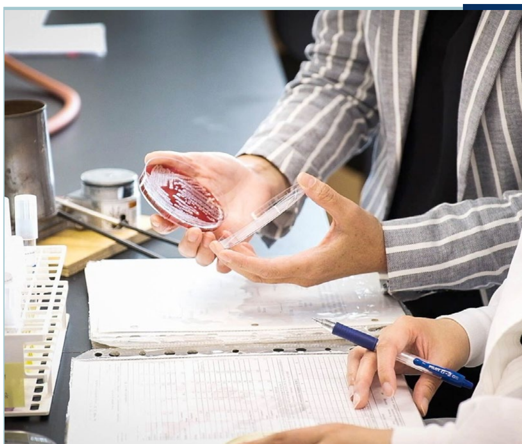

British Columbia Integrated Surveillance of Foodborne Pathogens (BCISFP) Annual Summary of *Salmonella* Findings

2018

Date of Publication: October, 2019



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Introduction

British Columbia Integrated Surveillance of Foodborne Pathogens (BCISFP) was initiated in October 2006 with the mission of providing surveillance along the food chain for safe food and healthy people in British Columbia (BC). *Salmonella* is an ideal candidate for integrated surveillance because it is cultured within all sectors (animal, food and humans), is recovered at relatively high frequencies and affects a great variety of food commodities. For more information please visit: www.bccdc.ca/integratedfoodchainsurveillance.

The 2018 report represents BCISFP's ninth annual summary. The purpose of the summary is to provide integrated information about the occurrence of *Salmonella* in BC among humans and at select points along the food chain. Data are sourced from four distinct sectors: human, animal (farm, domestic, and wild life), abattoir and food. Data are provided by the BCCDC Public Health Laboratory, National Microbiology Laboratory, Canadian Integrated Program for Antimicrobial Resistance Surveillance and FoodNetCanada, Public Health Agency of Canada and Animal Health Centre, BC Ministry of Agriculture. Details about the data sources and how they are integrated are described in BC Integrated Surveillance of Foodborne Pathogens Methods available at www.bccdc.ca/integratedfoodchainsurveillance.

In 2018, the majority of *Salmonella* isolates underwent whole genome sequencing (WGS) although some animal isolates (e.g. abattoir/slaughter) were not sequenced due to resource constraints or were sequenced but these data were unavailable at the time this summary. Due to the wide-scale implementation of WGS in 2018, no phage type data are presented in this summary as in previous years. It is expected that all *Salmonella* isolates in the next year from all sectors will undergo WGS allowing for a higher degree of integration within the BCISFP program.

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Results Overview

In 2018, *Salmonella* was isolated from 542 locally-acquired human clinical specimens, 189 food specimens, 25 abattoir specimens and 753 animal specimens (Table 1). A total of 82 different serotypes were observed in all 4 sectors (*i.e.* human, animal, abattoir and food) in 2018. Among the 20 most common serotypes that spanned multiple sectors, three serotypes (*S.* Enteritidis, *S.* Kentucky, *S.* Infantis) were found in all 4 sectors; 10 serotypes were found in three sectors and 7 serotypes in two sectors. As in previous years, serotypes overlapped primarily between humans, chicken meat and samples from on-farm chickens, and to a lesser extent, turkey meat and turkeys at the farm level; this is likely due to the large number of isolates from these sources.

As in previous years, in 2018 the most commonly detected serotype in BC was *S.* Enteritidis. Historically, *S.* Enteritidis has been the most common serotype in BC across all sectors. It was the most common serotype for locally-acquired human infections, fresh chicken meat, chicken nuggets, and abattoir chicken (Table 1).

Similarly to 2017, the second most common serotype was *S.* Kentucky in 2018. This serotype is particularly common in chickens on-farm and chicken food products (fresh chicken meat and chicken nuggets). *S.* Kentucky was more frequently isolated than *S.* Enteritidis from on-farm chicken samples in 2018. *S.* Kentucky rarely causes human illness and in 2018 there was only one locally-acquired human *S.* Kentucky infection (Table 1).

In 2018, *S.* Infantis was the second most common serotype associated with locally-acquired human infections. This increase in human cases was due to a national outbreak investigation of 56 cases (47 in BC), possibly associated with English cucumbers.[1] *S.* Infantis was represented in the top 5 serotypes for all chicken-related isolates (third for chicken nuggets, fourth for fresh chicken, and fifth for chickens on-farm) (Table 1). None of the chicken samples clustered by WGS with the outbreak of human cases.

In 2018 as in 2017, *S.* Reading was the most common serotype identified from ground turkey meat. It was also the most common serotype in turkeys on-farm, representing a 30% increase compared to 2017 where *S.* Reading was the fourth most common serotype (10% of all turkey on-farm isolates). In 2018, there was also an increase in *S.* Reading among locally-acquired human infections related to an outbreak.

Table 1. Salmonella serotypes reported in two or more sectors (human, food, abattoir, animal) in BC, 2018

Serotype	Locally-acquired human infections	Food				Abattoir	Animal								Total
		Fresh Chicken[1]	Chicken Nuggets[2]	Pork	Turkey	Chicken	Cattle	Chicken[3]	Domestic Duck/Goose	Exotic/ Zoo[4]	Swine	Turkey[5]	Wildlife[6]	Other[7]	
Enteritidis	280	55	20	1	8	14		236				7	1		**622**
Kentucky	1	28	7			8		241		2		1			**288**
Infantis	55	3	6			1	1	15				2		1	**84**
Typhimurium	26	6	3	1			5	20		1	1		1	3	**67**
Reading	12	1			13			1				27			**54**
Hadar	3	1			4			4	1			18			**31**
Brandenburg	12							16							**28**
4,5,12:i:-	18							7							**25**
Heidelberg	10	1	1					6						1	**19**
Schwarzengrund	2	2			2		1	10				2			**19**
Uganda	2	2		1	2							12			**19**
Senftenberg	1					1		12	1			2			**17**
Newport	10	1						3							**14**
Dublin	1						10							1	**12**
Thompson	5		3		1					3					**12**
Liverpool			1					5				3			**9**
Montevideo	4							4							**8**
Agona	2											5			**7**
Mbandaka	4							3							**7**
Muenchen	3				1							3			**7**
Other	91	8	0	3	3	1	0	41	0	2	1	7	1	2	**160**
Total	**542**	108	41	6	34	**25**	17	624	2	8	2	89	3	8	**1509**

1. 32 chicken samples are from BCCDC lab, 76 are from CIPARS/FoodNet.
2. 6 chicken nuggets samples are from BCCDC lab, and 35 are from CIPARS/FoodNet .
3. Samples taken from on-farm chickens and their environments. In 2018, these include 141 diagnostic isolates, 427 environmental isolates taken from chicken hatcheries/farms, and 56 CIPARS/FoodNet Canada farm isolates (pre-harvest only).
4. Exotic/Zoo includes 2 birds (falcon and owl), 3 turtles , 2 snakes and 1 coyote.
5. In 2018, the turkey isolates include 21 diagnostic isolates, 2 environmental isolates and 66 CIPARS/FoodNet Canada farm isolates (pre-harvest only).
6. Wildlife includes 1 raccoon, 1 seal and 1 pine siskin.
7. Other animals include 2 cats, 1 dog, 2 sheep and 3 pigeons.

Salmonella Enteritidis

In 2018, *S*. Enteritidis made up 51.7% of locally-acquired *Salmonella* infections in humans. This proportion has decreased compared to 2017 when *S*. Enteritidis made up approximately 60% of locally-acquired isolates. The proportion of other serotypes reported from locally-acquired cases has increased in 2018 compared to 2017.

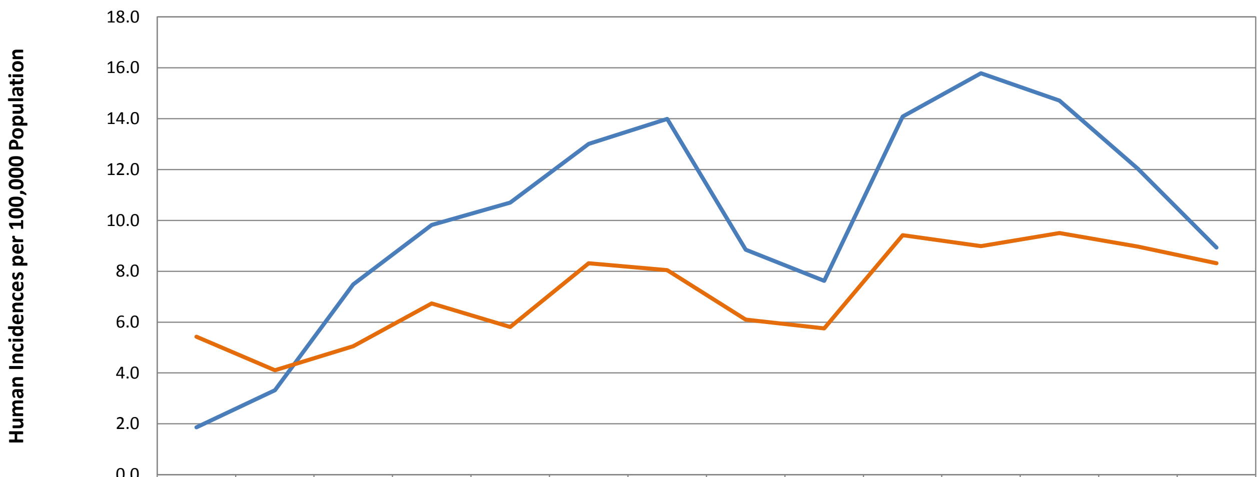
The total *S*. Enteritidis incidence in humans in BC has dropped considerably since it peaked in 2015 (Figure 1). A plateau in 2014-16 was followed by two years of declining incidence leading to 8.9 cases/100,000 in 2018, the lowest incidence reported in the last five years. However, this incidence is still higher than was seen before 2008 when the BC incidence was between 1.9-7.5/100,000 between 2005 and 2007. The 2018 BC incidence now approaches the national incidence of 8.3/100,000. Changes in national incidence may be due to an increase in other parts of the country.

The locally-acquired *S*. Enteritidis incidence in humans continues to parallel the *S*. Enteritidis recovery rate in chicken meat in BC (Figure 2). In general, as the proportion of chicken meat positive for *S*. Enteritidis has declined since 2015, so has the local human incidence.

In 2018, a report was commissioned by the BC Ministry of Agriculture, "Reviewing Interventions and Surveillance Activities for *Salmonella* Enteritidis in the Regulated Poultry Supply Chain Between 2012 and 2018." [2] The report was a follow-up to a paper published in 2018, describing interventions that were implemented between 2008 and 2012. [3] Interventions implemented between 2008 and 2012 including vaccination and separation during hatch, are largely unchanged and still in place. There were four new monitoring programs or projects for *S*. Enteritidis implemented since January 1, 2012. In addition, a number of interventions that might have an impact on *S*. Enteritidis have also been implemented, including: promoting and enforcing rodent control on poultry farms, striving to optimize egg incubation and hatching processes, and upgrades to equipment in abattoirs/processors to reduce *Salmonella* spp. on ready-to-market poultry products. The poultry industry's awareness of and responsiveness to *S*. Enteritidis may have contributed to the decline in *S*. Enteritidis observed in on-farm chicken isolates between 2015 and 2018 (data not shown).

In 2018, the predominant *Salmonella* serotype observed in on-farm chickens and their environments is Kentucky (Table 1). Not since 2008 has a strain other than *S*. Enteritidis been the predominant serotype, and in 2008 the most commonly observed strain was also Kentucky. *S*. Enteritidis and Kentucky represent the majority of the isolates from on-farm chicken samples. It is possible that these strains may be competing for an ecological niche in the chickens or the farm environment, leading to the hypothesis that a decrease in *S*. Enteritidis may be explained by strain replacement with Kentucky through a process of competitive exclusion. [4]

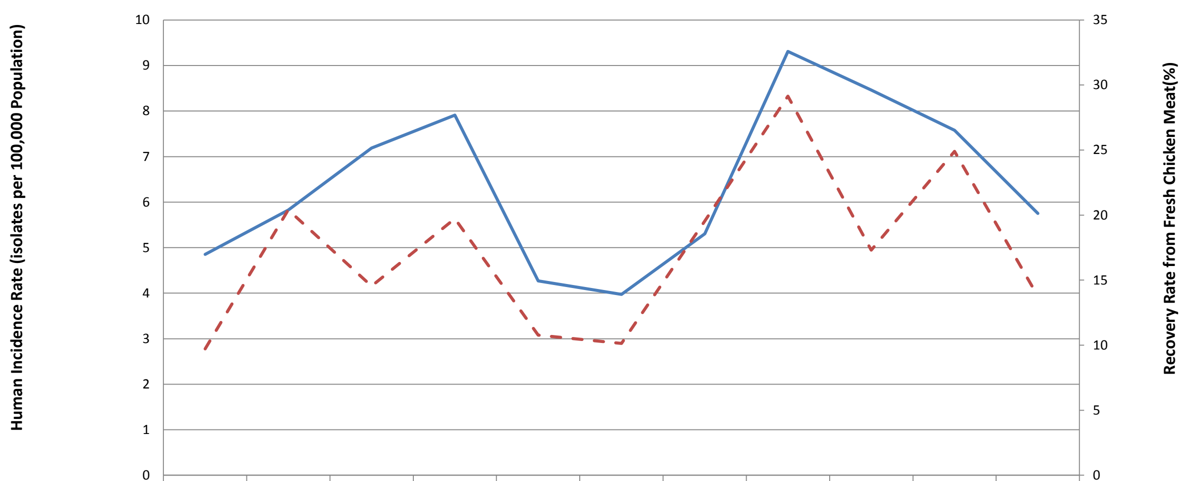
Figure 1: Salmonella Enteritidis human incidence (all), Canada vs BC, 2005-2018



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BC Rate	1.9	3.3	7.5	9.8	10.7	13.0	14.0	8.8	7.6	14.1	15.8	14.7	12.0	8.9
Canada Rate	5.4	4.1	5.1	6.7	5.8	8.3	8.0	6.1	5.8	9.4	9.0	9.5	9.0	8.3

Source for Canada Rate: National Enteric Surveillance Program, Public Health Agency of Canada

Figure 2: Salmonella Enteritidis human incidence (locally-acquired) and recovery rate from chicken meat, BC, 2008-2018



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Human (locally-acquired)	4.9	5.8	7.2	7.9	4.3	4.0	5.3	9.3	8.5	7.6	5.8
Fresh chicken meat	9.7	20.4	14.5	19.7	10.8	10.1	19.5	29.2	17.3	24.9	13.8

Source: FoodNet Canada and CIPARS, Public Health Agency of Canada

Salmonella Enteritidis- Whole Genome Sequencing

In May 2017, prospective WGS of all *Salmonella* human and food isolates was implemented across Canada, including in BC. WGS provides more discriminatory power than phage typing, and allows for the detection of smaller, more closely-related clusters. This has resulted in the detection and investigation of more *Salmonella* clusters, and in particular *S*. Enteritidis clusters. WGS clusters are defined as three or more isolates that cluster by 0-10 alleles using whole genome MLST. These clusters are then given a cluster code by the National Microbiology Laboratory.

Human

In 2018, three *S*. Enteritidis WGS clusters made up 41.9% of locally-acquired human isolates. They contain isolates identified since WGS was implemented in May 2017 and throughout 2018 and have been the most common WGS sequences found in BC. Cluster code 1705SENWGS-1MP is the most common among locally-acquired human isolates (22.4%). Cluster codes 1705SENWGS-8MP and 1707SENWGS-10 MP make up 7.2% and 12.3% of locally-acquired cases in BC respectively (Table 2, Figure 3).

These WGS cluster codes are seen primarily in western Canada. BC isolates makes up 79.0%, 40.0% and 14.9% of isolates in 1705SENWGS-1MP, 1705SENWGS-8MP and 1707SENWGS-10MP cluster codes respectively.

Food

All three of the most common WGS cluster codes include isolates from fresh chicken meat. Cluster code 1705SENWGS-1MP is the most common (31.6%). Among raw frozen breaded chicken isolates, two of the three common WGS cluster codes appear. In these products the most common WGS cluster codes are seen infrequently. The majority of isolates are either another WGS cluster (45.0%) or the isolate does not cluster with any other isolates (45.0%) (Table 2, Figure 3).

Animal

There is a notable lack of animal WGS. WGS is not routinely performed on isolates identified by the BC Animal Health Centre and although CIPARS is now routinely conducting WGS, the complete data set was not available for this analysis. Among available isolates from on-farm chicken, all isolates cluster with another isolate and two of the three most common cluster codes are present: 1705SENWGS-1MP and 1705SENWGS-8MP representing 30.8% of isolates with WGS. (Table 2, Figure 3). Among turkey isolates, none cluster in the top three WGS clusters in BC (data not shown).

Integrated

Cluster code 1705SENWGS-1MP was seen in all sectors in 2018 (chicken on-farm, chicken meat products and locally-acquired human infections). It is the most common cluster code among locally-acquired human isolates and chicken meat. It is also frequently seen in on-farm chicken isolates and less frequently reported from raw frozen breaded chicken products.

In 2018, cluster code 1705SENWGS-8MP was seen in on-farm chicken, chicken meat and locally-acquired human isolates but was not seen in raw frozen breaded chicken products. It made up a larger proportion among on-farm chicken isolates than in chicken meat or human isolates.

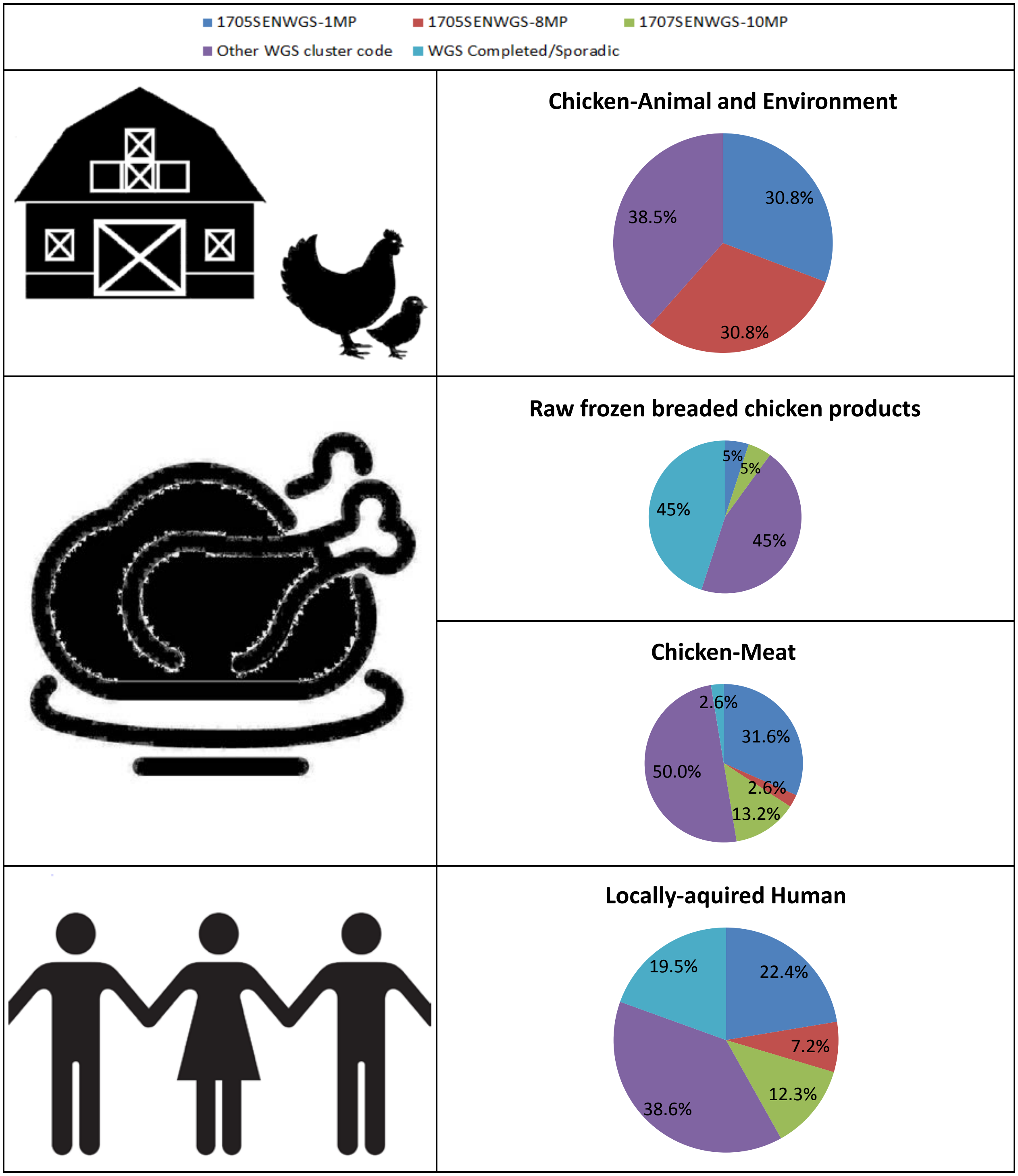
In 2018, cluster code 1707SENWGS-10MP was not seen in chicken on-farm isolates but was seen in all other sectors.

These three cluster codes have been circulating in BC since 2017 and possibly earlier. Data from 2017 show these three cluster codes were also seen in locally-acquired human isolates, chicken meat, raw frozen breaded chicken products and on-farm chicken isolates. Even with limited data from some sectors, especially on-farm, these three cluster codes appear to be endemic in BC and have been circulating in our poultry sector and human isolates.

Table 2: Number of S. Enteriditis isolates by cluster code and sector, BC, 2018

Cluster code	Locally-acquired Human cases	Chicken meat	Raw frozen breaded chicken products	Chicken on-farm: Animal and environment
1705SENWGS-1MP	62	12	1	4
1705SENWGS-8MP	20	1	0	4
1707SENWGS-10MP	34	5	1	0
Other WGS cluster code	107	19	9	5
WGS Completed/Sporadic	54	1	9	0
Total	277	38	20	13

Figure 3: Whole Genome Sequencing cluster codes by sector, BC, 2018



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Outbreaks and Investigations

Investigation and action on raw frozen breaded chicken products

In 2018, there were six national *S*. Enteritidis outbreak investigations that have involved BC human cases. Raw frozen breaded chicken products were suspected as the source in all. Food Recalls were conducted for five investigations. [5]

In 2018, 47 frozen raw breaded chicken products collected by FoodNet Canada had establishment information indicating where the product was produced available. Five establishments representing 46 of the samples were located in ON. Only one sample was from a production establishment located in BC. The majority of raw frozen breaded chicken products testing positive for *S*. Enteritidis are produced in ON and distributed nationally. The source of the chicken meat used in these products is not available; they may contain meat sourced from Canada, the US or internationally.

On April 1, 2019 new regulations were brought in by CFIA to reduce the burden of illness associated with frozen raw breaded chicken products. Over time, we anticipate seeing fewer human cases associated with these products. [6]

S. Reading

S. Reading was the most common serotype in turkey meat and turkey animals in 2018. In addition there was an increase in locally-acquired human cases (Table 1).

An international outbreak of human *S*. Reading with the same WGS sequence occurred in 2017-2019. [7] As of December 2018, there have been 95 cases nationally, with 23 in BC. In addition, there were 89 matching isolates from food or on-farm, 69 have been from BC including isolates collected by FoodNet Canada, CIPARS, BC health authorities and submitted by the BC Ministry of Agriculture. The majority of these non-human isolates are from turkey meat or turkey birds. An investigation identified raw turkey and raw chicken meat as the source of this outbreak based on case exposure information, food safety investigation and traceback, and laboratory data that indicated similarity between the food, animal and human isolates. This investigation demonstrated the use of whole genome sequencing across sectors to help identify sources of human illness.

Conclusions

Ongoing surveillance across sectors is important in order to assess changes and trends in *Salmonella* strains over time to improve our knowledge and inform actions about *Salmonella* across the farm to fork continuum in BC.

The current model of integrated surveillance in BC continues to be a good platform for data sharing, integration and analysis across human, food and animal sectors for *Salmonella*. Successful surveillance depends on a strong and supported network of individuals and agencies. The connectivity among partners in this system supports surveillance of *Salmonella* and sharing of data and information.

The transition from traditional laboratory subtyping tools to whole genome sequencing of *Salmonella* in 2017 and ongoing in 2018 has shown value, particularly for *S.* Enteritidis, by providing a more specific tool to link human cases to each other and to non-human sources, leading to an improved ability to control enteric illnesses. It should prove even more useful once it is routinely applied to animal isolates.

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