonella* were found to be associated with chicken exposure, which included FRBCP. These recent outbreaks represent a considerable increase in the number of national *Salmonella* outbreaks investigated in Canada. Eleven of these outbreak investigations led to product recalls and Canadian Food Inspection Agency Food Recall Warnings [9]. A twelfth outbreak investigation was found to be associated with a product that had been recalled from the marketplace by the retailer approximately 1 month earlier together with the other FRBCP under the same brand name. In their Public Health Notice, the Public Health Agency of Canada advised the public not to consume any of the specific products found to be associated with *Salmonella* illnesses. All recalled products were comminuted chicken products.

Despite previous and ongoing efforts to improve FRBCP package labelling and to educate the public about safe food-handling practices, illness outbreaks associated with exposure to these products continued to be identified. The Canadian Food Inspection Agency issued a notice to industry in March 2018, advising industry that *Salmonella* in FRBCP was a hazard that must be addressed in their Preventive Control Plan and provided four control options to reduce *Salmonella* to below detectable amounts: (1) Products can

be produced using a cooking process that has been validated to achieve a 7 log reduction of *Salmonella*, (2) a sampling program of the raw chicken mixture, (3) sampling program of finished raw breaded chicken product or (4) a combination of processes that have been validated to achieve a 2 log reduction in *Salmonella* along with a *Salmonella* sampling program of the raw chicken mixture [10]. These controls are to be implemented in FRBCPs that are comminuted, formed and packaged for retail sale. The control measures came into effect on 1 April 2019 [11]. Because FRBCPs have a long shelf life, it is anticipated that product available at the retail level prior to 1 April 2019 may be available on the market and in freezers for a significant period of time following the implementation of the new control measures.

Given the ongoing detection of *Salmonella* illness outbreaks and following the announcement of the new industry requirements, leading public health officials in Canada issued a public statement in September 2018 to stress the importance of handling and preparing FRBCP with caution to reduce the risk of becoming infected with *Salmonella* [12]. At the same time, the Public Health Agency of Canada issued an over-arching public health notice to inform the public about all of the outbreak investigations associated with raw chicken, including FRBCP exposure, since the introduction of WGS analysis for *Salmonella* in May 2017 [13].

The introduction of WGS was instrumental in providing the evidence needed to support the requirement to control a long identified risk factor for *Salmonella* infection. The new requirement is similar to one currently in place in the European

Union, where there must be an absence of *Salmonella* in minced and mechanically separated poultry products intended to be cooked [14]. This issue demonstrates the continued challenge of educating the public on safe food handling practices. In some instances, consumer education may not be sufficient and additional regulatory action may be required to reduce risk within the population. It is expected that the new requirement will reduce the burden of illness associated with FRBCP in Canada.

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