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2014

CANADIAN INTEGRATED PROGRAM FOR ANTIMICROBIAL RESISTANCE SURVEILLANCE (CIPARS)

ANNUAL REPORT

Canada

TO PROMOTE AND PROTECT THE HEALTH OF CANADIANS THROUGH LEADERSHIP, PARTNERSHIP, INNOVATION AND ACTION IN PUBLIC HEALTH.

—Public Health Agency of Canada

Également disponible en français sous le titre :

Rapport annuel du Programme intégré canadien de surveillance de la résistance aux antimicrobiens (PICRA) de 2014

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Publication date: September 2016

Cat.: HP2-4E-PDF

ISSN: 1925-9859

Pub.: 160126

Suggested Citation

Government of Canada. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2014 Annual Report. Public Health Agency of Canada, Guelph, Ontario, 2016.

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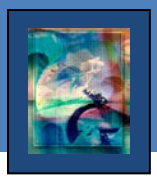
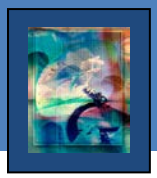
ANNUAL REPORT



2014 ANNUAL REPORT



EXECUTIVE SUMMARY

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) collects, analyses, and communicates trends in antimicrobial use and antimicrobial resistance in selected bacteria from humans, animals, and retail meat across Canada. The bacteria under surveillance are known as enteric bacteria (can be found within or infecting the intestines of people and animals) and can be transmitted between animals and people. Information from CIPARS supports measures to contain the emergence and spread of resistant bacteria among animals, food, and people, with the aim of prolonging the effectiveness of antimicrobials.

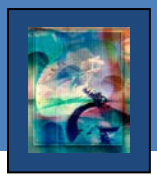
Between 2013 and 2014, CIPARS observed decreasing resistance to 3rd generation cephalosporins in *Salmonella* and *E. coli* isolated from chickens at the farm, at slaughter (abattoir) and from the grocery store (retail). CIPARS also noted significant decreases in the number of chicken farms reporting the use of this antimicrobial; ceftiofur was administered to chicks and hatching eggs in 6% of flocks in 2014 compared to 31% in 2013. This trend follows a May 2014 poultry industry-led policy change to eliminate the preventive use of 3rd generation cephalosporins, an antimicrobial class considered highly important to human medicine.

In 2014, the frequency of resistance to ciprofloxacin (an antimicrobial in the fluoroquinolone class, considered highly important to human medicine) in *Campylobacter* from chicken and turkey showed changing regional patterns. For grocery store chicken sampled in regions across Canada, ciprofloxacin resistance in *Campylobacter* remained highest in British Columbia in 2014 (21%), though the proportion of resistant isolates was lower than in 2013 (26%) in that province/region. Retail turkey sampling started in 2013 and ciprofloxacin resistance in *Campylobacter* from this product increased in most regions in 2014. For healthy animals at slaughter, the proportion of *Campylobacter* isolates that were resistant to ciprofloxacin in 2014 was 11% for chicken (significant increase from 4% in 2010), 7% for cattle and 11% for pigs. For broiler chickens on the farm, resistance to ciprofloxacin among *Campylobacter* decreased between 2013 (16%) and 2014 (10%).

Of all the medically important antimicrobials distributed for use in Canada, approximately 82% were intended for production animals, 18% were for humans, less than 1% for companion animals, and less than 1% for crops (as per the 2016 Canadian Antimicrobial Resistance Surveillance System Report (CARSS)—for data on antimicrobials intended for use in humans and comparisons with antimicrobials used in animals/agriculture). Adjusting for underlying populations and weights there was roughly 1.7 times more antimicrobials distributed for use in animals than humans (CARSS). Comparing 2006 to 2014, the total quantities of antimicrobials intended for use in animals (adjusted for populations and weights) were very similar. Seventy-three percent of this total in 2014 included antimicrobial classes also used in human medicine. Most antimicrobials were intended to be administered to animals via feed, a finding which was also reflected in data from sampled broiler chicken and grower-finisher pig farms. For chickens,

90% of sampled flocks reported using antimicrobials. Fewer flocks were medicated at the hatchery in 2014 compared to 2013 and fewer chicks and hatching eggs were exposed to ceftiofur (a 3rd generation cephalosporin). Disease prevention was the most frequently reported reason for antimicrobial use in feed and only 4% of sampled flocks reported using antimicrobials as growth promotants. For pigs, 91% of sampled grower-finisher pig herds reported using antimicrobials. Disease pressures and management practices were significantly different between regions for grower-finisher pig farms and may be reasons for regional differences in antimicrobial use practices.

CIPARS continues to evolve to meet stakeholder needs. To improve efficiency, CIPARS has returned to the release of a single Annual Report. For 2014, integrated findings have been published in the 2016 CARSS Report.



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- *Abattoir Surveillance*: Anne Deckert
- *Farm Surveillance*: Agnes Agunos, Anne Deckert, Sheryl Gow, and David Léger
- *Surveillance of Animal Clinical Isolates*: Jane Parmley
- *Quantities of Antimicrobials Distributed for Sale for Use in Animals*: Carolee Carson

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National Microbiology Laboratory @ Winnipeg

- *Salmonella* Serotyping: Helen Tabor
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- Antimicrobial Susceptibility Testing: Michael Mulvey

PROVINCIAL PUBLIC HEALTH LABORATORIES

We gratefully acknowledge the provincial public health laboratories for their longstanding support and for providing data and bacterial isolates for CIPARS:

- British Columbia Public Health Microbiology and Reference Laboratory, Provincial Health Services Authority, British Columbia (Judy Isaac-Renton)
- Provincial Laboratory for Public Health, Alberta (Marie Louie)
- Saskatchewan Laboratory and Disease Control Services (Greg Horsman)
- Cadham Provincial Laboratory, Manitoba (John Wylie)
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- Newfoundland Public Health Laboratory (Sam Ratnam)

[3] In 2015, the National Microbiology Laboratory and the Laboratory for Foodborne Zoonoses were combined into a single laboratory, the National Microbiology Laboratory with multiple campuses.

RETAIL MEAT SURVEILLANCE

We would like to extend our thanks to the following organizations for their participation in CIPARS *Retail Meat Surveillance*:

- Centre for Coastal Health
- Agriculture and Agri-Food Canada (Mueen Aslam, Tineke Jones, Cara Service, and Tim McAllister)
- University of Prince Edward Island, Atlantic Veterinary College (J.T. McClure, Carol McClure, Matthew Saab, Cynthia Mitchell, and Anne Muckle)

We also thank the following health unit managers, public health inspectors, and environmental health officers: Ken Adams, Renée Ansel, Lucy Beck, Bob Bell, Blake Gruszie, Kira Jang, Suzanne Lajoie, Edwin MacDougall, Shaun Malakoe, Ron Popoff, Diane Pustina, Doug Quibell, Jennifer Reid, Peter Richter, Torsten Schulz, Lee Siewerda, and Matthew Shumaker.

ABATTOIR SURVEILLANCE

We would like to thank the abattoir operators and the Canadian Food Inspection Agency's regional directors, inspection managers, and on-site staff, for their extensive voluntary participation in CIPARS *Abattoir Surveillance*.

FARM SURVEILLANCE

We are grateful for the efforts and participation of the Alberta Ministry of Agriculture and Rural Development and the Saskatchewan Ministry of Agriculture, as well as the sentinel veterinarians and the producers who participated in *Farm Surveillance* by providing data and enabling collection of samples for bacterial culture.

We would like to acknowledge the following organizations for their contribution to the CIPARS *Farm Surveillance* components:

- Alberta Chicken Producers
- British Columbia Chicken Marketing Board
- Canadian Hatcheries Federation
- Canadian Pork Council and Provincial Pork Boards
- Canadian Poultry and Egg Processors Council
- Chicken Farmers of Canada
- Chicken Farmers of Ontario
- CIPARS Farm Broiler Chicken Industry Antimicrobial Use/Resistance Working Group
- CIPARS Farm Swine Advisory Committees
- Les Éleveurs de volailles du Québec
- Participating veterinarians and producers

PROVINCIAL ANIMAL HEALTH LABORATORIES

We gratefully acknowledge the provincial animal health laboratories for their longstanding support and for providing data and bacterial isolates for CIPARS:

- Animal Health Centre, British Columbia Ministry of Agriculture (Erin Zabek and Nancy DeWith)
- Government of Alberta, Agriculture and Rural Development (Rashed Cassis)
- Saskatchewan Health, Saskatchewan (Paul Levett)
- Veterinary Services Branch Laboratory, Manitoba (Neil Pople)
- The Animal Health Laboratory, University of Guelph, Ontario (Durda Slavic)
- IDEXX Laboratories, Ontario (Hani Dick)
- Direction générale des laboratoires d'expertise du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (Marie Nadeau)
- Laboratoire d'épidémiosurveillance animale du Québec (Olivia Labrecque)
- Provincial Veterinary Laboratory, Department of Agriculture, Fisheries, and Aquaculture, New Brunswick (Jim Goltz)
- Veterinary Pathology Laboratory, Nova Scotia (Grant J. Spearman)
- Diagnostic Services, Atlantic Veterinary College, Prince Edward Island (Jan Giles)

QUANTITIES OF ANTIMICROBIALS DISTRIBUTED FOR SALE FOR USE IN ANIMALS

We would like to sincerely thank the Canadian Animal Health Institute and their member companies for voluntarily providing the quantities of antimicrobials distributed for sale for use in animals in Canada. We would also like to thank Impact Vet for many ideas for reporting format.

CIPARS would like to thank the small group of volunteer industry and provincial representatives who have participated in active discussions on appropriate denominators for quantities of antimicrobials distributed for use in animals.

OTHER PARTICIPANTS

We gratefully acknowledge the efforts of field workers, laboratory technicians, and data managers for their contributions. The careful collection of samples, processing of isolates, and recording of results are essential to the ongoing success of CIPARS.

We are grateful to the National Antimicrobial Resistance Monitoring System of the United States for sharing information and facilitating harmonization with CIPARS.

We would also like to thank the following individuals and organizations for their contribution to CIPARS in 2014:

Public Health Agency of Canada

Ashleigh Andrysiak, Louise Bellai, Mark Blenkinsop, Gail Christie, Sindy Cleary, Ann-Marie Cochrane, Marie-Claude Deshaies, Logan Flockhart, George Golding, Stefan Iwasawa, Nicol Janecko, Bernard Jackson, Mohamed Karmali, Jasmina Kircanski, Ora Kendall, Lisa Landry, Stacie Langner, Laura Martin, Sarah Matz, Ryan McKarron, Ketna Mistry, Ali Moterassed, Manuel Navas, Linda Nedd-Gbedemah, Derek Ozunk, Ann Perets, Frank Plummer, Frank Pollari, Susan Read, Julie Roy, Sophia Sheriff, Lien Mi Tien, Anatoliy Trokhymchuk, Rama Viswanathan, Victoria Weaver, and Betty Wilkie.

Canadian Food Inspection Agency

David Johnson, Daniel Leclair, Blaise Ouattara, and Marina Steele

Health Canada, Veterinary Drugs Directorate

Xian-Zhi Li and Manisha Mehrotra

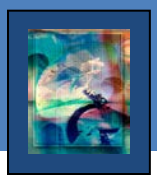
Canadian Meat Council

Independent contractors

John Ranson

Ron Templeman

We would like to acknowledge Dr. Richard Reid-Smith, the CIPARS "Superman"! Thank you Richard for your commitment and hard work done behind the scenes for this surveillance program. A special thanks to Dr. Anne Deckert for her outstanding efforts to make the last stages of this report move forward!



CHAPTER 1—PROGRAM OVERVIEW

ABOUT CIPARS

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS), created in 2002, is a national program dedicated to the collection, integration, analysis, and communication of trends in antimicrobial use (AMU) and resistance (AMR) in selected bacteria from humans, animals, and animal-derived food sources across Canada. This information supports (i) the creation of evidence-based policies for AMU in hospitals, communities, and food-animal production with the aim of prolonging the effectiveness of these drugs and (ii) the identification of appropriate measures to contain the emergence and spread of resistant bacteria among animals, food, and people.

CIPARS continues to evolve to meet stakeholder needs. To enhance the timeliness of reporting, between 2012 and 2014 CIPARS piloted the division of the annual report into separate chapters, with chapters being posted as they were completed. This reporting method did not result in efficiency and CIPARS has returned to the release of a single Annual Report. For 2014, integrated findings will be published in the 2016 Canadian Antimicrobial Resistance Surveillance System Report.

CIPARS OBJECTIVES

- Provide a unified approach to monitor trends in antimicrobial resistance and antimicrobial use in humans and animals.
- Facilitate assessment of the public health impact of antimicrobials used in humans and agricultural sectors.
- Allow accurate comparisons with data from other countries that use similar surveillance systems.

WHAT'S NEW

ANTIMICROBIAL RESISTANCE

- Resistance to kanamycin is no longer reported due to its removal from the Enterobacteriaceae Gram-negative plate (CMV3AGNF). Instead, the range of dilutions for streptomycin was extended to 2 to 64 µg/ml.
- Broiler chicken flocks from Saskatchewan were included in *Farm Surveillance*.
- In 2014, the *Farm Surveillance* grower-finisher pig component began reporting regional and national antimicrobial resistance at the farm level
- For *Retail Meat Surveillance*, data are stratified regionally (British Columbia, Prairies, Ontario, Québec, and the Atlantic region).
- Temporal analysis is truncated to include the last 5 years of data from components presenting regional or provincial data.

ANTIMICROBIAL USE IN ANIMALS

- The *Farm Surveillance* grower-finisher pig component began reporting regional and national antimicrobial use at the farm level.
- For the 2014 CIPARS Annual Report, the Canadian Animal Health Institute (CAHI) provided quantities of antimicrobials distributed for sale for use in animals stratified by route of administration (feed, water, injection, oral/topical, and intra-mammary). CAHI additionally retrospectively stratified their 2013 data by route of administration.
- The quantities of antimicrobials distributed for use in companion animals were also adjusted by populations and weights (of cats and dogs).

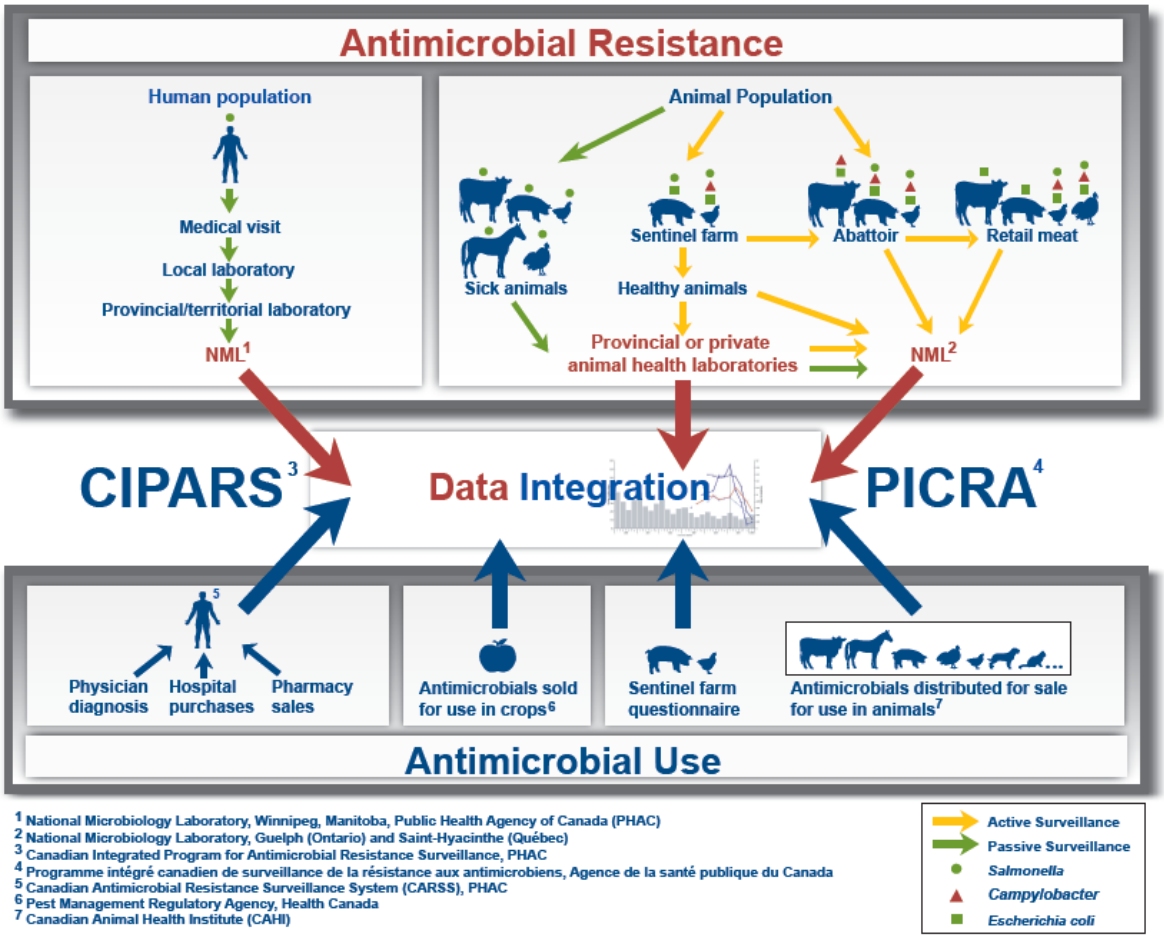
ANTIMICROBIAL USE IN CROPS

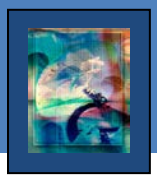
- Information on antimicrobials intended for use as pesticides on crops were provided to CIPARS and in 2014, this information will be reported in the 2016 Canadian Antimicrobial Resistance Surveillance System Report.

CIPARS SURVEILLANCE COMPONENTS AND DATA

The current components and data sources for CIPARS are assembled together for analysis and reporting as shown in Figure 1. The top half of the figure includes the antimicrobial resistance components and the antimicrobial use components of CIPARS are along the bottom of the figure. Bringing together all of the data from all the various surveillance components requires organization and flexibility. A detailed description of data sources, information flow and points of integration, analysis and reporting are illustrated in Figure A.8 in Appendix.

Figure 1. Diagram of the CIPARS components, 2014





CHAPTER 2—ANTIMICROBIAL RESISTANCE

HOW TO READ THIS CHAPTER

This chapter highlights the most notable antimicrobial resistance (AMR) findings across the different surveillance components of CIPARS. These findings are presented by component (human, retail, abattoir, farm, clinical animal, and feed and feed ingredients) to facilitate comparison of resistance patterns across humans, different animal species, and bacterial species.

TEMPORAL FIGURES AND DATA TABLES FOR SIGNIFICANCE TESTING

All temporal figures and accompanying data tables presented in this chapter depict the variation in the percentage of isolates that were resistant to select antimicrobials either over all years of surveillance (national data), the last 5 years (components with regional or provincial data) or the year surveillance was implemented in a new component, host species, bacteria or location. Statistical analyses were limited to comparison of 2014 results for selected antimicrobials with: 1) 2013 results, 2) 2010 (or 5 years previous) for components with regional results (e.g., human and retail components) and abattoir (for comparison between components) 3) the first year of surveillance for components (e.g., abattoir component) with national results shown. A 5 year timeframe was selected to facilitate easier reading of temporal figures and supporting tables.

All significant differences identified have been highlighted in blue (or underlined) in data tables underneath the temporal figures. Finally, for all statistical analyses, a *P*-value equal or less than 0.05 was used to indicate a significant difference between years. All statistically significant results are marked by the use of the words "significant" or "significantly" in the text. All other findings presented without this word should be considered as non-statistically significant and should be interpreted with caution.

For *Salmonella* Heidelberg and *Escherichia coli* isolates obtained from chicken (abattoir and retail) and human *S*. Heidelberg isolates, ceftiofur, and ampicillin resistance for 2014 were compared with 2004 and 2006 results. These years were chosen because of changes in ceftiofur use which occurred in early 2005 and in 2007 across the chicken hatcheries in Québec.

For retail chicken, comparisons using those reference years were limited to data for Ontario and Québec only.

For the *Human Surveillance* portion of this report, statistically significant changes with respect to the antimicrobials presented in the temporal figures were only assessed between the current surveillance year (i.e., 2014) and the previous year (i.e., 2013). Additionally, any statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only. Presentation of these results is slightly different than the approach used in the agri-food components of CIPARS (i.e., farm, abattoir and retail components). In the interest of timely reporting, the human data were presented with these slight differences for 2014; however, future reports will present these data in a similar format and overall approach.

For the *Farm Surveillance*, multiple samples are collected from each herd or flock, therefore, where temporal comparisons are made, the antimicrobial resistance data have been adjusted for clustering within the herd. *Farm Surveillance* in broiler chickens was implemented in April 2013, thus the temporal figures will not be reported until there are three years of data, but the 2013 and 2014 data are presented in the supporting tables.

Temporal variations in the data from *Surveillance of Animal Clinical Isolates* and *Feed and Feed Ingredients* were not investigated as the number of isolates from passive surveillance are unequal across years and provinces/regions. In addition, temporal figures were not presented if the total number of surveillance years was less than 3 years. In these situations, a bar chart figures with supporting tables were presented instead.

NATIONAL OR PROVINCIAL/REGIONAL PREVALENCE DATA

Data for humans, farm (broiler chickens and grower-finisher pigs) and retail surveillance components are presented at the provincial/regional level. Data for abattoir, animal clinical isolates, and feed and feed-ingredients are presented nationally with no provincial or regional breakdown.

HOW TO READ MINIMUM INHIBITORY CONCENTRATION TABLES

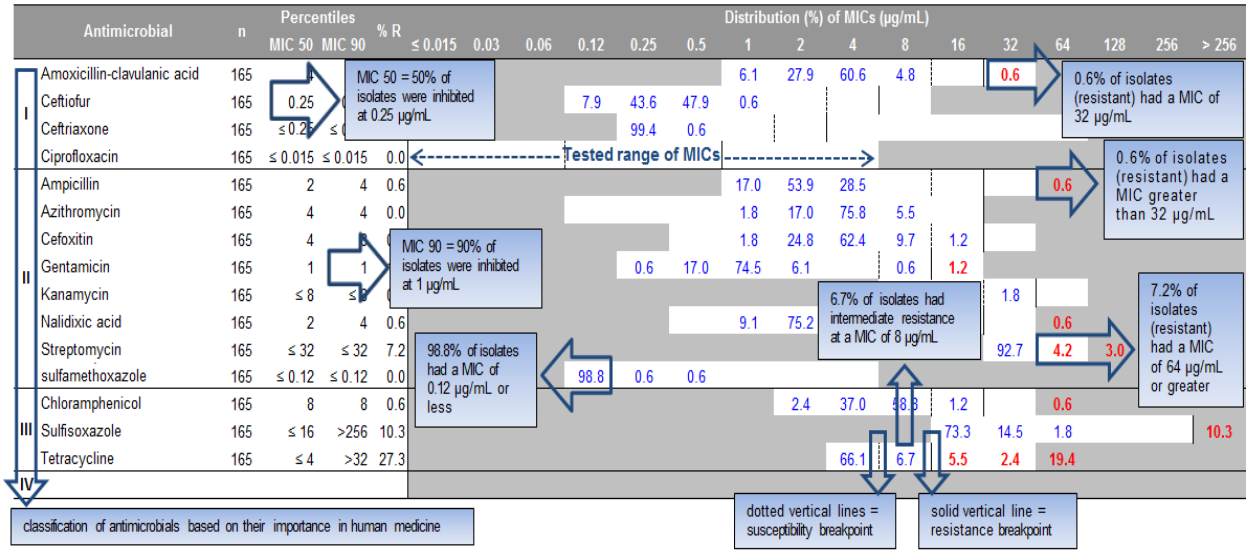
The following information is important for the interpretation of tables presenting results on the distribution of MICs. See how to interpret MIC results (on the next page):

- Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Health Canada's Veterinary Drugs Directorate
- The unshaded fields indicate the range of concentrations tested for each antimicrobial in the test plate configuration
- Blue numbers indicate the percentage of isolates that were susceptible to the antimicrobial according to the predefined susceptibility breakpoint
- Red numbers indicate the percentage of isolates that were resistant to the antimicrobial according to the predefined resistance breakpoint
- Numbers to the right of the highest concentration in the tested range (i.e., red numbers in shaded fields) represent the percentage of isolates with growth in all

wells of the test plate within the tested range, indicating that the actual MICs were greater than the tested range of concentrations

- Numbers at the lowest concentration in the tested range (i.e., blue numbers at the far left in unshaded fields) represent the percentage of isolates susceptible to the antimicrobial at the indicated or lower concentrations
- Solid vertical lines represent resistance breakpoints
- Dotted vertical lines represent susceptibility breakpoints.
- MIC 50 = MIC at which growth of 50% of isolates was inhibited by a specific antimicrobial
- MIC 90 = MIC at which growth of 90% of isolates was inhibited by a specific antimicrobial
- % R = Percentage of isolates that were resistant to a specific antimicrobial.

Example of how to read a minimum inhibitory concentration table



1. HUMAN SURVEILLANCE

KEY FINDINGS

The Provincial Public Health Laboratories forwarded a total of 4,548 *Salmonella* isolates (161 serovars) to the National Microbiology Laboratory, Public Health Agency of Canada in 2014. Antimicrobial susceptibility testing was performed for 2,668 of these isolates, and the remaining isolates were stored for future susceptibility testing[4].

SALMONELLA (n = 4,548)

Susceptibility testing was routinely carried out on 7 serovars in 2014: Enteritidis, Heidelberg, Newport, Paratyphi A and B[5], Typhi, Typhimurium, and 4,[5],12:i:-. There were 3,213 isolates from these 7 serovars, of which 2,668 had susceptibility testing performed. The remaining 1,335 isolates represented 153 other serovars, and susceptibility results were available for 221 of these isolates.

In 2014, as in all years since 2005, Enteritidis was the most common serovar (43%, 1,951/4,548) isolated among all human *Salmonella* infections. Therefore, without considering underreporting, 9.7 illnesses/100,000 people in 2014 were attributable to *Salmonella* Enteritidis (Figure 1.1). *Salmonella* Heidelberg (8%, 379/4,548) and Typhimurium (8%, 357/4,548) were the second and third most common serovars isolated, causing less than 1/5 of the number of cases attributable to Enteritidis.

The proportion of Enteritidis isolates out of all *Salmonella* isolates increased significantly from 2013 to 2014, from 32% (1,175/3,617) to 43% (1,951/4,548) (Figure 1.2), returning to the high rates seen in 2010 and 2011. In contrast, both Heidelberg and Typhimurium continued to decline from 2013 to 2014, following the overall trend seen since 2003 (Figure 1.2).

Salmonella is primarily an enteric pathogen of humans. Isolation from non-enteric samples (e.g., blood and urine) may be indicative of more invasive infections. Eight percent (363/4,548) of isolates were recovered from blood. Typhoidal isolates (Typhi, Paratyphi A and B) accounted for a large proportion of these isolates from blood (38%, 139/363). Recovery from urine occurred for 5% (234/4,548) of isolates. In contrast to isolation from blood, typhoidal isolates accounted for a very small proportion of isolates from urine (1%, 2/234). The proportion of isolates recovered from blood, urine, and other sample types varied by serovars. Figure 1.3 demonstrates the variability of source of infection (e.g., blood, urine, and stool) but only represents those select serovars for which antimicrobial susceptibility testing was completed.

[4] Slight differences may be observed in totals in tables and figures due to the staggered nature of the 2014 analysis; however, impact on antimicrobial resistance prevalence is negligible.

[5] Although the agri-food sector is not a source of *Salmonella* Typhi, *S*. Paratyphi A, or *S*. Paratyphi B, data for these serovars are also presented because they each cause severe disease in humans.

Due to the differences in invasiveness and presumably severity of illness, and the potential sources of infections, typhoidal and non-typhoidal *Salmonella* serovars are discussed separately for the following analyses.

NON-TYPHOIDAL *SALMONELLA* (n = 2,485)

In 2014, 25% (620/2,485) of non-typhoidal isolates were resistant to one or more antimicrobials tested. Fourteen percent (358/2,485) of isolates were resistant to a single antimicrobial, of which 50% (179/358) were resistant to nalidixic acid.

In 2014, a significant increase was observed in resistance to nalidixic acid (9%, 212/2,485) compared to 2013 (5%, 160/2,987) (Figure 1.4). This was likely a result of the increase in Enteritidis human infections that occurred between the two years, as nalidixic acid resistance alone was the most common resistance pattern seen in Enteritidis (when resistance is observed). Significant decreases in resistance among non-typhoidal isolates occurred from 2013 to 2014 for streptomycin (356/2,987, 12% in 2013 to 221/2,485, 9% in 2014), sulfamethoxazole with trimethoprim (88/2,987, 3% in 2013 to 43/2,485, 2% in 2014), and tetracycline (415/2,987, 14% in 2013 to 260/2,485, 11% in 2014).

At the provincial level, a large number of significant changes occurred in resistance from 2013 to 2014 among non-typhoidal Salmonella infections. The majority of the changes involved declines in resistance. In Alberta, a significant reduction in ampicillin resistance was observed. In British Columbia, decreases were documented for tetracycline and sulfamethoxazole with trimethoprim. In Manitoba, streptomycin and tetracycline resistances dropped significantly, and in Nova Scotia, resistance to ampicillin, ceftiofur, streptomycin and tetracycline all dropped significantly from 2013 to 2014. The only significant increases in resistance were for nalidixic acid in Ontario and Québec. The number and proportion of isolates with resistance in 2014 can be found in Table 1.2.

TYPHOIDAL *SALMONELLA* (n = 183) [6]

A total of 183 typhoidal isolates were tested for antimicrobial susceptibility; Typhi (147), Paratyphi A (29) and Paratyphi B (7). A total of 82% (150/183) were resistant to nalidixic acid. Accordingly, the most common resistance pattern in 2014 was of nalidixic acid alone (54%, 99/183) followed by CIP-NAL (12%, 22/183) and AMP-CHL-NAL-STR-SSS-SXT (12%, 22/183).

At the national level, the only significant change in resistance from 2013 to 2014 was a decrease in the proportion of isolates resistant to tetracycline (5% to 1%) (Figure 1.5). No significant changes in the proportion of resistance were seen at the provincial level. Provincial level numbers and proportions of resistance among typhoidal *Salmonella* isolates are reported in Table 1.3.

[6] *Salmonella* Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

ENTERITIDIS (n = 1,211)

Resistance among Enteritidis isolates is driven by the phage types isolated. The most common phage types (PTs) recovered in 2014 were PT 8 (36%, 441/1,211), PT 13 (15%, 183/1,211) and PT 64 (13%, 137/1,211). The proportion of PT 64 isolates has increased dramatically since 2011, the first year when it was reported by the National Enteric Surveillance Program. Between 2013 and 2014, the proportion of PT 64 among all Enteritidis significantly increased from 8% (58/746) to 13% (137/1,211). Similarly, PT 35 was the fifth most common PT identified in 2014 representing 5% (65/1,211) of all isolates. Prior to 2014, PT 35 represented 1% or less of all Enteritidis. Conversely, the proportion of PT 13a isolates over this same time frame declined from 15% (111/746) in 2013 to 11% (132/1,211) in 2014.

In 2014, as in all previous years of surveillance, the majority of Enteritidis isolates were recovered from stool samples (83%, 1,007/1,211) (Figure 1.3). Eight percent of isolates were recovered from blood (98/1,211) and 4% (54/1,211) were recovered from urine (Figure 1.3).

The majority of Enteritidis isolates (83%, 1,001/1,211) were susceptible to all antimicrobials tested. Resistance to nalidixic acid alone (10%, 170/1,211) was the most common antimicrobial resistance pattern, attributable to PT 64 (38%, 66/170) and PT 1 (31%, 53/170). In previous years, isolates resistant to the A2C and/or ACSSuT pattern were observed; however, this pattern was not observed among Enteritidis isolates in 2014. The patterns involving the greatest number of antimicrobials were AMP-NAL-STR-SSS-TET (1 PT 1 in Québec and 1 PT 53 in Ontario) and CIP-NAL-SSS-TET-SXT (1 PT 14b from Ontario, one PT 6a from Ontario, and one atypical PT from Québec).

Significant decreases in resistance between 2013 and 2014 were observed to ciprofloxacin (11/746, 1% in 2013 to 6/1,211, less than 1% in 2014), and tetracycline (3% to 1%) (Figure 1.6 and Table 1.4). At the provincial level, the only significant change in resistance was in Ontario, where resistance to nalidixic acid increased significantly between 2013 and 2014 (14% in 2013, 27/190) to 22% in 2014, 75/338) (Table 1.4).

HEIDELBERG (n = 359)

Similar to Enteritidis, observed resistance among Heidelberg isolates is affected by the circulating phage types. The most common PTs recovered in 2014 were PT 19 (37%, 132/359), PT 29 (22%, 78/359) and PT 10 (6%, 22/359). Phage type 19 continued to decrease in 2014 compared to 2013 and 2012 (47% and 53%, respectively) (data not shown). Phage type 29 decreased from 28% (109/418) in 2013 to 23% (78/359) in 2014. Other PTs making up the top 5 in 2014 were PT 10, PT 19a, and PT 32.

In 2014, 14% of Heidelberg isolates were recovered from blood, and 9% from urine (Figure 1.3), similar to the proportions seen in 2013. Thirty-five percent (127/359) of Heidelberg isolates in 2014 were resistant to one or more antimicrobials, lower than the 41% (170/418) reported in 2013. This was due to increases in PT 10 and PT 19a (data not shown); these PTs were both susceptible to all antimicrobials.

No significant changes in resistance within Heidelberg isolates occurred between 2013 and 2014 at the national or provincial levels (Figure 1.7 and Table 1.5). Resistance to azithromycin or ciprofloxacin were not observed among Heidelberg isolates in 2014.

The most common antimicrobial resistance pattern was A2C-AMP-CRO alone (26%, 95/359). This pattern showed a slight decrease from the percentage observed in 2013 (30%, 126/418). One isolate from British Columbia with an atypical phage type was resistant to 5 classes, with the ACSSuT-GEN resistance pattern.

NEWPORT (n = 201)

Similar to Enteritidis and Heidelberg, resistance among Newport isolates was driven by the proportion of various phage types isolated. In 2014, the most common PT recovered was PT 9 representing 16% (32/201) of all isolates tested in 2014 followed by PT 10 (12%, 24/201) and PT 13 (8%, 16/201). The proportion of PT9 isolates has remained relatively stable since 2007 (data not shown). In contrast, the proportion of PT 10, 13, 14b and 2 (the other top phage types) have been variable during this time frame. Of interest for 2013 to 2014 was the large increase in PT 10 isolates (3% in 2013 to 10% in 2014). Three percent (6/201) of Newport isolates were recovered from blood in 2014, similar to that reported in 2013 (3%, 6/174) (Figure 1.3). Five percent (10/201) of isolates were recovered from urine, which was a decrease from the 7% (12/174) observed in 2013.

The majority of Newport isolates in 2014 were susceptible to all antimicrobials tested (94%, 188/201). This represents an increase compared to 2013 (87%, 152/174) driven by the increase in the proportion of PT 10 isolates, of which 96% (23/24) were susceptible to all antimicrobials tested.

At the national level, a significant decline in the proportion of isolates resistant to streptomycin occurred from 2013 to 2014, with a decline from 9% (16/174) to 3% (7/201) (Figure 1.8). No significant changes in resistance occurred at the provincial level (Table 1.6). Resistance to ciprofloxacin or azithromycin was present among 1% (2/201) and less than 1% (1/201) of Newport isolates, respectively.

The most common antimicrobial resistance pattern observed was A2C-AMP-CRO (2 isolates from Ontario and 1 isolate from New Brunswick). The pattern involving the greatest number of antimicrobials was ACSSuT-AZM-CIP-GEN-NAL-SXT from a PT 14b isolate from Québec.

PARATYPHI A (n = 29) AND PARATYPHI B[7] (n = 7)

There were 29 Paratyphi A isolates tested in 2014. Eighty-three percent (24/29) and 3% (1/29) were recovered from blood and urine samples, respectively (Figure 1.3). Of the 7 Paratyphi B isolates tested in 2014, none were isolated from blood or urine.

In 2014, 86% (25/29) of Paratyphi A isolates and 14% (1/7) Paratyphi B isolates were resistant to one or more antimicrobials tested. Overall, the only resistance observed among these isolates was to nalidixic acid with or without ciprofloxacin resistance (Figure 1.9 and Table 1.7). Resistance to a variety of antimicrobials in Paratyphi A and B isolates was observed in 2014, including ampicillin, cefoxitin, streptomycin, trimethoprim-sulfamethoxazole, chloramphenicol, sulfisoxazole, and tetracycline.

Resistance to nalidixic acid alone was the most common resistance pattern observed (55%, 20/36). Six isolates Paratyphi A isolates were resistant to both ciprofloxacin and nalidixic acid, which was an increase from 16% (7/43) in 2013 to 21% (6/29) in 2014.

TYPHI (n = 147)

Of the 147 Typhi isolates received in 2014, 77 (113/147) were recovered from blood isolates (Figure 1.3). Eighty four percent (124/147) of Typhi isolates were resistant to one or more antimicrobials tested. Similar to resistance patterns seen in Enteritidis however, the majority of resistance in Typhi isolates was to nalidixic acid; 84% (124/147) of Typhi isolates in 2014 were resistant to nalidixic acid. Fifty-four percent (79/147) were resistant to nalidixic acid alone (Figure 1.10).

The second most common resistance pattern among Typhi isolates in 2014 was AMP-CHL-NAL-STR-SSS-SXT (15%, 22/147), followed by CIP-NAL (11%, 16/147). The patterns involving the greatest number of antimicrobials were AMP-CHL-NAL-STR-SSS-SXT (22 isolates) and CIP-NAL-STR-SSS-TET-SXT (1 isolate). There were no significant changes in resistance at the national or provincial levels between 2013 and 2014 (Table 1.8).

TYPHIMURIUM (n = 355)

Three percent (10/355) of Typhimurium isolates in 2014 were recovered from blood samples, which was within the historical range (low of 10/45, 31% in 2010, high of 16/474, 3% in 2008). The proportion of isolates recovered from urine was also 3% (10/355), similar to 2013 (3%, 11/384)

In 2014, 36% (127/355) of Typhimurium isolates were resistant to one or more antimicrobials tested, a slight increase from that reported in 2013 (33%, 128/384). No significant changes were observed in the proportion of isolates resistant to the individual antimicrobials (Figure 1.11). Less than 1% of isolates were resistant to either ciprofloxacin (3/355) or azithromycin (3/355). No provincial differences were observed between 2013 and 2014 (Table 1.9).

[7] *Salmonella* Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

The most common antimicrobial resistance pattern in 2014 was ACSSuT alone (15%, 53/355), mirroring that observed in 2013 (14%, 53/384). The pattern with the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (1 PT 193 from Ontario).

4,[5],12:i:- (n = 138)

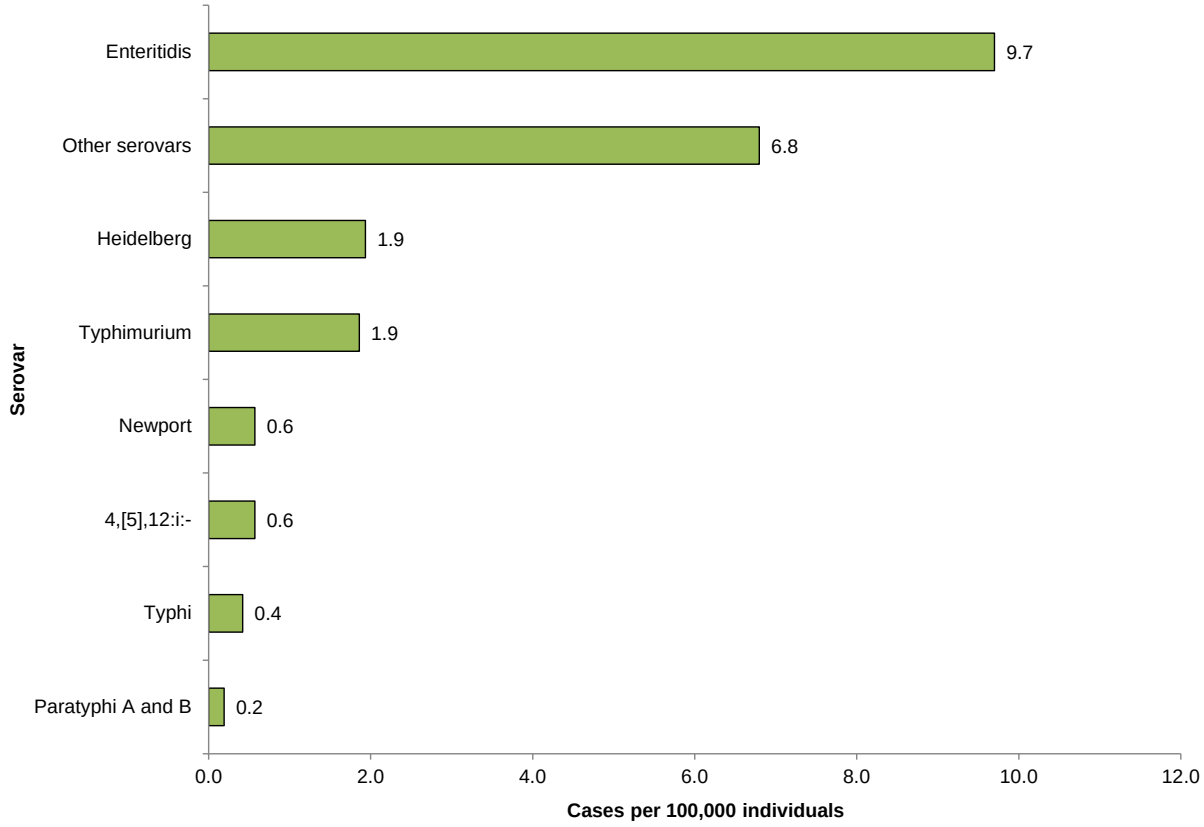
Three percent (4/138) of 4,[5],12:i- isolates were recovered from blood and 1% (2/138) from urine in 2014. Both of these values remain within the historical levels observed.

Seventy two percent (100/138) of 4,[5],12:i- isolates in 2014 were resistant to one or more antimicrobials tested. A significant increase occurred in gentamicin resistance from 2013 to 2014 (2%, 4/166 to 7%, 7/138); however, no other significant changes occurred during this time frame at the national or provincial levels (Figure 1.12). Two isolates were resistant to ciprofloxacin (1 isolate in British Columbia and 1 isolate in Québec) in 2014; when previously one other ciprofloxacin-resistant isolate had been observed, in 2012 (Table 1.10). Two isolates with resistance to azithromycin were observed in each of 2013 and 2014.

The most common resistance pattern was AMP-STR-SSS-TET (32%, 44/138); a decline from 36% (60/166) in 2013. The pattern involving the greatest number of antimicrobials was ACSSuT-TIO-CRO-CIP-NAL-SXT from a Québec isolate.

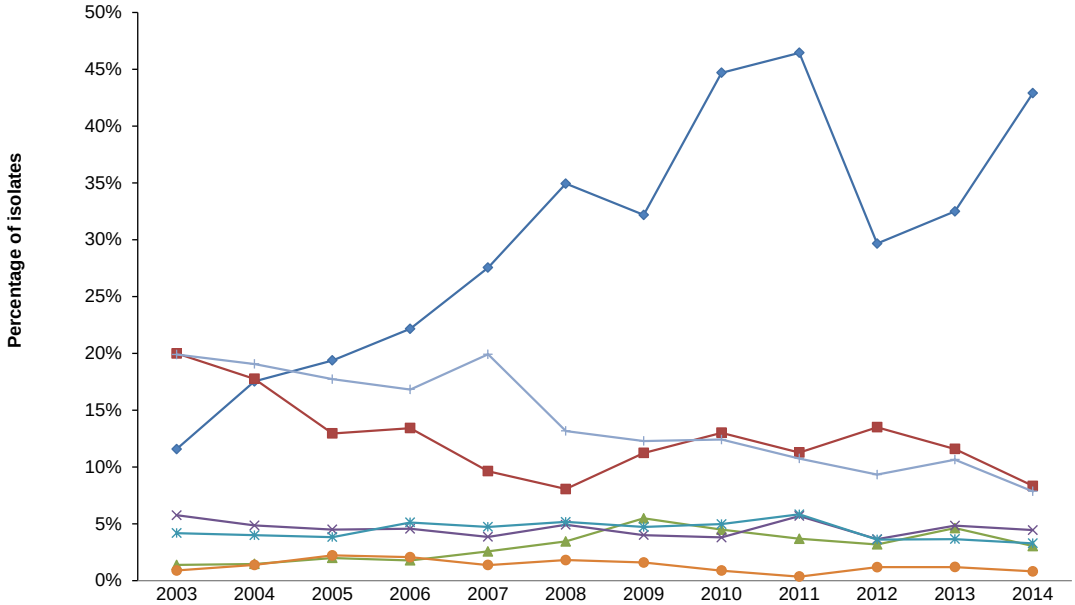
PROPORTIONAL REPRESENTATION OF *SALMONELLA* SEROVARS

Figure 1.1. Incidence of salmonellosis per 100,000 Canadians by serovar, 2014



Salmonella Paratyphi B does not include *S.* Paratyphi B var. L (+) tartrate (+), formerly called *S.* Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

Figure 1.2. Proportional representation of human *Salmonella* isolates, 2003–2014

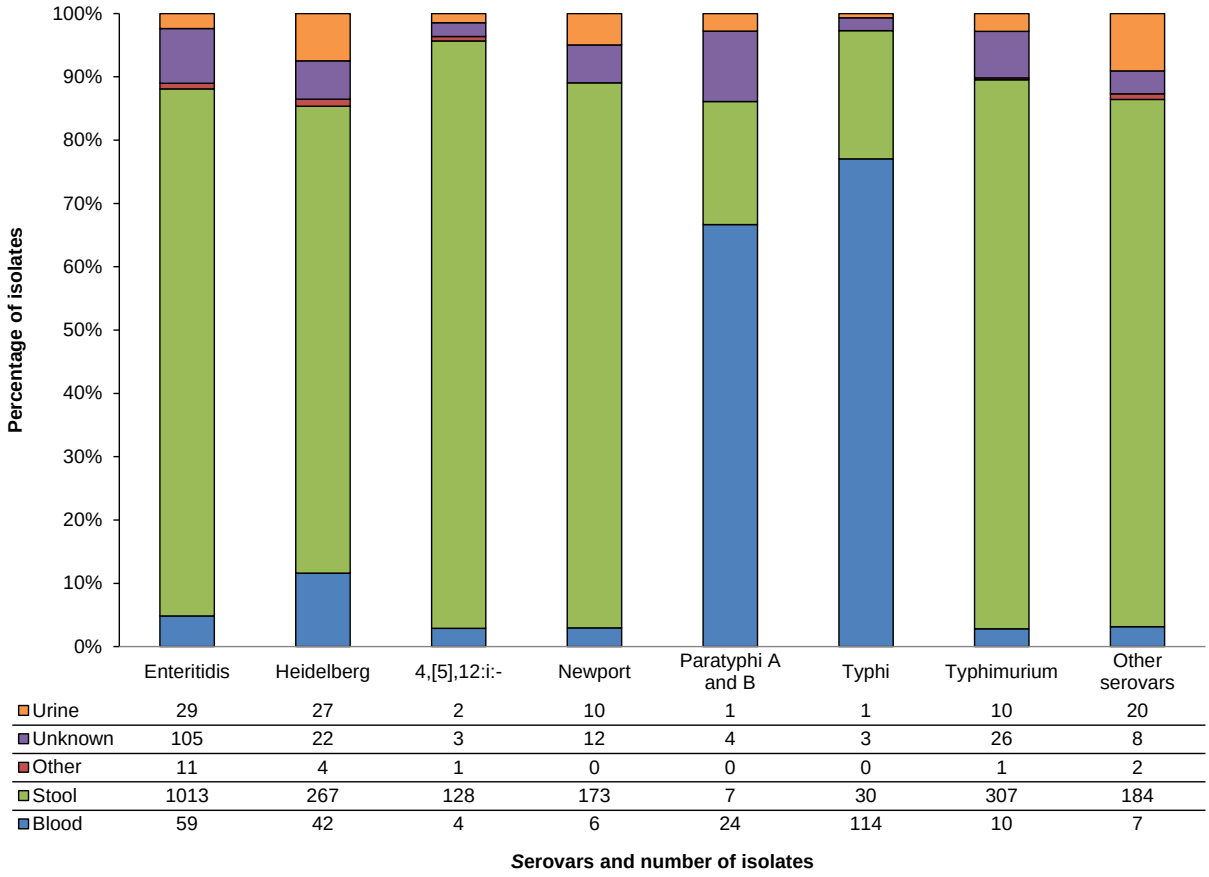


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Enteritidis	12%	18%	19%	22%	28%	35%	32%	45%	46%	30%	32%	43%
Heidelberg	20%	18%	13%	13%	10%	8%	11%	13%	11%	13%	12%	8%
4,[5],12:i:-	1%	1%	2%	2%	3%	3%	5%	4%	4%	3%	5%	3%
Newport	6%	5%	4%	5%	4%	5%	4%	4%	6%	4%	5%	4%
Paratyphi A and B	1%	1%	2%	2%	1%	2%	2%	1%	0%	1%	1%	1%
Typhi	4%	4%	4%	5%	5%	5%	5%	5%	6%	4%	4%	3%
Typhimurium	20%	19%	18%	17%	20%	13%	12%	12%	11%	9%	11%	8%

Salmonella Paratyphi B does not include *S.* Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

SEROVAR DISTRIBUTION

Figure 1.3. Proportion of human *Salmonella* serovars from all sample sources, 2014



Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

MULTICLASS RESISTANCE

Table 1.1. Number of antimicrobial classes in resistance patterns of *Salmonella* from humans, 2014

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																				
Enteritidis	162 (55.3)	141	17	4					2	8					3	1	1	1		13
Heidelberg	40 (13.7)	4	33	3					1						3	3		2	8	36
Typhi	36 (12.3)	26	1	1	8				7	8	3	3	2	3	9	2	1	7	1	
Typhimurium	20 (6.8)	18	1	1			1		1	2		1		1						
Newport	14 (4.8)	8	5		1		1		2	5	4	4	4	4	1			1		
4,[5],12:i:-	12 (4.1)			10	2		2		10	9					11	1	1	3	1	1
Paratyphi A and B	9 (3.1)	4	5																2	5
Total	**293 (100)**	**201**	**62**	**19**	**11**		**4**		**23**	**32**	**7**	**8**	**6**	**8**	**27**	**7**	**3**	**14**	**12**	**55**
Alberta																				
Enteritidis	133 (52.0)	122	10	1						2		1		1				1		9
Typhimurium	41 (16.0)	26	7	2	6				12	7	1	1	1	1	13	1		6		1
4,[5],12:i:-	26 (10.2)	4	10	7	5		5		12	11		1		1	12	2	1	5		1
Heidelberg	21 (8.2)	13	7	1					1	7	7	7	7	7	1	1				
Typhi	20 (7.8)	9	8		3				3	3					3	3		3	1	11
Newport	10 (3.9)	8	1		1				1	1	1	1	1	1	1	1		1		
Paratyphi A and B	5 (2.0)		5																1	5
Total	**256 (100)**	**182**	**48**	**11**	**15**		**5**		**29**	**31**	**9**	**11**	**9**	**11**	**30**	**8**	**1**	**16**	**2**	**27**
Saskatchewan																				
Enteritidis	81 (63.3)	65	15	1					1	4										13
4,[5],12:i:-	16 (12.5)	7	4	5					5	6	2	2	2	2	5					
Typhimurium	14 (10.9)	8	3	1	2				5	3					5			2		
Heidelberg	8 (6.3)	5	3							3	1	1	1	1						
Newport	6 (4.7)	5		1					1						1	1				
Typhi	2 (1.6)		2																1	2
Paratyphi A and B	1 (0.8)		1																	1
Total	**128 (100)**	**90**	**28**	**8**	**2**				**12**	**16**	**3**	**3**	**3**	**3**	**11**	**1**		**2**	**1**	**16**
Manitoba																				
Enteritidis	95 (62.9)	81	14							2										12
Typhimurium	19 (12.6)	13	3	1	2		1		6	1					6	2		2	1	1
Heidelberg	13 (8.6)	7	4	2					1	6	5	4	4	4	1					
4,[5],12:i:-	11 (7.3)	5	4	2			1		2	4	2	2	2	2	2					
Newport	8 (5.3)	6		1	1		1		2	2	1	1	1	1	2			1		
Paratyphi A and B	4 (2.6)	2	2																	2
Typhi	1 (0.7)	1																		
Total	**151 (100)**	**115**	**27**	**6**	**3**		**3**		**11**	**15**	**8**	**7**	**7**	**7**	**11**	**2**		**3**	**1**	**15**
Ontario																				
Enteritidis	338 (39.3)	260	70	7	1				3	5					6	3	1		4	75
Typhimurium	164 (19.0)	113	8	12	31		2		45	42	2	1	2	1	40	3		36		3
Heidelberg	142 (16.5)	93	47	2					4	47	45	45	41	45	2	1		1		
Newport	85 (9.9)	81	3	1					1	2	2	2	2	2	1			1	1	
Typhi	77 (8.9)	9	45	2	21				22	21					22	20		22	9	68
4,[5],12:i:-	41 (4.8)	12	6	21	2		2		22	19					22	5	1	4		
Paratyphi A and B	14 (1.6)	2	12																3	12
Total	**861 (100)**	**570**	**191**	**45**	**55**		**4**		**97**	**136**	**49**	**48**	**45**	**48**	**93**	**32**	**2**	**64**	**17**	**158**

Antimicrobial abbreviations are defined in the Appendix.

Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

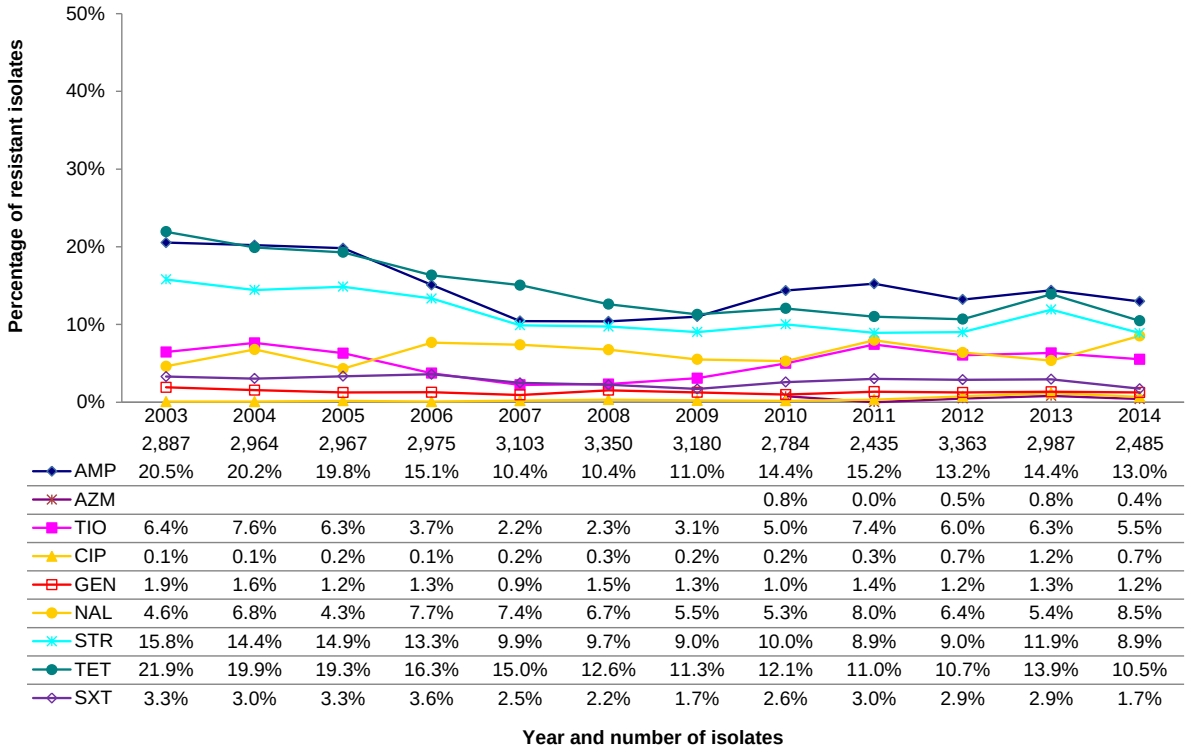
Table 1.1. Number of antimicrobial classes in resistance patterns of *Salmonella* from humans, 2014 (cont'd)

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial												
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Québec																				
Enteritidis	123 (32.0)	92	27	3	1				1	3					3	2			2	26
Heidelberg	114 (29.7)	67	45	2			2		4	42	40	40	38	40	2	1		1		3
Typhimurium	60 (15.6)	26	7	7	20		1		25	21	1	1		1	31	5	2	20	1	3
Newport	56 (14.6)	55				1	1		1	1					1	1	1	1	1	1
4,[5],12:i:-	22 (5.7)	3	1	15	3		1		16	17		1		1	17	1		3	1	1
Typhi	7 (1.8)		6		1				1	1					1	1		1		7
Paratyphi A and B	2 (0.5)	2																		
Total	**384 (100)**	**245**	**86**	**27**	**25**	**1**	**5**		**48**	**85**	**41**	**42**	**38**	**42**	**55**	**11**	**3**	**26**	**5**	**41**
New Brunswick																				
Enteritidis	96 (68.1)	87	9																	9
Heidelberg	21 (14.9)	17	3	1			1		1	3	3	3	3	3	1					
Newport	9 (6.4)	8	1							1	1	1	1	1						
Typhimurium	8 (5.7)	5		2	1				2	2					3			1		
4,[5],12:i:-	7 (5.0)	5		2					2	2					2					
Total	**141 (100)**	**122**	**13**	**5**	**1**		**1**		**5**	**8**	**4**	**4**	**4**	**4**	**6**			**1**		**9**
Nova Scotia																				
Enteritidis	123 (77.8)	102	19	2					1	2						1				19
Heidelberg	17 (10.8)	13	4				1		1	3	3	3	3	3	1					
Typhimurium	8 (5.1)	8																		
Newport	6 (3.8)	6																		
4,[5],12:i:-	2 (1.3)	1	1																	
Paratyphi A and B	1 (0.6)		1																	1
Typhi	1 (0.6)		1																	1
Total	**158 (100)**	**130**	**26**	**2**			**1**		**2**	**5**	**3**	**3**	**3**	**3**	**1**	**1**				**21**
Prince Edward Island																				
Enteritidis	21 (80.8)	16	4	1						1										4
Typhimurium	3 (11.5)	2		1						1					1					
4,[5],12:i:-	1 (3.8)	1																		
Newport	1 (3.8)	1																		
Total	**26 (100)**	**20**	**4**	**2**						**2**					**1**					**4**
Newfoundland and Labrador																				
Enteritidis	46 (75.4)	40	6																	6
Heidelberg	12 (19.7)	11	1							1	1	1	1	1						
Typhimurium	3 (4.9)	1		1	1				2	1					2			1		
Total	**61 (100)**	**52**	**7**	**1**	**1**				**2**	**2**	**1**	**1**	**1**	**1**	**2**			**1**		**6**
Total non-typhoidal *Salmonella*	**2,279**	**1,672**	**403**	**123**	**80**	**1**	**23**		**196**	**299**	**122**	**124**	**114**	**124**	**202**	**36**	**8**	**94**	**20**	**237**
Total typhoidal *Salmonella*	**180**	**55**	**89**	**3**	**33**				**33**	**33**	**3**	**3**	**2**	**3**	**35**	**26**	**1**	**33**	**18**	**115**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

ANTIMICROBIAL RESISTANCE SUMMARY

Figure 1.4. Temporal variations in resistance of non-typhoidal *Salmonella* from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	2,887	2,964	2,967	2,975	3,103	3,350	3,180	2,784	2,435	3,363	2,987	2,485
AMP	20.5%	20.2%	19.8%	15.1%	10.4%	10.4%	11.0%	14.4%	15.2%	13.2%	14.4%	13.0%
AZM								0.8%	0.0%	0.5%	0.8%	0.4%
TIO	6.4%	7.6%	6.3%	3.7%	2.2%	2.3%	3.1%	5.0%	7.4%	6.0%	6.3%	5.5%
CIP	0.1%	0.1%	0.2%	0.1%	0.2%	0.3%	0.2%	0.2%	0.3%	0.7%	1.2%	0.7%
GEN	1.9%	1.6%	1.2%	1.3%	0.9%	1.5%	1.3%	1.0%	1.4%	1.2%	1.3%	1.2%
NAL	4.6%	6.8%	4.3%	7.7%	7.4%	6.7%	5.5%	5.3%	8.0%	6.4%	5.4%	8.5%
STR	15.8%	14.4%	14.9%	13.3%	9.9%	9.7%	9.0%	10.0%	8.9%	9.0%	11.9%	8.9%
TET	21.9%	19.9%	19.3%	16.3%	15.0%	12.6%	11.3%	12.1%	11.0%	10.7%	13.9%	10.5%
SXT	3.3%	3.0%	3.3%	3.6%	2.5%	2.2%	1.7%	2.6%	3.0%	2.9%	2.9%	1.7%

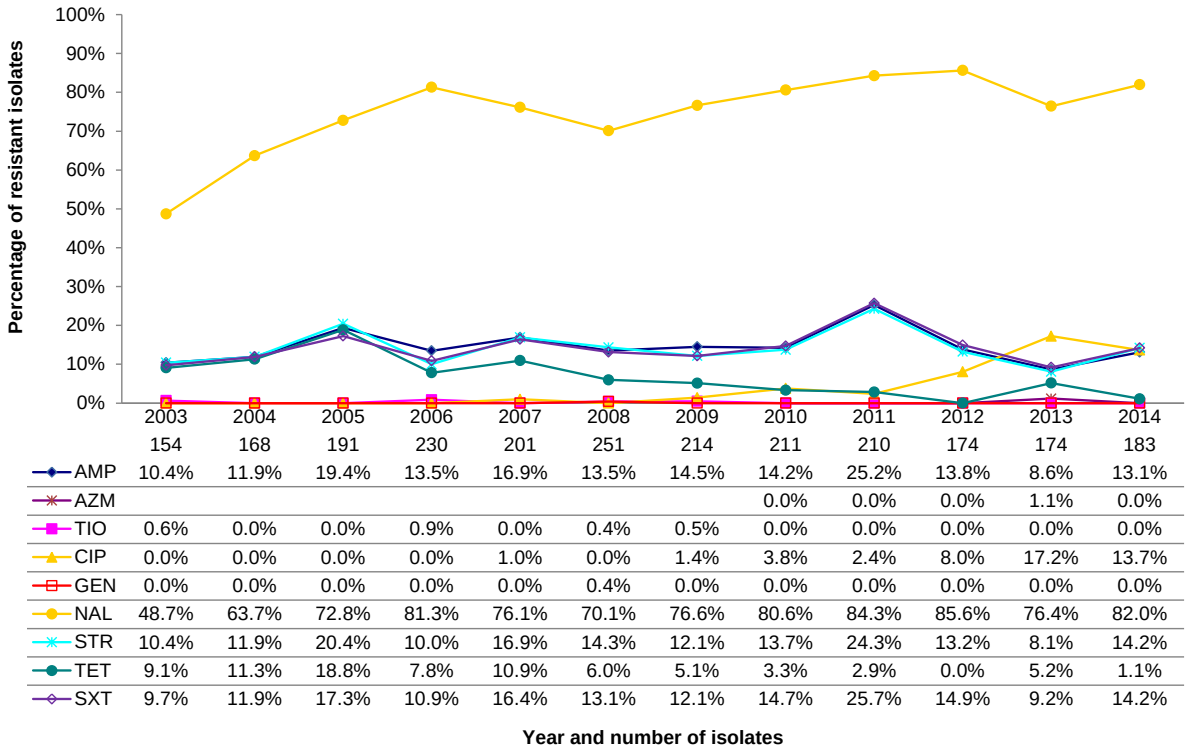
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.2. Resistance to antimicrobials among non-typhoidal *Salmonella* human infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 263	n = 263	n = 133	n = 157	n = 871	n = 411	n = 141	n = 161	n = 26	n = 59	%
I	Amoxicillin-clavulanic acid	7 (3)	11 (4)	3 (2)	8 (5)	55 (6)	43 (10)	4 (3)	3 (2)	0 (0)	1 (2)	6
	Ceftiofur	8 (3)	13 (5)	3 (2)	7 (4)	55 (6)	43 (10)	4 (3)	3 (2)	0 (0)	1 (2)	6
	Ceftriaxone	8 (3)	13 (5)	3 (2)	7 (4)	55 (6)	43 (10)	4 (3)	3 (2)	0 (0)	1 (2)	6
	Ciprofloxacin	2 (1)	0 (0)	0 (0)	1 (1)	9 (1)	5 (1)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Ampicillin	33 (13)	31 (12)	16 (12)	15 (10)	125 (14)	85 (21)	8 (6)	5 (3)	2 (8)	2 (3)	14
	Azithromycin	3 (1)	1 (0)	0 (0)	0 (0)	3 (0)	3 (1)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Cefoxitin	6 (2)	11 (4)	3 (2)	7 (4)	51 (6)	40 (10)	4 (3)	3 (2)	0 (0)	1 (2)	5
	Gentamicin	4 (2)	6 (2)	0 (0)	4 (3)	10 (1)	5 (1)	1 (1)	1 (1)	0 (0)	0 (0)	1
	Nalidixic acid	15 (6)	13 (5)	12 (9)	14 (9)	85 (10)	36 (9)	8 (6)	19 (12)	4 (15)	6 (10)	8
	Streptomycin	24 (9)	27 (10)	12 (9)	12 (8)	83 (10)	54 (13)	5 (4)	2 (1)	0 (0)	2 (3)	10
	Trimethoprim-sulfamethoxazole	4 (2)	5 (2)	1 (1)	2 (1)	17 (2)	12 (3)	0 (0)	2 (1)	0 (0)	0 (0)	2
III	Chloramphenicol	13 (5)	14 (5)	2 (2)	3 (2)	47 (5)	28 (7)	1 (1)	0 (0)	0 (0)	1 (2)	5
	Sulfisoxazole	26 (10)	29 (11)	11 (8)	12 (8)	84 (10)	60 (15)	6 (4)	2 (1)	1 (4)	2 (3)	10
	Tetracycline	29 (11)	36 (14)	12 (9)	12 (8)	96 (11)	63 (15)	6 (4)	3 (2)	1 (4)	2 (3)	11
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Figure 1.5. Temporal variations in resistance of typhoidal *Salmonella* from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	154	168	191	230	201	251	214	211	210	174	174	183
AMP	10.4%	11.9%	19.4%	13.5%	16.9%	13.5%	14.5%	14.2%	25.2%	13.8%	8.6%	13.1%
AZM								0.0%	0.0%	0.0%	1.1%	0.0%
TIO	0.6%	0.0%	0.0%	0.9%	0.0%	0.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%
CIP	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	1.4%	3.8%	2.4%	8.0%	17.2%	13.7%
GEN	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NAL	48.7%	63.7%	72.8%	81.3%	76.1%	70.1%	76.6%	80.6%	84.3%	85.6%	76.4%	82.0%
STR	10.4%	11.9%	20.4%	10.0%	16.9%	14.3%	12.1%	13.7%	24.3%	13.2%	8.1%	14.2%
TET	9.1%	11.3%	18.8%	7.8%	10.9%	6.0%	5.1%	3.3%	2.9%	0.0%	5.2%	1.1%
SXT	9.7%	11.9%	17.3%	10.9%	16.4%	13.1%	12.1%	14.7%	25.7%	14.9%	9.2%	14.2%

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

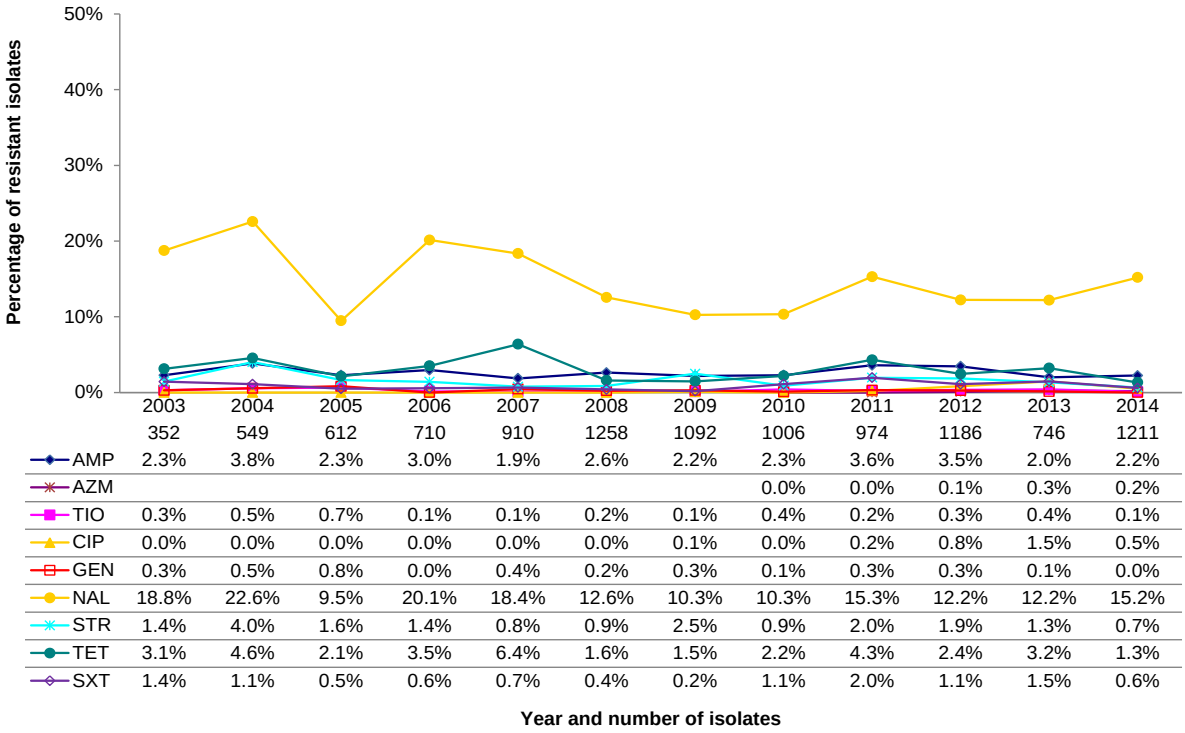
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

Table 1.3. Resistance to antimicrobials among typhoidal *Salmonella* human infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 49	n = 25	n = 3	n = 5	n = 90	n = 9	n = 0	n = 2	n = 0	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftiofur	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftriaxone	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ciprofloxacin	10 (20)	2 (8)	1 (33)	0 (0)	12 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	14
II	Ampicillin	0 (0)	3 (12)	0 (0)	0 (0)	20 (22)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)	13
	Azithromycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Nalidixic acid	41 (84)	16 (64)	3 (100)	2 (40)	79 (88)	7 (78)	0 (0)	2 (100)	0 (0)	0 (0)	82
	Streptomycin	1 (2)	3 (12)	0 (0)	0 (0)	21 (23)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)	15
	Trimethoprim-sulfamethoxazole	3 (6)	3 (12)	0 (0)	0 (0)	19 (21)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)	15
III	Chloramphenicol	2 (4)	3 (12)	0 (0)	0 (0)	21 (23)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)	15
	Sulfisoxazole	3 (6)	3 (12)	0 (0)	0 (0)	21 (23)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)	16
	Tetracycline	1 (2)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

Figure 1.6. Temporal variations in resistance of *Salmonella* Enteritidis from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	352	549	612	710	910	1258	1092	1006	974	1186	746	1211
AMP	2.3%	3.8%	2.3%	3.0%	1.9%	2.6%	2.2%	2.3%	3.6%	3.5%	2.0%	2.2%
AZM								0.0%	0.0%	0.1%	0.3%	0.2%
TIO	0.3%	0.5%	0.7%	0.1%	0.1%	0.2%	0.1%	0.4%	0.2%	0.3%	0.4%	0.1%
CIP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.2%	0.8%	1.5%	0.5%
GEN	0.3%	0.5%	0.8%	0.0%	0.4%	0.2%	0.3%	0.1%	0.3%	0.3%	0.1%	0.0%
NAL	18.8%	22.6%	9.5%	20.1%	18.4%	12.6%	10.3%	10.3%	15.3%	12.2%	12.2%	15.2%
STR	1.4%	4.0%	1.6%	1.4%	0.8%	0.9%	2.5%	0.9%	2.0%	1.9%	1.3%	0.7%
TET	3.1%	4.6%	2.1%	3.5%	6.4%	1.6%	1.5%	2.2%	4.3%	2.4%	3.2%	1.3%
SXT	1.4%	1.1%	0.5%	0.6%	0.7%	0.4%	0.2%	1.1%	2.0%	1.1%	1.5%	0.6%

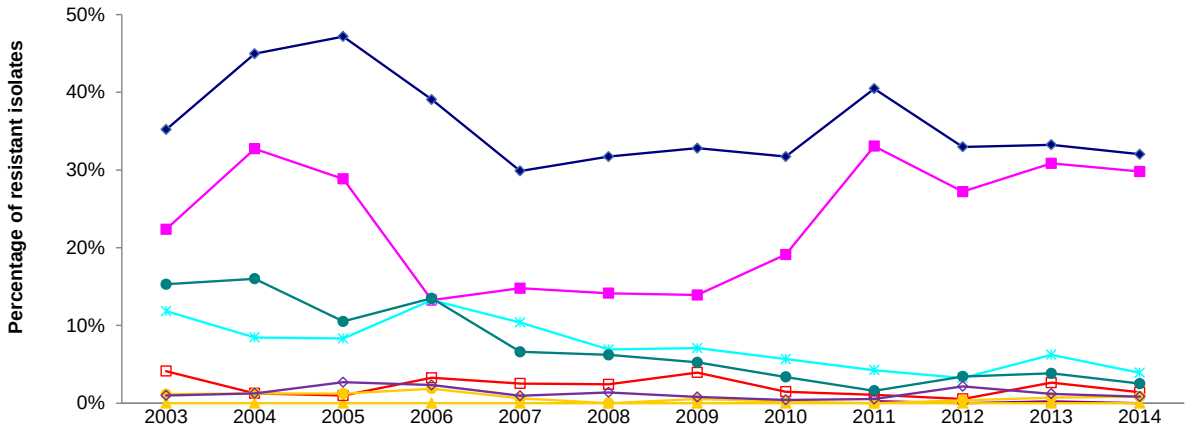
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.4. Resistance to antimicrobials among human *Salmonella* Enteritidis infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 162	n = 133	n = 79	n = 95	n = 338	n = 123	n = 94	n = 123	n = 21	n = 43	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftiofur	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ceftriaxone	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	4 (1)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Ampicillin	8 (5)	2 (2)	4 (5)	2 (2)	5 (1)	3 (2)	0 (0)	2 (2)	1 (5)	0 (0)	2
	Azithromycin	1 (1)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Nalidixic acid	13 (8)	9 (7)	12 (15)	12 (13)	75 (22)	26 (21)	8 (9)	19 (15)	4 (19)	6 (14)	16
	Streptomycin	2 (1)	0 (0)	1 (1)	0 (0)	3 (1)	1 (1)	0 (0)	1 (1)	0 (0)	0 (0)	< 1
	Trimethoprim-sulfamethoxazole	1 (1)	0 (0)	0 (0)	0 (0)	3 (1)	2 (2)	0 (0)	1 (1)	0 (0)	0 (0)	< 1
III	Chloramphenicol	1 (1)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Sulfisoxazole	3 (2)	0 (0)	0 (0)	0 (0)	6 (2)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1
	Tetracycline	2 (1)	0 (0)	1 (1)	0 (0)	5 (1)	6 (5)	0 (0)	1 (1)	1 (5)	0 (0)	1
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Figure 1.7. Temporal variations in resistance of *Salmonella* Heidelberg from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	608	556	409	430	318	290	381	476	378	555	418	359
AMP	35.2%	45.0%	47.2%	39.1%	29.9%	31.7%	32.8%	31.7%	40.5%	33.0%	33.3%	32.0%
AZM									0.3%	0.0%	0.2%	0.0%
TIO	22.4%	32.7%	28.9%	13.3%	14.8%	14.1%	13.9%	19.1%	33.1%	27.2%	30.9%	29.8%
CIP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GEN	4.1%	1.3%	1.0%	3.3%	2.5%	2.4%	3.9%	1.5%	1.1%	0.5%	2.6%	1.4%
NAL	1.2%	1.3%	1.2%	1.9%	0.6%	0.0%	0.5%	0.2%	0.0%	0.4%	0.7%	0.8%
STR	11.8%	8.5%	8.3%	13.3%	10.4%	6.9%	7.1%	5.7%	4.2%	3.2%	6.2%	3.9%
TET	15.3%	16.0%	10.5%	13.5%	6.6%	6.2%	5.2%	3.4%	1.6%	3.4%	3.8%	2.5%
SXT	1.0%	1.3%	2.7%	2.3%	0.9%	1.4%	0.8%	0.4%	0.5%	2.2%	1.2%	0.8%

Year and number of isolates

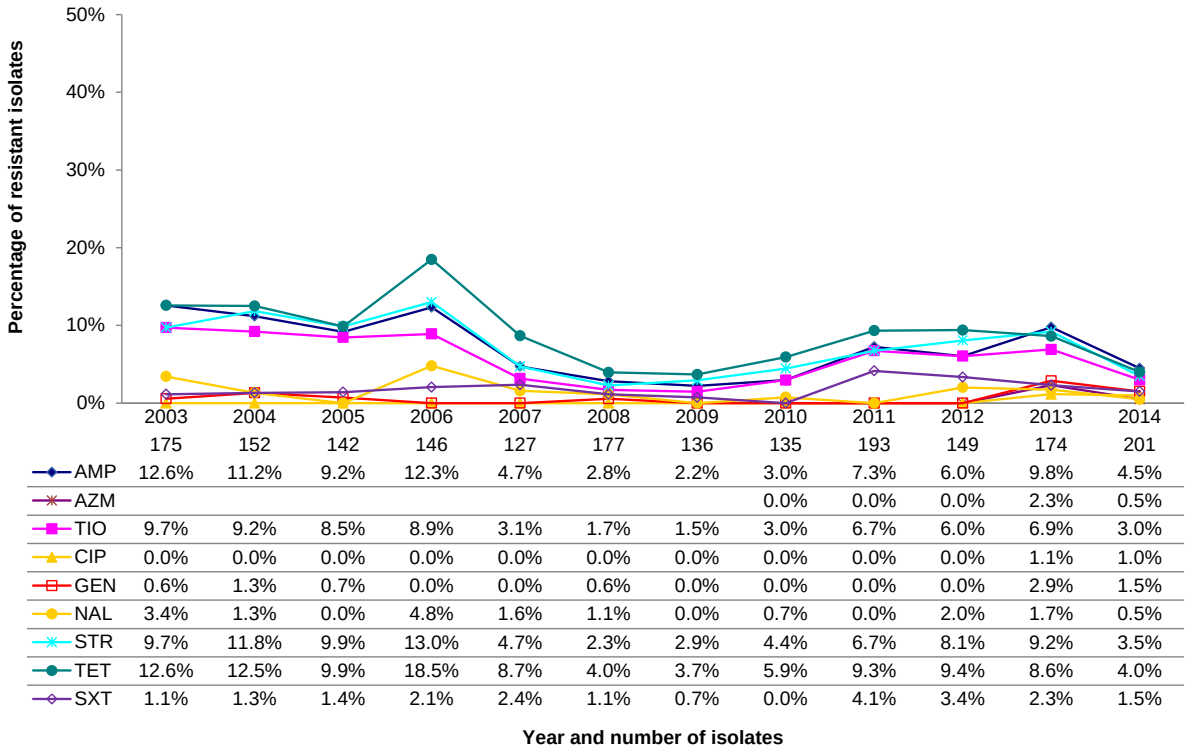
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.5. Resistance to antimicrobials among human *Salmonella* Heidelberg infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 14	n = 21	n = 8	n = 13	n = 142	n = 111	n = 21	n = 17	n = 0	n = 12	%
I	Amoxicillin-clavulanic acid	4 (29)	7 (33)	1 (13)	5 (38)	45 (32)	39 (35)	3 (14)	3 (18)	0 (0)	1 (8)	31
	Ceftiofur	4 (29)	7 (33)	1 (13)	4 (31)	45 (32)	39 (35)	3 (14)	3 (18)	0 (0)	1 (8)	31
	Ceftriaxone	4 (29)	7 (33)	1 (13)	4 (31)	45 (32)	39 (35)	3 (14)	3 (18)	0 (0)	1 (8)	31
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Ampicillin	5 (36)	7 (33)	3 (38)	6 (46)	47 (33)	40 (36)	3 (14)	3 (18)	0 (0)	1 (8)	33
	Azithromycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Cefoxitin	4 (29)	7 (33)	1 (13)	4 (31)	41 (29)	37 (33)	3 (14)	3 (18)	0 (0)	1 (8)	29
	Gentamicin	1 (7)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	1 (5)	1 (6)	0 (0)	0 (0)	1
	Nalidixic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (3)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Streptomycin	2 (14)	1 (5)	0 (0)	1 (8)	4 (3)	4 (4)	1 (5)	1 (6)	0 (0)	0 (0)	4
	Trimethoprim-sulfamethoxazole	0 (0)	1 (5)	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
III	Chloramphenicol	1 (7)	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Sulfisoxazole	1 (7)	1 (5)	0 (0)	1 (8)	2 (1)	2 (2)	1 (5)	1 (6)	0 (0)	0 (0)	2
	Tetracycline	2 (14)	1 (5)	0 (0)	2 (15)	2 (1)	1 (1)	1 (5)	0 (0)	0 (0)	0 (0)	2
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Figure 1.8. Temporal variations in resistance of *Salmonella* Newport from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	175	152	142	146	127	177	136	135	193	149	174	201
AMP	12.6%	11.2%	9.2%	12.3%	4.7%	2.8%	2.2%	3.0%	7.3%	6.0%	9.8%	4.5%
AZM								0.0%	0.0%	0.0%	2.3%	0.5%
TIO	9.7%	9.2%	8.5%	8.9%	3.1%	1.7%	1.5%	3.0%	6.7%	6.0%	6.9%	3.0%
CIP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	1.0%
GEN	0.6%	1.3%	0.7%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	2.9%	1.5%
NAL	3.4%	1.3%	0.0%	4.8%	1.6%	1.1%	0.0%	0.7%	0.0%	2.0%	1.7%	0.5%
STR	9.7%	11.8%	9.9%	13.0%	4.7%	2.3%	2.9%	4.4%	6.7%	8.1%	9.2%	3.5%
TET	12.6%	12.5%	9.9%	18.5%	8.7%	4.0%	3.7%	5.9%	9.3%	9.4%	8.6%	4.0%
SXT	1.1%	1.3%	1.4%	2.1%	2.4%	1.1%	0.7%	0.0%	4.1%	3.4%	2.3%	1.5%

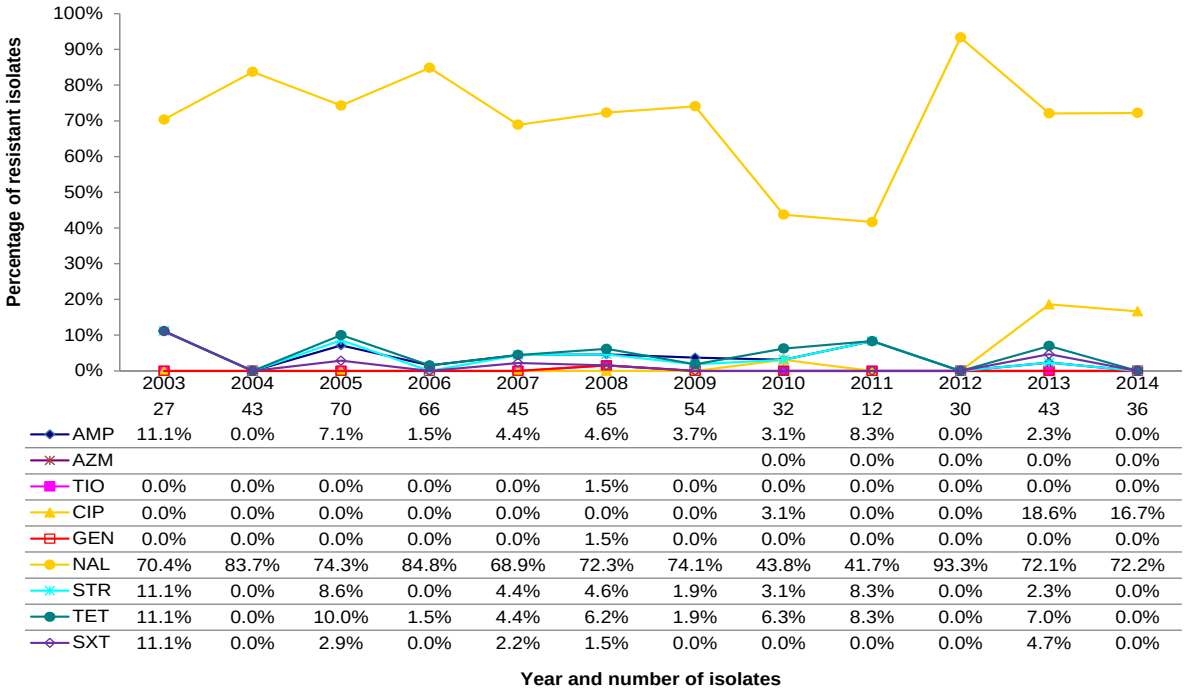
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.6. Resistance to antimicrobials among human *Salmonella* Newport infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 20	n = 10	n = 6	n = 8	n = 85	n = 56	n = 9	n = 6	n = 1	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	1 (10)	0 (0)	1 (13)	2 (2)	0 (0)	1 (11)	0 (0)	0 (0)	0 (0)	2
I	Ceftiofur	1 (5)	1 (10)	0 (0)	1 (13)	2 (2)	0 (0)	1 (11)	0 (0)	0 (0)	0 (0)	3
I	Ceftriaxone	1 (5)	1 (10)	0 (0)	1 (13)	2 (2)	0 (0)	1 (11)	0 (0)	0 (0)	0 (0)	3
I	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1
II	Ampicillin	2 (10)	1 (10)	0 (0)	2 (25)	2 (2)	1 (2)	1 (11)	0 (0)	0 (0)	0 (0)	4
II	Azithromycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Cefoxitin	0 (0)	1 (10)	0 (0)	1 (13)	2 (2)	0 (0)	1 (11)	0 (0)	0 (0)	0 (0)	2
II	Gentamicin	1 (5)	0 (0)	0 (0)	1 (13)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1
II	Nalidixic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Streptomycin	1 (5)	1 (10)	1 (17)	2 (25)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	3
II	Trimethoprim-sulfamethoxazole	0 (0)	1 (10)	1 (17)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1
III	Chloramphenicol	0 (0)	1 (10)	0 (0)	1 (13)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2
III	Sulfisoxazole	0 (0)	1 (10)	1 (17)	2 (25)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2
III	Tetracycline	1 (5)	2 (20)	1 (17)	2 (25)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	3
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Figure 1.9. Temporal variations in resistance of *Salmonella* Paratyphi A and B from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	27	43	70	66	45	65	54	32	12	30	43	36
AMP	11.1%	0.0%	7.1%	1.5%	4.4%	4.6%	3.7%	3.1%	8.3%	0.0%	2.3%	0.0%
AZM								0.0%	0.0%	0.0%	0.0%	0.0%
TIO	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CIP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	18.6%	16.7%
GEN	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NAL	70.4%	83.7%	74.3%	84.8%	68.9%	72.3%	74.1%	43.8%	41.7%	93.3%	72.1%	72.2%
STR	11.1%	0.0%	8.6%	0.0%	4.4%	4.6%	1.9%	3.1%	8.3%	0.0%	2.3%	0.0%
TET	11.1%	0.0%	10.0%	1.5%	4.4%	6.2%	1.9%	6.3%	8.3%	0.0%	7.0%	0.0%
SXT	11.1%	0.0%	2.9%	0.0%	2.2%	1.5%	0.0%	0.0%	0.0%	0.0%	4.7%	0.0%

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

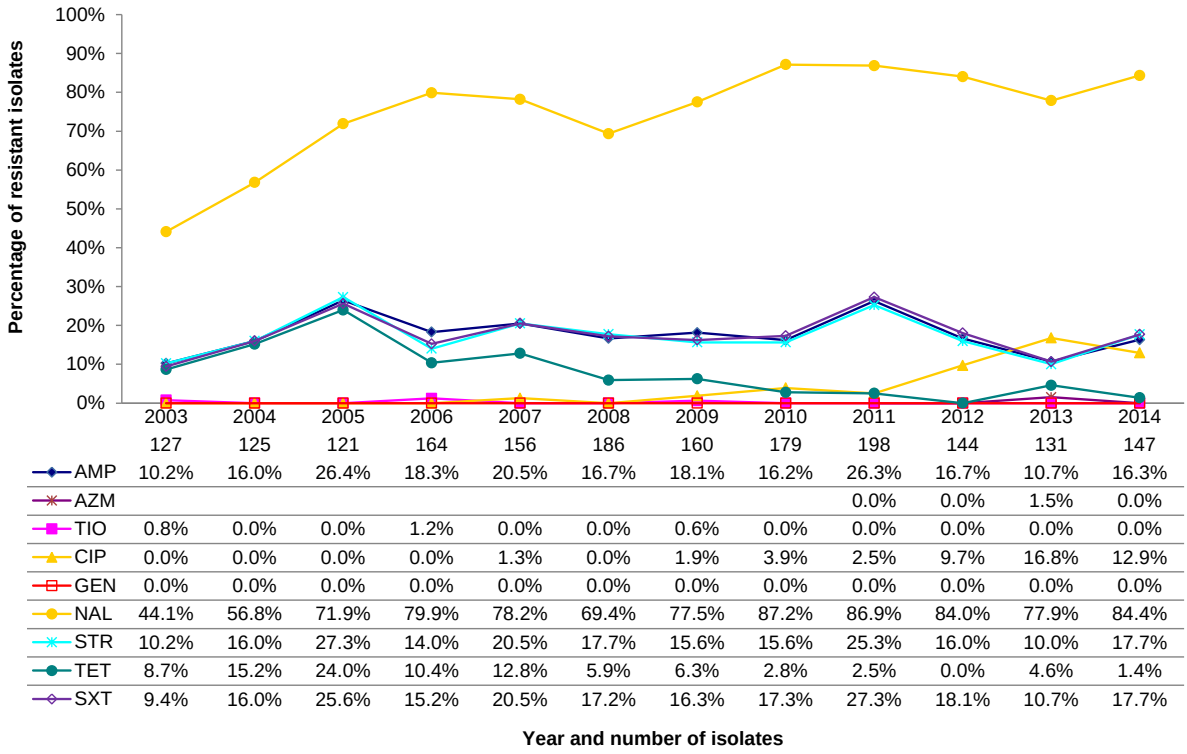
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

Table 1.7. Resistance to antimicrobials among human *Salmonella* Paratyphi A and B infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 9	n = 5	n = 1	n = 4	n = 14	n = 2	n = 0	n = 1	n = 0	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftiofur	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftriaxone	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ciprofloxacin	2 (22)	1 (20)	0 (0)	0 (0)	3 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	18
II	Ampicillin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Azithromycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Nalidixic acid	5 (56)	5 (100)	1 (100)	2 (50)	12 (86)	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)	73
	Streptomycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Trimethoprim-sulfamethoxazole	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
III	Chloramphenicol	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Sulfisoxazole	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Tetracycline	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

Figure 1.10. Temporal variations in resistance of *Salmonella* Typhi from humans, 2003–2014.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	127	125	121	164	156	186	160	179	198	144	131	147
AMP	10.2%	16.0%	26.4%	18.3%	20.5%	16.7%	18.1%	16.2%	26.3%	16.7%	10.7%	16.3%
AZM									0.0%	0.0%	1.5%	0.0%
TIO	0.8%	0.0%	0.0%	1.2%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%
CIP	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	1.9%	3.9%	2.5%	9.7%	16.8%	12.9%
GEN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NAL	44.1%	56.8%	71.9%	79.9%	78.2%	69.4%	77.5%	87.2%	86.9%	84.0%	77.9%	84.4%
STR	10.2%	16.0%	27.3%	14.0%	20.5%	17.7%	15.6%	15.6%	25.3%	16.0%	10.0%	17.7%
TET	8.7%	15.2%	24.0%	10.4%	12.8%	5.9%	6.3%	2.8%	2.5%	0.0%	4.6%	1.4%
SXT	9.4%	16.0%	25.6%	15.2%	20.5%	17.2%	16.3%	17.3%	27.3%	18.1%	10.7%	17.7%

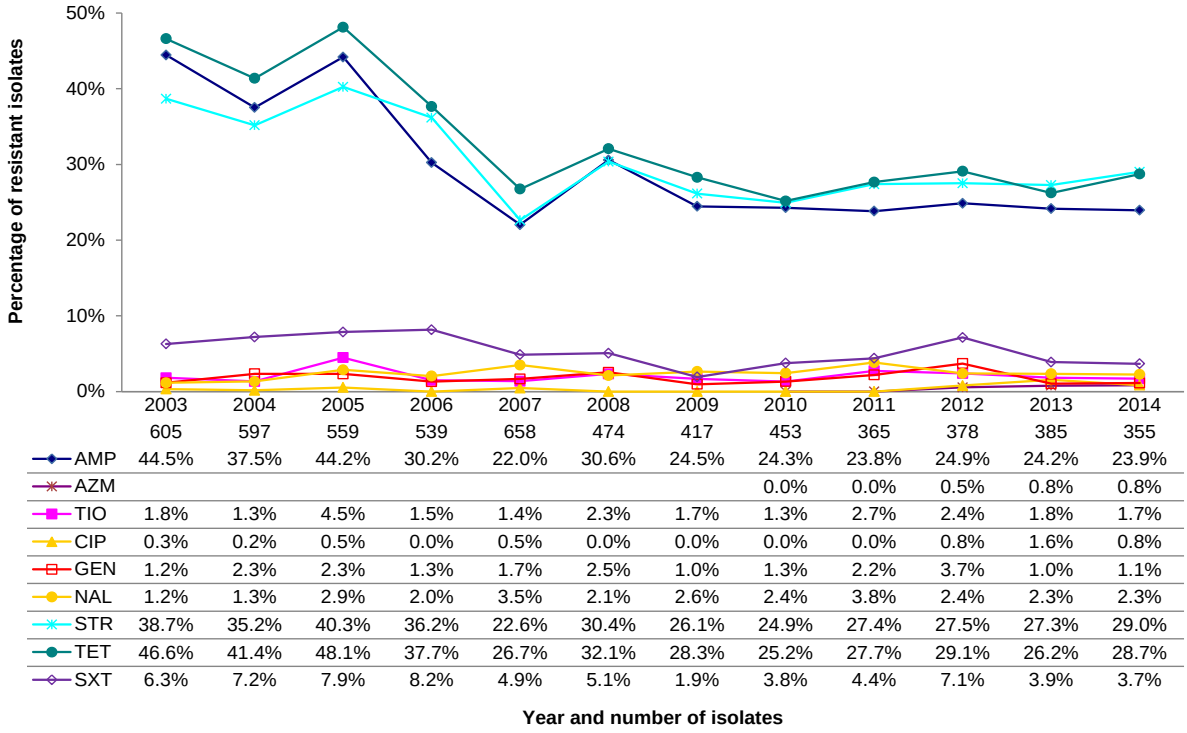
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.8. Resistance to antimicrobials among human *Salmonella* Typhi infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 40	n = 20	n = 2	n = 1	n = 76	n = 7	n = 0	n = 1	n = 0	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftiofur	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftriaxone	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ciprofloxacin	8 (20)	1 (5)	1 (50)	0 (0)	9 (12)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	13
II	Ampicillin	0 (0)	3 (15)	0 (0)	0 (0)	20 (26)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	17
	Azithromycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Nalidixic acid	36 (90)	11 (55)	2 (100)	0 (0)	67 (88)	7 (100)	0 (0)	1 (100)	0 (0)	0 (0)	84
	Streptomycin	1 (3)	3 (15)	0 (0)	0 (0)	21 (28)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	18
	Trimethoprim-sulfamethoxazole	3 (8)	3 (15)	0 (0)	0 (0)	19 (25)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	18
III	Chloramphenicol	2 (5)	3 (15)	0 (0)	0 (0)	21 (28)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	19
	Sulfisoxazole	3 (8)	3 (15)	0 (0)	0 (0)	21 (28)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	19
	Tetracycline	1 (3)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Figure 1.11. Temporal variations in resistance of *Salmonella* Typhimurium from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	605	597	559	539	658	474	417	453	365	378	385	355
AMP	44.5%	37.5%	44.2%	30.2%	22.0%	30.6%	24.5%	24.3%	23.8%	24.9%	24.2%	23.9%
AZM								0.0%	0.0%	0.5%	0.8%	0.8%
TIO	1.8%	1.3%	4.5%	1.5%	1.4%	2.3%	1.7%	1.3%	2.7%	2.4%	1.8%	1.7%
CIP	0.3%	0.2%	0.5%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.8%	1.6%	0.8%
GEN	1.2%	2.3%	2.3%	1.3%	1.7%	2.5%	1.0%	1.3%	2.2%	3.7%	1.0%	1.1%
NAL	1.2%	1.3%	2.9%	2.0%	3.5%	2.1%	2.6%	2.4%	3.8%	2.4%	2.3%	2.3%
STR	38.7%	35.2%	40.3%	36.2%	22.6%	30.4%	26.1%	24.9%	27.4%	27.5%	27.3%	29.0%
TET	46.6%	41.4%	48.1%	37.7%	26.7%	32.1%	28.3%	25.2%	27.7%	29.1%	26.2%	28.7%
SXT	6.3%	7.2%	7.9%	8.2%	4.9%	5.1%	1.9%	3.8%	4.4%	7.1%	3.9%	3.7%

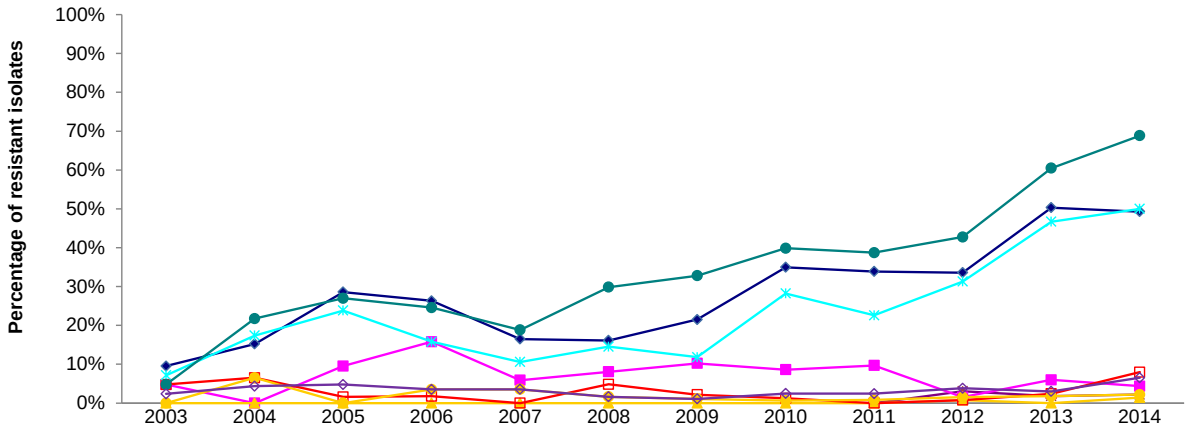
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.9. Resistance to antimicrobials among human *Salmonella* Typhimurium infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 36	n = 41	n = 14	n = 19	n = 164	n = 59	n = 8	n = 8	n = 3	n = 3	%
I	Amoxicillin-clavulanic acid	3 (8)	1 (2)	0 (0)	0 (0)	2 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2
I	Ceftiofur	3 (8)	1 (2)	0 (0)	0 (0)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2
I	Ceftriaxone	3 (8)	1 (2)	0 (0)	0 (0)	1 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2
I	Ciprofloxacin	1 (3)	0 (0)	0 (0)	1 (5)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Ampicillin	8 (22)	7 (17)	3 (21)	1 (5)	42 (26)	20 (34)	2 (25)	0 (0)	1 (33)	1 (33)	25
II	Azithromycin	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Cefoxitin	2 (6)	1 (2)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2
II	Gentamicin	0 (0)	0 (0)	0 (0)	1 (5)	2 (1)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1
II	Nalidixic acid	0 (0)	1 (2)	0 (0)	1 (5)	3 (2)	3 (5)	0 (0)	0 (0)	0 (0)	0 (0)	2
II	Streptomycin	7 (19)	12 (29)	5 (36)	6 (32)	45 (27)	24 (41)	2 (25)	0 (0)	0 (0)	2 (67)	29
II	Trimethoprim-sulfamethoxazole	2 (6)	1 (2)	0 (0)	2 (11)	3 (2)	5 (8)	0 (0)	0 (0)	0 (0)	0 (0)	4
III	Chloramphenicol	7 (19)	6 (15)	2 (14)	2 (11)	36 (22)	19 (32)	1 (13)	0 (0)	0 (0)	1 (33)	22
III	Sulfisoxazole	9 (25)	13 (32)	5 (36)	6 (32)	40 (24)	30 (51)	3 (38)	0 (0)	1 (33)	2 (67)	31
III	Tetracycline	9 (25)	9 (22)	3 (21)	3 (16)	45 (27)	28 (47)	3 (38)	0 (0)	0 (0)	2 (67)	29
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Figure 1.12. Temporal variations in resistance of *Salmonella* 4,[5],12:i:- from humans, 2003–2014



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	42	46	63	57	85	124	186	163	124	131	167	138
AMP	9.5%	15.2%	28.6%	26.3%	16.5%	16.1%	21.5%	35.0%	33.9%	33.6%	50.3%	49.3%
AZM									0.0%	3.1%	1.8%	2.2%
TIO	4.8%	0.0%	9.5%	15.8%	5.9%	8.1%	10.2%	8.6%	9.7%	1.5%	6.0%	4.3%
CIP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	1.4%
GEN	4.8%	6.5%	1.6%	1.8%	0.0%	4.8%	2.2%	1.2%	0.0%	0.8%	2.4%	8.0%
NAL	0.0%	6.5%	0.0%	3.5%	3.5%	1.6%	1.1%	0.6%	0.8%	1.5%	1.8%	2.2%
STR	7.1%	17.4%	23.8%	15.8%	10.6%	14.5%	11.8%	28.2%	22.6%	31.3%	46.7%	50.0%
TET	4.8%	21.7%	27.0%	24.6%	18.8%	29.8%	32.8%	39.9%	38.7%	42.7%	60.5%	68.8%
SXT	2.4%	4.3%	4.8%	3.5%	3.5%	1.6%	1.1%	2.5%	2.4%	3.8%	3.0%	6.5%

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous surveillance year. Statistically significant changes between 2014 and 2013 are highlighted in the text accompanying the temporal figures only.

Table 1.10. Resistance to antimicrobials among human *Salmonella* 4,[5],12:i:- infections, 2014

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	
		n = 12	n = 26	n = 16	n = 11	n = 41	n = 22	n = 7	n = 2	n = 1	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	2 (13)	2 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Ceftiofur	0 (0)	1 (4)	2 (13)	2 (18)	0 (0)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Ceftriaxone	0 (0)	1 (4)	2 (13)	2 (18)	0 (0)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Ciprofloxacin	1 (8)	0 (0)	0 (0)	0 (0)	0 (0)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	2
II	Ampicillin	9 (75)	11 (42)	6 (38)	4 (36)	19 (46)	17 (77)	2 (29)	0 (0)	0 (0)	0 (0)	52
	Azithromycin	1 (8)	1 (4)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Cefoxitin	0 (0)	0 (0)	2 (13)	2 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Gentamicin	2 (17)	5 (19)	0 (0)	1 (9)	2 (5)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	9
	Nalidixic acid	1 (8)	1 (4)	0 (0)	0 (0)	0 (0)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Streptomycin	10 (83)	12 (46)	5 (31)	2 (18)	22 (54)	16 (73)	2 (29)	0 (0)	0 (0)	0 (0)	54
	Trimethoprim-sulfamethoxazole	1 (8)	2 (8)	0 (0)	0 (0)	5 (12)	1 (5)	0 (0)	0 (0)	0 (0)	0 (0)	8
III	Chloramphenicol	3 (25)	5 (19)	0 (0)	0 (0)	4 (10)	3 (14)	0 (0)	0 (0)	0 (0)	0 (0)	13
	Sulfisoxazole	11 (92)	12 (46)	5 (31)	2 (18)	22 (54)	17 (77)	2 (29)	0 (0)	0 (0)	0 (0)	56
	Tetracycline	12 (100)	22 (85)	7 (44)	4 (36)	28 (68)	19 (86)	2 (29)	1 (50)	0 (0)	0 (0)	74
IV												

Province abbreviations are defined in the Appendix.
Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

MINIMUM INHIBITORY CONCENTRATIONS

See how to interpret the minimum inhibitory concentration tables in the section ''How to Read this Chapter''.

Table 1.11. Distribution of minimum inhibitory concentrations among non-typhoidal *Salmonella* from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	2,485	≤ 1	8	5.4							75.6	11.5	0.6	4.0	2.9	1.5	3.9			
I	Ceftiofur	2,485	1	1	5.5				0.0	0.2	6.8	84.5	2.9	0.0	0.1	5.4					
	Ceftriaxone	2,485	≤ 0.25	≤ 0.25	5.5					93.4	1.0	0.1		0.1	0.2	3.0	1.6	0.4	0.3		
	Ciprofloxacin	2,485	≤ 0.015	0.06	0.7	57.9	31.4	1.0	1.2	4.2	3.6	0.3	0.2	0.0	0.1						
	Ampicillin	2,485	≤ 1	> 32	13.0							55.5	30.5	1.0	0.0	0.0	0.1	12.9			
	Azithromycin	2,485	4	8	0.4								11.4	63.8	23.3	1.1	0.4				
	Cefoxitin	2,485	2	4	5.1							2.9	74.2	16.3	1.0	0.5	1.6	3.4			
II	Gentamicin	2,485	0.50	1	1.2					27.0	60.6	10.4	0.5	0.2	0.0	0.2	1.1				
	Nalidixic acid	2,485	4	8	8.5							0.1	15.9	71.8	2.2	1.4	1.1	7.4			
	Streptomycin	2,485	8	≤ 32	8.9								26.3	22.3	22.9	16.1	3.6	2.0	6.9		
	Trimethoprim-sulfamethoxazole	2,485	≤ 0.12	≤ 0.12	1.7				92.4	5.5	0.3		0.0	0.0	1.7						
	Chloramphenicol	2,485	8	8	4.4								0.1	19.3	75.3	0.9		4.4			
III	Sulfisoxazole	2,485	64	128	9.4											5.7	29.1	40.1	15.3	0.4	9.4
	Tetracycline	2,485	≤ 4	32	10.5									89.5		0.0	2.0	8.5			
IV																					

Table 1.12. Distribution of minimum inhibitory concentrations among typhoidal *Salmonella* from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	183	≤ 1	8	0.0							72.1	14.2	1.1	11.5	1.1					
I	Ceftiofur	183	1	1	0.0					1.6	39.9	57.4	1.1								
	Ceftriaxone	183	≤ 0.25	≤ 0.25	0.0					98.9	1.1										
	Ciprofloxacin	183	0.25	1	13.7	10.9	3.8	1.1	7.1	35.0	28.4	6.6			7.1						
	Ampicillin	183	≤ 1	> 32	13.1							68.9	16.4	1.6				13.1			
	Azithromycin	183	4	8	0.0								9.3	59.0	26.8	4.9					
	Cefoxitin	183	4	8	0.0							14.2	18.0	33.3	33.3	1.1					
II	Gentamicin	183	≤ 0.25	0.50	0.0					59.6	40.4										
	Nalidixic acid	183	> 32	> 32	82.0								9.3	7.1	1.6			82.0			
	Streptomycin	183	16	> 64	14.2									0.5	21.9	54.6	8.7	0.5	13.7		
	Trimethoprim-sulfamethoxazole	183	≤ 0.12	> 4	14.2				83.1	1.6	0.5	0.5			14.2						
	Chloramphenicol	183	8	> 32	14.8								0.5	25.7	55.7	3.3		14.8			
III	Sulfisoxazole	183	64	> 256	15.3											2.2	29.0	35.0	17.5	1.1	15.3
	Tetracycline	183	≤ 4	≤ 4	1.1									98.9				1.1			
IV																					

Table 1.13. Distribution of minimum inhibitory concentrations among *Salmonella* Enteritidis from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	1,211	≤ 1	2	0.0							78.0	19.7	0.2	2.0	0.2					
I	Ceftiofur	1,211	1	1	0.1					0.1	0.7	94.9	4.3			0.1					
	Ceftriaxone	1,211	≤ 0.25	≤ 0.25	0.1					98.8	1.0	0.2						0.1			
	Ciprofloxacin	1,211	0.03	0.25	0.5	37.8	44.7	1.2	2.1	7.7	5.9	0.2	0.3								
	Ampicillin	1,211	2	2	2.2							43.2	52.9	1.6	0.1		0.1	2.1			
	Azithromycin	1,211	4	8	0.2								16.0	70.3	12.8	0.7	0.2				
	Cefoxitin	1,211	2	4	0.0							0.2	80.8	18.2	0.7	0.2					
II	Gentamicin	1,211	0.50	0.50	0.0					48.3	45.7	5.8	0.2								
	Nalidixic acid	1,211	4	> 32	15.2								8.3	72.1	2.9	1.5	2.1	13.0			
	Streptomycin	1,211	2	4	0.7								53.9	41.6	3.1	0.5	0.2		0.7		
	Trimethoprim-sulfamethoxazole	1,211	≤ 0.12	≤ 0.12	0.6				97.4	1.8	0.1		0.1		0.6						
	Chloramphenicol	1,211	8	8	0.2									24.5	74.7	0.6		0.2			
III	Sulfisoxazole	1,211	64	128	1.0											7.4	24.4	42.9	23.7	0.6	1.0
	Tetracycline	1,211	≤ 4	≤ 4	1.3									98.7				1.3			
IV																					

Table 1.14. Distribution of minimum inhibitory concentrations among *Salmonella* Heidelberg from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	359	≤ 1	> 32	30.1							66.6	1.4		1.4	0.6	7.8	22.3			
I	Ceftiofur	359	1	> 8	29.8					0.3	14.2	55.4	0.3		0.3	29.5					
	Ceftriaxone	359	≤ 0.25	32	29.8					69.4	0.8			0.3	1.1	17.8	7.8	1.4	1.4		
	Ciprofloxacin	359	≤ 0.015	0.03	0.0	89.4	9.2	0.6			0.8										
	Ampicillin	359	≤ 1	> 32	32.0							63.8	3.9	0.3				32.0			
	Azithromycin	359	8	8	0.0								0.6	48.2	49.3	1.9					
	Cefoxitin	359	2	> 32	28.1							8.9	55.2	5.6	0.6	1.7	10.0	18.1			
II	Gentamicin	359	0.50	1	1.4					5.6	76.0	16.4	0.3	0.3			1.4				
	Nalidixic acid	359	4	4	0.8								11.4	85.8	1.7	0.3		0.8			
	Streptomycin	359	16	≤ 32	3.9										17.5	61.3	17.3	1.1	2.8		
	Trimethoprim-sulfamethoxazole	359	≤ 0.12	≤ 0.12	0.8				98.6	0.6					0.8						
	Chloramphenicol	359	8	8	0.8									2.8	95.8	0.6		0.8			
III	Sulfisoxazole	359	32	64	2.5											9.7	59.3	27.9	0.6		2.5
	Tetracycline	359	≤ 4	≤ 4	2.5									97.5				2.5			
IV																					

Table 1.15. Distribution of minimum inhibitory concentrations among *Salmonella* Newport from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	201	≤ 1	2	2.5							87.6	8.0	1.0	1.0		0.5	2.0			
I	Ceftiofur	201	1	1	3.0						22.4	73.6	1.0			3.0					
	Ceftriaxone	201	≤ 0.25	≤ 0.25	3.0					96.5	0.5						2.5		0.5		
	Ciprofloxacin	201	≤ 0.015	0.03	1.0	84.6	13.9			0.5		1.0									
	Ampicillin	201	≤ 1	2	4.5							79.1	16.4					4.5			
	Azithromycin	201	4	8	0.5								22.9	63.7	11.9	1.0	0.5				
	Cefoxitin	201	2	2	2.5							5.0	85.1	7.5			0.5	2.0			
II	Gentamicin	201	0.50	1	1.5					5.5	78.6	13.9	0.5				1.5				
	Nalidixic acid	201	4	4	0.5								34.8	62.7	1.0	1.0	0.5				
	Streptomycin	201	8	16	3.5									7.0	79.6	9.5	0.5	0.5	3.0		
	Trimethoprim-sulfamethoxazole	201	≤ 0.12	≤ 0.12	1.5				95.0	3.5					1.5						
	Chloramphenicol	201	8	8	2.0								0.5	48.3	48.8	0.5		2.0			
III	Sulfisoxazole	201	64	128	3.0											1.0	22.9	51.2	20.9	1.0	3.0
	Tetracycline	201	≤ 4	≤ 4	4.0									96.0				4.0			
IV																					

Table 1.16. Distribution of minimum inhibitory concentrations among *Salmonella* Paratyphi A and B from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	36	2	2	0.0							33.3	63.9	2.8							
I	Ceftiofur	36	1	1	0.0						2.8	97.2									
	Ceftriaxone	36	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	36	0.50	1	16.7	8.3	19.4		2.8		52.8	16.7									
	Ampicillin	36	2	2	0.0							22.2	72.2	5.6							
	Azithromycin	36	8	16	0.0									16.7	69.4	13.9					
	Cefoxitin	36	4	8	0.0							2.8	22.2	41.7	30.6	2.8					
II	Gentamicin	36	≤ 0.25	0.50	0.0					69.4	30.6										
	Nalidixic acid	36	> 32	> 32	72.2								8.3	19.4				72.2			
	Streptomycin	36	16	≤ 32	0.0									2.8	19.4	63.9	13.9				
	Trimethoprim-sulfamethoxazole	36	≤ 0.12	≤ 0.12	0.0				91.7	8.3											
	Chloramphenicol	36	8	16	0.0									5.6	77.8	16.7					
III	Sulfisoxazole	36	64	128	0.0												16.7	41.7	41.7		
	Tetracycline	36	≤ 4	≤ 4	0.0									100.0							
IV																					

Table 1.17. Distribution of minimum inhibitory concentrations among *Salmonella* Typhi from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	147	≤ 1	8	0.0							81.6	2.0	0.7	14.3	1.4					
	Ceftiofur	147	0.50	1	0.0					2.0	49.0	47.6	1.4								
	Ceftriaxone	147	≤ 0.25	≤ 0.25	0.0					98.6	1.4										
	Ciprofloxacin	147	0.25	1	12.9	11.6		1.4	8.2	43.5	22.4	4.1			8.8						
II	Ampicillin	147	≤ 1	> 32	16.3							80.3	2.7	0.7				16.3			
	Azithromycin	147	4	8	0.0								11.6	69.4	16.3	2.7					
	Cefoxitin	147	4	8	0.0							17.0	17.0	31.3	34.0	0.7					
	Gentamicin	147	≤ 0.25	0.50	0.0					57.1	42.9										
	Nalidixic acid	147	> 32	> 32	84.4								9.5	4.1	2.0			84.4			
	Streptomycin	147	16	> 64	17.7										22.4	52.4	7.5	0.7	17.0		
	Trimethoprim-sulfamethoxazole	147	≤ 0.12	> 4	17.7				81.0		0.7	0.7			17.7						
III	Chloramphenicol	147	8	> 32	18.4								0.7	30.6	50.3			18.4			
	Sulfisoxazole	147	64	> 256	19.0											2.7	32.0	33.3	11.6	1.4	19.0
	Tetracycline	147	≤ 4	≤ 4	1.4									98.6				1.4			
IV																					

Table 1.18. Distribution of minimum inhibitory concentrations among *Salmonella* Typhimurium from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	355	≤ 1	16	2.0							72.4	3.9	0.6	5.1	16.1	0.8	1.1			
	Ceftiofur	355	1	1	1.7						7.6	88.2	2.3	0.3		1.7					
	Ceftriaxone	355	≤ 0.25	≤ 0.25	1.7					97.2	1.1			0.3		0.6	0.6	0.3			
	Ciprofloxacin	355	≤ 0.015	0.03	0.8	74.6	20.8	0.8	0.3	1.4	1.1	0.8									
II	Ampicillin	355	≤ 1	> 32	23.9							62.0	13.5	0.6			0.3	23.7			
	Azithromycin	355	4	8	0.8								7.9	69.0	21.7	0.6	0.8				
	Cefoxitin	355	2	4	1.4							2.5	83.4	11.0	1.4	0.3	0.8	0.6			
	Gentamicin	355	0.50	1	1.1					4.2	76.1	16.1	2.3	0.3			1.1				
	Nalidixic acid	355	4	4	2.3								23.9	70.1	2.3	1.4		2.3			
	Streptomycin	355	16	> 64	29.0									2.3	41.7	23.7	3.4	10.4	18.6		
	Trimethoprim-sulfamethoxazole	355	≤ 0.12	0.25	3.7				73.8	22.3	0.3			0.3	3.4						
III	Chloramphenicol	355	8	> 32	20.8									11.0	67.0	1.1		20.8			
	Sulfisoxazole	355	64	> 256	30.7											2.0	17.5	40.0	9.9		30.7
	Tetracycline	355	≤ 4	> 32	28.7									71.3		0.3	12.7	15.8			
IV																					

Table 1.19. Distribution of minimum inhibitory concentrations among *Salmonella* 4,[5],12:i:- from humans, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	138	2	8	2.9							48.6	2.2	5.8	36.2	4.3		2.9			
	Ceftiofur	138	1	1	4.3						5.1	87.0	3.6		0.7	3.6					
	Ceftriaxone	138	≤ 0.25	≤ 0.25	4.3					92.8	2.9				0.7	2.2	0.7		0.7		
	Ciprofloxacin	138	≤ 0.015	0.03	1.4	56.5	37.0	1.4	0.7		2.9	0.7	0.7								
II	Ampicillin	138	2	> 32	49.3							43.5	7.2					49.3			
	Azithromycin	138	4	8	2.2								6.5	69.6	21.7		2.2				
	Cefoxitin	138	2	4	2.9							2.9	73.2	16.7	3.6	0.7	0.7	2.2			
	Gentamicin	138	0.50	1	8.0					8.0	63.8	18.8	0.7	0.7		1.4	6.5				
	Nalidixic acid	138	4	4	2.2							0.7	17.4	75.4	0.7	3.6		2.2			
	Streptomycin	138	64	> 64	50.0										30.4	17.4	2.2	0.7	49.3		
	Trimethoprim-sulfamethoxazole	138	≤ 0.12	0.25	6.5				81.2	10.1	2.2				6.5						
III	Chloramphenicol	138	8	> 32	10.9									6.5	81.9	0.7		10.9			
	Sulfisoxazole	138	> 256	> 256	51.4												10.9	32.6	5.1		51.4
	Tetracycline	138	> 32	> 32	68.8									31.2			0.7	68.1			
IV																					

2. RETAIL MEAT SURVEILLANCE

KEY FINDINGS

BEEF

ESCHERICHIA COLI (n = 460)

As in previous years, overall resistance levels of Category I β-lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) remained low in beef *E. coli* isolates in 2014. In fact, the only province/region where Category I β-lactam resistance was observed in 2014 was British Columbia (2%, 1/43) and the Atlantic region (2%, 2/114) (Table 2.1) compared to 2013 where low levels of Category 1 β-lactam resistance were seen in most provinces/regions. In contrast with recent years, no *E. coli* isolates from beef were resistant to all 7 classes of antimicrobials tested (Table 2.1). No ciprofloxacin resistance was observed among *E. coli* isolated from ground beef.

CHICKEN

SALMONELLA (n = 343)

Across all provinces/regions sampled, the top 3 chicken *Salmonella* serovars were Heidelberg, Enteritidis and Kentucky as in previous years although the ranking of the second and third most common serovars does vary from year to year. Regional differences in serovar distribution were observed in 2014 with Enteritidis being the most common serovar in the western Canadian provinces/regions of British Columbia (72%, 26/36) and the Prairies (51%, 41/81) unlike Ontario, Québec, and the Atlantic region where the most common serovar was Heidelberg (40%, 30/75; 34%, 31/92 and 58%, 34/59, respectively) (Table 2.2). Unlike previous recent years, where little to no Enteritidis was recovered in Ontario and Québec, Enteritidis was recovered in both Ontario (11%, 8/75) and Québec (3%, 3/92) in 2014.

All Enteritidis isolates were susceptible to all antimicrobials tested in 2014. In 2014, no ciprofloxacin resistance was observed and a single isolate of Heidelberg from the Atlantic region was resistant to nalidixic acid (Table 2.2). Across all provinces/regions sampled, resistance levels of Category I β-lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) (21%, 72/343) remained similar to levels in 2013 (25%, 65/264) (Figure 2.2). Resistance to ceftriaxone was significantly lower (6%, 2/36) in 2014 than 2013 (33%, 11/33) and 2010 (25%, 14/56) in British Columbia (Figure 2.2). Resistance to ceftriaxone was significantly lower (27%,

20/75) in 2014 than 2004 (46%, 25/54) in Ontario (Figure 2.2). Resistance to ceftriaxone was significantly higher (27%, 25/92) in 2014 than 2006 (9%, 3/33) in Québec (Figure 2.2)[8].

ESCHERICHIA COLI (n = 619)

Resistance levels of Category I β-lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) were lower compared to those in 2013 across all provinces/regions sampled (Figure 2.3). Resistance to ceftriaxone was significantly lower in 2014 (11%, 16/144) than 2013 (24%, 27/114), 2010 (24%, 24/100), 2006 (28%, 42/152) and 2004 (24%, 36/150) in Ontario (Figure 2.3)[10]. Resistance to ceftriaxone was significantly lower in 2014 (18%, 23/128) than 2010 (31%, 43/138) and 2004 (40%, 63/158) but was significantly higher than 2006 (7%, 9/135) in Québec (Figure 3)[10]. Resistance to gentamicin was significantly higher in 2014 (29%, 37/128) than 2010 (18%, 25/138) in Québec (Figure 2.3).

CAMPYLOBACTER (n = 277)

In 2014, no significant increases or decreases in ciprofloxacin resistance were observed. Ciprofloxacin resistance remained highest in British Columbia in 2014 (21%, 9/43) across provinces/regions sampled although this was lower compared to 2013 (26%, 15/57). The province/region with the second highest levels (12%) of ciprofloxacin resistance were Ontario (9/76) and the Prairies (8/67) (Figure 2.4). Telithromycin resistance was relatively low (less than 4%) in *Campylobacter* isolates across all provinces/regions sampled in 2014 with the exception of the Atlantic region (11%, 4/37); this finding is comparable to 2013 (10%, 5/52) (Figure 2.4). Resistance to azithromycin was significantly higher in 2014 (11%, 4/37) than 2010 (0%, 0/68) in the Atlantic region (Figure 2.4).

PORK

ESCHERICHIA COLI (n = 323)

In 2014, Category I β-lactam ceftriaxone and ceftiofur resistance levels in pork *E. coli* isolates remained stable at low (5%, 15/323) and somewhat similar levels compared to 2013 (3%, 6/221) (Figure 2.5). One isolate from each of the Atlantic region (1%, 1/70) and Québec (2%, 1/49) were resistant to azithromycin (Table 2.5).

TURKEY

SALMONELLA (n = 182)

The distribution of *Salmonella* serovars varied greatly by province in the third full year of retail surveillance of ground turkey (Table 2.6). No ciprofloxacin or nalidixic acid resistance was

[8] Additional temporal analyses for ampicillin and ceftiofur/ceftriaxone were conducted for *Salmonella* isolates from Ontario and Québec. These 2 antimicrobials, provinces, and years (2004 and 2006) were selected due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end of the voluntary period of withdrawal). Significant differences ($P \leq 0.05$) observed between the current year results and additional reference year results were reported in temporal tables.

observed (Table 2.6). Category I β-lactam (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) resistance levels in turkey *Salmonella* isolates were quite variable ranging from a low of 0% in the Prairies (0/44) to a high of 22% (11/51) in Québec (Table 2.6). Resistance to ceftriaxone and ampicillin was significantly higher in 2014 (8%, 3/40 and 15%, 6/40, respectively) than 2013 (38%, 11/29; 52%, 15/29, respectively) in Ontario (Figure 2.6).

ESCHERICHIA COLI (n = 561)

Ciprofloxacin resistance was observed in turkey *E. coli* isolates from Québec (2%, 2/118) and a single isolate from the Prairies (1%, 1/103) and the Atlantic region (less than 1%, 1/133) (Table 2.7). This is the first time that ciprofloxacin resistance has been observed in turkey *E. coli* isolates to-date (2012 to 2014) although it has been observed in other meat and poultry products in the past. Nalidixic acid resistance was observed in Québec (3%, 3/118), Prairies (2%, 2/103), Ontario (less than 1%, 1/143), and the Atlantic region (less than 1%, 1/133) (Table 2.7). In 2014, resistance levels of Category I β-lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) in turkey *E. coli* isolates ranged from less than 1% (1/143) in Ontario to 8% (5/64) in British Columbia (Table 2.7). One isolate from each of the Prairies and Atlantic region was resistant to 6 antimicrobial classes with the following patterns respectively: A2C-AMP-AZM-CRO-CHL-CIP-NAL-SSS-TET-SXT and ACSSuT-CIP-NAL-SXT.

CAMPYLOBACTER (n = 82)

At the time of release of this report, *Campylobacter* speciation results for the Atlantic region were unavailable. These results will be released once available.

Six of 28 isolates (21%) from Ontario and 1/5 (20%) isolates in Québec were resistant to telithromycin in 2014 (Table 2.8). Ciprofloxacin resistance was observed across all provinces/regions sampled with 32% (9/28) of isolates from British Columbia, 20% (1/5) isolate from Québec, 17% (2/12) isolates from the Prairies, and 14% (4/28) of isolates from Ontario (Table 2.8).

MULTICLASS RESISTANCE

Table 2.1. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from beef, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	43 (9.3)	39	2	2				1	1	1	1	1	1							4
Prairies	97 (21.1)	76	9	11	1		1	8	2					9	2		2		1	19
Ontario	121 (26.3)	99	7	6	9		1	11	5					12	3		8		2	21
Québec	85 (18.5)	63	10	6	6			7	4					9	7		8		1	21
Atlantic	114 (24.8)	84	17	8	5		1	9	13	16	2	3	2	10	4		3		2	13

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.2. Number of antimicrobial classes in resistance patterns of *Salmonella* from chicken, 2014

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																				
Enteritidis	26 (72.2)	26																		
Kentucky	5 (13.9)			5				5	1	1	1	1	1							5
Schwarzengrund	2 (5.6)	2																		
Hartford	1 (2.8)	1																		
Heidelberg	1 (2.8)		1						1	1	1	1	1							
Orion var. 15+	1 (2.8)	1																		
Total	**36 (100)**	**30**	**1**	**5**				**5**	**2**	**2**	**2**	**2**	**2**							**5**
Prairies																				
Enteritidis	41 (50.6)	41																		
Kentucky	9 (11.1)	3	2	4				4	3	3	3	3	3							4
Schwarzengrund	9 (11.1)	9																		
Infantis	3 (3.7)	2	1						1	1	1	1	1							
Thompson	3 (3.7)	1	1	1				2						1						
Braenderup	2 (2.5)	2																		
Hadar	2 (2.5)			2				2												2
Typhimurium	2 (2.5)	1	1						1	1	1	1	1							
Less common serovars	10 (12.3)	9	1						1	1	1	1	1							
Total	**81 (100)**	**68**	**6**	**7**				**8**	**6**	**6**	**6**	**6**	**6**	**1**						**6**
Ontario																				
Heidelberg	30 (40.0)	11	16	3			2	3	17	17	17	17	17	2						
Thompson	12 (16.0)	12																		
Kentucky	11 (14.7)	1		10			1	10	1	1	1	1	1	1						10
Enteritidis	8 (10.7)	8																		
Typhimurium	4 (5.3)			4										4						4
Hadar	2 (2.7)			2				2												2
Infantis	2 (2.7)			1	1		2	2	1	1	1	1	1	2			1			1
Less common serovars	6 (8.0)	2		3	1		1	4	1	1	1	1	1	3			1			3
Total	**75 (100)**	**34**	**16**	**23**	**2**		**6**	**21**	**20**	**20**	**20**	**20**	**20**	**12**			**2**			**20**
Québec																				
Heidelberg	31 (33.7)	11	20						20	20	20	20	20							
Kentucky	22 (23.9)	1	1	20				19	5	5	5	5	5							20
Thompson	19 (20.7)	18		1			1	1						1						
Give	4 (4.3)	4																		
Hadar	4 (4.3)	1		3				3												3
Enteritidis	3 (3.3)	3																		
Typhimurium	2 (2.2)			2			1							2						2
Less common serovars	7 (7.6)	6		1				1												1
Total	**92 (100)**	**44**	**21**	**27**			**2**	**24**	**25**	**25**	**25**	**25**	**25**	**3**						**26**
Atlantic																				
Heidelberg	34 (57.6)	15	19						18	18	18	18	18						1	
Thompson	8 (13.6)	8																		
Kentucky	7 (11.9)		1	6				6	1	1	1	1	1							7
Enteritidis	4 (6.8)	4																		
6,7:-:1,5	2 (3.4)	2																		
Less common serovars	4 (6.8)	3		1			1	1	1											
Total	**59 (100)**	**32**	**20**	**7**			**1**	**7**	**20**	**19**	**19**	**19**	**19**						**1**	**7**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.3. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chicken, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	65 (10.5)	12	19	18	16		7	27	45	31	31	30	30	22	5		4		3	23
Prairies	109 (17.6)	42	12	45	10		11	33	43	21	22	21	18	32	8		4		6	45
Ontario	144 (23.3)	35	20	71	17	1	28	65	47	16	16	16	15	56	13		9		4	81
Québec	128 (20.7)	16	21	68	23		37	61	55	20	23	20	21	75	27		10		1	75
Atlantic	173 (27.9)	49	28	64	31	1	36	76	70	31	28	29	26	72	31	1	11		4	84

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.4. Number of antimicrobial classes in resistance patterns of *Campylobacter* from chicken, 2014

Province or region / species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial								
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
British Columbia															
Campylobacter jejuni	37 (86.0)	26	6	5									6	6	10
Campylobacter coli	5 (11.6)	2	2	1									2	2	2
Campylobacter spp.	1 (2.3)		1										1	1	
Total	**43 (100)**	**28**	**9**	**6**									**9**	**9**	**12**
Prairies															
Campylobacter jejuni	59 (88.1)	27	28	4									4	4	32
Campylobacter coli	8 (11.9)	1	6	1									4	4	4
Total	**67 (100)**	**28**	**34**	**5**									**8**	**8**	**36**
Ontario															
Campylobacter jejuni	71 (93.4)	36	27	8				1	1	2	2		7	7	33
Campylobacter coli	5 (6.6)	2	3										2	2	1
Total	**76 (100)**	**38**	**30**	**8**				**1**	**1**	**2**	**2**		**9**	**9**	**34**
Québec															
Campylobacter jejuni	51 (94.4)	25	19	7				2	3	7	7		2	2	23
Campylobacter coli	3 (5.6)		3												3
Total	**54 (100)**	**25**	**22**	**7**				**2**	**3**	**7**	**7**		**2**	**2**	**26**
Atlantic															
Campylobacter spp.	37 (100)	15	17	4	1			4	2	4	4		2	2	20
Total	**37 (100)**	**15**	**17**	**4**	**1**			**4**	**2**	**4**	**4**		**2**	**2**	**20**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.
At the time of release of this report, *Campylobacter* speciation results for the Atlantic region were unavailable.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.5. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pork, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	29 (9.0)	17	4	6	2		1	6	6	3	3	3	3	7	3		2			5
Prairies	48 (14.9)	27	8	10	3			7	8	3	3	3	3	9	1		3			18
Ontario	127 (39.3)	48	20	38	21		2	37	36	3	3	3	3	40	13		16		3	72
Québec	49 (15.2)	25	9	9	5	1	2	10	10	4	4	4	3	9	5	1	1			24
Atlantic	70 (21.7)	30	18	19	3		1	10	20	9	2	2	2	12	7	1	1			26

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.6. Number of antimicrobial classes in resistance patterns of *Salmonella* from turkey, 2014

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																				
Enteritidis	10 (32.3)	10																		
Hadar	6 (19.4)	1		5			1	5	1											5
Liverpool	6 (19.4)	6																		
Reading	3 (9.7)	3																		
Heidelberg	2 (6.5)		2						2	2	2	2	2							
Schwarzengrund	2 (6.5)	2																		
Agona	1 (3.2)			1					1		1		1	1						1
Johannesburg	1 (3.2)			1			1	1						1						1
Total	**31 (100)**	**22**	**2**	**7**			**2**	**6**	**4**	**2**	**3**	**2**	**3**	**2**						**7**
Prairies																				
Reading	14 (31.8)	10	1	3				2						3			1			3
Enteritidis	6 (13.6)	6																		
Hadar	4 (9.1)			4				4	2											4
Heidelberg	4 (9.1)	4																		
Schwarzengrund	3 (6.8)	2		1			1	1						1						
4,[5],12:i:-	2 (4.5)			1	1		2	2	2					2						1
Muenchen	2 (4.5)	1		1				1						1						1
Newport	2 (4.5)	1		1			1	1	1											1
Alachua	1 (2.3)	1																		
Rough:e,h:1,5	1 (2.3)	1																		
Livingstone	1 (2.3)		1																	1
Livingstone var. 14+	1 (2.3)	1																		
Saintpaul	1 (2.3)		1																	1
Senftenberg	1 (2.3)			1			1		1											
Worthington	1 (2.3)			1				1						1						1
Total	**44 (100)**	**27**	**3**	**13**	**1**		**5**	**12**	**6**					**8**			**1**			**13**
Ontario																				
Heidelberg	9 (22.5)	4	2	3			2	2	4	3	3	3	3							3
Agona	6 (15.0)	6																		
Enteritidis	3 (7.5)	3																		
Muenchen	3 (7.5)		1	2			1	2						2						2
Saintpaul	3 (7.5)	3																		
Schwarzengrund	3 (7.5)			3			2	3						3						2
Hadar	2 (5.0)			2				2	1											2
Montevideo	2 (5.0)	1		1			1	1	1											
Muenster	2 (5.0)	2																		
Reading	2 (5.0)	2																		
Thompson	2 (5.0)	2																		
Give	1 (2.5)	1																		
Orion var. 15+ 34+	1 (2.5)			1				1												1
Ouakam	1 (2.5)		1				1	1												
Total	**40 (100)**	**24**	**4**	**12**			**7**	**12**	**6**	**3**	**3**	**3**	**3**	**5**						**10**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.6. Number of antimicrobial classes in resistance patterns of *Salmonella* from turkey, 2014 (cont'd)

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Québec																				
Schwarzengrund	14 (27.5)	5	1	8			1	3						8						9
Heidelberg	8 (15.7)	4	2	2			1	1	3	3	3	3	3	1						1
Brandenburg	4 (7.8)		4						4	4	4	4	4							
Muenchen	4 (7.8)	2		2				1						2						2
Worthington	4 (7.8)	1	1	2					2	2	2	2	2							3
Agona	3 (5.9)	2		1					1	1	1	1	1	1						1
Albany	2 (3.9)			2			2		2		1		1							1
Enteritidis	2 (3.9)	2																		
Saintpaul	2 (3.9)	1		1			1	1	1											1
Senftenberg	2 (3.9)	1		1			1		1											
Typhimurium	2 (3.9)			1	1		1	1	1					2	1		1			2
Less common serovars	4 (7.8)	2	1	1			1	1												1
Total	**51 (100)**	**20**	**9**	**21**	**1**		**8**	**8**	**15**	**10**	**11**	**10**	**11**	**14**	**1**		**1**			**21**
Atlantic																				
Heidelberg	8 (50.0)	6		2			1	1	2	1	1	1	1	1						1
Albany	3 (18.8)		2	1			3		1		1		1							
Hadar	1 (6.3)			1				1												1
Kentucky	1 (6.3)	1																		
Muenchen	1 (6.3)			1				1						1						1
Schwarzengrund	1 (6.3)	1																		
Senftenberg	1 (6.3)		1				1													
Total	**16 (100)**	**8**	**3**	**5**			**5**	**3**	**3**	**1**	**2**	**1**	**2**	**2**						**3**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.7. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from turkey, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	64 (11.4)	29	6	21	8		11	25	22	5	5	6	4	14	5		3			28
Prairies	103 (18.4)	33	14	42	13	1	21	40	34	4	3	4	3	32	6	1	5	1	2	61
Ontario	143 (25.5)	42	22	61	18		28	45	47	1	1	1	1	52	14		5		1	96
Québec	118 (21.0)	37	24	39	17	1	18	39	34	5	6	5	6	44	13		4	2	3	70
Atlantic	133 (23.7)	23	36	55	19		24	49	50	6	5	5	4	47	15		6	1	1	96

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table 2.8. Number of antimicrobial classes in resistance patterns of *Campylobacter* from turkey, 2014

Province or region / species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial								
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
British Columbia															
Campylobacter jejuni	22 (78.6)	11	5	6									7	7	10
Campylobacter coli	6 (21.4)	1	5										2	2	3
Total	**28 (100)**	**12**	**10**	**6**									**9**	**9**	**13**
Prairies															
Campylobacter jejuni	9 (75.0)	3	6												6
Campylobacter coli	3 (25.0)		2	1						1	1		2	2	2
Total	**12 (100)**	**3**	**8**	**1**						**1**	**1**		**2**	**2**	**8**
Ontario															
Campylobacter jejuni	20 (71.4)	2	15	3									4	4	17
Campylobacter coli	8 (28.6)	2		5	1			6	4	6	6				3
Total	**28 (100)**	**4**	**15**	**8**	**1**			**6**	**4**	**6**	**6**		**4**	**4**	**20**
Québec															
Campylobacter jejuni	5 (100)	2	2	1				1	1	1	1		1	1	1
Total	**5 (100)**	**2**	**2**	**1**				**1**	**1**	**1**	**1**		**1**	**1**	**1**
Atlantic															
Campylobacter spp.	9 (100)	4	4	1									1	1	5
Total	**9 (100)**	**4**	**4**	**1**									**1**	**1**	**5**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.
At the time of release of this report*, Campylobacter* speciation results for the Atlantic region were unavailable.
The Prairies is a region including the provinces of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.
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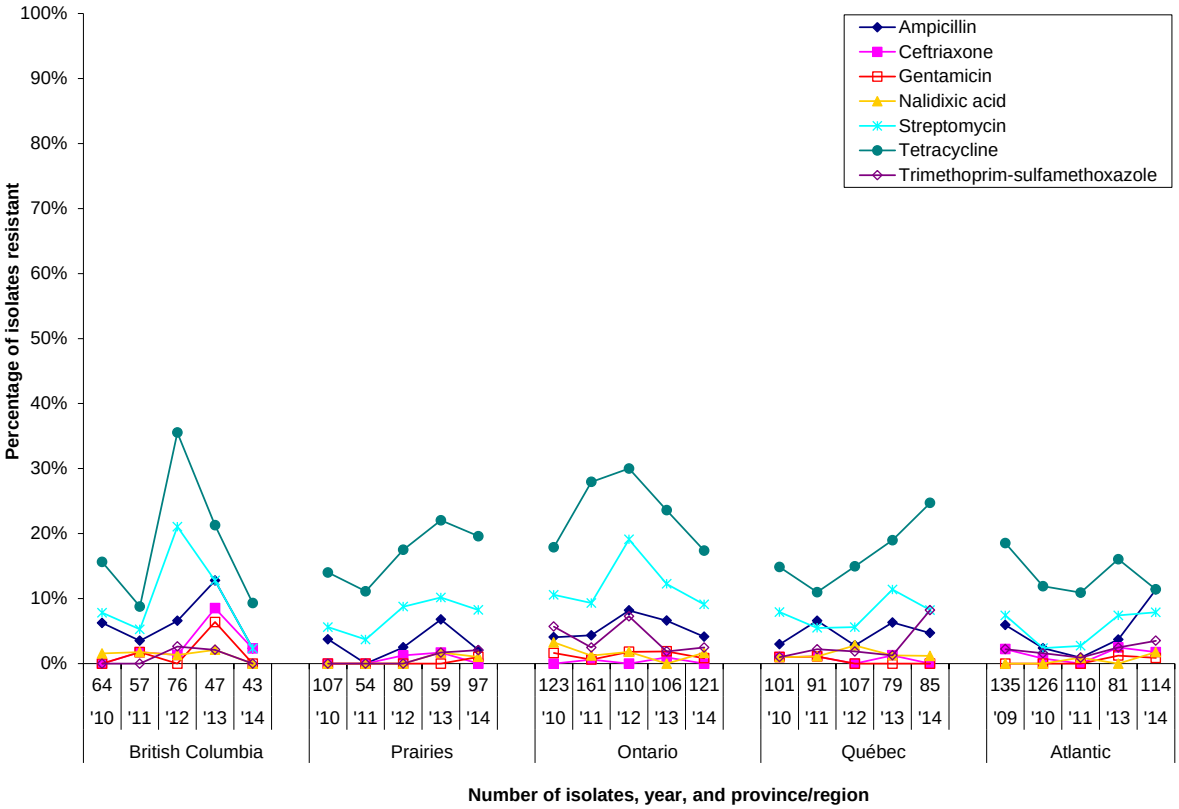
TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

Figure 2.1. Temporal variations in resistance of *Escherichia coli* isolates from beef, 2010–2014



Province / region	British Columbia					Prairies					Ontario					Québec					Atlantic				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'09	'10	'11	'13	'14
Number of isolates	64	57	76	47	43	107	54	80	59	97	123	161	110	106	121	101	91	107	79	85	135	126	110	81	114
Antimicrobial																									
Ampicillin	**6%**	4%	7%	**13%**	**2%**	**4%**	0%	3%	**7%**	**2%**	**4%**	4%	8%	**7%**	**4%**	**3%**	7%	3%	**6%**	**5%**	6%	**2%**	1%	**4%**	**11%**
Ceftriaxone	**0%**	2%	1%	**9%**	**2%**	**0%**	0%	1%	**2%**	**0%**	**0%**	1%	0%	**1%**	**0%**	**1%**	1%	0%	**1%**	**0%**	2%	**1%**	0%	**2%**	**2%**
Gentamicin	**0%**	2%	0%	**6%**	**0%**	**0%**	0%	0%	**0%**	**1%**	**2%**	1%	2%	**2%**	**1%**	**1%**	1%	0%	**0%**	**0%**	0%	**0%**	0%	**1%**	**1%**
Nalidixic acid	**2%**	2%	1%	**2%**	**0%**	**0%**	0%	0%	**2%**	**1%**	**3%**	1%	2%	**0%**	**2%**	**1%**	1%	3%	**1%**	**1%**	0%	**0%**	1%	**0%**	**2%**
Streptomycin	**8%**	5%	21%	**13%**	**2%**	**6%**	4%	9%	**10%**	**8%**	**11%**	9%	19%	**12%**	**9%**	**8%**	5%	6%	**11%**	**8%**	7%	**2%**	3%	**7%**	**8%**
Tetracycline	**16%**	9%	36%	**21%**	**9%**	**14%**	11%	18%	**22%**	**20%**	**18%**	28%	30%	**24%**	**17%**	**15%**	11%	15%	**19%**	**25%**	19%	**12%**	11%	**16%**	**11%**
Trimethoprim-sulfamethoxazole	**0%**	0%	3%	**2%**	**0%**	**0%**	0%	0%	**2%**	**2%**	**6%**	2%	7%	**2%**	**2%**	**1%**	2%	2%	**1%**	**8%**	2%	**2%**	1%	**2%**	**4%**

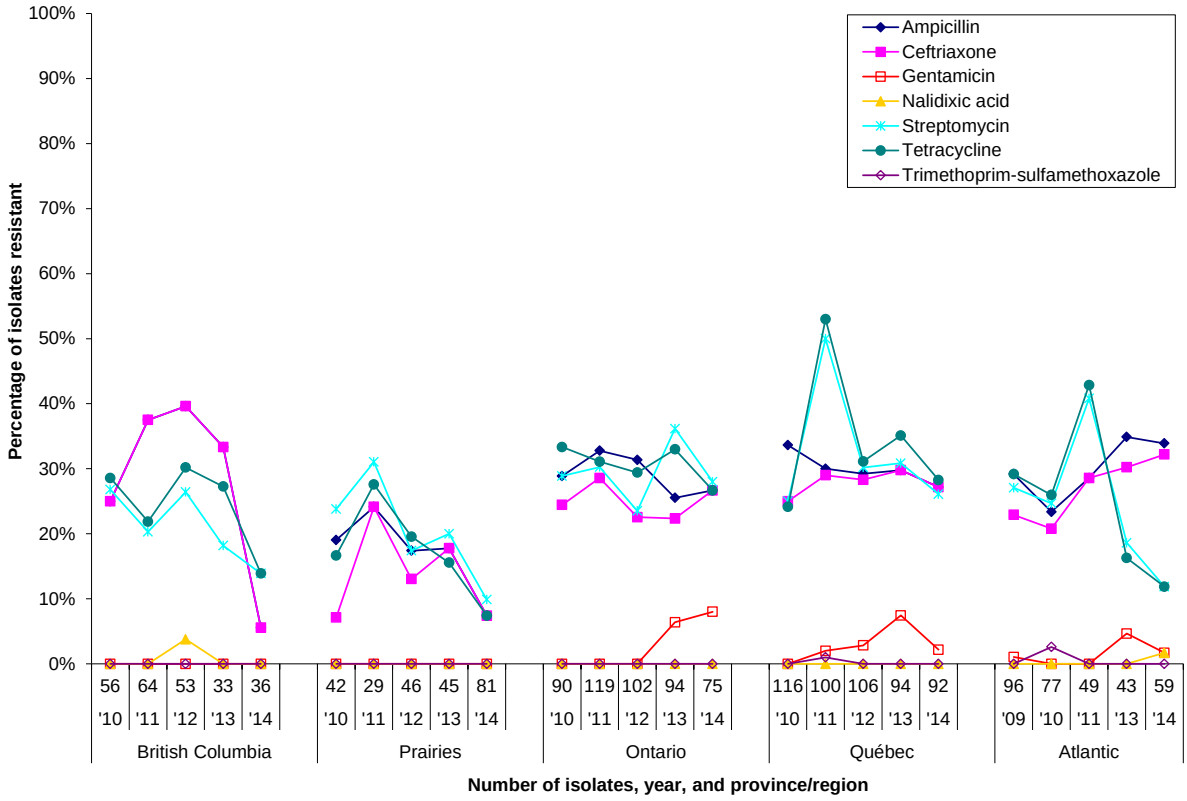
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas); the referent years for the Atlantic region were aligned with the other provinces/regions to standardize results. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Figure 2.2. Temporal variations in resistance of *Salmonella* isolates from chicken, 2010–2014



Province / region	British Columbia					Prairies					Ontario							Québec							Atlantic				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'04	'06	'10	'11	'12	'13	'14	'04	'06	'10	'11	'12	'13	'14	'09	'10	'11	'13	'14
Number of isolates	56	64	53	33	36	42	29	46	45	81	54	36	90	119	102	94	75	53	33	116	100	106	94	92	96	77	49	43	59
Antimicrobial																													
Ampicillin	25%	38%	40%	33%	6%	19%	24%	17%	18%	7%	52%	17%	29%	33%	31%	26%	27%	49%	15%	34%	30%	29%	30%	27%	29%	23%	29%	35%	34%
Ceftriaxone	25%	38%	40%	33%	6%	7%	24%	13%	18%	7%	46%	14%	24%	29%	23%	22%	27%	40%	9%	25%	29%	28%	30%	27%	23%	21%	29%	30%	32%
Gentamicin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%			0%	0%	0%	6%	8%			0%	2%	3%	7%	2%	1%	0%	0%	5%	2%
Nalidixic acid	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%			0%	0%	0%	0%	0%			0%	0%	0%	0%	0%	0%	0%	0%	0%	2%
Streptomycin	27%	20%	26%	18%	14%	24%	31%	17%	20%	10%			29%	30%	24%	36%	28%			25%	50%	30%	31%	26%	27%	25%	41%	19%	12%
Tetracycline	29%	22%	30%	27%	14%	17%	28%	20%	16%	7%			33%	31%	29%	33%	27%			24%	53%	31%	35%	28%	29%	26%	43%	16%	12%
Trimethoprim-sulfamethoxazole	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%			0%	0%	0%	0%	0%			0%	1%	0%	0%	0%	0%	3%	0%	0%	0%

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas); the referent years for the Atlantic region were aligned with the other provinces/regions to standardize results. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Additional temporal analyses for ampicillin and ceftiofur/ceftriaxone were conducted for *Salmonella* isolates from Ontario and Québec. These 2 antimicrobials, provinces, and years (2004 and 2006) were selected due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end of the voluntary period of withdrawal). Significant differences ($P \leq 0.05$) observed between the current year results and additional reference year results are indicated by underlined numbers.

Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

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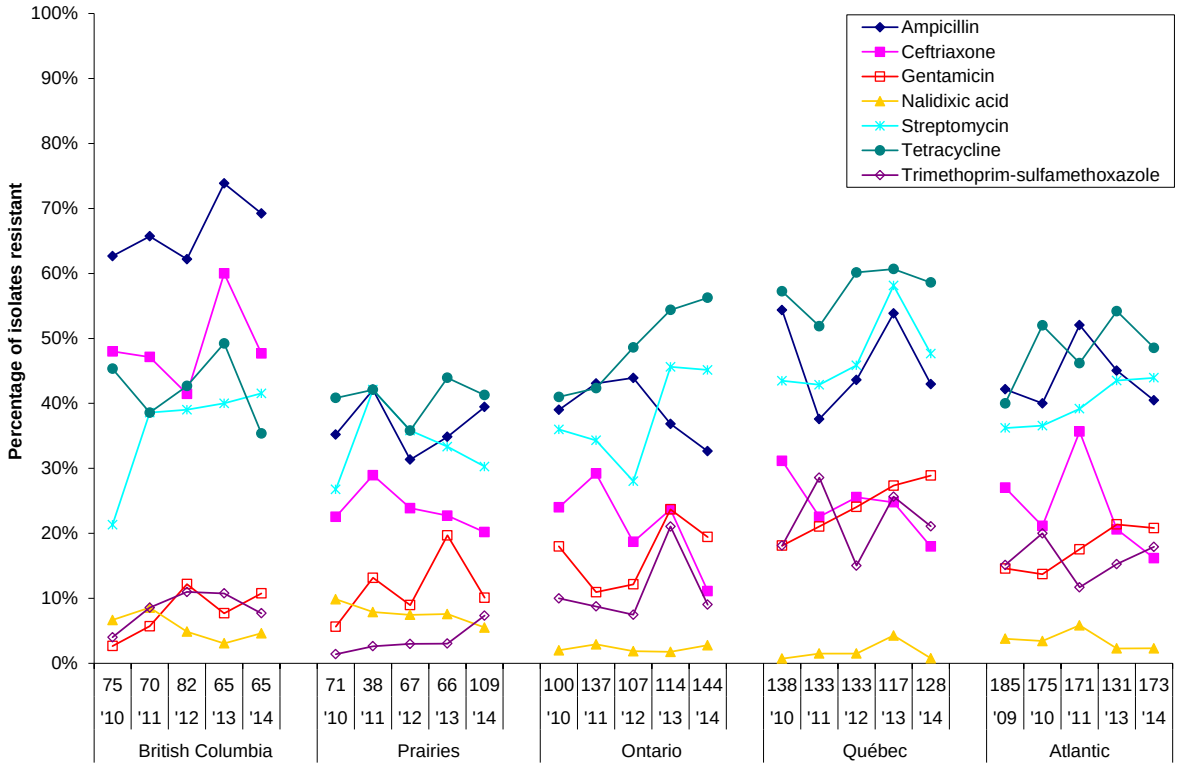
Figure 2.3. Temporal variations in resistance of *Escherichia coli* isolates from chicken, 2010–2014



Number of isolates, year, and province/region

Province / region	British Columbia					Prairies					Ontario							Québec							Atlantic				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'04	'06	'10	'11	'12	'13	'14	'04	'06	'10	'11	'12	'13	'14	'09	'10	'11	'13	'14
Number of isolates	75	70	82	65	65	71	38	67	66	109	150	152	100	137	107	114	144	158	135	138	133	133	117	128	185	175	171	131	173
Antimicrobial																													
Ampicillin	63%	66%	62%	74%	69%	35%	42%	31%	35%	39%	39%	42%	39%	43%	44%	37%	33%	52%	35%	54%	38%	44%	54%	43%	42%	40%	52%	45%	40%
Ceftriaxone	48%	47%	41%	60%	48%	23%	29%	24%	23%	20%	24%	28%	24%	29%	19%	24%	11%	40%	7%	31%	23%	26%	25%	18%	27%	21%	36%	21%	16%
Gentamicin	3%	6%	12%	8%	11%	6%	13%	9%	20%	10%			18%	11%	12%	24%	19%			18%	21%	24%	27%	29%	15%	14%	18%	21%	21%
Nalidixic acid	7%	9%	5%	3%	5%	10%	8%	7%	8%	6%			2%	3%	2%	2%	3%			1%	2%	2%	4%	1%	4%	3%	6%	2%	2%
Streptomycin	21%	39%	39%	40%	42%	27%	42%	36%	33%	30%			36%	34%	28%	46%	45%			43%	43%	46%	58%	48%	36%	37%	39%	44%	44%
Tetracycline	45%	39%	43%	49%	35%	41%	42%	36%	44%	41%			41%	42%	49%	54%	56%			57%	52%	60%	61%	59%	40%	52%	46%	54%	49%
Trimethoprim-sulfamethoxazole	4%	9%	11%	11%	8%	1%	3%	3%	3%	7%			10%	9%	7%	21%	9%			18%	29%	15%	26%	21%	15%	20%	12%	15%	18%

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas); the referent years for the Atlantic region were aligned with the other provinces/regions to standardize results. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

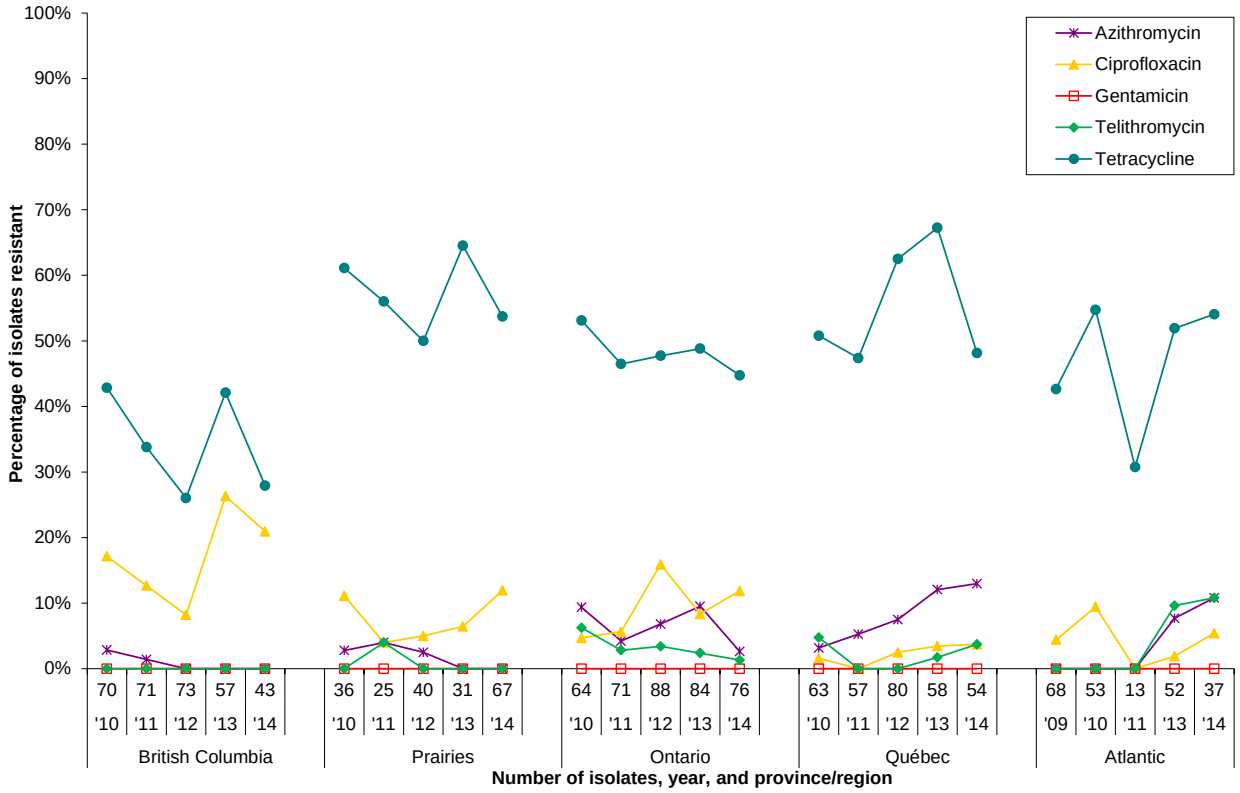
Additional temporal analyses for ampicillin and ceftiofur/ceftriaxone were conducted for *E. coli* isolates from Ontario and Québec. These 2 antimicrobials, provinces, and years (2004 and 2006) were selected due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end of the voluntary period of withdrawal). Significant differences ($P \leq 0.05$) observed between the current year results and additional reference year results are indicated by underlined numbers.

Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Figure 2.4. Temporal variations in resistance of *Campylobacter* isolates from chicken, 2010–2014



Province / region	British Columbia					Prairies					Ontario					Québec					Atlantic				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'09	'10	'11	'13	'14
Number of isolates	70	71	73	57	43	36	25	40	31	67	64	71	88	84	76	63	57	80	58	54	47	68	53	52	37
Antimicrobial																									
Azithromycin	**3%**	1%	0%	**0%**	**0%**	**3%**	4%	3%	**0%**	**0%**	**9%**	4%	7%	**10%**	**3%**	**3%**	5%	8%	**12%**	**13%**	6%	**0%**	0%	**8%**	**11%**
Ciprofloxacin	**17%**	13%	8%	**26%**	**21%**	**11%**	4%	5%	**6%**	**12%**	**5%**	6%	16%	**8%**	**12%**	**2%**	0%	3%	**3%**	**4%**	4%	**4%**	9%	**2%**	**5%**
Gentamicin	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	0%	**0%**	0%	**0%**	**0%**
Telithromycin	**0%**	0%	0%	**0%**	**0%**	**0%**	4%	0%	**0%**	**0%**	**6%**	3%	3%	**2%**	**1%**	**5%**	0%	0%	**2%**	**4%**	6%	**0%**	0%	**10%**	**11%**
Tetracycline	**43%**	34%	26%	**42%**	**28%**	**61%**	56%	50%	**65%**	**54%**	**53%**	46%	48%	**49%**	**45%**	**51%**	47%	63%	**67%**	**48%**	53%	**43%**	55%	**52%**	**54%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas); the referent years for the Atlantic region were aligned with the other provinces/regions to standardize results. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

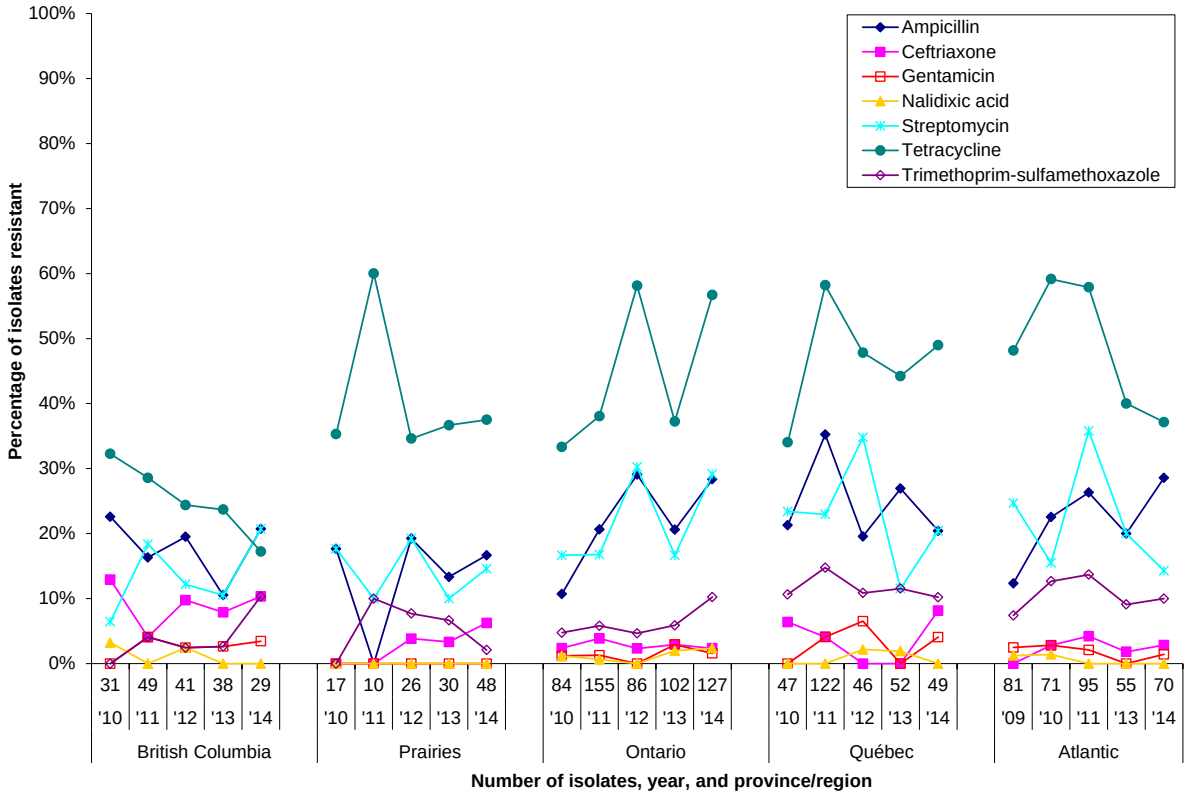
Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

Although routine retail surveillance began in the Atlantic region in 2008, no results are displayed for that year due to concerns regarding harmonization of laboratory methods.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Figure 2.5. Temporal variations in resistance of *Escherichia coli* isolates from pork, 2010–2014



Province / region	British Columbia					Prairies					Ontario					Québec					Atlantic				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'09	'10	'11	'13	'14
Number of isolates	31	49	41	38	29	17	10	26	30	48	84	155	86	102	127	47	122	46	52	49	81	71	95	55	70
Antimicrobial																									
Ampicillin	**23%**	16%	20%	**11%**	**21%**	**18%**	0%	19%	**13%**	**17%**	**11%**	21%	29%	**21%**	**28%**	**21%**	35%	20%	**27%**	**20%**	12%	**23%**	26%	**20%**	**29%**
Ceftriaxone	**13%**	4%	10%	**8%**	**10%**	**0%**	0%	4%	**3%**	**6%**	**2%**	4%	2%	**3%**	**2%**	**6%**	4%	0%	**0%**	**8%**	0%	**3%**	4%	**2%**	**3%**
Gentamicin	**0%**	4%	2%	**3%**	**3%**	**0%**	0%	0%	**0%**	**0%**	**1%**	1%	0%	**3%**	**2%**	**0%**	4%	7%	**0%**	**4%**	2%	**3%**	2%	**0%**	**1%**
Nalidixic acid	**3%**	0%	2%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**1%**	1%	0%	**2%**	**2%**	**0%**	0%	2%	**2%**	**0%**	1%	**1%**	0%	**0%**	**0%**
Streptomycin	**6%**	18%	12%	**11%**	**21%**	**18%**	10%	19%	**10%**	**15%**	**17%**	17%	30%	**17%**	**29%**	**23%**	23%	35%	**12%**	**20%**	25%	**15%**	36%	**20%**	**14%**
Tetracycline	**32%**	29%	24%	**24%**	**17%**	**35%**	60%	35%	**37%**	**38%**	**33%**	38%	58%	**37%**	**57%**	**34%**	58%	48%	**44%**	**49%**	48%	**59%**	58%	**40%**	**37%**
Trimethoprim-sulfamethoxazole	**0%**	4%	2%	**3%**	**10%**	**0%**	10%	8%	**7%**	**2%**	**5%**	6%	5%	**6%**	**10%**	**11%**	15%	11%	**12%**	**10%**	7%	**13%**	14%	**9%**	**10%**

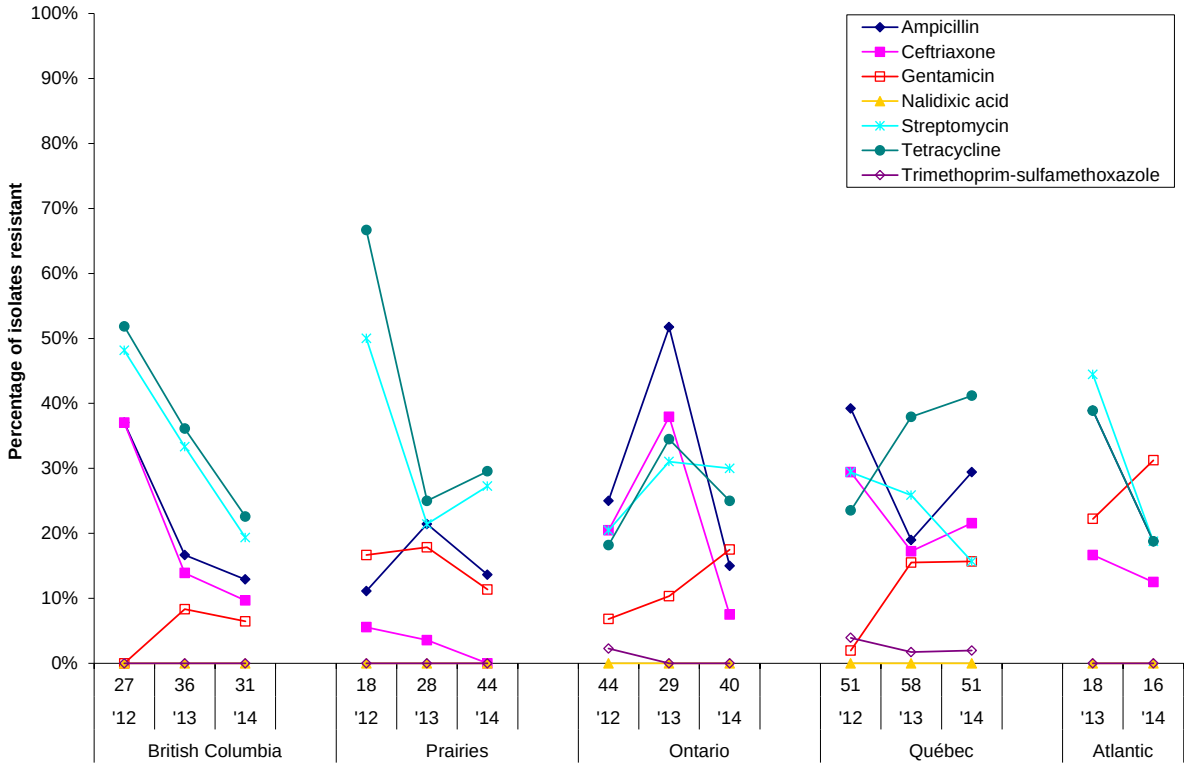
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas); the referent years for the Atlantic region were aligned with the other provinces/regions to standardize results. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Figure 2.6. Temporal variations in resistance of *Salmonella* isolates from turkey, 2012–2014



Province / region	British Columbia			Prairies			Ontario			Québec			Atlantic	
Year	'12	'13	'14	'12	'13	'14	'12	'13	'14	'12	'13	'14	'13	'14
Number of isolates	27	36	31	18	28	44	44	29	40	51	58	51	18	16
Antimicrobial														
Ampicillin	37%	17%	13%	11%	21%	14%	25%	52%	15%	39%	19%	29%	39%	19%
Ceftriaxone	37%	14%	10%	6%	4%	0%	20%	38%	8%	29%	17%	22%	17%	13%
Gentamicin	0%	8%	6%	17%	18%	11%	7%	10%	18%	2%	16%	16%	22%	31%
Nalidixic acid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Streptomycin	48%	33%	19%	50%	21%	27%	20%	31%	30%	29%	26%	16%	44%	19%
Tetracycline	52%	36%	23%	67%	25%	30%	18%	34%	25%	24%	38%	41%	39%	19%
Trimethoprim-sulfamethoxazole	0%	0%	0%	0%	0%	0%	2%	0%	0%	4%	2%	2%	0%	0%

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). Although temporal data are shown for most regions in 2012, 2013 represents the first year that retail turkey data were available in all regions and is therefore considered the first referent year. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

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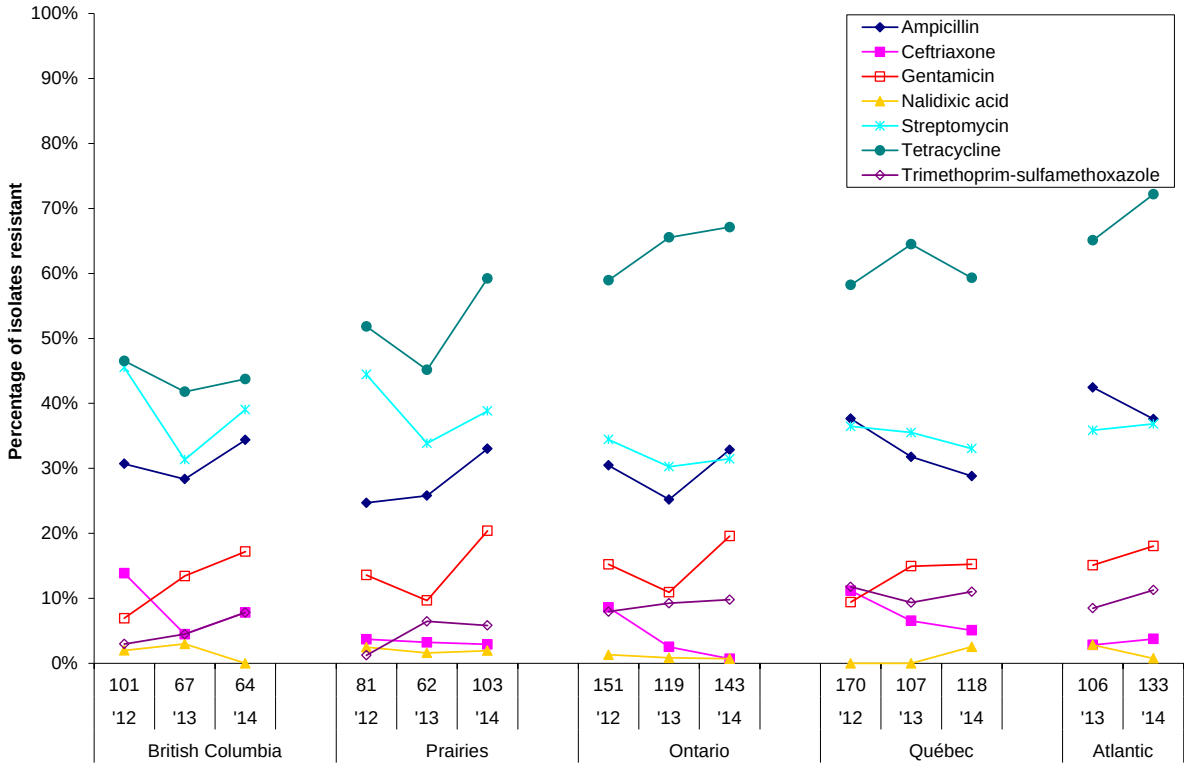
Figure 2.7. Temporal variations in resistance of *Escherichia coli* isolates from turkey, 2012–2014



Province / region	British Columbia			Prairies			Ontario			Québec			Atlantic	
Year	'12	'13	'14	'12	'13	'14	'12	'13	'14	'12	'13	'14	'13	'14
Number of isolates	101	67	64	81	62	103	151	119	143	170	107	118	106	133
Antimicrobial														
Ampicillin	31%	**28%**	**34%**	25%	**26%**	**33%**	30%	**25%**	**33%**	38%	**32%**	**29%**	**42%**	**38%**
Ceftriaxone	14%	**4%**	**8%**	4%	**3%**	**3%**	9%	**3%**	**1%**	11%	**7%**	**5%**	**3%**	**4%**
Gentamicin	7%	**13%**	**17%**	14%	**10%**	**20%**	15%	**11%**	**20%**	9%	**15%**	**15%**	**15%**	**18%**
Nalidixic acid	2%	**3%**	**0%**	2%	**2%**	**2%**	1%	**1%**	**1%**	0%	**0%**	**3%**	**3%**	**1%**
Streptomycin	46%	**31%**	**39%**	44%	**34%**	**39%**	34%	**30%**	**31%**	36%	**36%**	**33%**	**36%**	**37%**
Tetracycline	47%	**42%**	**44%**	52%	**45%**	**59%**	59%	**66%**	**67%**	58%	**64%**	**59%**	**65%**	**72%**
Trimethoprim-sulfamethoxazole	3%	**4%**	**8%**	1%	**6%**	**6%**	8%	**9%**	**10%**	12%	**9%**	**11%**	**8%**	**11%**

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). Although temporal data are shown for most regions in 2012, 2013 represents the first year that retail turkey data were available in all regions and is therefore considered the first referent year. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

Due to unforeseen and lengthy delays in retail sampling in the Atlantic region in 2012, data are not presented for this year in the interest of precision.

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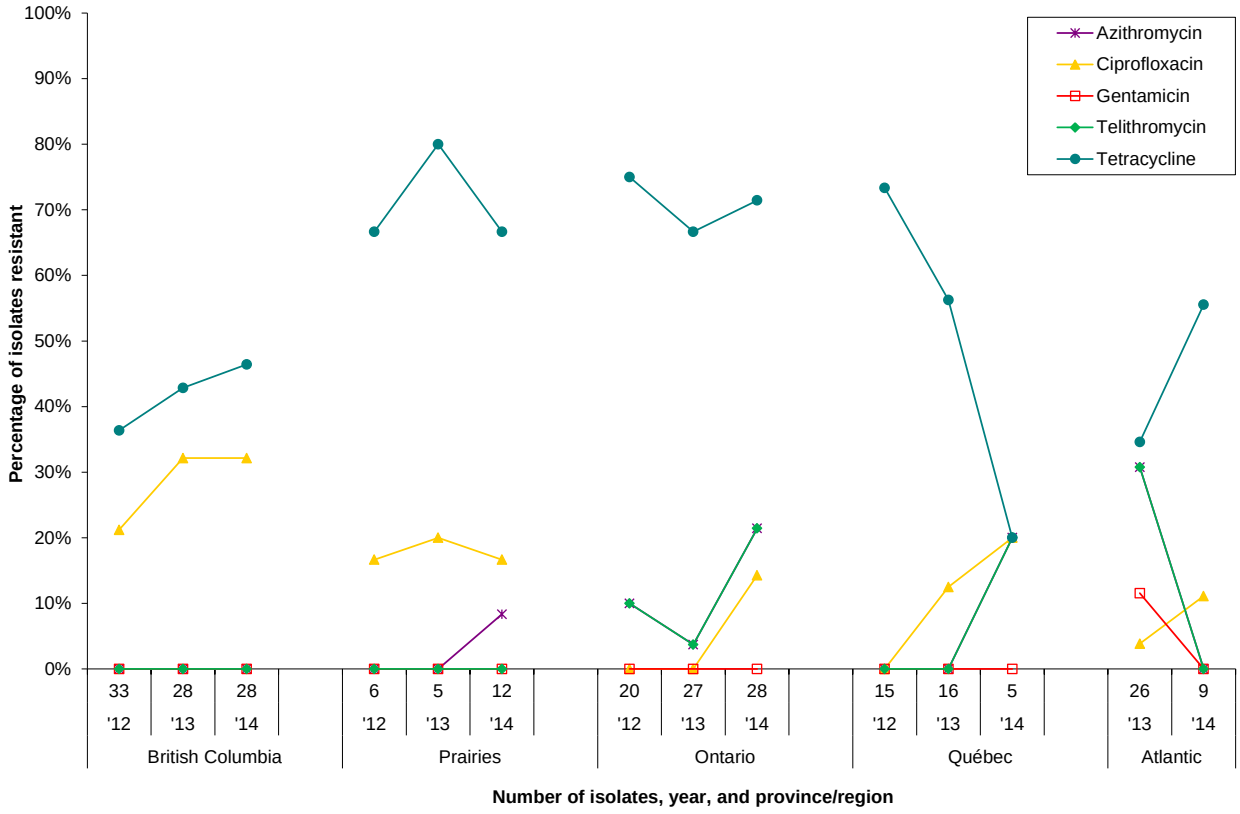
Figure 2.8. Temporal variations in resistance of *Campylobacter* isolates from turkey, 2012–2014



Province / region	British Columbia			Prairies			Ontario			Québec			Atlantic	
Year	'12	'13	'14	'12	'13	'14	'12	'13	'14	'12	'13	'14	'13	'14
Number of isolates	33	28	28	6	5	12	20	27	28	15	16	5	26	9
Antimicrobial														
Azithromycin	0%	**0%**	**0%**	0%	**0%**	**8%**	10%	**4%**	**21%**	0%	**0%**	**20%**	**31%**	**0%**
Ciprofloxacin	21%	**32%**	**32%**	17%	**20%**	**17%**	0%	**0%**	**14%**	0%	**13%**	**20%**	**4%**	**11%**
Gentamicin	0%	**0%**	**0%**	0%	**0%**	**0%**	0%	**0%**	**0%**	0%	**0%**	**0%**	**12%**	**0%**
Telithromycin	0%	**0%**	**0%**	0%	**0%**	**0%**	10%	**4%**	**21%**	0%	**0%**	**20%**	**31%**	**0%**
Tetracycline	36%	**43%**	**46%**	67%	**80%**	**67%**	75%	**67%**	**71%**	73%	**56%**	**20%**	**35%**	**56%**

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). Although temporal data are shown for most regions in 2012, 2013 represents the first year that retail turkey data were available in all regions and is therefore considered the first referent year. The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

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MINIMUM INHIBITORY CONCENTRATIONS

See how to interpret the minimum inhibitory concentration tables in the section ''How to Read this Chapter''.

Table 2.9. Distribution of minimum inhibitory concentrations among *Escherichia coli* from beef, 2014

Antimicrobial	Province/region	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
Amoxicillin-clavulanic acid	British Columbia	43	4	4	2.3							2.3	34.9	55.8	4.7			2.3			
	Prairies	97	4	4	0.0							4.1	34.0	55.7	6.2						
	Ontario	121	4	4	0.0							1.7	43.8	45.5	9.1						
	Québec	85	4	4	0.0							10.6	35.3	45.9	8.2						
	Atlantic	114	4	32	14.0							5.3	26.3	48.2	6.1		10.5	3.5			
Ceftiofur	British Columbia	43	0.50	0.50	2.3				9.3	39.5	48.8					2.3					
	Prairies	97	0.50	0.50	0.0				6.2	37.1	53.6	3.1									
	Ontario	121	0.50	0.50	0.0				9.1	33.9	55.4	1.7									
	Québec	85	0.25	0.50	0.0				9.4	43.5	44.7	2.4									
I	Atlantic	114	0.50	0.50	1.8				4.4	36.8	53.5	3.5				1.8					
Ceftriaxone	British Columbia	43	≤ 0.25	≤ 0.25	2.3					97.7						2.3					
	Prairies	97	≤ 0.25	≤ 0.25	0.0					100.0											
	Ontario	121	≤ 0.25	≤ 0.25	0.0					100.0											
	Québec	85	≤ 0.25	≤ 0.25	0.0					100.0											
	Atlantic	114	≤ 0.25	≤ 0.25	1.8					93.0	1.8	2.6	0.9			1.8					
Ciprofloxacin	British Columbia	43	≤ 0.015	≤ 0.015	0.0	97.7	2.3														
	Prairies	97	≤ 0.015	≤ 0.015	0.0	97.9	1.0			1.0											
	Ontario	121	≤ 0.015	≤ 0.015	0.0	96.7	1.7		0.8	0.8											
	Québec	85	≤ 0.015	≤ 0.015	0.0	96.5	2.4				1.2										
	Atlantic	114	≤ 0.015	≤ 0.015	0.0	93.9	4.4			1.8											
Ampicillin	British Columbia	43	2	4	2.3							14.0	58.1	25.6				2.3			
	Prairies	97	2	4	2.1							13.4	63.9	19.6	1.0			2.1			
	Ontario	121	2	4	4.1							14.9	59.5	20.7	0.8			4.1			
	Québec	85	2	4	4.7							23.5	44.7	27.1				4.7			
	Atlantic	114	2	32	11.4							9.6	44.7	26.3		7.9	4.4	7.0			
Azithromycin	British Columbia	43	4	8	0.0							2.3	2.3	51.2	44.2						
	Prairies	97	4	8	0.0							1.0	10.3	41.2	44.3	3.1					
	Ontario	121	4	8	0.0						0.8	1.7	3.3	50.4	43.0	0.8					
	Québec	85	4	8	0.0						1.2		11.8	45.9	37.6	3.5					
	Atlantic	114	4	16	0.0							0.9	7.9	45.6	31.6	14.0					
II Cefoxitin	British Columbia	43	4	8	2.3							2.3	30.2	55.8	9.3			2.3			
	Prairies	97	4	8	0.0							2.1	34.0	53.6	9.3	1.0					
	Ontario	121	4	8	0.0							0.8	24.8	59.5	13.2	1.7					
	Québec	85	4	8	0.0							3.5	27.1	55.3	11.8	2.4					
	Atlantic	114	4	4	2.6							3.5	27.2	60.5	5.3	0.9		2.6			
Gentamicin	British Columbia	43	1	2	0.0						34.9	53.5	11.6								
	Prairies	97	1	1	1.0						39.2	54.6	4.1		1.0	1.0					
	Ontario	121	1	1	0.8						36.4	58.7	4.1				0.8				
	Québec	85	1	1	0.0					1.2	36.5	61.2	1.2								
	Atlantic	114	1	1	0.9						47.4	47.4	4.4				0.9				

Table 2.9. Distribution of minimum inhibitory concentrations among *Escherichia coli* from beef, 2014 (cont'd)

	Antimicrobial	Province/region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)														
				MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Nalidixic acid	British Columbia	43	2	2	0.0						4.7	18.6	74.4	2.3							
		Prairies	97	2	2	1.0						3.1	20.6	71.1	4.1				1.0			
		Ontario	121	2	2	1.7							16.5	78.5	3.3				1.7			
		Québec	85	2	2	1.2						2.4	25.9	65.9	4.7			1.2				
		Atlantic	114	2	2	1.8						1.8	22.8	68.4	5.3				1.8			
	Streptomycin	British Columbia	43	8	16	2.3								2.3	18.6	65.1	11.6			2.3		
		Prairies	97	8	16	8.2									14.4	64.9	11.3	1.0	5.2	3.1		
II		Ontario	121	8	≤ 32	9.1									19.0	61.2	7.4	3.3	0.8	8.3		
		Québec	85	8	≤ 32	8.2									23.5	60.0	5.9	2.4	4.7	3.5		
		Atlantic	114	8	16	7.9									19.3	63.2	8.8	0.9	1.8	6.1		
	Trimethoprim-sulfamethoxazole	British Columbia	43	≤ 0.12	≤ 0.12	0.0				100.0												
		Prairies	97	≤ 0.12	≤ 0.12	2.1				96.9	1.0					2.1						
		Ontario	121	≤ 0.12	≤ 0.12	2.5				97.5						2.5						
		Québec	85	≤ 0.12	≤ 0.12	8.2				91.8						8.2						
		Atlantic	114	≤ 0.12	0.25	3.5				85.1	9.6	1.8				3.5						
	Chloramphenicol	British Columbia	43	8	8	0.0								7.0	27.9	65.1						
		Prairies	97	8	8	2.1								4.1	35.1	53.6	5.2	1.0	1.0			
		Ontario	121	8	16	6.6								6.6	32.2	50.4	4.1		6.6			
		Québec	85	8	16	9.4								7.1	24.7	52.9	5.9	4.7	4.7			
		Atlantic	114	8	8	2.6								4.4	43.0	49.1	0.9		2.6			
	Sulfisoxazole	British Columbia	43	≤ 16	32	0.0											86.0	11.6	2.3			
III		Prairies	97	≤ 16	32	9.3											80.4	10.3				9.3
		Ontario	121	≤ 16	32	9.9											84.3	5.8				9.9
		Québec	85	≤ 16	> 256	10.6											70.6	15.3	2.4		1.2	10.6
		Atlantic	114	≤ 16	64	8.8											75.4	5.3	9.6	0.9		8.8
	Tetracycline	British Columbia	43	≤ 4	≤ 4	9.3									90.7		4.7		4.7			
		Prairies	97	≤ 4	> 32	19.6									77.3	3.1	3.1	3.1	13.4			
		Ontario	121	≤ 4	> 32	17.4									79.3	3.3	1.7	3.3	12.4			
		Québec	85	≤ 4	> 32	24.7									72.9	2.4	4.7	3.5	16.5			
		Atlantic	114	≤ 4	32	11.4									85.1	3.5	0.9	1.8	8.8			
IV																						

Table 2.10. Distribution of minimum inhibitory concentrations among *Salmonella* from chicken, 2014

	Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	36	≤ 1	≤ 1	5.6							94.4					2.8	2.8			
		Prairies	81	≤ 1	2	7.4							88.9	3.7				1.2	6.2			
		Ontario	75	≤ 1	> 32	26.7							73.3					2.7	24.0			
		Quebec	92	≤ 1	> 32	27.2							72.8					9.8	17.4			
		Atlantic	59	≤ 1	> 32	32.2							66.1				1.7	8.5	23.7			
	Ceftiofur	British Columbia	36	1	1	5.6						30.6	63.9				5.6					
		Prairies	81	1	2	7.4						17.3	71.6	3.7			7.4					
		Ontario	75	1	> 8	26.7					1.3	40.0	32.0				26.7					
		Quebec	92	1	> 8	27.2					1.1	41.3	29.3	1.1			27.2					
I		Atlantic	59	1	> 8	32.2					1.7	40.7	25.4				32.2					
	Ceftriaxone	British Columbia	36	≤ 0.25	≤ 0.25	5.6					94.4					2.8	2.8					
		Prairies	81	≤ 0.25	≤ 0.25	7.4					92.6						6.2		1.2			
		Ontario	75	≤ 0.25	16	26.7					73.3						22.7	4.0				
		Quebec	92	≤ 0.25	16	27.2					72.8					4.3	15.2	7.6				
		Atlantic	59	≤ 0.25	16	32.2					67.8					1.7	27.1	3.4				
	Ciprofloxacin	British Columbia	36	≤ 0.015	0.03	0.0	69.4	30.6														
		Prairies	81	≤ 0.015	0.03	0.0	72.8	24.7	2.5													
		Ontario	75	≤ 0.015	0.03	0.0	85.3	14.7														
		Quebec	92	≤ 0.015	0.03	0.0	83.7	15.2	1.1													
		Atlantic	59	≤ 0.015	≤ 0.015	0.0	93.2	5.1	1.7													
	Ampicillin	British Columbia	36	≤ 1	≤ 1	5.6							91.7	2.8					5.6			
		Prairies	81	≤ 1	2	7.4							80.2	9.9	1.2	1.2			7.4			
		Ontario	75	≤ 1	> 32	26.7							72.0	1.3					26.7			
		Quebec	92	≤ 1	> 32	27.2							71.7	1.1					27.2			
		Atlantic	59	≤ 1	> 32	33.9							64.4	1.7					33.9			
	Azithromycin	British Columbia	36	4	8	0.0								22.2	63.9	13.9						
		Prairies	81	4	8	0.0								6.2	53.1	40.7						
		Ontario	75	4	8	0.0							2.7	9.3	45.3	38.7	4.0					
		Quebec	92	4	8	0.0					1.1	1.1	1.1	5.4	53.3	35.9	2.2					
		Atlantic	59	4	8	0.0							1.7	3.4	62.7	30.5	1.7					
	Cefoxitin	British Columbia	36	2	4	5.6							11.1	75.0	8.3			5.6				
		Prairies	81	2	4	7.4							3.7	74.1	12.3	1.2	1.2	4.9	2.5			
		Ontario	75	2	32	26.7							10.7	54.7	8.0			20.0	6.7			
		Quebec	92	2	32	27.2							13.0	57.6	2.2			22.8	4.3			
		Atlantic	59	2	> 32	32.2						1.7	33.9	23.7	6.8	1.7		22.0	10.2			
	Gentamicin	British Columbia	36	0.50	0.50	0.0					38.9	52.8	8.3									
		Prairies	81	0.50	0.50	0.0					33.3	56.8	9.9									
II		Ontario	75	0.50	1	8.0					25.3	62.7	4.0				1.3	6.7				
		Quebec	92	0.50	0.50	2.2					27.2	66.3	4.3				1.1	1.1				
		Atlantic	59	0.50	1	1.7					22.0	66.1	10.2					1.7				
	Nalidixic acid	British Columbia	36	4	4	0.0							2.8	38.9	52.8	5.6						
		Prairies	81	4	4	0.0								29.6	64.2	6.2						
		Ontario	75	4	4	0.0							1.3	32.0	62.7	4.0						
		Quebec	92	4	4	0.0							4.3	31.5	62.0	2.2						
		Atlantic	59	4	4	1.7							3.4	40.7	54.2				1.7			
	Streptomycin	British Columbia	36	4	64	13.9								27.8	38.9	11.1	5.6	2.8	11.1	2.8		
		Prairies	81	8	≤ 32	9.9								12.3	37.0	18.5	21.0	1.2	1.2	8.6		
		Ontario	75	16	> 64	28.0								1.3	12.0	30.7	25.3	2.7	5.3	22.7		
		Quebec	92	16	> 64	26.1									5.4	30.4	32.6	5.4	12.0	14.1		
		Atlantic	59	16	64	11.9								1.7	10.2	35.6	35.6	5.1	8.5	3.4		
	Trimethoprim-sulfamethoxazole	British Columbia	36	≤ 0.12	≤ 0.12	0.0				100.0												
		Prairies	81	≤ 0.12	≤ 0.12	0.0				100.0												
		Ontario	75	≤ 0.12	≤ 0.12	0.0				97.3	2.7											
		Quebec	92	≤ 0.12	≤ 0.12	0.0				100.0												
		Atlantic	59	≤ 0.12	≤ 0.12	0.0				100.0												
	Chloramphenicol	British Columbia	36	8	8	0.0									41.7	58.3						
		Prairies	81	8	8	0.0								1.2	30.9	64.2	3.7					
		Ontario	75	8	8	2.7								1.3	40.0	56.0			2.7			
		Quebec	92	8	8	0.0								5.4	44.6	50.0						
		Atlantic	59	8	8	0.0								6.8	37.3	55.9						
	Sulfisoxazole	British Columbia	36	32	64	0.0											19.4	66.7	11.1	2.8		
		Prairies	81	32	64	1.2											17.3	70.4	11.1			1.2
III		Ontario	75	32	> 256	16.0											42.7	34.7	6.7			16.0
		Quebec	92	32	32	3.3											42.4	48.9	5.4			3.3
		Atlantic	59	32	32	0.0											44.1	50.8	5.1			
	Tetracycline	British Columbia	36	≤ 4	> 32	13.9									80.6	5.6			13.9			
		Prairies	81	≤ 4	≤ 4	7.4									92.6				7.4			
		Ontario	75	≤ 4	> 32	26.7									73.3			1.3	25.3			
		Quebec	92	≤ 4	> 32	28.3									71.7			1.1	27.2			
		Atlantic	59	≤ 4	> 32	11.9									88.1				11.9			
IV																						

Table 2.11. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chicken, 2014

Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
Amoxicillin-clavulanic acid	British Columbia	65	8	32	47.7							3.1	15.4	18.5	15.4		44.6	3.1			
	Prairies	109	4	32	19.3							0.9	27.5	32.1	16.5	3.7	19.3				
	Ontario	144	4	32	11.1							3.5	27.1	38.2	19.4	0.7	10.4	0.7			
	Québec	128	4	32	15.6							2.3	25.0	32.0	21.9	3.1	13.3	2.3			
	Atlantic	173	4	32	17.9							2.3	22.5	40.5	15.6	1.2	12.1	5.8			
Ceftiofur	British Columbia	65	2	> 8	46.2					13.8	24.6	4.6	9.2	1.5	30.8	15.4					
	Prairies	109	0.50	8	16.5				2.8	22.9	51.4	2.8		3.7	9.2	7.3					
	Ontario	144	0.50	8	10.4				1.4	31.9	54.2	1.4		0.7	6.3	4.2					
	Québec	128	0.50	8	16.4				0.8	35.2	46.1			1.6	10.2	6.3					
I	Atlantic	173	0.50	8	15.0				0.6	38.7	42.2	1.7	0.6	1.2	8.1	6.9					
Ceftriaxone	British Columbia	65	2	16	47.7					40.0	1.5	7.7	3.1	1.5	16.9	27.7	1.5				
	Prairies	109	≤ 0.25	16	20.2					78.0		1.8			9.2	9.2	0.9		0.9		
	Ontario	144	≤ 0.25	8	11.1					88.9					4.9	5.6	0.7				
	Québec	128	≤ 0.25	16	18.0					81.3	0.8				7.0	7.8	2.3		0.8		
	Atlantic	173	≤ 0.25	16	16.2					82.1	1.7			0.6	4.0	11.0	0.6				
Ciprofloxacin	British Columbia	65	≤ 0.015	≤ 0.015	0.0	90.8	3.1			3.1	3.1										
	Prairies	109	≤ 0.015	≤ 0.015	0.0	91.7	1.8		0.9	4.6	0.9										
	Ontario	144	≤ 0.015	≤ 0.015	0.0	95.8	1.4		0.7	2.1											
	Québec	128	≤ 0.015	≤ 0.015	0.0	98.4				0.8	0.8										
	Atlantic	173	≤ 0.015	≤ 0.015	0.0	95.4	2.3		0.6	1.7											
Ampicillin	British Columbia	65	> 32	> 32	69.2							3.1	24.6	3.1				69.2			
	Prairies	109	4	> 32	39.4							9.2	35.8	15.6				39.4			
	Ontario	144	4	> 32	32.6							9.0	38.2	19.4	0.7		0.7	31.9			
	Québec	128	4	> 32	43.0							12.5	28.9	14.8	0.8			43.0			
	Atlantic	173	4	> 32	40.5							12.1	27.2	20.2			0.6	39.9			
Azithromycin	British Columbia	65	4	8	0.0								9.2	55.4	35.4						
	Prairies	109	4	8	0.0								9.2	62.4	23.9	4.6					
	Ontario	144	4	8	0.0				0.7			0.7	8.3	50.0	37.5	2.8					
	Québec	128	4	8	0.0							0.8	8.6	50.0	39.1	1.6					
	Atlantic	173	4	8	0.6								9.8	63.0	24.9	1.7	0.6				
Cefoxitin	British Columbia	65	8	> 32	46.2								7.7	33.8	10.8	1.5	3.1	43.1			
	Prairies	109	4	> 32	19.3							0.9	16.5	46.8	16.5		1.8	17.4			
	Ontario	144	4	32	11.1								16.0	59.7	13.2		1.4	9.7			
	Québec	128	4	> 32	15.6								18.8	50.8	14.1	0.8	2.3	13.3			
	Atlantic	173	4	> 32	16.8								17.9	58.4	6.9		2.3	14.5			
Gentamicin	British Columbia	65	1	16	10.8						20.0	52.3	7.7		9.2	3.1	7.7				
	Prairies	109	1	16	10.1					0.9	26.6	61.5	0.9			0.9	9.2				
II	Ontario	144	1	> 16	19.4						29.2	47.9	2.8	0.7		4.2	15.3				
	Québec	128	1	> 16	28.9						20.3	47.7	1.6	0.8	0.8	6.3	22.7				
	Atlantic	173	1	> 16	20.8						31.2	45.1	2.3	0.6		4.6	16.2				
Nalidixic acid	British Columbia	65	2	4	4.6						1.5	24.6	63.1	4.6	1.5			4.6			
	Prairies	109	2	4	5.5							22.9	66.1	5.5			0.9	4.6			
	Ontario	144	2	2	2.8						2.1	27.8	63.9	3.5			0.7	2.1			
	Québec	128	2	2	0.8						0.8	35.2	57.8	4.7		0.8		0.8			
	Atlantic	173	2	2	2.3							24.9	71.1	1.7				2.3			
Streptomycin	British Columbia	65	8	> 64	41.5									15.4	38.5	1.5	3.1	10.8	30.8		
	Prairies	109	8	> 64	30.3									25.7	33.0	6.4	4.6	11.0	19.3		
	Ontario	144	≤ 32	> 64	45.1								0.7	11.1	31.3	4.9	6.9	20.8	24.3		
	Québec	128	≤ 32	> 64	47.7									9.4	24.2	5.5	13.3	20.3	27.3		
	Atlantic	173	16	> 64	43.9									15.0	31.8	4.6	4.6	15.6	28.3		
Trimethoprim-sulfamethoxazole	British Columbia	65	≤ 0.12	0.25	7.7				84.6	7.7					7.7						
	Prairies	109	≤ 0.12	0.50	7.3				85.3	4.6	2.8				7.3						
	Ontario	144	≤ 0.12	0.25	9.0				81.3	9.0	0.7			0.7	8.3						
	Québec	128	≤ 0.12	> 4	21.1				64.1	10.2	1.6	3.1			21.1						
	Atlantic	173	≤ 0.12	> 4	17.9				72.8	4.6	2.9	1.2	0.6		17.9						
Chloramphenicol	British Columbia	65	8	8	6.2								3.1	41.5	46.2	3.1		6.2			
	Prairies	109	8	8	3.7								3.7	30.3	60.6	1.8		3.7			
	Ontario	144	8	8	6.3								5.6	34.7	51.4	2.1	1.4	4.9			
	Québec	128	8	16	7.8								1.6	24.2	64.1	2.3	2.3	5.5			
	Atlantic	173	4	8	6.4								1.2	52.6	37.6	2.3	1.7	4.6			
Sulfisoxazole	British Columbia	65	≤ 16	> 256	33.8											63.1	3.1				33.8
	Prairies	109	≤ 16	> 256	29.4											61.5	9.2				29.4
III	Ontario	144	≤ 16	> 256	38.9											52.8	7.6	0.7			38.9
	Québec	128	> 256	> 256	58.6											36.7	3.9	0.8			58.6
	Atlantic	173	≤ 16	> 256	41.6											52.0	5.8	0.6			41.6
Tetracycline	British Columbia	65	≤ 4	> 32	35.4									61.5	3.1		1.5	33.8			
	Prairies	109	≤ 4	> 32	41.3									58.7			4.6	36.7			
	Ontario	144	32	> 32	56.3									43.8			7.6	48.6			
	Québec	128	> 32	> 32	58.6									41.4			4.7	53.9			
	Atlantic	173	≤ 4	> 32	48.6									51.4		0.6	6.9	41.0			
IV																					

Table 2.12. Distribution of minimum inhibitory concentrations among *Campylobacter* from chicken, 2014

Antimicrobial	Species	Province / region	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)												
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
Ciprofloxacin	*Campylobacter coli*	British Columbia	5	0.125	8	40.0				60.0						40.0				
Ciprofloxacin	*Campylobacter coli*	Prairies	8	8	16	50.0			12.5	37.5						37.5	12.5			
Ciprofloxacin	*Campylobacter coli*	Ontario	5	0.125	16	40.0				60.0						20.0	20.0			
Ciprofloxacin	*Campylobacter coli*	Québec	3	0.064	0.125	0.0			66.7	33.3										
Ciprofloxacin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Ciprofloxacin	*Campylobacter jejuni*	British Columbia	37	0.125	16	16.2			27.0	56.8						5.4	10.8			
Ciprofloxacin	*Campylobacter jejuni*	Prairies	59	0.125	0.125	6.8			28.8	62.7	1.7					3.4	3.4			
Ciprofloxacin	*Campylobacter jejuni*	Ontario	71	0.125	0.25	9.9		1.4	42.3	39.4	7.0					4.2	5.6			
Ciprofloxacin	*Campylobacter jejuni*	Québec	51	0.125	0.25	3.9			41.2	43.1	11.8					3.9				
Ciprofloxacin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	British Columbia	1	4	4	100.0									100.0					
Ciprofloxacin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Atlantic	37	0.125	0.25	5.4		2.7	24.3	45.9	21.6						5.4			
Telithromycin	*Campylobacter coli*	British Columbia	5	0.25	0.25	0.0				20.0	80.0									
Telithromycin	*Campylobacter coli*	Prairies	8	2	4	0.0					50.0			37.5	12.5					
Telithromycin	*Campylobacter coli*	Ontario	5	0.5	1	0.0				20.0	20.0	20.0	40.0							
Telithromycin	*Campylobacter coli*	Québec	3	0.5	2	0.0					33.3	33.3		33.3						
Telithromycin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Telithromycin	*Campylobacter jejuni*	British Columbia	37	0.5	1	0.0				5.4	8.1	64.9	18.9	2.7						
Telithromycin	*Campylobacter jejuni*	Prairies	59	0.5	1	0.0				1.7	10.2	50.8	35.6	1.7						
Telithromycin	*Campylobacter jejuni*	Ontario	71	0.5	1	1.4				4.2	14.1	52.1	21.1	5.6		1.4	1.4			
Telithromycin	*Campylobacter jejuni*	Québec	51	0.5	4	3.9					17.6	51.0	13.7	5.9	3.9	3.9	3.9			
Telithromycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	British Columbia	1	0.25	0.25	0.0					100.0									
Telithromycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Atlantic	37	1	16	10.8				2.7	10.8	21.6	43.2	10.8			10.8			
Azithromycin	*Campylobacter coli*	British Columbia	5	0.064	0.064	0.0		40.0	60.0											
Azithromycin	*Campylobacter coli*	Prairies	8	0.064	0.25	0.0		37.5	25.0	25.0	12.5									
Azithromycin	*Campylobacter coli*	Ontario	5	0.064	0.064	0.0			100.0											
Azithromycin	*Campylobacter coli*	Québec	3	0.064	0.125	0.0		33.3	33.3	33.3										
Azithromycin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Azithromycin	*Campylobacter jejuni*	British Columbia	37	0.032	0.064	0.0		73.0	24.3	2.7										
Azithromycin	*Campylobacter jejuni*	Prairies	59	0.064	0.064	0.0	1.7	45.8	49.2	3.4										
Azithromycin	*Campylobacter jejuni*	Ontario	71	0.032	0.064	2.8	2.8	53.5	39.4	1.4										2.8
Azithromycin	*Campylobacter jejuni*	Québec	51	0.032	> 64	13.7	3.9	51.0	31.4											13.7
Azithromycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	British Columbia	1	0.064	0.064	0.0			100.0											
Azithromycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Atlantic	37	0.064	> 64	10.8		16.2	62.2	10.8										10.8
Clindamycin	*Campylobacter coli*	British Columbia	5	0.125	0.25	0.0				60.0	40.0									
Clindamycin	*Campylobacter coli*	Prairies	8	0.25	1	0.0				37.5	25.0	12.5	25.0							
Clindamycin	*Campylobacter coli*	Ontario	5	0.25	0.25	0.0				20.0	80.0									
Clindamycin	*Campylobacter jejuni*	Québec	3	0.125	4	0.0				66.7					33.3					
Clindamycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Clindamycin	*Campylobacter jejuni*	British Columbia	37	0.125	0.25	0.0			16.2	67.6	13.5	2.7								
Clindamycin	*Campylobacter jejuni*	Prairies	59	0.125	0.25	0.0			22.0	59.3	18.6									
Clindamycin	*Campylobacter jejuni*	Ontario	71	0.125	0.25	1.4		4.2	22.5	57.7	11.3		1.4		1.4	1.4				
Clindamycin	*Campylobacter jejuni*	Québec	51	0.125	4	5.9			21.6	49.0	17.6				5.9	5.9				
Clindamycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	British Columbia	1	0.125	0.125	0.0				100.0										
Clindamycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Atlantic	37	0.125	4	5.4			16.2	48.6	24.3				5.4	5.4				
Erythromycin	*Campylobacter coli*	British Columbia	5	0.25	0.25	0.0					100.0									
Erythromycin	*Campylobacter coli*	Prairies	8	0.5	2	0.0				12.5	37.5	12.5	25.0	12.5						
Erythromycin	*Campylobacter coli*	Ontario	5	0.25	0.5	0.0					60.0	40.0								
Erythromycin	*Campylobacter coli*	Québec	3	0.25	1	0.0					66.7		33.3							
Erythromycin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Erythromycin	*Campylobacter jejuni*	British Columbia	37	0.25	0.5	0.0				5.4	75.7	13.5	5.4							
Erythromycin	*Campylobacter jejuni*	Prairies	59	0.25	0.5	0.0				6.8	57.6	33.9	1.7							
Erythromycin	*Campylobacter jejuni*	Ontario	71	0.25	0.5	2.8				11.3	70.4	12.7	2.8							2.8
Erythromycin	*Campylobacter jejuni*	Québec	51	0.25	> 64	13.7					56.9	23.5	5.9							13.7
Erythromycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	British Columbia	1	0.5	0.5	0.0						100.0								
Erythromycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Atlantic	37	0.5	> 64	10.8				2.7	32.4	37.8	16.2							10.8

Speciation data for the Atlantic region were not available at the time of report release.

Table 2.12. Distribution of minimum inhibitory concentrations among *Campylobacter* from chicken, 2014 (cont'd)

	Antimicrobial	Species	Province / region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)												
					MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
	Gentamicin	*Campylobacter coli*	British Columbia	5	1	1	0.0						20.0	80.0							
	Gentamicin	*Campylobacter coli*	Prairies	8	1	2	0.0						12.5	75.0	12.5						
	Gentamicin	*Campylobacter coli*	Ontario	5	1	2	0.0							80.0	20.0						
	Gentamicin	*Campylobacter coli*	Québec	3	1	2	0.0						33.3	33.3	33.3						
	Gentamicin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Gentamicin	*Campylobacter jejuni*	British Columbia	37	1	1	0.0						16.2	81.1	2.7						
	Gentamicin	*Campylobacter jejuni*	Prairies	59	1	2	0.0						5.1	81.4	13.6						
	Gentamicin	*Campylobacter jejuni*	Ontario	71	1	1	0.0						9.9	88.7	1.4						
	Gentamicin	*Campylobacter jejuni*	Québec	51	1	1	0.0						5.9	88.2	5.9						
	Gentamicin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	British Columbia	1	1	1	0.0							100.0							
	Gentamicin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Québec	0	0	0	0.0														
II	Gentamicin	*Campylobacter* spp.	Atlantic	37	1	1	0.0					2.7	21.6	75.7							
	Nalidixic acid	*Campylobacter coli*	British Columbia	5	8	> 64	40.0									40.0	20.0			20.0	20.0
	Nalidixic acid	*Campylobacter coli*	Prairies	8	64	> 64	50.0									25.0	25.0			25.0	25.0
	Nalidixic acid	*Campylobacter coli*	Ontario	5	8	> 64	40.0									40.0	20.0				40.0
	Nalidixic acid	*Campylobacter coli*	Québec	3	≤ 4	8	0.0									66.7	33.3				
	Nalidixic acid	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Nalidixic acid	*Campylobacter jejuni*	British Columbia	37	≤ 4	> 64	16.2									62.2	21.6				16.2
	Nalidixic acid	*Campylobacter jejuni*	Prairies	59	≤ 4	8	6.8									81.4	11.9				6.8
	Nalidixic acid	*Campylobacter jejuni*	Ontario	71	≤ 4	8	9.9									74.6	15.5				9.9
	Nalidixic acid	*Campylobacter jejuni*	Québec	51	≤ 4	8	3.9									68.6	27.5				3.9
	Nalidixic acid	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	British Columbia	1	> 64	> 64	100.0														100.0
	Nalidixic acid	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Québec	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Atlantic	37	≤ 4	8	5.4									62.2	32.4				5.4
	Florfenicol	*Campylobacter coli*	British Columbia	5	1	2	0.0							80.0	20.0						
	Florfenicol	*Campylobacter coli*	Prairies	8	1	2	0.0							75.0	25.0						
	Florfenicol	*Campylobacter coli*	Ontario	5	1	1	0.0							100.0							
	Florfenicol	*Campylobacter coli*	Québec	3	1	1	0.0						33.3	66.7							
	Florfenicol	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Florfenicol	*Campylobacter jejuni*	British Columbia	37	1	1	0.0						13.5	83.8	2.7						
	Florfenicol	*Campylobacter jejuni*	Prairies	59	1	1	0.0						15.3	81.4	3.4						
	Florfenicol	*Campylobacter jejuni*	Ontario	71	1	1	0.0					1.4	15.5	78.9	4.2						
	Florfenicol	*Campylobacter jejuni*	Québec	51	1	1	0.0						17.6	76.5	5.9						
	Florfenicol	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	British Columbia	1	0.5	0.5	0.0						100.0								
	Florfenicol	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Québec	0	0	0	0.0														
III	Florfenicol	*Campylobacter* spp.	Atlantic	37	1	2	0.0						10.8	70.3	18.9						
	Tetracycline	*Campylobacter coli*	British Columbia	5	0.25	64	40.0					60.0								40.0	
	Tetracycline	*Campylobacter coli*	Prairies	8	64	> 64	50.0					37.5		12.5						12.5	37.5
	Tetracycline	*Campylobacter coli*	Ontario	5	0.25	> 64	20.0					60.0	20.0								20.0
	Tetracycline	*Campylobacter coli*	Québec	3	> 64	> 64	100.0													33.3	66.7
	Tetracycline	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Tetracycline	*Campylobacter jejuni*	British Columbia	37	0.5	64	27.0				29.7	18.9	21.6	2.7					2.7	24.3	
	Tetracycline	*Campylobacter jejuni*	Prairies	59	32	> 64	54.2				15.3	28.8			1.7				5.1	20.3	28.8
	Tetracycline	*Campylobacter jejuni*	Ontario	71	1	> 64	46.5			1.4	26.8	15.5	2.8	7.0					7.0	16.9	22.5
	Tetracycline	*Campylobacter jejuni*	Québec	51	0.5	> 64	45.1				23.5	25.5	3.9			2.0				15.7	29.4
	Tetracycline	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	British Columbia	1	0.125	0.125	0.0				100.0										
	Tetracycline	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Québec	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Atlantic	37	64	> 64	54.1				18.9	21.6	5.4							10.8	43.2
IV																					

Speciation data for the Atlantic region were not available at the time of report release.

Table 2.13. Distribution of minimum inhibitory concentrations among *Escherichia coli* from pork, 2014

	Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	29	4	32	10.3							6.9	31.0	44.8	6.9		10.3				
		Prairies	48	4	8	6.3							4.2	39.6	35.4	12.5	2.1	4.2	2.1			
		Ontario	127	4	8	2.4							3.9	26.8	40.2	26.8		2.4				
		Québec	49	4	8	8.2							6.1	36.7	36.7	12.2		6.1	2.0			
		Atlantic	70	4	32	12.9							1.4	21.4	41.4	20.0	2.9	10.0	2.9			
	Ceftiofur	British Columbia	29	0.50	8	10.3				3.4	24.1	58.6	3.4			10.3						
		Prairies	48	0.25	0.50	6.3				2.1	52.1	37.5	2.1				6.3					
		Ontario	127	0.50	0.50	2.4				3.1	37.0	56.7	0.8			1.6	0.8					
		Québec	49	0.50	1	6.1				4.1	42.9	42.9	2.0		2.0	4.1	2.0					
I		Atlantic	70	0.50	0.50	2.9				1.4	37.1	55.7	2.9			1.4	1.4					
	Ceftriaxone	British Columbia	29	≤ 0.25	8	10.3					86.2	3.4				6.9	3.4					
		Prairies	48	≤ 0.25	≤ 0.25	6.3					93.8						6.3					
		Ontario	127	≤ 0.25	≤ 0.25	2.4					97.6					0.8	1.6					
		Québec	49	≤ 0.25	≤ 0.25	8.2					91.8				2.0	2.0	2.0	2.0				
		Atlantic	70	≤ 0.25	≤ 0.25	2.9					91.4	2.9	2.9			1.4		1.4				
	Ciprofloxacin	British Columbia	29	≤ 0.015	≤ 0.015	0.0	96.6	3.4														
		Prairies	48	≤ 0.015	≤ 0.015	0.0	100.0															
		Ontario	127	≤ 0.015	≤ 0.015	0.0	95.3	0.8	0.8	1.6	1.6											
		Québec	49	≤ 0.015	≤ 0.015	0.0	93.9	4.1	2.0													
		Atlantic	70	≤ 0.015	≤ 0.015	0.0	98.6	1.4														
	Ampicillin	British Columbia	29	2	> 32	20.7							13.8	51.7	13.8				20.7			
		Prairies	48	2	> 32	16.7							12.5	50.0	14.6	4.2	2.1		16.7			
		Ontario	127	4	> 32	28.3							9.4	40.2	21.3	0.8			28.3			
		Québec	49	2	> 32	20.4							16.3	42.9	18.4	2.0			20.4			
		Atlantic	70	4	> 32	28.6							5.7	34.3	17.1	2.9	11.4	2.9	25.7			
	Azithromycin	British Columbia	29	4	8	0.0									51.7	41.4	6.9					
		Prairies	48	4	8	0.0							2.1	10.4	50.0	35.4	2.1					
		Ontario	127	4	8	0.0								6.3	49.6	40.9	3.1					
		Québec	49	4	8	2.0								6.1	57.1	34.7		2.0				
		Atlantic	70	4	16	1.4								10.0	42.9	32.9	12.9	1.4				
	Cefoxitin	British Columbia	29	4	> 32	10.3								17.2	62.1	10.3			10.3			
		Prairies	48	4	8	6.3							4.2	33.3	47.9	6.3	2.1		6.3			
		Ontario	127	4	8	2.4							1.6	28.3	55.9	10.2	1.6	0.8	1.6			
		Québec	49	4	16	8.2						2.0		24.5	53.1	10.2	2.0	2.0	6.1			
		Atlantic	70	4	4	2.9							1.4	34.3	57.1	4.3		1.4	1.4			
	Gentamicin	British Columbia	29	1	1	3.4						27.6	65.5	3.4				3.4				
		Prairies	48	1	1	0.0					4.2	35.4	56.3	2.1	2.1							
II		Ontario	127	1	1	1.6						27.6	63.0	7.9				1.6				
		Québec	49	1	1	4.1					2.0	36.7	53.1	4.1			2.0	2.0				
		Atlantic	70	1	1	1.4					1.4	47.1	42.9	7.1				1.4				
	Nalidixic acid	British Columbia	29	2	2	0.0							20.7	79.3								
		Prairies	48	2	2	0.0							31.3	64.6	4.2							
		Ontario	127	2	2	2.4							26.8	63.8	7.1			0.8	1.6			
		Québec	49	2	4	0.0							28.6	61.2	8.2	2.0						
		Atlantic	70	2	2	0.0						1.4	34.3	58.6	5.7							
	Streptomycin	British Columbia	29	8	64	20.7									13.8	44.8	20.7		13.8	6.9		
		Prairies	48	8	64	14.6								2.1	14.6	41.7	18.8	8.3	8.3	6.3		
		Ontario	127	16	> 64	29.1									10.2	37.8	17.3	5.5	8.7	20.5		
		Québec	49	8	> 64	20.4									16.3	42.9	14.3	6.1	4.1	16.3		
		Atlantic	70	8	64	14.3									18.6	45.7	12.9	8.6	5.7	8.6		
	Trimethoprim-sulfamethoxazole	British Columbia	29	≤ 0.12	> 4	10.3				86.2	3.4					10.3						
		Prairies	48	≤ 0.12	≤ 0.12	2.1				93.8	4.2					2.1						
		Ontario	127	≤ 0.12	> 4	10.2				81.1	7.9	0.8				10.2						
		Québec	49	≤ 0.12	> 4	10.2				87.8	2.0					10.2						
		Atlantic	70	≤ 0.12	> 4	10.0				74.3	14.3		1.4			10.0						
	Chloramphenicol	British Columbia	29	8	16	6.9									31.0	55.2	6.9	6.9				
		Prairies	48	8	16	6.3								8.3	25.0	56.3	4.2	2.1	4.2			
		Ontario	127	8	32	12.6								1.6	28.3	53.5	3.9	5.5	7.1			
		Québec	49	8	8	2.0								6.1	36.7	53.1	2.0		2.0			
		Atlantic	70	8	8	1.4								4.3	44.3	44.3	5.7	1.4				
	Sulfisoxazole	British Columbia	29	≤ 16	> 256	24.1											65.5	10.3				24.1
		Prairies	48	≤ 16	> 256	18.8											75.0	6.3				18.8
III		Ontario	127	≤ 16	> 256	31.5											62.2	5.5	0.8			31.5
		Québec	49	≤ 16	> 256	18.4											69.4	12.2				18.4
		Atlantic	70	≤ 16	> 256	17.1											64.3	5.7	10.0	2.9		17.1
	Tetracycline	British Columbia	29	≤ 4	> 32	17.2									82.8				17.2			
		Prairies	48	≤ 4	> 32	37.5									62.5			2.1	35.4			
		Ontario	127	32	> 32	56.7									43.3			7.1	49.6			
		Québec	49	≤ 4	> 32	49.0									51.0			4.1	44.9			
		Atlantic	70	≤ 4	> 32	37.1									62.9			5.7	31.4			
IV																						

Table 2.14. Distribution of minimum inhibitory concentrations in *Salmonella* from turkey, 2014

	Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	31	≤ 1	4	6.5							77.4	9.7	3.2	3.2			6.5			
		Prairies	44	≤ 1	4	0.0							68.2	18.2	4.5	4.5	4.5					
		Ontario	40	≤ 1	16	7.5							85.0			2.5	5.0	2.5	5.0			
		Québec	51	≤ 1	> 32	19.6							66.7	3.9		7.8	2.0	2.0	17.6			
		Atlantic	16	≤ 1	8	6.3							81.3			12.5			6.3			
	Ceftiofur	British Columbia	31	1	2	9.7						6.5	80.6	3.2		3.2	6.5					
		Prairies	44	1	2	0.0						27.3	50.0	18.2	4.5							
		Ontario	40	1	1	7.5						25.0	67.5				7.5					
		Québec	51	1	> 8	21.6						21.6	54.9	2.0			21.6					
I		Atlantic	16	1	> 8	12.5					6.3	12.5	68.8				12.5					
	Ceftriaxone	British Columbia	31	≤ 0.25	≤ 0.25	9.7					90.3					3.2	3.2	3.2				
		Prairies	44	≤ 0.25	≤ 0.25	0.0					100.0											
		Ontario	40	≤ 0.25	≤ 0.25	7.5					92.5						2.5	5.0				
		Québec	51	≤ 0.25	32	21.6					78.4						7.8	11.8		2.0		
		Atlantic	16	≤ 0.25	64	12.5					87.5								6.3	6.3		
	Ciprofloxacin	British Columbia	31	≤ 0.015	0.03	0.0	80.6	16.1	3.2													
		Prairies	44	≤ 0.015	0.06	0.0	61.4	22.7	13.6	2.3												
		Ontario	40	≤ 0.015	0.03	0.0	80.0	20.0														
		Québec	51	≤ 0.015	0.03	0.0	86.3	13.7														
		Atlantic	16	≤ 0.015	≤ 0.015	0.0	100.0															
	Ampicillin	British Columbia	31	≤ 1	> 32	12.9							80.6	3.2	3.2				12.9			
		Prairies	44	≤ 1	> 32	13.6							63.6	6.8	15.9				13.6			
		Ontario	40	≤ 1	> 32	15.0							82.5	2.5					15.0			
		Québec	51	≤ 1	> 32	29.4							66.7	3.9					29.4			
		Atlantic	16	≤ 1	> 32	18.8							81.3						18.8			
	Azithromycin	British Columbia	31	4	8	0.0								9.7	67.7	19.4	3.2					
		Prairies	44	4	16	0.0					2.3		2.3	6.8	43.2	27.3	18.2					
		Ontario	40	8	8	0.0					2.5			7.5	37.5	47.5	5.0					
		Québec	51	8	8	0.0							2.0	5.9	37.3	47.1	7.8					
		Atlantic	16	4	8	0.0							6.3	12.5	43.8	37.5						
	Cefoxitin	British Columbia	31	2	16	6.5								54.8	32.3		6.5		6.5			
		Prairies	44	2	16	0.0							11.4	50.0	20.5		18.2					
		Ontario	40	2	8	7.5							7.5	57.5	22.5	5.0		2.5	5.0			
		Québec	51	2	> 32	19.6							3.9	51.0	23.5	2.0		5.9	13.7			
		Atlantic	16	2	8	6.3						6.3	12.5	50.0	18.8	6.3			6.3			
	Gentamicin	British Columbia	31	0.50	2	6.5					25.8	51.6	9.7	3.2		3.2		6.5				
		Prairies	44	0.50	16	11.4					22.7	63.6		2.3			2.3	9.1				
II		Ontario	40	0.50	> 16	17.5					15.0	57.5	5.0	2.5		2.5		17.5				
		Québec	51	0.50	16	15.7					17.6	56.9	7.8	2.0			5.9	9.8				
		Atlantic	16	1	> 16	31.3					6.3	43.8	18.8				6.3	25.0				
	Nalidixic acid	British Columbia	31	4	4	0.0								35.5	58.1	6.5						
		Prairies	44	4	8	0.0							2.3	22.7	52.3	22.7						
		Ontario	40	4	4	0.0							2.5	20.0	75.0	2.5						
		Québec	51	4	4	0.0								45.1	54.9							
		Atlantic	16	4	4	0.0						6.3		37.5	56.3							
	Streptomycin	British Columbia	31	16	> 64	19.4								16.1	12.9	19.4	32.3		6.5	12.9		
		Prairies	44	16	> 64	27.3								9.1	9.1	25.0	25.0	4.5	11.4	15.9		
		Ontario	40	8	> 64	30.0									10.0	42.5	15.0	2.5	20.0	10.0		
		Québec	51	16	64	15.7								2.0	5.9	25.5	33.3	17.6	9.8	5.9		
		Atlantic	16	16	64	18.8									6.3	25.0	43.8	6.3	18.8			
	Trimethoprim-sulfamethoxazole	British Columbia	31	≤ 0.12	≤ 0.12	0.0				100.0												
		Prairies	44	≤ 0.12	≤ 0.12	0.0				100.0												
		Ontario	40	≤ 0.12	≤ 0.12	0.0				97.5	2.5											
		Québec	51	≤ 0.12	≤ 0.12	2.0				96.1	2.0					2.0						
		Atlantic	16	≤ 0.12	≤ 0.12	0.0				100.0												
	Chloramphenicol	British Columbia	31	8	8	0.0									29.0	67.7	3.2					
		Prairies	44	8	16	2.3								2.3	20.5	56.8	18.2	2.3				
		Ontario	40	8	8	0.0								2.5	22.5	72.5	2.5					
		Québec	51	8	8	2.0									23.5	74.5			2.0			
		Atlantic	16	8	8	0.0								6.3	18.8	75.0						
	Sulfisoxazole	British Columbia	31	32	64	6.5											12.9	64.5	16.1			6.5
III		Prairies	44	32	> 256	18.2											13.6	52.3	15.9			18.2
		Ontario	40	32	> 256	12.5											17.5	62.5	7.5			12.5
		Québec	51	32	> 256	27.5											21.6	41.2	7.8	2.0		27.5
		Atlantic	16	32	> 256	12.5											37.5	37.5	12.5			12.5
	Tetracycline	British Columbia	31	≤ 4	> 32	22.6									77.4				22.6			
		Prairies	44	≤ 4	> 32	29.5									70.5			4.5	25.0			
		Ontario	40	≤ 4	> 32	25.0									75.0				25.0			
		Québec	51	≤ 4	> 32	41.2									58.8				41.2			
		Atlantic	16	≤ 4	> 32	18.8									81.3				18.8			
IV																						

Table 2.15. Distribution of minimum inhibitory concentrations in *Escherichia coli* from turkey, 2014

Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
Amoxicillin-clavulanic acid	British Columbia	64	4	16	7.8								25.0	37.5	26.6	3.1	7.8				
	Prairies	103	4	8	3.9							1.0	35.0	33.0	24.3	2.9	2.9	1.0			
	Ontario	143	4	8	0.7							2.8	29.4	35.7	28.7	2.8	0.7				
	Québec	118	4	8	4.2							3.4	23.7	39.8	27.1	1.7	4.2				
	Atlantic	133	4	8	4.5							2.3	31.6	34.6	24.1	3.0	4.5				
Ceftiofur	British Columbia	64	0.50	1	6.3				1.6	28.1	59.4	3.1		1.6	1.6	4.7					
	Prairies	103	0.50	0.50	2.9				2.9	43.7	49.5		1.0		1.0	1.9					
	Ontario	143	0.50	0.50	0.7				2.8	32.2	63.6	0.7			0.7						
	Québec	118	0.50	0.50	5.1					34.7	59.3	0.8			4.2	0.8					
I	Atlantic	133	0.50	0.50	3.0				2.3	38.3	54.9	0.8		0.8	0.8	2.3					
Ceftriaxone	British Columbia	64	≤ 0.25	≤ 0.25	7.8					92.2					1.6	3.1	3.1				
	Prairies	103	≤ 0.25	≤ 0.25	2.9					96.1			1.0			1.9	1.0				
	Ontario	143	≤ 0.25	≤ 0.25	0.7					99.3						0.7					
	Québec	118	≤ 0.25	≤ 0.25	5.1					94.9					4.2			0.8			
	Atlantic	133	≤ 0.25	≤ 0.25	3.8					95.5	0.8			0.8		3.0					
Ciprofloxacin	British Columbia	64	≤ 0.015	≤ 0.015	0.0	96.9	3.1														
	Prairies	103	≤ 0.015	≤ 0.015	1.0	98.1				1.0					1.0						
	Ontario	143	≤ 0.015	≤ 0.015	0.0	98.6	0.7			0.7											
	Québec	118	≤ 0.015	≤ 0.015	1.7	95.8	1.7			0.8					1.7						
	Atlantic	133	≤ 0.015	≤ 0.015	0.8	99.2									0.8						
Ampicillin	British Columbia	64	4	> 32	34.4							7.8	31.3	26.6				34.4			
	Prairies	103	2	> 32	33.0							12.6	43.7	10.7				33.0			
	Ontario	143	2	> 32	32.9							12.6	39.9	14.7				32.9			
	Québec	118	2	> 32	28.8							6.8	44.9	18.6	0.8			28.8			
	Atlantic	133	2	> 32	37.6							6.8	44.4	11.3				37.6			
Azithromycin	British Columbia	64	4	8	0.0								17.2	45.3	35.9	1.6					
	Prairies	103	4	8	1.0							1.0	19.4	55.3	22.3	1.0	1.0				
	Ontario	143	4	8	0.0							0.7	11.9	48.3	37.8	1.4					
	Québec	118	4	8	0.0							1.7	13.6	55.1	26.3	3.4					
	Atlantic	133	4	8	0.0							0.8	18.8	50.4	30.1						
Cefoxitin	British Columbia	64	4	8	9.4								23.4	48.4	18.8		3.1	6.3			
	Prairies	103	4	8	3.9							1.0	26.2	48.5	19.4	1.0		3.9			
	Ontario	143	4	8	0.7								21.7	65.0	11.9	0.7		0.7			
	Québec	118	4	8	4.2							0.8	18.6	61.9	12.7	1.7	1.7	2.5			
	Atlantic	133	4	8	3.8							1.5	33.1	53.4	8.3		0.8	3.0			
Gentamicin	British Columbia	64	1	> 16	17.2						26.6	46.9	3.1		6.3	1.6	15.6				
	Prairies	103	1	> 16	20.4						31.1	43.7	1.0	1.0	2.9	6.8	13.6				
II	Ontario	143	1	> 16	19.6					0.7	32.9	41.3	2.8		2.8	3.5	16.1				
	Québec	118	1	> 16	15.3						33.9	47.5	1.7	0.8	0.8	5.1	10.2				
	Atlantic	133	1	> 16	18.0					0.8	36.8	42.1	0.8		1.5	4.5	13.5				
Nalidixic acid	British Columbia	64	2	2	0.0						1.6	29.7	68.8								
	Prairies	103	2	2	1.9						1.0	43.7	51.5	1.9				1.9			
	Ontario	143	2	2	0.7							29.4	67.1	2.8				0.7			
	Québec	118	2	2	2.5							24.6	68.6	4.2				2.5			
	Atlantic	133	2	2	0.8						1.5	29.3	66.2	2.3				0.8			
Streptomycin	British Columbia	64	8	> 64	39.1									18.8	32.8	4.7	4.7	12.5	26.6		
	Prairies	103	16	> 64	38.8									21.4	27.2	6.8	5.8	16.5	22.3		
	Ontario	143	8	> 64	31.5									17.5	36.4	3.5	11.2	14.7	16.8		
	Québec	118	8	> 64	33.1									22.9	30.5	4.2	9.3	14.4	18.6		
	Atlantic	133	8	> 64	36.8									15.8	34.6	6.8	6.0	12.8	24.1		
Trimethoprim-sulfamethoxazole	British Columbia	64	≤ 0.12	≤ 0.12	7.8				90.6	1.6					7.8						
	Prairies	103	≤ 0.12	0.25	5.8				89.3	4.9					5.8						
	Ontario	143	≤ 0.12	1	9.8				83.2	5.6	0.7	0.7			9.8						
	Québec	118	≤ 0.12	> 4	11.0				78.8	7.6	0.8	1.7			11.0						
	Atlantic	133	≤ 0.12	> 4	11.3				81.2	6.0	0.8	0.8			11.3						
Chloramphenicol	British Columbia	64	8	8	4.7								4.7	32.8	57.8			4.7			
	Prairies	103	8	8	4.9								2.9	35.9	55.3	1.0		4.9			
	Ontario	143	8	8	3.5								1.4	37.1	53.8	4.2		3.5			
	Québec	118	8	8	3.4								1.7	48.3	43.2	3.4		3.4			
	Atlantic	133	8	8	4.5								3.8	44.4	47.4			4.5			
Sulfisoxazole	British Columbia	64	≤ 16	> 256	21.9											70.3	7.8				21.9
III	Prairies	103	≤ 16	> 256	31.1											61.2	5.8	1.9			31.1
	Ontario	143	≤ 16	> 256	36.4											54.5	9.1				36.4
	Québec	118	32	> 256	37.3											46.6	14.4	1.7			37.3
	Atlantic	133	≤ 16	> 256	35.3											59.4	5.3				35.3
Tetracycline	British Columbia	64	≤ 4	> 32	43.8									56.3			1.6	42.2			
	Prairies	103	> 32	> 32	59.2									40.8			5.8	53.4			
	Ontario	143	> 32	> 32	67.1									32.2	0.7	0.7	14.0	52.4			
	Québec	118	32	> 32	59.3									40.7			20.3	39.0			
	Atlantic	133	32	> 32	72.2									27.8		2.3	21.8	48.1			
IV																					

Table 2.16. Distribution of minimum inhibitory concentrations in *Campylobacter* from turkey, 2014

Antimicrobial	Species	Province / region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)											
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
Ciprofloxacin	*Campylobacter coli*	British Columbia	6	0.125	32	33.3			50.0	16.7							16.7	16.7		
Ciprofloxacin	*Campylobacter coli*	Prairies	3	8	16	66.7				33.3						33.3	33.3			
Ciprofloxacin	*Campylobacter coli*	Ontario	8	0.25	0.25	0.0				25.0	75.0									
Ciprofloxacin	*Campylobacter coli*	Québec	0	0	0	0.0														
Ciprofloxacin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Ciprofloxacin	*Campylobacter jejuni*	British Columbia	22	0.125	8	31.8			22.7	45.5						27.3	4.5			
Ciprofloxacin	*Campylobacter jejuni*	Prairies	9	0.064	0.125	0.0			66.7	33.3										
Ciprofloxacin	*Campylobacter jejuni*	Ontario	20	0.125	8	20.0			40.0	35.0	5.0					15.0	5.0			
Ciprofloxacin	*Campylobacter jejuni*	Québec	5	0.064	16	20.0			60.0		20.0						20.0			
Ciprofloxacin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Atlantic	9	0.125	16	11.1			33.3	55.6							11.1			
Telithromycin	*Campylobacter coli*	British Columbia	6	1	8	0.0					50.0		16.7		16.7	16.7				
Telithromycin	*Campylobacter coli*	Prairies	3	2	2	0.0					33.3			66.7						
Telithromycin	*Campylobacter coli*	Ontario	8	16	16	75.0								25.0			75.0			
Telithromycin	*Campylobacter coli*	Québec	0	0	0	0.0														
Telithromycin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Telithromycin	*Campylobacter jejuni*	British Columbia	22	0.5	1	0.0					18.2	59.1	22.7							
Telithromycin	*Campylobacter jejuni*	Prairies	9	0.5	1	0.0					33.3	33.3	33.3							
Telithromycin	*Campylobacter jejuni*	Ontario	20	0.5	1	0.0					20.0	55.0	20.0	5.0						
Telithromycin	*Campylobacter jejuni*	Québec	5	0.5	16	20.0					20.0	60.0					20.0			
Telithromycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Atlantic	9	0.5	1	0.0					33.3	22.2	44.4							
Azithromycin	*Campylobacter coli*	British Columbia	6	0.064	0.25	0.0		50.0	16.7	16.7	16.7									
Azithromycin	*Campylobacter coli*	Prairies	3	0.125	> 64	33.3		33.3		33.3										33.3
Azithromycin	*Campylobacter coli*	Ontario	8	> 64	> 64	75.0			25.0											75.0
Azithromycin	*Campylobacter coli*	Québec	0	0	0	0.0														
Azithromycin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Azithromycin	*Campylobacter jejuni*	British Columbia	22	0.032	0.064	0.0	4.5	59.1	36.4											
Azithromycin	*Campylobacter jejuni*	Prairies	9	0.032	0.125	0.0		55.6	22.2	22.2										
Azithromycin	*Campylobacter jejuni*	Ontario	20	0.064	0.064	0.0		50.0	50.0											
Azithromycin	*Campylobacter jejuni*	Québec	5	0.032	> 64	20.0		80.0												20.0
Azithromycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Atlantic	9	0.064	0.064	0.0		11.1	88.9											
Clindamycin	*Campylobacter coli*	British Columbia	6	0.25	0.5	0.0				50.0	33.3	16.7								
Clindamycin	*Campylobacter coli*	Prairies	3	0.5	4	0.0				33.3		33.3			33.3					
Clindamycin	*Campylobacter coli*	Ontario	8	8	8	50.0					25.0				25.0	50.0				
Clindamycin	*Campylobacter jejuni*	Québec	0	0	0	0.0														
Clindamycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Clindamycin	*Campylobacter jejuni*	British Columbia	22	0.125	0.125	0.0			9.1	86.4	4.5									
Clindamycin	*Campylobacter jejuni*	Prairies	9	0.125	0.25	0.0			11.1	55.6	33.3									
Clindamycin	*Campylobacter jejuni*	Ontario	20	0.125	0.25	0.0			20.0	65.0	15.0									
Clindamycin	*Campylobacter jejuni*	Québec	5	0.125	16	20.0			20.0	60.0							20.0			
Clindamycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Atlantic	9	0.125	0.25	0.0			11.1	55.6	33.3									
Erythromycin	*Campylobacter coli*	British Columbia	6	0.5	4	0.0					50.0	16.7		16.7	16.7					
Erythromycin	*Campylobacter coli*	Prairies	3	1	64	33.3					33.3		33.3						33.3	
Erythromycin	*Campylobacter coli*	Ontario	8	> 64	> 64	75.0						12.5	12.5							75.0
Erythromycin	*Campylobacter coli*	Québec	0	0	0	0.0														
Erythromycin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
Erythromycin	*Campylobacter jejuni*	British Columbia	22	0.25	0.25	0.0				13.6	81.8	4.5								
Erythromycin	*Campylobacter jejuni*	Prairies	9	0.25	0.5	0.0				11.1	66.7	22.2								
Erythromycin	*Campylobacter jejuni*	Ontario	20	0.25	0.5	0.0				15.0	55.0	25.0	5.0							
Erythromycin	*Campylobacter jejuni*	Québec	5	0.25	> 64	20.0					80.0									20.0
Erythromycin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Atlantic	9	0.5	1	0.0					44.4	44.4	11.1							

Speciation data for the Atlantic region were not available at the time of report release.

Table 2.16. Distribution of minimum inhibitory concentrations in *Campylobacter* from turkey, 2014 (cont'd)

	Antimicrobial	Species	Province / region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)												
					MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
	Gentamicin	*Campylobacter coli*	British Columbia	6	1	1	0.0							100.0							
	Gentamicin	*Campylobacter coli*	Prairies	3	1	1	0.0							100.0							
	Gentamicin	*Campylobacter coli*	Ontario	8	1	1	0.0						12.5	87.5							
	Gentamicin	*Campylobacter coli*	Québec	0	0	0	0.0														
	Gentamicin	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Gentamicin	*Campylobacter jejuni*	British Columbia	22	1	2	0.0						4.5	81.8	13.6						
	Gentamicin	*Campylobacter jejuni*	Prairies	9	1	1	0.0						22.2	77.8							
	Gentamicin	*Campylobacter jejuni*	Ontario	20	1	1	0.0						10.0	90.0							
	Gentamicin	*Campylobacter jejuni*	Québec	5	1	1	0.0							100.0							
	Gentamicin	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Québec	0	0	0	0.0														
II	Gentamicin	*Campylobacter* spp.	Atlantic	9	1	1	0.0						44.4	55.6							
	Nalidixic acid	*Campylobacter coli*	British Columbia	6	≤ 4	> 64	33.3									66.7					33.3
	Nalidixic acid	*Campylobacter coli*	Prairies	3	64	64	66.7										33.3			66.7	
	Nalidixic acid	*Campylobacter coli*	Ontario	8	8	8	0.0									50.0	50.0				
	Nalidixic acid	*Campylobacter coli*	Québec	0	0	0	0.0														
	Nalidixic acid	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Nalidixic acid	*Campylobacter jejuni*	British Columbia	22	≤ 4	> 64	31.8									59.1	9.1				31.8
	Nalidixic acid	*Campylobacter jejuni*	Prairies	9	≤ 4	≤ 4	0.0									100.0					
	Nalidixic acid	*Campylobacter jejuni*	Ontario	20	≤ 4	> 64	20.0									70.0	10.0				20.0
	Nalidixic acid	*Campylobacter jejuni*	Québec	5	8	> 64	20.0									40.0	40.0				20.0
	Nalidixic acid	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Québec	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Atlantic	9	≤ 4	> 64	11.1									77.8	11.1				11.1
	Florfenicol	*Campylobacter coli*	British Columbia	6	1	2	0.0							83.3	16.7						
	Florfenicol	*Campylobacter coli*	Prairies	3	1	1	0.0							100.0							
	Florfenicol	*Campylobacter coli*	Ontario	8	1	1	0.0							100.0							
	Florfenicol	*Campylobacter coli*	Québec	0	0	0	0.0														
	Florfenicol	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Florfenicol	*Campylobacter jejuni*	British Columbia	22	1	1	0.0						18.2	81.8							
	Florfenicol	*Campylobacter jejuni*	Prairies	9	1	2	0.0							88.9	11.1						
	Florfenicol	*Campylobacter jejuni*	Ontario	20	1	1	0.0						10.0	90.0							
	Florfenicol	*Campylobacter jejuni*	Québec	5	1	1	0.0							100.0							
	Florfenicol	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Québec	0	0	0	0.0														
III	Florfenicol	*Campylobacter* spp.	Atlantic	9	1	1	0.0							100.0							
	Tetracycline	*Campylobacter coli*	British Columbia	6	> 64	> 64	50.0					16.7	16.7	16.7							50.0
	Tetracycline	*Campylobacter coli*	Prairies	3	> 64	> 64	66.7						33.3								66.7
	Tetracycline	*Campylobacter coli*	Ontario	8	0.5	> 64	37.5						62.5								37.5
	Tetracycline	*Campylobacter coli*	Québec	0	0	0	0.0														
	Tetracycline	*Campylobacter coli*	Atlantic	0	0	0	0.0														
	Tetracycline	*Campylobacter jejuni*	British Columbia	22	1	> 64	45.5					31.8	13.6	9.1					4.5	27.3	13.6
	Tetracycline	*Campylobacter jejuni*	Prairies	9	> 64	> 64	66.7				11.1	11.1		11.1						11.1	55.6
	Tetracycline	*Campylobacter jejuni*	Ontario	20	> 64	> 64	85.0				10.0	5.0								15.0	70.0
	Tetracycline	*Campylobacter jejuni*	Québec	5	0.25	> 64	20.0				20.0	40.0	20.0								20.0
	Tetracycline	*Campylobacter jejuni*	Atlantic	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	British Columbia	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Prairies	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Québec	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Atlantic	9	> 64	> 64	55.6				11.1	33.3									55.6
IV																					

Speciation data for the Atlantic region were not available at the time of report release.

RECOVERY RESULTS

Table 2.17. *Retail Meat Surveillance* recovery rates, 2003–2014

CIPARS Component / Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted					
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Beef	British Columbia	2005	**93%**	27/29						
		2007	**79%**	49/62						
		2008	**77%**	88/115						
		2009	**71%**	79/112						
		2010	**51%**	64/125						
		2011	**53%**	57/107						
		2012	**60%**	76/126						
		2013	**47%**	40/85						
		2014	**43%**	43/100						
	Prairies	2005	**79%**	120/151						
		2006	**76%**	123/161						
		2007	**78%**	118/151						
		2008	**76%**	134/177						
		2009	**83%**	135/163						
		2010	**80%**	107/134						
		2011[a]	**75%**	54/72						
		2012	**75%**	80/107						
		2013	**53%**	48/90						
		2014	**53%**	97/184						
	Ontario	2003	**66%**	101/154	**2%**	2/84	**3%**	2/76	**91%**	69/76
		2004	**80%**	190/237						
		2005	**81%**	184/227						
		2006	**81%**	189/235						
		2007	**71%**	184/227						
		2008	**78%**	185/236						
		2009	**79%**	195/248						
		2010	**69%**	123/177						
		2011	**73%**	161/222						
		2012	**63%**	110/176						
		2013	**58%**	104/180						
		2014	**51%**	121/236						
	Québec	2003	**57%**	84/147	**0%**	0/33	**0%**	0/33	**80%**	28/35
		2004	**56%**	137/245						
		2005	**56%**	126/225						
		2006	**50%**	109/215						
		2007	**68%**	147/216						
		2008	**59%**	126/214						
		2009	**54%**	108/201						
		2010	**46%**	102/223						
		2011	**45%**	91/204						
		2012	**51%**	107/219						
		2013	**42%**	74/175						
		2014	**41%**	85/207						
	Atlantic	2004	**67%**	16/24						
		2007	**52%**	16/31						
		2008	**70%**	39/56						
		2009	**69%**	137/200						
		2010	**69%**	126/183						
		2011	**58%**	110/191						
		2012[d]	**50%**	24/48						
		2013	**58%**	83/143						
		2014	**57%**	118/207						

See corresponding footnotes at the end of the table.

Table 2.17. *Retail Meat Surveillance* recovery rates, 2003–2014 (cont'd)

CIPARS Component / Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Chicken	British Columbia	2005	**95%**	19/20	**13%**	5/39	**69%**	27/39	**100%**	20/20
		2007	**98%**	42/43	**22%**[b]	18/81	**35%**	28/80	**100%**	34/34
		2008	**90%**	70/78	**32%**	47/145	**34%**	50/145	**100%**	78/78
		2009	**95%**	70/74	**40%**	59/146	**53%**	78/146	**97%**	72/74
		2010	**89%**	75/84	**34%**	56/166	**42%**	70/166		
		2011	**96%**	70/73	**45%**	64/143	**50%**	71/143		
		2012	**99%**	82/83	**32%**	53/166	**44%**	73/166		
		2013	**95%**	57/60	**24%**	28/118	**42%**	50/118		
		2014	**98%**	65/66	**27%**	36/133	**32%**	43/133		
	Prairies	2005	**98%**	81/83	**14%**	21/153	**37%**	53/145	**98%**	83/85
		2006	**98%**	85/86	**16%**	25/153	**33%**	51/155	**98%**	85/87
		2007	**97%**	75/77	**31%**[b]	43/141	**35%**	49/141	**100%**	77/77
		2008	**99%**	91/92	**40%**	64/161	**25%**	41/161	**100%**	92/92
		2009	**98%**	90/92	**47%**	71/150	**32%**	48/150	**100%**	92/92
		2010	**90%**	71/79	**32%**	42/132	**28%**	37/132		
		2011[a]	**97%**	38/39	**40%**	29/73	**34%**	25/73		
		2012	**94%**	67/71	**33%**	46/140	**29%**	40/140		
		2013	**97%**	58/60	**32%**	38/120	**20%**	24/120		
		2014	**97%**	109/112	**36%**	81/222	**30%**	67/222		
	Ontario	2003	**95%**	137/144	**16%**	27/167	**47%**	78/166	**99%**	143/144
		2004	**95%**	150/158	**17%**	54/315	**45%**	143/315	**100%**	158/158
		2005	**95%**	145/153	**9%**	26/303	**40%**	120/303	**99%**	150/152
		2006	**97%**	152/156	**12%**	36/311	**34%**	104/311	**98%**	154/156
		2007	**98%**	157/161	**54%**[b]	172/320	**37%**	117/320	**100%**	161/161
		2008	**96%**	150/156	**45%**	139/311	**39%**	121/311	**99%**	154/156
		2009	**95%**	155/164	**43%**	142/328	**31%**	101/328	**100%**	164/164
		2010	**86%**	100/116	**39%**	90/232	**28%**	64/232		
		2011	**93%**	137/147	**40%**	119/294	**24%**	71/293		
		2012	**92%**	107/116	**44%**	102/232	**39%**	87/226		
		2013	**93%**	110/118	**39%**	89/231	**35%**	83/234		
		2014	**92%**	144/157	**24%**	75/312	**25%**	78/312		
	Québec	2003	**89%**	112/126	**16%**	29/171	**55%**	94/170	**100%**	125/125
		2004	**96%**	157/161	**17%**	53/320	**50%**	161/322	**100%**	161/161
		2005	**95%**	142/149	**9%**	26/300	**34%**	103/299	**100%**	150/150
		2006	**94%**	135/144	**12%**	33/288	**35%**	100/288	**100%**	144/144
		2007	**90%**	129/144	**40%**[b]	113/287	**21%**	59/287	**99%**	143/144
		2008	**91%**	131/144	**42%**	120/287	**19%**	54/287	**100%**	144/144
		2009	**94%**	126/134	**39%**	105/267	**20%**	52/266	**99%**	132/134
		2010	**93%**	138/148	**39%**	116/296	**21%**	63/296		
		2011	**99%**	134/136	**37%**	100/272	**21%**	57/272		
		2012	**95%**	133/140	**38%**	106/280	**28%**	78/274		
		2013	**90%**	105/117	**37%**	89/243	**23%**	55/243		
		2014	**93%**	129/138	**33%**	92/276	**20%**	54/276		
	Atlantic	2004	**100%**	13/13	**4%**	1/25	**40%**	10/25	**100%**	13/13
		2007[c]	**91%**	29/32	**22%**[b]	7/32				
		2008[c]	**68%**	38/56	**22%**	12/56				
		2009[c]	**94%**	187/199	**49%**	97/199	**29%**	57/199		
		2010	**93%**	176/190	**41%**	77/190	**37%**	70/190		
		2011	**89%**	171/192	**28%**	53/192	**30%**	57/192		
		2012[d]	**96%**	46/48	**23%**	11/48	**21%**	10/48		
		2013	**92%**	133/144	**31%**	44/144	**47%**	67/144		
		2014	**86%**	179/207	**31%**	64/207	**25%**	52/206		

See corresponding notes at the end of the table.

Table 2.17. *Retail Meat Surveillance* recovery rates, 2003–2014 (cont'd)

CIPARS Component / Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Pork	British Columbia	2005	**31%**	10/32						
		2007	**29%**	23/79	**1%**	1/79				
		2008	**30%**	44/148	**2%**	3/148				
		2009	**26%**	38/145	**1%**	2/145				
		2010	**19%**	31/166	**1%**	2/167				
		2011	**27%**	49/180	**2%**	3/180				
		2012	**25%**	41/167	**0%**	0/167				
		2013	**28%**	33/118	**0%**	0/118				
		2014	**22%**	29/131	**2%**	2/132				
	Prairies	2005	**30%**	48/162						
		2006	**30%**	49/165	**2%**	3/134				
		2007	**25%**	38/154	**2%**	3/154				
		2008	**23%**	41/176	**1%**	1/176				
		2009	**18%**	29/164	**0%**	0/164				
		2010	**12%**	17/142	**1%**	1/142				
		2011[a]	**11%**	10/90	**1%**	1/90				
		2012	**19%**	26/140	**1%**	2/141				
		2013	**24%**	28/119	**3%**	3/120				
		2014	**22%**	48/223	**1%**	3/223				
	Ontario	2003	**58%**	90/154	**1%**	1/93	**0%**	0/76	**87%**	66/76
		2004	**71%**	198/279						
		2005	**59%**	179/303						
		2006	**59%**	182/311	**< 1%**	1/255				
		2007	**54%**	172/320	**2%**	6/319				
		2008	**50%**	155/312	**2%**	7/310				
		2009	**41%**	136/328	**2%**	8/327				
		2010	**38%**	84/224	**0%**	0/224				
		2011	**42%**	155/371	**2%**	6/370				
		2012	**37%**	86/231	**2%**	5/231				
		2013	**43%**	100/233	**1%**	3/232				
		2014	**41%**	127/312	**2%**	6/312				
	Québec	2003	**42%**	61/147	**3%**	1/32	**9%**	3/32	**82%**	28/34
		2004	**38%**	109/290						
		2005	**26%**	79/300						
		2006	**20%**	57/287	**0%**	0/232				
		2007	**22%**	64/287	**1%**	3/288				
		2008	**21%**	60/287	**2%**	5/286				
		2009	**15%**	41/268	**1%**	3/268				
		2010	**16%**	47/296	**1%**	4/296				
		2011	**32%**	122/387	**4%**	17/387				
		2012	**16%**	46/279	**3%**	8/279				
		2013	**20%**	48/239	**<1%**	1/239				
		2014	**18%**	49/276	**<1%**	2/276				
	Atlantic	2004	**58%**	14/24						
		2007	**39%**	13/31	**3%**	1/30				
		2008	**30%**	17/56	**2%**	1/56				
		2009	**41%**	82/200	**3%**	5/199				
		2010	**39%**	74/190	**4%**	8/190				
		2011	**43%**	95/223	**3%**	7/221				
		2012[d]	**25%**	12/48	**0%**	0/48				
		2013	**40%**	57/143	**1%**	2/142				
		2014	**41%**	86/209	**6%**	13/208				

See corresponding notes at the end of the table.

Table 2.17. *Retail Meat Surveillance* recovery rates, 2003–2014 (cont'd)

CIPARS Component / Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted						
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*
Turkey	British Columbia	2011	**97%**	59/61	**11%**	8/71	**24%**	17/71	
		2012	**97%**	101/104	**18%**	27/153	**22%**	33/153	
		2013	**98%**	59/60	**26%**	30/115	**22%**	25/115	
		2014	**97%**	64/66	**25%**	31/122	**23%**	28/122	
	Prairies	2011[a]	**100%**	10/10	**20%**	2/10	**10%**	1/10	
		2012	**91%**	81/89	**14%**	18/128	**5%**	6/128	
		2013	**90%**	56/62	**23%**	25/107	**4%**	4/105	
		2014	**93%**	103/111	**22%**	44/196	**7%**	13/196	
	Ontario	2011	**95%**	162/171	**14%**	27/191	**9%**	18/191	
		2012	**97%**	152/156	**20%**	44/223	**9%**	20/223	
		2013	**95%**	115/121	**12%**	'28/228	**12%**	27/227	
		2014	**92%**	143/156	**13%**	40/310	**9%**	28/310	
	Québec	2011	**91%**	138/152	**17%**	27/163	**10%**	16/163	
		2012	**96%**	170/178	**21%**	51/246	**6%**	15/246	
		2013	**89%**	98/110	**32%**	57/177	**9%**	16/178	
		2014	**86%**	119/138	**19%**	51/262	**2%**	5/262	
	Atlantic	2013	**85%**	107/126	**19%**	24/126	**23%**	29/124	
		2014	**76%**	143/187	**12%**	23/187	**8%**	15/185	

Grey-shaded areas indicate either: a) isolates recovered from sampling activities outside the scope of CIPARS routine (or "core") surveillance in the specified year (i.e., grey-shaded areas with data) or b) discontinuation or no surveillance activity (i.e., grey-shaded areas with no data).
The Prairies is a region including the province of Alberta and Saskatchewan.
The Atlantic region includes New Brunswick, Nova Scotia, and Prince Edward Island.

[a] In 2011, due to an unforeseeable pause in retail sampling in Saskatchewan of approximately 3 months, the expected number of samples was not met and thus, results for this province for this year should be interpreted with caution.

[b] Enhancement to the *Salmonella* recovery method yielded higher recovery rates from retail chicken in 2007 than in prior years.

[c] For the Atlantic region, recovery results are not presented for *Campylobacter* in 2007 and 2008 as well as for *Enterococcus* in 2007, 2008, and 2009 due to concerns regarding harmonization of laboratory methods.

[d] Due to an unforeseeable pause in retail sampling in the Atlantic region from April through December in 2012, the expected number of samples was not achieved and thus, results for this region in 2012 are not representative and potentially lack the precision necessary to be included as regular surveillance data. For this reason, these data are not presented anywhere else in this report.

3. ABATTOIR SURVEILLANCE

KEY FINDINGS

BEEF CATTLE

ESCHERICHIA COLI (n = 141)

In 2014, there were no ceftiofur-resistant isolates (Table 3.1). One isolate (1%) was resistant to 6 antimicrobials (ACSSuT-SXT). No isolates were resistant to Category I antimicrobials (Table 3.1).

CAMPYLOBACTER (n = 121)

The proportion of *Campylobacter* isolates resistant to ciprofloxacin was 1% (1/105) in 2006 and 7% (9/121) in 2014, however this difference was not statistically significant (Figure 3.2).

CHICKENS

SALMONELLA (n = 103)

Recovery of *Salmonella* in chickens continued to decline to 15% (103/684) from a peak of 28% (234/851) in 2008. This was similar to levels from the first 3 years of the program (2003 to 2005) (Table 3.17).

In 2014, Enteritidis isolates remained susceptible (Table 3.3). The proportion of Kentucky isolates resistant to 2 to 3 classes of antimicrobials increased from 68% (27/40) in 2013 to 89% (25/28) in 2014 (Table 3.3).

The proportion of isolates resistant to ceftriaxone was significantly lower in 2014 (12%) (12/103) than in 2004 (22%, 31/142) and 2010 (32%, 46/142) (Figure 3.3). The proportion of isolates resistant to ampicillin was significantly higher in 2003 (25%, 32/126) and 2010 (37%, 52/142) than in 2014 (12%, 12/103) (Figure 3.3). Conversely, the proportion of isolates resistant to tetracycline was significantly higher in 2014 (41%, 42/103) than in 2003 (19%, 24/126) (Figure 3.3).

Seven isolates (7%) were resistant to 7 antimicrobials. This included 6 Kentucky isolates with an A2C-AMP-CRO-STR-TET pattern and 1 Typhimurium isolate with an A2C-AMP-CRO-SSS-TET pattern.

ESCHERICHIA COLI (n = 170)

In 2014, 1 isolate (1%) was resistant to 6 classes of antimicrobials (Table 3.4). The proportion of isolates resistant to trimethoprim-sulfamethoxazole was significantly higher in 2014 (21%, 35/170) than in 2010 (10%, 12/119) and 2003 (8%, 12/153) (Figure 3.4). The proportion of isolates resistant to tetracycline was significantly lower in 2014 (57%, 97/170) than in 2003 (69%, 106/153) (Figure 3.4).

Sixteen percent (27/170) of isolates were resistant to ceftriaxone in 2014 and this proportion was significantly lower than the proportion observed in 2010 (38%, 45/119) (Figure 3.4). The proportion of isolates resistant to ampicillin was significantly lower in 2014 (39%, 67/170) than in 2010 (53%, 63/119).

One isolate (1%) was resistant to 10 antimicrobials (ACSSuT-A2C-CRO-GEN) and 5 isolates (3%) were resistant to 9 antimicrobials [ACSSuT-A2C-CRO (2 isolates), A2C-AMP-CRO-CHL-SSS-SXT-TET (1 isolate), A2C-AMP-CRO-GEN-STR-SSS-TET (1 isolate), ACSSuT-TIO-CRO-CIP-NAL (1 isolate)].

CAMPYLOBACTER (n = 188)

The proportion of isolates resistant to ciprofloxacin was significantly higher in 2014 (11%, 20/188) than in 2010 (4%, 4/111) (Figure 3.5).

PIGS

SALMONELLA (n = 158)

The proportion of isolates resistant to ceftiofur remained the same as in 2013 at 3% (5/181 in 2013 and 5/158 in 2014) (Figure 3.6). One 6,7,14:-:1,w isolate (1%, 1/158) was resistant to 10 antimicrobials (ACSSuT-A2C-CRO-SXT).

ESCHERICHIA COLI (n = 161)

In 2014, 1 isolate (1%, 1/161) was resistant to 11 antimicrobials (A2C-AMP-AZM-CRO-GEN-STR-SSS-SXT-TET).

CAMPYLOBACTER (n = 236)

There were no notable findings to report in 2014.

MULTICLASS RESISTANCE

Table 3.1. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from beef cattle, 2014

Animal species	Number of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial										
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Beef cattle	141	97	24	14	6			15	7					15	4		5		1	44

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Table 3.2. Number of antimicrobial classes in resistance patterns of *Campylobacter* from beef cattle, 2014

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial								
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
Campylobacter jejuni	77 (63.6)	31	41	5									5	5	46
Campylobacter spp.	27 (22.3)	13	7	7				1	1	1	1		4	9	10
Campylobacter coli	17 (14.0)	8	8	1										1	9
Total	**121 (100)**	**52**	**56**	**13**				**1**	**1**	**1**	**1**		**9**	**15**	**65**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table 3.3. Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial										
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Enteritidis	29 (28.2)	29																		
Kentucky	28 (27.2)	2	1	25				25	7	7	7	7	7							25
Heidelberg	12 (11.7)	8	4						4	4	4	4	4							
Typhimurium	7 (6.8)	1	1	5					1	1	1	1	1	5						6
Hadar	3 (2.9)			3				3												3
Infantis	3 (2.9)	3																		
Livingstone	3 (2.9)		2	1				1						1						3
Thompson	3 (2.9)	3																		
Less common serovars	15 (14.6)	9	6					1												5
Total	**103 (100)**	**55**	**14**	**34**				**30**	**12**	**12**	**12**	**12**	**12**	**6**						**42**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.

Table 3.4. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chickens, 2014

Animal species	Number of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Chickens	170	40	23	75	31	1	27	83	67	27	27	26	25	78	35		8	2	11	97

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

Table 3.5. Number of antimicrobial classes in resistance patterns of *Campylobacter* from chickens, 2014

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial							
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
Campylobacter jejuni	121 (64.4)	62	50	9					1	3	3		9	9	55
Campylobacter spp.	40 (21.3)	22	9	9				3	2	4	4		6	6	14
Campylobacter coli	27 (14.4)	13	12	1	1			1	2	2	2		5	5	8
Total	**188 (100)**	**97**	**71**	**19**	**1**			**4**	**5**	**9**	**9**		**20**	**20**	**77**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table 3.6. Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Derby	43 (27.2)	7	11	20	5			23	8	3	3	3	3	24	1					33
Typhimurium	26 (16.5)	4	1	8	13		1	19	16					21	3		11			19
Bovismorbificans	15 (9.5)	12	1	1	1			2	2					2						2
Brandenburg	7 (4.4)	3	3		1			1	1					1			1			3
Infantis	7 (4.4)	5	1	1					1					1	1					2
Schwarzengrund	6 (3.8)	2	1	3			1	3						2						4
Ohio	5 (3.2)	5																		
London	4 (2.5)	3	1											1						
Uganda	4 (2.5)	3		1				1						1						1
Worthington	4 (2.5)	2	1	1					1	1	1	1	1	1	1					1
Less common serovars	37 (23.4)	22	3	7	5		1	11	7	1	1	1	1	9	1		5			14
Total	**158 (100)**	**68**	**23**	**42**	**25**		**3**	**60**	**36**	**5**	**5**	**5**	**5**	**63**	**7**		**17**			**79**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.

Table 3.7. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pigs, 2014

Animal species	Number of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Pigs	161	20	42	81	18		2	51	57	3	3	3	3	68	19	1	28			119

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

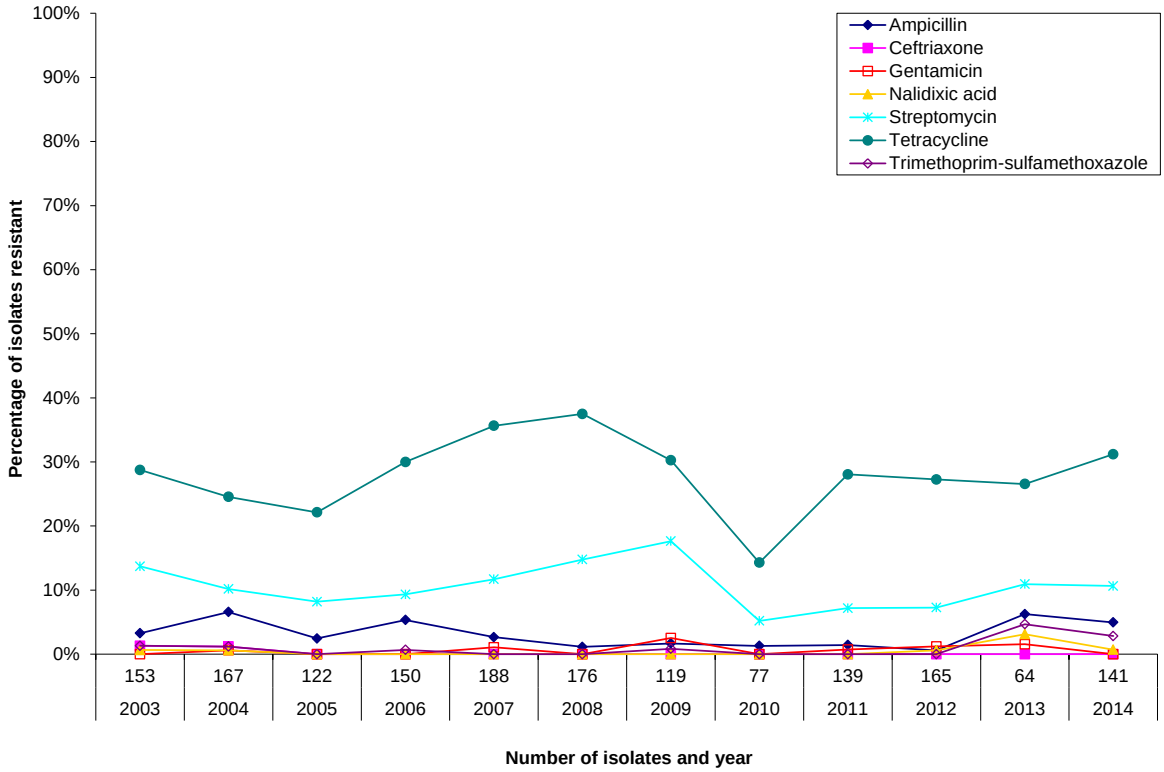
Table 3.8. Number of antimicrobial classes in resistance patterns of *Campylobacter* from pigs, 2014

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial							
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
Campylobacter coli	202 (85.6)	28	52	52	70			84	98	106	106		23	23	157
Campylobacter spp.	33 (14.0)	5	5	11	12			17	17	20	20		2	5	25
Campylobacter jejuni	1 (0.4)		1												1
Total	**236 (100)**	**33**	**58**	**63**	**82**			**101**	**115**	**126**	**126**		**25**	**28**	**183**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

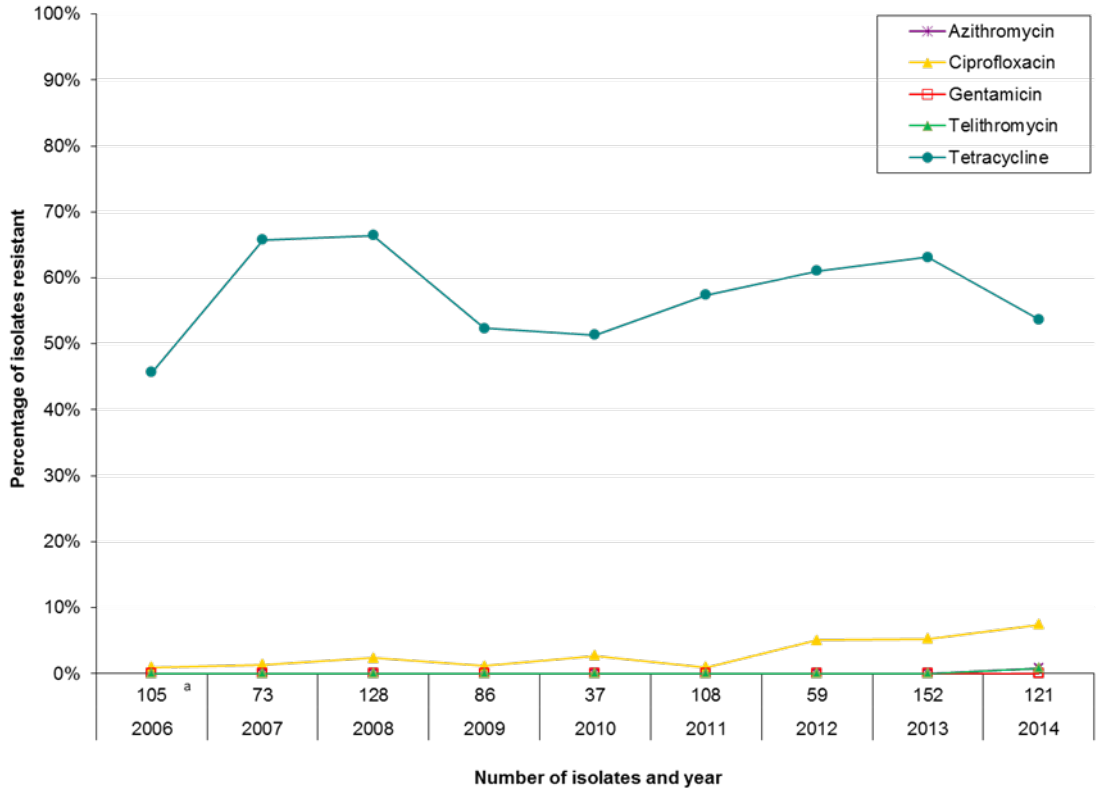
Figure 3.1. Temporal variations in resistance of *Escherichia coli* isolates from beef cattle, 2003–2014



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of isolates	153	167	122	150	188	176	119	77	139	165	64	141
Antimicrobial												
Ampicillin	**3%**	7%	2%	5%	3%	1%	2%	**1%**	1%	1%	**6%**	**5%**
Ceftriaxone	**1%**	1%	0%	0%	0%	0%	0%	**0%**	0%	0%	**0%**	**0%**
Gentamicin	**0%**	1%	0%	0%	1%	0%	3%	**0%**	1%	1%	**2%**	**0%**
Nalidixic acid	**1%**	1%	0%	0%	0%	0%	0%	**0%**	0%	1%	**3%**	**1%**
Streptomycin	**14%**	10%	8%	9%	12%	15%	18%	**5%**	7%	7%	**11%**	**11%**
Tetracycline	**29%**	25%	22%	30%	36%	38%	30%	**14%**	28%	27%	**27%**	**31%**
Trimethoprim-sulfamethoxazole	**1%**	1%	0%	1%	0%	0%	1%	**0%**	0%	0%	**5%**	**3%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years, the first year of surveillance, and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 3.2. Temporal variations in resistance of *Campylobacter* isolates from beef cattle, 2006–2014

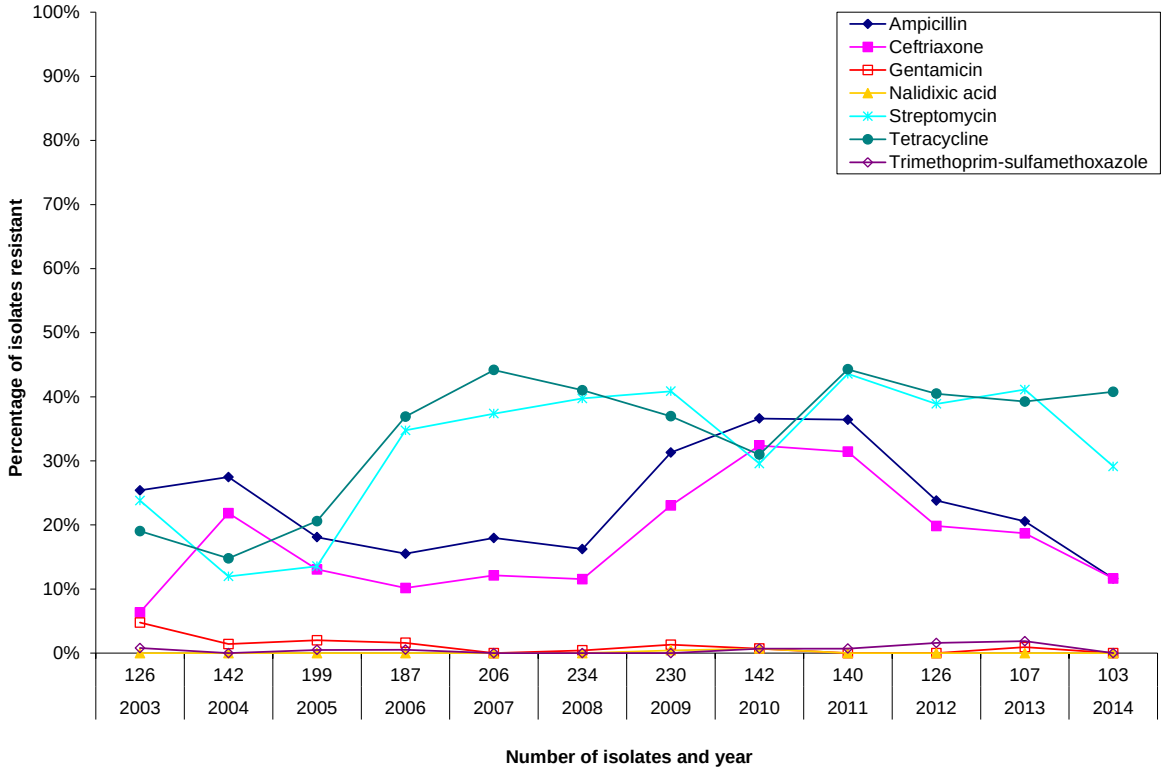


Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of isolates	105[a]	73	128	86	37	108	59	152	121
Antimicrobial									
Azithromycin	**0%**	0%	0%	0%	**0%**	0%	0%	**0%**	**1%**
Ciprofloxacin	**1%**	1%	2%	1%	**3%**	1%	5%	**5%**	**7%**
Gentamicin	**0%**	0%	0%	0%	**0%**	0%	0%	**0%**	**0%**
Telithromycin	**0%**	0%	0%	0%	**0%**	0%	0%	**0%**	**1%**
Tetracycline	**46%**	66%	66%	52%	**51%**	57%	61%	**63%**	**54%**

[a] This number of isolates includes isolates from the end of year 2005 (n = 23).

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years, the first year of surveillance, and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 3.3. Temporal variations in resistance of *Salmonella* isolates from chickens, 2003–2014

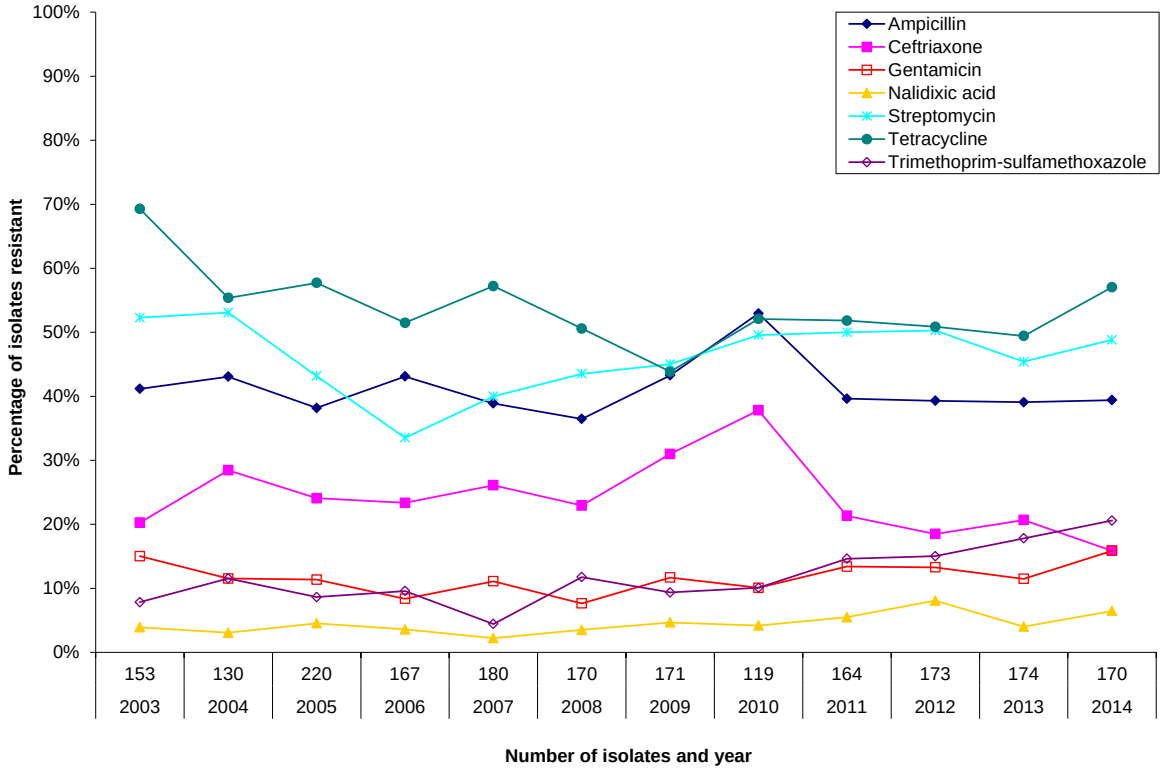


Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of isolates	126	142	199	187	206	234	230	142	140	126	107	103
Antimicrobial												
Ampicillin	**25%**	**27%**	18%	**16%**	18%	16%	31%	**37%**	36%	24%	**21%**	**12%**
Ceftriaxone	**6%**	**22%**	13%	**10%**	12%	12%	23%	**32%**	31%	20%	**19%**	**12%**
Gentamicin	**5%**	1%	2%	2%	0%	0%	1%	**1%**	0%	0%	**1%**	**0%**
Nalidixic acid	**0%**	0%	0%	0%	0%	0%	0%	**1%**	0%	0%	**0%**	**0%**
Streptomycin	**24%**	12%	14%	35%	37%	40%	41%	**30%**	44%	39%	**41%**	**29%**
Tetracycline	**19%**	15%	21%	37%	44%	41%	37%	**31%**	44%	40%	**39%**	**41%**
Trimethoprim-sulfamethoxazole	**1%**	0%	1%	1%	0%	0%	0%	**1%**	1%	2%	**2%**	**0%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years, the first year of surveillance, and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Additional temporal analyses for ampicillin and ceftiofur/ceftriaxone were conducted for *Salmonella* isolates from Ontario and Québec. These 2 antimicrobials and years (2004 and 2006) were selected due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end of the voluntary period of withdrawal). Significant differences ($P \leq 0.05$) observed between the current year results and additional reference year results are indicated by underlined numbers.

Figure 3.4. Temporal variations in resistance of *Escherichia coli* isolates from chickens, 2003–2014

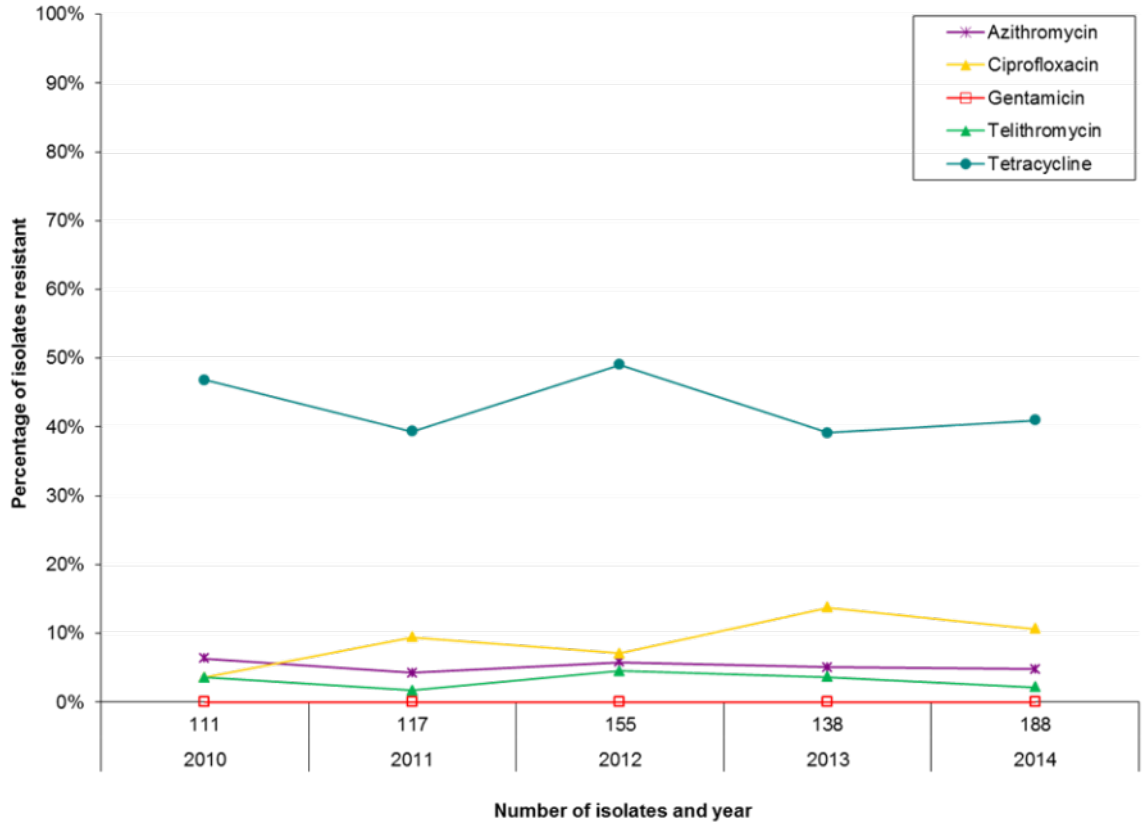


Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of isolates	153	130	220	167	180	170	171	119	164	173	174	170
Antimicrobial												
Ampicillin	**41%**	**43%**	38%	**43%**	39%	36%	43%	**53%**	40%	39%	**39%**	**39%**
Ceftriaxone	**20%**	**28%**	24%	**23%**	26%	23%	31%	**38%**	21%	18%	**21%**	**16%**
Gentamicin	**15%**	12%	11%	8%	11%	8%	12%	**10%**	13%	13%	**11%**	**16%**
Nalidixic acid	**4%**	3%	5%	4%	2%	4%	5%	**4%**	5%	8%	**4%**	**6%**
Streptomycin	**52%**	53%	43%	34%	40%	44%	45%	**50%**	50%	50%	**45%**	**49%**
Tetracycline	**69%**	55%	58%	51%	57%	51%	44%	**52%**	52%	51%	**49%**	**57%**
Trimethoprim-sulfamethoxazole	**8%**	12%	9%	10%	4%	12%	9%	**10%**	15%	15%	**18%**	**21%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years, the first year of surveillance, and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Additional temporal analyses for ampicillin and ceftiofur/ceftriaxone were conducted for *E. coli* isolates from Ontario and Québec. These 2 antimicrobials and years (2004 and 2006) were selected due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end of the voluntary period of withdrawal). Significant differences ($P \leq 0.05$) observed between the current year results and additional reference year results are indicated by underlined numbers.

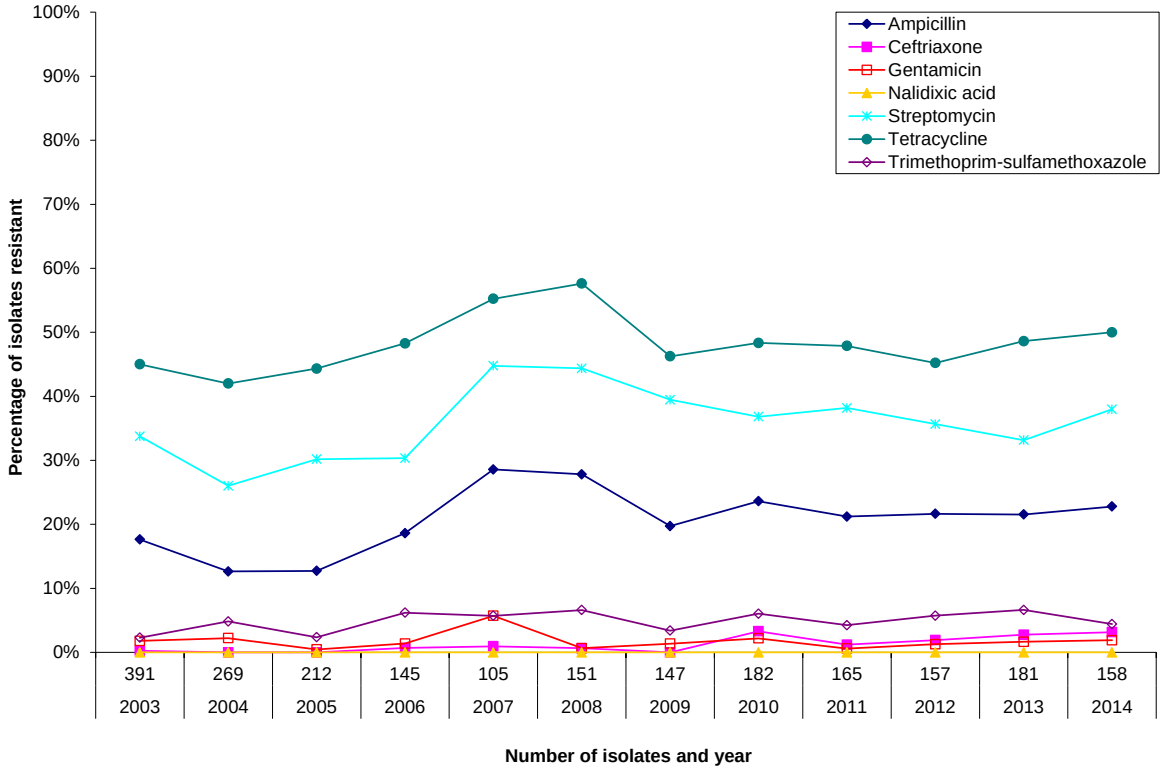
Figure 3.5. Temporal variations in resistance of *Campylobacter* isolates from chickens, 2010–2014



Year Number of isolates	2010 111	2011 117	2012 155	2013 138	2014 188
Antimicrobial					
Azithromycin	**6%**	4%	6%	**5%**	**5%**
Ciprofloxacin	**4%**	9%	7%	**14%**	**11%**
Gentamicin	**0%**	0%	0%	**0%**	**0%**
Telithromycin	**4%**	2%	5%	**4%**	**2%**
Tetracycline	**47%**	39%	49%	**39%**	**41%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first year of surveillance and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

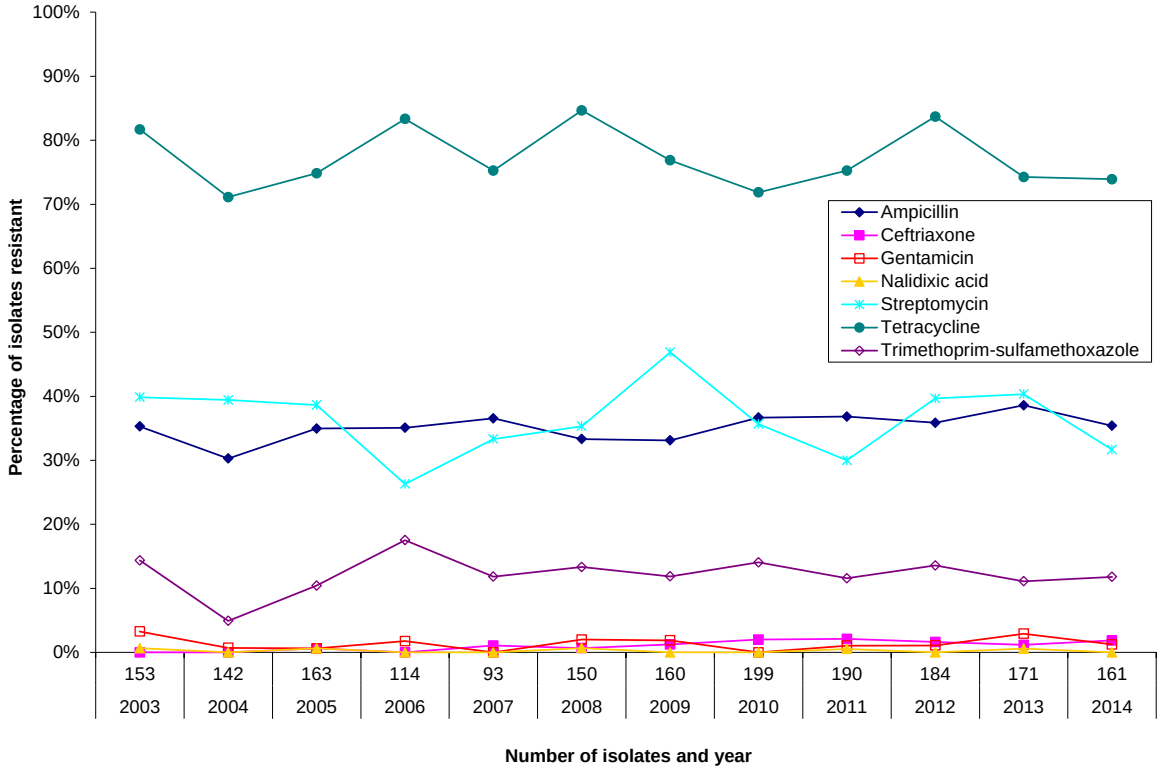
Figure 3.6. Temporal variations in resistance of *Salmonella* isolates from pigs, 2003–2014



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of isolates	391	269	212	145	105	151	147	182	165	157	181	158
Antimicrobial												
Ampicillin	**18%**	13%	13%	19%	29%	28%	20%	**24%**	21%	22%	**22%**	**23%**
Ceftriaxone	**0%**	0%	0%	1%	1%	1%	0%	**3%**	1%	2%	**3%**	**3%**
Gentamicin	**2%**	2%	0%	1%	6%	1%	1%	**2%**	1%	1%	**2%**	**2%**
Nalidixic acid	**0%**	0%	0%	0%	0%	0%	0%	**0%**	0%	0%	**0%**	**0%**
Streptomycin	**34%**	26%	30%	30%	45%	44%	39%	**37%**	38%	36%	**33%**	**38%**
Tetracycline	**45%**	42%	44%	48%	55%	58%	46%	**48%**	48%	45%	**49%**	**50%**
Trimethoprim-sulfamethoxazole	**2%**	5%	2%	6%	6%	7%	3%	**6%**	4%	6%	**7%**	**4%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years, the first year of surveillance, and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

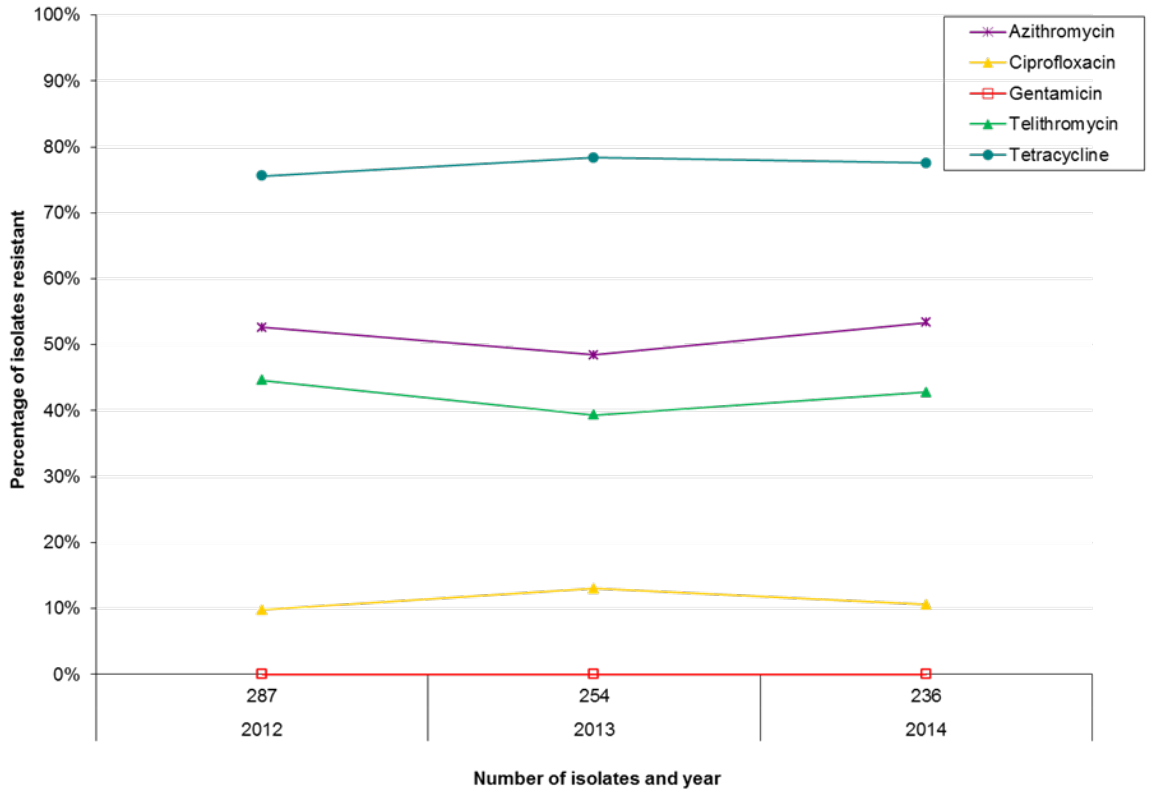
Figure 3.7. Temporal variations in resistance of *Escherichia coli* isolates from pigs, 2003–2014



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of isolates	153	142	163	114	93	150	160	199	190	184	171	161
Antimicrobial												
Ampicillin	**35%**	30%	35%	35%	37%	33%	33%	**37%**	37%	36%	**39%**	**35%**
Ceftriaxone	**0%**	0%	1%	0%	1%	1%	1%	**2%**	2%	2%	**1%**	**2%**
Gentamicin	**3%**	1%	1%	2%	0%	2%	2%	**0%**	1%	1%	**3%**	**1%**
Nalidixic acid	**1%**	0%	1%	0%	0%	1%	0%	**0%**	1%	0%	**1%**	**0%**
Streptomycin	**40%**	39%	39%	26%	33%	35%	47%	**36%**	30%	40%	**40%**	**32%**
Tetracycline	**82%**	71%	75%	83%	75%	85%	77%	**72%**	75%	84%	**74%**	**74%**
Trimethoprim-sulfamethoxazole	**14%**	5%	10%	18%	12%	13%	12%	**14%**	12%	14%	**11%**	**12%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years, the first year of surveillance, and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 3.8. Temporal variations in resistance of *Campylobacter* isolates from pigs, 2012–2014



Year Number of isolates	2012 287	2013 254	2014 236
Antimicrobial			
Azithromycin	**53%**	**48%**	**53%**
Ciprofloxacin	**10%**	**13%**	**11%**
Gentamicin	**0%**	**0%**	**0%**
Telithromycin	**45%**	**39%**	**43%**
Tetracycline	**76%**	**78%**	**78%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first year of surveillance and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

MINIMUM INHIBITORY CONCENTRATIONS

See how to interpret the minimum inhibitory concentration tables in the section ''How to Read this Chapter''.

Table 3.9. Distribution of minimum inhibitory concentrations among *Escherichia coli* from beef cattle, 2014

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	141	4	4	0.0							7.8	29.8	56.0	5.0	1.4					
	Ceftiofur	141	0.50	0.50	0.0				7.1	34.0	58.2	0.7									
	Ceftriaxone	141	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	141	≤ 0.015	≤ 0.015	0.0	98.6	0.7		0.7												
II	Ampicillin	141	2	4	5.0							14.9	47.5	31.9	0.7			5.0			
	Azithromycin	141	4	8	0.0							2.8	14.2	48.9	31.9	2.1					
	Cefoxitin	141	4	8	0.0							4.3	19.1	63.1	13.5						
	Gentamicin	141	0.50	1	0.0					2.8	56.0	39.7	1.4								
	Nalidixic acid	141	2	2	0.7							17.0	73.8	8.5			0.7				
	Streptomycin	141	8	64	10.6									41.1	38.3	7.1	2.8	6.4	4.3		
	Trimethoprim-sulfamethoxazole	141	≤ 0.12	≤ 0.12	2.8				97.2						2.8						
III	Chloramphenicol	141	8	8	3.5								2.8	31.9	57.4	4.3	0.7	2.8			
	Sulfisoxazole	141	≤ 16	> 256	10.6											85.1	4.3				10.6
	Tetracycline	141	≤ 4	> 32	31.2									61.0	7.8	7.8	5.7	17.7			
IV																					

Table 3.10. Distribution of minimum inhibitory concentrations among *Campylobacter* from beef cattle, 2014

	Antimicrobial	Species	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
I	Ciprofloxacin	*Campylobacter coli*	17	0.125	0.25	0.0				64.7	35.3									
	Ciprofloxacin	*Campylobacter jejuni*	77	0.125	0.25	6.5			32.5	51.9	9.1					3.9	2.6			
	Ciprofloxacin	*Campylobacter* spp.	27	0.125	4	14.8			25.9	44.4	14.8				7.4	7.4				
	Telithromycin	*Campylobacter coli*	17	2	4	0.0							5.9	47.1	47.1					
	Telithromycin	*Campylobacter jejuni*	77	1	1	0.0					5.2	39.0	48.1	7.8						
	Telithromycin	*Campylobacter* spp.	27	1	2	3.7					7.4	33.3	48.1	7.4			3.7			
II	Azithromycin	*Campylobacter coli*	17	0.125	0.25	0.0			5.9	82.4	11.8									
	Azithromycin	*Campylobacter jejuni*	77	0.032	0.064	0.0	1.3	62.3	35.1	1.3										
	Azithromycin	*Campylobacter* spp.	27	0.064	0.125	3.7		48.1	25.9	22.2										3.7
	Clindamycin	*Campylobacter coli*	17	1	1	0.0				5.9	5.9	23.5	58.8	5.9						
	Clindamycin	*Campylobacter jejuni*	77	0.125	0.25	0.0			18.2	57.1	23.4	1.3								
	Clindamycin	*Campylobacter* spp.	27	0.125	0.5	3.7			29.6	40.7	14.8	11.1					3.7			
	Erythromycin	*Campylobacter coli*	17	2	2	0.0						5.9	5.9	82.4	5.9					
	Erythromycin	*Campylobacter jejuni*	77	0.25	0.5	0.0				2.6	51.9	44.2	1.3							
	Erythromycin	*Campylobacter* spp.	27	0.25	2	3.7				3.7	59.3	25.9		7.4						3.7
	Gentamicin	*Campylobacter coli*	17	1	1	0.0						5.9	88.2	5.9						
	Gentamicin	*Campylobacter jejuni*	77	1	2	0.0						3.9	77.9	18.2						
	Gentamicin	*Campylobacter* spp.	27	0.5	1	0.0					7.4	48.1	40.7	3.7						
	Nalidixic acid	*Campylobacter coli*	17	16	16	5.9										29.4	64.7		5.9	
	Nalidixic acid	*Campylobacter jejuni*	77	≤ 4	8	6.5									64.9	27.3	1.3			6.5
	Nalidixic acid	*Campylobacter* spp.	27	≤ 4	> 64	33.3									51.9	14.8			7.4	25.9
III	Florfenicol	*Campylobacter coli*	17	2	2	0.0							23.5	76.5						
	Florfenicol	*Campylobacter jejuni*	77	1	1	0.0						13.0	80.5	6.5						
	Florfenicol	*Campylobacter* spp.	27	1	1	0.0						37.0	59.3	3.7						
	Tetracycline	*Campylobacter coli*	17	32	> 64	52.9					5.9	5.9	35.3					5.9		47.1
	Tetracycline	*Campylobacter jejuni*	77	32	> 64	59.7			1.3	20.8	9.1	9.1						10.4	24.7	24.7
	Tetracycline	*Campylobacter* spp.	27	1	> 64	37.0				25.9	11.1	11.1	3.7		7.4	3.7		11.1	3.7	22.2
IV																				

Table 3.11. Distribution of minimum inhibitory concentrations among *Salmonella* from chickens, 2014

	Antimicrobial	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	103	≤ 1	32	11.7							85.4	2.9				1.9	9.7			
	Ceftiofur	103	1	> 8	11.7					1.0	35.0	50.5	1.9			11.7					
	Ceftriaxone	103	≤ 0.25	16	11.7					88.3					1.0	5.8	2.9	1.9			
	Ciprofloxacin	103	≤ 0.015	0.03	0.0	81.6	17.5	1.0													
II	Ampicillin	103	≤ 1	> 32	11.7							84.5	3.9					11.7			
	Azithromycin	103	4	8	0.0								5.8	62.1	32.0						
	Cefoxitin	103	2	32	11.7							12.6	66.0	8.7	1.0		5.8	5.8			
	Gentamicin	103	0.50	0.50	0.0					33.0	62.1	4.9									
	Nalidixic acid	103	2	4	0.0							6.8	46.6	44.7	1.9						
	Streptomycin	103	16	> 64	29.1								12.6	16.5	20.4	19.4	1.9	13.6	15.5		
	Trimethoprim-sulfamethoxazole	103	≤ 0.12	≤ 0.12	0.0				98.1	1.9											
III	Chloramphenicol	103	8	8	0.0								2.9	44.7	50.5	1.9					
	Sulfisoxazole	103	32	64	5.8											22.3	64.1	7.8			5.8
	Tetracycline	103	≤ 4	> 32	40.8									57.3	1.9		1.0	39.8			
IV																					

Table 3.12. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chickens, 2014

	Antimicrobial	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	170	4	32	15.9							1.8	24.7	34.7	20.0	2.9	13.5	2.4			
	Ceftiofur	170	0.50	8	14.7				0.6	27.6	51.8	2.4	1.8	1.2	5.9	8.8					
	Ceftriaxone	170	≤ 0.25	16	15.9					81.2	0.6	1.8	0.6		4.1	8.8	1.8	1.2			
	Ciprofloxacin	170	≤ 0.015	0.03	1.2	90.0	2.9		0.6	5.3		0.6	0.6								
II	Ampicillin	170	4	> 32	39.4							10.6	32.4	16.5	1.2			39.4			
	Azithromycin	170	4	8	0.0								8.8	53.5	34.7	2.9					
	Cefoxitin	170	4	> 32	15.3								5.3	56.5	20.6	2.4	3.5	11.8			
	Gentamicin	170	1	>16	15.9					0.6	45.3	34.1	1.8	0.6	1.8	0.6	15.3				
	Nalidixic acid	170	2	4	6.5						0.6	25.9	58.8	8.2			0.6	5.9			
	Streptomycin	170	≤ 32	> 64	48.8									15.9	22.4	4.7	8.2	15.9	32.9		
	Trimethoprim-sulfamethoxazole	170	≤ 0.12	> 4	20.6				72.9	5.3	0.6	0.6			20.6						
III	Chloramphenicol	170	8	8	4.7								1.2	30.0	60.0	4.1	1.8	2.9			
	Sulfisoxazole	170	≤ 16	> 256	45.9											50.6	3.5				45.9
	Tetracycline	170	> 32	> 32	57.1									42.9			2.9	54.1			
IV																					

Table 3.13. Distribution of minimum inhibitory concentrations among *Campylobacter* from chickens, 2014

	Antimicrobial	Species	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)												
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
I	Ciprofloxacin	*Campylobacter coli*	27	0.125	8	18.5			29.6	48.1	3.7					14.8	3.7			
	Ciprofloxacin	*Campylobacter jejuni*	121	0.125	0.25	7.4			18.2	64.5	9.9					5.0	2.5			
	Ciprofloxacin	*Campylobacter* spp.	40	0.125	8	15.0			22.5	62.5						7.5	7.5			
	Telithromycin	*Campylobacter coli*	27	0.25	2	3.7				3.7	48.1	11.1	18.5	14.8			3.7			
	Telithromycin	*Campylobacter jejuni*	121	0.5	1	0.0				0.8	9.9	41.3	38.8	7.4		1.7				
	Telithromycin	*Campylobacter* spp.	40	0.5	1	7.5					17.5	47.5	27.5				7.5			
	Azithromycin	*Campylobacter coli*	27	0.064	0.125	7.4		29.6	48.1	14.8										7.4
	Azithromycin	*Campylobacter jejuni*	121	0.064	0.064	2.5	2.5	38.8	48.8	6.6	0.8									2.5
	Azithromycin	*Campylobacter* spp.	40	0.064	> 64	10.0	2.5	35.0	52.5											10.0
	Clindamycin	*Campylobacter coli*	27	0.25	1	7.4				40.7	44.4	3.7	3.7			7.4				
	Clindamycin	*Campylobacter jejuni*	121	0.125	0.25	0.8			18.2	60.3	18.2	0.8			1.7	0.8				
	Clindamycin	*Campylobacter* spp.	40	0.125	4	5.0		2.5	20.0	50.0	17.5				5.0	2.5	2.5			
II	Erythromycin	*Campylobacter coli*	27	0.25	2	7.4				7.4	51.9	18.5	11.1	3.7					3.7	3.7
	Erythromycin	*Campylobacter jejuni*	121	0.25	1	2.5				6.6	57.0	24.0	9.9					0.8		1.7
	Erythromycin	*Campylobacter* spp.	40	0.25	64	10.0				7.5	57.5	25.0							2.5	7.5
	Gentamicin	*Campylobacter coli*	27	1	1	0.0						18.5	81.5							
	Gentamicin	*Campylobacter jejuni*	121	1	1	0.0						7.4	87.6	5.0						
	Gentamicin	*Campylobacter* spp.	40	1	1	0.0					2.5	37.5	60.0							
	Nalidixic acid	*Campylobacter coli*	27	≤ 4	> 64	18.5									59.3	18.5	3.7		3.7	14.8
	Nalidixic acid	*Campylobacter jejuni*	121	≤ 4	8	7.4									68.6	24.0				7.4
	Nalidixic acid	*Campylobacter* spp.	40	≤ 4	> 64	15.0									70.0	15.0				15.0
III	Florfenicol	*Campylobacter coli*	27	1	2	0.0						7.4	81.5	11.1						
	Florfenicol	*Campylobacter jejuni*	121	1	1	0.0						11.6	80.2	8.3						
	Florfenicol	*Campylobacter* spp.	40	1	1	0.0						20.0	77.5	2.5						
	Tetracycline	*Campylobacter coli*	27	0.25	> 64	29.6				11.1	40.7	14.8	3.7						3.7	25.9
	Tetracycline	*Campylobacter jejuni*	121	0.5	> 64	45.5				21.5	21.5	8.3	1.7	1.7			0.8	4.1	14.9	25.6
	Tetracycline	*Campylobacter* spp.	40	0.25	64	35.0				22.5	42.5							10.0	20.0	5.0
IV																				

Table 3.14. Distribution of minimum inhibitory concentrations among *Salmonella* isolates from pigs, 2014

	Antimicrobial	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	158	≤ 1	8	3.2							72.8	7.0	4.4	7.0	5.7	1.3	1.9			
	Ceftiofur	158	1	1	3.2						17.7	74.7	4.4			3.2					
	Ceftriaxone	158	≤ 0.25	≤ 0.25	3.2					96.8						1.3	1.9				
	Ciprofloxacin	158	≤ 0.015	0.03	0.0	86.7	10.8	2.5													
II	Ampicillin	158	≤ 1	> 32	22.8							66.5	10.1	0.6			1.9	20.9			
	Azithromycin	158	4	8	0.0								4.4	48.1	44.3	3.2					
	Cefoxitin	158	4	8	3.2						0.6	4.4	40.5	43.7	7.6			3.2			
	Gentamicin	158	0.50	1	1.9					13.3	71.5	10.8	0.6	1.3	0.6	1.3	0.6				
	Nalidixic acid	158	4	4	0.0								46.2	50.0	3.8						
	Streptomycin	158	16	> 64	38.0									3.8	27.8	24.7	5.7	3.8	34.2		
	Trimethoprim-sulfamethoxazole	158	≤ 0.12	0.25	4.4				81.0	11.4	3.2				4.4						
III	Chloramphenicol	158	8	> 32	10.8								1.9	19.6	63.3	4.4		10.8			
	Sulfisoxazole	158	32	> 256	39.9											14.6	36.7	8.2	0.6		39.9
	Tetracycline	158	16	> 32	50.0									49.4	0.6	1.3	5.1	43.7			
IV																					

Table 3.15. Distribution of minimum inhibitory concentrations among *Escherichia coli* isolates from pigs, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	161	4	8	1.9							1.9	24.2	42.2	28.6	1.2	1.9				
	Ceftiofur	161	0.50	0.50	1.9				2.5	46.6	47.2	1.9			0.6	1.2					
	Ceftriaxone	161	≤ 0.25	≤ 0.25	1.9					98.1						1.2	0.6				
	Ciprofloxacin	161	≤ 0.015	≤ 0.015	0.0	98.1	1.9														
II	Ampicillin	161	4	> 32	35.4							9.3	37.3	16.1	0.6	1.2		35.4			
	Azithromycin	161	4	8	0.6							1.2	14.9	51.6	29.2	2.5	0.6				
	Cefoxitin	161	4	8	1.9							1.2	24.8	58.4	12.4	1.2		1.9			
	Gentamicin	161	0.50	1	1.2					1.9	49.7	45.3	1.9				1.2				
	Nalidixic acid	161	2	2	0.0							23.0	69.6	7.5							
	Streptomycin	161	16	> 64	31.7									14.3	24.2	13.0	16.8	12.4	19.3		
	Trimethoprim-sulfamethoxazole	161	≤ 0.12	> 4	11.8				74.5	11.8	1.2	0.6			11.8						
III	Chloramphenicol	161	8	32	17.4								3.1	23.6	49.7	6.2	8.1	9.3			
	Sulfisoxazole	161	≤ 16	> 256	42.2											52.8	4.3	0.6			42.2
	Tetracycline	161	> 32	> 32	73.9									24.8	1.2		6.8	67.1			
IV																					

Table 3.16. Distribution of minimum inhibitory concentrations among *Campylobacter* from pigs, 2014

	Antimicrobial	Species	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
I	Ciprofloxacin	*Campylobacter coli*	202	0.125	8	11.4			9.9	58.9	18.8	1.0				3.5	5.9	2.0		
	Ciprofloxacin	*Campylobacter jejuni*	1	0.25	0.25	0.0					100.0									
	Ciprofloxacin	*Campylobacter* spp.	33	0.125	0.5	6.1			9.1	48.5	30.3	6.1				3.0	3.0			
	Telithromycin	*Campylobacter coli*	202	8	16	41.6				0.5	6.4	2.5	18.8	13.9	7.9	8.4	41.6			
	Telithromycin	*Campylobacter jejuni*	1	2	2	0.0								100.0						
	Telithromycin	*Campylobacter* spp.	33	16	16	51.5						3.0	21.2	12.1	6.1	6.1	51.5			
II	Azithromycin	*Campylobacter coli*	202	> 64	> 64	52.5	0.5	2.5	24.8	13.4	5.9	0.5								52.5
	Azithromycin	*Campylobacter jejuni*	1	0.064	0.064	0.0			100.0											
	Azithromycin	*Campylobacter* spp.	33	> 64	> 64	60.6			24.2	6.1	9.1									60.6
	Clindamycin	*Campylobacter coli*	202	4	16	48.5				3.0	15.8	7.4	5.4	6.4	13.4	22.3	19.3	6.9		
	Clindamycin	*Campylobacter jejuni*	1	0.5	0.5	0.0						100.0								
	Clindamycin	*Campylobacter* spp.	33	8	> 16	51.5				3.0		9.1	12.1	12.1	12.1	24.2	15.2	12.1		
	Erythromycin	*Campylobacter coli*	202	> 64	> 64	52.5				1.0	8.4	8.9	21.3	7.4		0.5		0.5	1.0	51.0
	Erythromycin	*Campylobacter jejuni*	1	1	1	0.0							100.0							
	Erythromycin	*Campylobacter* spp.	33	> 64	> 64	60.6					3.0	21.2	12.1	3.0						60.6
	Gentamicin	*Campylobacter coli*	202	2	2	0.0						0.5	37.6	61.9						
	Gentamicin	*Campylobacter jejuni*	1	1	1	0.0							100.0							
	Gentamicin	*Campylobacter* spp.	33	1	1	0.0						9.1	81.8	9.1						
	Nalidixic acid	*Campylobacter coli*	202	8	> 64	11.4									21.8	60.4	6.4		1.0	10.4
	Nalidixic acid	*Campylobacter jejuni*	1	8	8	0.0										100.0				
	Nalidixic acid	*Campylobacter* spp.	33	8	64	15.2									12.1	69.7		3.0	6.1	9.1
III	Florfenicol	*Campylobacter coli*	202	1	2	0.0					0.5	22.3	64.4	12.4	0.5					
	Florfenicol	*Campylobacter jejuni*	1	2	2	0.0								100.0						
	Florfenicol	*Campylobacter* spp.	33	1	2	0.0					3.0	24.2	57.6	15.2						
	Tetracycline	*Campylobacter coli*	202	64	> 64	77.7				0.5	4.0	5.4	3.0	3.5	1.5	4.5	7.9	4.5	18.3	47.0
	Tetracycline	*Campylobacter jejuni*	1	> 64	> 64	100.0														100.0
	Tetracycline	*Campylobacter* spp.	33	> 64	> 64	75.8						9.1	3.0	3.0		9.1	9.1	3.0	9.1	54.5
IV																				

RECOVERY RESULTS

Table 3.17. *Abattoir Surveillance* recovery rates, 2002–2014

CIPARS Component/ Animal species	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
		Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Beef cattle	2002	**97%**	76/78	**1%**	3/78				
	2003	**97%**	155/159	**< 1 %**	1/114				
	2004	**98%**	167/170						
	2005	**97%**	122/126			**66%**	23/35		
	2006	**100%**	150/150			**36%**	31/87		
	2007	**99%**	188/190			**39%**	75/190		
	2008	**97%**	176/182			**71%**[a]	129/182		
	2009	**94%**	119/126			**68%**	86/126		
	2010	**97%**[b]	77/79			**53%**[b]	37/70		
	2011	**99%**	139/141			**77%**	108/141		
	2012	**99%**	165/166			**92%**	152/166		
	2013	**100%**[b]	59/59			**92%**[b]	54/59		
	2014	**99%**	141/142			**87%**	123/142		
Chickens	2002	**100%**	40/40	**13%**	25/195				
	2003	**97%**	150/153	**16%**	126/803				
	2004	**99%**	130/131	**16%**	142/893				
	2005	**99%**	218/220	**18%**	200/1,103				
	2006	**100%**	166/166	**23%**	187/824				
	2007	**99%**	180/181	**25%**	204/808				
	2008	**99%**	170/171	**28%**	234/851				
	2009	**100%**	171/171	**27%**	230/851				
	2010	**99%**	119/120	**24%**	142/599	**19%**	111/599		
	2011	**99%**	164/166	**20%**	140/701	**17%**	117/696		
	2012	**100%**	173/173	**18%**[c]	126/684	**23%**	155/685		
	2013	**99%**	171/172	**16%**	105/672	**21%**	137/662		
	2014	**100%**	170/170	**15%**	103/684	**27%**	187/683		
Pigs	2002	**97%**	38/39	**27%**	103/385				
	2003	**98%**	153/155	**28%**	395/1,393				
	2004	**99%**	142/143	**38%**	270/703				
	2005	**99%**	163/164	**42%**	212/486				
	2006	**98%**	115/117	**40%**	145/359				
	2007	**98%**	93/95	**36%**	105/296				
	2008	**100%**	150/150	**44%**	151/340				
	2009	**98%**	160/163	**45%**	147/327				
	2010	**98%**	199/203	**44%**	182/410				
	2011	**99%**	190/191	**43%**	165/382				
	2012	**100%**	184/184	**42%**	157/370	**78%**	289/370		
	2013	**99%**	166/168	**52%**	171/330	**76%**	237/314		
	2014	**99%**	161/162	**49%**	158/325	**73%**	237/325		

Grey-shaded areas indicate either: a) isolates recovered from sampling activities outside the scope of CIPARS routine (or "core") surveillance in the specified year (i.e., grey-shaded areas with data) or b) discontinuation or no surveillance activity (i.e., grey-shaded areas with no data).

[a] Implementation of a new *Campylobacter* recovery method in 2008 in abattoir beef cattle isolates.

[b] In 2010 and 2013, the number of samples received from abattoir beef cattle was much lower than anticipated due to substantial drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.

[c] Decreased prevalence in chickens and one non-compliant plant (lack of sampling) resulted in a shortfall of *Salmonella* isolates from chickens.

4. FARM SURVEILLANCE

KEY FINDINGS

GROWER-FINISHER PIGS

SALMONELLA (n = 147)

The recovery rate of *Salmonella* increased on a national basis from 19% (99/534) in 2013 to 26% (147/570) in 2014 (Table 4.17). There was an increase between 2013 and 2014 in Ontario from 26% (43/168) to 41% (67/162) and in Québec from 17% (23/138) to 26% (40/156).

The 2 most common serovars regardless of region were Derby and Typhimurium (Table 4.1). Nationally, resistance to either ceftriaxone, ceftiofur or amoxicillin-clavulanic acid was less than or equal to 5%. No isolates were resistant to more than 5 classes of antimicrobials and no isolates were resistant to the quinolones (Table 4.1). One Derby isolate from Ontario was resistant to 8 antimicrobials (A2C-AMP-CRO-STR-SSS-TET) and 4 antimicrobial classes.

Tetracycline resistance in Ontario and Québec have been steadily rising since 2010 and 2011, respectively.

ESCHERICHIA COLI (n = 1,672) [9]

Recovery of *E. coli* was stable at greater than or equal to 99% on both a national and regional basis (Table 4.17).

Nationally, resistance to either ceftriaxone, ceftiofur or amoxicillin-clavulanic acid was less than or equal to 2%. No isolates were resistant to ciprofloxacin but 5 (less than 1%) were resistant to more than 5 classes of antimicrobials; 1 from the Prairies and 4 from Québec (Table 4.2). The isolate from the Prairies was ACSSuT-A2C-AZM-CRO-SXT resistant. The 4 isolates from Québec had the following patterns: ACSSuT-GEN-NAL-SXT (2 isolates), ACSSuT-AZM-GEN-SXT (1 isolate) and ACSSuT-A2C-AZM-CRO-SXT (1 isolate).

A decline in tetracycline resistance in *E. coli* in both the Prairies and Québec was noted.

[9] Up to 3 generic *E. coli* isolates per positive sample were kept for analysis. The expected number of total isolates was 1,698 (566 x 3) but only 1,672 isolates were collected for antimicrobials susceptibility testing leaving a difference of 26 isolates. The number of isolates recovered through *Farm Surveillance* was much higher than through other surveillance components. The reason for collecting a larger number of isolates in *Farm Surveillance* is to ensure adequate power to investigate the association between antimicrobial resistance and antimicrobial use.

BROILER CHICKENS[10]

SALMONELLA (n = 285)

Placement (n = 36)

Overall, *Salmonella* was recovered from 12% (36/291) of chick placement samples (chick pads or environmental swabs). This level was relatively lower compared to 2013 (22%, 51/235) and was noted in all provinces/regions sampled (Table 4.18). Across all provinces/regions sampled, the top 3 *Salmonella* serovars were Enteritidis, Kentucky, and Agona (Table 4.3). No Heidelberg was isolated. Provincial differences in serovar distribution were noted with Enteritidis being the most common serovar in British Columbia (89%, 16/18 isolates) and the Prairies (71%, 5/7) whereas Kentucky was the most common serovar in Québec (89%, 8/9) (Table 4.3). Enteritidis was the top serovar detected from the 2 types of chick placement samples: chick pads (61%, 17/28 isolates) and environmental swabs (50%, 4/8) (Table 4.4). Eighty-one percent (17/21) of the Enteritidis were isolated from chick pad samples but all the isolates, including the 4 from the environment, were susceptible to all antimicrobials tested (Table 4.4).

No ciprofloxacin or nalidixic acid resistance was observed in any serovar.

Only 6% (2/36) of all the chick placement isolates were resistant to ceftriaxone and all other β-lactam antimicrobials (Figure 4.3); these 2 isolates were chick pad samples (Kentucky) from Québec. No isolates were resistant to more than or equal to 4 classes of antimicrobials.

Pre-harvest (n = 249)

The overall recovery rate of *Salmonella* of broiler chicken samples was 44% (249/564). This rate was relatively lower than the previous year (59%, 229/388). Across all provinces/regions sampled, the top 3 *Salmonella* serovars were Kentucky, Enteritidis, and Schwarzengrund (Table 4.7). No Enteritidis was recovered in Ontario. Regional differences in serovar distribution were observed with Enteritidis (62%, 46/74) being the most common serovar in British Columbia, Schwarzengrund (28%, 15/54) in the Prairies, and Kentucky in Ontario (29%, 12/42) and Québec (66%, 52/79).

All of the Enteritidis isolates were also susceptible to all antimicrobials tested.

No ciprofloxacin or nalidixic acid resistance was observed in any serovar (Table 4.7).

Across all provinces/regions sampled, ceftriaxone resistance was 12% (31/249), this was lower by 10% compared to 2013 (22%, 53/229). Provincial differences in ceftriaxone resistance were also observed: British Columbia (14%, 11/74), Prairies (4%, 2/54), Ontario (5%, 2/42), and Québec (20%, 16/79) (Figure 4.7). Overall, 12% (31/249) of isolates were resistant to most of the β-lactams (amoxicillin-clavulanic acid, ceftriaxone, cefoxitin, and ceftiofur) but a slightly higher proportion (13%, 33/249) of isolates was resistant to ampicillin (Table 4.7). Only 1 isolate (less than 1%) was resistant to 4 classes of antimicrobials.

[10] One hundred and forty-three flocks from 141 different farm premises across 4 poultry producing provinces/regions (British Columbia, Prairies, Ontario, and Québec) were enrolled in 2014, 58 flocks (41%) were also sampled at chick placement.

ESCHERICHIA COLI (n = 795) [11]

Placement (n = 234)

Overall, *E. coli* was recovered from 80% (234/291) of the samples. Nalidixic acid resistance was noted in 6% (10/163) of chick pads isolates and 1% (1/71) environmental isolates. Provincial/regional differences in the proportion of ceftriaxone resistant isolates were observed: British Columbia (33%, 19/57), Prairies (13%, 6/46), Ontario (12%, 8/65), and Québec (37%, 24/66) (Figure 4.5). Sample type differences in the proportion of ceftriaxone resistance were also noted: chick pads (30%, 49/163) versus environmental (11%, 8/71) (Figure 4.6).

The proportion of *E. coli* resistant to β-lactam antimicrobials varied depending on the antimicrobial (ampicillin [49%, 113/234], amoxicillin-clavulanic acid and cefoxitin [23%, 53/234], ceftriaxone [25%, 57/234], cefoxitin [23%, 53/234], and ceftiofur [24%, 56/234]) (Table 4.5). This variation was consistently noted in both chick pad and environmental samples (Table 4.6).

Only 1 isolate (less than 1%), from a chick pad sample from British Columbia, was resistant to 6 classes of antimicrobials. Forty-seven isolates (20%) were resistant to 4 to 5 classes of antimicrobials (Table 4.5 and Table 4.6).

Pre-harvest (n = 561)

Ninety-nine percent (561/564) of *E. coli* isolates were recovered from pooled fecal/caecal specimens. Only 1 chicken *E. coli* isolate (less than 1%), recovered from British Columbia, was resistant to ciprofloxacin (Table 4.8). Resistance to azithromycin was detected in 2% of *E. coli* isolates from Ontario (3/166) and less than 1% (1/132) from Québec (Table 4.8). As in placement, resistance to nalidixic acid was noted in 5% (25/561) of isolates: British Columbia (9%, 10/116), Prairies (7%, 11/147), Ontario (2%, 3/166), and Québec (2%, 2/132) (Figure 4.8).

Across all provinces/regions, although not significant, resistance to ceftriaxone decreased from 32% (123/385) in 2013 to 24% (135/561) in 2014 (Figure 4.8). Provincial/regional differences in ceftriaxone resistance were also observed but there was a relatively lower proportion of isolates resistant compared to 2013: British Columbia (51%, 59/116), Prairies (31%, 44/147), Ontario (11%, 18/166), and Québec (11%, 15/132) (Figure 4.8). As in chick placement, the proportion of *E. coli* isolate resistant to β-lactam antimicrobials varied depending on the antimicrobial (ampicillin [46%, 259/561], amoxicillin-clavulanic acid, ceftriaxone, cefoxitin [24%, 127/561], and ceftiofur [23%, 127/561]) (Table 4.8).

Only 2 isolates (less than 1 %) were resistant to 6 to 7 classes of antimicrobials. Eighty-five isolates (15%) were resistant to 4 to 6 classes of antimicrobials (Table 4.8).

[11] Consisted of normal avian gut, environmental commensals, and avian pathogenic *E. coli* responsible for yolksacculitis and septicemic diseases. As in other components, isolates were not further characterized.

CAMPYLOBACTER (n = 93)

Placement (n = 0)

Campylobacter was not isolated from the chick placement samples because of well documented/reported challenges in recovering the organism from chicks or newly cleaned barn environment.

Pre-harvest (n = 93)

Sixteen percent (93/564) of isolates were recovered from pooled fecal samples; a slightly lower recovery rate than in 2013 (20%, 81/388).

Resistance to nalidixic acid and ciprofloxacin decreased from 16% (16/81) in 2013 to 9% (9/93) in 2014. The resistant isolates were collected in British Columbia (29%, 7/26) and Ontario (5%, 2/35) (Figure 4.9). Two telithromycin resistant isolates (9%, 2/21) and 3 azithromycin and erythromycin resistant isolates (12%, 3/21) were collected in Québec; no isolates from this province were resistant to nalidixic acid or ciprofloxacin.

No isolates were resistant to greater than 4 classes of antimicrobials.

MULTICLASS RESISTANCE

Table 4.1. Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs, 2014

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Prairies																				
Derby	9 (22.5)	1	2	6				6						6						8
Typhimurium	7 (17.5)	1	1		5			5	6					5			5			5
Uganda	5 (12.5)	5																		
Infantis	3 (7.5)	3																		
Schwarzengrund	3 (7.5)				3			3	3					3						3
10:l,z13:-	2 (5.0)	2																		
6,7:-:l,w	2 (5.0)			1	1			1	2		2			2	2					1
Worthington	2 (5.0)	1	1						1											
Bovismorbificans	1 (2.5)	1																		
Give	1 (2.5)	1																		
4,12:l,v:-	1 (2.5)		1																	1
4,[5],12:i:-	1 (2.5)	1																		
6,7:b:-	1 (2.5)	1																		
Manhattan	1 (2.5)	1																		
Putten	1 (2.5)	1																		
Total	**40 (100.0)**	**19**	**5**	**7**	**9**			**15**	**12**			**2**			**16**	**2**		**5**			**18**
Ontario																				
Derby	23 (34.3)	1	9	12	1			13	1	1	1	1	1	13						22
Typhimurium	16 (23.9)		2	4	10			12	12					14			10			16
4,[5],12:i:-	10 (14.9)		1		9			9	9					9	4		3			10
Livingstone	8 (11.9)		8																	8
Anatum var. 15+	2 (3.0)		2																	2
Less common serovars	8 (11.9)	5	2		1		1	1	1					1	1	1				3
Total	**67 (100.0)**	**6**	**24**	**16**	**21**		**1**	**35**	**23**	**1**	**1**	**1**	**1**	**37**	**5**	**1**	**13**			**61**
Québec																				
Typhimurium	12 (30.0)	2	2		8		1	4	8					8	4	4	3			10
Derby	8 (20.0)		4	4				4						4						8
Brandenburg	6 (15.0)	2	4						4	4	4	4	4							
4,[5],12:i:-	5 (12.5)			1	4			4	5					4						5
10:e,h:-	2 (5.0)			2			2	2	2											2
Infantis	2 (5.0)	2																		
Ohio	2 (5.0)	1			1			1	1					1			1			1
4,12:-:1,2	1 (2.5)				1			1	1					1	1		1			1
Rough-O:r:-	1 (2.5)				1			1	1					1	1					1
Schwarzengrund	1 (2.5)	1																		
Total	**40 (100.0)**	**8**	**10**	**7**	**15**		**3**	**17**	**22**	**4**	**4**	**4**	**4**	**19**	**6**	**4**	**5**			**28**
National																				
Derby	40 (27.2)	2	15	22	1			23	1	1	1	1	1	23						38
Typhimurium	35 (23.8)	3	5	4	23		1	21	26					27	4	4	18			31
4,[5],12:i:-	16 (10.8)	1	1	1	13			13	14					13	4		3			15
Livingstone	8 (5.4)		8																	8
Brandenburg	6 (4.1)	2	4						4	4	4	4	4							
Infantis	6 (4.1)	6																		
Uganda	5 (3.4)	5																		
Schwarzengrund	4 (2.7)	1			3			3	3					3						3
Ohio	3 (2.0)	1			2		1	2	2					2	1	1	1			2
Worthington	3 (2.0)	2	1						1											
Less common serovars	21 (14.3)	10	5	3	3		2	5	6		2			4	4		1			10
Total	**147 (100.0)**	**33**	**39**	**30**	**45**		**4**	**67**	**57**	**5**	**7**	**5**	**5**	**72**	**13**	**5**	**23**			**107**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Table 4.2. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pigs, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Prairies	735	222	146	268	98	1		195	201	9	9	9	8	260	60	2	126		4	440
Ontario	478	44	101	232	101		19	146	220	11	10	11	10	230	81	6	105			409
Québec	459	55	111	214	75	4	5	166	159	13	15	13	15	206	83	4	79		2	368
National	**1,672**	**321**	**358**	**714**	**274**	**5**	**24**	**507**	**580**	**33**	**34**	**33**	**33**	**696**	**224**	**12**	**310**		**6**	**1,217**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Table 4.3. Number of antimicrobial classes in resistance patterns of *Salmonella* from chicks and barn environment at placement, by province/region, 2014

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Bristish Columbia																				
Enteritidis	16 (88.9)	16																		
Braenderup	1 (5.6)			1			1	1						1						
Kentucky	1 (5.6)	1																		
Total	**18 (100)**	**17**		**1**			**1**	**1**						**1**						
Prairies																				
Enteritidis	5 (71.2)	5																		
Mbandaka	1 (14.3)	1																		
Montevideo	1 (14.3)	1																		
Total	**7 (100)**	**7**																		
Ontario																				
Agona	1 (50.0)	1																		
Muenchen	1 (50.0)			1				1						1						1
Total	**2 (100)**	**1**		**1**				**1**						**1**						**1**
Québec																				
Kentucky	1 (11.1)			8					2	2	2	2	2							8
Agona	8 (88.9)			1										1						1
Total	**9 (100)**			**9**					**2**	**2**	**2**	**2**	**2**	**1**						**9**
National																				
Enteritidis	21 (58.3)	21																		
Kentucky	9 (25.0)	1		8				8	2	2	2	2	2							8
Agona	2 (5.5)	1		1				1						1						1
Braenderup	1 (2.8)			1			1	1						1						
Mbandaka	1 (2.8)	1																		
Montevideo	1 (2.8)	1																		
Muenchen	1 (2.8)			1				1						1						1
Total	**36 (100)**	**25**		**11**			**1**	**11**	**2**	**2**	**2**	**2**	**2**	**3**						**10**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

Table 4.4. Number of antimicrobial classes in resistance patterns of *Salmonella* from chicks and barn environment at placement, 2014

Sample type / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Chick pad																				
Enteritidis	17 (60.7)	17																		
Kentucky	7 (25.0)			7				7	2	2	2	2	2							7
Agona	1 (3.6)			1				1						1						1
Braenderup	1 (3.6)			1			1	1						1						
Mbandaka	1 (3.6)	1																		
Montevideo	1 (3.6)	1																		
Total	**28 (100)**	**19**		**9**			**1**	**9**	**2**	**2**	**2**	**2**	**2**	**2**						**8**
Environmental																				
Enteritidis	4 (50.0)	4																		
Kentucky	2 (25.0)	1		1				1												1
Agona	1 (12.5)	1																		
Muenchen	1 (12.5)			1				1						1						1
Total	**8 (100)**	**6**		**2**				**2**						**1**						**2**
All sample types																				
Enteritidis	21 (58.3)	21																		
Kentucky	9 (25.0)	1		8				8	2	2	2	2	2							8
Agona	2 (5.5)	1		1				1						1						1
Braenderup	1 (2.8)			1			1	1						1						
Mbandaka	1 (2.8)	1																		
Montevideo	1 (2.8)	1																		
Muenchen	1 (2.8)			1				1						1						1
Total	**36 (100)**	**25**		**11**			**1**	**11**	**2**	**2**	**2**	**2**	**2**	**3**						**10**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

Table 4.5. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chicks and barn environment at placement, by province, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial													
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	57 (24.4)	11	10	28	7	1	12	27	27	18	19	18	18	18	2		1		7	31
Prairies	46 (19.7)	10	9	23	4		10	15	20	6	6	6	6	15	5		1		2	28
Ontario	65 (27.8)	22	11	24	8		19	17	23	8	8	8	8	23	6		2			31
Québec	66 (28.1)	7	6	25	28		32	39	43	21	24	21	24	43	11		11		2	52
National	**234 (100)**	**50**	**36**	**100**	**47**	**1**	**73**	**98**	**113**	**53**	**57**	**53**	**56**	**99**	**24**		**15**		**11**	**142**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

Table 4.6. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chicks and barn environment at placement, 2014

Sample type	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial													
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Chick pad	163 (69.7)	27	51	72	40	1	62	71	87	47	49	47	48	78	14		12		10	103
Environmental	71 (30.3)	23	8	33	7		11	27	26	6	8	6	8	21	10		3		1	39
Total	**234 (100)**	**50**	**36**	**100**	**47**	**1**	**73**	**98**	**113**	**53**	**57**	**53**	**56**	**99**	**24**		**15**		**11**	**142**

See notes at Table 4.4.

Table 4.7. Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens at pre-harvest, 2015

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																				
Enteritidis	46 (62.2)	46																		
Kentucky	16 (21.6)	2	6	8				8	9	9	9	9	9							8
Cubana	3 (4.1)	3																		
8,20:-:z6	3 (4.1)			3				3	2	2	2	1	1							3
Liverpool	3 (4.1)	3																		
Less common serovars	3 (4.1)	1		2				2						2						2
Total	**74 (100)**	**55**	**6**	**13**				**13**	**11**	**11**	**11**	**10**	**10**	**2**						**13**
Prairies																				
Schwarzengrund	15 (27.8)	15																		
Enteritidis	10 (18.5)	10																		
Kentucky	6 (11.1)	4		2				2	1	1	1	1	1							2
Montevideo	5 (9.3)	5																		
8,20:-:z6	4 (7.4)			4				4												4
Infantis	4 (7.4)	4																		
Agona	3 (5.6)	3																		
Less common serovars	7 (12.9)	5	1	1			1	1	1	1	1	1	1	1						2
Total	**54 (100)**	**46**	**1**	**7**			**1**	**7**	**2**	**2**	**2**	**2**	**2**	**1**						**6**
Ontario																				
Kentucky	12 (28.6)	1	1	10			2	11						2						10
Heidelberg	9 (21.4)	9																		
Typhimurium var. 5-	5 (11 .9)			5										5						5
Agona	4 (9.5)	4																		
Muenchen	4 (9.5)	1		3			1	2						3						3
Senftenberg	3 (7.1)	3																		
4,5,12:i:-	2 (4.8)		2						2	2	2	2	2							
Montevideo	1 (2.4)	1																		
Oranienburg	1 (2.4)	1																		
Ouakam	1 (2.4)		1																	1
Total	**42 (100)**	**20**	**4**	**18**			**3**	**13**	**2**	**2**	**2**	**2**	**2**	**10**						**19**
Québec																				
Kentucky	52 (65.8)		1	50	1		1	48	12	11	11	10	11	2	1					52
Heidelberg	7 (8.9)	2	4	1					5	4	4	4	4	1	1					
Schwarzengrund	5 (6.4)			5				1						5						5
Hadar	4 (5.1)			4				4												4
Agona	3 (3.8)			3				1						3						3
Enteritidis	2 (2.5)	2																		
Tennessee	2 (2.5)	2																		
Less common serovars	4 (5.1)	1		3				1	1	1	1	1	1	1	1					3
Total	**79 (100)**	**7**	**5**	**66**	**1**		**1**	**55**	**18**	**16**	**16**	**15**	**16**	**12**	**3**					**67**
National																				
Kentucky	86 (34.5)	7	8	70	1		3	69	22	21	21	20	21	4	1					72
Enteritidis	58 (23.3)	58																		
Schwarzengrund	20 (8.0)	15		5				1						5						5
Heidelberg	16 (6.4)	11	4	1					5	4	4	4	4	1	1					
Agona	10 (4.0)	7		3				1						3						3
8,20:-:z6	7 (2.8)			7				7	2	2	2	1	1							7
Montevideo	6 (2.4)	6																		
Typhimurium var. 5-	5 (2.0)			5										5						5
Less common serovars	41 (16.5)	24	4	13			2	10	4	4	4	4	4	7	1					13
Total	**249 (100)**	**128**	**16**	**104**	**1**		**5**	**88**	**33**	**31**	**31**	**29**	**30**	**25**	**3**					**105**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

Table 4.8. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chickens at pre-harvest, 2014

Province or region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	116 (20.6)	17	43	38	17	1	18	39	78	60	59	60	57	32	3		2	1	10	44
Prairies	147 (26.2)	45	37	48	17		18	36	57	44	44	44	39	39	5		5		11	69
Ontario	166 (29.6)	43	34	64	25		25	63	75	19	18	19	17	60	32	3	8		3	83
Québec	132 (23.6)	20	14	71	26	1	37	80	49	13	15	13	14	84	55	1	12		2	78
National	**561 (100)**	**125**	**128**	**221**	**85**	**2**	**98**	**218**	**259**	**136**	**136**	**136**	**127**	**215**	**95**	**4**	**27**	**1**	**26**	**274**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

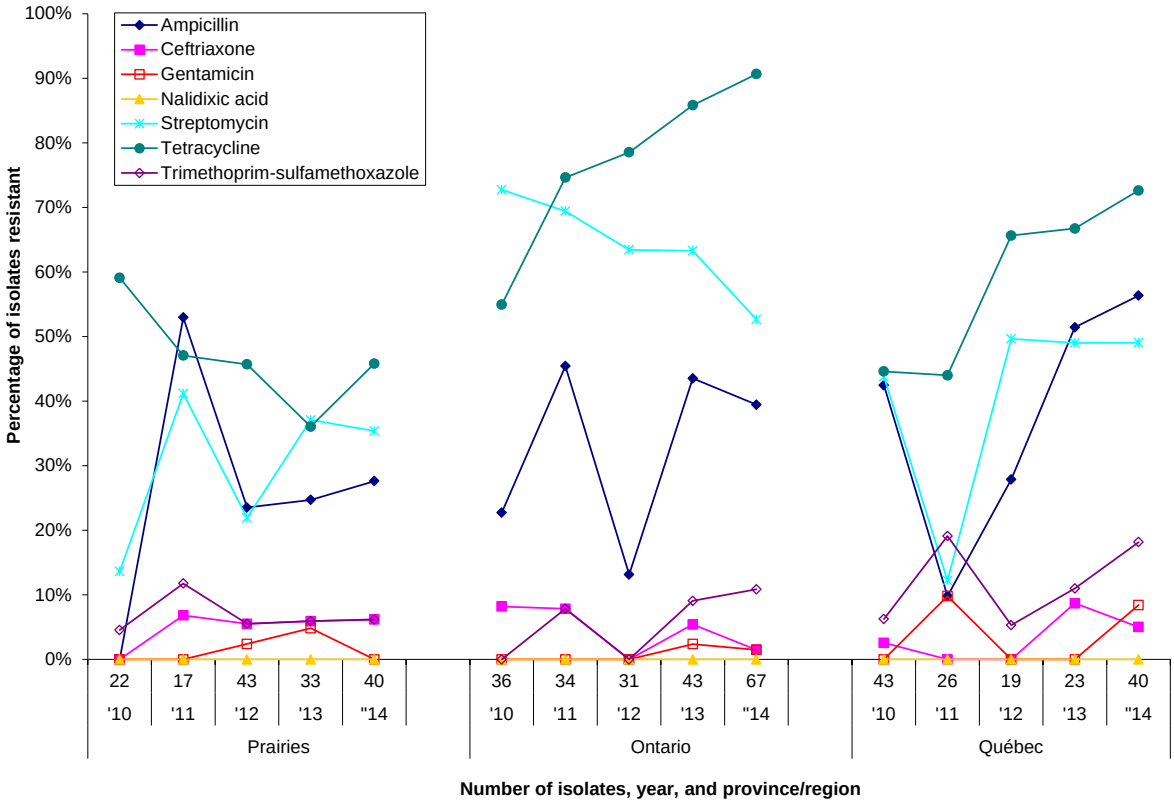
Table 4.9. Number of antimicrobial classes in resistance patterns of *Campylobacter* from chicken at pre-harvest, 2014

Province or region / species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial								
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
British Columbia															
Campylobacterjejuni	26 (100)	9	10	7									7	7	17
Total	**26 (100)**	**9**	**10**	**7**									**7**	**7**	**17**
Prairies															
Campylobacterjejuni	11 (100)	6	5												5
Total	**11(100)**	**6**	**5**												**5**
Ontario															
Campylobacter coli	5(14.3)	3	2												2
Campylobacter jejuni	30 (85.7)	22	6	2									2	2	8
Total	**35 (100)**	**25**	**8**	**2**									**2**	**2**	**10**
Québec															
Campylobacter jejuni	21 (100)	7	12	2				2		3	3				11
Total	**21 (100)**	**7**	**12**	**2**				**2**		**3**	**3**				**11**
National															
Campylobacter coli	5 (5.4)	3	2												2
Campylobacter jejuni	88 (94.6)	44	33	11				2		3	3		9	9	41
Total	**93 (100)**	**47**	**34**	**11**				**2**		**3**	**3**		**9**	**9**	**43**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

Figure 4.1. Temporal variations in resistance of *Salmonella* isolates from pigs, 2010–2014

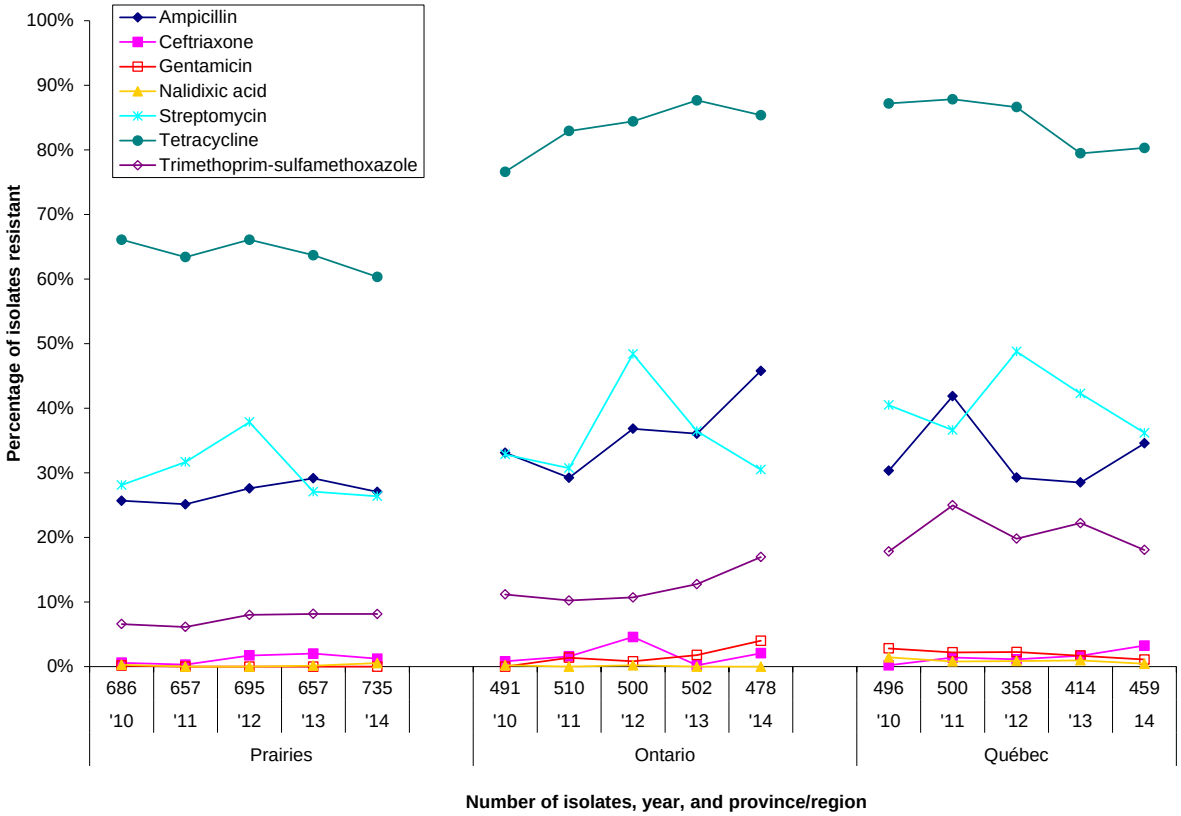


Province / region	Prairies					Ontario					Québec				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14
Number of isolates	22	17	43	33	40	36	34	31	43	67	43	26	19	23	40
Antimicrobial															
Ampicillin	**0%**	53%	24%	**25%**	**28%**	**23%**	45%	13%	**44%**	**39%**	**42%**	10%	28%	**51%**	**56%**
Ceftriaxone	**0%**	7%	6%	**6%**	**6%**	**8%**	8%	0%	**5%**	**1%**	**3%**	0%	0%	**9%**	**5%**
Gentamicin	**0%**	0%	2%	**5%**	**0%**	**0%**	0%	0%	**2%**	**1%**	**0%**	10%	0%	**0%**	**8%**
Nalidixic acid	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
Streptomycin	**14%**	41%	22%	**37%**	**35%**	**73%**	69%	63%	**63%**	**53%**	**44%**	12%	50%	**49%**	**49%**
Tetracycline	**59%**	47%	46%	**36%**	**46%**	**55%**	75%	79%	**86%**	**91%**	**45%**	44%	66%	**67%**	**73%**
Trimethoprim-sulfamethoxazole	**5%**	12%	6%	**6%**	**6%**	**0%**	8%	0%	**9%**	**11%**	**6%**	19%	5%	**11%**	**18%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 4.2. Temporal variations in resistance of *Escherichia coli* isolates from pigs, 2010–2014



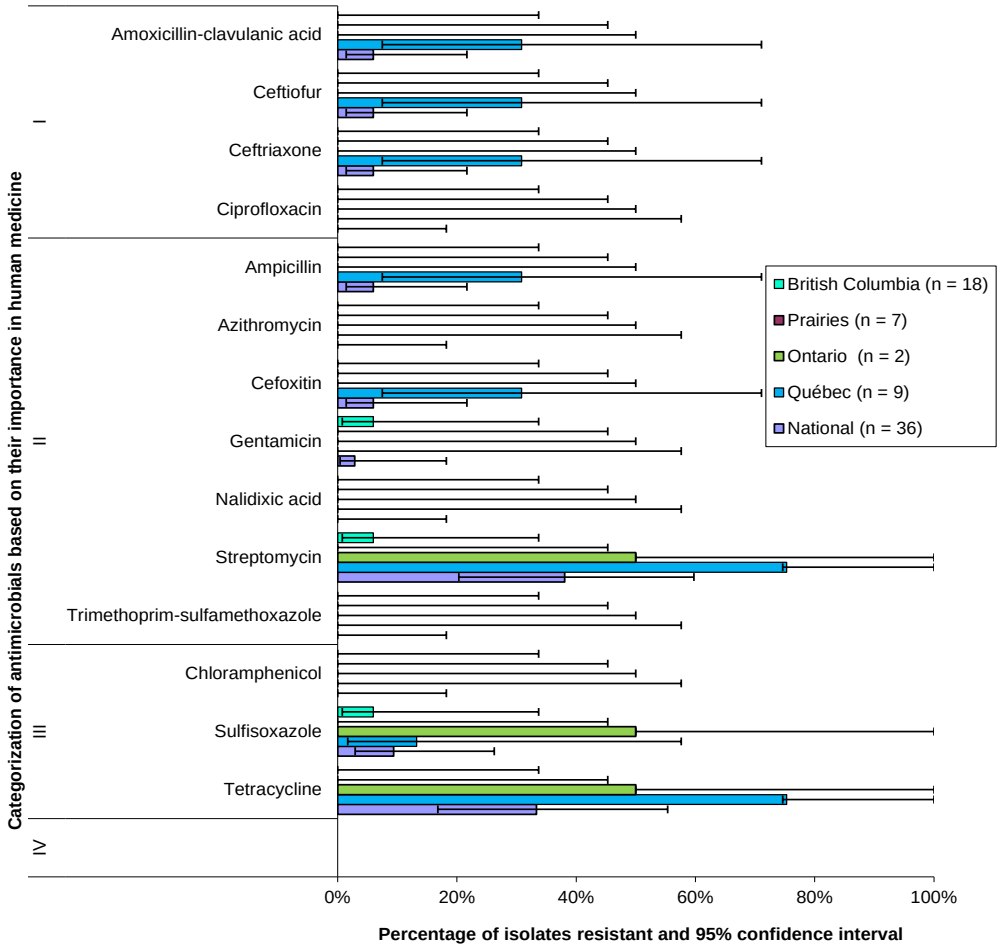
Province / region	Prairies					Ontario					Québec				
Year	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14	'10	'11	'12	'13	'14
Number of isolates	686	657	695	657	735	491	510	500	502	478	496	500	358	414	459
Antimicrobial															
Ampicillin	**26%**	25%	28%	**29%**	**27%**	**33%**	29%	37%	**36%**	**46%**	**30%**	42%	29%	**28%**	**35%**
Cefriaxone	**< 1%**	< 1%	2%	**2%**	**1%**	**< 1%**	2%	5%	**< 1%**	**2%**	**< 1%**	1%	1%	**2%**	**3%**
Gentamicin	**< 1%**	0%	0%	**0%**	**0%**	**0%**	1%	< 1%	**2%**	**4%**	**3%**	2%	2%	**2%**	**1%**
Nalidixic acid	**< 1%**	0%	0%	**< 1%**	**< 1%**	**< 1%**	0%	< 1%	**0%**	**0%**	**1%**	< 1%	< 1%	**1%**	**< 1%**
Streptomycin	**28%**	32%	38%	**27%**	**26%**	**33%**	31%	48%	**36%**	**30%**	**40%**	37%	49%	**42%**	**36%**
Tetracycline	**66%**	63%	66%	**64%**	**60%**	**77%**	83%	84%	**88%**	**85%**	**87%**	88%	87%	**79%**	**80%**
Trimethoprim-sulfamethoxazole	**7%**	6%	8%	**8%**	**8%**	**11%**	10%	11%	**13%**	**17%**	**18%**	25%	20%	**22%**	**18%**

For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the previous 5 years and the preceding surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

ANTIMICROBIAL RESISTANCE SUMMARY

Figure 4.3. Resistance of *Salmonella* isolates from chicks at placement, by province/region, 2014



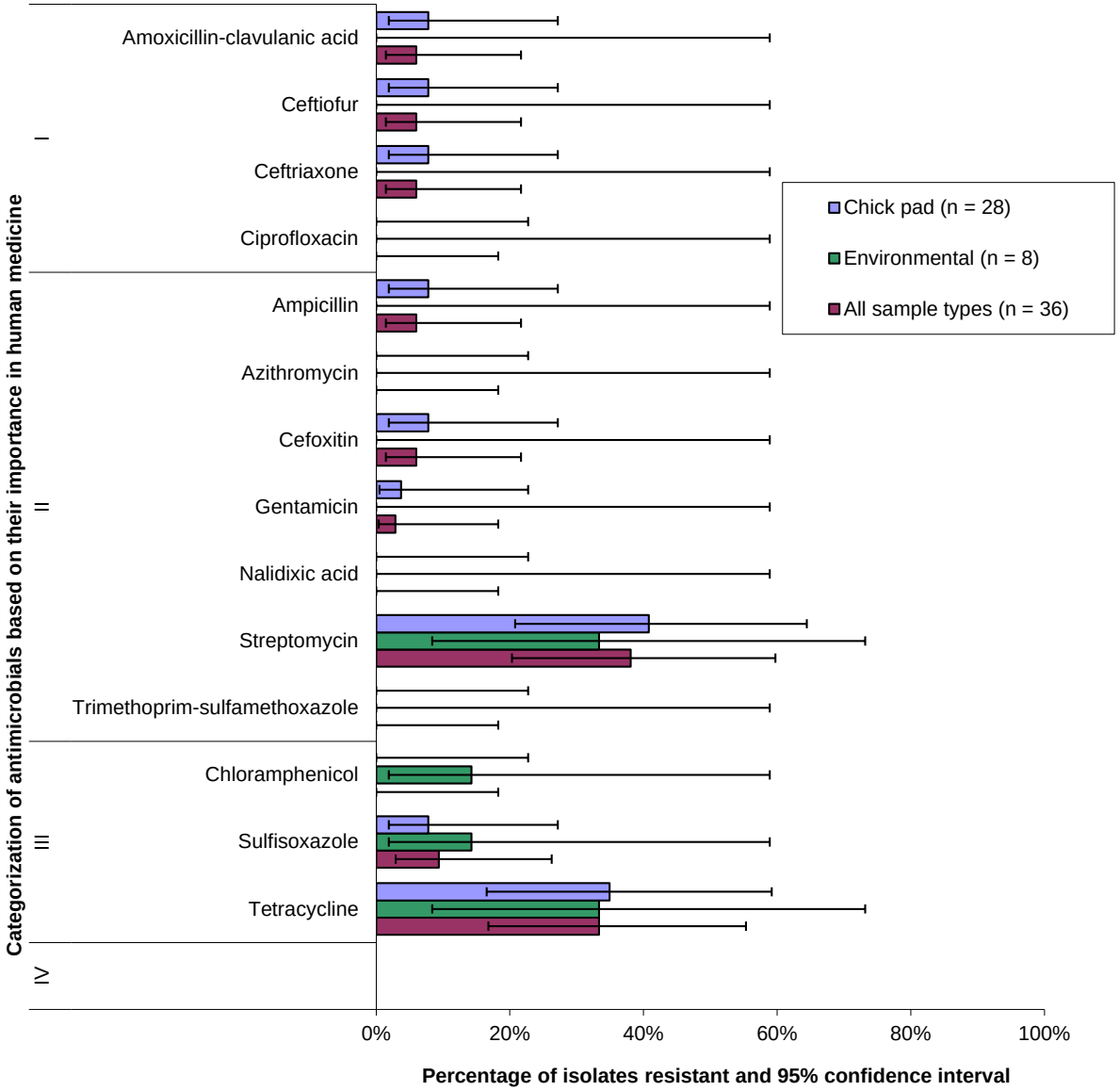
Province / region	National		British Columbia		Prairies		Ontario		Québec	
Year	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of isolates	51	36	17	18	10	7	13	2	11	9
Antimicrobial										
Ampicillin	29%	6%	18%	0%	35%	0%	58%	0%	0%	31%
Ceftriaxone	29%	6%	18%	0%	35%	0%	58%	0%	0%	31%
Gentamicin	2%	3%	0%	6%	0%	0%	8%	0%	0%	0%
Nalidixic acid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Streptomycin	41%	38%	28%	6%	35%	0%	39%	50%	71%	75%
Tetracycline	46%	33%	28%	0%	35%	0%	39%	50%	71%	75%
Trimethoprim-sulfamethoxazole	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

This figure summarizes the proportion (percentage adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at chick placement by province/region for the 2014 sampling year. The table summarizes 2013 to 2014 results.

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

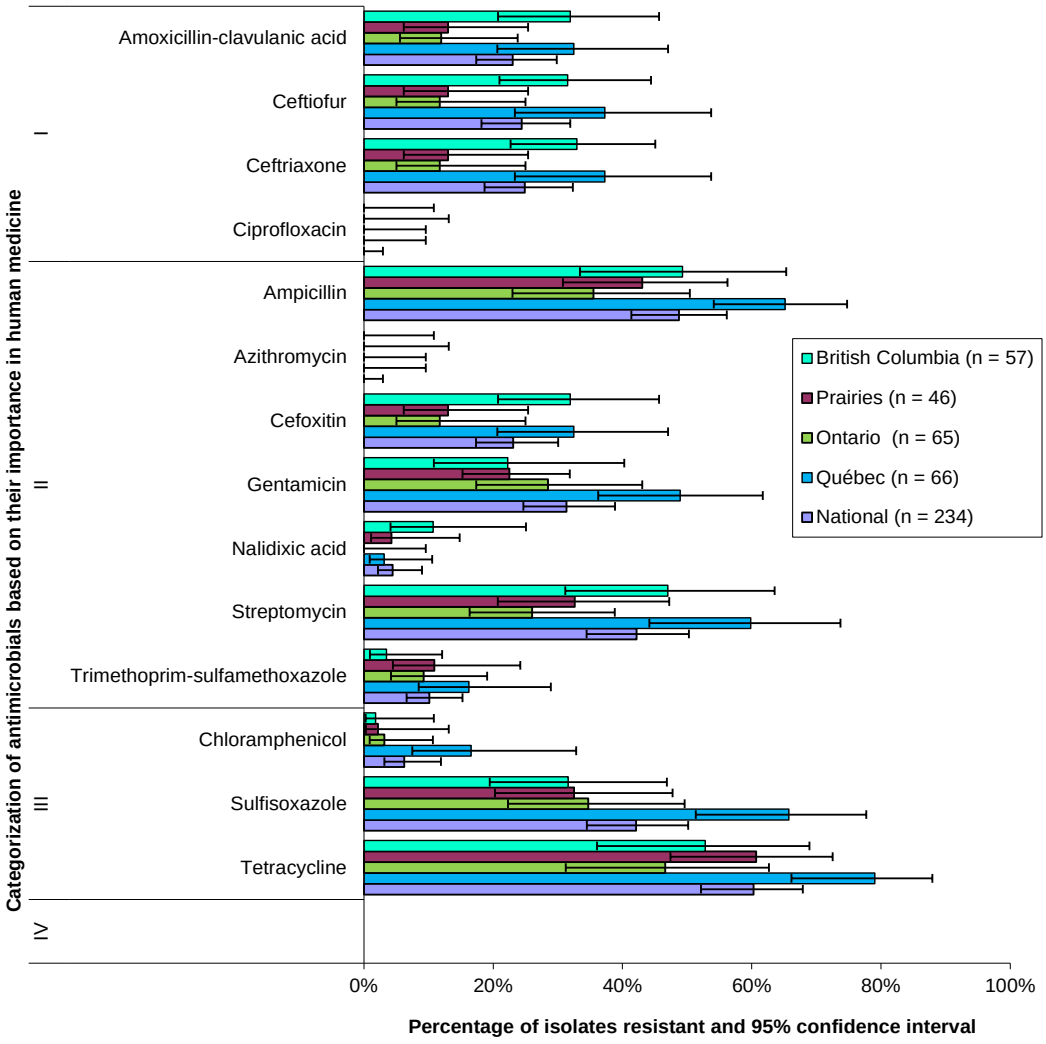
Figure 4.4. Resistance of *Salmonella* isolates from chicks and barn environment at placement, 2014



Sample type	Chick pad		Environmental		All sample types	
Year	2013	2014	2013	2014	2013	2014
Number of isolates	42	36	9	8	51	36
Antimicrobial						
Ampicillin	26%	8%	33%	0%	29%	6%
Ceftriaxone	26%	8%	33%	0%	29%	6%
Gentamicin	2%	4%	0%	0%	2%	3%
Nalidixic acid	0%	0%	0%	0%	0%	0%
Streptomycin	38%	41%	44%	33%	41%	38%
Tetracycline	43%	35%	44%	33%	46%	33%
Trimethoprim-sulfamethoxazole	0%	0%	0%	0%	0%	0%

This figure summarizes the proportion (percentage adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at chick placement by sample type for the 2014 sampling year. The table summarizes 2013 to 2014 results by sample type.

Figure 4.5. Resistance of *Escherichia coli* isolates from chicks at placement, by province/region, 2014



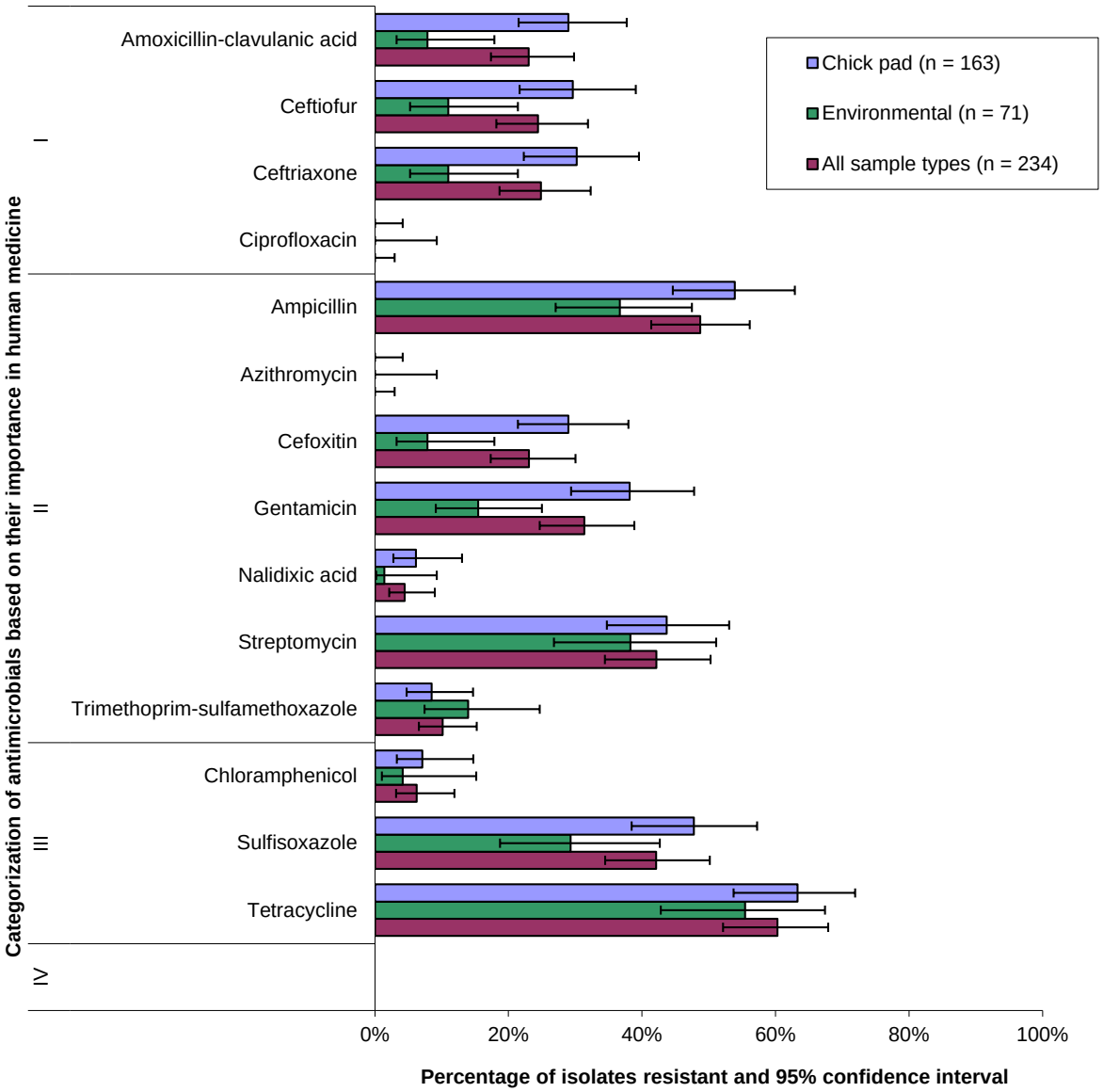
Province / region	National		British Columbia		Prairies		Ontario		Québec	
Year	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of isolates	191	234	43	57	31	46	64	65	53	66
Antimicrobial										
Ampicillin	60%	49%	76%	49%	81%	43%	50%	36%	46%	65%
Ceftriaxone	39%	25%	67%	33%	68%	13%	19%	12%	21%	37%
Gentamicin	30%	31%	14%	22%	39%	22%	25%	28%	44%	49%
Nalidixic acid	3%	4%	2%	11%	7%	4%	2%	0%	4%	3%
Streptomycin	34%	42%	21%	47%	33%	33%	28%	26%	53%	60%
Tetracycline	59%	60%	44%	53%	59%	61%	61%	47%	66%	79%
Trimethoprim-sulfamethoxazole	13%	10%	7%	3%	6%	11%	16%	9%	20%	16%

The figure above summarizes the proportion (percentage, adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at chick placement by province/region for the 2014 sampling year. The table summarizes 2013 to 2014 results.

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

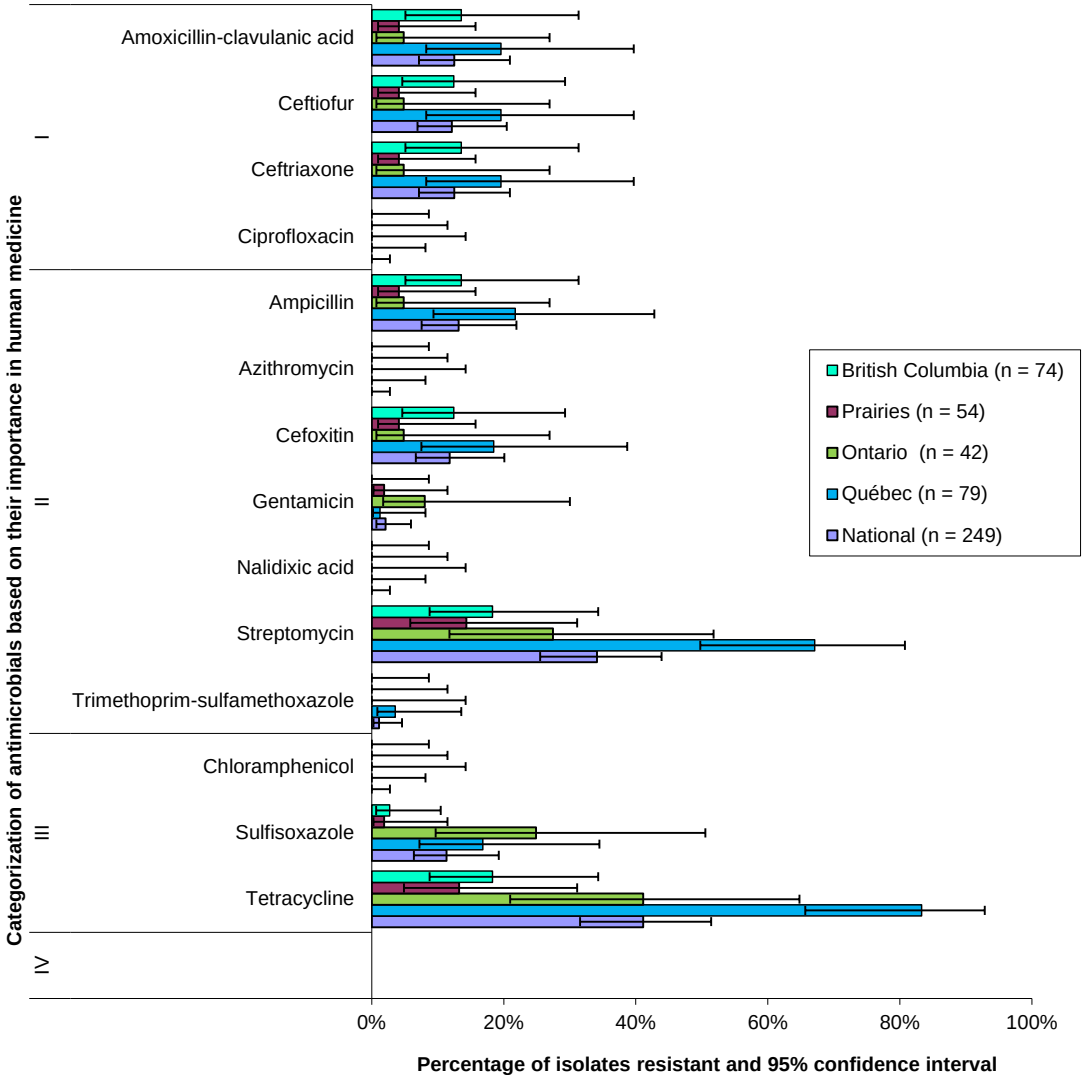
Figure 4.6. Resistance of *Escherichia coli* isolates from chicks at placement, 2014



Sample type	Chick pad		Environmental		All sample types	
Year	2013	2014	2013	2014	2013	2014
Number of isolates	129	163	62	71	191	234
Antimicrobial						
Ampicillin	65%	54%	49%	37%	60%	49%
Ceftriaxone	44%	30%	25%	11%	38%	25%
Gentamicin	35%	38%	19%	15%	30%	31%
Nalidixic acid	4%	6%	2%	1%	3%	4%
Streptomycin	35%	44%	32%	38%	34%	42%
Tetracycline	61%	63%	53%	55%	59%	60%
Trimethoprim-sulfamethoxazole	14%	8%	11%	14%	13%	10%

The figure above summarizes the proportion (percentage, adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at chick placement by sample type for the 2014 sampling year. The table summarizes 2013 to 2014 results by sample type.

Figure 4.7. Resistance of *Salmonella* isolates from chickens at pre-harvest, 2014



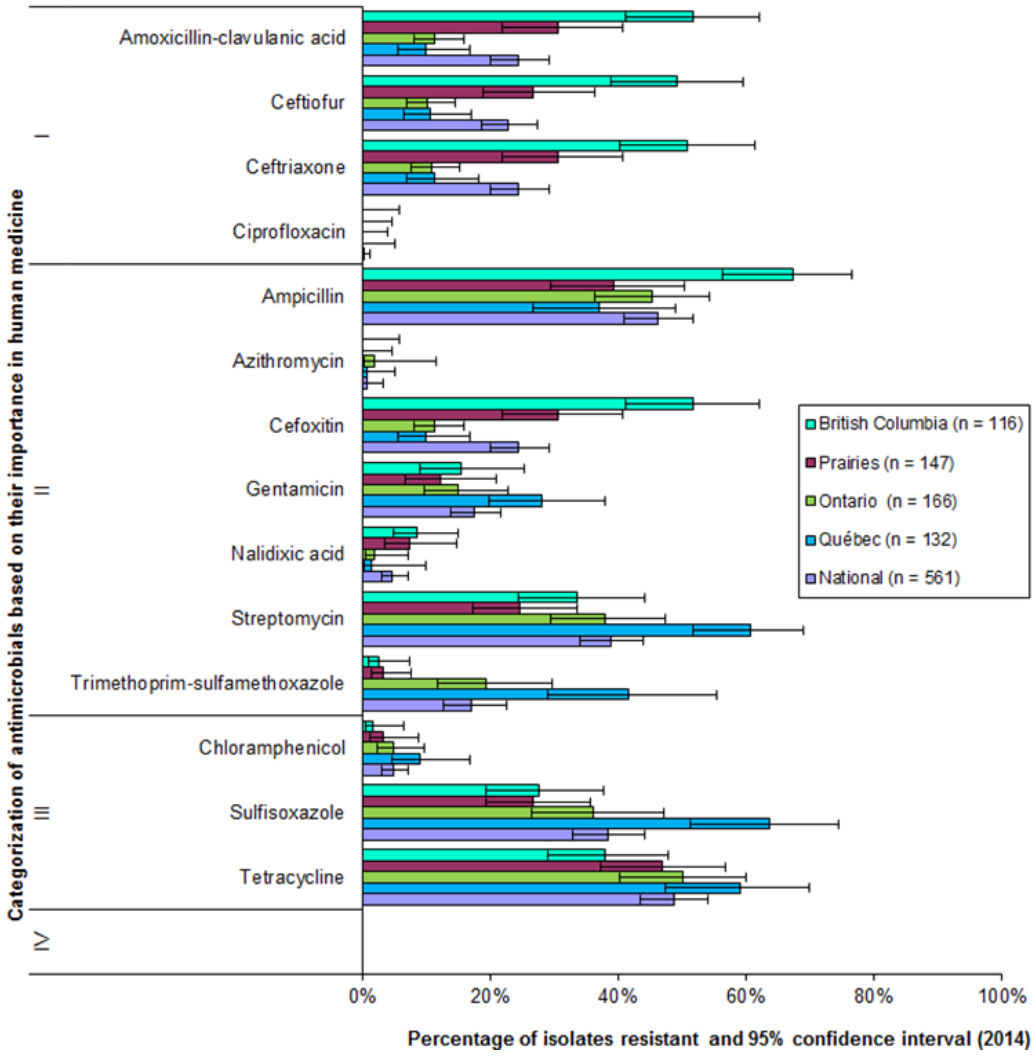
Province / region	National		British Columbia		Prairies		Ontario		Québec	
Year	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of isolates	229	249	68	74	24	54	65	42	72	79
Antimicrobial										
Ampicillin	23%	13%	18%	14%	37%	4%	44%	5%	4%	22%
Ceftriaxone	22%	12%	18%	14%	32%	4%	43%	5%	4%	20%
Gentamicin	0%	2%	0%	0%	0%	2%	0%	8%	1%	1%
Nalidixic acid	1%	0%	5%	0%	0%	0%	0%	0%	0%	0%
Streptomycin	37%	34%	14%	18%	45%	14%	41%	27%	52%	67%
Tetracycline	37%	41%	14%	18%	35%	13%	37%	41%	59%	83%
Trimethoprim-sulfamethoxazole	3%	1%	0%	0%	0%	0%	4%	0%	0%	4%

The figure above summarizes the proportion (percentage, adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at pre-harvest by province/region for the 2014 sampling year. The table summarizes 2013 to 2014 results.

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

Figure 4.8. Resistance of *Escherichia coli* isolates from chickens at pre-harvest, 2014



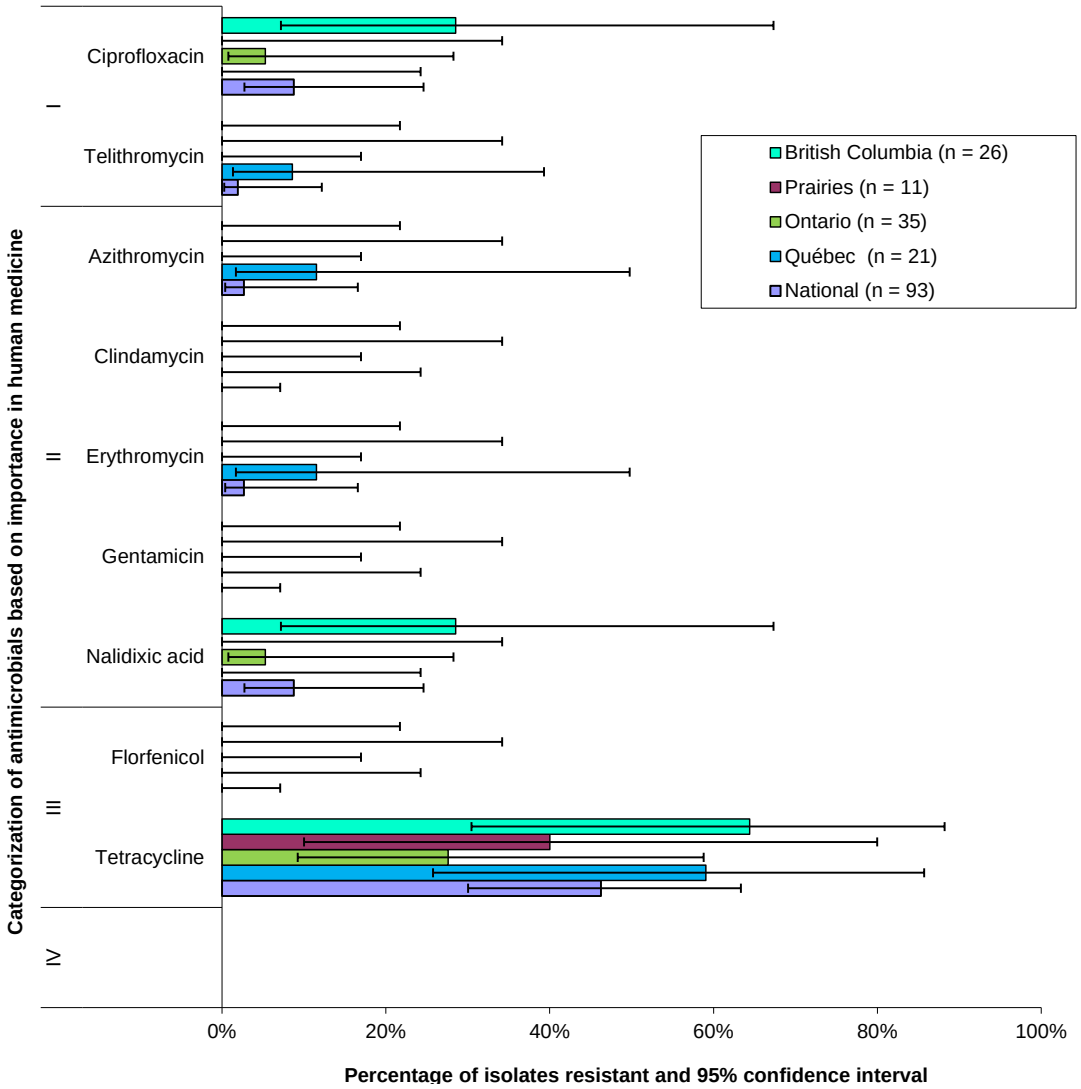
Province / region	National		British Columbia		Prairies		Ontario		Québec	
Year	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of isolates	385	561	94	116	60	147	120	166	111	132
Antimicrobial										
Ampicillin	61%	46%	88%	67%	68%	39%	49%	45%	48%	37%
Ceftriaxone	32%	24%	63%	51%	47%	31%	14%	11%	17%	11%
Gentamicin	13%	17%	8%	16%	10%	12%	10%	15%	23%	28%
Nalidixic acid	4%	5%	10%	9%	8%	7%	2%	2%	1%	2%
Streptomycin	48%	39%	38%	34%	52%	25%	37%	38%	65%	61%
Tetracycline	50%	49%	40%	38%	53%	47%	46%	50%	60%	59%
Trimethoprim-sulfamethoxazole	21%	17%	5%	3%	7%	3%	23%	19%	41%	42%

The figure above summarizes the proportion (percentage, adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at pre-harvest by province/region for the 2014 sampling year. The table summarizes 2013 to 2014 results.

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

Figure 4.9. Resistance of *Campylobacter* isolates from chickens at pre-harvest, 2014



Province / region	National		British Columbia		Prairies		Ontario		Québec	
Year	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of isolates	81	93	27	26	15	11	20	35	19	21
Antimicrobial										
Azithromycin	0%	3%	0%	0%	0%	0%	0%	0%	0%	12%
Ciprofloxacin	16%	9%	30%	29%	0%	0%	20%	5%	5%	0%
Gentamicin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Telithromycin	0%	2%	0%	0%	0%	0%	0%	0%	0%	9%
Tetracycline	59%	46%	44%	64%	60%	40%	55%	28%	83%	59%

The figure above summarizes the proportion (percentage, adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at pre-harvest by province/region for the 2014 sampling year. The table summarizes 2013 to 2014 results.

For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

MINIMUM INHIBITORY CONCENTRATIONS

See how to interpret the minimum inhibitory concentration tables in the section ''How to Read this Chapter''.

Table 4.10. Distribution of minimum inhibitory concentrations among *Salmonella* from pigs, 2014

Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
Amoxicillin-clavulanic acid	Prairies	40	≤ 1	8	0.0							67.5	2.5	5.0	15.0	10.0					
	Ontario	67	≤ 1	16	1.5							64.2	1.5	10.4	10.4	11.9		1.5			
	Québec	40	4	16	10.0							45.0		7.5	15.0	22.5		10.0			
	National	147	≤ 1	16	3.4							59.9	1.4	8.2	12.9	14.3		3.4			
Ceftiofur	Prairies	40	1	1	0.0						30.0	60.0	5.0	5.0							
	Ontario	67	1	1	1.5						19.4	76.1	3.0			1.5					
I	Québec	40	1	1	10.0						10.0	80.0				10.0					
	National	147	1	1	3.4						19.7	72.8	2.7	1.4		3.4					
Ceftriaxone	Prairies	40	≤ 0.25	≤ 0.25	5.0					95.0				5.0							
	Ontario	67	≤ 0.25	≤ 0.25	1.5					98.5							1.5				
	Québec	40	≤ 0.25	≤ 0.25	10.0					90.0						10.0					
	National	147	≤ 0.25	≤ 0.25	4.8					95.2				1.4		2.7	0.7				
Ciprofloxacin	Prairies	40	≤ 0.015	≤ 0.015	0.0	92.5	7.5														
	Ontario	67	≤ 0.015	0.03	0.0	74.6	25.4														
	Québec	40	≤ 0.015	0.03	0.0	70.0	27.5	2.5													
	National	147	≤ 0.015	0.03	0.0	78.2	21.1	0.7													
Ampicillin	Prairies	40	≤ 1	> 32	30.0							65.0	5.0					30.0			
	Ontario	67	1	> 32	34.3							58.2	7.5					34.3			
	Québec	40	> 32	> 32	55.0							45.0						55.0			
	National	147	≤ 1	> 32	38.8							56.5	4.8					38.8			
Azithromycin	Prairies	40	4	8	0.0								12.5	42.5	40.0	5.0					
	Ontario	67	4	8	1.5								9.0	55.2	34.3		1.5				
	Québec	40	8	16	10.0								2.5	37.5	47.5	2.5	10.0				
	National	147	4	8	3.4								8.2	46.9	39.5	2.0	3.4				
Cefoxitin	Prairies	40	2	4	0.0							5.0	45.0	50.0							
	Ontario	67	4	8	1.5							4.5	44.8	40.3	9.0			1.5			
	Québec	40	4	4	10.0							5.0	40.0	45.0			2.5	7.5			
	National	147	4	4	3.4							4.8	43.5	44.2	4.1		0.7	2.7			
Gentamicin	Prairies	40	0.5	1	0.0					2.5	77.5	20.0									
	Ontario	67	0.5	1	1.5					11.9	62.7	23.9					1.5				
II	Québec	40	0.5	1	7.5					25.0	52.5	15.0				7.5					
	National	147	0.5	1	2.7					12.9	63.9	20.4				2.0	0.7				
Nalidixic acid	Prairies	40	4	4	0.0								45.0	55.0							
	Ontario	67	4	4	0.0							1.5	20.9	77.6							
	Québec	40	4	4	0.0								42.5	52.5	5.0						
	National	147	4	4	0.0							0.7	33.3	64.6	1.4						
Streptomycin	Prairies	40	16	> 64	37.5										45.0	17.5		2.5	35.0		
	Ontario	67	64	> 64	52.2									1.5	13.4	26.9	6.0	4.5	47.8		
	Québec	40	16	> 64	42.5									2.5	32.5	20.0	2.5	2.5	40.0		
	National	147	16	> 64	45.6									1.4	27.2	22.4	3.4	3.4	42.2		
Trimethoprim-sulfamethoxazole	Prairies	40	≤ 0.12	≤ 0.12	5.0				90.0	5.0					5.0						
	Ontario	67	0.25	0.5	7.5				68.7	20.9	3.0				7.5						
	Québec	40	≤ 0.12	8	15.0				67.5	17.5					15.0						
	National	147	≤ 0.12	0.5	8.8				74.1	15.6	1.4				8.8						
Chloramphenicol	Prairies	40	8	> 32	12.5									27.5	57.5	2.5		12.5			
	Ontario	67	8	> 32	19.4									25.4	55.2			19.4			
	Québec	40	8	> 32	12.5								2.5	12.5	70.0	2.5		12.5			
	National	147	8	> 32	15.6								0.7	22.4	59.9	1.4		15.6			
Sulfisoxazole	Prairies	40	64	> 256	40.0											10.0	30.0	20.0			40.0
	Ontario	67	> 256	> 256	55.2											6.0	29.9	9.0			55.2
III	Québec	40	32	> 256	47.5											20.0	32.5				47.5
	National	147	64	> 256	49.0											10.9	30.6	9.5			49.0
Tetracycline	Prairies	40	≤ 4	> 32	45.0									55.0			7.5	37.5			
	Ontario	67	> 32	> 32	91.0									9.0		1.5	13.4	76.1			
	Québec	40	> 32	> 32	70.0									30.0		2.5	2.5	65.0			
	National	147	> 32	> 32	72.8									27.2		1.4	8.8	62.6			
IV																					

Percentage of isolates resistant are not adjusted for clustering.

Table 4.11. Distribution of minimum inhibitory concentrations among *Escherichia coli* from pigs, 2014

Antimicrobial	Province/region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
Amoxicillin-clavulanic acid	Prairies	735	4	8	1.2							4.9	29.3	39.0	24.1	1.5	0.7	0.5			
	Ontario	478	4	8	2.3							1.9	17.6	39.3	37.0	1.9	2.3				
	Québec	459	4	8	2.8							2.6	22.2	41.8	28.5	2.0	2.0	0.9			
	National	1,672	4	8	2.0							3.4	24.0	39.9	29.0	1.7	1.5	0.5			
Ceftiofur	Prairies	735	0.25	0.5	1.1				3.1	46.9	48.3	0.4		0.1	0.3	0.8					
	Ontario	478	0.5	0.5	2.1				3.6	46.2	47.5	0.2	0.4		1.5	0.6					
	Québec	459	0.5	0.5	3.3				1.3	45.8	49.5	0.2			2.0	1.3					
I	National	1,672	0.5	0.5	2.0				2.8	46.4	48.4	0.3	0.1	0.1	1.1	0.9					
Ceftriaxone	Prairies	735	≤ 0.25	≤ 0.25	1.2					98.6	0.1			0.1	0.3	0.5	0.3				
	Ontario	478	≤ 0.25	≤ 0.25	2.1					97.5		0.4			0.8	1.0		0.2			
	Québec	459	≤ 0.25	≤ 0.25	3.3					96.7					1.1	1.7		0.2	0.2		
	National	1,672	≤ 0.25	≤ 0.25	2.0					97.8	0.1	0.1		0.1	0.7	1.0	0.1	0.1	0.1		
Ciprofloxacin	Prairies	735	≤ 0.015	≤ 0.015	0.0	97.7	1.8		0.4	0.1											
	Ontario	478	≤ 0.015	≤ 0.015	0.0	98.3	0.2			0.4	1.0										
	Québec	459	≤ 0.015	≤ 0.015	0.0	96.9	1.7	0.2		0.2	0.9										
	National	1,672	≤ 0.015	≤ 0.015	0.0	97.7	1.3	0.1	0.2	0.2	0.5										
Ampicillin	Prairies	735	2	> 32	27.3							11.0	44.9	15.8	0.8	0.1		27.3			
	Ontario	478	4	> 32	46.0							8.8	29.3	15.3	0.4	0.2	0.6	45.4			
	Québec	459	4	> 32	34.6							8.3	39.2	13.5	2.8	1.5	0.4	34.2			
	National	1,672	4	> 32	34.7							9.6	38.9	15.0	1.3	0.5	0.3	34.4			
Azithromycin	Prairies	735	4	8	0.3						0.1	0.5	12.9	57.7	27.6	0.8	0.3				
	Ontario	478	4	8	1.3						0.2	1.5	15.7	54.8	25.3	1.3	1.3				
	Québec	459	4	8	0.9							0.4	10.9	53.2	32.0	2.6	0.9				
	National	1,672	4	8	0.7						0.1	0.8	13.2	55.6	28.2	1.4	0.7				
Cefoxitin	Prairies	735	4	4	1.2						0.5	0.3	25.6	61.2	10.5	0.7	0.3	1.0			
	Ontario	478	4	8	2.3								23.8	57.9	14.2	1.7	1.0	1.3			
	Québec	459	4	8	2.8								21.4	64.1	11.5	0.2	1.3	1.5			
	National	1,672	4	8	2.0						0.2	0.1	23.9	61.1	11.8	0.8	0.8	1.2			
Gentamicin	Prairies	735	1	1	0.0					1.0	44.2	52.1	2.4	0.3							
	Ontario	478	1	1	4.0					1.0	42.3	48.3	3.1	0.8	0.4	0.2	3.8				
II	Québec	459	1	1	1.1					2.0	45.8	48.1	2.6		0.4	0.2	0.9				
	National	1,672	1	1	1.4					1.3	44.1	49.9	2.7	0.4	0.2	0.1	1.3				
Nalidixic acid	Prairies	735	2	2	0.5						1.4	23.7	71.0	3.4				0.5			
	Ontario	478	2	2	0.0						3.3	24.7	67.6	3.3	1.0						
	Québec	459	2	2	0.4						1.1	22.9	71.7	3.3	0.7		0.2	0.2			
	National	1,672	2	2	0.4						1.9	23.7	70.2	3.3	0.5		0.1	0.3			
Streptomycin	Prairies	735	8	> 64	26.5								0.7	21.4	28.3	10.7	12.4	11.6	15.0		
	Ontario	478	16	> 64	30.5								0.2	20.7	21.5	10.5	16.5	13.2	17.4		
	Québec	459	32	> 64	36.2								0.4	16.3	20.0	9.4	17.6	17.4	18.7		
	National	1,672	16	> 64	30.3								0.5	19.8	24.1	10.3	15.0	13.6	16.7		
Trimethoprim-sulfamethoxazole	Prairies	735	≤ 0.12	0.25	8.2				81.9	8.6	1.0	0.4			8.2						
	Ontario	478	≤ 0.12	> 4	16.9				69.7	10.5	2.7	0.2			16.9						
	Québec	459	≤ 0.12	> 4	18.1				74.3	5.2	1.1	0.9	0.4		18.1						
	National	1,672	≤ 0.12	> 4	13.4				76.3	8.2	1.5	0.5	0.1		13.4						
Chloramphenicol	Prairies	735	8	> 32	17.1								1.6	30.1	46.3	4.9	11.0	6.1			
	Ontario	478	8	32	22.0								2.9	29.7	41.6	3.8	12.3	9.6			
	Québec	459	8	> 32	17.2								2.2	28.5	47.9	4.1	6.3	10.9			
	National	1,672	8	32	18.5								2.2	29.5	45.4	4.4	10.1	8.4			
Sulfisoxazole	Prairies	735	≤ 16	> 256	35.4											60.1	3.5	0.5	0.3	0.1	35.4
III	Ontario	478	32	> 256	48.1											47.7	3.3	0.6	0.2		48.1
	Québec	459	≤ 16	> 256	44.9											50.8	3.9	0.4			44.9
	National	1,672	≤ 16	> 256	41.6											54.0	3.6	0.5	0.2	0.1	41.6
Tetracycline	Prairies	735	> 32	> 32	59.9									39.9	0.3	0.5	6.0	53.3			
	Ontario	478	> 32	> 32	85.6									13.4	1.0		6.7	78.9			
	Québec	459	> 32	> 32	80.2									19.2	0.7		10.5	69.7			
	National	1,672	> 32	> 32	72.8									26.6	0.6	0.2	7.4	65.1			
IV																					

Percentage of isolates resistant are not adjusted for clustering.

Table 4.12. Distribution of minimum inhibitory concentrations among *Salmonella* from chicks at placement, 2014

	Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	18	1	1	0.0							100.0									
		Prairies	7	1	1	0.0							100.0									
		Ontario	2	1	1	0.0							100.0									
		Québec	9	1	> 32	22.2							77.8						22.2			
		National	36	1	1	5.6							94.4						5.6			
	Ceftiofur	British Columbia	18	1	1	0.0						22.2	77.8									
		Prairies	7	1	1	0.0							100.0									
		Ontario	2	0.5	1	0.0						50.0	50.0									
		Québec	9	0.5	> 8	22.2					11.1	55.6	11.1				22.2					
I		National	36	1	1	5.6					2.8	27.8	63.9				5.6					
	Ceftriaxone	British Columbia	18	≤ 0.25	≤ 0.25	0.0					100.0											
		Prairies	7	≤ 0.25	≤ 0.25	0.0					100.0											
		Ontario	2	≤ 0.25	≤ 0.25	0.0					100.0											
		Québec	9	≤ 0.25	16	22.2					77.8					11.1	11.1					
		National	36	≤ 0.25	≤ 0.25	5.6					94.4					2.8	2.8					
	Ciprofloxacin	British Columbia	18	≤ 0.015	0.03	0.0	83.3	16.7														
		Prairies	7	≤ 0.015	≤ 0.015	0.0	100.0															
		Ontario	2	≤ 0.015	≤ 0.015	0.0	100.0															
		Québec	9	≤ 0.015	0.03	0.0	77.8	22.2														
		National	36	≤ 0.015	0.03	0.0	86.1	13.9														
	Ampicillin	British Columbia	18	1	2	0.0							88.9	11.1								
		Prairies	7	1	2	0.0							57.1	42.9								
		Ontario	2	1	1	0.0							100.0									
		Québec	9	1	> 32	22.2							77.8						22.2			
		National	36	1	2	5.6							80.6	13.9					5.6			
	Azithromycin	British Columbia	18	4	8	0.0								5.6	83.3	11.1						
		Prairies	7	4	4	0.0								42.9	57.1							
		Ontario	2	4	8	0.0									50.0	50.0						
		Québec	9	4	4	0.0									100.0							
		National	36	4	4	0.0								11.1	80.6	8.3						
	Cefoxitin	British Columbia	18	2	2	0.0							33.3	66.7								
		Prairies	7	2	4	0.0								85.7	14.3							
		Ontario	2	2	4	0.0								50.0	50.0							
		Québec	9	2	32	22.2								66.7	11.1			22.2				
		National	36	2	4	5.6							16.7	69.4	8.3			5.6				
	Gentamicin	British Columbia	18	0.25	0.5	5.6					61.1	33.3						5.6				
		Prairies	7	0.5	1	0.0						85.7	14.3									
II		Ontario	2	≤ 0.25	≤ 0.25	0.0					100.0											
		Québec	9	0.5	1	0.0					44.4	44.4	11.1									
		National	36	0.5	0.5	2.8					47.2	44.4	5.6					2.8				
	Nalidixic acid	British Columbia	18	4	4	0.0								38.9	55.6	5.6						
		Prairies	7	4	4	0.0									100.0							
		Ontario	2	2	4	0.0								50.0	50.0							
		Québec	9	2	4	0.0							11.1	77.8	11.1							
		National	36	4	4	0.0							2.8	41.7	52.8	2.8						
	Streptomycin	British Columbia	18	4	16	5.6								38.9	50.0		5.6		5.6			
		Prairies	7	4	8	0.0								42.9	28.6	28.6						
		Ontario	2	8	64	50.0										50.0			50.0			
		Québec	9	64	> 64	100.0													55.6	44.4		
		National	36	4	> 64	30.6								27.8	30.6	8.3	2.8		19.4	11.1		
	Trimethoprim-sulfamethoxazole	British Columbia	18	≤ 0.12	≤ 0.12	0.0				100.0												
		Prairies	7	≤ 0.12	≤ 0.12	0.0				100.0												
		Ontario	2	≤ 0.12	≤ 0.12	0.0				100.0												
		Québec	9	≤ 0.12	≤ 0.12	0.0				100.0												
		National	36	≤ 0.12	≤ 0.12	0.0				100.0												
	Chloramphenicol	British Columbia	18	4	8	0.0									50.0	50.0						
		Prairies	7	4	8	0.0									28.6	71.4						
		Ontario	2	4	8	0.0									50.0	50.0						
		Québec	9	4	8	0.0								11.1	77.8	11.1						
		National	36	4	8	0.0								2.8	52.8	44.4						
	Sulfisoxazole	British Columbia	18	32	64	5.6											11.1	66.7	16.7			5.6
		Prairies	7	32	> 32	0.0											14.3	42.9	42.9			
III		Ontario	2	32	> 256	50.0												50.0				50.0
		Québec	9	32	> 256	11.1											44.4	33.3	11.1			11.1
		National	36	32	64	8.3											19.4	52.8	19.4			8.3
	Tetracycline	British Columbia	18	4	4	0.0									100.0							
		Prairies	7	4	4	0.0									100.0							
		Ontario	2	4	> 32	50.0									50.0				50.0			
		Québec	9	> 32	> 32	100.0													100.0			
		National	36	4	> 32	27.8									72.2				27.8			
IV																						

Table 4.13. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chicks and barn environment at placement, 2014

	Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	57	4	> 32	31.6							1.8	12.3	38.6	15.8		22.8	8.8			
		Prairies	46	4	32	13.0								8.7	45.7	30.4	2.2	8.7	4.3			
		Ontario	65	4	32	12.3							1.5	20.0	41.5	23.1	1.5	9.2	3.1			
		Québec	66	8	32	31.8							1.5	6.1	27.3	30.3	3.0	22.7	9.1			
		National	234	4	> 32	22.6							1.3	12.0	37.6	24.8	1.7	16.2	6.4			
	Ceftiofur	British Columbia	57	0.5	> 8	31.6					22.8	40.4		3.5	1.8	12.3	19.3					
		Prairies	46	0.5	> 8	13.0					30.4	52.2	4.3			2.2	10.9					
		Ontario	65	0.5	8	12.3					23.1	63.1	1.5			6.2	6.2					
		Québec	66	0.5	> 8	36.4					12.1	50.0	1.5			12.1	24.2					
I		National	234	0.5	> 8	23.9					21.4	51.7	1.7	0.9	0.4	8.5	15.4					
	Ceftriaxone	British Columbia	57	≤ 0.25	16	33.3					63.2		3.5			5.3	22.8	5.3				
		Prairies	46	≤ 0.25	16	13.0					87.0					2.2	6.5	4.3				
		Ontario	65	≤ 0.25	8	12.3					86.2	1.5				4.6	7.7					
		Québec	66	≤ 0.25	32	36.4					63.6					3.0	22.7	3.0	6.1	1.5		
		National	234	≤ 0.25	16	24.4					74.4	0.4	0.9			3.8	15.4	3.0	1.7	0.4		
	Ciprofloxacin	British Columbia	57	≤ 0.015	0.12	0.0	86.0	1.8		3.5	8.8											
		Prairies	46	≤ 0.015	≤ 0.015	0.0	93.5	2.2			4.3											
		Ontario	65	≤ 0.015	≤ 0.015	0.0	100.0															
		Québec	66	≤ 0.015	≤ 0.015	0.0	95.5	1.5			3.0											
		National	234	≤ 0.015	≤ 0.015	0.0	94.0	1.3		0.9	3.8											
	Ampicillin	British Columbia	57	4	> 32	47.4							7.0	33.3	12.3				47.4			
		Prairies	46	4	> 32	43.5							2.2	34.8	19.6				43.5			
		Ontario	65	4	≥ 32	35.4							4.6	44.6	13.8	1.5			35.4			
		Québec	66	> 32	> 32	65.2							1.5	18.2	15.2				65.2			
		National	234	4	> 32	48.3							3.8	32.5	15.0	0.4			48.3			
	Azithromycin	British Columbia	57	4	8	0.0								5.3	63.2	31.6						
		Prairies	46	4	8	0.0								34.8	41.3	23.9						
		Ontario	65	4	8	0.0								9.2	55.4	32.3	3.1					
		Québec	66	8	8	0.0								4.5	43.9	43.9	7.6					
		National	234	4	8	0.0								12.0	51.3	33.8	3.0					
	Cefoxitin	British Columbia	57	4	> 32	31.6								10.5	49.1	8.8		1.8	29.8			
		Prairies	46	4	> 32	13.0								4.3	67.4	13.0	2.2		13.0			
		Ontario	65	4	≥ 32	12.3								10.8	67.7	7.7	1.5		12.3			
		Québec	66	4	> 32	31.8								7.6	50.0	10.6			31.8			
		National	234	4	> 32	22.6								8.5	58.1	9.8	0.9	0.4	22.2			
	Gentamicin	British Columbia	57	1	> 16	21.1						38.6	36.8			3.5		21.1				
		Prairies	46	0.5	> 16	21.7						52.2	26.1				4.3	17.4				
II		Ontario	65	1	≥ 16	29.2						18.5	50.8		1.5		6.2	23.1				
		Québec	66	2	> 16	48.5						19.7	28.8	3.0			10.6	37.9				
		National	234	1	> 16	31.2						30.3	36.3	0.9	0.4	0.9	5.6	25.6				
	Nalidixic acid	British Columbia	57	2	32	12.3							10.5	73.7	3.5			3.5	8.8			
		Prairies	46	2	4	4.3							6.5	76.1	13.0				4.3			
		Ontario	65	2	2	0.0							13.8	83.1	3.1							
		Québec	66	2	2	3.0							15.2	80.3	1.5				3.0			
		National	234	2	2	4.7							12.0	78.6	4.7			0.9	3.8			
	Streptomycin	British Columbia	57	32	> 64	47.4									8.8	35.1	3.5	5.3	22.8	24.6		
		Prairies	46	8	> 64	32.6									28.3	23.9	2.2	13.0	13.0	19.6		
		Ontario	65	8	> 64	26.2									16.9	41.5	3.1	12.3	15.4	10.8		
		Québec	66	64	> 64	59.1									6.1	18.2	3.0	13.6	15.2	43.9		
		National	234	≤ 32	> 64	41.9									14.1	29.9	3.0	11.1	16.7	25.2		
	Trimethoprim-sulfamethoxazole	British Columbia	57	≤ 0.12	0.25	3.5				89.5	7.0					3.5						
		Prairies	46	≤ 0.12	8	10.9				84.8	4.3					10.9						
		Ontario	65	≤ 0.12	0.25	9.2				87.7	3.1					9.2						
		Québec	66	≤ 0.12	> 4	16.7				69.7	10.6	1.5	1.5			16.7						
		National	234	≤ 0.12	> 4	10.3				82.5	6.4	0.4	0.4			10.3						
	Chloramphenicol	British Columbia	57	8	8	1.8								5.3	40.4	52.6			1.8			
		Prairies	46	4	8	2.2								2.2	52.2	39.1	4.3		2.2			
		Ontario	65	8	8	3.1									36.9	55.4	4.6	1.5	1.5			
		Québec	66	8	≥ 32	16.7								1.5	27.3	53.0	1.5		16.7			
		National	234	8	8	6.4								2.1	38.0	50.9	2.6	0.4	6.0			
	Sulfisoxazole	British Columbia	57	16	> 256	31.6											57.9	10.5				31.6
		Prairies	46	16	> 256	32.6											65.2	2.2				32.6
III		Ontario	65	16	> 256	35.4											56.9	7.7				35.4
		Québec	66	> 256	> 256	65.2											31.8	3.0				65.2
		National	234	≤ 16	> 256	42.3											51.7	6.0				42.3
	Tetracycline	British Columbia	57	> 32	> 32	54.4									45.6			3.5	50.9			
		Prairies	46	> 32	> 32	60.9									39.1			2.2	58.7			
		Ontario	65	> 32	> 32	47.7									52.3			3.1	44.6			
		Québec	66	> 32	> 32	78.8									21.2				78.8			
		National	234	> 32	> 32	60.7									39.3			2.1	58.5			
IV																						

Table 4.14. Distribution of minimum inhibitory concentrations among *Salmonella* from chickens at pre-harvest, 2014

	Antimicrobial	Province/region	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
				MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	74	1	32	14.9							83.8	1.4				8.1	6.8			
		Prairies	54	1	1	3.7							90.7	5.6					3.7			
		Ontario	42	1	1	4.8							95.2						4.8			
		Québec	79	1	> 32	20.3							72.2	5.1		2.5		2.5	17.7			
		National	249	1	32	12.4							83.5	3.2		0.8		3.2	9.2			
	Ceftiofur	British Columbia	74	1	> 8	13.5						17.6	66.2	1.4	1.4	1.4	12.2					
		Prairies	54	1	1	3.7						44.4	51.9				3.7					
		Ontario	42	0.5	1	4.8					2.4	47.6	45.2				4.8					
		Québec	79	0.5	> 8	20.3						50.6	25.3	3.8		1.3	19.0					
I		National	249	1	> 8	12.0					0.4	39.0	46.6	1.6	0.4	0.8	11.2					
	Ceftriaxone	British Columbia	74	≤ 0.25	8	14.9					85.1				1.4	5.4	6.8	1.4				
		Prairies	54	≤ 0.25	≤ 0.25	3.7					96.3						1.9	1.9				
		Ontario	42	≤ 0.25	≤ 0.25	4.8					95.2					4.8						
		Québec	79	≤ 0.25	16	20.3					79.7					6.3	11.4	2.5				
		National	249	≤ 0.25	8	12.4					87.6				0.4	4.4	6.0	1.6				
	Ciprofloxacin	British Columbia	74	≤ 0.015	0.03	0.0	89.2	9.5	1.4													
		Prairies	54	≤ 0.015	≤ 0.015	0.0	96.3	3.7														
		Ontario	42	≤ 0.015	0.03	0.0	83.3	16.7														
		Québec	79	≤ 0.015	0.03	0.0	88.6	10.1	1.3													
		National	249	≤ 0.015	0.03	0.0	89.6	9.6	0.8													
	Ampicillin	British Columbia	74	1	> 32	14.9							71.6	12.2	1.4				14.9			
		Prairies	54	1	2	3.7							83.3	13.0					3.7			
		Ontario	42	1	2	4.8							88.1	7.1					4.8			
		Québec	79	1	> 32	22.8							67.1	7.6	2.5				22.8			
		National	249	1	> 32	13.3							75.5	10.0	1.2				13.3			
	Azithromycin	British Columbia	74	4	8	0.0								16.2	58.1	24.3	1.4					
		Prairies	54	4	4	0.0								33.3	61.1	3.7	1.9					
		Ontario	42	4	8	0.0								9.5	57.1	31.0	2.4					
		Québec	79	4	8	0.0								16.5	53.2	27.8	2.5					
		National	249	4	8	0.0								18.9	57.0	22.1	2.0					
	Cefoxitin	British Columbia	74	2	32	13.5						1.4	8.1	66.2	8.1	1.4	1.4	10.8	2.7			
		Prairies	54	2	4	3.7							5.6	64.8	22.2	3.7		3.7				
		Ontario	42	2	4	4.8							23.8	38.1	33.3			4.8				
		Québec	79	2	32	19.0							6.3	58.2	13.9	1.3	1.3	15.2	3.8			
		National	249	2	32	11.6						0.4	9.6	58.6	17.3	1.6	0.8	9.6	2.0			
	Gentamicin	British Columbia	74	0.5	0.5	0.0					41.9	51.4	6.8									
		Prairies	54	0.5	1	1.9					7.4	68.5	20.4	1.9				1.9				
II		Ontario	42	0.5	1	7.1					33.3	52.4	4.8	2.4				7.1				
		Québec	79	0.5	1	1.3					16.5	55.7	25.3	1.3			1.3					
		National	249	0.5	1	2.0					24.9	56.6	15.3	1.2			0.4	1.6				
	Nalidixic acid	British Columbia	74	2	4	0.0							8.1	50.0	41.9							
		Prairies	54	4	4	0.0								24.1	74.1	1.9						
		Ontario	42	4	4	0.0								45.2	52.4		2.4					
		Québec	79	2	4	0.0							7.6	55.7	32.9	3.8						
		National	249	2	4	0.0							4.8	45.4	47.8	1.6	0.4					
	Streptomycin	British Columbia	74	4	64	17.6								25.7	33.8	18.9	4.1		13.5	4.1		
		Prairies	54	8	> 32	13.0								9.3	11.1	50.0	16.7		13.0			
		Ontario	42	16	> 64	31.0									2.4	42.9	14.3	9.5	19.0	11.9		
		Québec	79	64	> 64	69.6									1.3	10.1	8.9	10.1	39.2	30.4		
		National	249	16	> 64	35.3								9.6	13.3	26.9	10.0	4.8	22.5	12.9		
	Trimethoprim-sulfamethoxazole	British Columbia	74	≤ 0.12	≤ 0.12	0.0				100.0												
		Prairies	54	≤ 0.12	≤ 0.12	0.0				100.0												
		Ontario	42	≤ 0.12	≤ 0.12	0.0				97.6	2.4											
		Québec	79	≤ 0.12	≤ 0.12	3.8				92.4	3.8					3.8						
		National	249	≤ 0.12	≤ 0.12	1.2				97.2	1.6					1.2						
	Chloramphenicol	British Columbia	74	8	8	0.0								5.4	40.5	51.4	2.7					
		Prairies	54	8	8	0.0									38.9	61.1						
		Ontario	42	8	8	0.0								2.4	45.2	52.4						
		Québec	79	4	8	0.0								12.7	54.4	30.4	2.5					
		National	249	4	8	0.0								6.0	45.4	47.0	1.6					
	Sulfisoxazole	British Columbia	74	32	64	2.7											18.9	50.0	28.4			2.7
		Prairies	54	32	64	1.9											13.0	50.0	35.2			1.9
III		Ontario	42	32	> 256	23.8											23.8	45.2	7.1			23.8
		Québec	79	32	> 256	15.2											19.0	57.0	8.9			15.2
		National	249	32	64	10.0											18.5	51.4	20.1			10.0
	Tetracycline	British Columbia	74	4	> 32	17.6									82.4				17.6			
		Prairies	54	4	> 32	11.1									88.9				11.1			
		Ontario	42	4	> 32	45.2									54.8				45.2			
		Québec	79	> 32	> 32	84.8									15.2			1.3	83.5			
		National	249	4	> 32	42.2									57.8			0.4	41.8			
IV																						

Table 4.15. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chickens at pre-harvest, 2014

	Antimicrobial	Province/region	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	116	32	32	51.7								15.5	20.7	12.1		45.7	6.0			
		Prairies	147	4	32	29.9							2.0	29.3	29.3	9.5		23.8	6.1			
		Ontario	166	4	32	11.4							3.0	21.7	33.1	28.3	2.4	9.0	2.4			
		Québec	132	4	16	9.8							1.5	26.5	34.1	26.5	1.5	9.8				
		National	561	4	32	24.2							1.8	23.5	29.8	19.6	1.1	20.7	3.6			
	Ceftiofur	British Columbia	116	4	> 8	49.1				1.7	11.2	24.1	6.0	5.2	2.6	30.2	19.0					
		Prairies	147	0.5	> 8	26.5				0.7	38.1	28.6	2.7		3.4	15.0	11.6					
		Ontario	166	0.5	8	10.2				1.8	34.3	49.4	3.0	1.2		4.8	5.4					
		Québec	132	0.5	8	10.6				1.5	32.6	51.5	3.0		0.8	5.3	5.3					
I		National	561	0.5	8	22.6				1.4	30.1	39.2	3.6	1.4	1.6	12.8	9.8					
	Ceftriaxone	British Columbia	116	8	16	50.9					37.9		9.5	1.7		13.8	31.0	4.3	1.7			
		Prairies	147	≤ 0.25	16	29.9					68.7	0.7	0.7			9.5	16.3	4.1				
		Ontario	166	≤ 0.25	8	10.8					86.7	0.6	1.8		0.6	1.2	6.6	1.2	0.6	0.6		
		Québec	132	≤ 0.25	≤ 0.25	11.4					88.6				1.5	1.5	6.1	0.8	0.8	0.8		
		National	561	≤ 0.25	16	24.2					72.4	0.4	2.7	0.4	0.5	6.1	14.1	2.5	0.7	0.4		
	Ciprofloxacin	British Columbia	116	≤ 0.015	0.03	0.9	88.8	2.6		1.7	6.0					0.9						
		Prairies	147	≤ 0.015	≤ 0.015	0.0	91.2	1.4		2.0	4.8	0.7										
		Ontario	166	≤ 0.015	≤ 0.015	0.0	96.4	1.2		0.6	1.8											
		Québec	132	≤ 0.015	≤ 0.015	0.0	98.5			1.5												
		National	561	≤ 0.015	≤ 0.015	0.2	93.9	1.2		1.4	3.0	0.2				0.2						
	Ampicillin	British Columbia	116	> 32	> 32	67.2							6.0	19.8	6.9				67.2			
		Prairies	147	4	> 32	38.8							7.5	38.1	15.0	0.7			38.8			
		Ontario	166	4	> 32	45.2							10.8	30.7	13.3				45.2			
		Québec	132	4	> 32	37.1							3.8	40.2	15.9	3.0			37.1			
		National	561	4	> 32	46.2							7.3	32.6	13.0	0.9			46.2			
	Azithromycin	British Columbia	116	4	8	0.0								10.3	53.4	33.6	2.6					
		Prairies	147	4	4	0.0							1.4	34.7	54.4	8.8	0.7					
		Ontario	166	4	8	1.8							0.6	9.0	51.2	32.5	4.8	1.8				
		Québec	132	4	8	0.8								12.1	45.5	37.9	3.8	0.8				
		National	561	4	8	0.7							0.5	16.8	51.2	27.8	3.0	0.7				
	Cefoxitin	British Columbia	116	32	> 32	51.7								11.2	27.6	9.5		3.4	48.3			
		Prairies	147	4	> 32	29.9								11.6	40.8	15.6	2.0	3.4	26.5			
		Ontario	166	4	32	11.4							1.2	15.7	56.6	14.5	0.6	2.4	9.0			
		Québec	132	4	16	9.8							0.8	11.4	55.3	20.5	2.3	2.3	7.6			
		National	561	8	> 32	24.2							0.5	12.7	46.2	15.2	1.2	2.9	21.4			
	Gentamicin	British Columbia	116	1	16	15.5					2.6	35.3	41.4		0.9	4.3	7.8	7.8				
		Prairies	147	0.5	16	12.2					2.0	49.0	34.7			2.0	2.7	9.5				
II		Ontario	166	1	> 16	15.1					1.8	37.3	41.6	4.2			3.6	11.4				
		Québec	132	1	> 16	28.0					1.5	32.6	32.6	3.0		2.3	4.5	23.5				
		National	561	1	> 16	17.5					2.0	38.9	37.6	2.0	0.2	2.0	4.5	13.0				
	Nalidixic acid	British Columbia	116	2	4	8.6							24.1	63.8	3.4			0.9	7.8			
		Prairies	147	2	4	7.5						0.7	22.4	63.9	5.4			2.0	5.4			
		Ontario	166	2	2	1.8						1.8	18.1	71.1	7.2				1.8			
		Québec	132	2	2	1.5						0.8	14.4	75.0	8.3			1.5				
		National	561	2	4	4.6						0.9	19.6	68.6	6.2			1.1	3.6			
	Streptomycin	British Columbia	116	8	> 64	33.6								0.9	21.6	33.6	4.3	6.0	10.3	23.3		
		Prairies	147	8	> 64	24.5								1.4	43.5	20.4	6.1	4.1	10.2	14.3		
		Ontario	166	16	> 64	38.0									14.5	32.5	6.6	8.4	9.6	28.3		
		Québec	132	64	> 64	60.6									9.1	11.4	3.0	15.9	29.5	31.1		
		National	561	16	> 64	38.9								0.5	22.3	24.6	5.2	8.6	14.6	24.2		
	Trimethoprim-sulfamethoxazole	British Columbia	116	≤ 0.12	≤ 0.12	2.6				92.2	5.2					2.6						
		Prairies	147	≤ 0.12	0.25	3.4				85.0	7.5	3.4	0.7			3.4						
		Ontario	166	≤ 0.12	> 4	19.3				74.1	4.2	1.8	0.6			19.3						
		Québec	132	≤ 0.12	> 4	41.7				52.3	4.5	0.8	0.8			41.7						
		National	561	≤ 0.12	> 4	16.9				75.6	5.3	1.6	0.5			16.9						
	Chloramphenicol	British Columbia	116	8	8	1.7								0.9	35.3	56.9	5.2	0.9	0.9			
		Prairies	147	8	8	3.4								2.7	46.9	44.2	2.7		3.4			
		Ontario	166	8	16	4.8								1.8	39.8	48.2	5.4	1.8	3.0			
		Québec	132	8	16	9.1									23.5	54.5	12.9	2.3	6.8			
		National	561	8	16	4.8								1.4	36.9	50.4	6.4	1.2	3.6			
	Sulfisoxazole	British Columbia	116	≤ 16	> 256	27.6											66.4	6.0				27.6
		Prairies	147	16	> 256	26.5											71.4	1.4	0.7			26.5
III		Ontario	166	≤ 16	> 256	36.1											59.6	3.6	0.6			36.1
		Québec	132	> 256	> 256	63.6											30.3	5.3		0.8		63.6
		National	561	16	> 256	38.3											57.2	3.9	0.4	0.2		38.3
	Tetracycline	British Columbia	116	4	> 32	37.9									61.2	0.9		3.4	34.5			
		Prairies	147	4	> 32	46.9									53.1			2.0	44.9			
		Ontario	166	≤ 4	> 32	50.0									50.0			4.2	45.8			
		Québec	132	> 32	> 32	59.1									40.9			3.0	56.1			
		National	561	4	> 32	48.8									51.0	0.2		3.2	45.6			
IV																						

Table 4.16. Distribution of minimum inhibitory concentrations among *Campylobacter* from chickens at pre-harvest, 2014

Antimicrobial	Species	Province / region	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)												
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
Ciprofloxacin	*Campylobacter coli*	British Columbia	0	0	0	0.0														
Ciprofloxacin	*Campylobacter coli*	Prairies	0	0	0	0.0														
Ciprofloxacin	*Campylobacter coli*	Ontario	5	0.06	0.12	0.0			60.0	40.0										
Ciprofloxacin	*Campylobacter coli*	Québec	0	0.25	16	0.0														
Ciprofloxacin	*Campylobacter coli*	National	5	0.06	0.12	0.0			60.0	40.0										
Ciprofloxacin	*Campylobacter jejuni*	British Columbia	26	0.12	16	26.9			46.2	15.4	11.5					3.8	23.1			
Ciprofloxacin	*Campylobacter jejuni*	Prairies	11	0.12	0.25	0.0			45.5	27.3	27.3									
Ciprofloxacin	*Campylobacter jejuni*	Ontario	30	0.12	0.12	6.7			30.0	63.3							6.7			
Ciprofloxacin	*Campylobacter jejuni*	Québec	21	0.06	0.25	0.0			57.1	28.6	14.3									
Ciprofloxacin	*Campylobacter jejuni*	National	88	0.12	8	10.2			43.2	36.4	10.2					1.1	9.1			
Ciprofloxacin	*Campylobacter spp.*	British Columbia	26	0.12	16	26.9			46.2	15.4	11.5					3.8	23.1			
Ciprofloxacin	*Campylobacter spp.*	Prairies	11	0.12	0.25	0.0			45.5	27.3	27.3									
Ciprofloxacin	*Campylobacter spp.*	Ontario	35	0.12	0.12	5.7			34.3	60.0							5.7			
Ciprofloxacin	*Campylobacter spp.*	Québec	21	0.06	0.25	0.0			57.1	28.6	14.3									
Ciprofloxacin	*Campylobacter spp.*	National	93	0.12	0.25	9.7			44.1	36.6	9.7					1.1	8.6			
Telithromycin	*Campylobacter coli*	British Columbia	0	0	0	0.0														
Telithromycin	*Campylobacter coli*	Prairies	0	0	0	0.0														
Telithromycin	*Campylobacter coli*	Ontario	5	0.5	1	0.0				20.0	20.0	40.0	20.0							
Telithromycin	*Campylobacter coli*	Québec	0	2	4	0.0														
Telithromycin	*Campylobacter coli*	National	5	0.5	1	0.0				20.0	20.0	40.0	20.0							
Telithromycin	*Campylobacter jejuni*	British Columbia	26	0.5	2	0.0				3.8	7.7	46.2	26.9	15.4						
Telithromycin	*Campylobacter jejuni*	Prairies	11	0.5	2	0.0						63.6	18.2	18.2						
Telithromycin	*Campylobacter jejuni*	Ontario	30	0.5	1	0.0					6.7	73.3	16.7	3.3						
Telithromycin	*Campylobacter jejuni*	Québec	21	0.25	8	9.5					57.1	19.0	9.5			4.8	9.5			
Telithromycin	*Campylobacter jejuni*	National	88	0.5	2	2.3				1.1	18.2	51.1	18.2	8.0		1.1	2.3			
Telithromycin	*Campylobacter spp.*	British Columbia	26	0.5	2	0.0				3.8	7.7	46.2	26.9	15.4						
Telithromycin	*Campylobacter spp.*	Prairies	11	0.5	2	0.0						63.6	18.2	18.2						
Telithromycin	*Campylobacter spp.*	Ontario	35	0.5	1	0.0				2.9	8.6	68.6	17.1	2.9						
Telithromycin	*Campylobacter spp.*	Québec	21	0.25	8	9.5					57.1	19.0	9.5			4.8	9.5			
Telithromycin	*Campylobacter spp.*	National	93	0.5	2	2.2				2.2	18.3	50.5	18.3	7.5		1.1	2.2			
Azithromycin	*Campylobacter coli*	British Columbia	0	0	0	0.0														
Azithromycin	*Campylobacter coli*	Prairies	0	0	0	0.0														
Azithromycin	*Campylobacter coli*	Ontario	5	0.06	0.06	0.0		40.0	60.0											
Azithromycin	*Campylobacter coli*	Québec	0	0.12	0.12	0.0														
Azithromycin	*Campylobacter coli*	National	5	0.06	0.06	0.0		40.0	60.0											
Azithromycin	*Campylobacter jejuni*	British Columbia	26	0.06	0.12	0.0		23.1	65.4	11.5										
Azithromycin	*Campylobacter jejuni*	Prairies	11	0.06	0.06	0.0		27.3	63.6	9.1										
Azithromycin	*Campylobacter jejuni*	Ontario	30	0.06	0.06	0.0		43.3	56.7											
Azithromycin	*Campylobacter jejuni*	Québec	21	0.03	0.06	14.3	4.8	57.1	23.8											14.3
Azithromycin	*Campylobacter jejuni*	National	88	0.06	0.06	3.4	1.1	38.6	52.3	4.5										3.4
Azithromycin	*Campylobacter spp.*	British Columbia	26	0.06	0.12	0.0		23.1	65.4	11.5										
Azithromycin	*Campylobacter spp.*	Prairies	11	0.06	0.06	0.0		27.3	63.6	9.1										
Azithromycin	*Campylobacter spp.*	Ontario	35	0.06	0.06	0.0		42.9	57.1											
Azithromycin	*Campylobacter spp.*	Québec	21	0.03	0.06	14.3	4.8	57.1	23.8											14.3
Azithromycin	*Campylobacter spp.*	National	93	0.06	0.06	3.2	1.1	38.7	52.7	4.3										3.2
Clindamycin	*Campylobacter coli*	British Columbia	0	0	0	0.0														
Clindamycin	*Campylobacter coli*	Prairies	0	0	0	0.0														
Clindamycin	*Campylobacter coli*	Ontario	5	0.25	0.25	0.0			40.0		60.0									
Clindamycin	*Campylobacter coli*	Québec	0	4	4	0.0														
Clindamycin	*Campylobacter coli*	National	5	0.25	0.25	0.0			40.0		60.0									
Clindamycin	*Campylobacter jejuni*	British Columbia	26	0.12	0.25	0.0			15.4	65.4	19.2									
Clindamycin	*Campylobacter jejuni*	Prairies	11	0.12	0.25	0.0				72.7	27.3									
Clindamycin	*Campylobacter jejuni*	Ontario	30	0.12	0.12	0.0		3.3	30.0	60.0	6.7									
Clindamycin	*Campylobacter jejuni*	Québec	21	0.12	4	0.0			23.8	61.9					14.3					
Clindamycin	*Campylobacter jejuni*	National	88	0.12	0.25	0.0		1.1	20.5	63.6	11.4				3.4					
Clindamycin	*Campylobacter spp.*	British Columbia	26	0.12	0.25	0.0			15.4	65.4	19.2									
Clindamycin	*Campylobacter spp.*	Prairies	11	0.12	0.25	0.0				72.7	27.3									
Clindamycin	*Campylobacter spp.*	Ontario	35	0.12	0.25	0.0		2.9	31.4	51.4	14.3									
Clindamycin	*Campylobacter spp.*	Québec	21	0.12	4	0.0			23.8	61.9					14.3					
Clindamycin	*Campylobacter spp.*	National	93	0.12	0.25	0.0		1.1	21.5	60.2	14.0				3.2					
Erythromycin	*Campylobacter coli*	British Columbia	0	0	0	0.0														
Erythromycin	*Campylobacter coli*	Prairies	0	0	0	0.0														
Erythromycin	*Campylobacter coli*	Ontario	5	0.5	0.5	0.0					40.0	60.0								
Erythromycin	*Campylobacter coli*	Québec	0	1	2	0.0														
Erythromycin	*Campylobacter coli*	National	5	0.5	0.5	0.0					40.0	60.0								
Erythromycin	*Campylobacter jejuni*	British Columbia	26	0.25	1	0.0				3.8	73.1	7.7	15.4							
Erythromycin	*Campylobacter jejuni*	Prairies	11	0.5	1	0.0					45.5	36.4	18.2							
Erythromycin	*Campylobacter jejuni*	Ontario	30	0.25	0.25	0.0				10.0	80.0	10.0								
Erythromycin	*Campylobacter jejuni*	Québec	21	0.25	128	14.3				9.5	71.4	4.8								14.3
Erythromycin	*Campylobacter jejuni*	National	88	0.25	1	3.4				6.8	71.6	11.4	6.8							3.4
Erythromycin	*Campylobacter spp.*	British Columbia	26	0.25	1	0.0				3.8	73.1	7.7	15.4							
Erythromycin	*Campylobacter spp.*	Prairies	11	0.5	1	0.0					45.5	36.4	18.2							
Erythromycin	*Campylobacter spp.*	Ontario	35	0.25	0.5	0.0				8.6	74.3	17.1								
Erythromycin	*Campylobacter spp.*	Québec	21	0.25	128	14.3				9.5	71.4	4.8								14.3
Erythromycin	*Campylobacter spp.*	National	93	0.25	0.5	3.2				6.5	69.9	14.0	6.5							3.2

Table 4.16. Distribution of minimum inhibitory concentrations among *Campylobacter* from chickens at pre-harvest, 2014 (cont'd)

	Antimicrobial	Species	Province / region	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)											
					MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
	Gentamicin	*Campylobacter coli*	British Columbia	0	0	0	0.0														
	Gentamicin	*Campylobacter coli*	Prairies	0	0	0	0.0														
	Gentamicin	*Campylobacter coli*	Ontario	5	1	1	0.0						40.0	60.0							
	Gentamicin	*Campylobacter coli*	Québec	0	1	1	0.0														
	Gentamicin	*Campylobacter coli*	National	5	1	1	0.0						40.0	60.0							
	Gentamicin	*Campylobacter jejuni*	British Columbia	26	0.5	1	0.0						50.0	50.0							
	Gentamicin	*Campylobacter jejuni*	Prairies	11	1	1	0.0							90.9	9.1						
	Gentamicin	*Campylobacter jejuni*	Ontario	30	1	1	0.0						40.0	60.0							
	Gentamicin	*Campylobacter jejuni*	Québec	21	1	1	0.0						76.2	23.8							
	Gentamicin	*Campylobacter jejuni*	National	88	1	1	0.0						46.6	52.3	1.1						
	Gentamicin	*Campylobacter spp.*	British Columbia	26	0.5	1	0.0						50.0	50.0							
	Gentamicin	*Campylobacter spp.*	Prairies	11	1	1	0.0							90.9	9.1						
	Gentamicin	*Campylobacter spp.*	Ontario	35	1	1	0.0						40.0	60.0							
	Gentamicin	*Campylobacter spp.*	Québec	21	1	1	0.0						76.2	23.8							
II	Gentamicin	*Campylobacter spp.*	National	93	1	1	0.0						46.2	52.7	1.1						
	Nalidixic acid	*Campylobacter coli*	British Columbia	0	0	0	0.0														
	Nalidixic acid	*Campylobacter coli*	Prairies	0	0	0	0.0														
	Nalidixic acid	*Campylobacter coli*	Ontario	5	4	4	0.0									100.0					
	Nalidixic acid	*Campylobacter coli*	Québec	0	8	> 64	0.0														
	Nalidixic acid	*Campylobacter coli*	National	5	4	4	0.0									100.0					
	Nalidixic acid	*Campylobacter jejuni*	British Columbia	26	4	> 64	26.9									61.5	11.5				26.9
	Nalidixic acid	*Campylobacter jejuni*	Prairies	11	4	8	0.0									54.5	36.4	9.1			
	Nalidixic acid	*Campylobacter jejuni*	Ontario	30	4	8	6.7									86.7	6.7				6.7
	Nalidixic acid	*Campylobacter jejuni*	Québec	21	4	8	0.0									85.7	14.3				
	Nalidixic acid	*Campylobacter jejuni*	National	88	8	> 64	10.2									75.0	13.6	1.1			10.2
	Nalidixic acid	*Campylobacter spp.*	British Columbia	26	4	> 64	26.9									61.5	11.5				26.9
	Nalidixic acid	*Campylobacter spp.*	Prairies	11	4	8	0.0									54.5	36.4	9.1			
	Nalidixic acid	*Campylobacter spp.*	Ontario	35	4	8	5.7									88.6	5.7				5.7
	Nalidixic acid	*Campylobacter spp.*	Québec	21	4	8	0.0									85.7	14.3				
	Nalidixic acid	*Campylobacter spp.*	National	93	≤ 4	16	9.7									76.3	12.9	1.1			9.7
	Florfenicol	*Campylobacter coli*	British Columbia	0	0	0	0.0														
	Florfenicol	*Campylobacter coli*	Prairies	0	0	0	0.0														
	Florfenicol	*Campylobacter coli*	Ontario	5	1	1	0.0						40.0	60.0							
	Florfenicol	*Campylobacter coli*	Québec	0	1	2	0.0														
	Florfenicol	*Campylobacter coli*	National	5	1	1	0.0						40.0	60.0							
	Florfenicol	*Campylobacter jejuni*	British Columbia	26	1	1	0.0						30.8	69.2							
	Florfenicol	*Campylobacter jejuni*	Prairies	11	1	2	0.0						9.1	72.7	18.2						
	Florfenicol	*Campylobacter jejuni*	Ontario	30	1	1	0.0						26.7	73.3							
	Florfenicol	*Campylobacter jejuni*	Québec	21	1	1	0.0						14.3	81.0	4.8						
	Florfenicol	*Campylobacter jejuni*	National	88	1	1	0.0						22.7	73.9	3.4						
	Florfenicol	*Campylobacter spp.*	British Columbia	26	1	1	0.0						30.8	69.2							
	Florfenicol	*Campylobacter spp.*	Prairies	11	1	2	0.0						9.1	72.7	18.2						
	Florfenicol	*Campylobacter spp.*	Ontario	35	1	1	0.0						28.6	71.4							
	Florfenicol	*Campylobacter spp.*	Québec	21	1	1	0.0						14.3	81.0	4.8						
III	Florfenicol	*Campylobacter spp.*	National	93	1	1	0.0						23.7	73.1	3.2						
	Tetracycline	*Campylobacter coli*	British Columbia	0	0	0	0.0														
	Tetracycline	*Campylobacter coli*	Prairies	0	0	0	0.0														
	Tetracycline	*Campylobacter coli*	Ontario	5	1	> 64	40.0							60.0							40.0
	Tetracycline	*Campylobacter coli*	Québec	0	> 64	> 64	0.0														
	Tetracycline	*Campylobacter coli*	National	5	1	> 64	40.0							60.0							40.0
	Tetracycline	*Campylobacter jejuni*	British Columbia	26	32	> 64	65.4				11.5	23.1						15.4	15.4	26.9	7.7
	Tetracycline	*Campylobacter jejuni*	Prairies	11	1	> 64	45.5					18.2	27.3	9.1					9.1		36.4
	Tetracycline	*Campylobacter jejuni*	Ontario	30	0.25	64	26.7				33.3	40.0							6.7	20.0	
	Tetracycline	*Campylobacter jejuni*	Québec	21	64	> 64	52.4				33.3		14.3							42.9	9.5
	Tetracycline	*Campylobacter jejuni*	National	88	0.5	64	46.6				22.7	22.7	6.8	1.1				4.5	8.0	25.0	9.1
	Tetracycline	*Campylobacter spp.*	British Columbia	26	32	> 64	65.4				11.5	23.1						15.4	15.4	26.9	7.7
	Tetracycline	*Campylobacter spp.*	Prairies	11	1	> 64	45.5					18.2	27.3	9.1					9.1		36.4
	Tetracycline	*Campylobacter spp.*	Ontario	35	0.25	64	28.6				28.6	34.3		8.6					5.7	17.1	5.7
	Tetracycline	*Campylobacter spp.*	Québec	21	64	> 64	52.4				33.3		14.3							42.9	9.5
	Tetracycline	*Campylobacter spp.*	National	93	1	> 64	46.2				21.5	21.5	6.5	4.3				4.3	7.5	23.7	10.8
IV																					

RECOVERY RESULTS

Table 4.17. *Farm Surveillance* recovery rates in grower-finisher pigs, 2006–2014

CIPARS Component/ Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Pigs	Prairies	2012	**100%**	232/232	**19%**	43/232				
		2013	**98%**	224/228	**14%**	33/228				
		2014	**99%**	248/252	**16%**	40/252				
	Ontario	2012	**99%**	167/168	**18%**	31/168				
		2013	**100%**	168/168	**26%**	43/168				
		2014	**100%**	162/162	**41%**	67/162				
	Québec	2012	**100%**	120/120	**16%**	19/120				
		2013	**100%**	138/138	**17%**	23/138				
		2014	**100%**	156/156	**26%**	40/156				
	National	2006	**99%**	459/462	**20%**	94/462			**81%**	374/462
		2007	**100%**	612/612	**21%**	136/612			**81%**	495/612
		2008	**99%**	481/486	**13%**	61/486			**92%**	448/486
		2009	**99%**	695/698	**18%**	124/698			**97%**	680/698
		2010	**99%**	566/569	**18%**	101/569			**96%**	545/569
		2011	**100%**	560/560	**14%**	77/560				
		2012	**99%**	519/520	**18%**	93/520				
		2013	**99%**	530/534	**19%**	99/534				
		2014	**99%**	566/570	**26%**	147/570				

Grey-shaded areas indicate either: a) isolates recovered from sampling activities outside the scope of CIPARS routine (or "core") surveillance in the specified year (i.e., grey-shaded areas with data) or b) discontinuation or no surveillance activity (i.e., grey-shaded areas with no data).
The Prairies is a region including the provinces of Alberta, Saskatchewan and Manitoba.

Table 4.18. *Farm Surveillance* recovery rates in broiler chickens, 2013–2014

CIPARS Component / Animal species	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Chickens (Chick placement)	British Columbia	2013	**72%**	43/60	**28%**	17/60				
		2014	**71%**	57/80	**23%**	18/80				
	Prairies	2013	**89%**	31/35	**29%**	10/35				
		2014	**82%**	46/56	**13%**	7/56				
	Ontario	2013	**85%**	64/75	**17%**	13/75				
		2014	**87%**	65/75	**3%**	2/75				
	Québec	2013	**82%**	53/65	**17%**	11/65				
		2014	**83%**	66/80	**11%**	9/80				
	National	2013	**81%**	191/235	**22%**	51/235				
		2014	**80%**	234/291	**12%**	36/291				
Chickens (Pre-harvest)	British Columbia	2013	**98%**	94/96	**71%**	68/96	**28%**	27/96		
		2014	**100%**	116/116	**64%**	74/116	**22%**	26/116		
	Prairies	2013	**100%**	60/60	**40%**	24/60	**25%**	15/60		
		2014	**99%**	147/148	**36%**	54/148	**7%**	11/148		
	Ontario	2013	**100%**	120/120	**54%**	65/120	**17%**	20/120		
		2014	**99%**	166/168	**25%**	42/168	**21%**	35/168		
	Québec	2013	**99%**	111/112	**64%**	72/112	**17%**	19/112		
		2014	**100%**	132/132	**60%**	79/132	**16%**	21/132		
	National	2013	**99%**	385/388	**59%**	229/388	**20%**	81/388		
		2014	**99%**	561/564	**44%**	249/564	**16%**	93/564		

Grey-shaded areas indicate either: a) isolates recovered from sampling activities outside the scope of CIPARS routine (or "core") surveillance in the specified year (i.e., grey-shaded areas with data) or b) discontinuation or no surveillance activity (i.e., grey-shaded areas with no data).
The Prairies is a region including the provinces of Alberta and Saskatchewan.

5. SURVEILLANCE OF ANIMAL CLINICAL ISOLATES

KEY FINDINGS

CATTLE

SALMONELLA (n = 149)

Salmonella Typhimurium was the most common serovar recovered from cattle (42%, 63/149). One isolate (2%) was resistant to all antimicrobial classes tested and 9 isolates (14%) were resistant to 6 antimicrobial classes (all except the macrolides). Forty-eight percent (30/63) of Typhimurium isolates were susceptible to all antimicrobials tested (Table 5.1).

The second most common serovar observed in cattle was Dublin (18%, 27/149). Fifteen Dublin isolates (56%) were resistant to 6 antimicrobial classes (all except the macrolides).

No Cerro isolates demonstrated resistance to any of the antimicrobials tested (0/17). One Heidelberg isolate was resistant to all antimicrobial classes except the β-lactams.

CHICKENS

SALMONELLA (n = 195)

Salmonella Enteritidis was the most common serovar recovered from chicken samples (48%, 93/195). Two isolates (2%) were resistant to 1 or more antimicrobials: 1 isolate (1%) was resistant to a single antimicrobial class (folate pathway inhibitors) and 1 isolate (1%) was resistant to 2 antimicrobial classes (β-lactams and tetracyclines). All other Enteritidis isolates from chickens were susceptible to all of the antimicrobials tested (Table 5.2).

Salmonella Heidelberg was the second most common serovar recovered from chicken samples (15%, 30/195). Three isolates (10%) were resistant to 2 antimicrobial classes and 9 isolates (31%) were resistant to just 1 class (β-lactams).

There were 21 Kentucky isolates (11%) from chickens in 2014. One isolate (5%) was susceptible to all antimicrobials tested; all of the others were resistant to 2 to 3 classes.

One Typhimurium isolate (1%) was resistant to 4 antimicrobial classes.

Seventy-four percent (144/195) of all *Salmonella* isolates from chickens were susceptible to all antimicrobials tested.

PIGS

SALMONELLA (n = 316)

Salmonella Typhimurium, Derby, and 4,[5],12:i:- were the most common serovars recovered from clinical pig samples in 2014, representing 40% (125/316), 16% (51/316), and 16% (50/316), respectively.

Seven isolates (2%) from pigs were resistant to 6 antimicrobial classes (all except the quinolones). These included 2 Typhimurium isolates, 2 Rough:i:1,2, 1 Ohio, and 2 Ohio var. 14+. As in 2013, no quinolone resistance was observed in any clinical isolates from pigs (Table 5.3).

TURKEYS

SALMONELLA (n = 62)

Salmonella Senftenberg, Agona, and Heidelberg were the most common serovars recovered from clinical turkey samples in 2014, representing 15% (9/62), 11% (7/62), and 11% (7/62), respectively.

Five isolates (8%) were resistant to 4 or more antimicrobial classes: 1 Agona was resistant to 4 classes, 1 Indiana was resistant to 5 classes, 1 Kentucky was resistant to 4 classes (including the quinolones), and 2 Senftenberg isolates were resistant to 5 classes (Table 5.4).

No resistance to macrolide antimicrobials was observed in any isolates from turkeys in 2014.

HORSES

SALMONELLA (n = 11)

Three Typhimurium isolates were resistant to tetracyclines and 1 Kentucky isolate was resistant to tetracycline and the aminoglycosides (Table 5.5).

MULTICLASS RESISTANCE

Table 5.1. Number of antimicrobial classes in resistance patterns of *Salmonella* from cattle, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial												
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Typhimurium	63 (42.3)	30			23	10	7	33	33	11	12	11	12	33	12	1	32	1	9	33
Dublin	27 (18.1)	1	1		10	15	2	25	22	22	22	22	22	26	1		25	4	17	25
Cerro	17 (11.4)	17																		
4,[5],12:i:-	9 (6.0)				8	1		9	9	7	7	7	7	9	7	1	9			9
Heidelberg	6 (4.0)		1		4	1	1	5	1	1	1	1	1	5	5	1	5	5	5	5
Give	3 (2.0)	3																		
Muenster	3 (2.0)	3																		
Uganda	3 (2.0)	1		2				2						2						2
Less common serovars	18 (12.1)	14		3	1			4	1	1	1	1	1	4			1			4
Total	**149 (100)**	**69**	**2**	**5**	**46**	**27**	**10**	**78**	**66**	**42**	**43**	**42**	**43**	**79**	**25**	**3**	**72**	**10**	**31**	**78**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.

Table 5.2. Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial												
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Enteritidis	93 (47.7)	91	1	1					1					1						1
Heidelberg	30 (15.4)	18	9	3			2	3	10	10	10	10	10	2						
Kentucky	21 (10.8)	1		20				20	8	8	8	7	8							20
Typhimurium	7 (3.6)	6			1			1	1					1						1
Mbandaka	6 (3.1)	1		5				5						5						5
Thompson	6 (3.1)	6																		
Senftenberg	5 (2.6)	4		1			1	1	1											
4,[5],12:-:-	4 (2.1)	4																		
Less common serovars	23 (11.8)	13	1	9			3	6	2	1	1	1	1	3						8
Total	**195 (100)**	**144**	**11**	**39**	**1**		**6**	**36**	**23**	**19**	**19**	**18**	**19**	**12**						**35**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.

Table 5.3. Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Typhimurium	125 (39.6)	4	4	19	96	2	9	103	108	3	1	1	1	116	33	4	84			117
Derby	51 (16.1)	10	7	22	12			34	13	4	4	4	4	34	3		3			40
4,[5],12:i:-	50 (15.8)	2	2	1	45		7	46	45	1	3	1	1	46	3	2	5			48
Infantis	20 (6.3)	15	2	2	1			3	4	2	2	2	2	1	1					4
Ohio var. 14+	8 (2.5)			1	5	2	2	8	7	2	2	2	2	7	2	2	7			8
Less common serovars	62 (19.6)	25	3	18	13	3	6	31	19	3	3	3	3	34	7	5	7			33
Total	**316 (100)**	**56**	**18**	**63**	**172**	**7**	**24**	**225**	**196**	**15**	**15**	**13**	**13**	**238**	**49**	**13**	**106**			**250**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.

Table 5.4. Number of antimicrobial classes in resistance patterns of *Salmonella* from turkeys, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Senftenberg	9 (14.5)	2	3	2	2		7	5	4		1		1	2			2			2
Agona	7 (11.3)	1		5	1		3	4	4	2	2	2	2	6						3
Heidelberg	7 (11.3)	1		6			6	6						6						
Albany	5 (8.1)			5			5	1	4	1	4	1	4	2						
Liverpool	5 (8.1)	3		2			2	2	1					1						1
Muenchen	5 (8.1)	1	1	3			3	2						3						2
Braenderup	3 (4.8)			3			3	3						3						
Bredeney	3 (4.8)		2	1			3	2						1						1
Hadar	3 (4.8)			3			1	3						1						3
Montevideo	2 (3.2)		1	1			2	2	1											
Less common serovars	13 (21.0)	4	1	6	2		6	9	3	2	2	2	2	4			1		1	6
Total	**62 (100)**	**12**	**8**	**37**	**5**		**41**	**39**	**17**	**5**	**9**	**5**	**9**	**29**			**3**		**1**	**18**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Serovars represented by less than 2% of isolates were classified as ''Less common serovars''.

Table 5.5. Number of antimicrobial classes in resistance patterns of *Salmonella* from horses, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial											
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Typhimurium	5 (45.5)	2	3																	3
Enteritidis	2 (18.2)	2																		
6,7:-:1,6	1 (9.1)	1																		
Kentucky	1 (9.1)			1				1												1
Oranienburg	1 (9.1)	1																		
Thompson	1 (9.1)	1																		
Total	**11 (100)**	**7**	**3**	**1**				**1**												**4**

Antimicrobial abbreviations are defined in the Appendix.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

MINIMUM INHIBITORY CONCENTRATIONS

See how to interpret the minimum inhibitory concentration tables in the section ''How to Read this Chapter''.

Table 5.6. Distribution of minimum inhibitory concentrations among *Salmonella* from cattle, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	149	≤ 1	> 32	28.2							52.3	3.4		3.4	12.8	10.1	18.1			
	Ceftiofur	149	1	> 8	28.9						16.1	53.7	1.3		2.7	26.2					
	Ceftriaxone	149	≤ 0.25	32	28.9					71.1						13.4	10.7	2.7	2.0		
	Ciprofloxacin	149	≤ 0.015	0.50	6.7	74.5	4.0		2.0	5.4	7.4	6.7									
II	Ampicillin	149	2	> 32	44.3							49.0	6.7					44.3			
	Azithromycin	149	4	16	2.0								4.0	46.3	39.6	8.1	2.0				
	Cefoxitin	149	2	> 32	28.2							5.4	51.0	13.4	1.3	0.7	3.4	24.8			
	Gentamicin	149	0.50	1	6.7					3.4	69.8	17.4	1.3		1.3	0.7	6.0				
	Nalidixic acid	149	4	> 32	20.8								42.3	36.2		0.7	2.0	18.8			
	Streptomycin	149	64	> 64	52.3									8.7	29.5	8.1	1.3	4.0	48.3		
	Trimethoprim-sulfamethoxazole	149	≤ 0.12	> 4	16.8				59.7	16.8	4.7	2.0		0.7	16.1						
III	Chloramphenicol	149	8	> 32	48.3								1.3	20.1	30.2			48.3			
	Sulfisoxazole	149	> 256	> 256	53.0											9.4	36.2	1.3			53.0
	Tetracycline	149	32	> 32	52.3									47.7			3.4	49.0			
IV																					

Table 5.7. Distribution of minimum inhibitory concentrations among *Salmonella* from chickens, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	195	≤ 1	16	9.7							87.7	0.5		1.5	0.5	2.1	7.7			
	Ceftiofur	195	1	2	9.7						11.8	77.9	0.5		0.5	9.2					
	Ceftriaxone	195	≤ 0.25	≤ 0.25	9.7					90.3				0.5		8.2	0.5	0.5			
	Ciprofloxacin	195	≤ 0.015	0.03	0.0	79.0	21.0														
II	Ampicillin	195	≤ 1	> 32	11.8							84.6	3.6					11.8			
	Azithromycin	195	4	8	0.0								2.6	64.6	30.3	2.6					
	Cefoxitin	195	2	16	9.2							11.3	62.1	15.4	1.0	1.0	7.7	1.5			
	Gentamicin	195	0.50	1	3.1					27.7	59.0	9.2	0.5		0.5		3.1				
	Nalidixic acid	195	4	4	0.0							1.5	42.6	55.9							
	Streptomycin	195	8	64	18.5								16.9	28.7	14.9	13.8	7.2	8.7	9.7		
	Trimethoprim-sulfamethoxazole	195	≤ 0.12	≤ 0.12	0.0				99.5	0.5											
III	Chloramphenicol	195	8	8	0.0								1.0	36.4	62.6						
	Sulfisoxazole	195	32	64	6.2											15.4	73.3	5.1			6.2
	Tetracycline	195	≤ 4	> 32	17.9									82.1				17.9			
IV																					

Table 5.8. Distribution of minimum inhibitory concentrations among *Salmonella* from pigs, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	316	8	16	4.7							36.7	2.5	7.0	20.9	28.2	2.2	2.5			
	Ceftiofur	316	1	2	4.1						8.2	81.6	5.4	0.6	0.3	3.8					
	Ceftriaxone	316	≤ 0.25	≤ 0.25	4.7					94.9	0.3			0.6	0.3	1.6	1.6	0.6			
	Ciprofloxacin	316	≤ 0.015	≤ 0.015	0.0	92.7	5.4	1.9													
II	Ampicillin	316	> 32	> 32	62.0							34.5	3.2	0.3			1.6	60.4			
	Azithromycin	316	8	8	4.1								1.3	38.0	50.9	5.7	4.1				
	Cefoxitin	316	2	4	4.1							5.1	50.6	36.7	2.5	0.9	0.9	3.2			
	Gentamicin	316	0.50	1	7.6					3.5	69.6	18.4			0.9	3.5	4.1				
	Nalidixic acid	316	4	4	0.0								49.1	46.8	4.1						
	Streptomycin	316	> 64	> 64	71.2									0.6	13.6	11.4	3.2	8.5	62.7		
	Trimethoprim-sulfamethoxazole	316	≤ 0.12	> 4	15.5				73.1	11.4					15.5						
III	Chloramphenicol	316	8	> 32	33.5								0.6	6.3	57.3	2.2		33.5			
	Sulfisoxazole	316	> 256	> 256	75.3											3.8	16.5	4.4			75.3
	Tetracycline	316	> 32	> 32	79.1									20.9			11.1	68.0			
IV																					

Table 5.9. Distribution of minimum inhibitory concentrations among *Salmonella* from turkeys, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	62	≤ 1	16	8.1							72.6			11.3	8.1	3.2	4.8			
	Ceftiofur	62	1	> 8	14.5						17.7	66.1	1.6			14.5					
	Ceftriaxone	62	≤ 0.25	32	14.5					85.5					1.6			4.8		8.1	
	Ciprofloxacin	62	≤ 0.015	≤ 0.015	0.0	91.9	6.5			1.6											
II	Ampicillin	62	≤ 1	> 32	27.4							66.1	6.5					27.4			
	Azithromycin	62	4	8	0.0							1.6	8.1	58.1	27.4	4.8					
	Cefoxitin	62	4	8	8.1							11.3	19.4	56.5	4.8		3.2	4.8			
	Gentamicin	62	> 16	> 16	66.1					6.5	27.4					4.8	61.3				
	Nalidixic acid	62	2	4	1.6								54.8	43.5				1.6			
	Streptomycin	62	64	> 64	62.9								1.6	4.8	12.9	9.7	8.1	24.2	38.7		
	Trimethoprim-sulfamethoxazole	62	≤ 0.12	≤ 0.12	0.0				95.2	4.8											
III	Chloramphenicol	62	8	8	4.8									35.5	59.7			4.8			
	Sulfisoxazole	62	64	> 256	46.8											11.3	37.1	4.8			46.8
	Tetracycline	62	≤ 4	> 32	29.0									71.0				29.0			
IV																					

Table 5.10. Distribution of minimum inhibitory concentrations among *Salmonella* from horses, 2014

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	11	≤ 1	≤ 1	0.0							100.0									
	Ceftiofur	11	1	1	0.0						18.2	81.8									
	Ceftriaxone	11	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	11	≤ 0.015	≤ 0.015	0.0	100.0															
II	Ampicillin	11	≤ 1	≤ 1	0.0							100.0									
	Azithromycin	11	4	8	0.0								9.1	45.5	45.5						
	Cefoxitin	11	2	4	0.0							9.1	63.6	27.3							
	Gentamicin	11	0.50	0.50	0.0					9.1	90.9										
	Nalidixic acid	11	2	4	0.0								72.7	27.3							
	Streptomycin	11	8	16	9.1									9.1	72.7	9.1			9.1		
	Trimethoprim-sulfamethoxazole	11	≤ 0.12	≤ 0.12	0.0				100.0												
III	Chloramphenicol	11	8	8	0.0									27.3	72.7						
	Sulfisoxazole	11	32	32	0.0											45.5	54.5				
	Tetracycline	11	≤ 4	> 32	36.4									63.6				9.1	27.3		
IV																					

6. SURVEILLANCE OF FEED AND FEED INGREDIENTS

KEY FINDINGS

SALMONELLA (n = 25)

One *Salmonella* Livingstone isolate was resistant to 3 antimicrobial classes; this isolate was from a starter ration intented for turkeys in Ontario (Table 6.1). No resistance to Category I antimicrobials was detected.

More information about the feed and feed ingredients was available in 2014, than in previous years. In addition to the source of the isolate described above, the other products from which *Salmonella* was recovered included avian ingredients (n = 1), canola meal (n = 4), corn (n = 1), feed (n = 4), fish ingredients (n = 1), fish meal (n = 4), meat and bone meal (n = 3), porcine ingredients (n = 2), and soybean meal (n = 4).

MULTICLASS RESISTANCE

Table 6.1. Number of antimicrobial classes in resistance patterns of *Salmonella* from feed and feed ingredients, 2014

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial										
							Aminoglycosides		β-Lactams					Folate pathway inhibitors		Macrolides	Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Schwarzengrund	4 (16)	4																		
Senftenberg	4 (16)	4																		
Infantis	2 (8)	2																		
Mbandaka	2 (8)	2																		
Montevideo	2 (8)	2																		
Orion var.15+34+	2 (8)	2																		
Alachua	1 (4)	1																		
Havana	1 (4)	1																		
Johannesburg	1 (4)	1																		
Livingstone	1 (4)			1				1						1						1
Livingstone var. 14+	1 (4)	1																		
Newport	1 (4)	1																		
Ohio	1 (4)	1																		
Putten	1 (4)	1																		
Soerenga	1 (4)	1																		
Total	**25 (100)**	**24**		**1**				**1**						**1**						**1**

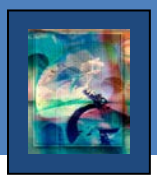
Antimicrobial abbreviations are defined in the Appendix
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

MINIMUM INHIBITORY CONCENTRATIONS

See how to interpret the minimum inhibitory concentration tables in the section ''How to Read this Chapter''.

Table 6.2. Distribution of minimum inhibitory concentrations among *Salmonella* from feed and feed ingredients, 2014

	Antimicrobial	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)													
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	25	≤ 1	≤ 1	0.0							100.0									
	Ceftiofur	25	1	1	0.0						8.0	92.0									
	Ceftriaxone	25	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	25	≤ 0.015	≤ 0.015	0.0	96.0	4.0														
II	Ampicillin	25	≤ 1	≤ 1	0.0							100.0									
	Azithromycin	25	8	8	0.0									44.0	48.0	8.0					
	Cefoxitin	25	2	4	0.0								60.0	40.0							
	Gentamicin	25	0.50	1	0.0					16.0	72.0	12.0									
	Nalidixic acid	25	2	4	0.0								60.0	40.0							
	Streptomycin	25	8	≤ 32	4.0									4.0	76.0	8.0	8.0		4.0		
	Trimethoprim-sulfamethoxazole	25	≤ 0.12	≤ 0.12	0.0				100.0												
III	Chloramphenicol	25	8	8	0.0									36.0	64.0						
	Sulfisoxazole	25	32	64	4.0											20.0	48.0	28.0			4.0
	Tetracycline	25	≤ 4	≤ 4	4.0									96.0				4.0			
IV																					



CHAPTER 3—ANTIMICROBIAL USE IN ANIMALS

HOW TO READ THIS CHAPTER

This chapter highlights the most notable antimicrobial use findings across the animal surveillance components of CIPARS for 2014. These findings are presented by component (farm–broiler chickens, farm–grower-finisher pigs, quantities of antimicrobials distributed for sale for use in animals). For the 2 *Farm Surveillance* components, information about the farm demographics, animal health and biosecurity are also presented to provide context and possible reasons for antimicrobial use.

PRESENTATION OF ANTIMICROBIAL USE DATA

The antimicrobial use data collected on farm (broiler chicken and grower-finisher pigs) is largely presented by antimicrobial except in the feed sections where some figures and tables are presented by antimicrobial class. The *Farm Surveillance* data are reported as both qualitative antimicrobial use metrics (e.g., number of farms reporting using an antimicrobial), as well as quantitative antimicrobial (active ingredient) use metrics (e.g., median g/1,000 pig-days).

Summary antimicrobial use data in feed are presented in Table 7.4 for broiler chickens and in Table 8.3 for grower-finisher pigs. These tables provide key antimicrobial use data including the number and percent of flocks/herds exposed to each listed antimicrobial (active ingredient), the number and percent of rations that contained each antimicrobial, the median number of days the herd/flock was fed the antimicrobial (days exposed), the percent of the flock/herds that was exposed to the antimicrobial, the median concentration of the antimicrobial in the feed (g/tonne), the rate of antimicrobial consumption (g/1,000 chicken-days or 1,000 pig-days), and the amount antimicrobial fed adjusted for chicken or pig population and weight. This last measure provides a standardized estimate of use that can be compared with estimates from other countries and surveillance programs.

For the antimicrobial distribution data provided by the Canadian Animal Health Institute (CAHI), the data are aggregated by CAHI according to accounting rules and are provided in antimicrobial categories/classes. The CAHI data are reported as quantitative information (e.g., kg of active ingredient or as mg of active ingredient/population correction unit).

NATIONAL OR PROVINCIAL/REGIONAL PREVALENCE ESTIMATES

Data for the farm antimicrobial use components in this chapter are presented at the national and regional level. For broiler chickens on farm, the 4 provinces/regions were British Columbia, Prairies (Alberta and Saskatchewan), Ontario, and Québec. For grower-finisher pigs on farm, the 5 provinces (or 3 provinces/regions) were the Prairies (Alberta, Saskatchewan, and Manitoba), Ontario, and Québec. Data from CAHI are presented nationally and provincially.

TEMPORAL FIGURES AND DATA TABLES FOR SIGNIFICANCE TESTING

All temporal figures and accompanying data tables presented in this chapter for the *Farm Surveillance* components depict the variation in antimicrobial use since the year surveillance was implemented or a significant change was made in the data collection; this is 2009 for grower-finisher pigs, 2013 for broiler chickens and 2006 for the CAHI data. For consistency across the farm components, statistical analyses were limited to comparison of 2014 results with: 1) 2013 results and 2) the first year of surveillance. Where temporal analyses are presented regionally for the *Farm Surveillance* components, the data are truncated to a maximum of 5 surveillance years. Therefore, temporal figures for grower-finisher pigs are limited from 2010 to 2014 data where the national data include 2009 data.

To facilitate the assessment of significant results at a glance, all significant differences found have been highlighted in blue (or red for significant regional differences and purple to indicate significant differences in both year and region) in data tables underneath the temporal figures. Finally, for all statistical analyses, a *P*-value less than or equal to the level of significance of 0.05 (≤ 0.05) was used to indicate a significant difference between years. All statistically significant results are marked by the use of the words "significant" or "significantly" in the text. All other findings presented without this word should be considered as non-statistically significant and should be interpreted with caution.

As the CAHI data represent census type information, there is no testing of statistical differences between years (i.e., the CAHI data are not data derived from samples); any difference in findings between years should reflect a true difference.

BACKGROUND INFORMATION

FARM—BROILER CHICKENS

A total of 143 farms across 4 poultry producing provinces/regions (British Columbia, Prairies [Alberta and Saskatchewan], Ontario, and Québec) participated in the CIPARS *Farm Surveillance* program in 2014. The proportion of flocks sampled that were antimicrobial-free and organic in a certain region, such as in British Columbia, may not be representative of the volume of birds raised under these management practices in the participating province/region or nationally.

One hundred and forty-three chick placement and 141 pre-harvest questionnaires were received. The sampling and data collection in broiler farms commenced in January and covered 8 quota periods (A-121 to A-128). Fifteen poultry veterinary practices conducted the survey and collected samples associated with the flock visit (placement or pre-harvest).

The overall capacity of the sentinel farms was 7.6 million birds at 1 grow-out period; overall contribution to national production was approximately 7%, similar to the previous year. The chicks placed in these farms were from 19 major commercial broiler hatcheries in the 5 provinces (Canadian Hatcheries Federation members). A proportion of chicks in 22 flocks were from imported sources. The mean age at pre-harvest sampling was 34 days and mean body weight was 2.00 kg. Table 7.7 summarizes the farm level demographics of the 143 farms included in the survey.

FARM—GROWER-FINISHER PIGS

Data were collected from sentinel swine farms through questionnaires administered by the herd veterinarian (or designated staff) to the producer (or designated farm staff). The questionnaires collected data on antimicrobial use (AMU), herd demographics, and animal health—antimicrobial use data pertain only to the grow-finish phase of production.

Over the 5-year period from 2009 to 2014, 549 questionnaires were received from 146 sentinel swine farms, with 34% of farms (50/146) reporting in each of the 6 years. In 2014, questionnaires were submitted from 95 sentinel farms by 21 veterinarians, contributing 17% (95/549) of the total number of questionnaires to the data presented in this section.

In 2014, questionnaires were received from 18 herds in Alberta (19%, 18/95), 17 in Saskatchewan (18%, 17/95), 8 in Manitoba (8%, 8/95), 26 in Ontario (27%, 26/95) and 26 in Québec (27%, 26/95).

In 2014, 62% of farms (59/95) reported owning their own breeding sows; 44% (42/95) kept sows on-site and 18% (17/95) had sows off-site. Twenty-seven percent (26/95) of farms reported that they purchased pigs from a single source while 11% (10/95) purchased pigs from multiple sources.

Fifty-nine percent of farms (56/95) reported being all-in-all-out operations and 41% of farms (39/95) indicated operating as continuous flow systems. These proportions represent are a shift in operation types compared to 2013, where 52% of sentinel farms (46/89) reported all-in-all-out operations and 48% of farms (43/89) indicated operating as a continuous flow system.

QUANTITIES OF ANTIMICROBIALS DISTRIBUTED FOR SALE FOR USE IN ANIMALS

As an estimate of the quantities of licensed antimicrobials used in animals, data on active ingredients distributed for sale were aggregated and provided to the Public Health Agency of Canada by the Canadian Animal Health Institute (CAHI). CAHI is the trade association representing the companies that manufacture and distribute drugs for administration to food (including fish), sporting, and companion animals in Canada. The association estimates that its members' sales represent about 90% of all sales of licensed animal pharmaceutical products in Canada[12]. The CAHI data provides a measure of antimicrobials distributed for sale for all animal species, including those not covered by CIPARS farm-level surveillance. The CAHI data do not include antimicrobials manufactured for export.

The CAHI data do not include antimicrobials imported under the personal-use provision of the federal Food and Drugs Act Regulations (own use import—OUI), nor do they include imported active pharmaceutical ingredients (API), which are drugs imported in non-dosage form and compounded by a licensed pharmacist or veterinarian. The latest information from an Ipsos/Impact Vet study prepared for CAHI is that the lost opportunity value due to OUI and API was estimated to be 13% of total animal health product sales. Health Canada's Veterinary Drugs Directorate is currently reviewing these importation processes as part of their regulatory modernization discussions, to enable appropriate oversight. The CAHI data do not include prescriptions filled at community pharmacies for antimicrobials to be used in companion animals using human labeled drugs. Hence, distribution data should always be considered with other sources of information (such as farm-level surveillance and antimicrobial resistance findings) for any decision-making. Strong caution should be applied with making inferences with the CAHI to any use practice for a particular animal species. As stated in the United Kingdom's surveillance report on antimicrobials sold for use in animals[13], the population is an important denominator, as the greater the number of animals, the greater the potential need for antimicrobial therapy. A standard weight was used for each production class to determine the biomass of the animal population; the population correction unit (PCU). However, a static standard weight may not reflect an industry shift in production affecting the average weights of animals treated, related to weather, trade, or other reasons. For the first time, we are presenting the companion animal data adjusted for population and weights of cats and dogs. Other animals (pocket pets, caged pet birds, reptiles, etc.) were not included in the denominator.

Distribution data in broad categories, whether adjusted for populations and weights or not, cannot account for the individual potencies of the antimicrobials administered to different species; having implications for interpretations in trends over time. For example, a decrease in the milligrams of antimicrobials distributed reported for a given year could potentially reflect a

[12] Available at: http://cahi-icsa.ca/about/

[13] 2012. UK Veterinary Antibiotic Resistance and Sales Surveillance Report. Veterinary Medicines Directorate - Government Department for the Environment, Food and Rural Affairs. UK-VARSS. Available at: http://webarchive.nationalarchives.gov.uk/20140909112428/http://www.vmd.defra.gov.uk/pharm/antibiotic_salesdata.aspx. Accessed March 2014.

switch to using a more potent drug, as opposed to reflecting a decrease in the actual exposure of animals to antimicrobials.

There have been several advances in detail of this data over the past five years. Since 2011, the data were stratified by province, since 2012 stratified by companion animal/production animal, and since 2013 stratified by route of administration.

CIPARS continues to work to improve this measure and other appropriate measures, to best reflect antimicrobial use in the Canadian context.

7. FARM SURVEILLANCE—BROILER CHICKENS

KEY FINDINGS

- The 143 sentinel farms represent a cross-section of hatcheries, chick source (e.g., domestic and few broiler chicken flocks with imported chicks mixed), production type, farm size, and breed/genetics (Table 7.7 and Table 7.8); sample and data were collected over 8 quota periods. Two cohort flocks were not sampled at pre-harvest.
- Antimicrobials administered via feed represented the greatest route of administration/exposure (91%, 128/141 flocks) for broilers (Table 7.1).
- Thirty-five percent of broiler flocks were medicated at the hatchery; significantly lower than 2013.
- At the hatchery, ceftiofur, a third-generation cephalosporin, was the only Category I (a category considered of very high importance to human medicine) antimicrobial administered. The number of broiler flocks that reported using ceftiofur was significantly lower in 2014 than in 2013; it was administered to only 9 flocks in 2014 compared to 31 flocks in 2013. All flocks that reported using this antimicrobial were medicated prior to the May 2014 change in industry use practice[14] eliminating the preventive use of Category I antimicrobials.
- There were no reported use of Category I antimicrobials in either feed or water; all Category I antimicrobials were administered by injection.
- Among the broiler flocks surveyed, the most commonly used antimicrobials were bacitracin (57%, 82/143), salinomycin (35%, 50/143), and monensin (31%, 45/143) (Table 7.2). These are all antimicrobials administered via feed.
- Fourteen broiler flocks (10%, 14/143) reported no use of antimicrobials (Table 7.1). These were flocks raised as antimicrobial-free, organic, and conventional flocks that were fed un-medicated rations.

ADMINISTRATION IN FEED

- Overall, 91% (128/141) of broiler chicken flocks reported antimicrobial use in feed; the antimicrobials used belonged to Categories II, III, and IV. No Category I antimicrobials were used in feed.

[14] Agrimedia Inc. 2014. Canada's chicken farmers plan to eliminate some antibiotic use by May 2014. Available at: www.betterfarming.com/online-news/canada%E2%80%99s-chicken-farmers-plan-eliminate-some-antibiotic-use-may-2014-54120. Accessed January 2016.

- Provincial/regional variations in antimicrobial use were observed in 2014 (Figure 7.4), but the following antimicrobial classes were used across the 4 provinces/region: streptogramins, bacitracins, ionophores, and chemical coccidiostats.
- The use of avilamycin, an orthosomycin indicated for the prevention of necrotic enteritis, was reported by the producers/veterinarians after it was licensed for use and added to Health Canada's Human and Veterinary Prescription Drugs List in March, 2014[15].
- Disease prevention was the most frequently reported reason for antimicrobial use in broiler flocks (91%, 128/141) (Figure 7.5).
- Fifteen percent (21/141) of flocks used antimicrobials for disease treatment in 2014.
- Only 4% (6/141) of broiler flocks reported use of antimicrobials for growth promotion.
- Trimethoprim-sulfadiazine, reported being used for disease treatment, had the highest grams per 1,000 chicken-days (Table 7.4).

ADMINISTRATION IN WATER

- No antimicrobial belonging to Category I was reported used in water in 2014.
- Unlike in the feed antimicrobials, the water-level medications were used largely for disease treatment and rarely for prevention (Figure 7.11).
- Sulfonamide antimicrobials also had the highest grams per 1,000 chicken-days (Table 7.5).

ADMINISTRATION *IN OVO* OR SUBCUTANEOUS INJECTION

- The use of 3 injectable antimicrobials was reported in 2014. These were: ceftiofur (6%, 9/143), gentamicin (5%, 7/143), and lincomycin-spectinomycin (24%, 34/143).
- Provincial/regional differences in antimicrobials used at the hatcheries were observed (Figure 7.1).
- The primary reason for use reported for all antimicrobials administered by injection was mainly for disease prevention, except for 1 flock that used injectable antimicrobial for disease treatment (Figure 7.2). Avian pathogenic *E. coli* (APEC), which causes yolk-sacculitis and neonatal septicemia, was the most frequently targeted pathogen for preventive use of any antimicrobials administered at the hatchery in 2014 (Figure 7.3).
- Final doses for hatchery administered antimicrobials reported in the questionnaires were consistent with the manufacturer recommended dosages (Compendium of

[15] Health Canada 2015. Product Information, Surmax. Available at: http://webprod5.hc-sc.gc.ca/dpd-bdpp/dispatch-repartition.do?lang=eng. Accessed January 2016.

Veterinary Products[16]) or based on the quantities of active ingredient per body weight (mg/kg) calculated by standard egg or chick weight (Table 7.3).

SUMMARY OF ANTIMICROBIAL USE BY ROUTE OF ADMINISTRATION

Table 7.1. Number of broiler flocks with reported antimicrobial use by route of administration, 2014

Antimicrobial use	Route of administration			
	Any route[a] n (%)	*In ovo*/subcutaneous n (%)	Feed n (%)	Water n (%)
Any antimicrobial use	129 (90)	50 (35)	128 (91)	20 (14)
No antimicrobial use[b]	14 (10)	93 (65)	13 (9)	121 (86)
Total flocks	**143 (100)**	**143 (100)**	**141 (100)**	**141 (100)**

Two flocks were sampled at placement but were not sampled at pre-harvest (no feed and water data).

[a] Flocks with reported use of an antimicrobial class by feed, water, *in ovo*/subcutaneous, or any combination of these routes are included in each count.

[b] These were antibiotic free, organic and a conventional flock that were fed unmedicated feed ration and no medications in water throughout the grow-out period. The proportion of flocks sampled that were antimicrobial-free and organic in certain province, such as in British Columbia, may not be representative of the volume of birds raised under these management practices in that participating province or nationally.

[16] North American Compendiums 2015. Compendium of Veterinary Products online. Available at: https://bam.naccvp.com. Accessed January 2016.

Table 7.2. Number of broiler flocks with reported use of antimicrobial by route of administration, 2014

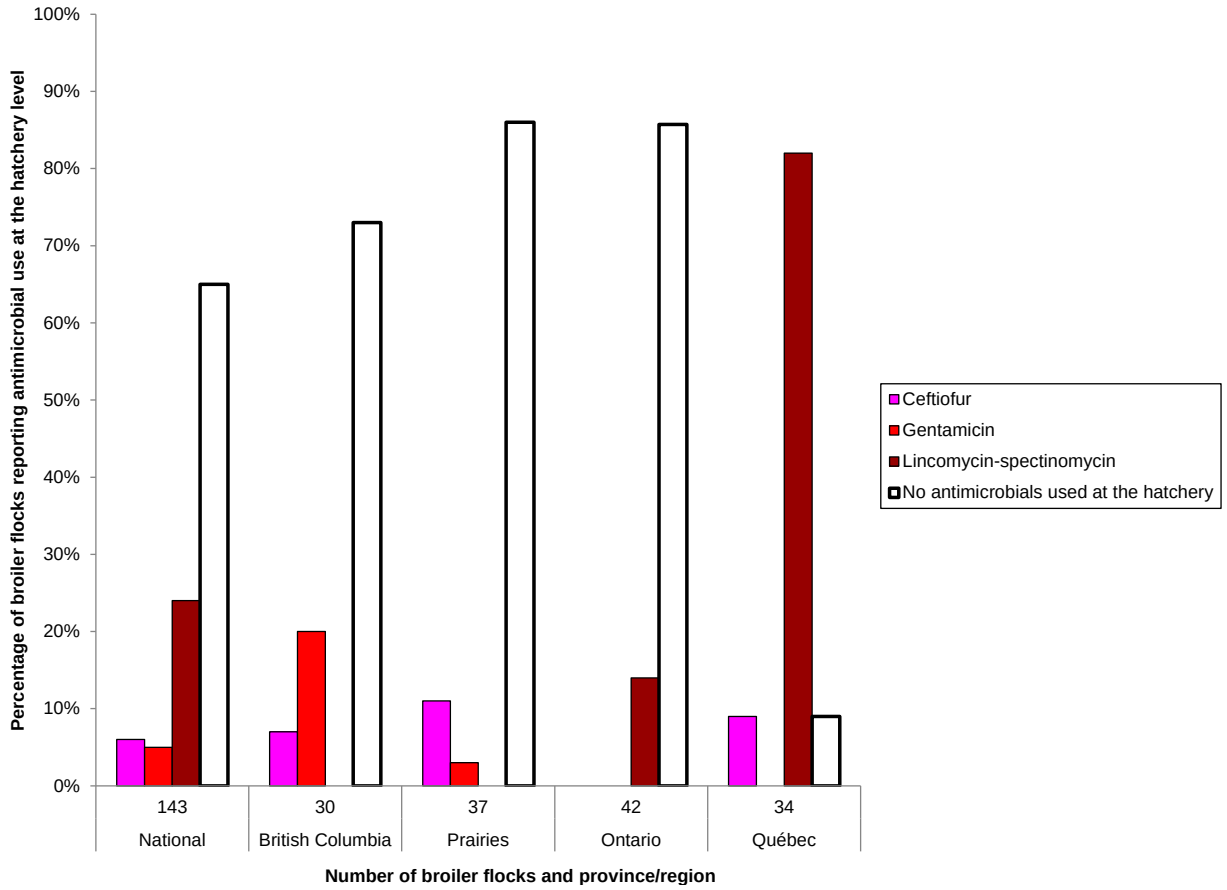
	Antimicrobial class	Antimicrobial	Route of administration			
			Any route[a]	*In ovo*/SC	Feed	Water
			n (%)	n (%)	n (%)	n (%)
I	Third generation cephalosporins	Ceftiofur	9 (6)	9 (6)	0 (0)	0 (0)
	Fluoroquinolone	Enrofloxacin	0 (0)	0 (0)	0 (0)	0 (0)
II	Aminoglycosides	Apramycin	1 (1)	0 (0)	0 (0)	1 (1)
		Gentamicin	7 (5)	7 (5)	0 (0)	0 (0)
	Lincosamides-aminocyclitols	Lincomycin-spectinomycin	34 (24)	34 (24)	0 (0)	0 (0)
	Macrolides	Tylosin	28 (20)	0 (0)	28 (20)	0 (0)
	Penicillins	Amoxicillin	2 (1)	0 (0)	0 (0)	2 (1)
		Penicillin G potassium	13 (9)	0 (0)	5 (4)	8 (6)
		Penicillin G procaine	12 (8)	0 (0)	12 (9)	0 (0)
	Streptogramins	Virginiamycin	28 (20)	0 (0)	28 (20)	0 (0)
	Trimethoprim-sulfonamides	Trimethoprim-sulfadiazine	17 (12)	0 (0)	17 12)	0 (0)
III	Bacitracin	Bacitracin	82 (57)	0 (0)	82 (58)	0 (0)
	Sulfonamides	Sulfamethazine	1 (1)	0 (0)	0 (0)	1 (1)
		Sulfaquinoxaline	5 (3)	0 (0)	0 (0)	5 (4)
		Sulfaquinoxaline-pyrimethamine	1 (1)	0 (0)	0 (0)	1 (1)
	Tetracyclines	Oxytetracycline	1 (1)	0 (0)	1 (1)	0 (0)
		Tetracycline-neomycin	4 (3)	0 (0)	0 (0)	4 (3)
IV	Flavophospholipids	Bambermycin	0 (0)	0 (0)	0 (0)	0 (0)
	Ionophores	Lasalocid	4 (3)	0 (0)	4 (3)	0 (0)
		Maduramicin	10 (7)	0 (0)	10 (7)	0 (0)
		Monensin	45 (31)	0 (0)	45 (32)	0 (0)
		Narasin	31 (22)	0 (0)	31 (22)	0 (0)
		Narasin-nicarbazin	37 (26)	0 (0)	37 (26)	0 (0)
		Salinomycin	50 (35)	0 (0)	50 (35)	0 (0)
N/A	Chemical coccidiostats	Clopidol	7 (5)	0 (0)	7 (5)	0 (0)
		Decoquinate	24 (17)	0 (0)	24 (17)	0 (0)
		Diclazuril	0 (0)	0 (0)	0 (0)	0 (0)
		Nicarbazin	40 (28)	0 (0)	40 (28)	0 (0)
		Robenidine	1 (1)	0 (0)	1 (1)	0 (0)
		Zoalene	3 (2)	0 (0)	3 (2)	0 (0)
	Orthosomycins	Avilamycine	32 (23)	0 (0)	32 (23)	0 (0)

Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
N/A = not applicable (no classification available at the time of writing of this report).
SC = subcutaneous route of injection.

[a] Flocks with reported use of an antimicrobial class by feed, water, in ovo/subcutaneous, or any combination of these routes are included in each count.

ANTIMICROBIAL USE *IN OVO* OR SUBCUTANEOUS INJECTION

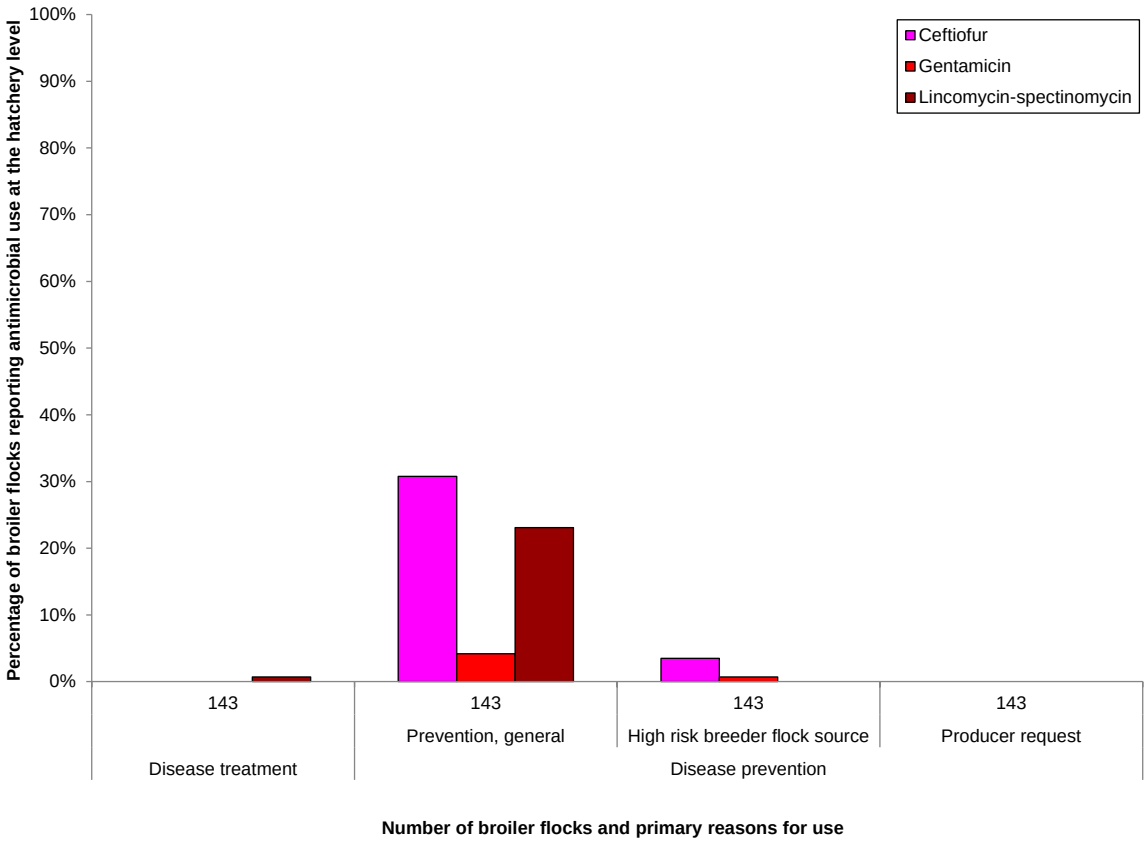
Figure 7.1. Percentage of broiler flocks reporting antimicrobial use *in ovo* or subcutaneous injection at the hatchery level by province/region, 2014



Province/region		National		British Columbia		Prairies		Ontario		Québec	
Year		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of flocks		99	143	26	30	15	37	30	42	28	34
Antimicrobial											
I	Ceftiofur	**31%**	**6%**	**58%**	**7%**	**53%**	**11%**	0%	0%	**29%**	**9%**
II	Gentamicin	3%	5%	12%	20%	0%	3%	0%	0%	0%	0%
	Lincomycin-spectinomycin	24%	24%	0%	0%	0%	0%	17%	14%	68%	82%
	No antimicrobials used at the hatchery	**42%**	**65%**	**35%**	**73%**	**47%**	**86%**	83%	86%	4%	9%

Roman numerals I to II indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Only the current year is depicted in the figure but all surveillance years are included in the table.
Numbers per column may not add up to 100% due to rounding or batches of chicks (hatched at the same time to supply 1 barn) may have used more than 1 antimicrobial.
Data represent flocks medicated at the hatchery at day 18 of incubation or upon hatch.
For the temporal analyses nationally and by province/region, the proportion (%) of flocks using antimicrobial over the current year has been compared to the proportion (%) of flocks using the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

Figure 7.2. Percentage of broiler flocks reporting antimicrobial use *in ovo* or subcutaneous injection at the hatchery by primary reason, 2014

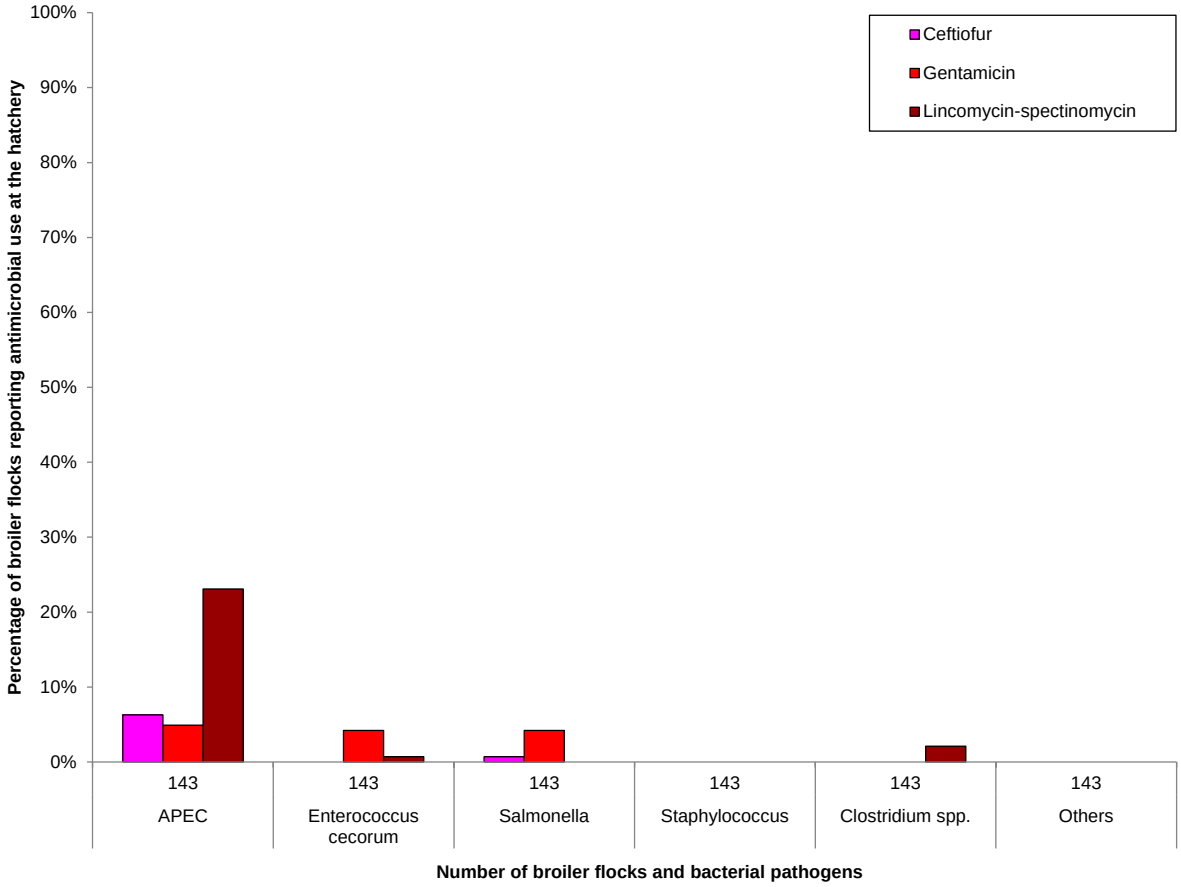


Primary reasons for use		Disease treatment	Disease prevention		
Subcategory			Prevention, general	High risk breeder flock source	Producer request
Number of flocks		143	143	143	143
Antimicrobial					
I	Ceftiofur	0%	31%	3%	0%
II	Gentamicin	0%	4%	1%	0%
	Lincomycin-spectinomycin	0.7%	23%	0%	0%

Roman numerals I to II indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Respondents were instructed to select only one of "Disease treatment", "Disease prevention", "High risk breeder flock source" (i.e., hatching eggs from old flocks that may have poor shell quality; any disease pressure, infectious or metabolic) as a primary reason for use of an antimicrobial. High risk breeder flock source and producer request were deemed preventive reasons for use.

Figure 7.3. Percentage of broiler flocks reporting antimicrobial use *in ovo* or subcutaneous injection at the hatchery for *Disease prevention*, 2014



Primary reason for use		Disease prevention					
Bacterial pathogen		APEC	*Enterococcus cecorum*	*Salmonella*	*Staphylococcus*	*Clostridium* spp.	Others
Number of flocks		143	143	143	143	143	143
Antimicrobial							
I	Ceftiofur	6%	0%	1%	0%	0%	0%
II	Gentamicin	5%	4%	4%	0%	0%	0%
	Lincomycin-spectinomycin	23%	1%	0%	0%	2%	0%

Roman numerals I to II indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
The respondents were instructed to select all potential pathogens affecting chicks post-hatch as diagnosis cannot be made at the time of hatchery medication; lesions typically occur post-hatch. These are largely for prevention.
APEC = Avian pathogenic *E. coli* (responsible for yolk sacculitis and septicemia).
In 2014, lincomycin-spectinomycin was largely used for prevention except in 1 flock that reported use of this antimicrobial for treatment.

Table 7.3. Summary of antimicrobial use administered *in ovo* or subcutaneous injection at the hatchery, 2014

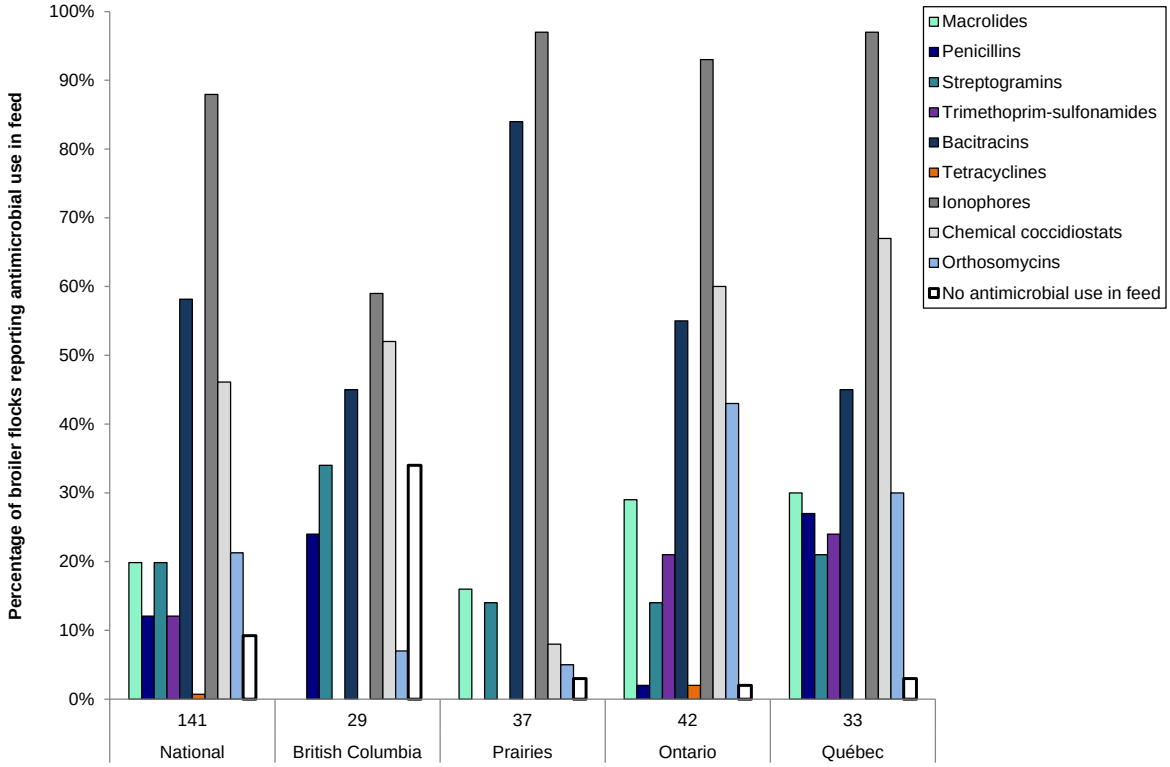
	Antimicrobial	Flock n (%)	Days exposed median (min.; max.)	Dose (mg) per egg/chick median (min. ; max.)[a,b,c]
I	Ceftiofur	9 (6%)	N/A	0.20 (0.10 ; 0.20)
II	Gentamicin	7 (5%)	N/A	0.20 (0.20 ; 0.20)
	Lincomycin-spectinomycin	34 (24%)	N/A	0.75 (0.75 ; 0.75)

Roman numerals I to II indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
N/A = not applicable (these were administered only once).

[a] Doses used for *in ovo* applications in hatching eggs at day 18 of incubation or subcutaneous applications in chicks at day of hatch.
[b] Median use estimates are based on flocks that used the specified antimicrobial in mg per hatching egg or chick.
[c] Doses reported were based on milligrams per egg or chick suggested by the manufacturer or from veterinary consultation (based on mg/body weight of the treated animal or any available recommendations based on residue avoidance): ceftiofur routine dose (0.10 to 0.20 mg/egg or chick), gentamicin routine dose (0.20 mg/chick or egg), lincomycin-spectinomycin routine dose (0.75 mg/egg or chick consisting of 0.50 mg spectinomycin and 0.25 mg of lincomycin).

ANTIMICROBIAL USE IN FEED

Figure 7.4. Percentage of broiler flocks reporting antimicrobial use in feed by province/region, 2014

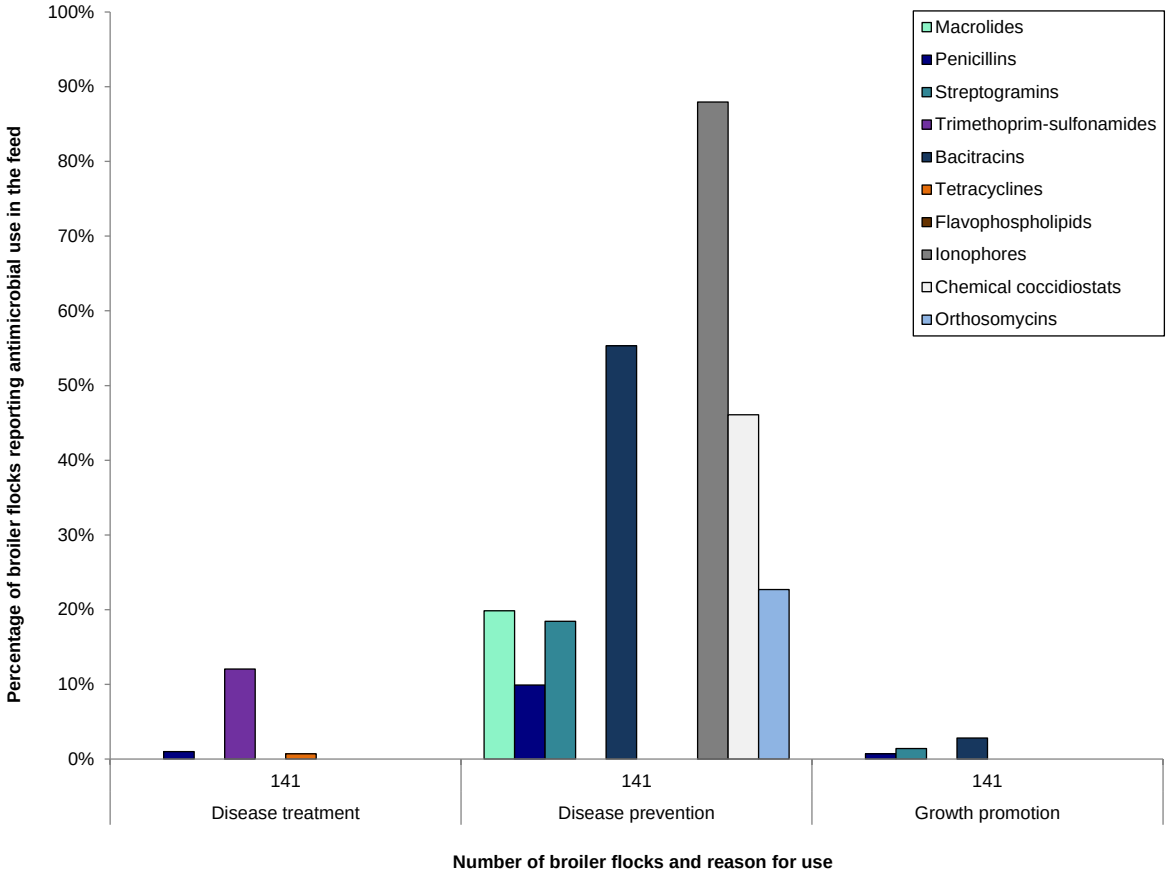


Number of broiler flocks and province/region

Province/region		National		British Columbia		Prairies		Ontario		Québec	
Year		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of flocks		97	141	24	29	15	37	30	42	28	33
Antimicrobial class											
II	Macrolides	**7%**	**20%**	0%	0%	7%	16%	20%	29%	0%	30%
	Penicillins	12%	12%	**50%**	**24%**	0%	0%	0%	2%	0%	27%
	Streptogramins	**46%**	**20%**	54%	34%	**40%**	**14%**	**43%**	**14%**	**46%**	**21%**
	Trimethoprim-sulfonamides	15%	12%	0%	0%	0%	0%	23%	21%	29%	24%
III	Bacitracins	48%	58%	50%	45%	67%	84%	37%	55%	50%	45%
	Tetracyclines	1%	1%	0%	0%	0%	0%	3%	2%	0%	0%
IV	Flavophospholipids	1%	0%	0%	0%	0%	0%	0%	0%	4%	0%
	Ionophores	91%	88%	**88%**	**59%**	93%	97%	87%	93%	96%	97%
N/A	Chemical coccidiostats	49%	46%	63%	52%	13%	8%	53%	60%	54%	67%
	Orthosomycin	0%	21%	0%	7%	0%	5%	0%	43%	0%	30%
	No antimicrobial use in feed	7%	9%	13%	34%	0%	3%	10%	2%	4%	3%

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification at the time of writing of this report).
Only the current year is depicted in the figure but all surveillance years are included in the table.
Ionophores and chemical coccidiostats are listed in Table 7.2 and Table 7.4.
Numbers per column may not add up to 100% as some flocks may have used an antimicrobial more than once or used multiple antimicrobials throughout the grow-out period.
For the temporal analyses nationally and by province/region, the proportion (%) of flocks using antimicrobial class over the current year has been compared to the proportion (%) of flocks using the same antimicrobial class during the first and the previous surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

Figure 7.5. Percentage of broiler flocks reporting antimicrobial use in feed by primary reason, 2014

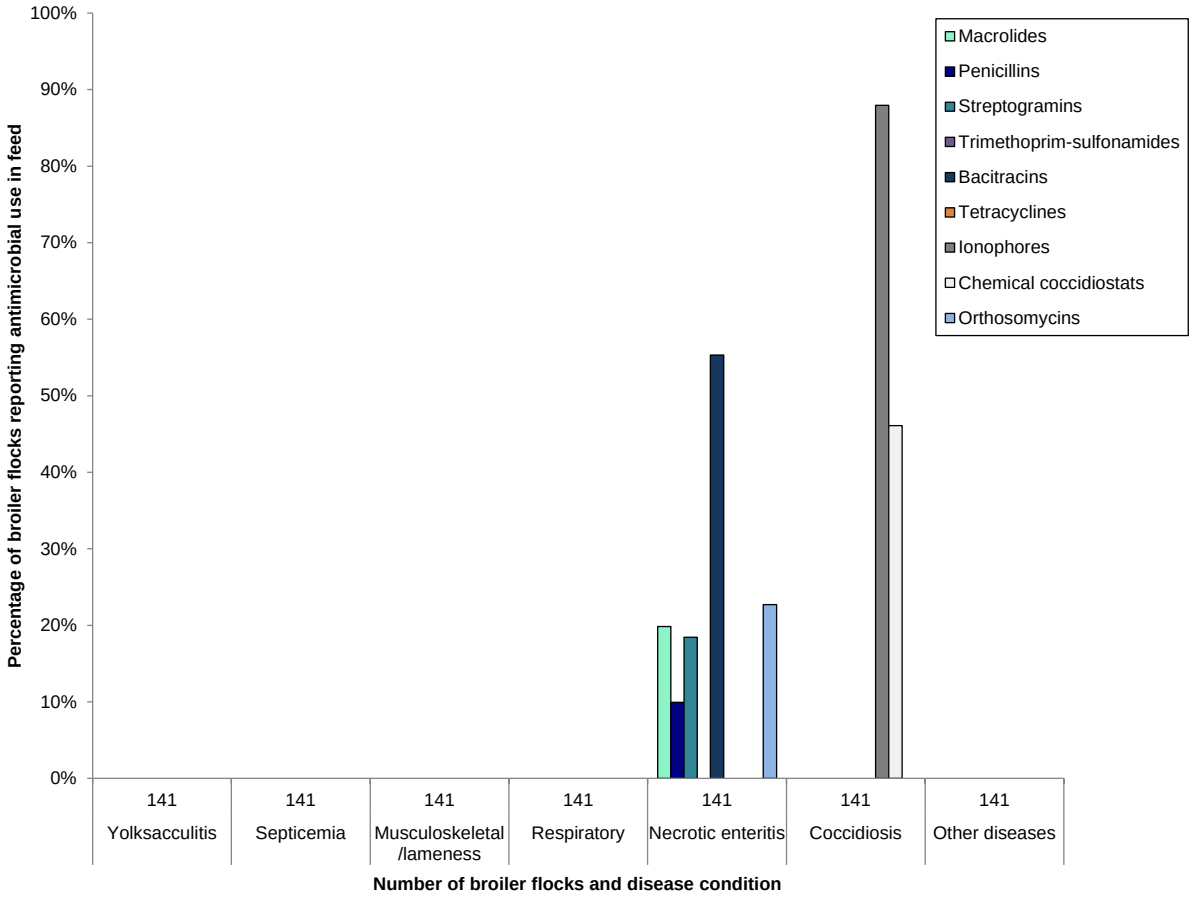


Reason for use		Disease treatment		Disease prevention		Growth promotion	
Year		2013	2014	2013	2014	2013	2014
Number of flocks		97	141	97	141	97	141
Antimicrobial class							
II	Macrolides	0%	0%	7%	20%	0%	0%
	Penicillins	0%	1%	10%	10%	2%	1%
	Streptogramins	0%	0%	41%	18%	5%	1%
	Trimethoprim-sulfonamides	15%	12%	0%	0%	0%	0%
III	Bacitracins	1%	0%	39%	55%	8%	3%
	Tetracyclines	1%	1%	0%	0%	0%	0%
IV	Flavophospholipids	0%	0%	0%	0%	1%	0%
	Ionophores	0%	0%	91%	88%	0%	0%
N/A	Chemical coccidiostats	0%	0%	49%	46%	0%	0%
	Orthosomycins	0%	0%	0%	23%	0%	0%

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification available at the time of writing of this report).
Ionophores and chemical coccidiostats are listed in Table 7.2 and Table 7.4.
Growth promotion includes production uses/claims listed in the Compendium of Medicating Ingredients Brochure[17] other than disease prevention or treatment such as 1) to increase the rate of weight gain, and 2) to improve feed efficiency.
Only the current year is depicted in the figure but all surveillance years are included in the table.

[17] Available at: www.inspection.gc.ca/animals/feeds/medicating-ingredients/eng/1300212600464/1320602461227. Accessed January 2016.

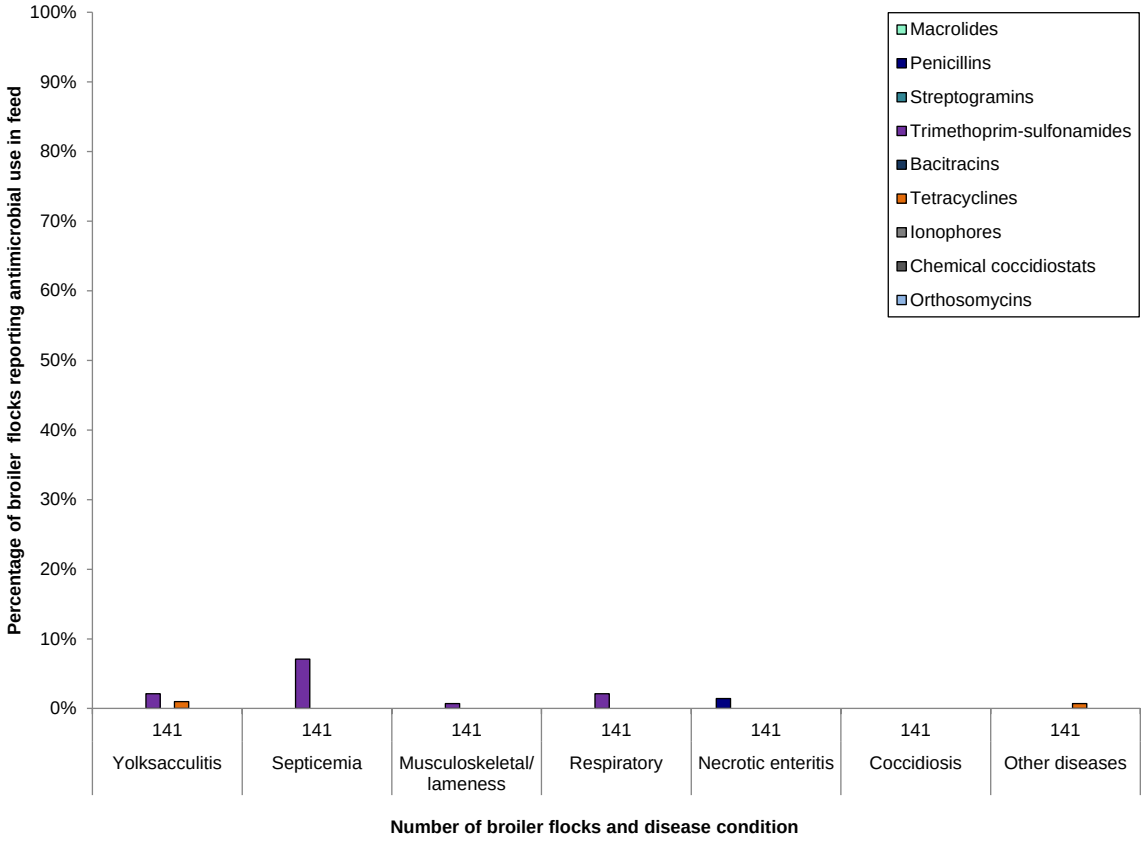
Figure 7.6. Percentage of broiler flocks reporting antimicrobial use in feed for *Disease prevention*, 2014



Primary reason for use		Disease prevention						
Disease conditions		Yolksacculitis	Septicemia	Musculoskeletal /lameness	Respiratory	Necrotic enteritis	Coccidiosis	Other diseases
Number of flocks		141	141	141	141	141	141	141
Antimicrobial class								
II	Macrolides	0%	0%	0%	0%	20%	0%	0%
	Penicillins	0%	0%	0%	0%	10%	0%	0%
	Streptogramins	0%	0%	0%	0%	18%	0%	0%
	Trimethoprim-sulfonamides	0%	0%	0%	0%	0%	0%	0%
III	Bacitracins	0%	0%	0%	0%	55%	0%	0%
	Tetracyclines	0%	0%	0%	0%	0%	0%	0%
IV	Ionophores	0%	0%	0%	0%	0%	88%	0%
N/A	Chemical coccidiostats	0%	0%	0%	0%	0%	46%	0%
	Orthosomycins	0%	0%	0%	0%	23%	0%	0%

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification available at the time of writing of this report).
Ionophores and chemical coccidiostats are listed in Table 7.2 and Table 7.4.
Data presented in the above figure were number of flocks reporting disease prevention including few flocks reporting growth promotion: bacitracins (4 flocks), penicillins (1 flock), and streptogramin (2 flocks).

Figure 7.7. Percentage of broiler flocks reporting antimicrobial use in feed for *Disease treatment*, 2014



Primary reason for use		Disease treatment						
Disease condition		Yolksacculitis	Septicemia	Musculoskeletal/ lameness	Respiratory	Necrotic enteritis	Coccidiosis	Other diseases
Number of flocks		141	141	141	141	141	141	141
Antimicrobial class								
II	Macrolides	0%	0%	0%	0%	0%	0%	0%
	Penicillins	0%	0%	0%	0%	1%	0%	0%
	Streptogramins	0%	0%	0%	0%	0%	0%	0%
	Trimethoprim-sulfonamides	2%	7%	1%	2%	0%	0%	0%
III	Bacitracins	0%	0%	0%	0%	0%	0%	0%
	Tetracyclines	1%	0%	0%	0%	0%	0%	1%
IV	Ionophores	0%	0%	0%	0%	0%	0%	0%
N/A	Chemical coccidiostats	0%	0%	0%	0%	0%	0%	0%
	Orthosomycins	0%	0%	0%	0%	0%	0%	0%

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification available at the time of writing of this report).
Ionophores and chemical coccidiostats are listed in Table 7.2 and Table 7.4.

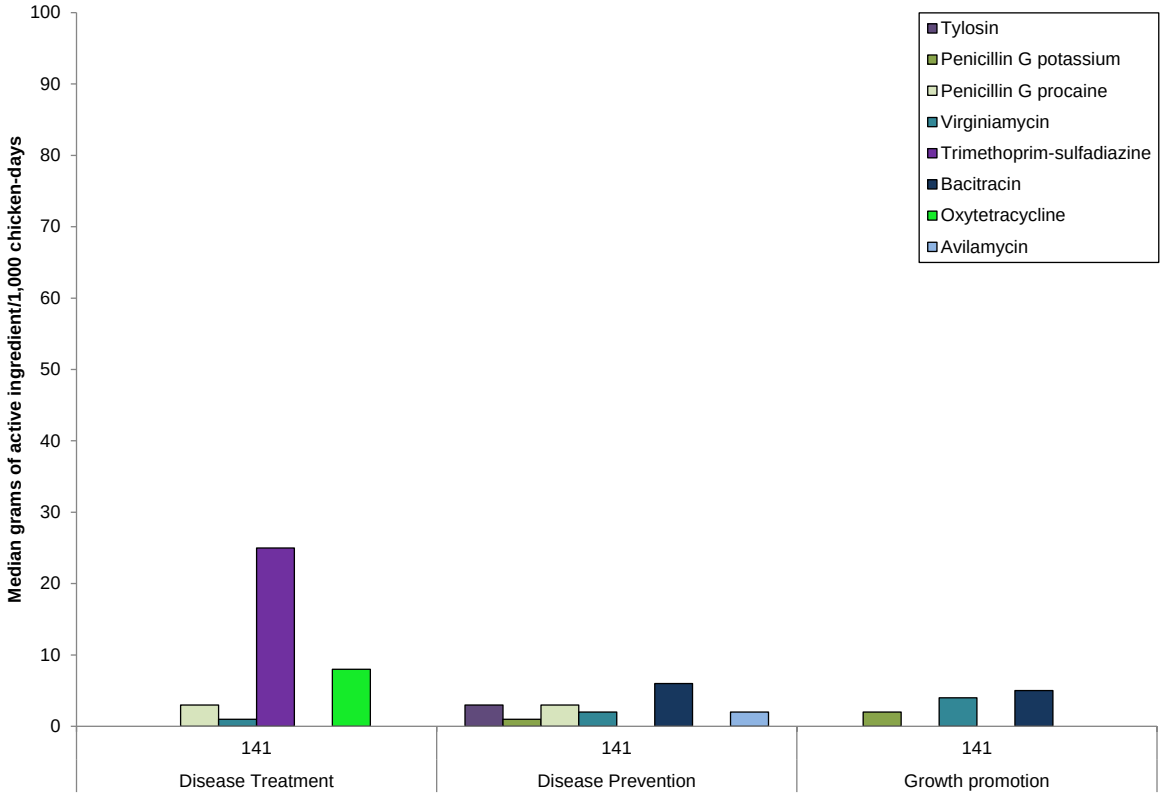
Table 7.4. Quantitative summary of antimicrobial use in feed, 2014

	Antimicrobial	Flock n (%)	Ration n (%)	Days exposed median (min. ; max.)[a]	Inclusion rate (g/tonne) median (min. ; max.)[b]	Grams/1,000 chicken-days median (min. ; max.)[c,d,e]
II	Tylosin	28 (20)	70 (6)	8 (1 ; 18)	22 (22 ; 22)	3 (0.5 ; 5)
	Penicillin G potassium	5 (4)	9 (1)	8 (3 ; 9)	20 (20 ; 20)	1 (1 ; 2)
	Penicillin G procaine	12 (9)	15 (1)	12 (8 ; 18)	110 (33 ; 110)	3 (2 ; 4)
	Virginiamycin	28 (20)	65 (6)	7 (1 ; 19)	22 (22 ; 44)	3 (0.4 ; 8)
	Trimethoprim-sulfadiazine	17 (12)	17 (1)	7 (2 ; 14)	200 (200 ; 300)	25 (7 ; 46)
III	Bacitracin	82 (52)	243 (21)	9 (1 ; 20)	55 (55 ; 110)	6 (1 ; 21)
	Oxytetracycline	1 (1)	1 (0.1)	7 (7 ; 7)	97 (97 ; 97)	8 (8 ; 8)
IV	Lasalocid	4 (3)	8 (1)	7 (3 ; 9)	60 (60 ; 105)	10 (5 ; 19)
	Maduramicin	10 (7)	27 (2)	8 (3 ; 11)	4 (4 ; 5)	0.2 (0.1 ; 1)
	Monensin	45 (32)	95 (8)	8 (1 ; 20)	99 (50 ; 100)	12 (1 ; 21)
	Narasin	31 (22)	61 (5)	8 (1 ; 16)	70 (40 ; 70)	11 (2 ; 15)
	Narasin-nicarbazin	37 (26)	156 (13)	9 (2 ; 18)	80 (80 ; 80)	5 (2 ; 14)
	Salinomycin	50 (35)	125 (11)	8 (1 ; 18)	60 (30 ; 120)	7 (1 ; 14)
N/A	Clopidol	7 (5)	19 (2)	7 (3 ; 17)	125 (25 ; 125)	7 (1 ; 26)
	Decoquinate	24 (17)	42 (4)	9 (2 ; 18)	30 (10 ; 60)	2 (1 ; 6)
	Nicarbazin	40 (28)	82 (7)	8 (3 ; 17)	50 (50 ; 125)	3 (1 ; 16)
	Robenidine	1 (1)	1 (0.1)	7 (7 ; 7)	33 (33 ; 33)	3 (3 ; 3)
	Zoalene	3 (2)	6 (1)	10 (8 ; 12)	125 (125 ; 125)	7 (4 ; 10)
	Avilamycin	32 (23)	68 (5)	8 (1 ; 17)	15 (15 ; 25)	2 (0.4 ; 4)
	Unmedicated flock/ration	13 (9)	60 (6)			

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification available at the time of writing of this report).
Combination antimicrobials (trimethoprim-sulfadiazine and narasin-nicarbazin) include the inclusion rate for both antimicrobial components.

[a] Days exposed are by ration.
[b] Inclusion rate per tonne of feed reported by the veterinarian/producer.
[c] Estimates are based on consumption tables of the common breeds prevalent in Canada(Ross x Ross, Cobb x Cobb) and representative Canadian feed company standards (Nutreco Canada Inc., Wallenstein Feed and Supply Ltd.) for straight-run birds.
[d] Median use estimates are based on rations that used the specified antimicrobial and are estimated in "grams per 1,000 chicken-days (g/TCD)".
[e] TCD values are by ration.

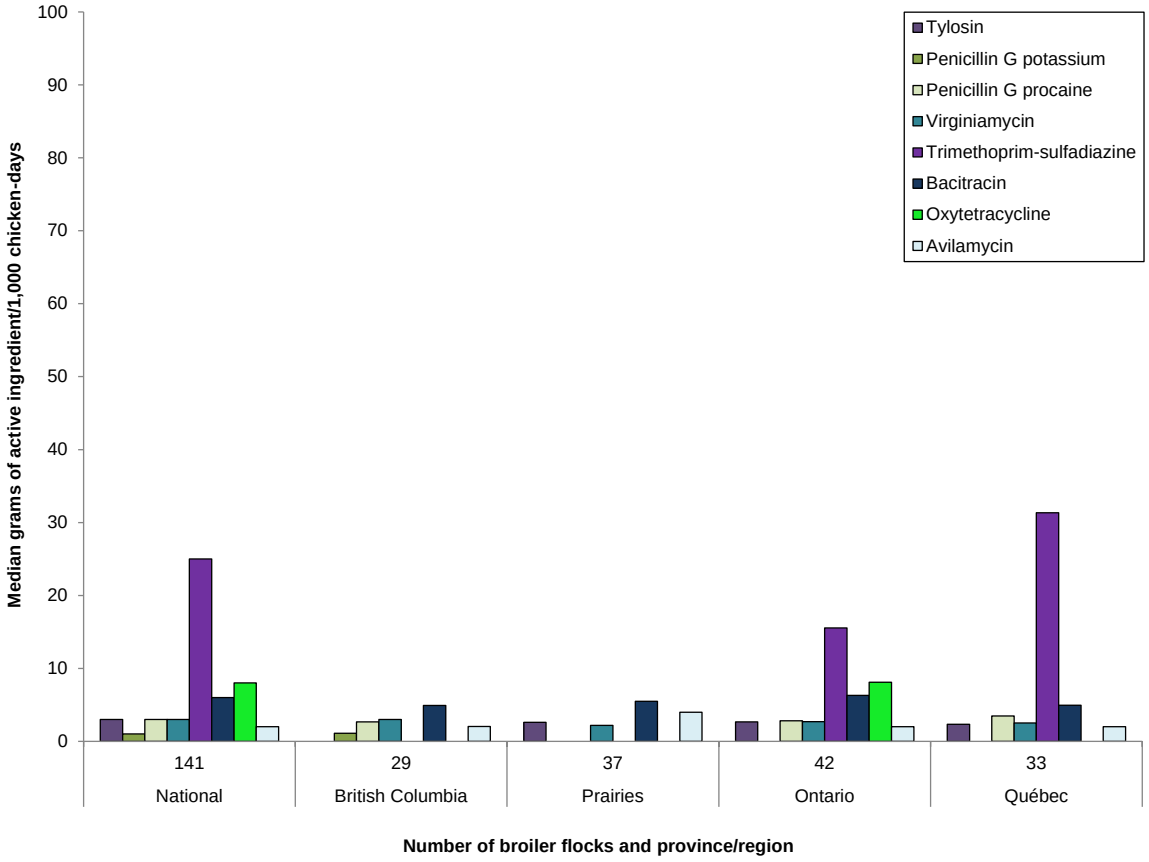
Figure 7.8. Quantity of antimicrobials used in feed by reason for use, 2014



Reason for use		Disease treatment		Disease prevention		Growth promotion	
Year		2013	2014	2013	2014	2013	2014
Number of flocks		97	141	97	141	97	141
Antimicrobial							
II	Tylosin	0 (0)	0 (0)	25 (3)	3 (70)	0 (0)	0 (0)
	Penicillin G potassium	0 (0)	0 (0)	0 (0)	1 (7)	0 (0)	2 (2)
	Penicillin G procaine	0 (0)	3 (2)	19 (3)	3 (13)	3 (4)	0 (0)
	Virginiamycin	0 (0)	1 (1)	120 (2)	2 (55)	22 (3)	4 (9)
	Trimethoprim-sulfadiazine	16 (37)	25 (17)	0 (0)	0 (0)	0 (0)	0 (0)
III	Bacitracin	3 (8)	0 (0)	124 (6)	6 (228)	24 (5)	5 (15)
	Oxytetracycline	1 (55)	8 (1)	0 (0)	0 (0)	0 (0)	0 (0)
IV	Bambermycin	0 (0)	0 (0)	0 (0)	0 (0)	4 (0.2)	0 (0)
N/A	Avilamycin	0 (0)	0 (0)	0 (0)	2 (68)	0 (0)	0 (0)

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification available at the time of writing of this report).
Median use estimates are based on rations that used the specified antimicrobial and are estimated in "grams per 1,000 chicken-days".
Estimates are based on the average feed consumption from common breeds (Ross x Ross, Cobb x Cobb) and representative Canadian feed company standards for straight run birds.
Numbers in parentheses are total rations.
Only the current year is depicted in the figure but all surveillance years are included in the table.

Figure 7.9. Quantity of antimicrobial use in feed by province/region, 2014

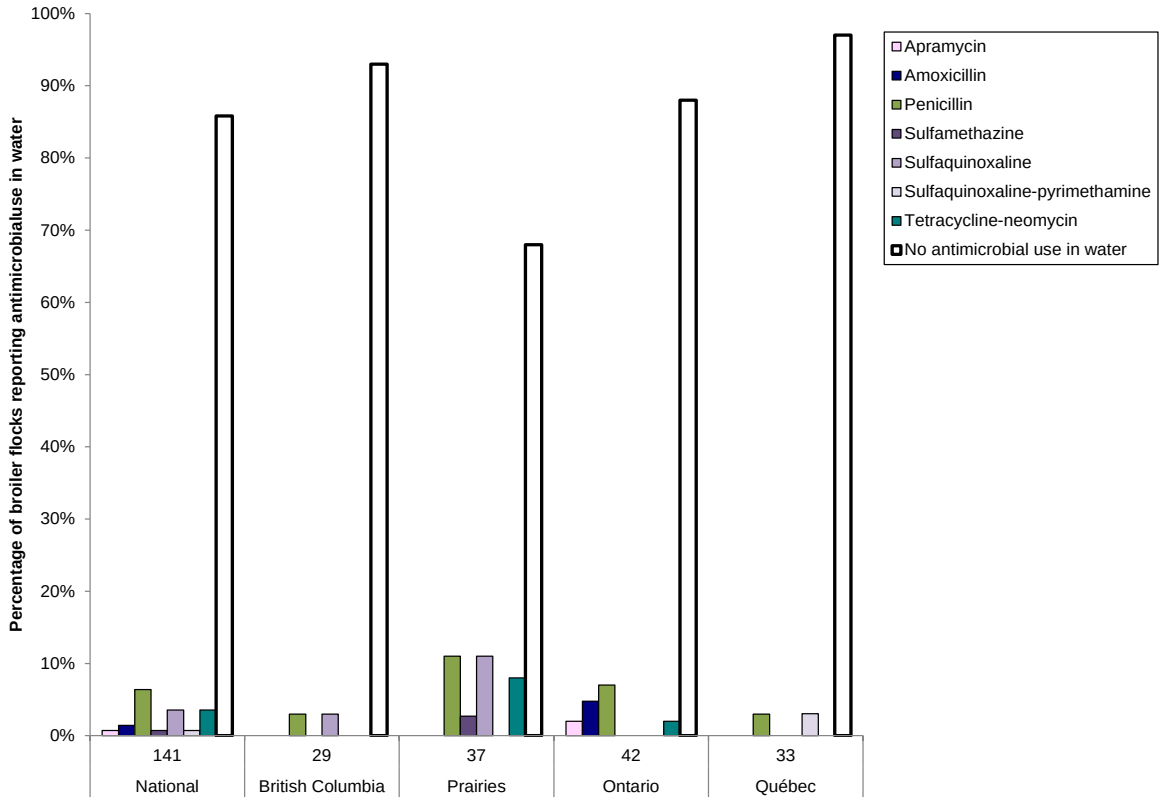


Province/region		National		British Columbia		Prairies		Ontario		Québec	
Year		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of flocks		97	141	24	29	15	37	30	42	28	33
Antimicrobial											
II	Tylosin	3 (25)	3 (70)	0 (0)	0 (0)	0 (0)	3 (11)	3 (23)	3 (34)	0 (0)	2 (25)
II	Penicillin G potassium	0 (0)	1 (9)	0 (0)	1 (9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
II	Penicillin G procaine	3 (22)	3 (15)	3 (22)	3 (4)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	3 (9)
II	Virginiamycin	2 (142)	3 (65)	2 (35)	3 (23)	2 (21)	2 (13)	3 (48)	3 (15)	2 (38)	3 (14)
II	Trimethoprim-sulfadiazine	37 (16)	25 (17)	0 (0)	0 (0)	0 (0)	0 (0)	15 (7)	16 (9)	46 (9)	31 (8)
III	Bacitracin	6 (151)	6 (243)	5 (32)	5 (42)	6 (34)	5 (90)	7 (31)	6 (56)	4 (54)	5 (55)
III	Oxytetracycline	55 (1)	8 (1)	0 (0)	0 (0)	0 (0)	0 (0)	55 (1)	8 (1)	0 (0)	0 (0)
IV	Bambermycin	0.2 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.2 (4)	0 (0)	0 (0)	0 (0)
N/A	Avilamycin	0 (0)	2 (61)	0 (0)	2 (4)	0 (0)	4 (3)	0 (0)	2 (39)	0 (0)	2 (20)

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate. N/A = not applicable (no classification available at the time of writing of this report).
Median use estimates are based on rations that used the specified antimicrobial and are estimated in "grams per 1,000 chicken-days".
Estimates are based on the average feed consumption from common breeds (Ross x Ross, Cobb x Cobb) and representative Canadian feed company standards for straight run birds.
This figure does not include ionophores and chemical coccidiostats.
Only the current year is depicted in the figure but all surveillance years are included in the table (i.e., no flavophospholipids use reported in 2014).
Numbers in parenthesis are total rations.
The Prairies is a region including the provinces of Alberta and Saskatchewan.

ANTIMICROBIAL USE IN WATER

Figure 7.10. Percentage of broiler flocks reporting antimicrobial use in water by province/region, 2014



Province/region		National		British Columbia		Prairies		Ontario		Québec	
Year		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of flocks		97	141	24	29	15	37	30	42	28	33
Antimicrobial											
I	Enrofloxacin	2%	0%	8%	0%	0%	0%	0%	0%	0%	0%
II	Apramycin	0%	1%	0%	0%	0%	0%	0%	2%	0%	0%
	Amoxicillin	0%	1%	0%	0%	0%	0%	0%	5%	0%	0%
	Penicillin	4%	6%	4%	3%	7%	11%	7%	7%	0%	3%
III	Sulfamethazine	0%	1%	0%	0%	0%	3%	0%	0%	0%	0%
	Sulfaquinoxaline	1%	4%	0%	3%	7%	11%	0%	0%	0%	0%
	Sulfaquinoxaline-pyrimethamine	2%	1%	0%	0%	7%	0%	3%	0%	4%	3%
	Tetracycline-neomycin	0%	4%	0%	0%	0%	8%	0%	2%	0%	0%
	No antimicrobial use in water	93%	86%	96%	93%	93%	68%	93%	88%	96%	97%

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

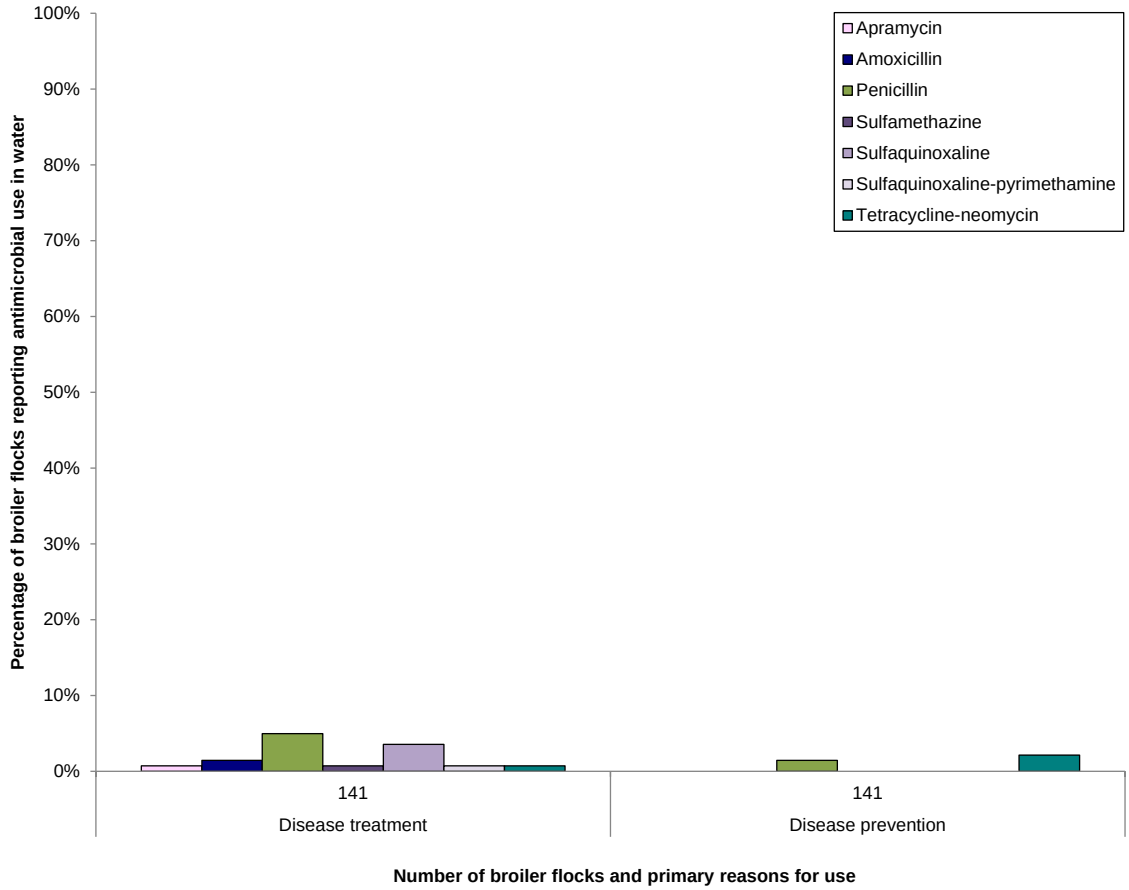
Only the current year is depicted in the figure but all surveillance years are included in the table (i.e., enrofloxacin use reported only in 2013).

Numbers per column may not add up to 100% as some flocks may have used an antimicrobial more than once or used multiple antimicrobials throughout the grow-out period.

For the temporal analyses nationally and by province/region, the proportion (%) of flocks using antimicrobial over the current year has been compared to the proportion (%) of flocks using the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicate significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

The Prairies is a region including the provinces of Alberta and Saskatchewan.

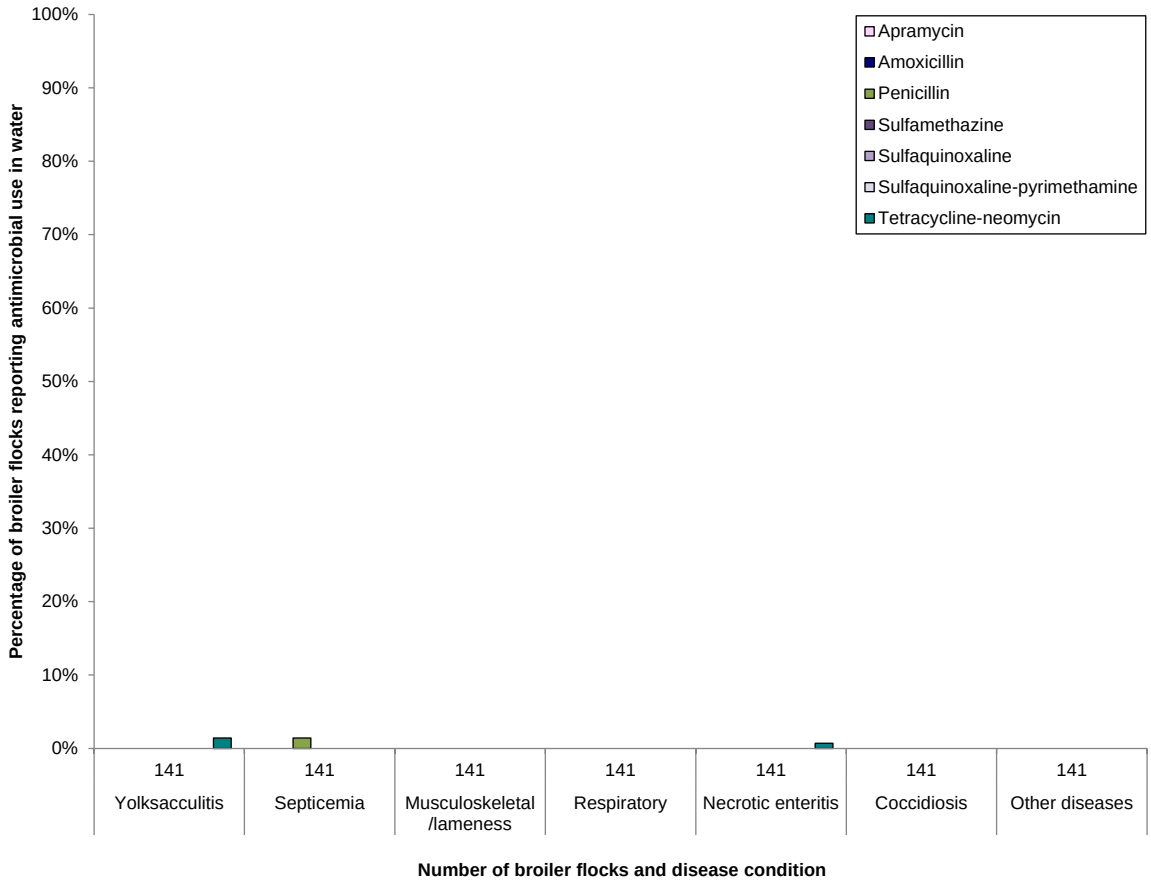
Figure 7.11. Percentage of broiler flocks reporting antimicrobial use in water by primary reason, 2014



Primary reasons for use Number of flocks		Disease treatment 141	Disease prevention 141
Antimicrobial			
II	Apramycin	1%	0%
	Amoxicillin	1%	0%
	Penicillin	5%	1%
III	Sulfamethazine	1%	0%
	Sulfaquinoxaline	4%	0%
	Sulfaquinoxaline-pyrimethamine	1%	0%
	Tetracycline-neomycin	1%	2%

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Respondents were instructed to select only one of "Disease treatment" or "Disease prevention" as a primary reason for use of an antimicrobial.

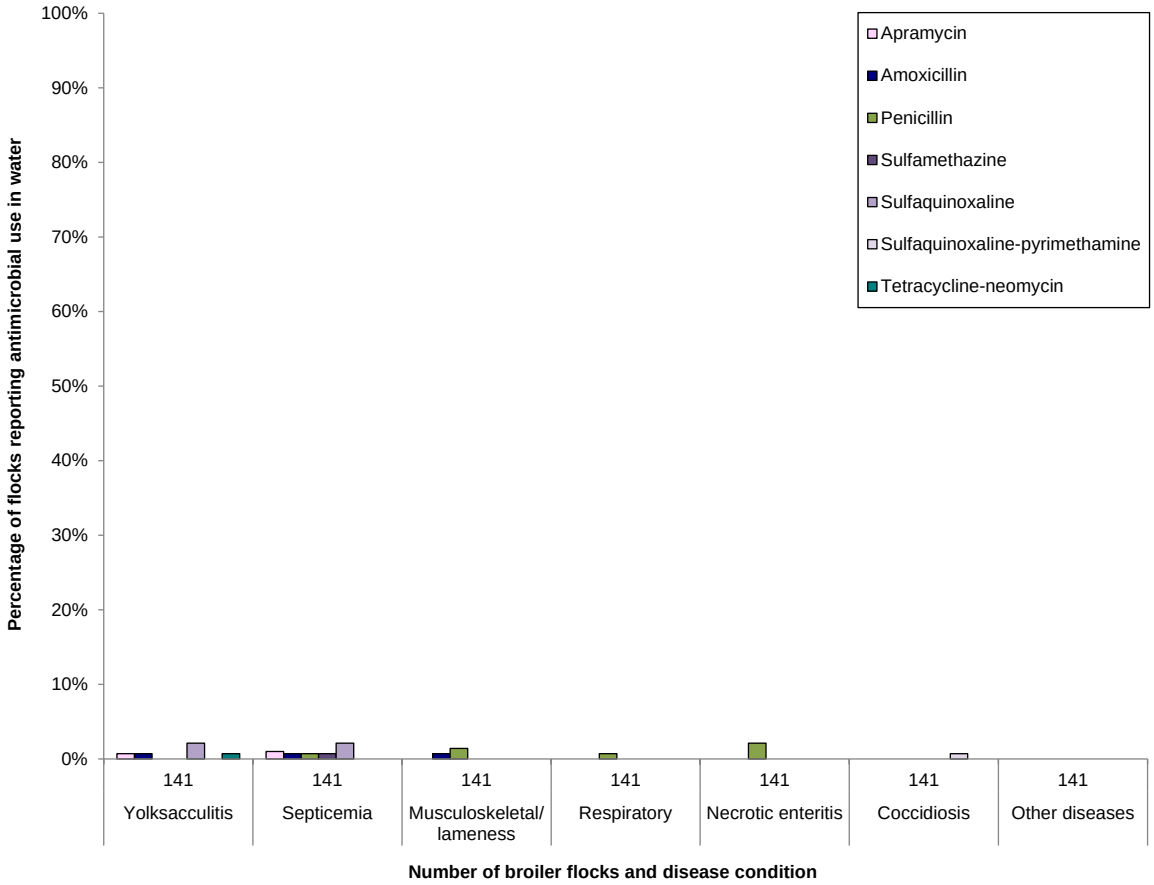
Figure 7.12. Percentage of broiler flocks reporting antimicrobial use in water for *Disease prevention*, 2014



Primary reason for use		Disease prevention						
Disease condition		Yolksacculitis	Septicemia	Musculoskeletal /lameness	Respiratory	Necrotic enteritis	Coccidiosis	Other diseases
Number of flocks		141	141	141	141	141	141	141
Antimicrobial								
II	Apramycin	0%	0%	0%	0%	0%	0%	0%
	Amoxicillin	0%	0%	0%	0%	0%	0%	0%
	Penicillin	0%	1%	0%	0%	0%	0%	0%
III	Sulfamethazine	0%	0%	0%	0%	0%	0%	0%
	Sulfaquinoxaline	0%	0%	0%	0%	0%	0%	0%
	Sulfaquinoxaline-pyrimethamine	0%	0%	0%	0%	0%	0%	0%
	Tetracycline-neomycin	1%	0%	0%	0%	1%	0%	0%

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
For "Disease prevention", the respondents were instructed to select all applicable disease conditions.

Figure 7.13. Percentage of broiler flocks reporting antimicrobial use in water for *Disease treatment*, 2014



Primary reason for use		Disease treatment						
Disease condition		Yolksacculitis	Septicemia	Musculoskeletal/ lameness	Respiratory	Necrotic enteritis	Coccidiosis	Other diseases
Number of flocks		141	141	141	141	141	141	141
Antimicrobial								
II	Apramycin	1%	1%	0%	0%	0%	0%	0%
	Amoxicillin	1%	1%	1%	0%	0%	0%	0%
	Penicillin	0%	1%	1%	1%	2%	0%	0%
III	Sulfamethazine	0%	1%	0%	0%	0%	0%	0%
	Sulfaquinoxaline	2%	2%	0%	0%	0%	0%	0%
	Sulfaquinoxaline-pyrimethamine	0%	0%	0%	0%	0%	1%	0%
	Tetracycline-neomycin	1%	0%	0%	0%	0%	0%	0%

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
For "Disease treatment", the respondents were instructed to select all applicable disease conditions.

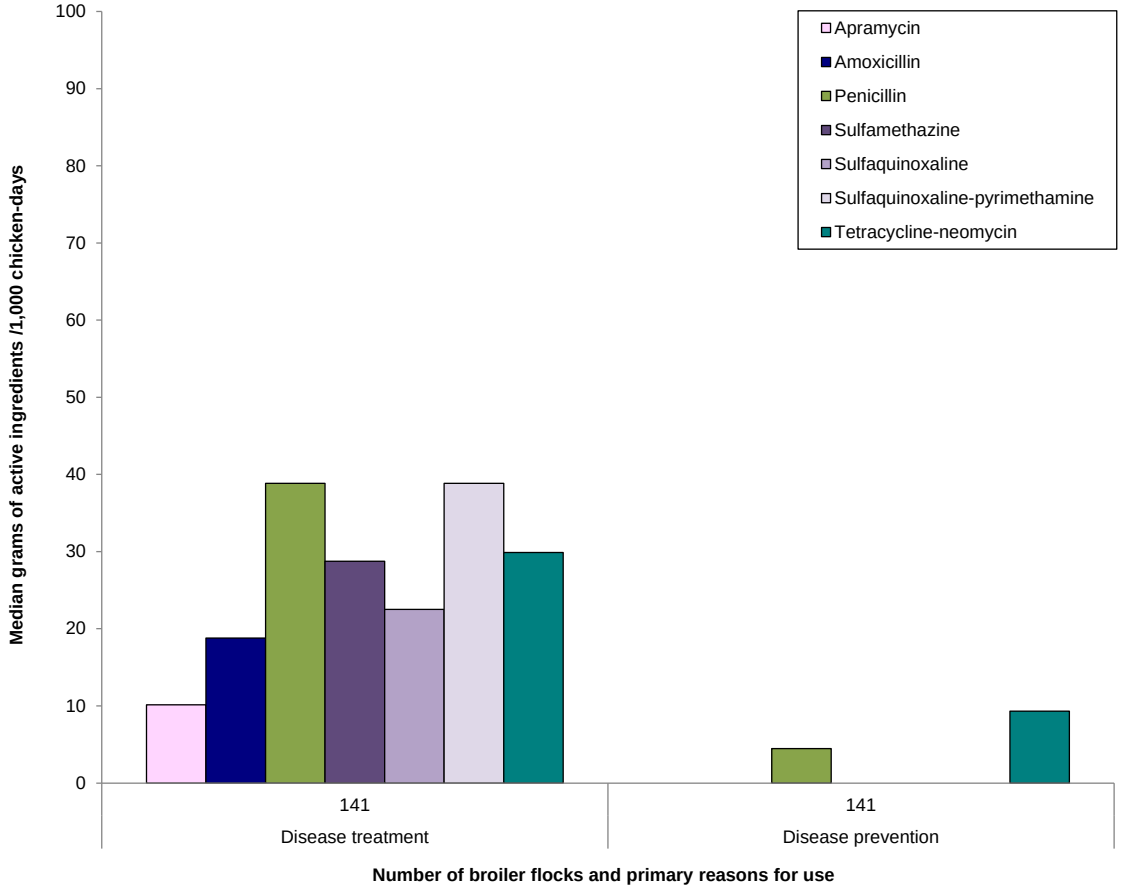
Table 7.5. Quantitative summary of antimicrobial use in water, 2014

	Antimicrobial	Flock n (%)	Days exposed median (min. ; max.)	Inclusion rate (g/L)[a]	Level of drug (g/L)[b]	Grams/1,000 chicken-days median (min. ; max.)[c]
II	Apramycin	1 (1%)	4 (4 ; 4)	0.5	0.3	10 (10 ; 10)
	Amoxicillin	2 (1%)	5 (5 ; 5)	0.2	0.1	19 (10 ; 28)
	Penicillin G potassium	8 (6%)	4 (3 ; 8)	0.2	0.2	35 (4 ; 90)
III	Sulfamethazine	1 (1%)	4 (3 ; 3)	4.0	1.0	29 (29 ; 29)
	Sulfaquinoxaline	5 (4%)	4 (3 ; 5)	2.0	0.4	23 (16 ; 52)
	Sulfaquinoxaline-pyrimethamine	1 (1%)	4 (4 ; 4)	1.5	0.2	39 (39 ; 39)
	Tetracycline-neomycin	4 (3%)	5 (4 ; 5)	0.9	0.3	16 (9 ; 38)

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

[a] Inclusion rate in grams per liter of drinking water reported by the veterinarian/producer.
[b] Level of drug (median) is the final grams of product per liter of drinking water (reported inclusion rate x product concentration).
[c] Estimated based on daily water consumption chart (Nutreco Canada Inc.).

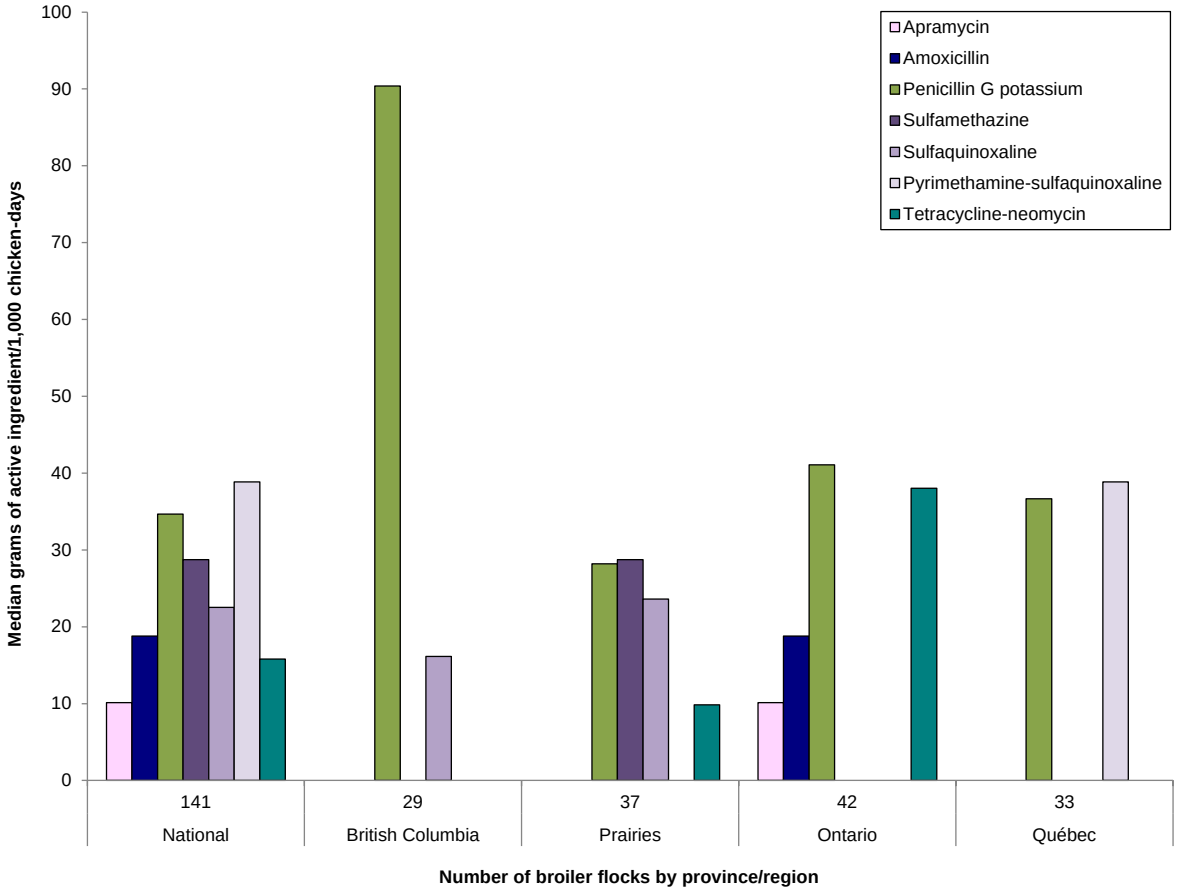
Figure 7.14. Quantity of antimicrobial use in water by reason for use, 2014



Primary reasons for use Number of flocks		Disease treatment 141	Disease prevention 141
Antimicrobial			
II	Apramycin	10	0
	Amoxicillin	19	0
	Penicillin	39	4
III	Sulfamethazine	29	0
	Sulfaquinoxaline	23	0
	Sulfaquinoxaline-pyrimethamine	39	0
	Tetracycline-neomycin	30	9

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Median use estimates are based on flocks that used the specified antimicrobial and are estimated in "grams per 1,000 chicken-days".
Estimates are based on daily water consumption chart (Nutreco Canada Inc.).

Figure 7.15. Quantity of antimicrobial use in water by province/region, 2014



Province/region		National		British Columbia		Prairies		Ontario		Québec	
Year		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Number of flocks		97	141	24	29	15	37	30	42	28	33
Antimicrobial											
I	Enrofloxacin	0	0	0	0	0	0	0	0	0	0
II	Apramycin	0	10	0	0	0	0	0	10	0	0
	Amoxicillin	0	19	0	0	0	0	0	19	0	0
	Penicillin G potassium	17	35	41	90	13	28	17	41	0	37
III	Sulfamethazine	0	29	0	0	0	29	0	0	0	0
	Sulfaquinoxaline	37	23	0	16	37	24	0	0	0	0
	Sulfaquinoxaline-pyrimethamine	25	39	0	0	0	0	26	0	24	39
	Tetracycline-neomycin	0	16	0	0	0	10	0	38	0	0

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Median use estimates are based on flocks that used the specified antimicrobial and are estimated in "grams per 1,000 chicken-days".
Estimates are based on daily water consumption chart (Nutreco Canada Inc.).
Only the current year is depicted in the figure but all surveillance years are included in the table (i.e., no enrofloxacin reported in 2014).

OTHER QUANTITATIVE RESULTS

Table 7.6. Quantity of antimicrobial use based on different metrics, 2013–2014

Route of administration	Antimicrobial class	Antimicrobial	Kilograms of active ingredient		mg/PCU	
			2013	2014	2013	2014
Feed						
I						
II	Macrolides	Tylosin	16.2	35.5	7.1	10.8
	Penicillins	Penicillin G potassium	0.0	4.1	0.0	1.2
		Penicillin G procaine	13.2	12.1	5.8	3.7
	Streptogramins	Virginiamycin	54.4	26.8	23.7	8.1
	Trimethoprim-sulfonamides	Trimethoprim-sulfadiazine	43.6	59.6	19.0	18.1
III	Bacitracins	Bacitracin	173.3	262.1	75.4	79.5
	Tetracyclines	Oxytetracycline	11.3	1.7	4.9	0.5
IV	Flavophospholipids	Bambermycin	0.4	0.0	0.2	0.0
	Ionophores	Lasalocid	41.9	16.7	18.2	5.1
		Maduramicin	0.0	1.6	0.0	0.5
		Monensin	69.8	173.7	30.4	52.7
		Narasin	74.6	109.5	32.4	33.2
		Narasin-nicarbazin	73.5	79.9	32.0	24.2
		Salinomycin	134.0	172.9	58.3	52.4
N/A	Chemical coccidiostat	Clopidol	28.6	39.2	12.5	11.9
		Decoquinate	0.0	19.5	0.0	5.9
		Diclazuril	0.2	0.0	0.1	0.0
		Nicarbazin	77.6	78.0	33.7	23.7
		Robenidine	0.0	0.3	0.0	0.1
		Zoalene	8.1	11.2	3.5	3.4
	Orthosomycins	Avilamycin	0.0	23.4	0.0	7.1
	Total, feed[a]		820.7	1,127.8	357.0	342.1
	Total, feed without ionophores/chemical coccidiostats		706.2	425.2	135.7	129.0
Water						
I	Fluoroquinolones	Enrofloxacin	< 0.1	0.0	< 0.1	0.0
II	Aminoglycosides	Apramycin	0.0	1.2	0.0	0.4
	Penicillins	Amoxicillin	0.0	4.6	0.0	1.4
		Penicillin G potassium	11.2	41.0	4.9	12.4
III	Sulfonamides	Sulfamethazine	0.0	3.0	0.0	0.9
		Sulfaquinoxaline	1.7	16.4	0.7	5.0
		Sulfaquinoxaline-pyrimethamine	2.4	3.2	1.0	1.0
	Tetracyclines-aminoglycosides	Tetracycline-neomycin	0.0	12.0	0.0	3.6
	Total, water[b]		15.4	81.3	6.7	24.7
	Total, water without coccidiostats/antiprotozoals		14.0	79.0	6.1	24.0
Injection						
I	Third generation cephalosporins	Ceftiofur	0.1	0.0	0.0	0.0
II	Aminoglycosides	Gentamicin	< 0.1	< 0.1	< 0.1	< 0.1
	Lincosamides-aminocyclitols	Lincomycin-spectinomycin	0.2	0.4	0.1	0.1
	Total injectable		0.3	0.5	0.1	0.2
All routes of administration						
	kg antimicrobials, all administration routes		836.4	1,209.5		
	kg live weight at pre-harvest sampling day		2,298,639.0	3,297,027.5		
	mg/PCU, with coccidiostats				363.9	366.9
	mg/PCU, without coccidiostats				142.0	153.1

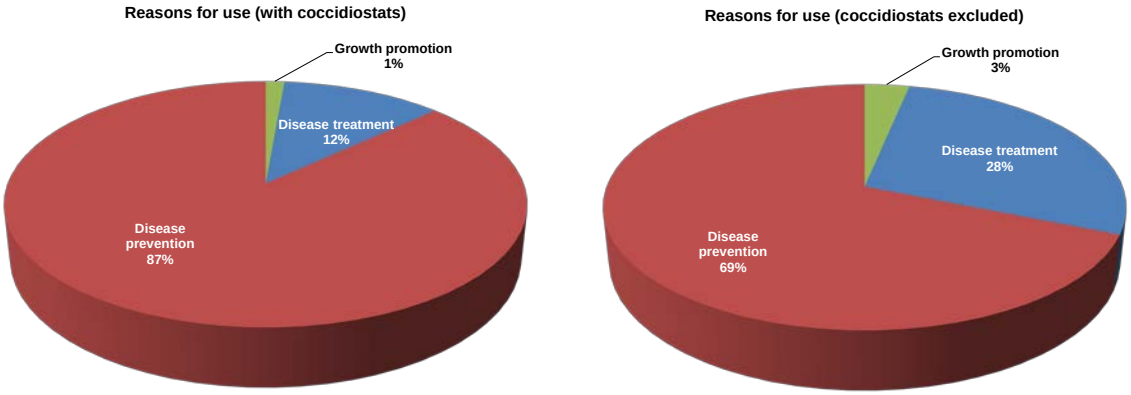
See corresponding footnotes on next page.

Table 7.6. Quantity of antimicrobial use based on different metrics, 2013–2014 (cont'd)

Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
N/A = not applicable (no classification available at the time of writing of this report).
mg/PCU = mg (total milligrams of active ingredient consumed by the flocks included in the survey) divided by PCU (population correction unit, adjusted by population size and weight of birds at treatment); the average weight of broilers at treatment used in the estimates above are based on the European Surveillance of Veterinary Antimicrobial Consumption weight for broiler chickens at 1 kg/bird.

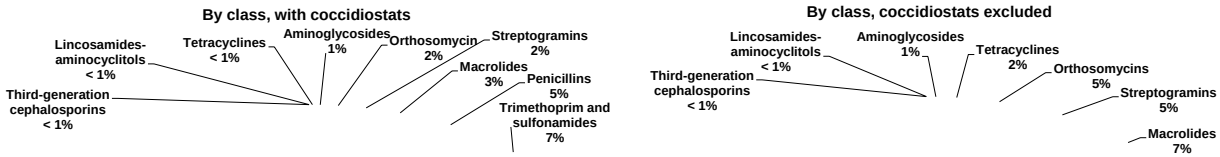
[a] The feed component is also collected in the swine program, thus farm-level broiler estimates could be compared to this species.
[b] The antimicrobial combination sulfaquinoxaline-pyrimethamine is indicated for coccidiodis prevention, this was excluded in the estimates in the next row ("without coccidiostats/antiprotozoals").

Figure 7.16. Milligrams per Population Correction Unit (mg/PCU) by primary reasons for use, 2014



Estimates above include antimicrobials administered via feed, water, and injection.
[a] PCU = Population correction unit.

Figure 7.17. Milligrams per Population Correction Unit (mg/PCU) by antimicrobial class, 2014



Estimates above include antimicrobials administered via feed, water, and injection.
[a] PCU = Population correction unit.

ANIMAL HEALTH AND BIOSECURITY

- Yolk-sacculitis and septicemia were the top 2 diseases diagnosed in 2014 (Figure 7.18).
- Confirmed diagnosis of enteric diseases (e.g., *Clostridium perfringens* and coccidiosis) that are targeted by most of the antimicrobials included in this report was less frequently reported compared to the systemic/neonatal diseases. This is likely due to the more frequent occurrence of subclinical cases of many enteric pathogens and the frequent preventive use of antimicrobials that are efficacious against *C. perfringens* and *Eimeria* spp. throughout the grow-out period.
- Among the bacterial diseases prevalent in broiler flocks, only 2 commercial vaccines are available to help prevent field infections (e.g., *E. coli* and coccidiosis vaccines) (Table 7.9). Trends in the use of these non-antimicrobial preventive approaches that potentially have sparing effect on the overall usage of antimicrobials will continue to be monitored.
- Biosecurity practices at the national level were summarized in 2014 (Table 7.10). Some components of biosecurity will be used in future analyses to identify management or operational risk or protective factors for antimicrobial-resistant and multidrug-resistant organisms.

Table 7.7. Summary of broiler farm characteristics, 2014

	Number of farms reporting	Units	Median	Mean	Minimum	Maximum	Total
Farm capacity[a]	141	Birds (n)	36,200	54,262	4,000	300,000	7,650,915
Chicks placed on floor sampled[b]	141	Chicks (n)	11,000	12,016	3,400	37,682	901,217
Chicks placed on barn sampled	141	Chicks (n)	20,200	24,105	1,700	75,364	3,374,714
Broiler population on floor at pre-harvest	141	Birds (n)	10,624	11,616	3,378	35,874	871,198
Broiler population on barn at pre-harvest	141	Birds (n)	19,674	22,995	1,693	69,510	3,219,341
Floor-level mortality at pre-harvest	141	Birds (%)	2.44	3.35	0.65	12.82	N/A
Barn-level mortality at pre-harvest	141	Birds (%)	3.51	4.37	0.41	17.44	N/A
Domestic chicks, proportion placed to barn sampled	135	Birds (%)	100	96	13	100	N/A
Youngest age of breeder source in chicks delivered	132	Age (weeks)	35	36	25	56	N/A
Oldest age of breeder source in chicks delivered	132	Age (weeks)	45	45	30	64	N/A
Imported chicks, proportion placed to barn sampled	22	Birds (%)	74	62	5	100	N/A
Youngest age of breeder source in chicks delivered	21	Age (weeks)	35	36	25	56	N/A
Oldest age of breeder source in chicks delivered	21	Age (weeks)	45	44	28	63	N/A
Hatchery sources of chicks sampled	143	Establishment (n)	N/A	N/A	N/A	N/A	19
Age of broilers at pre-harvest sampling day	141	Days (n)	34	34	22	49	N/A
Weight of broilers at pre-harvest sampling day	141	kg	1.95	2.00	1.20	3.50	N/A
Stocking density	141	Chicks placed/sq ft	0.80	0.85	0.49	2.53	N/A
Quota Period[c]	141	n	N/A	N/A	N/A	N/A	8
Downtime[d]	141	Days (n)	16	17	2	60	NA

N/A = not applicable.

[a] Total capacity of the 141 farms sampled at pre-harvest in the 2014 sampling year. Estimated number of birds grown in the 143 participating farms in 2014 sampling year in approximately 8 quota periods (A-121 to A-128) is equivalent to 7% of national production (765,0915 x 6 cycle/640,630,200 heads) .

[b] Two cohort flocks not sampled at pre-harvest were excluded.

[c] Quota period is an 8-week production period (A-121 to A-128) in the Chicken Farmers of Canada's allocation calendar.

[d] In the poultry industry, this pertains to a period of time between flocks, starting with a barn being emptied of birds and ending with the placement of chicks. It allows for the natural reduction in number of diseases causing micro-organisms within the barn (i.e., carry-over from previous flock)[18].

[18] Chicken Farmers of Canada, On-farm Food Safety Program. Available at: www.chickenfarmers.ca/wp-content/uploads/2014/07/OFFSAP-Manual-2014.pdf. Accessed 28 January 2016.

Table 7.8. Summary of broiler production and operational factors, 2013–2014

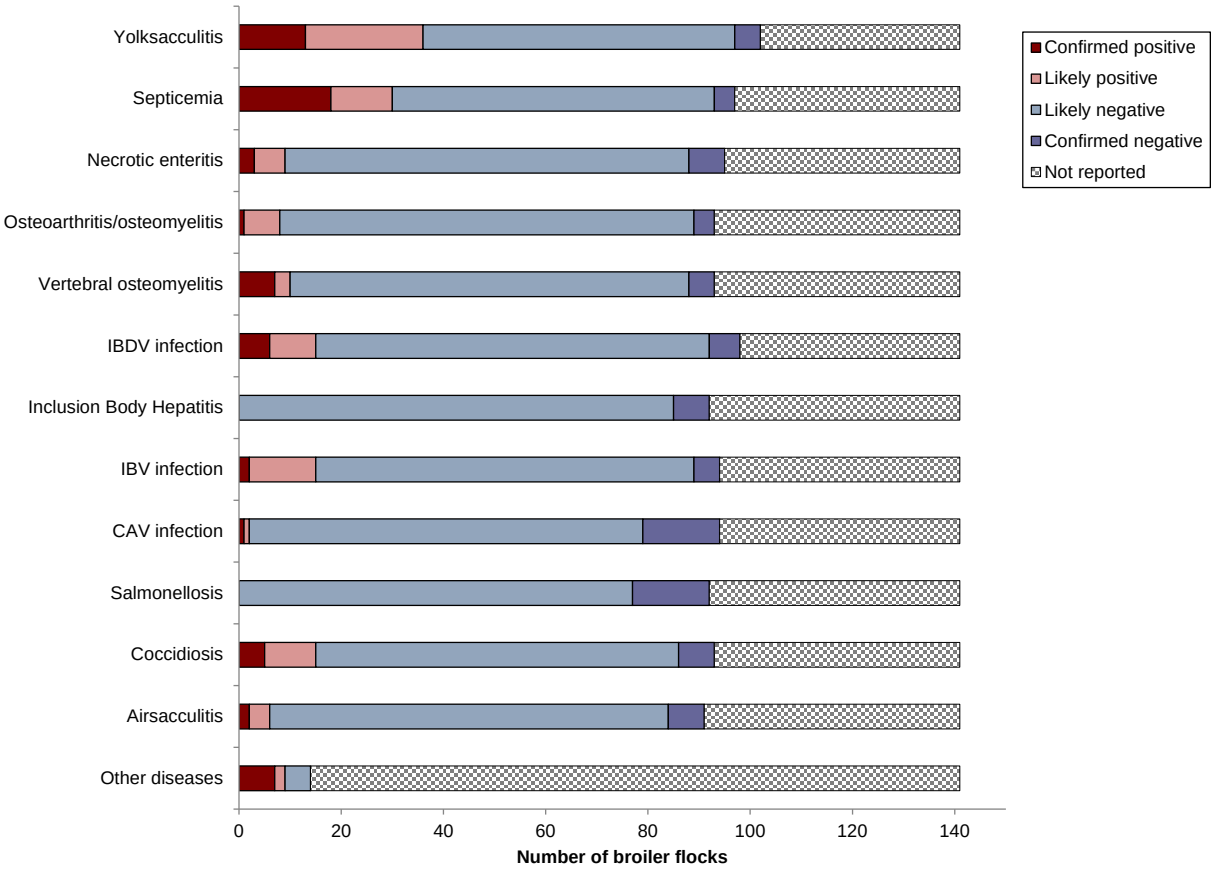
Operational factors	Units	Year	
		2013	2014
Farm operation, general			
All-in-all-out	Farms (n)	82	116
Multi-barn facilities	Farms (n)	16	22
Multispecies/commodity	Farms (n)	1	1
Production type			
Antimicrobial-free or raised without antibiotics[a]	Flocks (n)	5	12
Conventional	Flocks (n)	93	126
Organic[b]	Flocks (n)	1	1
Others (conventional but no antimicrobial used)	Flocks (n)	0	2
Strains			
Ross x Ross			
Ross 308	Flocks (n)	63	88
Ross 708	Flocks (n)	17	24
Unspecified or unknown	Flocks (n)	9	9
Cobb x Cobb			
Cobb 500	Flocks (n)	4	28
Cobb 700	Flocks (n)	1	1
Unspecified or unknown	Flocks (n)	8	13
Other strains			
Hubbard	Flocks (n)	0	1
Hubbard and Cobb mixed flock	Flocks (n)	0	1

[a] Antimicrobial/antibiotic free (ABF) production in Canada is synonymous to "Raised Without Antibiotics" (RWA); an animal production claim. According to the Canadian Food Inspection Agency Manual of Procedures, product labelled as RWA or ABF "will be acceptable provided the animals were not administered any medication that could fall in the definition of an antibiotic or have the same purpose, for example, coccidiostats or monensin"[19]. Flocks in this category were not medicated with any antimicrobials including ionophores or chemical coccidiostats in any route of administration from incubation to pre-harvest stage.

[b] Also an animal production claim that requires mandatory certification to the revised National Organic Standard[19].

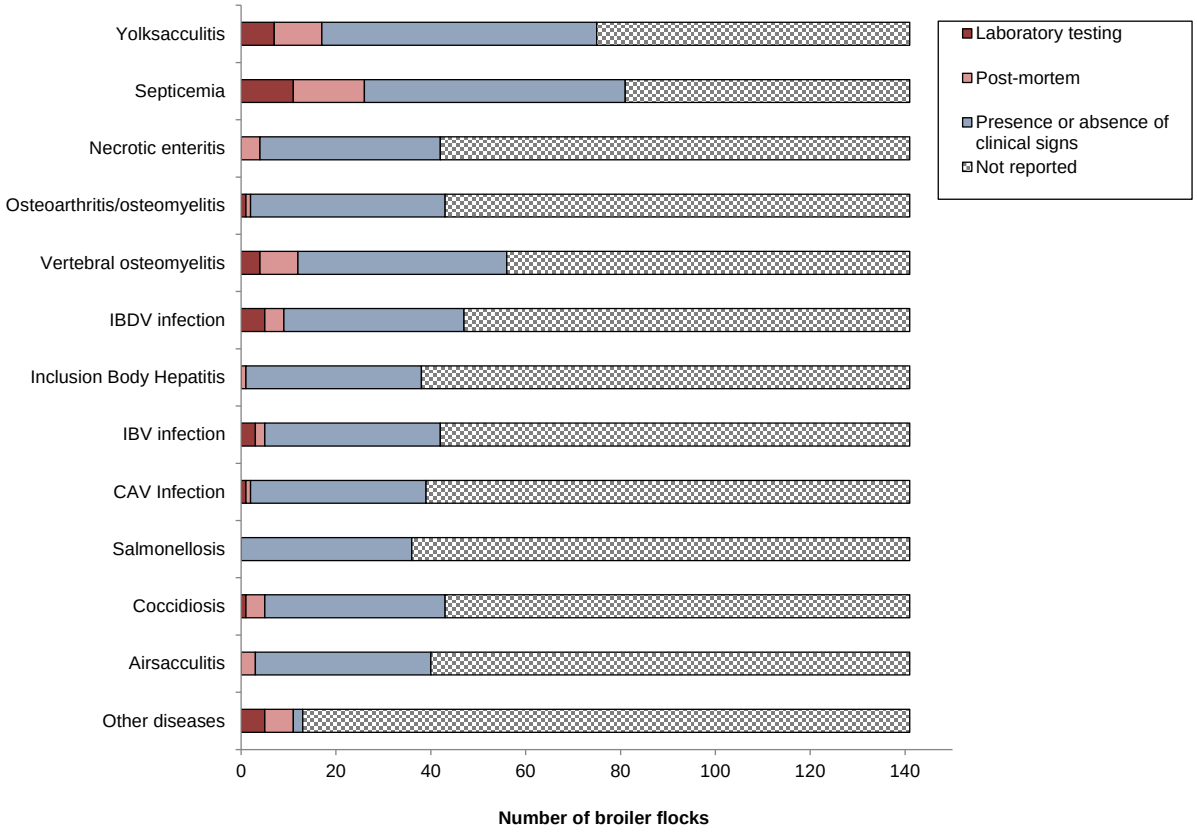
[19] Canadian Food Inspection Agency. Available from: http://www.inspection.gc.ca/food/meat-and-poultry-products/manual-of-procedures/chapter-7/eng/1367720000285/1367720106452?chap=7. Accessed January 2016.

Figure 7.18. Health status of broiler chicken flocks during the grow-out period, 2014



CAV = Chicken Anemia Virus.
IBDV = Infectious Bursal Disease Virus.
IBV = Infectious Bronchitis Virus.
Common disease agents implicated in bacterial diseases are: avian pathogenic *E. coli* (for yolk sacculitis and septicemia), *Clostridium perfringens* (necrotic enteritis), *Staphylococcus aureus* and/or *Streptococcus* spp. (for osteomyelitis/osteoarthritis), and *Enterococcus cecorum* (for vertebral osteomyelitis).
Other diseases include ascites due to sodium toxicity, bacterial hepatitis, mixed bacterial infections, other manifestations of *E. coli* (air sacculitis with synovitis complications), gangrenous dermatitis, and reovirus-like signs (tenosynovitis).
The respondents were instructed to select all applicable diseases and only one of "Confirmed positive", "Likely positive", "Likely negative", and "Confirmed negative".

Figure 7.19. Disease diagnostic tools to establish the health status of broiler flocks, 2014



CAV = Chicken Anemia Virus.
IBDV = Infectious Bursal Disease Virus.
IBV = Infectious Bronchitis Virus.
Common disease agents implicated in disease syndromes above are: avian pathogenic *E. coli* (for yolk sacculitis and septicemia), *Clostridium perfringens* (necrotic enteritis), *Staphylococcus aureus* and/or *Streptococcus* spp. (for osteomyelitis/osteoarthritis), and *Enterococcus cecorum* (for vertebral osteomyelitis).
Other diseases include ascites due to sodium toxicity, bacterial hepatitis (unknown etiology), mixed bacterial infections, other manifestations of *E. coli* (air sacculitis with synovitis complications), gangrenous dermatitis (Clostridium septicum), and Reovirus-like lesions (tenosynovitis)
The respondents were instructed to select all applicable tools to establish the health status of the broiler flocks. The total flocks reporting diagnostic tools (depicted in red, blue, and grey bars) are total number of responses and do not necessary indicate a disease-positive status.
Grey bars represent flocks that have no recorded disease diagnostic tool applied.

Table 7.9. Vaccination summary of broiler chicken flocks at the hatchery and after chick placement, 2014

Agent/disease	Vaccine strains	Number of flocks n (%)	Vaccination age Days, median (min. ; max.)
Hatchery-level applications[a]			
Coccidiosis	*Eimeria* spp. (broiler strains)	18 (13)	N/A
Infectious Bronchitis Virus	Massachusetts	124 (87)	N/A
	Massachusetts-Connecticut	0 (0)	N/A
Infectious Bursal Disease Virus (IBD)	Standard/classical	4 (3)	N/A
Marek's Disease Virus	HVT	72 (50)	N/A
Marek's Disease Virus-IBD	Vectored HVT, VP2 antigen	44 (31)	N/A
Escherichia coli	O78 strain	5 (4)	N/A
Farm applications[b]			
Coccidiosis	*Eimeria* spp. (broiler strains)	2 (1)	1 (1 ; 1)
Infectious Bronchitis Virus	Massachusetts	5 (4)	9 (1 ; 11)
	Massachusetts-Connecticut	8 (6)	10 (10 ; 18)
Infectious Bursal Disease Virus	Standard/classical	23 (16)	10 (1 ; 18)
Escherichia coli	O78 strain	2 (1)	4 (1 ; 7)

The respondents were instructed to select all applicable vaccines administered at the hatchery. If flocks were also vaccinated on-farm after placement, the respondents were instructed to indicate the age of the flock for each vaccine application.
N/A = not applicable; all hatchery level administrations were either at Day 18 of incubation or at the day of hatch (Day 1).

[a] Flocks (94%, 134/143) were vaccinated with one or more agent at the hatchery.
[b] Flocks (24%, 34/141) were vaccinated with one or more agent after placement on-farm.

Table 7.10. Biosecurity summary, 2014

	Response			All applicable subcategories	Proportion of farms[a]
	Unknown	No	Yes		
Access management					
Presence of livestock and poultry within a 1 km radius	0%	15%	85%	Broiler chickens	46%
				Broiler breeders	9%
				Hatchery	2%
				Layers	21%
				Turkeys	14%
				Cattle	43%
				Pigs	23%
				Other animals	13%
Presence of domestic and wild animals on-farm as observed at the time of visit	0%	53%	47%	Dogs	33%
				Cats	18%
				Horses	6%
				Other domestic/wild	12%
Recognizable biosecurity zone	0%	1%	99%		
Foot bath/foot dip	0%	79%	21%		
Personal protective equipment required for access to production areas	0%	6%	94%	Boots	93%
				Gloves	42%
				Coveralls or designated farm clothes	72%
				Other (hair net)	1%
Animal health management					
Downtime between flocks[b]	0%	0%	100%		
Operational management					
Daily dead bird collection/removal from production areas	0%	0%	100%		
Manure stored within farm premise	0%	50%	50%	Adjacent to barns	18%
				Designated storage within controlled access zone	21%
				Others (100 to 400 meters away from barn, field behind barn and other farm sites/same owner)	10%
Manure removal process				Removed from barn under nutrient management plan	32%
				On-farm composting	12%
				Spread on field (0.5 km from farm)	12%
				Spread on field (> 1 km away from farm)	35%
				Spread elsewhere by contracted services	40%
				Others (hauled away, sold, stock-piled elsewhere, mushroom farm use)	8%

[a] The respondents were instructed to select all applicable subcategories/specific type if the response was "Yes"; Total percentage (%) may not be 100% because of multiple options provided per biosecurity item.

[b] See Table 7.7 for downtime days observed.

Table 7.10. Biosecurity summary, 2014 (cont'd)

	Response			All applicable subcategories	Proportion of farms[a]
	Unknown	No	Yes		
Operational management (cont'd)					
Months of spread if spread on field	N/A	N/A	N/A	January	5%
				February	6%
				March	6%
				April	25%
				May	29%
				June	12%
				July	11%
				August	13%
				September	18%
				October	33%
				November	19%
				December	7%
Integrated pest control program	0%	1%	99%	Rodents	97%
				Beetles	80%
				Wild birds	53%
				Flies	43%
				Others (wildlife control)	1%
Premise cleaning and washing for the cycle	0%	5%	95%	Dry clean only	38%
				Dry clean and washed	22%
				Washed	16%
				Washed, hot water	24%
				Other	4%
Premise disinfection	1%	26%	74%	Quaternary ammonium compounds	20%
				Aldehydes	11%
				Phenol	4%
				Chlorine-based	18%
				Others (combination, various ingredients)	26%
Water source	N/A	N/A	N/A	Municipal	26%
				Well water	71%
				Ponds, other surface waters (dug-out, rain water collected in cisterns)	6%
Analyse régulière de l'eau	0%	1%	99%	Monthly	4%
				Yearly	86%
				Other (quarterly, 2-3 times a year)	10%
Water treatment between flocks	1%	18%	81%	Chlorine-based	28%
				Hydrogen peroxide	40%
				Water acidifiers	21%
				Iodine	1%
				Others (reverse osmosis, ultraviolet, disinfectants)	10%
Water treatment during the grow-out period	1%	21%	78%	Chlorine-based	52%
				Hydrogen peroxide	16%
				Water acidifiers	31%
				Iodine	0%
				Others (surface water treatment/mud reduction, phosphoric acids, reverse osmosis system, ultraviolet)	10%

N/A = not applicable.

[a] The respondents were instructed to select all applicable subcategories/specific type if the response was "Yes". Total percentage (%) may not be 100% because of multiple options provided per biosecurity item.

8. FARM SURVEILLANCE—GROWER-FINISHER PIGS

KEY FINDINGS

- Ninety-five grower-finisher pig herds participated in *Farm Surveillance* in 2014.
- Most of the participating herds reported using antimicrobials in feed (78 herds, 82%) and by injection (59 herds, 62%). Twenty-seven herds (28%) reported using antimicrobials in water and 9 herds (9%) reported no use of antimicrobials by any route of administration.
- The most commonly reported antimicrobials used were penicillin G (56 herds, 59%) mostly by injection, lincomycin (38 herds, 40%) mainly in feed, tylosin (34 herds, 36%) mainly in feed, and chlortetracycline (30 herds, 32%) all in feed.
- At a national level, no significant differences where noted in the antimicrobials used in feed or their relative use frequencies between 2009 and 2014.
- Most feed antimicrobial use in the Prairies and Québec was for growth promotion and disease prevention purposes but in Ontario, most feed use was only for disease prevention purposes. In all regions, fewest herds used in-feed antimicrobials for disease treatment.
- In 2014, 13% of herds reported using florfenicol by injection; this is a significant increase since 2009 when just 1% of herds reported using florfenicol.
- Disease pressures on grower-finisher farms were significantly different between regions
- Overall herd size was bigger, farm density lower and source of pigs was different on the Prairies than in Ontario or Québec.

ADMINISTRATION IN FEED

- There were no significant changes in the number of herds reporting the use of specified antimicrobials in feed in 2014.
- Since 2009, there has been an increasing trend in the number of herds reporting the use of salinomycin and tiamulin in feed.
- In 2014, there was no significant change in the number of herds reporting that no antimicrobials were used in feed.

ADMINISTRATION IN WATER

- More grower-finisher herds in the Prairies (88%, 38/43) did not use antimicrobials in water than in Québec (42%, 11/26) (Figure 8.14).

ADMINISTRATION BY INJECTION

- When antimicrobials were used by injection in 2014, the greatest proportion of the herd exposed was 25% and in most situations less than 5% of the herd was exposed (Table 8.7)
- More penicillin was used by injection to treat respiratory disease and lameness than enteric disease (Figure 8.16)
- Most florfenicol use was reported by herds in Ontario and Québec (Figure 8.17).

SUMMARY OF ANTIMICROBIAL USE BY ROUTE OF ADMINISTRATION

Table 8.1. Number of pig herds with reported use by route of administration, 2014

Antimicrobial use	Route of Administration			
	Any Route[a] n (%)	Feed n (%)	Water n (%)	Injection n (%)
Any antimicrobial use	86 (91)	78 (82)	27 (28)	59 (62)
No antimicrobial use	9 (9)	17 (18)	68 (72)	36 (38)
Total Herds	**95 (100)**	**95 (100)**	**95 (100)**	**95 (100)**

[a] Herds with reported use of an antimicrobial class by feed, water, injection, or any combination of these routes are included in each count.

Table 8.2. Number of pig herds (n = 95) with reported use of specific antimicrobial by route of administration, 2014

	Antimicrobial class	Antimicrobial	Route of Administration			
			Any Route[a] n (%)	Feed n (%)	Water n (%)	Injection n (%)
I	Extended-spectrum cephalosporins	Ceftiofur	18 (19)	0 (0)	0 (0)	18 (19)
II	Aminoglycosides	Streptomycin	9 (9)	0 (0)	9 (9)	0 (0)
	Lincosamides	Lincomycin	38 (40)	35 (37)	1 (1)	4 (4)
	Macrolides	Erythromycin	0 (0)	0 (0)	0 (0)	0 (0)
		Tulathromycin	13 (14)	0 (0)	0 (0)	13 (14)
		Tilmicosin	3 (3)	3 (3)	0 (0)	0 (0)
		Tylosin	34 (36)	32 (34)	0 (0)	5 (5)
		Tyvalosin	3 (3)	3 (3)	0 (0)	0 (0)
	Penicillins	Ampicillin	3 (3)	0 (0)	0 (0)	3 (3)
		Penicillin G	56 (59)	9 (9)	18 (19)	42 (44)
	Streptogramins	Virginiamycin	2 (2)	2 (2)	0 (0)	0 (0)
	Potentiated sufonamides	Trimethoprim-sulfadoxine	12 (13)	0 (0)	6 (6)	7 (7)
III	Aminocyclotols	Spectinomycin	1 (1)	1 (1)	0 (0)	0 (0)
	Aminoglycosides	Neomycin	5 (5)	0 (0)	5 (5)	0 (0)
	Bacitracins	Bacitracin	0 (0)	0 (0)	0 (0)	0 (0)
	Phenicols	Florfenicol	12 (13)	0 (0)	0 (0)	12 (13)
	Pleuromutilins[b]	Tiamulin	8 (8)	8 (8)	0 (0)	0 (0)
	Sulfonamides	Sulfonamide (unspecified)	6 (6)	4 (4)	2 (2)	0 (0)
	Tetracyclines	Chlortetracycline	30 (32)	30 (32)	0 (0)	0 (0)
		Oxytetracycline	10 (11)	1 (1)	0 (0)	9 (9)
		Tetracycline hydrochloride	2 (2)	0 (0)	2 (2)	0 (0)
IV	Flavophospholipids	Bambermycin	2 (2)	2 (2)	0 (0)	0 (0)
	Ionophores	Salinomycin	22 (23)	22 (23)	0 (0)	0 (0)

Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

[a] Herds with reported use of an antimicrobial class by feed, water, injection, or any combination of these routes are included in each count.

[b] Pleuromutilins are not officially categorized in the current Health Canada Classification System. However, according to the criteria provided by Health Canada, pleuromutilins meet the criteria for Category III.

ANTIMICROBIAL USE IN FEED

Table 8.3. Summary of antimicrobial use in feed, 2014

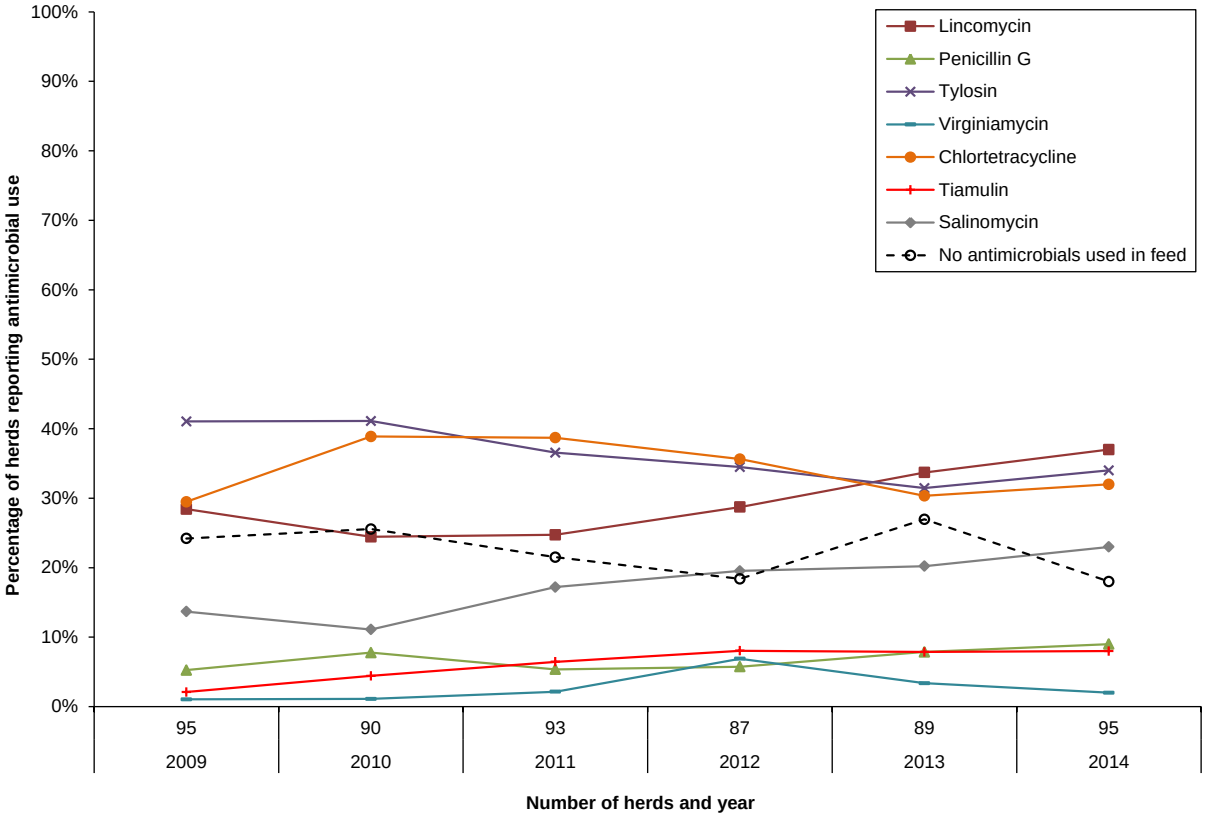
	Antimicrobial	Herds (n = 95) N (%)	Rations (n = 455) N (%)	Days exposed median (min. ; max.)	% Herd exposed median (min. ; max.)	Drug level in feed grams/tonne median (min. ; max.)	Antimicrobial consumption[a] grams/1000 pig-days median (min. ; max.)	Adjusted antimicrobial consumption[a] Total milligrams adjusted for pig population and weight
II	Lincomycin	35 (37)	72 (16)	25 (3 ; 56)	100 (29 ; 100)	44 (22 ; 550)	114 (32 ; 1265)	146
	Penicillin	9 (9)	12 (3)	19 (3 ; 35)	100 (33 ; 100)	105 (55 ; 134)	160 (82 ; 219)	13
	Tilmicosin	3 (3)	3 (1)	14 (14 ; 14)	100 (100 ; 100)	200 (200 ; 200)	489 (472 ; 512)	11
	Tylosin	32 (34)	85 (19)	28 (1 ; 70)	100 (25 ; 100)	33 (11 ; 110)	61 (26 ; 297)	210
	Tylvalosin	3 (3)	3 (1)	7 (7 ; 21)	100 (100 ; 100)	43 (43 ; 43)	107 (103 ; 112)	1
	Virginiamycin	2 (2)	4 (1)	35 (28 ; 60)	99 (94 ; 100)	22 (11 ; 22)	48 (31 ; 60)	5
III	Chlortetracycline	30 (32)	40 (9)	14 (3 ; 42)	100 (15 ; 100)	550 (51 ; 1100)	715 (65 ; 1604)	414
	Oxytetracylcine	1 (1)	1 (0)	10 (10 ; 10)	100 (100 ; 100)	550 (550 ; 550)	704 (704 ; 704)	31
	Spectinomycin	1 (1)	2 (0)	28 (28 ; 28)	100 (100 ; 100)	22 (22 ; 22)	37 (32 ; 43)	1
	Sulfamethazine	4 (4)	5 (1)	6 (3 ; 35)	100 (33 ; 100)	110 (110 ; 220)	175 (163 ; 373)	10
	Tiamulin	8 (8)	9 (2)	18 (7 ; 42)	100 (100 ; 100)	70 (31 ; 176)	86 (41 ; 297)	14
IV	Bambermycin	2 (2)	4 (1)	32 (28 ; 56)	100 (100 ; 100)	251 (2 ; 500)	610 (5 ; 1402)	17
	Salinomycin	22 (23)	62 (14)	28 (14 ; 56)	100 (2 ; 100)	25 (24 ; 60)	61 (35 ; 105)	86
Unmedicated rations		59 (62)	153 (34)	28 (1 ; 168)	100 (33 ; 100)	N/A	N/A	N/A

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
N/A: not applicable.
ESVAC: European Surveillance of Veterinary Antimicrobial Consumption.
Level of drug: grams of active ingredient per tonne of feed.
Adjusted antimicrobial consumption: Estimated quantity of antimicrobials (mg) consumed through feed/(Total number of pigs in the sampled grow-finish period x ESVAC standard weight of 65 kg).

[a] Median antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[20], adjusted for herd average daily gain; only rations medicated with the specified antimicrobial were included in the analysis for each antimicrobial.

[20] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

Figure 8.1. Percentage of pig herds reporting antimicrobial use in feed, 2009–2014



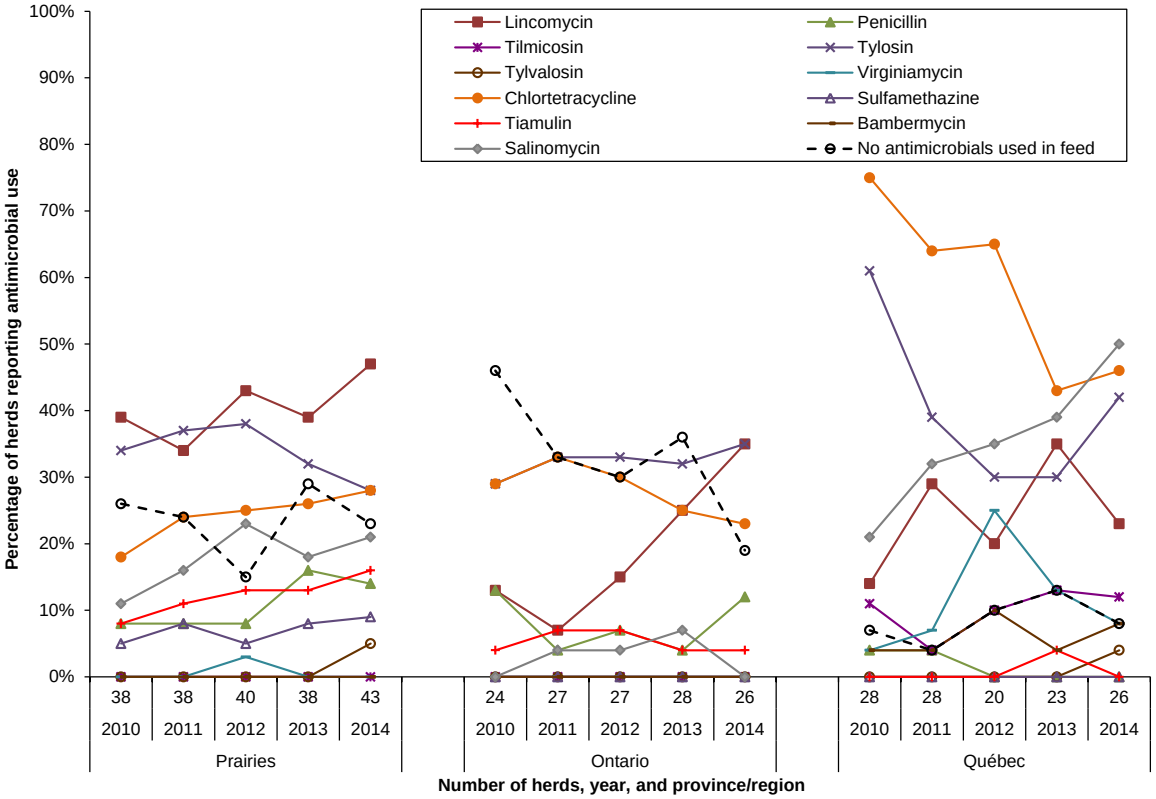
Year Number of herds	2009 95	2010 90	2011 93	2012 87	2013 89	2014 95
Antimicrobial						
Lincomycin	**28%**	24%	25%	29%	**34%**	**37%**
II Penicillin	**5%**	8%	5%	6%	**8%**	**9%**
II Tylosin	**41%**	41%	37%	34%	**31%**	**34%**
II Virginiamycin	**1%**	2%	2%	7%	**3%**	**2%**
III Chlortetracycline	**29%**	39%	39%	36%	**30%**	**32%**
III Tiamulin	**2%**	4%	6%	8%	**8%**	**8%**
IV Salinomycin	**14%**	12%	17%	20%	**20%**	**23%**
No antimicrobials used in feed	**24%**	24%	22%	18%	**27%**	**18%**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in feed reported by fewer than 5% of herds included: tilmicosin (Category II); bacitracin, neomycin, oxytetracycline, spectinomycin, and sulfamethazine (Category III); bambermycin (Category IV).

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2009 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 8.2. Percentage of pig herds reporting antimicrobial use in feed by province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of herds		38	38	40	38	43	24	27	27	28	26	28	28	20	23	26
Antimicrobial																
II	Lincomycin	**39%**	34%	43%	**39%**	**47%**	**13%**	7%	15%	**25%**	**35%**	**14%**	29%	20%	**35%**	**23%**
	Penicillin	**8%**	8%	8%	**16%**	**14%**	**13%**	4%	7%	**4%**	**12%**	**4%**	4%	0%	**0%**	**0%**
	Tilmicosin	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**11%**	4%	10%	**13%**	**12%**
	Tylosin	**34%**	37%	38%	**32%**	**28%**	**29%**	33%	33%	**32%**	**35%**	**61%**	39%	30%	**30%**	**42%**
	Tylvalosin	**0%**	0%	0%	**0%**	**5%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**4%**
	Virginiamycin	**0%**	0%	3%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**4%**	7%	25%	**13%**	**8%**
III	Chlortetracycline	**18%**	24%	25%	**26%**	**28%**	**29%**	33%	30%	**25%**	**23%**	**75%**	64%	65%	**43%**	**46%**
	Sulfamethazine	**5%**	8%	5%	**8%**	**9%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
	Tiamulin	**8%**	11%	13%	**13%**	**16%**	**4%**	7%	7%	**4%**	**4%**	**0%**	0%	0%	**4%**	**0%**
IV	Bambermycin	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**4%**	4%	10%	**4%**	**8%**
	Salinomycin	**11%**	16%	23%	**18%**	**21%**	**0%**	4%	4%	**7%**	**0%**	**21%**	32%	35%	**39%**	**50%**
	No antimicrobials used in feed	**26%**	24%	15%	**29%**	**23%**	**46%**	33%	30%	**36%**	**19%**	**7%**	4%	10%	**13%**	**8%**

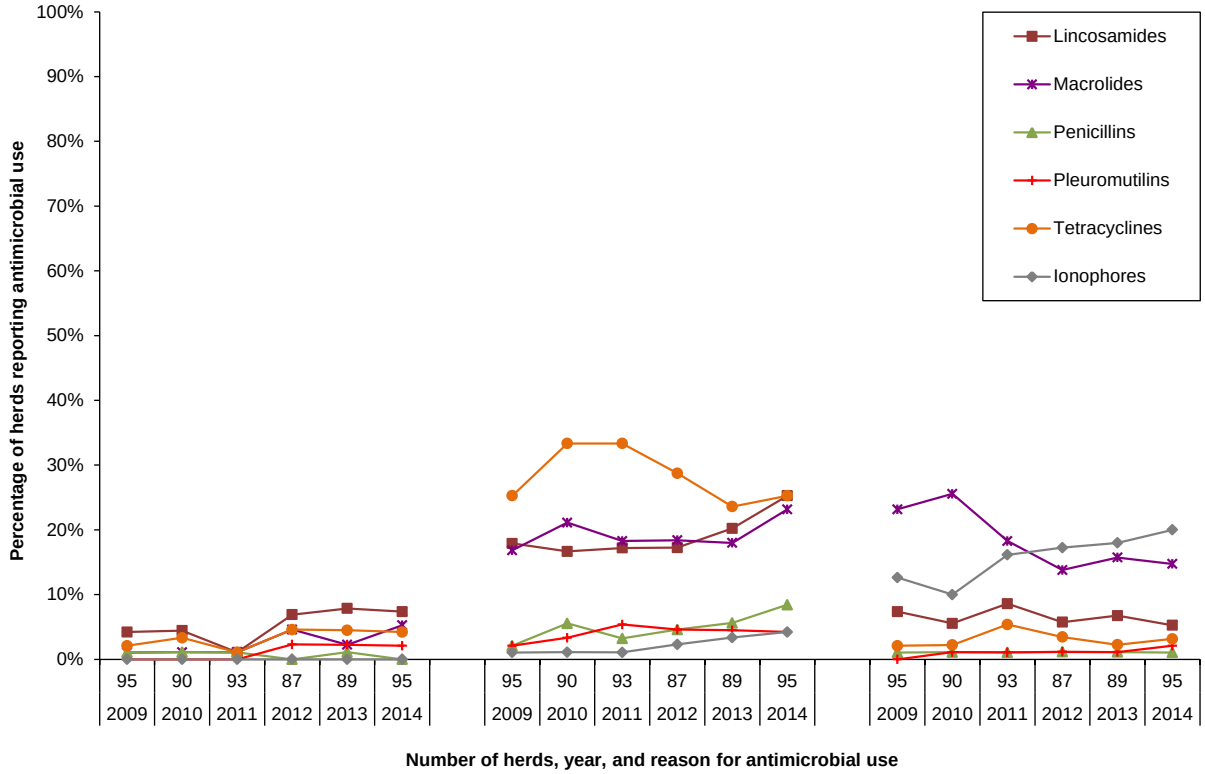
Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Only antimicrobials used by 5% of herds or more in a given year within any province/region are depicted in this figure. Antimicrobial use in feed reported by fewer than 5% of herds included: bacitracin, neomycin, oxytetracycline, and spectinomycin (Category III).

For the temporal analyses within province/region, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2010 and the previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences within province/region ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.3. Percentage of pig herds reporting antimicrobial use in feed by primary reasons, 2009–2014



Reason for use		Disease treatment						Disease prevention						Growth promotion					
Year		2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Number of herds		95	90	93	87	89	95	95	90	93	87	89	95	95	90	93	87	89	95
Antimicrobial class																			
II	Lincosamides	**4%**	4%	1%	7%	**8%**	**7%**	**18%**	17%	17%	17%	**20%**	**25%**	**7%**	6%	9%	6%	**7%**	**5%**
II	Macrolides	**1%**	1%	1%	5%	**2%**	**5%**	**17%**	21%	18%	18%	**18%**	**23%**	**23%**	26%	18%	14%	**16%**	**15%**
II	Penicillins	**1%**	1%	1%	0%	**1%**	**0%**	**2%**	6%	3%	5%	**6%**	**8%**	**1%**	1%	1%	1%	**1%**	**1%**
III	Pleuromutilins	**0%**	0%	0%	2%	**2%**	**2%**	**2%**	3%	5%	5%	**4%**	**4%**	**0%**	1%	1%	1%	**1%**	**2%**
III	Tetracyclines	**2%**	3%	1%	5%	**4%**	**4%**	**25%**	33%	33%	29%	**24%**	**25%**	**2%**	2%	5%	3%	**2%**	**3%**
IV	Ionophores	**0%**	0%	0%	0%	**0%**	**0%**	**1%**	1%	1%	2%	**3%**	**4%**	**13%**	10%	16%	17%	**18%**	**20%**

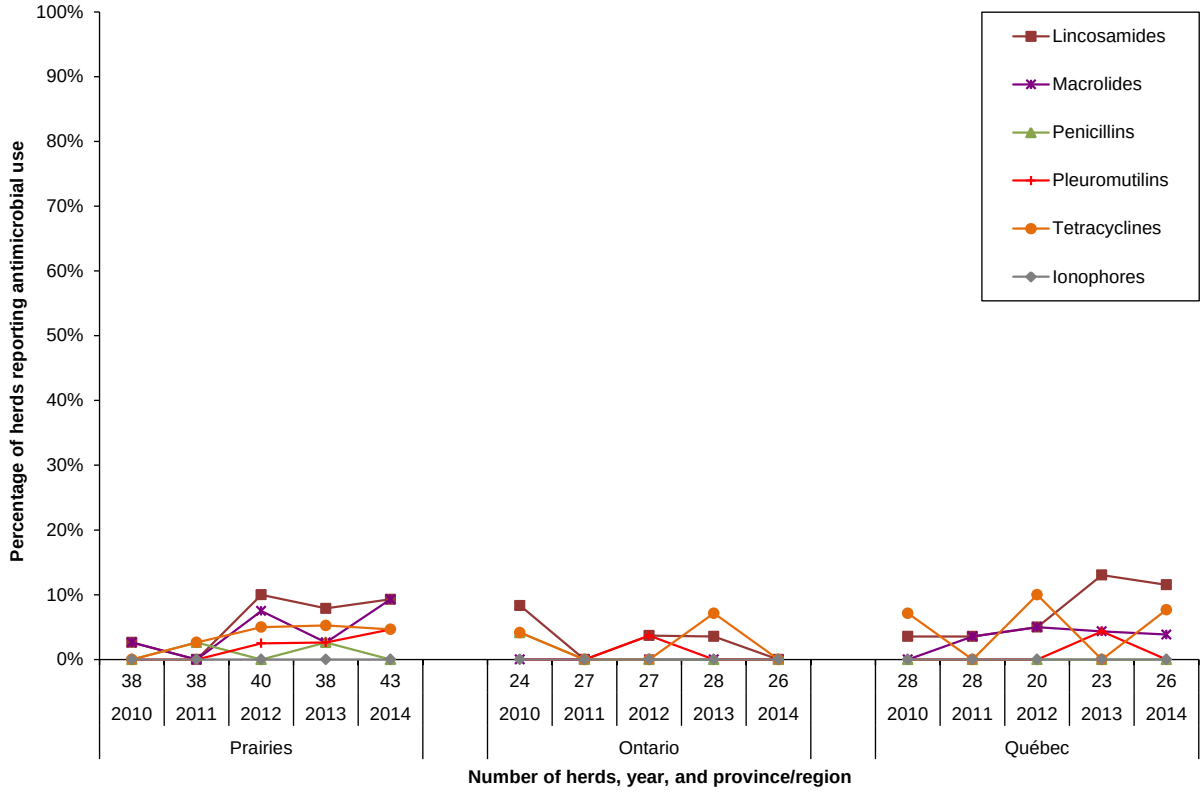
Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2009 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

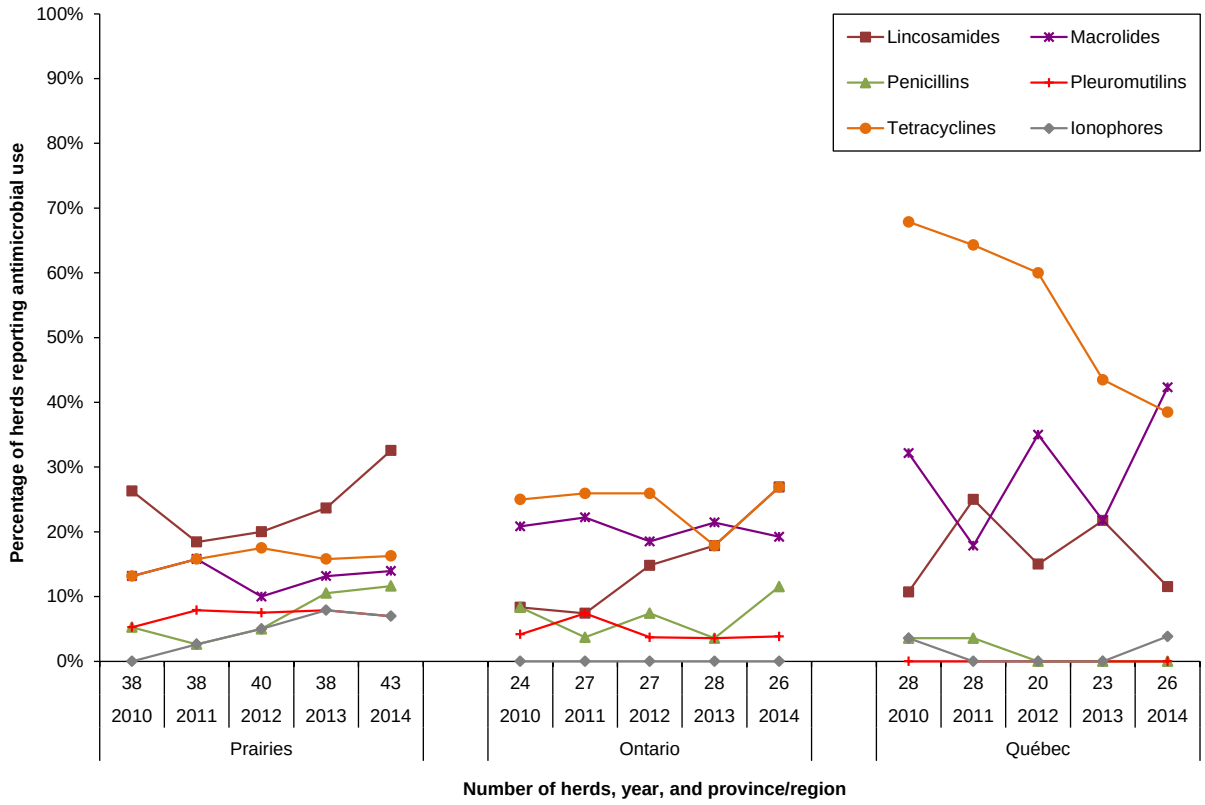
Figure 8.4. Percentage of pig herds reporting antimicrobial use in feed for *Disease treatment* by province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of herds		38	38	40	38	43	24	27	27	28	26	28	28	20	23	26
Antimicrobial class																
II	Lincosamides	**3%**	0%	10%	**8%**	**9%**	**8%**	0%	4%	**4%**	**0%**	**4%**	4%	5%	**13%**	**12%**
II	Macrolides	**3%**	0%	8%	**3%**	**9%**	**0%**	0%	0%	**0%**	**0%**	**0%**	4%	5%	**4%**	**4%**
II	Penicillins	**0%**	3%	0%	**3%**	**0%**	**4%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
III	Pleuromutilins	**0%**	0%	3%	**3%**	**5%**	**0%**	0%	4%	**0%**	**0%**	**0%**	0%	0%	**4%**	**0%**
III	Tetracyclines	**0%**	3%	5%	**5%**	**5%**	**4%**	0%	0%	**7%**	**0%**	**7%**	0%	10%	**0%**	**8%**
IV	Ionophores	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.
For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2010 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

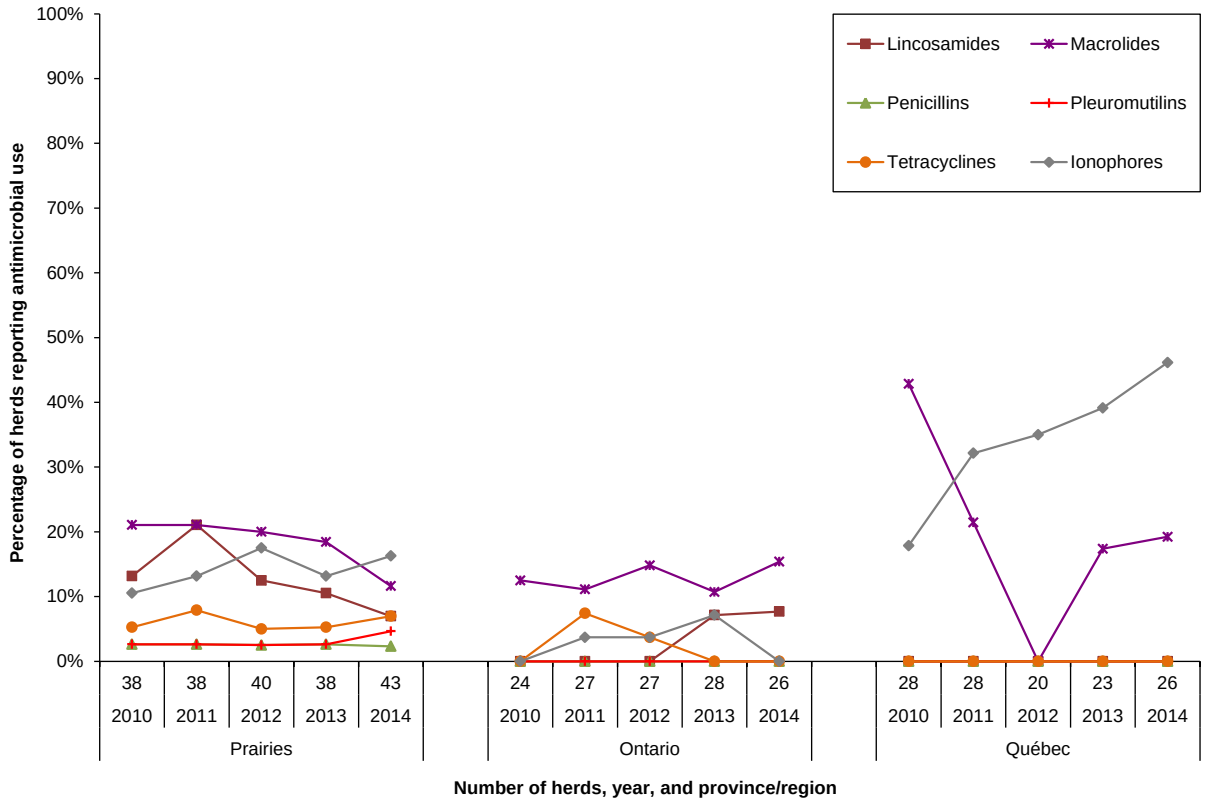
Figure 8.5. Percentage of pig herds reporting antimicrobial use in feed for *Disease prevention* by province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of herds		38	38	40	38	43	24	27	27	28	26	28	28	20	23	26
Antimicrobial class																
II	Lincosamides	**26%**	18%	20%	**24%**	**33%**	**8%**	7%	15%	**18%**	**27%**	**11%**	25%	15%	**22%**	**12%**
II	Macrolides	**13%**	16%	10%	**13%**	**14%**	**21%**	22%	19%	**21%**	**19%**	**32%**	18%	35%	**22%**	**42%**
II	Penicillins	**5%**	3%	5%	**11%**	**12%**	**8%**	4%	7%	**4%**	**12%**	**4%**	4%	0%	**0%**	**0%**
III	Pleuromutilins	**5%**	8%	8%	**8%**	**7%**	**4%**	7%	4%	**4%**	**4%**	**0%**	0%	0%	**0%**	**0%**
III	Tetracyclines	**13%**	16%	18%	**16%**	**16%**	**25%**	26%	26%	**18%**	**27%**	**68%**	64%	60%	**43%**	**38%**
IV	Ionophores	**0%**	3%	5%	**8%**	**7%**	**0%**	0%	0%	**0%**	**0%**	**4%**	0%	0%	**0%**	**4%**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.
For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2010 and the previous surveillance year (grey areas). The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial. The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

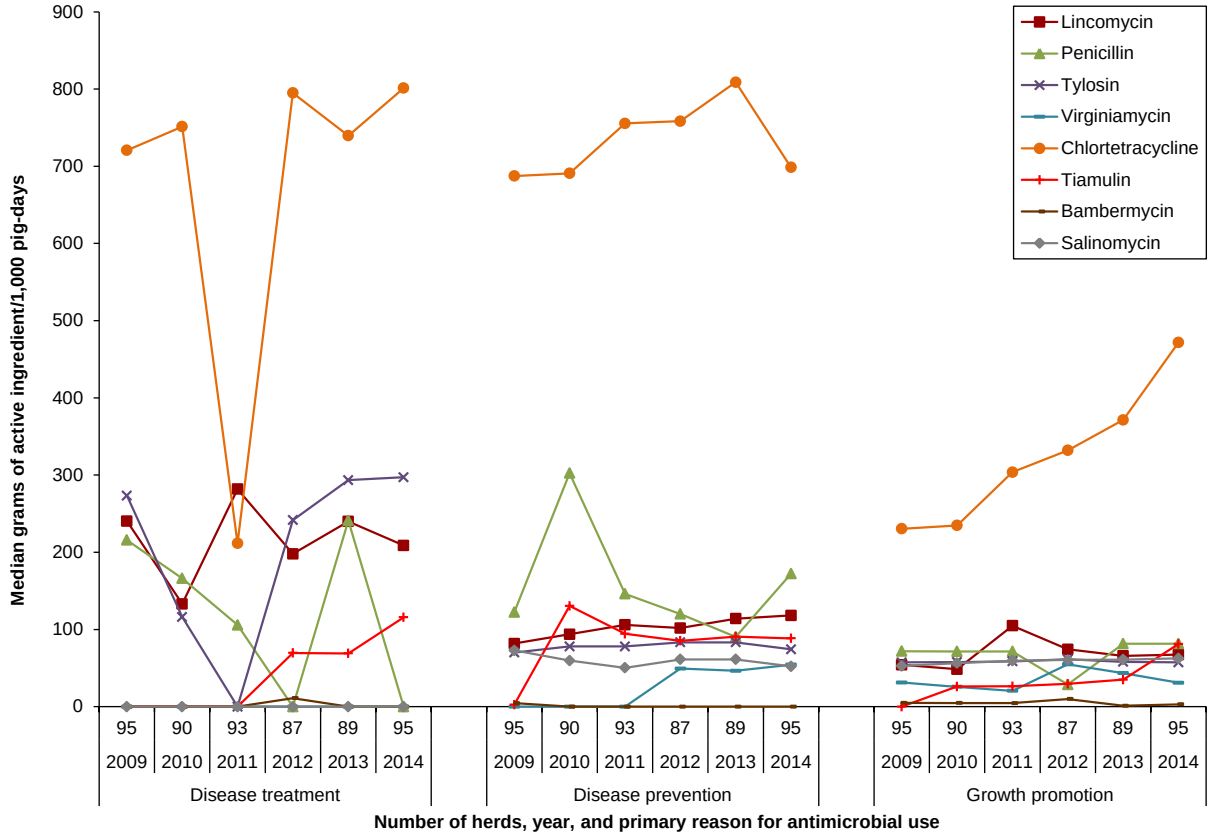
Figure 8.6. Percentage of pig herds reporting antimicrobial use in feed for *Growth promotion* by province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of herds		38	38	40	38	43	24	27	27	28	26	28	28	20	23	26
Antimicrobial class																
II	Lincosamides	**13%**	21%	13%	**11%**	**7%**	**0%**	0%	0%	**7%**	**8%**	**0%**	0%	0%	**0%**	**0%**
II	Macrolides	**21%**	21%	20%	**18%**	**12%**	**13%**	11%	15%	**11%**	**15%**	**43%**	21%	0%	**17%**	**19%**
II	Penicillins	**3%**	3%	3%	**3%**	**2%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
III	Pleuromutilins	**3%**	3%	3%	**3%**	**5%**	**0%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
III	Tetracyclines	**5%**	8%	5%	**5%**	**7%**	**0%**	7%	4%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**
IV	Ionophores	**11%**	13%	18%	**13%**	**16%**	**0%**	4%	4%	**7%**	**0%**	**18%**	32%	35%	**39%**	**46%**

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.
For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2010 and the previous surveillance year (grey areas). The presence of blue areas indicates significant temporal differences within province/region ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.7. Quantity of antimicrobials used in feed by reason for use, 2009–2014



Reason for use		Disease treatment						Disease prevention						Growth promotion					
Year		2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Number of herds		95	90	93	87	89	95	95	90	93	87	89	95	95	90	93	87	89	95
Antimicrobial		Median grams/1,000 pig-days[a] (number of rations medicated)																	
	Lincomycin	240 (9)	133 (5)	282 (2)	198 (10)	240 (11)	209 (9)	82 (35)	94 (34)	106 (31)	102 (26)	114 (31)	118 (50)	54 (28)	48 (15)	105 (18)	74 (15)	66 (14)	67 (13)
II	Penicillin	216 (1)	166 (1)	106 (1)	0	241 (1)	0 (0)	122 (2)	303 (6)	146 (4)	120 (4)	90 (4)	172 (11)	72 (1)	72 (1)	72 (1)	29 (1)	82 (1)	82 (1)
	Tylosin	273 (1)	116 (5)	0	242 (7)	293 (1)	297 (3)	70 (40)	78 (30)	78 (47)	83 (33)	83 (31)	74 (41)	57 (58)	58 (56)	59 (52)	61 (39)	58 (37)	57 (43)
	Virginiamycin	0	0	0	0	0	0 (0)	0	0	0	49 (3)	47 (2)	54 (3)	31 (1)	26 (2)	21 (5)	55 (8)	43 (5)	31 (1)
III	Chlortetracycline	721 (2)	751 (3)	212 (1)	795 (4)	740 (5)	801 (7)	687 (24)	691 (32)	756 (36)	758 (30)	809 (27)	699 (29)	230 (2)	235 (2)	304 (5)	332 (3)	372 (3)	472 (4)
	Tiamulin	0	0	0	70 (3)	69 (3)	116 (2)	3 (2)	131 (4)	94 (5)	85 (4)	91 (4)	88 (4)	0	26 (1)	26 (1)	30 (1)	35 (2)	81 (3)
IV	Bambermycin	0	0	0	11 (1)	0	0 (0)	5 (2)	0	0	0	0	0 (0)	5 (7)	5 (2)	5 (2)	10 (1)	1 (2)	3 (4)
	Salinomycin	0	0	0	0	0	0 (0)	73 (1)	60 (1)	50 (4)	61 (7)	61 (7)	52 (12)	53 (33)	56 (26)	60 (50)	61 (49)	61 (54)	63 (51)

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

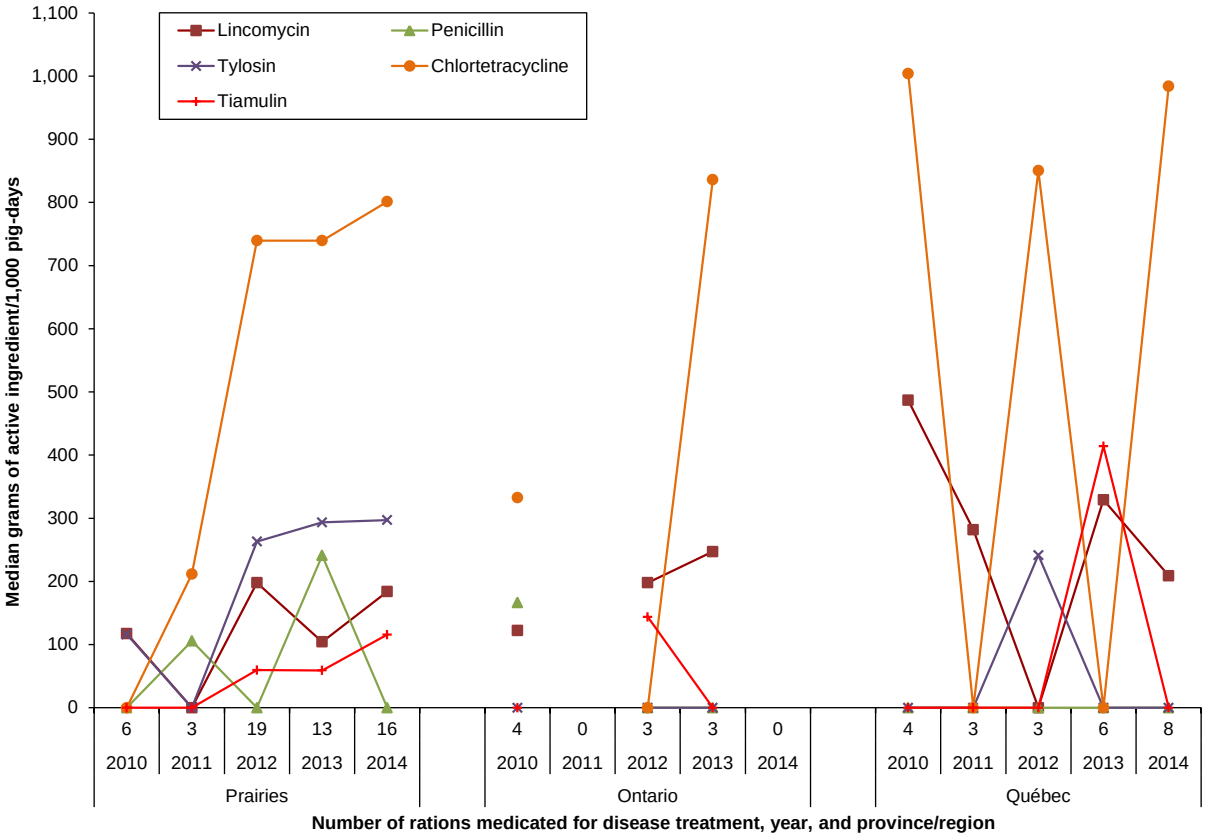
Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.

[a] Median antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[21], adjusted for herd average daily gain; only rations medicated with the specified antimicrobial were included in the analysis for each antimicrobial.

[21] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

Figure 8.8. Quantity of antimicrobial used in feed (rations) for *Disease treatment* by province/region, 2010–2014



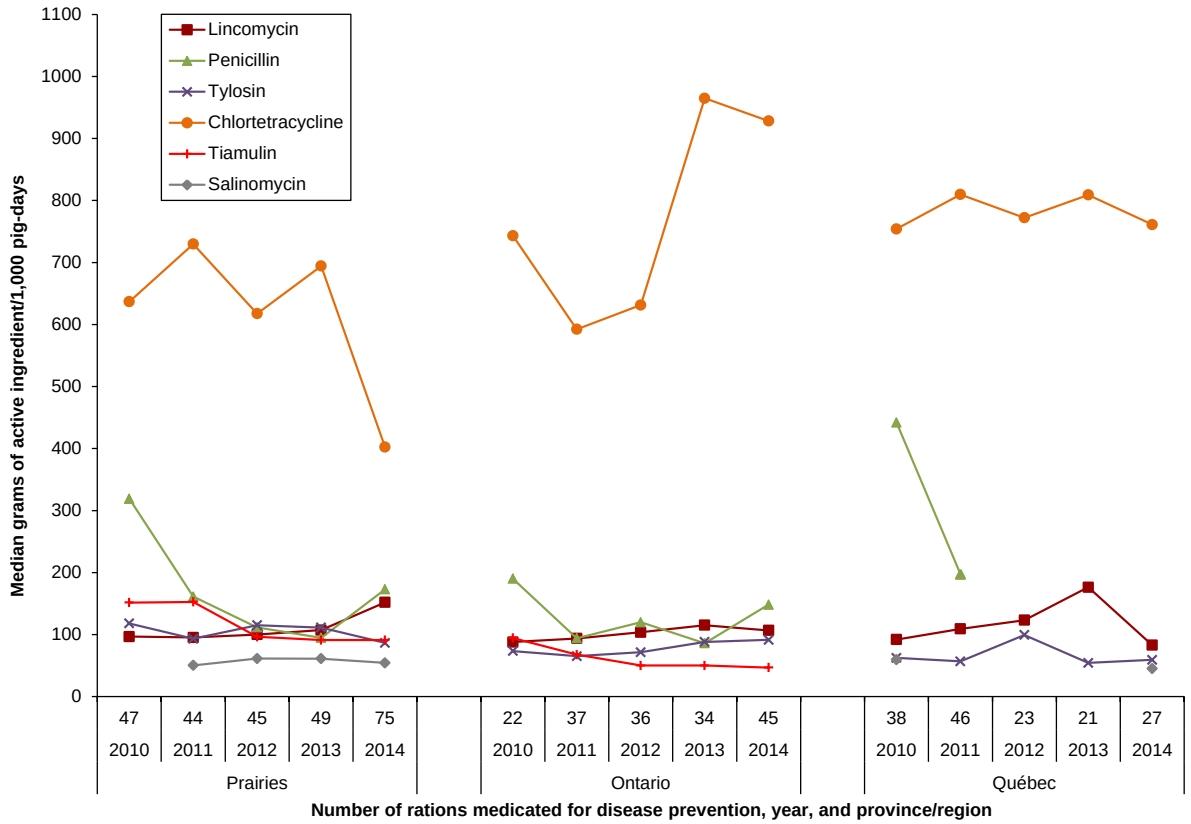
Province/region	Prairies					Ontario					Québec				
Year	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of rations	6	3	19	13	16	4	0	3	3	0	4	3	3	6	8
Antimicrobial	**Median grams/1,000 pig-days[a]**														
II Lincomycin	118	0	198	104	184	122	0	198	247	0	487	282	0	329	209
II Penicillin	0	106	0	241	0	166	0	0	0	0	0	0	0	0	0
II Tylosin	116	0	263	293	297	0	0	0	0	0	0	0	242	0	0
III Chlortetracycline	0	212	740	740	801	333	0	0	836	0	1,004	0	850	0	984
III Tiamulin	0	0	60	59	116	0	0	144	0	0	0	0	0	414	0

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

[a] Median antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[22], adjusted for herd average daily gain; only rations medicated with the specified antimicrobial were included in the analysis for each antimicrobial.

[22] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

Figure 8.9. Quantity of antimicrobial used in feed (rations) for *Disease prevention* by province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of rations		47	44	45	49	75	22	37	36	34	45	38	46	23	21	27
Antimicrobial		**Median grams/1000 pig-days[a]**														
II	Lincomycin	97	95	100	107	152	88	94	104	115	107	92	109	123	176	83
II	Penicillin	319	161	112	95	173	190	94	120	86	148	442	197	0	0	0
II	Tylosin	118	93	115	111	87	74	65	71	88	92	62	57	99	54	59
III	Chlortetracycline	637	730	618	694	402	743	592	631	965	928	754	810	772	809	761
III	Tiamulin	152	153	96	91	91	94	68	50	50	47	0	0	0	0	0
IV	Salinomycin	0	50	61	61	54	0	0	0	0	0	60	0	0	0	45

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.

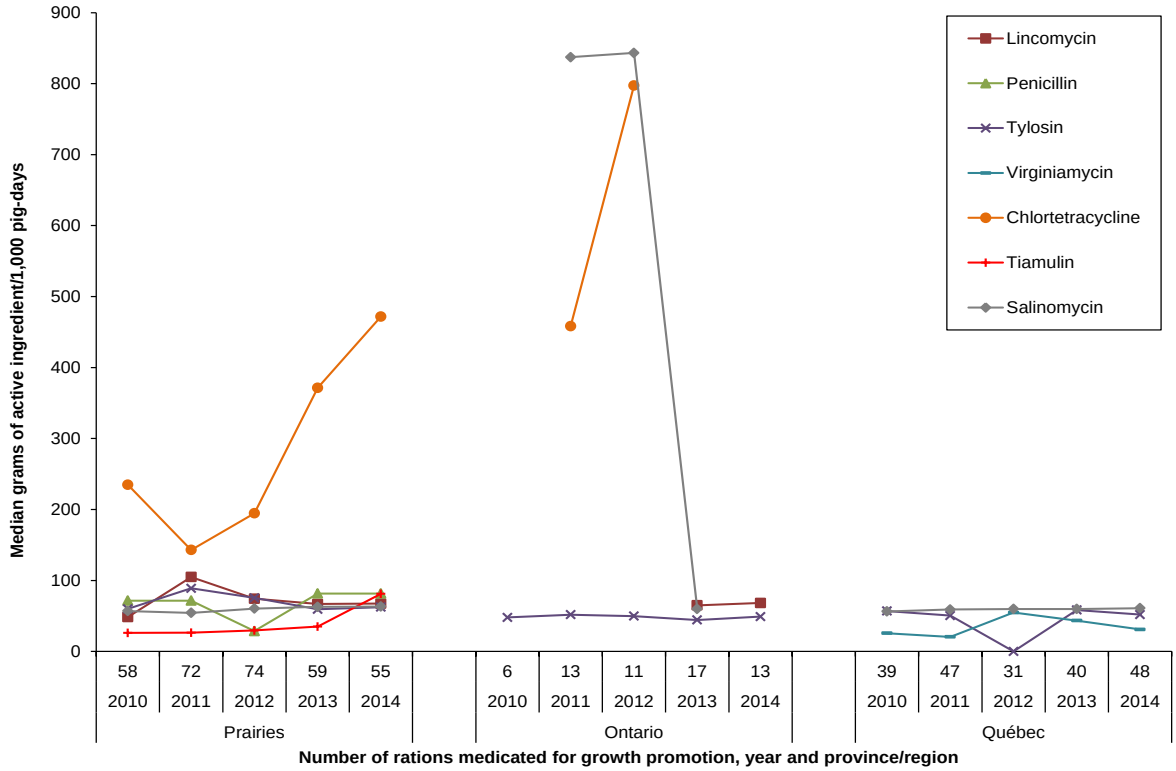
Only antimicrobials used by 5% of farms or more in a given year are depicted in this figure; those antimicrobials used for disease prevention by < 5% of herds included: tilmicosin, virginiamycin, oxytetracycline, spectinomycin, and sulfamethazine.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

[a] Median antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[23], adjusted for herd average daily gain; only rations medicated with the specified antimicrobial were included in the analysis for each antimicrobial.

[23] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

Figure 8.10. Quantity of antimicrobial used in feed (rations) for *Growth promotion* province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of rations		58	72	74	59	55	6	13	11	17	13	39	47	31	40	48
Antimicrobial		**Median grams/1000 pig-days[a]**														
II	Lincomycin	48	105	74	67	67	0	0	0	65	68	0	0	0	0	0
II	Penicillin	72	72	29	82	82	0	0	0	0	0	0	0	0	0	0
II	Tylosin	60	89	75	59	62	48	52	50	44	49	57	50	0	58	52
II	Virginiamycin	0	0	0	0	0	0	0	0	0	0	26	21	55	43	31
III	Chlortetracycline	235	143	195	372	472	0	458	797	0	0	0	0	0	0	0
III	Tiamulin	26	26	30	35	81	0	0	0	0	0	0	0	0	0	0
IV	Salinomycin	57	54	60	63	63	0	837	843	60	0	56	59	60	60	61

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Respondents were instructed to select only one of "Disease treatment", "Disease prevention" or "Growth promotion" as a primary reason for use of an antimicrobial.

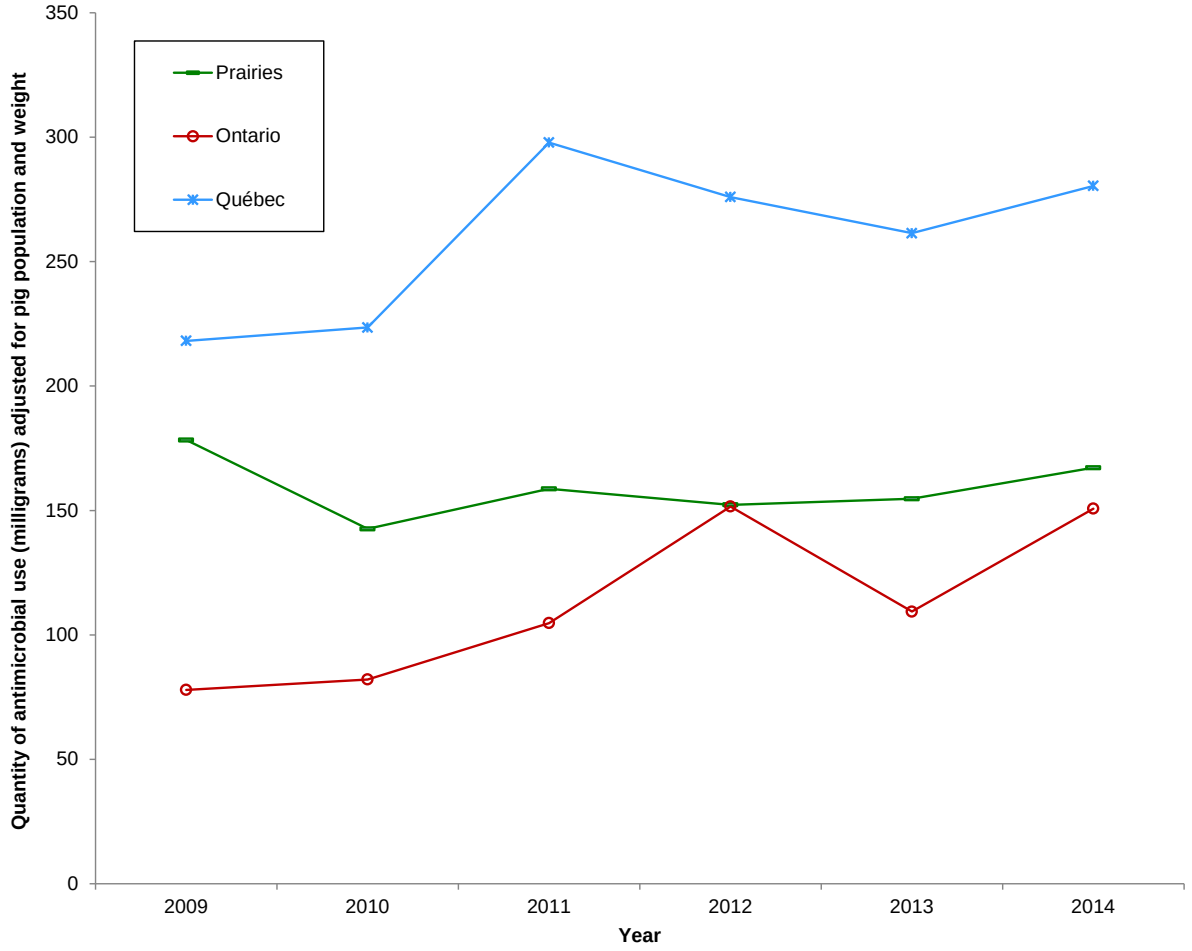
Only antimicrobials used by 5% of herds or more in a given year within any province/region are depicted in this figure. Antimicrobial use in feed for growth promotion reported by fewer than 5% of herds included: tilmicosin, virginiamycin, oxytetracycline, spectinomycin and sulfamethazine.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

[a] Median antimicrobial consumption estimates were calculated using reported ration days fed and predicted feed intake[24], adjusted for herd average daily gain; only rations medicated with the specified antimicrobial were included in the analysis for each antimicrobial.

[24] National Research Council. 2012. Nutrient Requirements of Swine, Eleventh Edition. Washington, DC: National Academy Press.

Figure 8.11. Trends in quantitative estimates of total antimicrobial use in feed adjusted for population and pig weight by province/region, 2009–2014

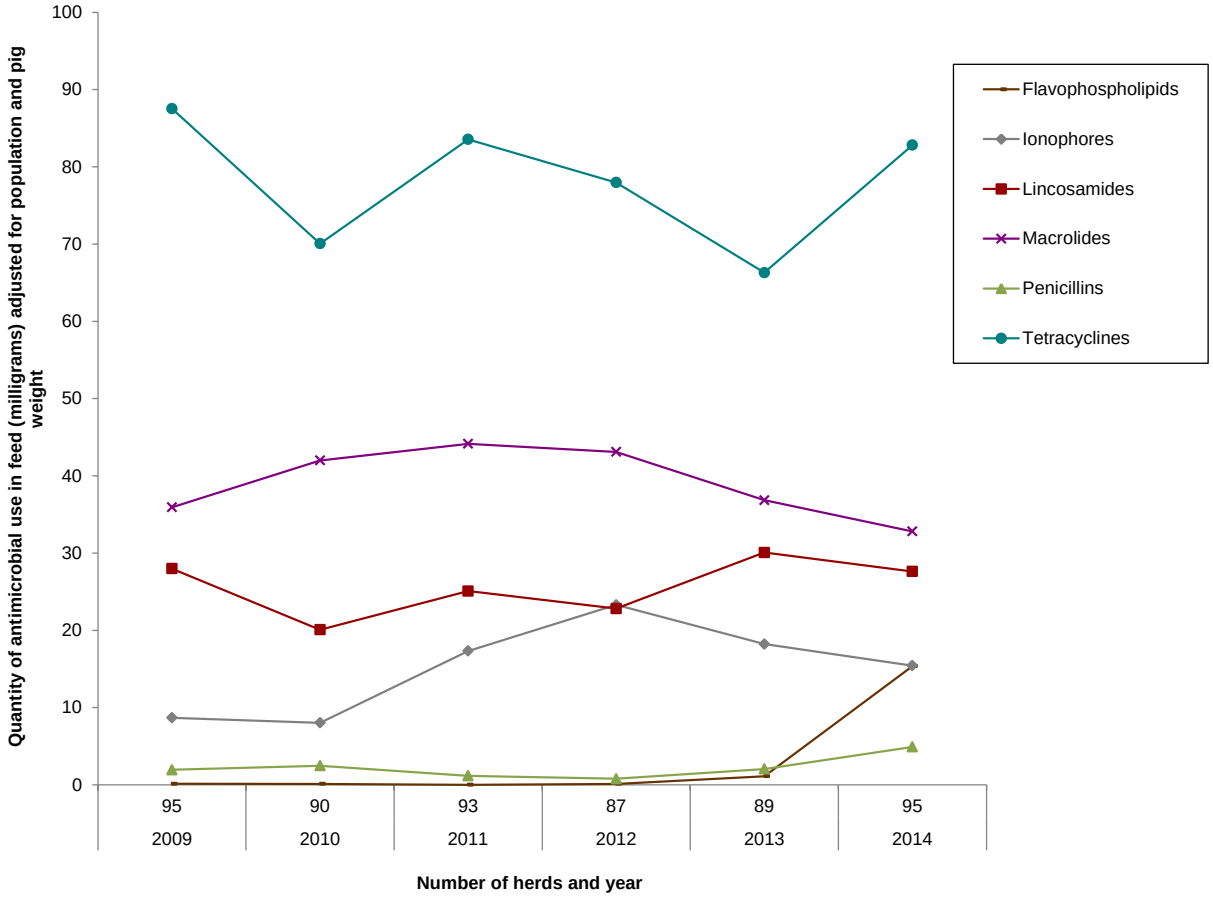


Year Province/region	2009	2010	2011	2012	2013	2014
Prairies	178	143	159	152	155	167
Ontario	78	82	105	152	109	151
Québec	218	224	298	276	261	280

ESVAC = European Surveillance of Veterinary Antimicrobial Consumption.
Adjusted antimicrobial use estimate: Estimated quantity of antimicrobials (mg) consumed through feed/(Total number of pigs in the sampled grow-finish period x ESVAC[25] standard weight of 65 kg).
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

[25] Available at: www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00.

Figure 8.12. Trends in quantitative estimates of antimicrobial use in feed, adjusted for population and pig weight by antimicrobial class, 2009–2014

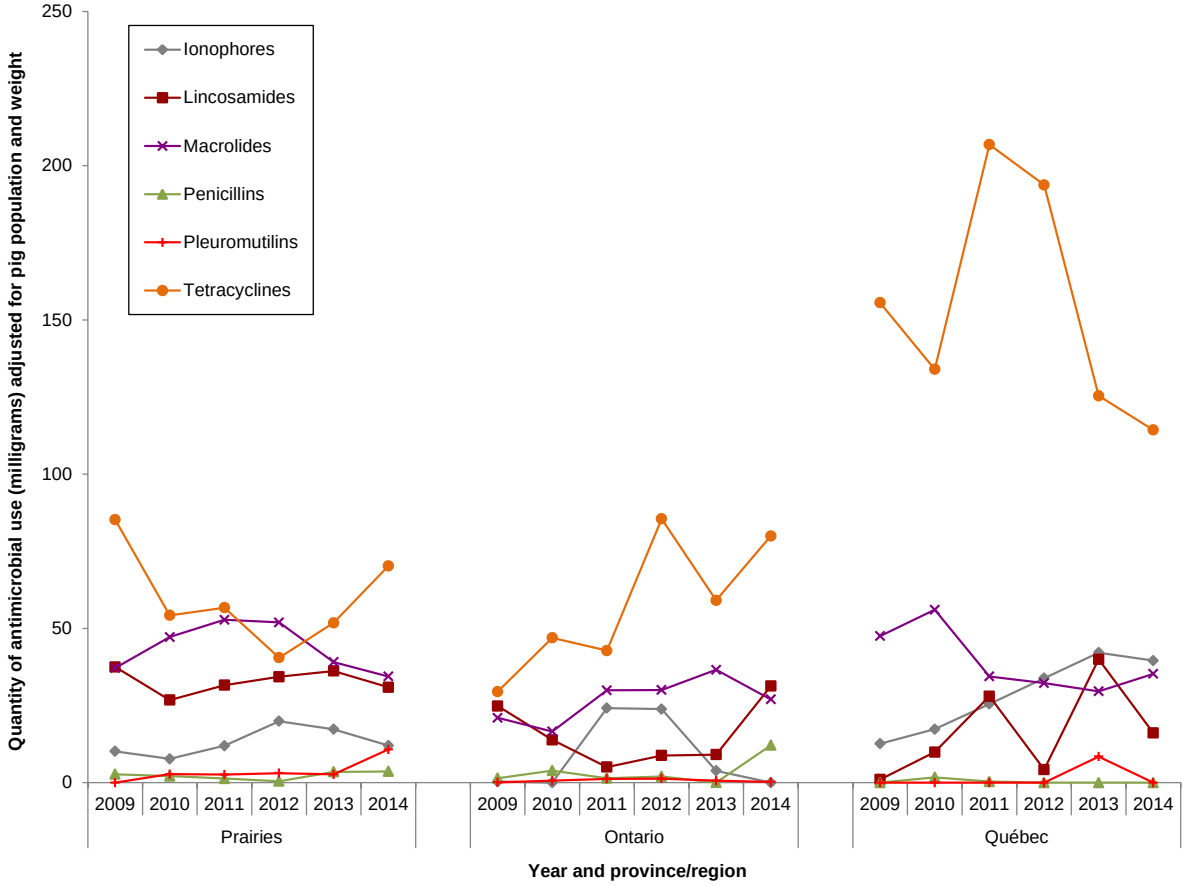


Year Number of herds	2009 95	2010 90	2011 93	2012 87	2013 89	2014 95
Antimicrobial class						
Flavophospholipids	0	0	0	0	1	15
Ionophores	9	8	17	23	18	15
Lincosamides	28	20	25	23	30	28
Macrolides	36	42	44	43	37	33
Penicillins	2	2	1	1	2	5
Tetracyclines	88	70	84	78	66	83

ESVAC = European Surveillance of Veterinary Antimicrobial Consumption.
Antimicrobial classes used at lower frequencies and quantities were excluded from this figure: aminoglycosides, bacitracins, streptogramins, and sulfonamides.
Adjusted antimicrobial use estimate = Estimated quantity of antimicrobials (mg) consumed through feed/(Total number of pigs in the sampled grow-finish period x ESVAC[26] standard weight of 65 kg).

[26] Available at: www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00.

Figure 8.13. Trends in quantitative estimates of antimicrobial use in feed adjusted for population and pig weight by antimicrobial class and province/region, 2009–2014

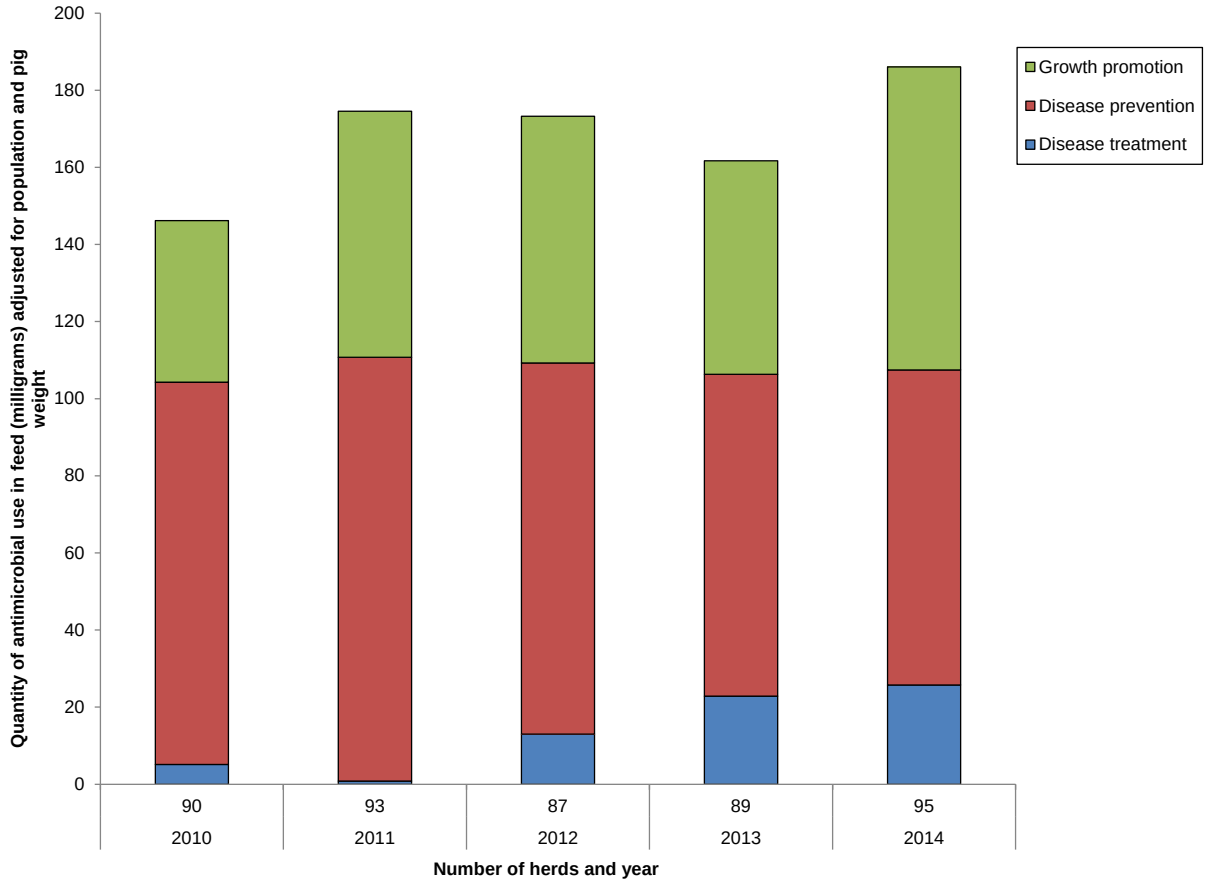


Province/region	Prairies						Ontario						Québec					
Year	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Antimicrobial class																		
Ionophores	10	8	12	20	17	12	0	0	24	24	4	0	13	17	26	34	42	40
Lincosamides	38	27	32	34	36	31	25	14	5	9	9	31	1	10	28	4	40	16
Macrolides	37	47	53	52	39	34	21	17	30	30	37	27	48	56	34	32	30	35
Penicillins	3	2	1	0	4	4	1	4	1	2	0	12	0	2	0	0	0	0
Pleuromutilins	0	3	3	3	3	11	0	1	1	1	1	0	0	0	0	0	8	0
Tetracyclines	85	54	57	41	52	70	30	47	43	86	59	80	156	134	207	194	125	114

ESVAC = European Surveillance of Veterinary Antimicrobial Consumption.
Antimicrobial classes used at lower frequencies and quantities excluded from this figure: aminoglycosides, bacitracins, flavophospholipids, streptogramins, and sulfonamides.
Adjusted antimicrobial use estimate = Estimated quantity of antimicrobials (mg) consumed through feed/(Total number of pigs in the sampled grow-finish period x ESVAC[27] standard weight of 65 kg).
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

[27]Available at: www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00.

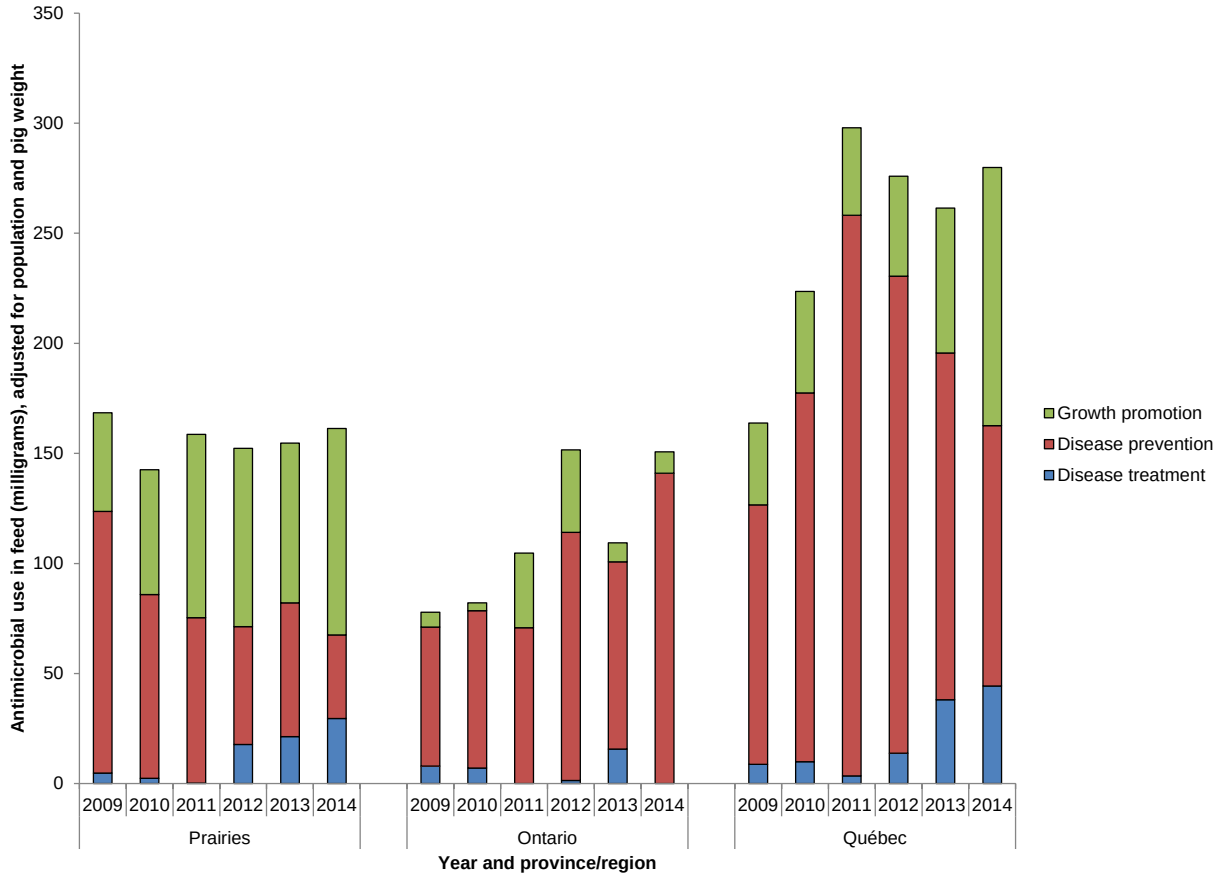
Figure 8.14. Quantity of antimicrobial use in feed adjusted for population and weight, by primary reasons for use, 2010–2014



ESVAC = European Surveillance of Veterinary Antimicrobial Consumption.
Adjusted antimicrobial use estimate = Estimated quantity of antimicrobials (mg) consumed through feed/(Total number of pigs in the sampled grow-finish period x ESVAC[28] standard weight of 65 kg).
Analysis includes ionophores.

[28] Available at: www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00.

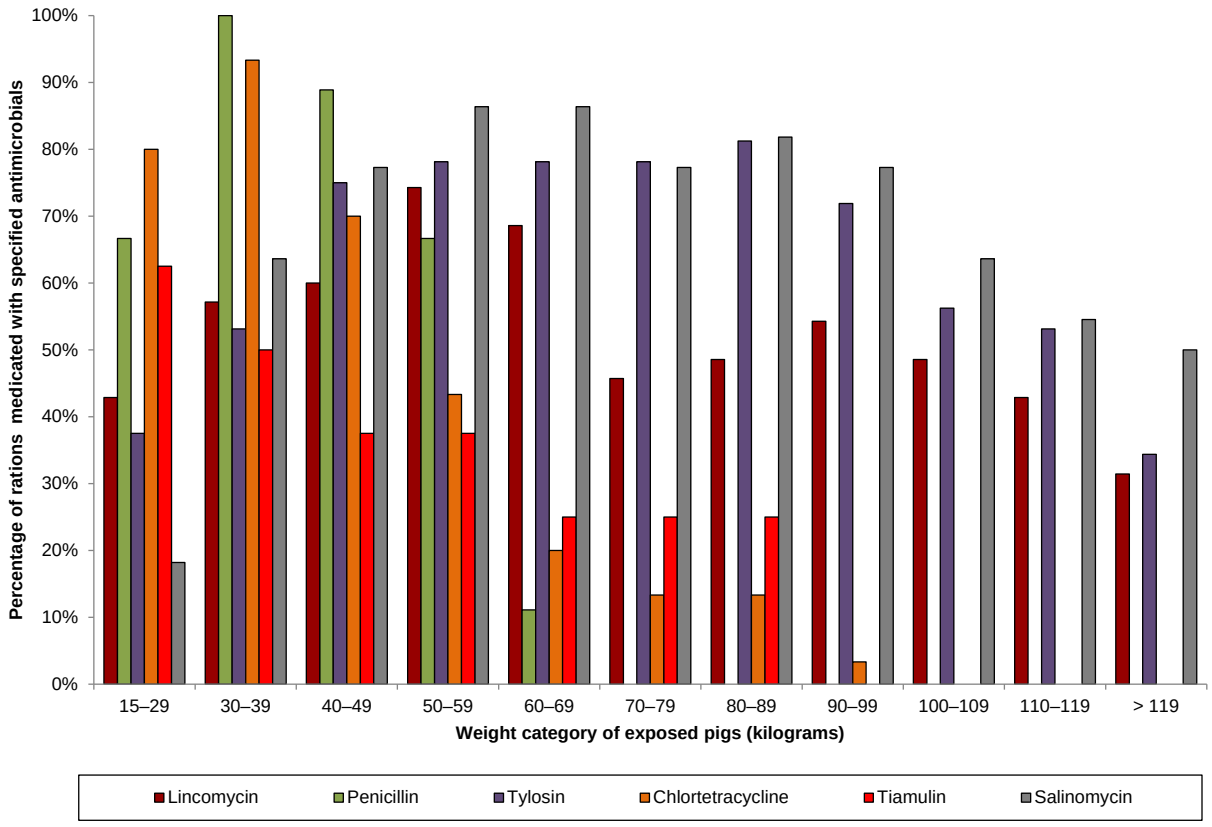
Figure 8.15. Quantity of antimicrobial use in feed adjusted for population and pig weight, by primary reason for use and province/region, 2009–2014



ESVAC = European Surveillance of Veterinary Antimicrobial Consumption.
Adjusted antimicrobial use estimate = Estimated quantity of antimicrobials (mg) consumed through feed/(Total number of pigs in the sampled grow-finish period x ESVAC[29] standard weight of 65 kg).
Analysis includes ionophores.

[29] Available at: www.ema.europa.eu/ema/index.jsp?curl=pages/regulation/document_listing/document_listing_000302.jsp&mid=WC0b01ac0580153a00.

Figure 8.16. Percentage of rations medicated with specified antimicrobials fed over the grow-finish period by reported pig weight, 2014

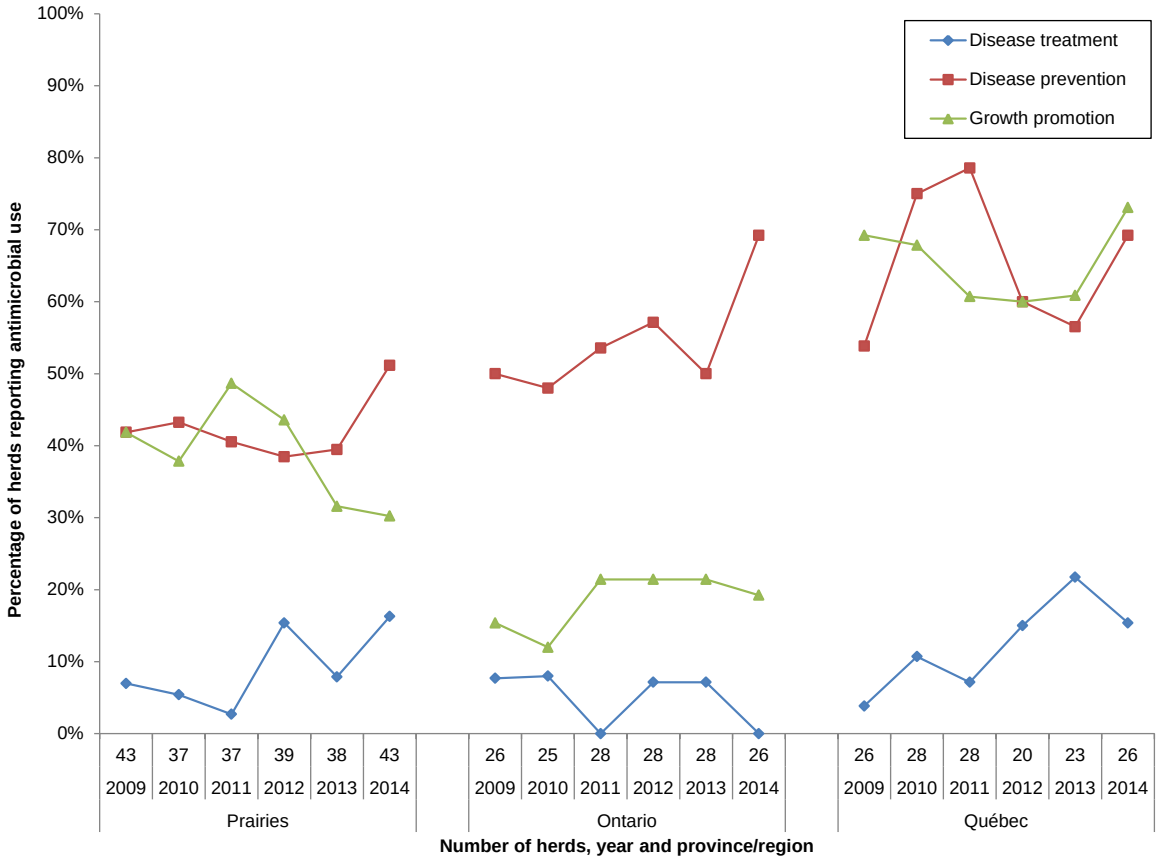


	Antimicrobial	Number of medicated rations	Pig weight categories over the grow-finish period (kg)										
			15–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99	100–109	110–119	> 119
II	Lincomycin	35	43%	57%	60%	74%	69%	46%	49%	54%	49%	43%	31%
II	Penicillin	9	67%	100%	89%	67%	11%	0%	0%	0%	0%	0%	0%
II	Tylosin	32	38%	53%	75%	78%	78%	78%	81%	72%	56%	53%	34%
III	Chlortetracycline	30	80%	93%	70%	43%	20%	13%	13%	3%	0%	0%	0%
III	Tiamulin	8	63%	50%	38%	38%	25%	25%	25%	0%	0%	0%	0%
IV	Salinomycin	22	18%	64%	77%	86%	86%	77%	82%	77%	64%	55%	50%

Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobials used in medicated rations by fewer than 5% of herds included: tilmicosin, tylvalosin, and virginiamycin (Category II); oxytetracycline, spectinomycin, and sulfamethazine (Category III); bambermycin (Category IV).

Figure 8.17. Percentage of pig herds reporting antimicrobial use in feed by primary reason and province/region, 2010–2014



Province/region	Prairies						Ontario						Québec					
Year	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Number of herds	43	37	37	39	38	43	26	25	28	28	28	26	26	28	28	20	23	26
Disease treatment	7%	5%	3%	15%	8%	**16%**	8%	8%	0%	7%	7%	**0%**	4%	11%	7%	15%	22%	**15%**
Disease prevention	42%	43%	41%	38%	39%	**51%**	50%	48%	54%	57%	50%	**69%**	54%	75%	79%	60%	57%	**69%**
Growth promotion	42%	38%	49%	44%	32%	**30%**	15%	12%	21%	21%	21%	**19%**	69%	68%	61%	60%	61%	**73%**

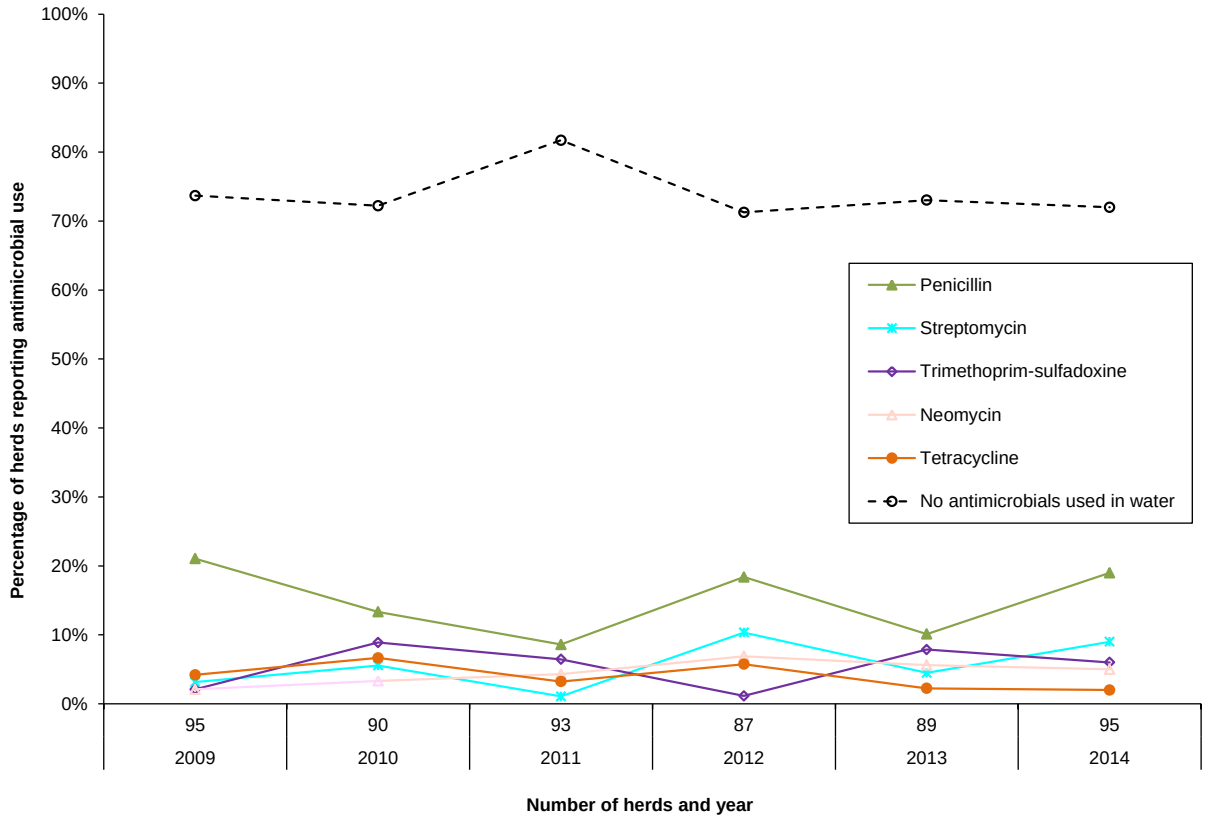
Respondents were instructed to select only one of "Disease Treatment", "Disease Prevention" or "Growth Promotion" as a primary reason for use of an antimicrobial

The proportion (%) of farms using antimicrobials in feed for the same primary reason were compared across regions for the current year (grey areas). The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

ANTIMICROBIAL USE IN WATER

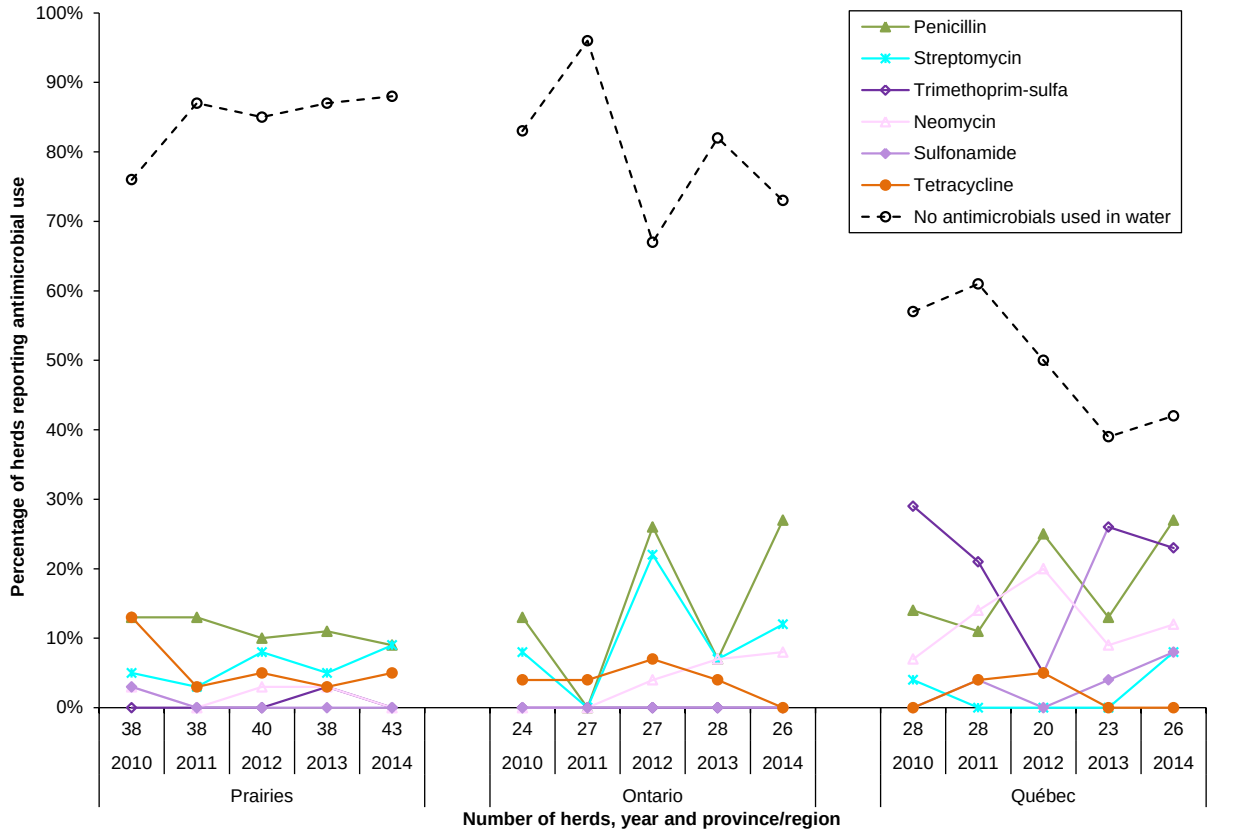
Figure 8.18. Percentage of pig herds reporting antimicrobial use in water, 2009–2014



Year Number of herds		2009 95	2010 90	2011 93	2012 87	2013 89	2014 95
Antimicrobial							
II	Penicillin	**21%**	13%	9%	18%	**10%**	**19%**
II	Streptomycin	**3%**	4%	1%	10%	**4%**	**9%**
II	Trimethoprim-sulfadoxine	**2%**	9%	6%	1%	**8%**	**6%**
III	Neomycin	**2%**	4%	4%	7%	**6%**	**5%**
III	Tetracycline	**4%**	7%	3%	6%	**2%**	**2%**
	No antimicrobials used in water	**74%**	72%	82%	71%	**73%**	**72%**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in water reported by fewer than 5% of herds included: lincomycin (Category II); sulfonamides (Category III).
For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2009 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 8.19. Percentage of pig herds reporting antimicrobial use in water by province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of herds		38	38	40	38	43	24	27	27	28	26	28	28	20	23	26
Antimicrobial																
II	Penicillin	**13%**	13%	10%	**11%**	**9%**	**13%**	0%	26%	**7%**	**27%**	**14%**	11%	25%	**13%**	**27%**
II	Streptomycin	**5%**	3%	8%	**5%**	**9%**	**8%**	0%	22%	**7%**	**12%**	**4%**	0%	0%	**0%**	**8%**
II	Trimethoprim-sulfadoxine	**0%**	0%	0%	**3%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**29%**	21%	5%	**26%**	**23%**
III	Neomycin	**3%**	0%	3%	**3%**	**0%**	**0%**	0%	4%	**7%**	**8%**	**7%**	14%	20%	**9%**	**12%**
III	Sulfonamide	**3%**	0%	0%	**0%**	**0%**	**0%**	0%	0%	**0%**	**0%**	**0%**	4%	0%	**4%**	**8%**
	Tetracycline	**13%**	3%	5%	**3%**	**5%**	**4%**	4%	7%	**4%**	**0%**	**0%**	4%	5%	**0%**	**0%**
	No antimicrobials used in water	**76%**	87%	85%	**87%**	**88%**	**83%**	96%	67%	**82%**	**73%**	**57%**	61%	50%	**39%**	**42%**

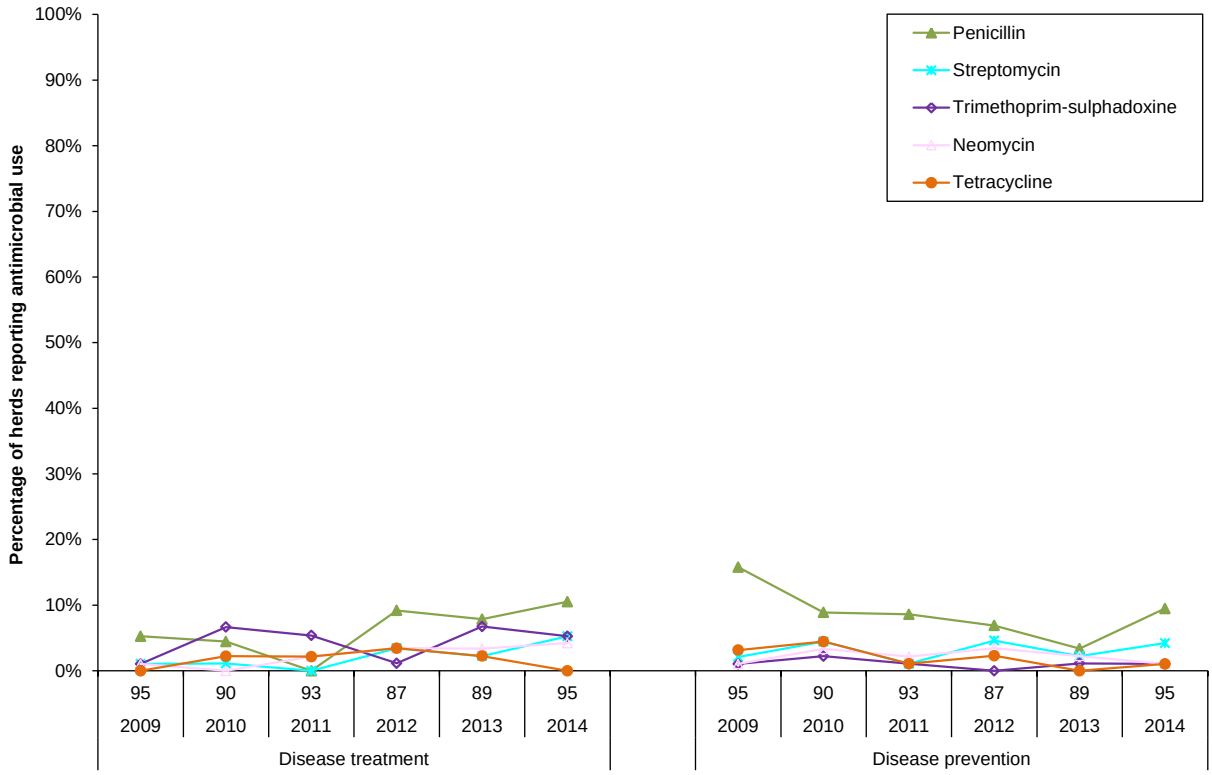
Roman numerals II to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in water reported by fewer than 5% of herds included: lincomycin (Category II) and spectinomycin (Category III).

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2009 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.20. Percentage of pig herds reporting antimicrobial use in water by primary reason for use, 2009–2014



Reason for use		Disease treatment						Disease prevention					
Year		2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Number of herds		95	90	93	87	89	95	95	90	93	87	89	95
Antimicrobial													
II	Penicillin	5%	6%	0%	9%	8%	11%	16%	8%	9%	7%	3%	9%
II	Streptomycin	1%	1%	0%	3%	2%	5%	2%	3%	1%	5%	2%	4%
II	Trimethoprim-sulfadoxine	1%	7%	5%	1%	7%	5%	1%	2%	1%	0%	1%	1%
III	Neomycin	1%	1%	2%	3%	3%	4%	1%	3%	2%	3%	2%	1%
III	Tetracycline	0%	2%	2%	3%	2%	0%	3%	4%	1%	2%	0%	1%

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
Respondents were instructed to select only one of "Disease treatment" or "Disease prevention" as a primary reason for use of an antimicrobial.
Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in water reported by fewer than 5% of herds included: lincomycin, tilmycosin, and tylvalosin (Category II); Spectinomycin and sulfonamides (Category III).

Table 8.4. Frequency of antimicrobial use in water by the proportion of pigs exposed, 2014

	Antimicrobial	Proportion of pigs exposed				Total
		1–25%	26–50%	51–75%	76–100%	
		Number of medicated water use (% of total)				
II	Lincomycin	0 (0)	0 (0)	0 (0)	1 (2)	1 (2)
	Penicillin	2 (4)	1 (2)	1 (2)	15 (31)	19 (40)
	Streptomycin	1 (2)	1 (2)	1 (2)	6 (13)	9 (19)
	Tilmicosin	0 (0)	0 (0)	0 (0)	1 (2)	1 (2)
	Trimethoprim-sulfadoxine	1 (2)	2 (4)	0 (0)	3 (6)	6 (13)
	Tylvalosin	0 (0)	0 (0)	0 (0)	3 (6)	3 (6)
III	Neomycin	0 (0)	0 (0)	2 (4)	3 (6)	5 (10)
	Sulfonamide	0 (0)	1 (2)	0 (0)	1 (2)	2 (4)
	Tetracycline	0 (0)	0 (0)	0 (0)	2 (4)	2 (4)
	Total	**4 (8)**	**5 (10)**	**4 (8)**	**35 (73)**	**48 (100)**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

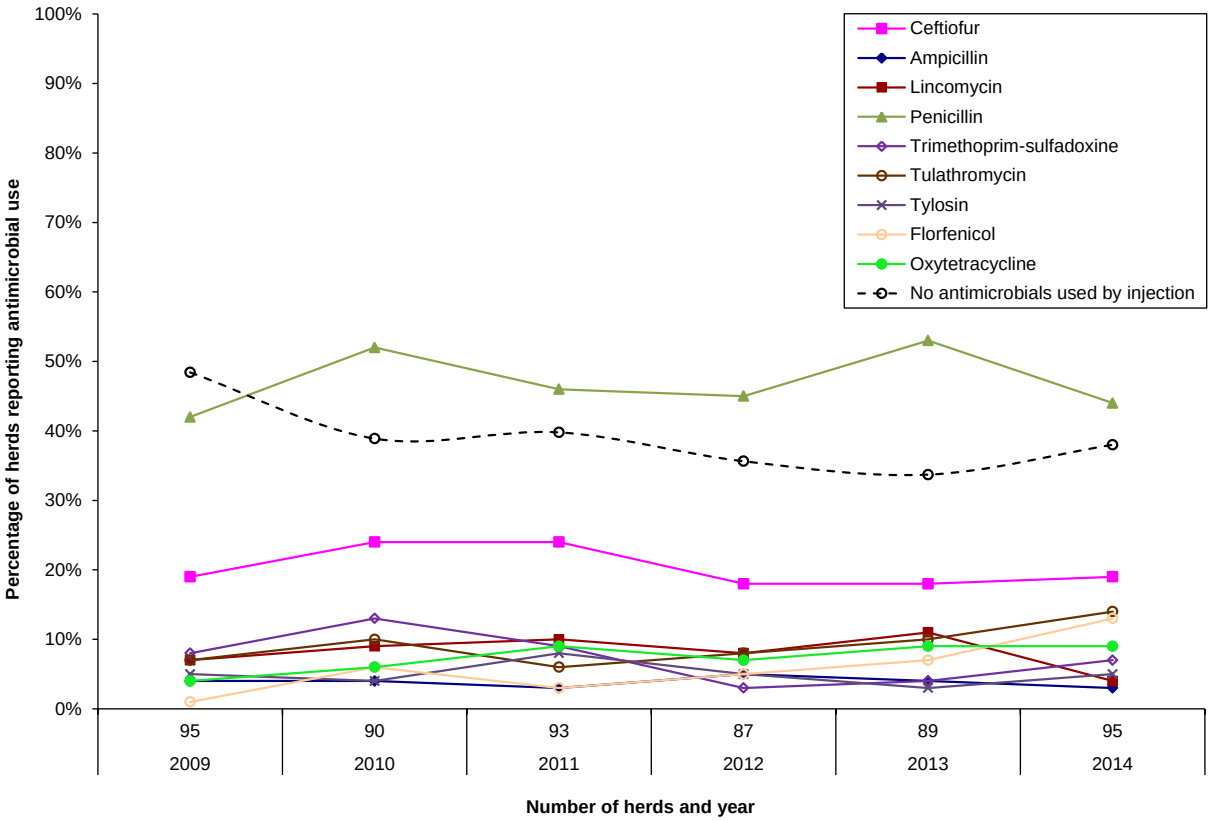
Table 8.5. Frequency of antimicrobial use in water by the proportion of pigs exposed, 2009–2013

	Antimicrobial	Proportion of pigs exposed				Total
		1–25%	26–50%	51–75%	76–100%	
		Number of medicated water uses (% of total)				
II	Lincomycin	0 (0)	1 (1)	0 (0)	2 (1)	3 (2)
	Penicillin	1 (1)	6 (4)	2 (1)	58 (36)	67 (41)
	Streptomycin	1 (1)	2 (1)	0 (0)	19 (12)	22 (13)
	Trimethoprim-sulfadoxine	0 (0)	3 (2)	1 (1)	20 (12)	24 (15)
III	Neomycin	0 (0)	0 (0)	1 (1)	19 (12)	20 (12)
	Spectinomycin	0 (0)	0 (0)	0 (0)	2 (1)	2 (1)
	Sulfonamide	1 (1)	0 (0)	0 (0)	4 (2)	5 (3)
	Tetracycline	0 (0)	0 (0)	0 (0)	20 (12)	20 (12)
	Total	**3 (2)**	**12 (7)**	**4 (2)**	**144 (88)**	**163 (100)**

Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

ANTIMICROBIAL USE BY INJECTION

Figure 8.21. Percentage of pig herds reporting antimicrobial use by injection, 2009–2014



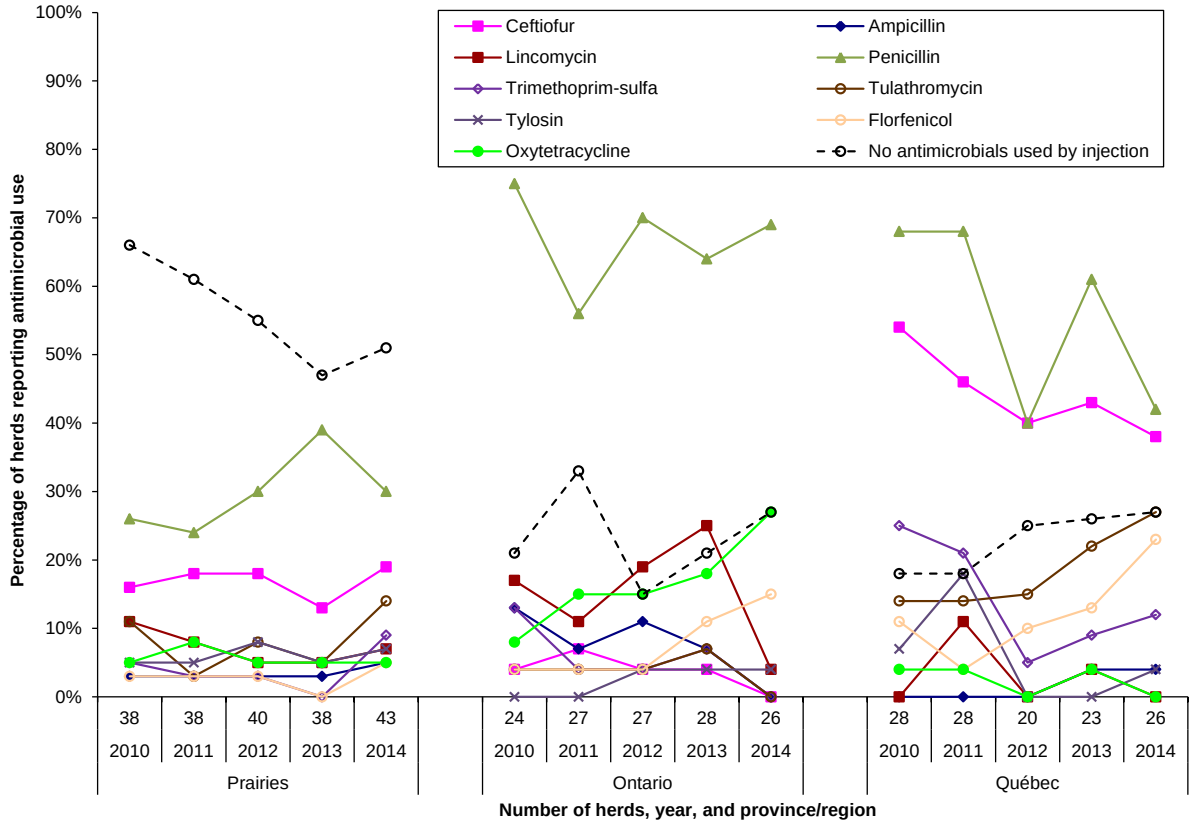
Year Number of herds		2009 95	2010 90	2011 93	2012 87	2013 89	2014 95
Antimicrobial							
I	Ceftiofur	**20%**	24%	24%	18%	**18%**	**19%**
I	Ampicillin	**4%**	4%	3%	5%	**4%**	**3%**
II	Lincomycin	**8%**	9%	10%	8%	**11%**	**4%**
II	Penicillin	**41%**	51%	46%	45%	**53%**	**44%**
II	Trimethoprim-sulfadoxine	**9%**	13%	9%	3%	**4%**	**7%**
II	Tulathromycin	**8%**	10%	6%	8%	**10%**	**14%**
II	Tylosin	**5%**	4%	8%	5%	**3%**	**5%**
III	Florfenicol	**1%**	6%	3%	5%	**7%**	**13%**
III	Oxytetracycline	**4%**	6%	9%	7%	**9%**	**9%**
	No antimicrobials used by injection	**47%**	40%	40%	36%	**34%**	**38%**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure.

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2009 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 8.22. Percentage of pig herds reporting antimicrobial use by injection and province/region, 2010–2014



Province/region		Prairies					Ontario					Québec				
Year		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Number of herds		38	38	40	38	43	24	27	27	28	26	28	28	20	23	26
Antimicrobial																
I	Ceftiofur	**16%**	18%	18%	**13%**	**19%**	**4%**	7%	4%	**4%**	**0%**	**54%**	46%	40%	**43%**	**38%**
II	Ampicillin	**3%**	3%	3%	**3%**	**5%**	**13%**	7%	11%	**7%**	**0%**	**0%**	0%	0%	**4%**	**4%**
II	Lincomycin	**11%**	8%	5%	**5%**	**7%**	**17%**	11%	19%	**25%**	**4%**	**0%**	11%	0%	**4%**	**0%**
II	Penicillin	**26%**	24%	30%	**39%**	**30%**	**75%**	56%	70%	**64%**	**69%**	**68%**	68%	40%	**61%**	**42%**
II	Trimethoprim-sulfa	**5%**	3%	3%	**0%**	**9%**	**13%**	4%	4%	**7%**	**0%**	**25%**	21%	5%	**9%**	**12%**
II	Tulathromycin	**11%**	3%	8%	**5%**	**14%**	**4%**	4%	4%	**7%**	**0%**	**14%**	14%	15%	**22%**	**27%**
II	Tylosin	**5%**	5%	8%	**5%**	**7%**	**0%**	0%	4%	**4%**	**4%**	**7%**	18%	0%	**0%**	**4%**
III	Florfenicol	**3%**	3%	3%	**0%**	**5%**	**4%**	4%	4%	**11%**	**15%**	**11%**	4%	10%	**13%**	**23%**
III	Oxytetracycline	**5%**	8%	5%	**5%**	**5%**	**8%**	15%	15%	**18%**	**27%**	**4%**	4%	0%	**4%**	**0%**
	No antimicrobials used by injection	**26%**	24%	15%	**29%**	**23%**	**46%**	33%	30%	**36%**	**19%**	**7%**	4%	10%	**13%**	**8%**

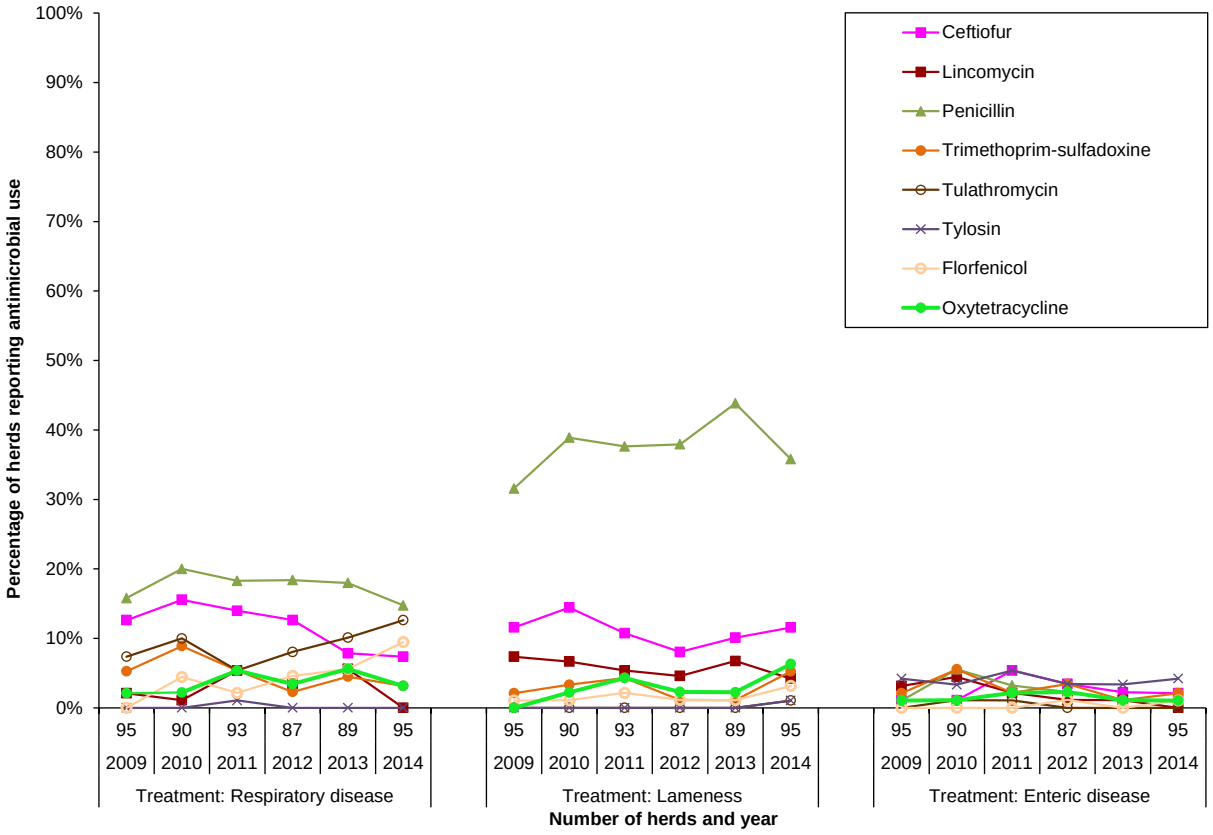
Roman numerals II to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure. Antimicrobial use in feed reported by fewer than 5% of herds included: erythromycin (Category II), spectinomycin and tiamulin (Category III).

For the temporal analyses, the proportion (%) of herds using a specific antimicrobial in the current year has been compared to the proportion (%) of herds using the same antimicrobial in 2009 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial. The presence of red areas indicates significant provincial/regional differences ($P \leq 0.05$) for a given antimicrobial within the current year. The presence of purple areas indicates significant temporal and provincial/regional differences ($P \leq 0.05$) for a given antimicrobial.

The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.23. Percentage of pig herds reporting antimicrobial use by injection by reasons for use, 2009–2014



Reason for use		Respiratory disease						Lameness						Enteric disease					
Year		2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Number of herds		95	90	93	87	89	95	95	90	93	87	89	95	95	90	93	87	89	95
Antimicrobial																			
I	Ceftiofur	13%	16%	14%	13%	8%	7%	12%	14%	11%	8%	10%	12%	1%	1%	5%	3%	2%	2%
II	Lincomycin	2%	1%	5%	3%	6%	0%	7%	7%	5%	5%	7%	4%	3%	4%	2%	1%	1%	0%
	Penicillin	16%	20%	18%	18%	18%	15%	32%	38%	38%	38%	44%	36%	1%	6%	3%	2%	1%	1%
	Trimethoprim-sulfadoxine	5%	9%	5%	2%	4%	3%	2%	3%	4%	1%	1%	5%	2%	6%	2%	3%	1%	2%
	Tulathromycin	7%	10%	5%	8%	10%	13%	0%	0%	0%	0%	0%	1%	0%	1%	1%	0%	0%	0%
	Tylosin	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	4%	3%	5%	3%	3%	4%
III	Florfenicol	0%	4%	2%	5%	6%	9%	1%	1%	2%	1%	1%	3%	0%	0%	0%	1%	0%	1%
	Oxytetracycline	2%	2%	5%	3%	6%	3%	0%	2%	4%	2%	2%	6%	1%	1%	2%	2%	1%	1%

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Respondents were instructed to "Check all that apply" from a list of reasons for an antimicrobial use: "Respiratory disease", "Enteric disease", "Lameness", and "Other ".

Only antimicrobials used by 5% of herds or more in a given year are depicted in this figure; Antimicrobials used by fewer than 5 % of herds included: ampicillin, erythromycin, and tiamulin (Category II); spectinomycin (Category III).

Table 8.6. Frequency of antimicrobial treatments by injection by the proportion of pigs exposed, 2014

	Antimicrobial	Proportion of pigs exposed					Total
		< 5%	6–25%	26–50%	51–75%	76–100%	
		Number of uses by injection (% of total)					
I	Ceftiofur	16 (14)	2 (2)	0 (0)	0 (0)	0 (0)	18 (16)
	Enrofloxacin	3 (3)	0 (0)	0 (0)	0 (0)	0 (0)	3 (3)
II	Ampicillin	2 (2)	1 (1)	0 (0)	0 (0)	0 (0)	3 (3)
	Lincomycin	4 (3)	0 (0)	0 (0)	0 (0)	0 (0)	4 (3)
	Penicillin	39 (34)	3 (3)	0 (0)	0 (0)	0 (0)	42 (36)
	Trimethoprim-sulfadoxine	6 (5)	1 (1)	0 (0)	0 (0)	0 (0)	7 (6)
	Tulathromycin	13 (11)	0 (0)	0 (0)	0 (0)	0 (0)	13 (11)
	Tylosin	5 (4)	0 (0)	0 (0)	0 (0)	0 (0)	5 (4)
III	Florfenicol	11 (9)	1 (1)	0 (0)	0 (0)	0 (0)	12 (10)
	Oxytetracycline	9 (8)	0 (0)	0 (0)	0 (0)	0 (0)	9 (8)
	Total	**108 (93)**	**8 (7)**	**0 (0)**	**0 (0)**	**0 (0)**	**116 (100)**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

Table 8.7. Frequency of antimicrobial treatments by injection by the proportion of pigs exposed, 2009–2013

	Antimicrobial	Proportion of pigs exposed					Total
		< 5%	6–25%	26–50%	51–75%	76–100%	
		Number of uses by injection (% of total)					
I	Ceftiofur	87 (17)	6 (1)	0 (0)	0 (0)	1 (0)	94 (18)
	Enrofloxacin	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
II	Ampicillin	18 (3)	1 (0)	0 (0)	0 (0)	0 (0)	19 (4)
	Erythromycin	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
	Lincomycin	40 (8)	1 (0)	0 (0)	0 (0)	0 (0)	41 (8)
	Penicillin	203 (39)	10 (2)	1 (0)	2 (0)	0 (0)	216 (41)
	Tiamulin	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0)
	Trimethoprim-sulfadoxine	31 (6)	4 (1)	0 (0)	0 (0)	0 (0)	35 (7)
	Tulathromycin	36 (7)	2 (0)	0 (0)	0 (0)	0 (0)	38 (7)
	Tylosin	23 (4)	0 (0)	0 (0)	0 (0)	0 (0)	23 (4)
III	Florfenicol	16 (3)	3 (1)	0 (0)	0 (0)	0 (0)	19 (4)
	Oxytetracycline	30 (6)	1 (0)	0 (0)	0 (0)	0 (0)	31 (6)
	Spectinomycin	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0)
	Total	**490 (94)**	**28 (5)**	**1 (0)**	**2 (0)**	**1 (0)**	**522 (100)**

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

ANIMAL HEALTH AND BIOSECURITY

The diseases most commonly reported in CIPARS grower-finisher herds in all 3 province/region in 2014 were *Streptococcus suis* (78%, 91%, 85%), Porcine Circovirus Associated Disease (PCVAD) (86%, 100%, 83%), and *Lawsonia* (89%, 75%, 77%) in the Prairies, Ontario and Québec, respectively. In 2014, Ontario grower-finisher herds had a significantly higher reported prevalence of *E. coli*, *Mycoplasma* and *Salmonella* than grower-finisher herds in the Prairies. In 2014, Québec grower-finisher herds had a significantly higher reported prevalence of *Mycoplasma* and *Salmonella* than grower-finisher herds in the Prairies (Figure 8.25).

In 2014, Ontario nurseries supplying CIPARS grower-finisher herds had a significantly higher reported prevalence of *Mycoplasma* than nurseries in the Prairies. In 2014, Québec nurseries supplying CIPARS grower-finisher herds had a significantly higher reported prevalence of *Mycoplasma* and *Salmonella* than nurseries in the Prairies (Figure 8.26).

In 2014, Ontario sow herds supplying CIPARS grower-finisher herds had a significantly higher reported prevalence of *E. coli* and Swine Influenza and a significantly lower reported prevalence of *Lawsonia* than sow herds in the Prairies. Québec sow herds supplying grower-finisher herds had a significantly higher reported prevalence of Salmonella and a significantly lower reported prevalence of Lawsonia than sow herds in the Prairies (Figure 8.27).

Antimicrobials were most commonly reported in grower-finisher herds for the control or treatment of *Streptococcus* suis (30%, 35%, 38%) and *Lawsonia* (39%, 42%, 31%) in all 3 regions (Prairies, Ontario, and Québec) in 2014, respectively. There was significantly more antimicrobial use reported for *Mycoplasma* in Ontario grower-finisher herds than in herds in the Prairies. There was significantly more antimicrobial use reported for swine Influenza, *Mycoplasma*, and *Salmonella* in grower-finisher herds in Québec than in grower-finisher herds in the Prairies (Figure 8.30).

In 2014, there was significantly more reported antimicrobial use for PCVAD, *E. coli* and *Mycoplasma* in Ontario nurseries supplying grower-finisher herds than in nurseries supplying grower-finisher herds in the Prairies. There was significantly more reported antimicrobial use for *E. coli*, Swine Influenza, *Mycoplasma*, *Salmonella* and *Streptococcus suis* in Québec nurseries supplying grower-finisher herds than in nurseries supplying herds in the Prairies (Figure 8.31).

In 2014, there was significantly more reported use for *Erysipelas* in Ontario sow herds supplying CIPARS grower-finisher herds than in sow herds supplying grower-finisher herds in the Prairies. In 2014, there was significantly more reported use for *Streptococcus suis* in Québec sow herds supplying CIPARS grower-finisher herds than in the Prairies (Figure 8.32).

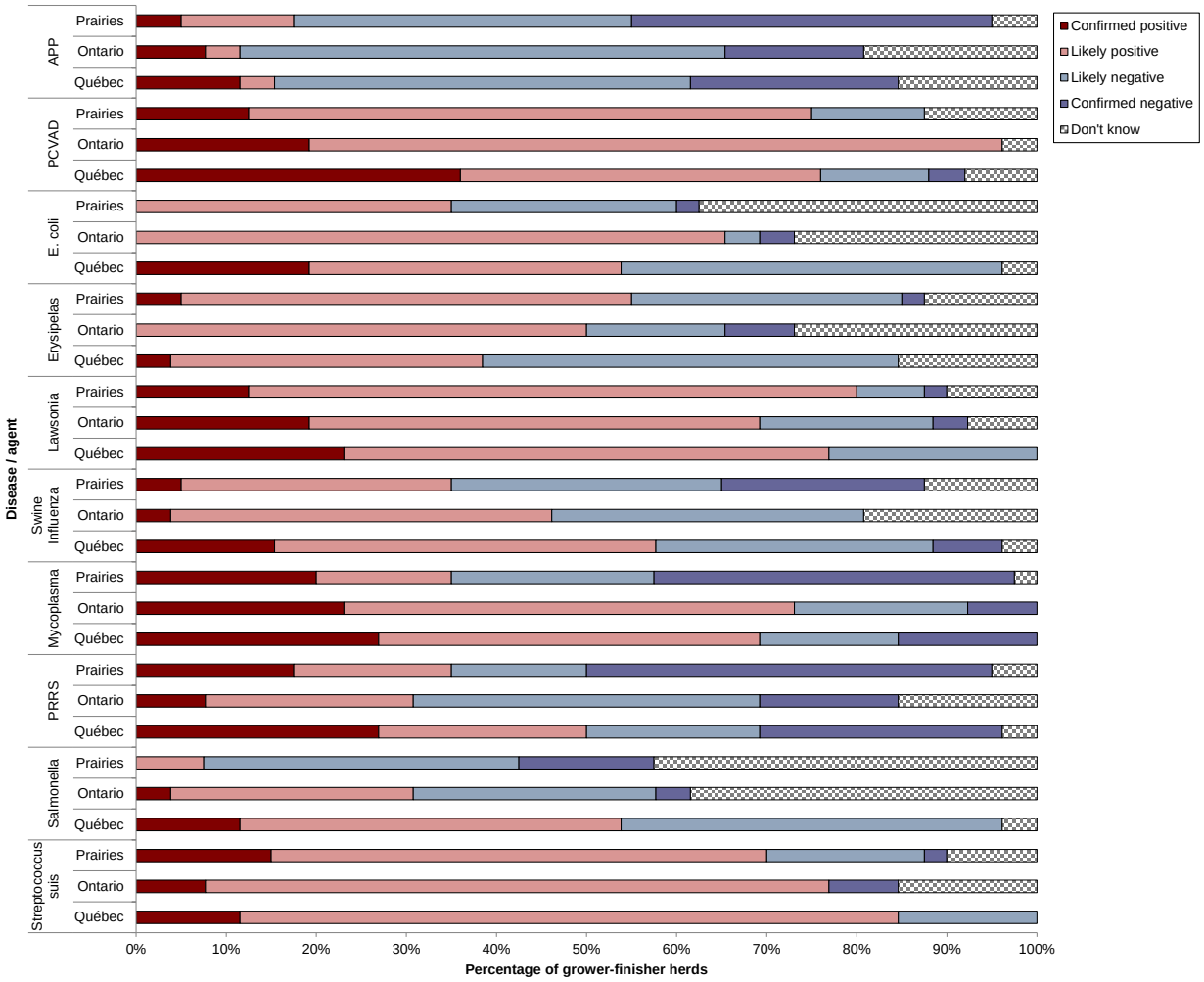
There were significantly more grower-finisher herds reporting vaccination for *Mycoplasma* in Ontario than in the Prairies in 2014. There were significantly more grower-finisher herds reporting vaccination for *Mycoplasma* and Porcine Reproductive and Respiratory Syndrome (PRRS) in Québec than in the Prairies (Figure 8.33).

In 2014, there were significantly fewer herds with their own sows in Ontario and Québec than in the Prairies and significantly more single source grower-finisher herds in Ontario than in the Prairies (Figure 8.34).

Grower-finisher herds in Ontario and Québec were significantly smaller than in the Prairies in 2014 (Figure 8.35). As well, the number of pig farms within 2 km of CIPARS grower-finisher herds was significantly higher in Ontario and Québec than in the Prairies (Figure 8.36).

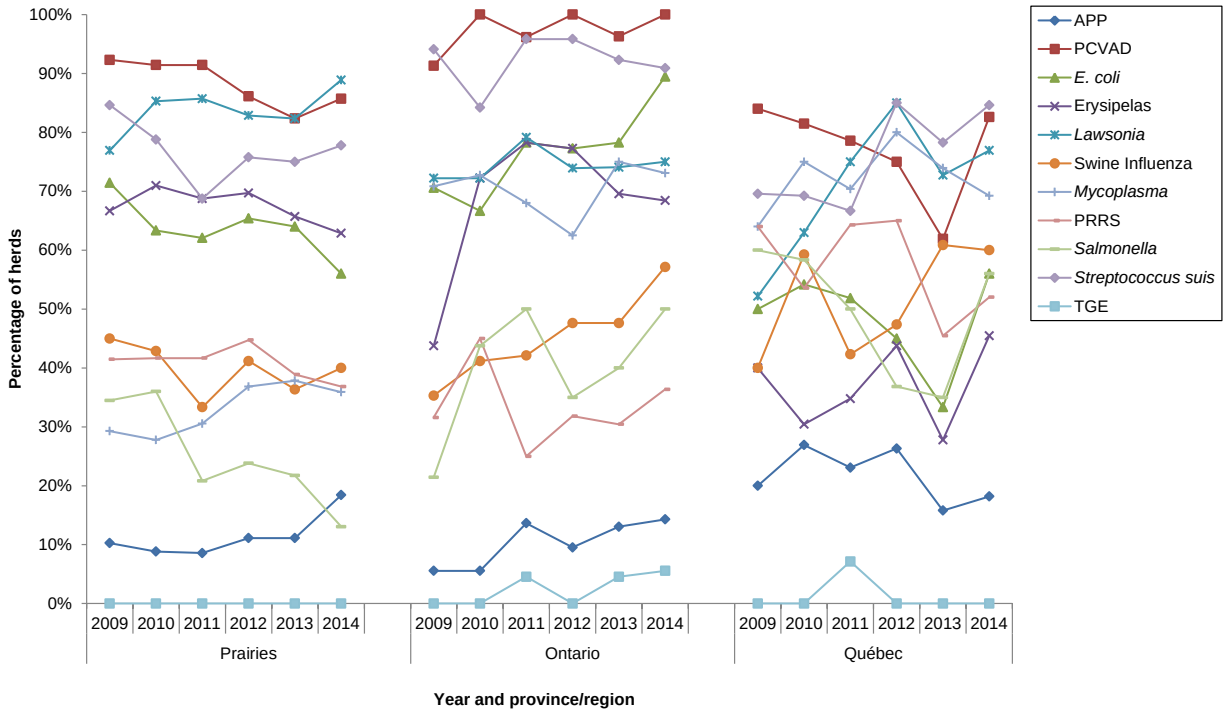
In 2014, the number of grower-finisher herds with the following biosecurity measures: boots provided, coveralls provided, biosecurity sign, shower required and downtime required were significantly lower in Québec than in the Prairies (Figure 8.37).

Figure 8.24. Reported health status of grower-finisher herds (n = 95), 2014



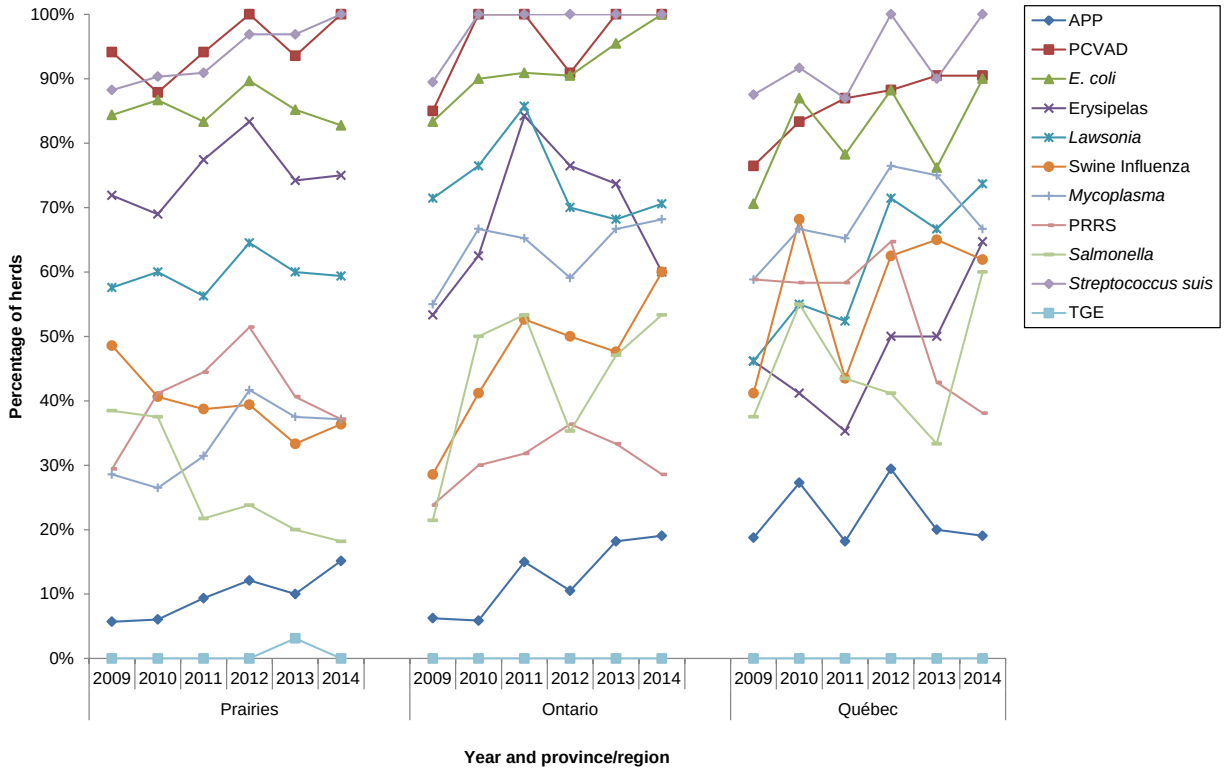
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Other disease reported in grower-finisher herds included: *Actinobacillus suis*, *Brachyspira*, *Hemophilus parasuis*, *Mycoplasma hyosynoviae*, and Porcine Epidemic Diarrhea.
Only one grower-finisher herd was reported as "Likely positive" for TGE. There were no herds reported as "Confirmed positive".

Figure 8.25. Reported health status of grower-finisher herds by province/region, 2010–2014



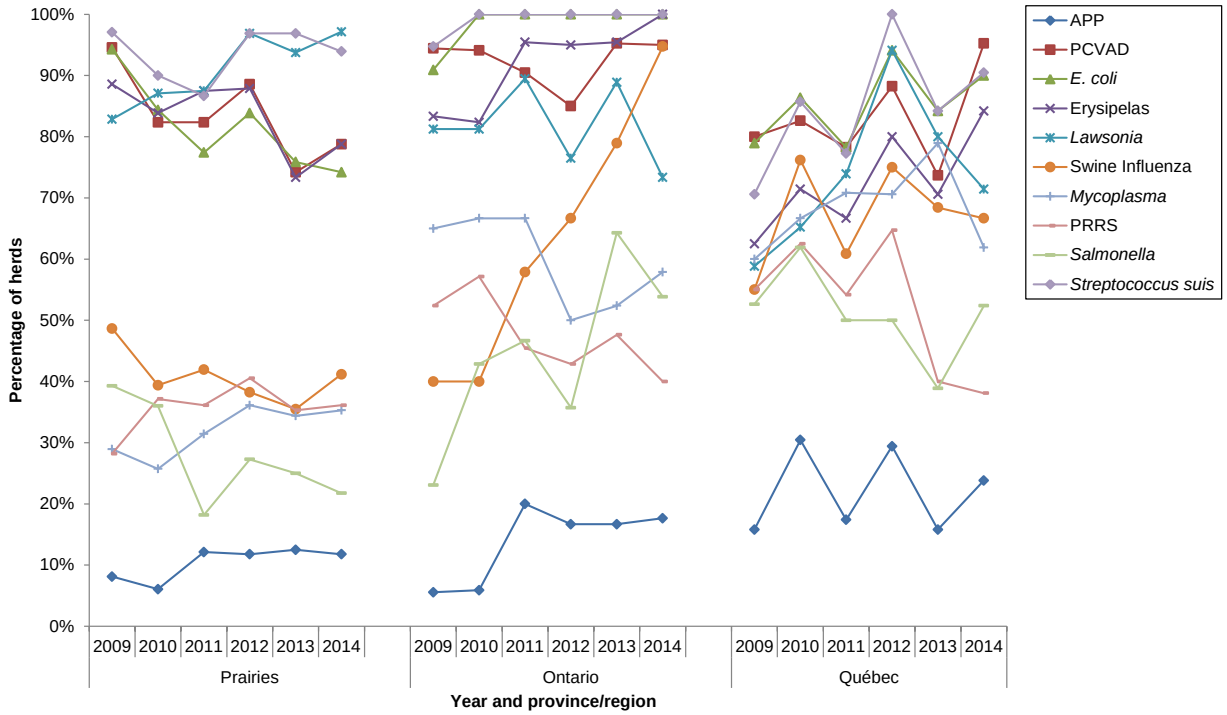
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.26. Reported health status in nurseries supplying grower-finisher herds, by province/region, 2010–2014



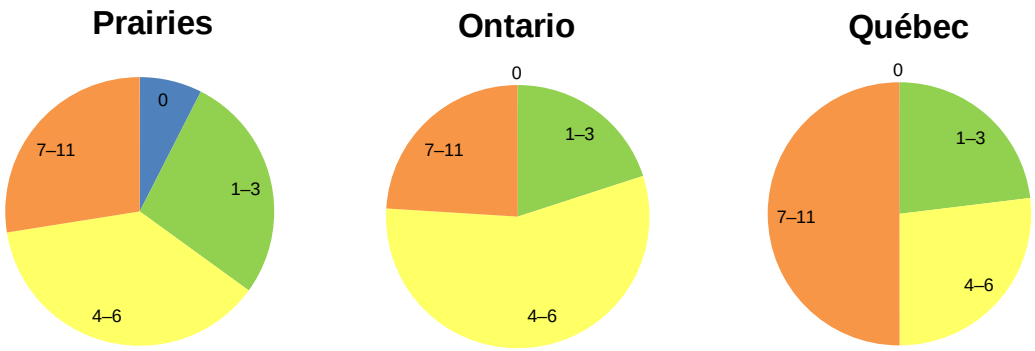
APP = *Actinobacillus pleuropneumoniae*.
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
Note that for grower-finisher pigs received from more than 1 source, if at least 1 nursery was positive, the nursery was categorized as positive.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.27. Reported health status in sow herds supplying grower-finisher herds by province/region, 2010–2014



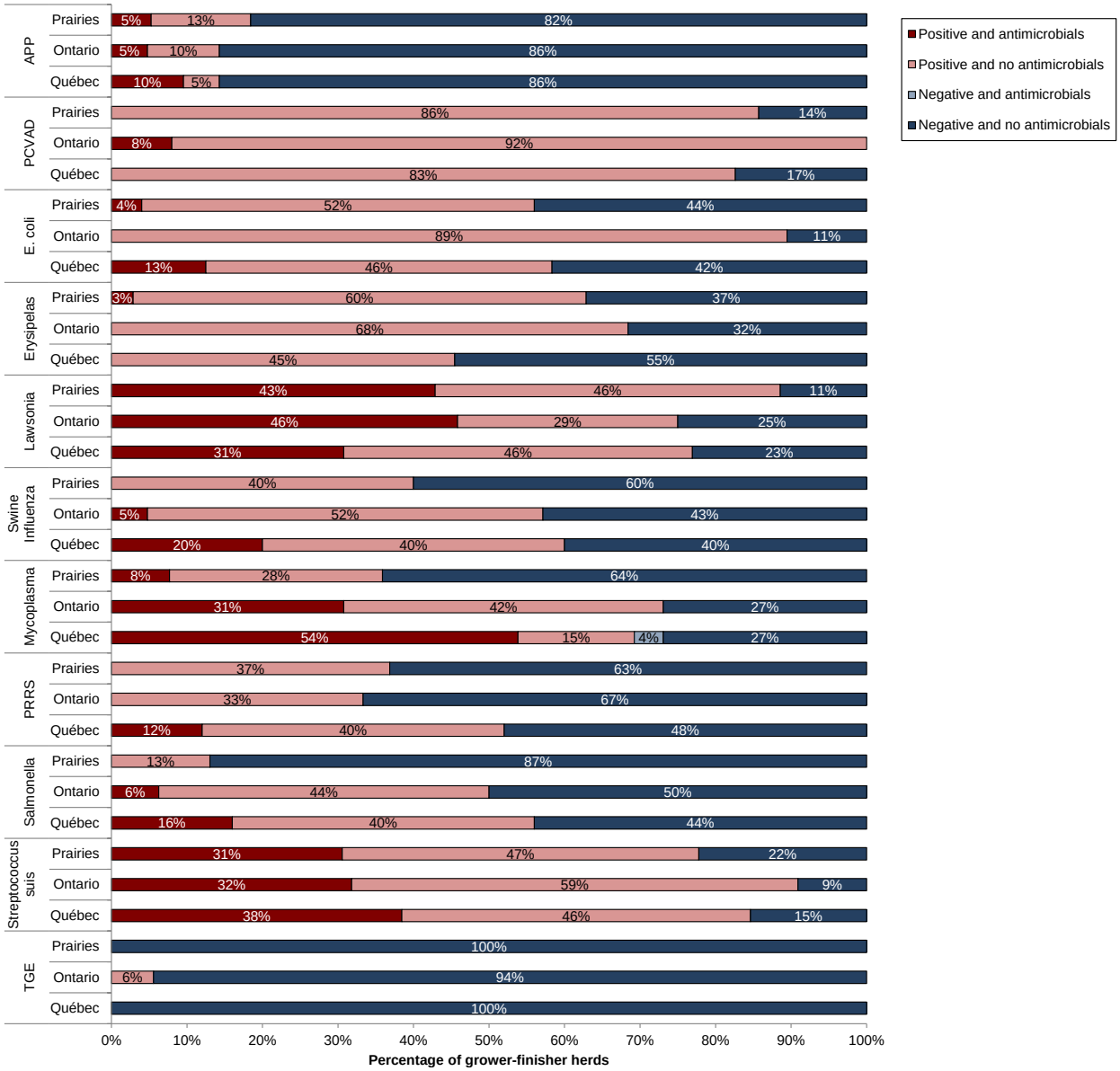
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE was not included in the sow herd survey.
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
For grower-finisher pigs received from more than one source, if at least one sow herd was positive, the sow herds were categorized as positive.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.28. Number of infectious diseases reported on grower-finisher herds (n = 92) by province/region, 2014



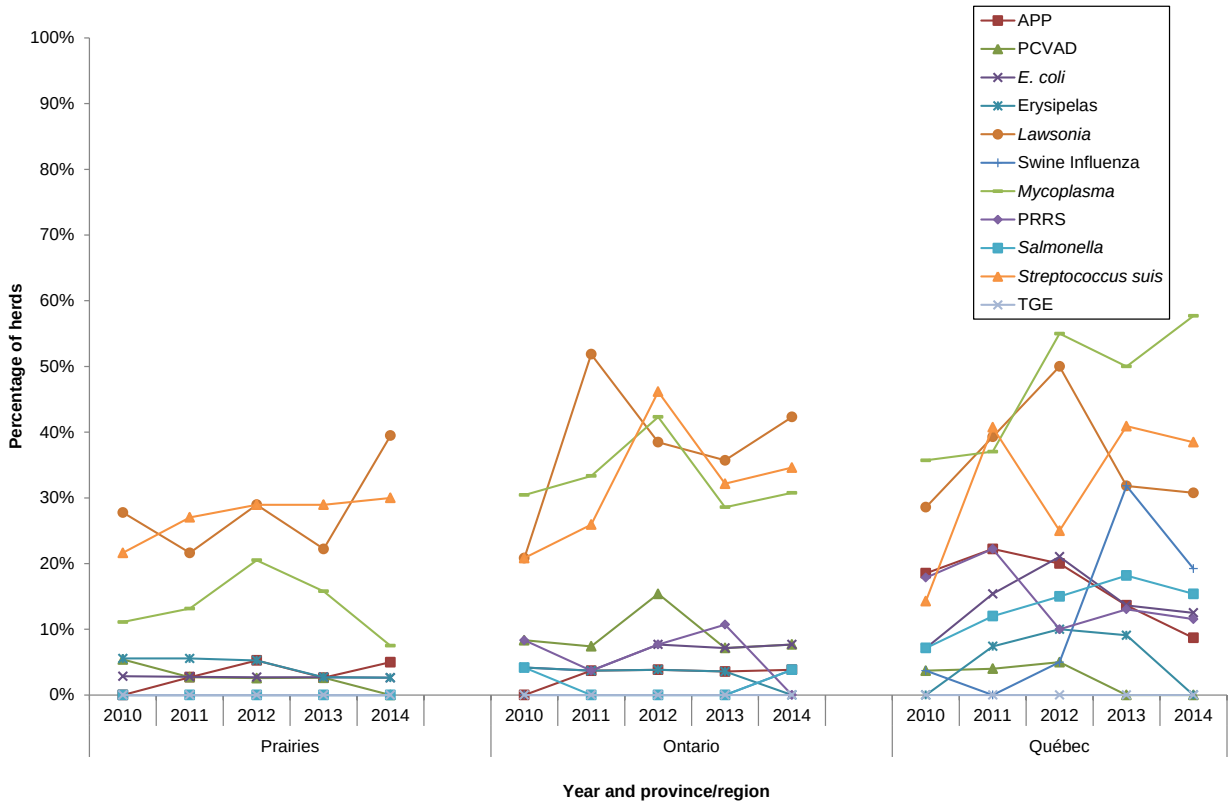
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.29. Reported antimicrobial use for specific diseases in grower-finisher herds by province/region and disease status, 2014



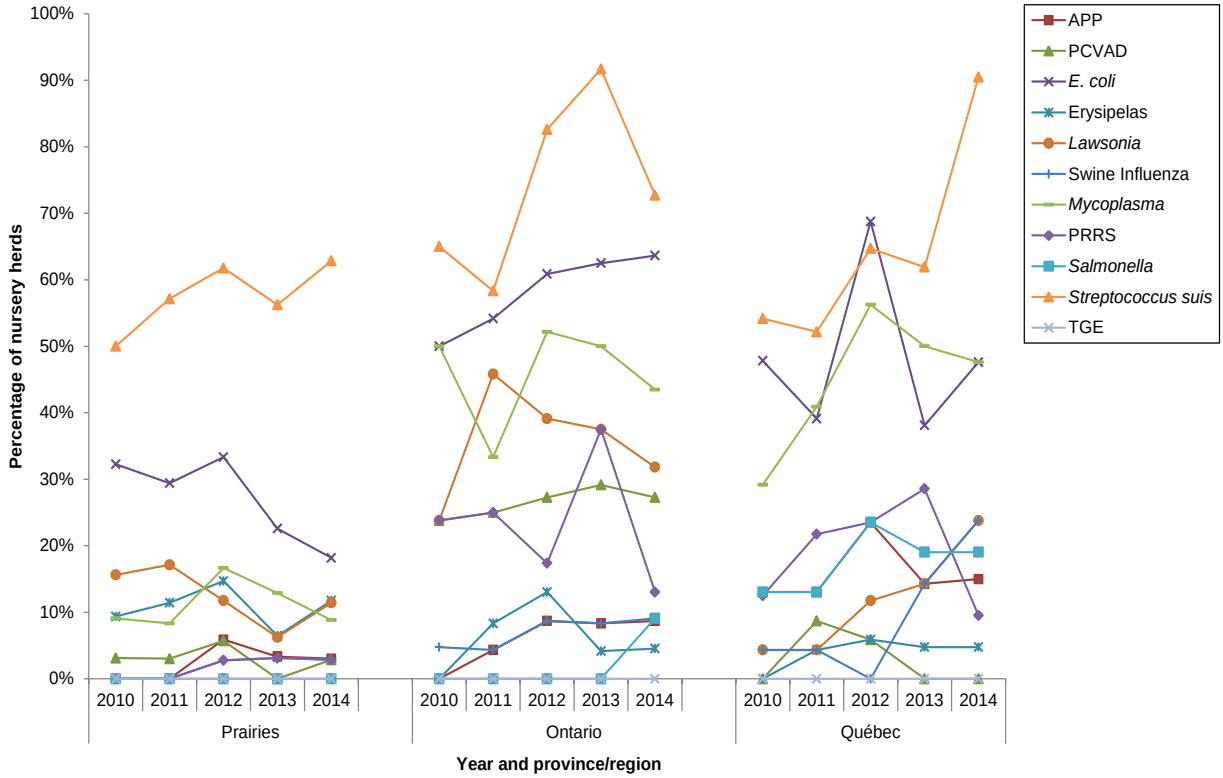
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Not all questionnaires were completed for all diseases listed.
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".

Figure 8.30. Reported antimicrobial use for specific diseases in grower-finisher herds by province/region, 2010–2014



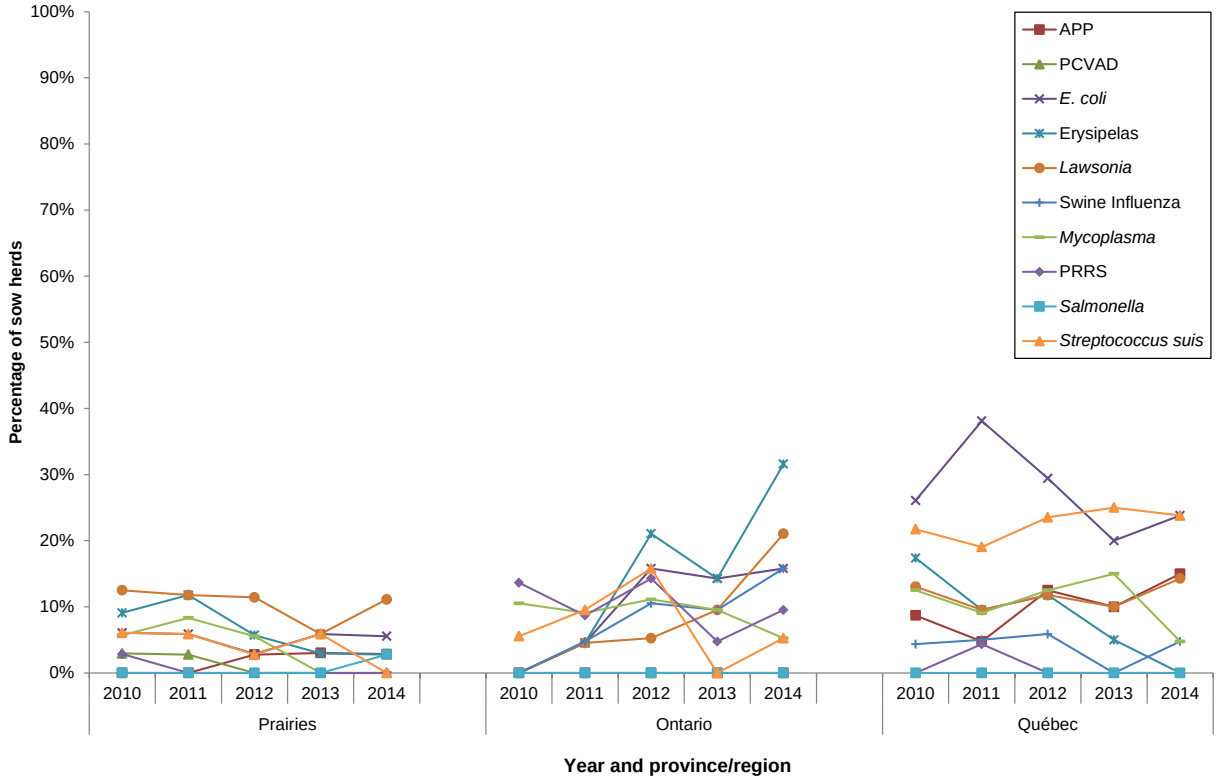
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.31. Reported antimicrobial use for specific diseases in nurseries supplying grower-finisher herds by province/region, 2010–2014



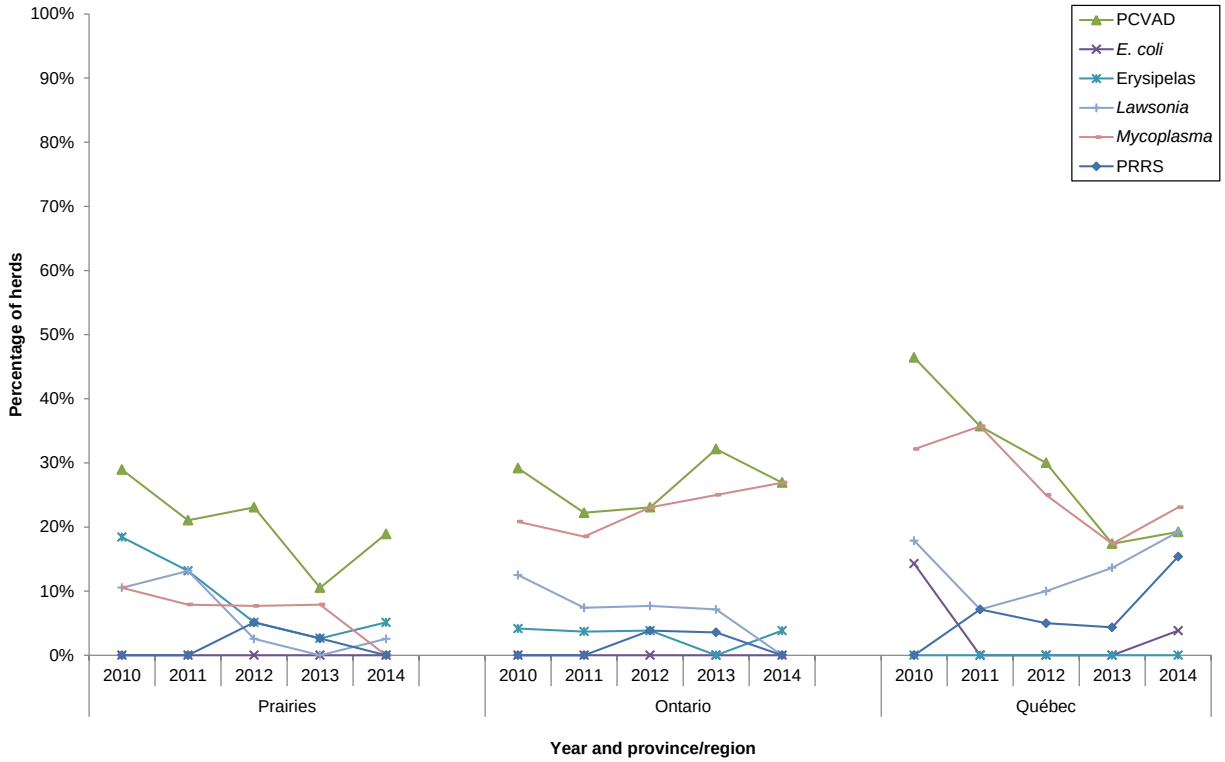
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Not all questionnaires were completed for all diseases listed
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.32. Reported antimicrobial use for specific diseases in sow herds supplying grower-finisher herds, by province/region, 2010–2014



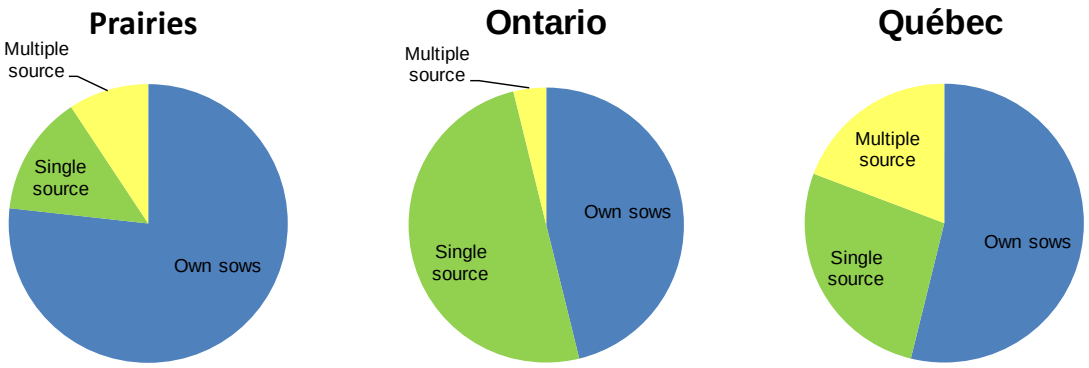
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE was not included in the sow herd survey.
Not all questionnaires were completed for all diseases listed
Health status was considered to be positive if the questionnaire response was "Confirmed positive" or "Likely positive". Health status was considered to be negative if the questionnaire response was "Confirmed negative" or "Likely negative".
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.33. Reported vaccination status of grower-finisher herds by province/region, 2010–2014



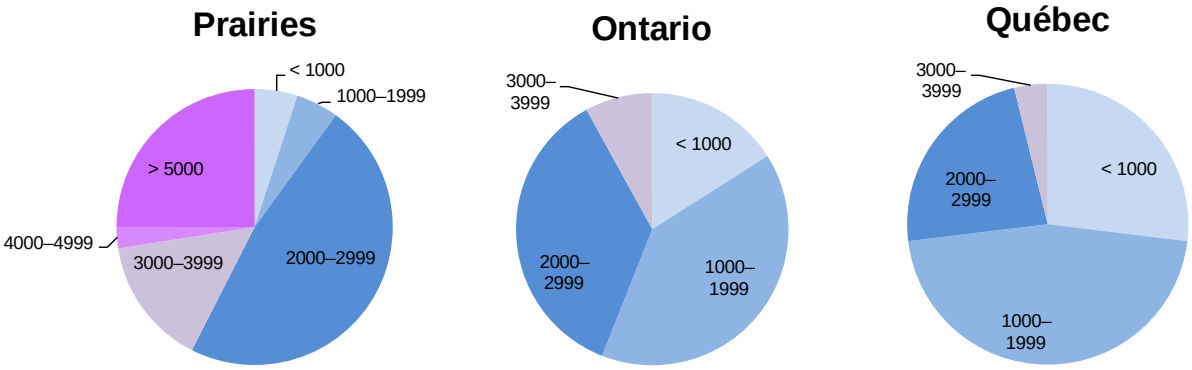
APP = *Actinobacillus pleuropneumoniae.*
PCVAD = Porcine Circovirus Associated Disease.
PRRS = Porcine Reproductive and Respiratory Syndrome.
TGE = Transmissible gastroenteritis.
Diseases where less than 5% of herds vaccinated for all years (2009 to 2014) were not included in the graph. This included, APP, Swine influenza, *Salmonella*, *Streptococcus suis* and TGE.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.34. Source of pigs for grower-finisher herds (n = 95) by province/region, 2014



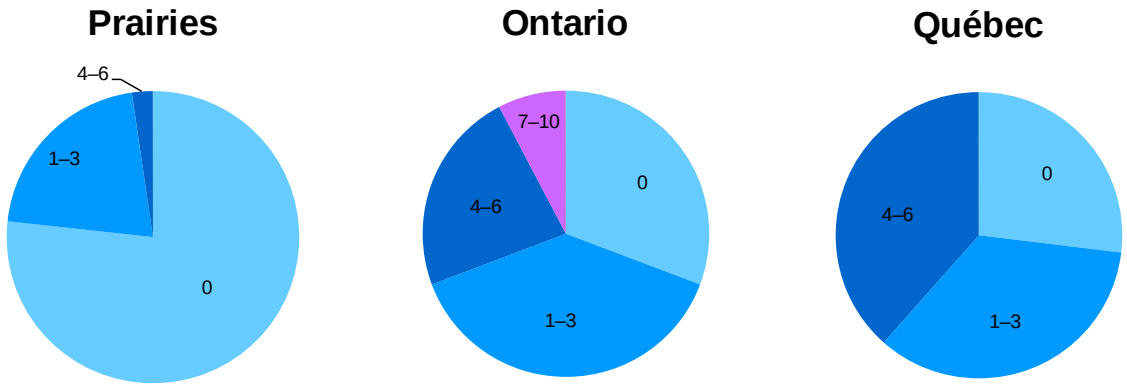
Herds that had their own sows and also purchased pigs from a single source/ multiple sources were classified as multiple source herds.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.35. Barn capacity of grower-finisher herds by province/region, 2014



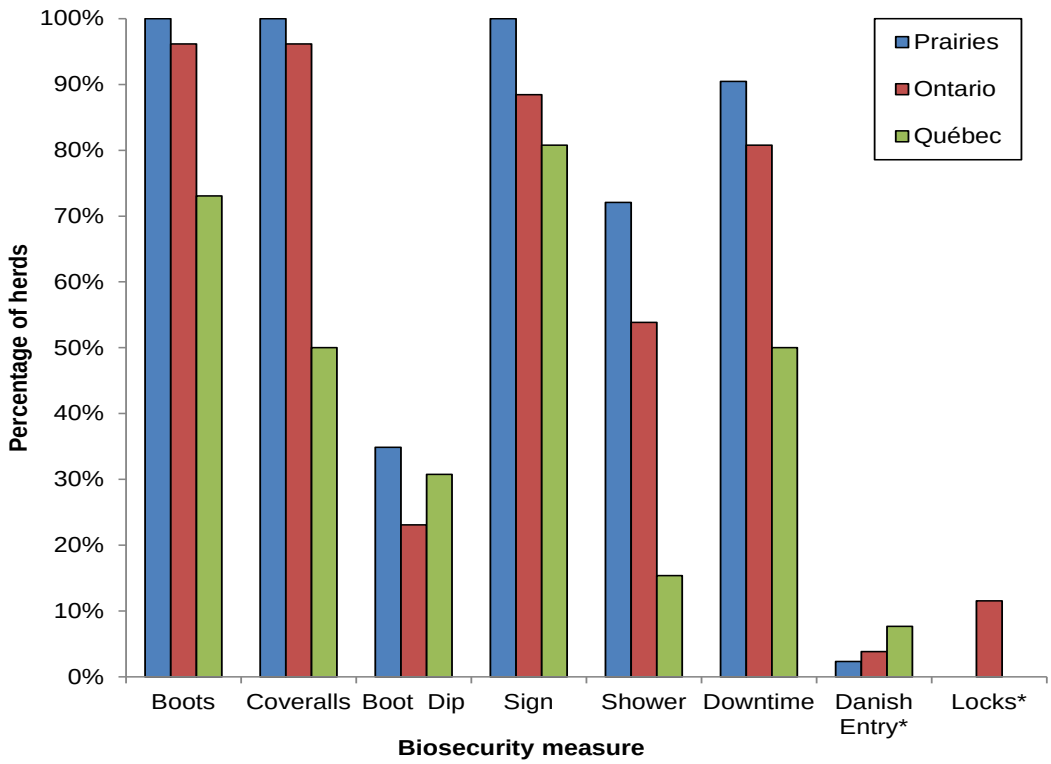
Capacity indicates the maximum number of pigs that the barn is designed to house.
Participating herds may have additional barns that were not sampled for the CIPARS program therefore this barn capacity is not necessarily equivalent to grower-finisher herd size.
Data on barn size was directly collected in 2014 for the first time.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.36. Number of pig farms (n = 95) within 2 km of grower-finisher herds by province/region, 2014



The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

Figure 8.37. Biosecurity measures utilized in grower-finisher herds (n = 95) by province/region, 2014



Danish entry and locks were not specifically listed in the questionnaire but were indicated in the "Other" category, therefore the number of herds reporting this biosecurity measure may be an under-representation.
The Prairies is a region including the provinces of Alberta, Saskatchewan, and Manitoba.

9. QUANTITIES OF ANTIMICROBIALS DISTRIBUTED FOR SALE FOR USE IN ANIMALS

KEY FINDINGS

In 2014, 1.5 million kg of antimicrobials were distributed for sale for use in animals in Canada by the Canadian Animal Health Institute (CAHI) member companies; a decrease of 12% relative to the 2006 total and an increase of 5% relative to the 2013 total (Table 9.1). Though when the Category IV antimicrobials were removed, the decrease since 2006 was 14% and there was a 1% increase since 2013. Of the 1.5 million kg, 73% included antimicrobial classes also used in human medicine. The remaining 27% were in Category IV; considered of low importance in human medicine (ionophores and chemical coccidiostats) (Table 9.1 and Figure 9.1).

Similar to other years, the predominant classes of antimicrobials distributed for sale in 2014 were the tetracyclines, ionophores, β-lactams, "other antimicrobials", and the macrolides (based on kg of active ingredient; Table 9.1 and Figure 9.1).

The quantity of fluoroquinolones distributed for use in animals in 2014 decreased by 10% relative to the 2006 total and increased by 14% relative to the 2013 total (based on kg of active ingredient; Table 9.1 and Figure 9.2).

There were provincial differences between the quantities of antimicrobials distributed for sale (Table 9.2, Figure 9.3, and Figure 9.4) and differences within provinces in the quantities distributed between years. These differences could be related to different numbers and types of animals in each province, differences in disease pressure, or differences in antimicrobial use or other management practices. The quantities reported per province reflect the quantities distributed to veterinary clinics, feed mills, and over-the-counter outlets by CAHI member companies. There may be subsequent re-distribution of antimicrobials across provincial borders after this point.

British Columbia, Alberta, Manitoba, and Ontario all reported an increase in antimicrobials distributed for sale (by % of change) between 2013 and 2014; with the most notable increases occurring in Ontario (30%) and Alberta (24%). Québec and the Atlantic provinces all had a decrease in antimicrobials distributed for sale; ranging between a 9% decline (New Brunswick) to an 80% decline (Newfoundland and Labrador). These values do not account for changes in underlying population or disease pressures.

In 2014, the quantity of antimicrobials distributed for use in companion animals represented less than 1% of the total antimicrobials distributed for sale. Antimicrobials distributed for sale for use in companion animal were mostly β-lactams (penicillins), trimethoprim and sulfonamides, and cephalosporins (Table 9.3 and Figure 9.5). For production animals, the antimicrobials distributed for sale were mostly tetracyclines, ionophores, and β-lactams (penicillins) (Table 9.3 and Figure 9.6).

For the first time, CAHI have stratified their data by pharmaceutical form/route of administration (feed, water, injection, oral/topical, and intra-mammary). Overall, antimicrobials are predominantly distributed for use in feed (84% of total kg) (Figure 9.7). Since 2013 (data not shown), the changes of sales by route of administration were all less than 6%, other than for "oral/topical" where 2014 was 19% higher relative to the 2013 "oral/topical" total. The predominant classes of antimicrobials vary considerably across the routes of administration (Figure 9.8, Figure 9.9, Figure 9.10, Figure 9.11, and Figure 9.12).

New macrolides were registered in 2012 and 2013 in Canada and the volumes for the new product have been reported since 2012.

In terms of the Canadian animal population, the animal biomass (otherwise known as the population correction unit—PCU) in Canada has decreased over time from the highest point in 2006. Since 2006, there has been a 16% decline in the PCU and a 0% change since 2013 (Figure 9.13). Comparing the 2014 animal biomass to 2006, the respective declines in the PCU were as follows: fish 22%, cattle 19%, swine 16%, poultry 4%, rabbits 2%, and sheep and goats 1%. The detailed data used to calculate the PCU for 2014 can be found in Table A.4 in the Appendix. Recent live horse data were not available at the time of writing.

For production animals, the total quantity of antimicrobials distributed for sale adjusted for populations and weights (mg/PCU)in 2014 was 164; an increase of 3% since 2006 and a 1% increase since 2013 (Figure 9.14). New in 2014, the mg/PCU for companion animals was 32.

For international comparison, the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC), at the time of writing, had data available for 26 member countries for 2013. Comparing the most recent data (Canada 2014, ESVAC 2013), Canada ranked as 4th highest for PCU (with first rank being the country with the highest animal biomass); only lower than France, Germany, and Spain. When compared to the countries participating in the ESVAC network, for the mg/PCU, Canada was 21 out of 27 countries (Figure 9.15), when ranked from smallest to highest mg/PCU. Canada's position would be further to the left on the figure (higher mg adjusted by populations and weights) if we could account for the currently unrecorded imports of antimicrobials which fall under own-use importation and imports of active pharmaceutical ingredients intended for further compounding.

Canadian standard weights and provincial-level animal numbers are currently being further developed.

NATIONAL-LEVEL ANTIMICROBIAL DISTRIBUTION DATA

Table 9.1. Quantity of antimicrobials (kg) distributed in Canada for sale for use in animals, 2006–2014

Antimicrobial class aggregation	Quantity of active ingredient (kg)									Change (%) from 2006 to 2014	Change (%) from 2013 to 2014
	2006	2007	2008	2009	2010	2011	2012	2013	2014		
Aminoglycosides	5,122	4,302								NA	NA
			5,817	4,652	3,961					NA	NA
						12,250	10,372	10,785	13,276	NA	23%
Amphenicols	NA	NA	3,242	4,001	4,391	NA	NA	NA	NA	NA	NA
β-Lactams	58,538	52,594								NA	NA
			109,153	118,109	201,934					NA	NA
						147,908				NA	NA
							136,611			NA	NA
								134,838	148,187	NA	10%
Cephalosporins	702	850	NA	NA	NA					NA	NA
						6,725	6,388	2,403	2,714	NA	13%
Fluoroquinolones	591	443	411	377	381	519	406	469	533	-10%	14%
Ionophores, chemical anticoccidials, and arsenicals[a]	455,753	445,952								NA	NA
Ionophores, chemical anticoccidials, arsenicals, and nitroimidazoles[a]			472,384	491,152	490,355					NA	NA
Chemical coccidiostats[a]						22,372				NA	NA
							18,471			NA	NA
								78,493	99,037	NA	26%
Ionophore coccidiostats[a]						433,897				NA	NA
							473,595			NA	NA
								278,297	318,961	NA	15%
Lincosamides	67,825	55,872	41,222	44,137	46,373	43,261	51,027	54,784	60,006	-12%	10%
Macrolides and pleuromutilins	136,497	118,725								NA	NA
Macrolides, pleuromutilins, and bacitracins	NA	NA	210,869	204,169	170,154					NA	NA
Macrolides	NA	NA	NA	NA	NA	108,862	98,622	93,870	112,340	NA	20%
Other antimicrobials	143,029	146,880								NA	NA
			32,706	21,339	26,757					NA	NA
						130,911				NA	NA
							129,614			NA	NA
								125,511	125,230	NA	0%
Tetracyclines	847,281	753,168	680,601	686,832	535,142	600,930	635,435	635,675	599,540	-29%	-6%
Trimethoprim and sulfonamides	50,789	38,961	59,166	57,596	48,221	70,465	58,716			NA	NA
								63,367	68,762	NA	9%
Total	**1,766,126**	**1,617,748**	**1,615,571**	**1,632,365**	**1,527,669**	**1,578,100**	**1,619,257**	**1,478,492**	**1,548,585**	**-12%**	**5%**

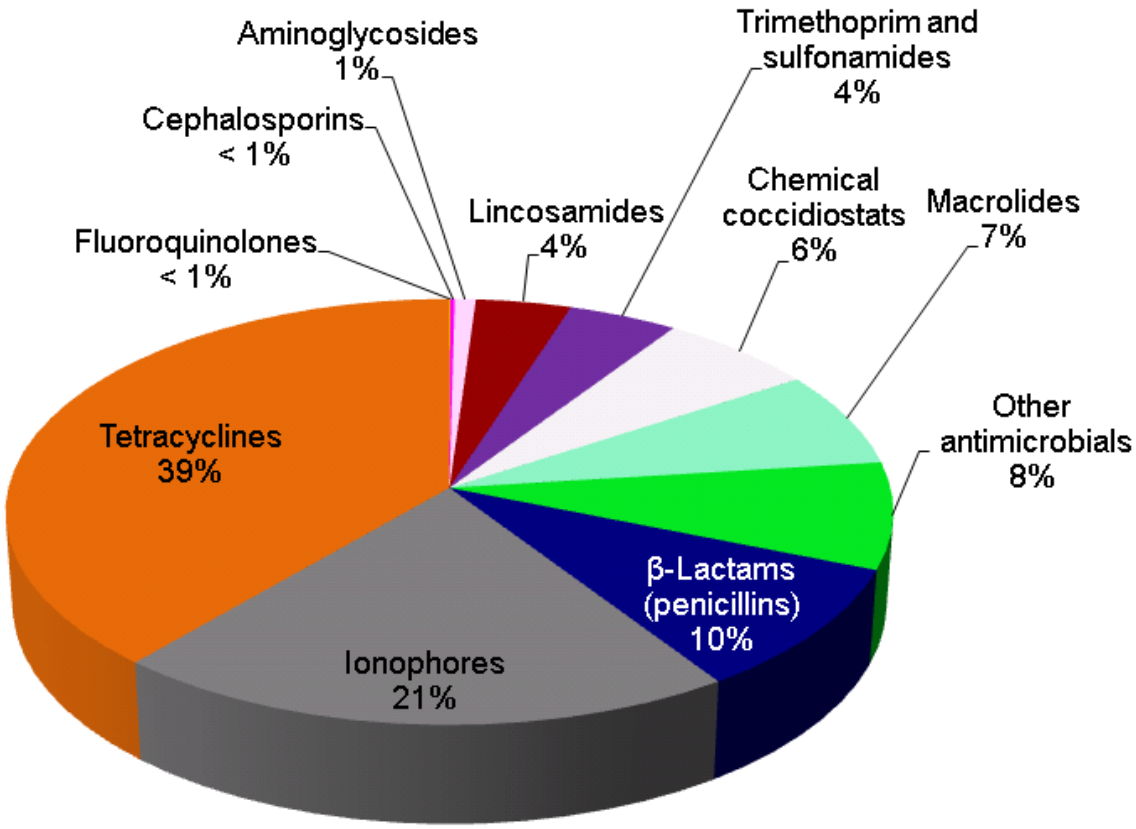
See corresponding footnotes on next pages.

Table 9.1. Quantity of antimicrobials (kg) distributed in Canada for sale for use in animals, 2006–2014 (cont'd)

Values do not include own use imports or active pharmaceutical ingredients used in compounding.
NA = not available or not applicable.
CAHI provides the information according to a "3 company accounting rule" established by CAHI to comply with the European Union and the United States' anti-competition regulations. CAHI added in some cases a "90% rule" to be sure not to infringe the regulations in the United States. These accounting rules can result in changes to the categorization of specific antimicrobials over time; hence within an antimicrobial category, columns with different colours should not be compared.
Changes in percentage over time from 2006 to 2014 are relative to the quantities reported in 2006. Changes in percentage over time from 2013 to 2014 are relative to the quantities reported in 2013.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

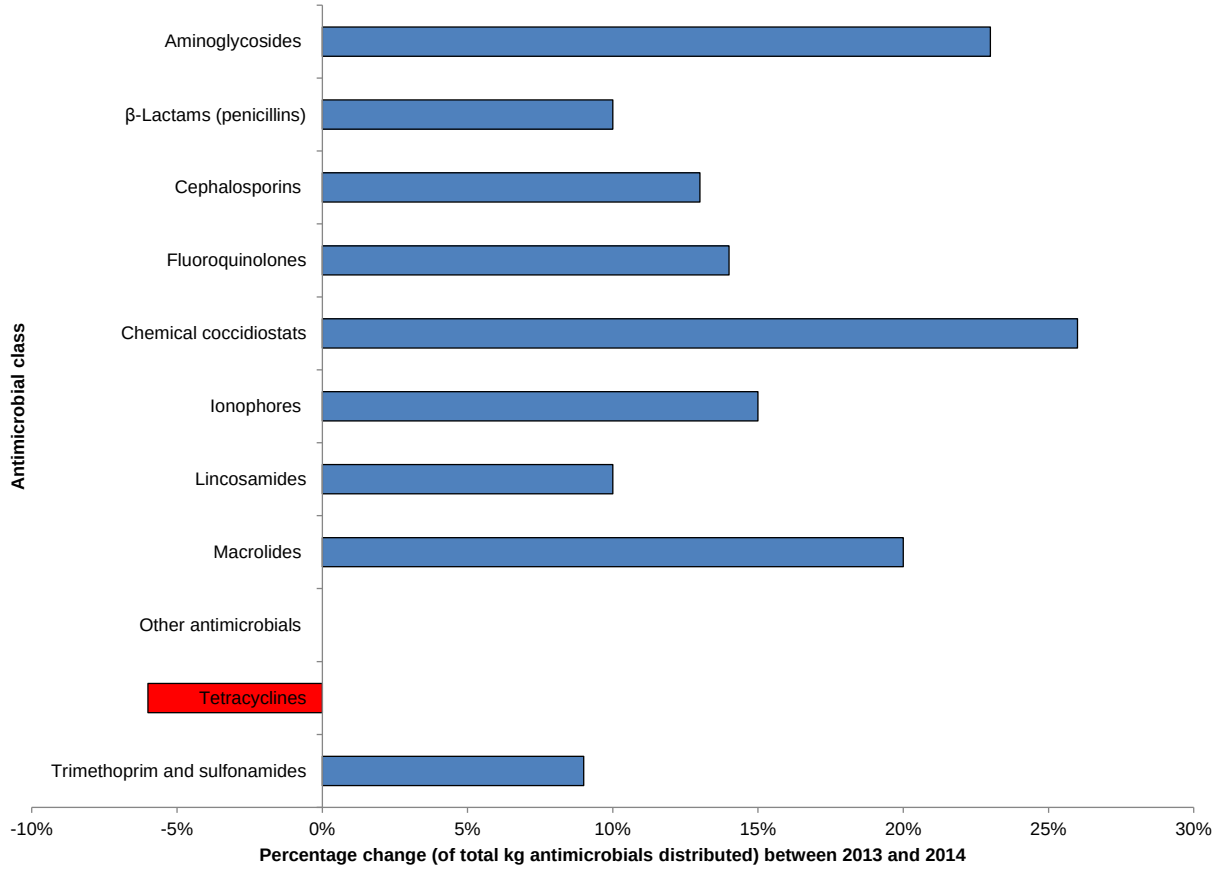
[a] These antimicrobial classes are considered of low importance to human medicine (Category IV) according to Veterinary Drugs Directorate.

Figure 9.1 Percentages of the quantities (kg of active ingredient) of antimicrobials distributed in Canada for sale for use in animals, 2014



Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.2. Percentage change in the quantities of antimicrobials distributed for use in animals between 2013 and 2014



Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

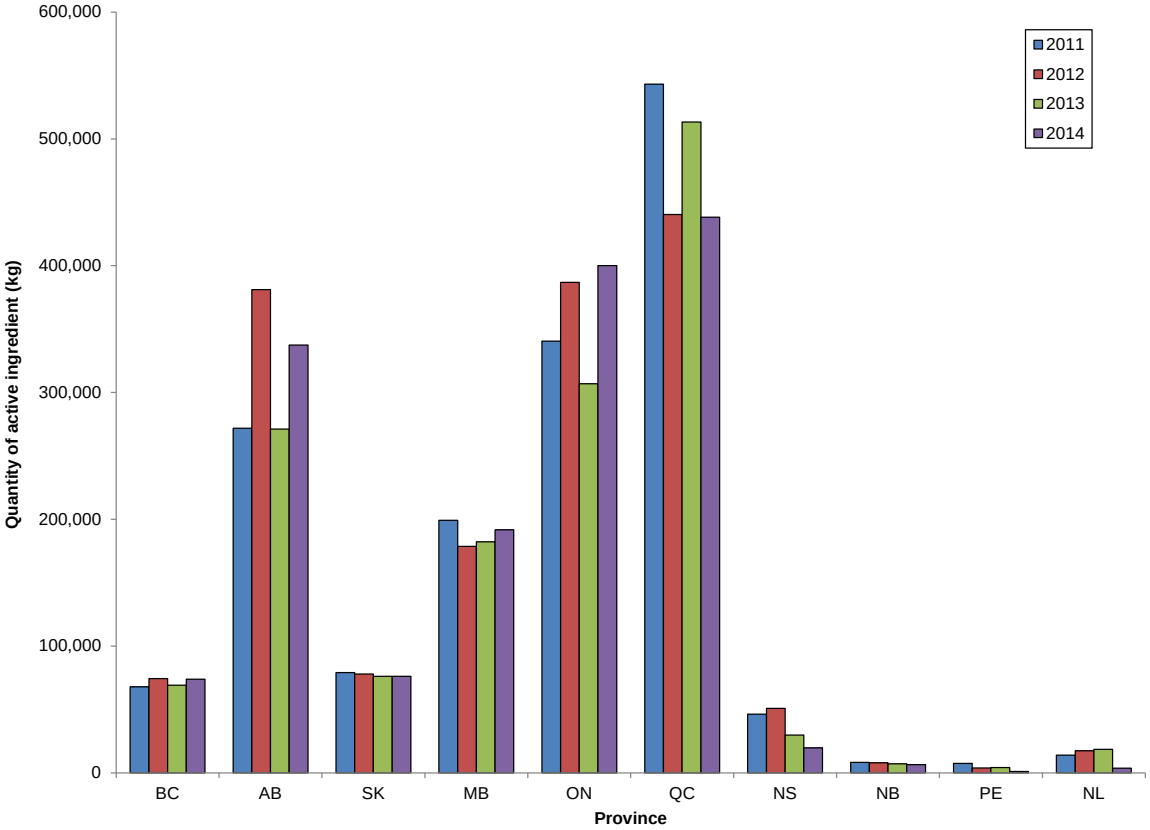
PROVINCIAL-LEVEL ANTIMICROBIAL DISTRIBUTION DATA

Table 9.2. Quantity of antimicrobials (kg of active ingredient) distributed for sale for use in animals, by province, 2011–2014

Year	Province	Aminoglycosides	β-Lactams (penicillins)	Cephalosporins	Fluoroquinolones	Chemical coccidiostats	Ionophores	Lincosamides	Macrolides	Other antimicrobials	Tetracyclines	Trimethoprim and sulfonamides	Total
2014	BC	614	11,405	216	54	16,100	11,008	92	582	11,949	19,384	2,442	73,848
	AB	735	20,897	507	125	21,244	106,645	7,942	30,683	19,586	116,755	12,275	337,394
	SK	668	6,699	125	6	3,388	22,106	3,260	2,991	5,490	27,507	3,974	76,215
	MB	652	18,277	269	21	7,105	36,554	13,673	23,013	11,840	71,478	8,863	191,745
	ON	4,154	56,407	695	234	29,104	67,081	19,559	26,880	37,133	134,221	24,595	400,063
	QC	6,052	30,986	795	80	20,363	69,372	15,314	27,754	35,849	216,041	15,691	438,297
	NS	180	1,412	47	8	1,481	3,719	51	419	1,814	10,112	446	19,688
	NB	103	1,229	26	3	63	795	89	9	153	3,741	316	6,526
	PE	47	581	17	1	1	0	2	8	70	278	99	1,103
	NL	72	293	16	2	188	1,680	24	0	1,347	23	61	3,706
Total		**13,276**	**148,187**	**2,714**	**533**	**99,037**	**318,961**	**60,006**	**112,340**	**125,230**	**599,540**	**68,762**	**1,548,585**
2013	BC	628	10,669	181	49	12,619	17,890	90	928	11,267	12,474	2,395	69,189
	AB	664	19,613	437	102	2,652	79,208	7,596	12,803	17,160	118,675	12,195	271,106
	SK	311	6,707	101	6	454	24,717	3,224	5,592	6,030	24,787	4,204	76,132
	MB	553	16,184	206	16	889	29,728	13,490	10,955	9,494	91,201	9,575	182,292
	ON	3,007	48,319	596	192	9,832	47,434	14,289	13,053	33,254	116,662	20,248	306,886
	QC	3,997	29,926	792	91	17,187	103,767	15,898	50,121	29,562	248,315	13,610	513,266
	NS	793	1,367	35	7	1,201	4,681	64	410	8,784	11,679	711	29,732
	NB	125	1,147	28	3	89	919	85	4	494	4,035	250	7,180
	PE	50	501	16	1	1	0	1	4	604	2,881	107	4,164
	NL	658	404	11	2	213	3,308	47	0	8,863	4,967	72	18,544
Total		**10,785**	**134,838**	**2,403**	**469**	**45,138**	**311,652**	**54,784**	**93,870**	**125,511**	**635,675**	**63,367**	**1,478,492**
2012	BC	598	9,966	658	42	1,017	26,973	81	454	17,255	15,233	2,100	74,376
	AB	643	20,939	1,102	88	1,745	181,282	6,921	30,355	14,592	113,282	10,242	381,193
	SK	294	5,449	229	6	300	27,290	4,581	2,939	5,060	28,622	3,203	77,971
	MB	674	16,057	404	21	1,001	34,213	13,175	11,434	9,285	84,755	7,557	178,577
	ON	3,012	54,031	2,248	172	5,436	113,602	11,796	23,651	37,735	114,729	20,505	386,917
	QC	4,175	26,322	1,376	65	8,430	78,308	14,077	29,163	27,747	236,532	14,168	440,364
	NS	520	1,624	199	7	489	7,658	48	590	7,572	31,534	556	50,797
	NB	116	1,332	99	4	52	720	343	11	1,060	4,018	203	7,959
	PE	46	499	34	1	2	0	3	7	690	2,382	117	3,781
	NL	294	391	40	2	0	3,549	2	18	8,617	4,347	62	17,322
Total		**10,372**	**136,611**	**6,388**	**406**	**18,471**	**473,595**	**51,027**	**98,622**	**129,614**	**635,435**	**58,716**	**1,619,257**
2011	BC	775	11,690	583	50	1,190	24,089	113	827	15,186	10,371	2,881	67,755
	AB	930	22,497	1,190	137	2,338	71,682	6,711	41,567	13,015	97,868	13,853	271,788
	SK	206	6,112	308	15	1,294	22,369	4,821	5,187	4,600	28,401	5,786	79,099
	MB	1,117	17,896	501	22	928	57,400	9,849	14,326	7,119	80,852	9,156	199,166
	ON	3,448	54,305	1,938	206	4,433	89,954	8,410	13,326	39,170	105,905	19,388	340,483
	QC	4,443	30,277	1,881	73	9,330	156,118	12,952	32,275	34,709	242,951	18,126	543,135
	NS	614	1,919	140	9	2,742	8,577	48	615	8,875	22,069	684	46,292
	NB	156	2,244	98	4	117	666	351	566	945	2,915	267	8,329
	PE	60	531	40	1	0	1,271	0	153	586	4,626	197	7,465
	NL	493	382	37	2	0	1,206	1	16	6,694	4,960	116	13,907
Total		**12,242**	**147,853**	**6,716**	**519**	**22,372**	**433,332**	**43,256**	**108,858**	**130,899**	**600,918**	**70,454**	**1,577,419**

Province abbreviations are defined in the Appendix.
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
There may be subsequent distribution of antimicrobials across provincial borders after being distributed to the veterinary clinics.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.3. Quantity of antimicrobials (kg of active ingredient) distributed for sale for use in animals, by province, 2011–2014

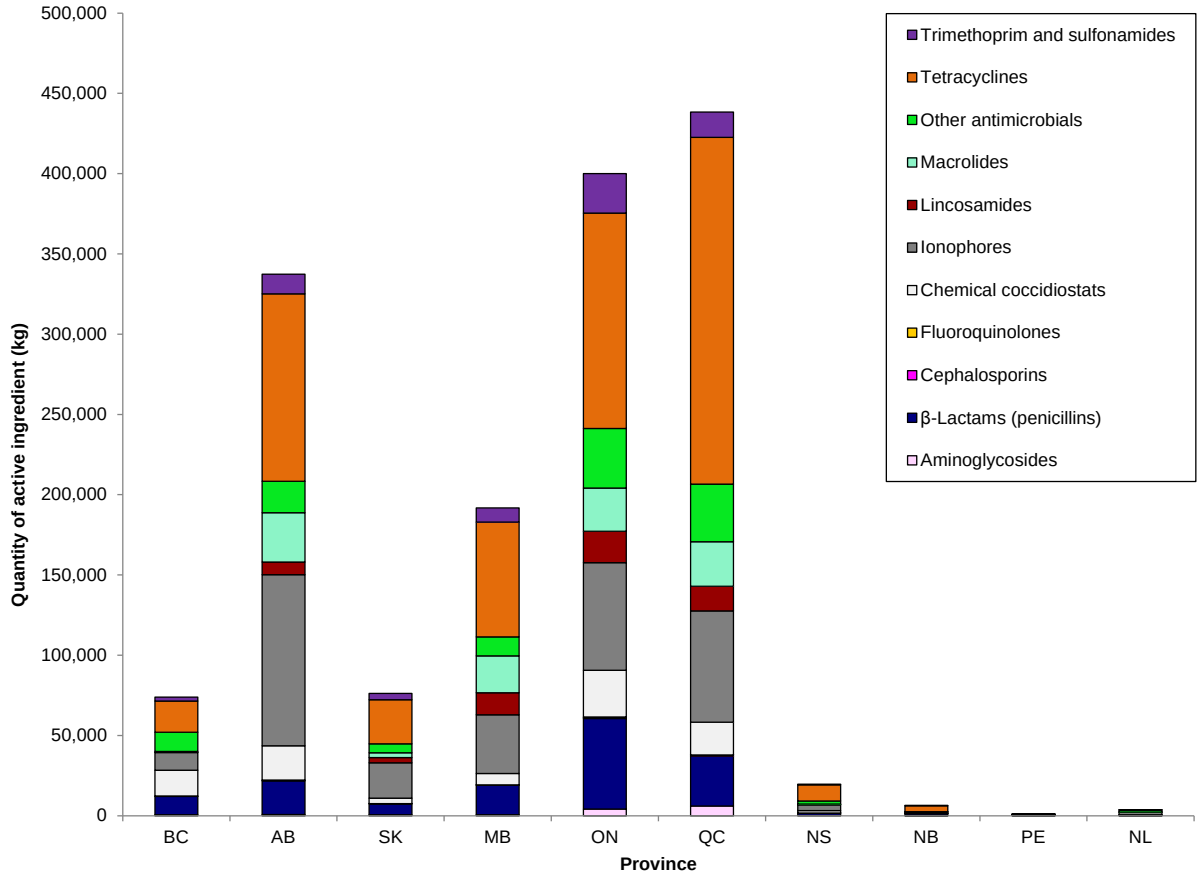


Province	2011	2012	2013	2014	Change (%) since 2011	Change (%) since 2013
BC	67,755	74,376	69,189	73,848	9	7
AB	271,788	381,193	271,106	337,394	24	24
SK	79,099	77,971	76,132	76,215	-4	0
MB	199,166	178,577	182,292	191,745	-4	5
ON	340,483	386,917	306,886	400,063	17	30
QC	543,135	440,364	513,266	438,297	-19	-15
NS	46,292	50,797	29,732	19,688	-57	-34
NB	8,329	7,959	7,180	6,526	-22	-9
PE	7,465	3,781	4,164	1,103	-85	-74
NL	13,907	17,322	18,544	3,706	-73	-80
Total	**1,577,419**	**1,619,257**	**1,478,492**	**1,548,585**	**-2**	**5**

> 10% but < 20% increase
≥ 20% but < 30% increase
≥ 30% increase
> 10% but < 20% decrease
≥ 20% but < 30% decrease
≥ 30% decrease

Province abbreviations are defined in the Appendix.
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
There may be subsequent distribution of antimicrobials across provincial borders after being distributed to the veterinary clinics.
This figure does not account for provincial differences in numbers or types of animals.

Figure 9.4. Quantity of antimicrobials (kg of active ingredient) distributed for sale for use in animals by province and antimicrobial class, 2014



Province abbreviations are defined in the Appendix.
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
There may be subsequent distribution of antimicrobials across provincial borders after being distributed to the veterinary clinics.
This figure does not account for provincial differences in numbers or types of animals.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

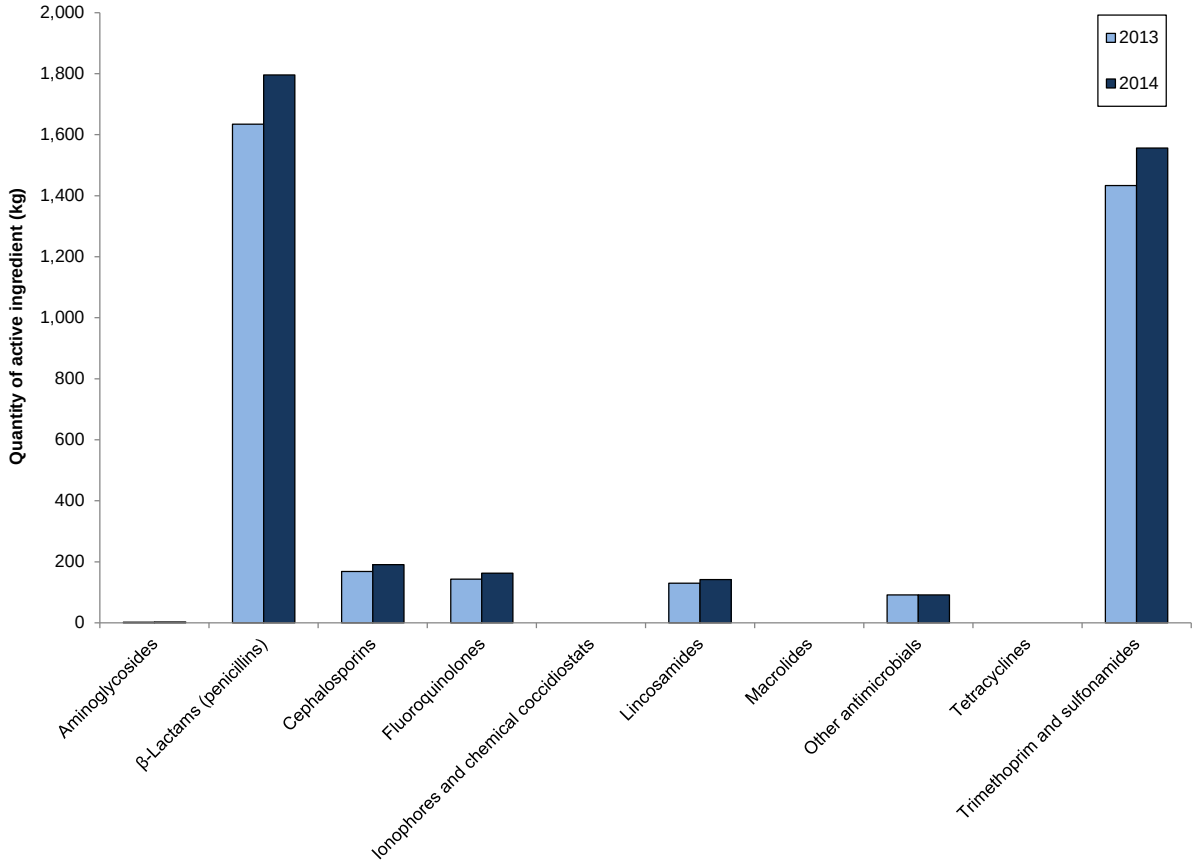
DISTRIBUTION BY ANIMAL TYPE

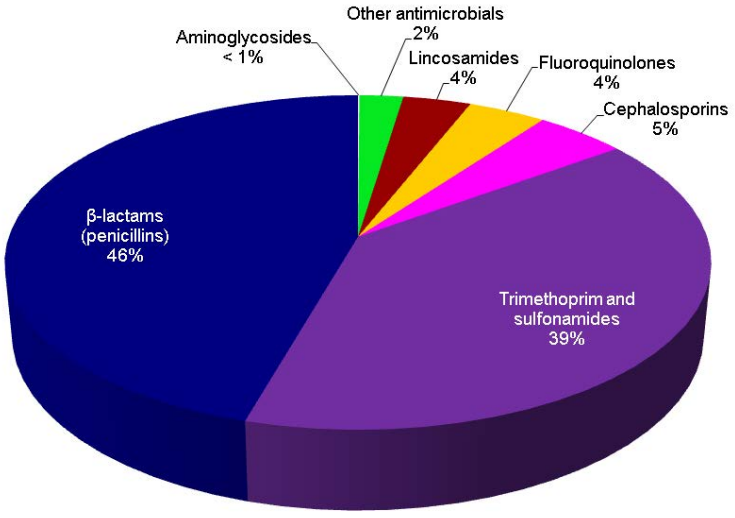
Table 9.3. Quantity of antimicrobials (kg of active ingredient) distributed for sale for use in animals, by province and animal type, 2014

Animal type / province	Aminoglycosides	B-Lactams (penicillins)	Cephalosporins	Fluoroquinolones	Chemical coccidiostats	Ionophores	Lincosamides	Macrolides	Other antimicrobials	Tetracyclines	Trimethoprim and sulfonamides	Total
Production animal												
BC	614	11,267	201	38	16,100	11,008	92	582	11,940	19,384	2,387	73,614
AB	734	20,644	472	87	21,244	106,645	7,923	30,683	19,572	116,755	11,998	336,755
SK	668	6,618	116	4	3,388	22,106	3,253	2,991	5,486	27,507	3,884	76,022
MB	652	18,056	250	14	7,105	36,554	13,640	23,013	11,831	71,478	8,663	191,256
ON	4,153	55,724	646	162	29,104	67,081	19,512	26,880	37,105	134,221	24,038	398,628
QC	6,050	30,610	739	56	20,363	69,372	15,278	27,754	35,823	216,041	15,336	437,422
NS	180	1,395	44	5	1,481	3,719	51	419	1,813	10,112	436	19,654
NB	103	1,214	24	2	63	795	88	9	153	3,741	309	6,501
PE	47	573	15	1	1	0	2	8	70	278	97	1,092
NL	72	290	15	1	188	1,680	24	0	1,346	23	60	3,698
Total	**13,273**	**146,391**	**2,523**	**370**	**99,037**	**318,961**	**59,864**	**112,340**	**125,139**	**599,540**	**67,206**	**1,544,643**
Companion animal												
BC	0	138	15	17	0	0	0	0	9	0	55	234
AB	0	253	36	38	0	0	19	0	14	0	278	638
SK	0	81	9	2	0	0	8	0	4	0	90	194
MB	0	222	19	6	0	0	32	0	9	0	201	489
ON	1	684	49	72	0	0	46	0	27	0	556	1,435
QC	1	376	56	25	0	0	36	0	26	0	355	875
NS	0	17	3	2	0	0	0	0	1	0	10	34
NB	0	15	2	1	0	0	0	0	0	0	7	25
PE	0	7	1	0	0	0	0	0	0	0	2	11
NL	0	4	1	1	0	0	0	0	1	0	1	8
Total	**3**	**1,796**	**191**	**163**	**0**	**0**	**142**	**0**	**92**	**0**	**1,556**	**3,943**
Total (animal types combined)	**13,276**	**148,187**	**2,714**	**533**	**99,037**	**318,961**	**60,006**	**112,340**	**125,230**	**599,540**	**68,762**	**1,548,585**

Province abbreviations are defined in the Appendix.
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
Production animals include horses.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.
The attribution of antimicrobials sold in each province to the type of animal (companion animals vs. production animals) was based on multiplying a national average percentage of the antimicrobial sold for companion animals/production animals by the total reported in that province.
Province abbreviations are defined in the Appendix.

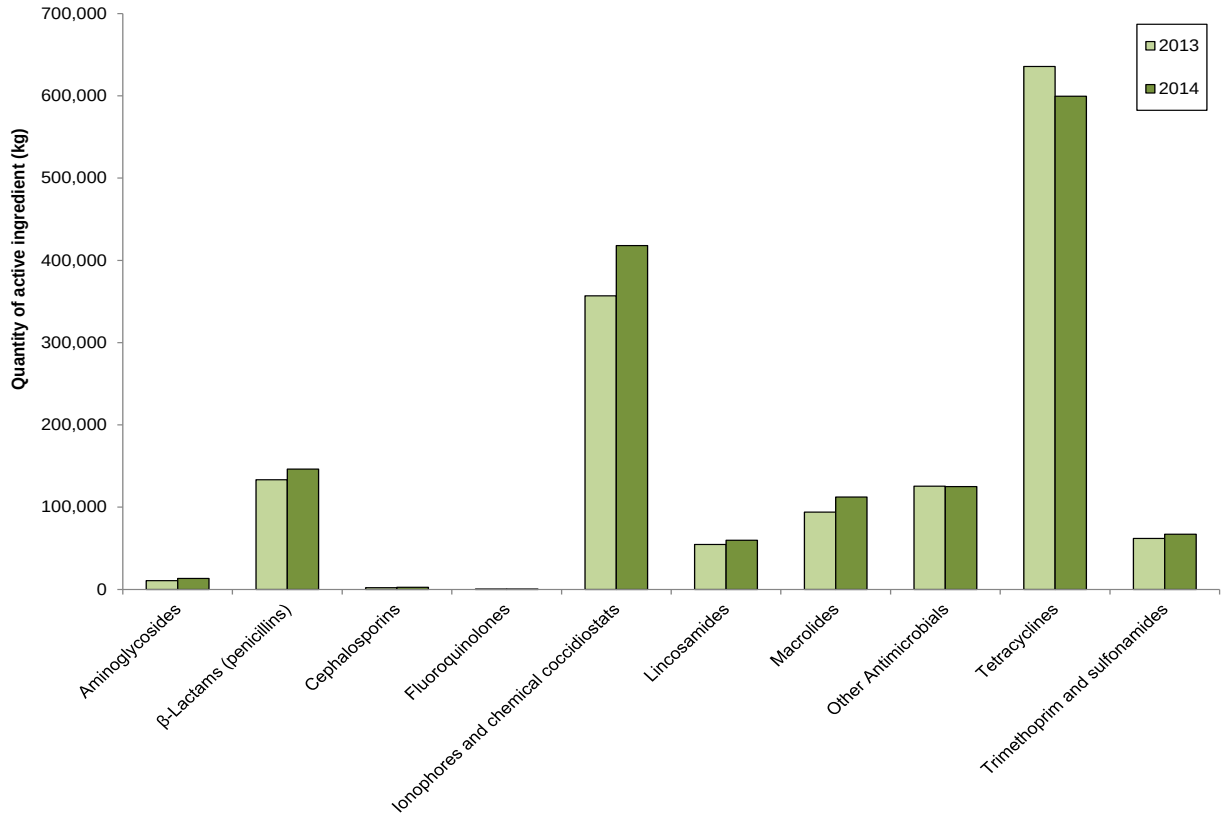
Figure 9.5. Quantity of antimicrobials (kg of active ingredient) distributed for use in companion animals (a) over time and (b) 2014

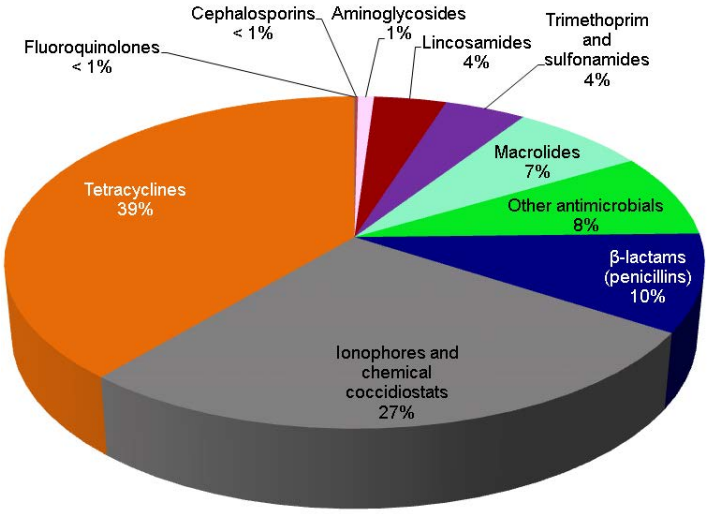




Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.
Antimicrobial sales were assigned to animal type according to label claim and in the situation where mixed species was indicated on the label, the manufacturer assigned the species as either "Companion animal" or "Production animal".

Figure 9.6. Quantity of antimicrobials (kg) distributed for use in production animals (a) over time and (b) 2014

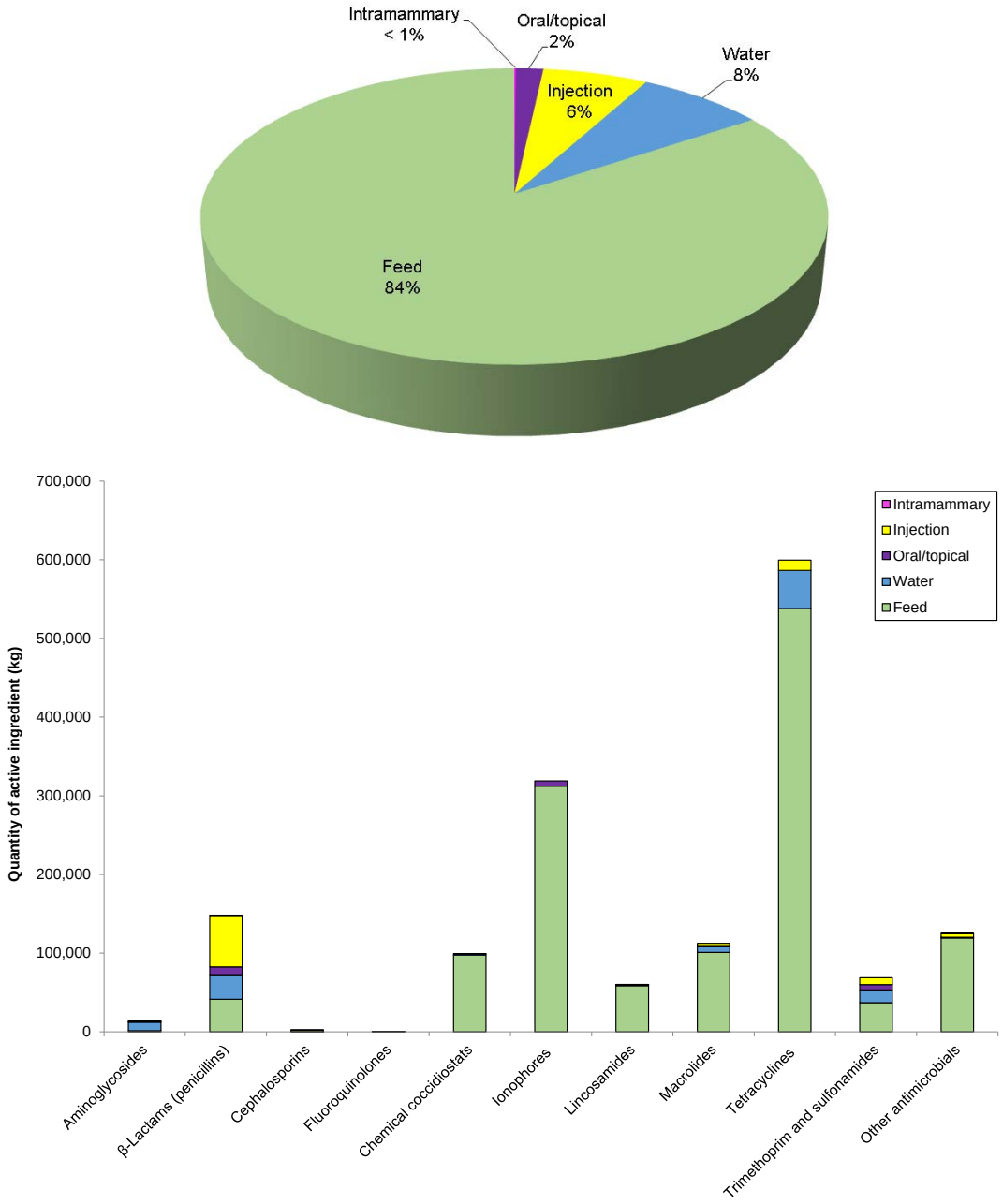




Note the differences in scale of the vertical axes between the companion animal and the production animal figures.
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.
Antimicrobial sales were assigned to animal type according to label claim and in the situation where mixed species was indicated on the label, the manufacturer assigned the species as either "Companion animal" or "Production animal". Production animals include horses.

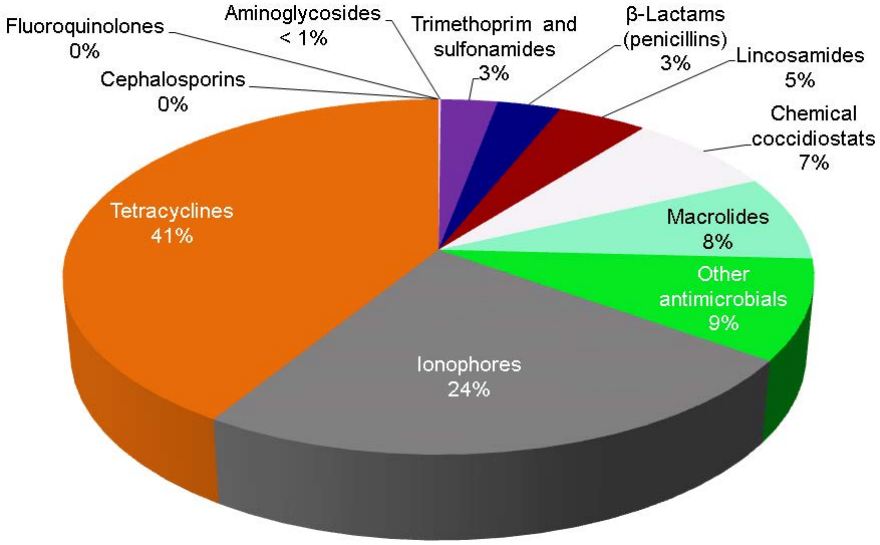
DISTRIBUTION BY ROUTE OF ADMINISTRATION

Figure 9.7. Quantity of antimicrobials (% of total kg and kg of active ingredient) distributed for use in animals, by route of administration and antimicrobial class, 2014



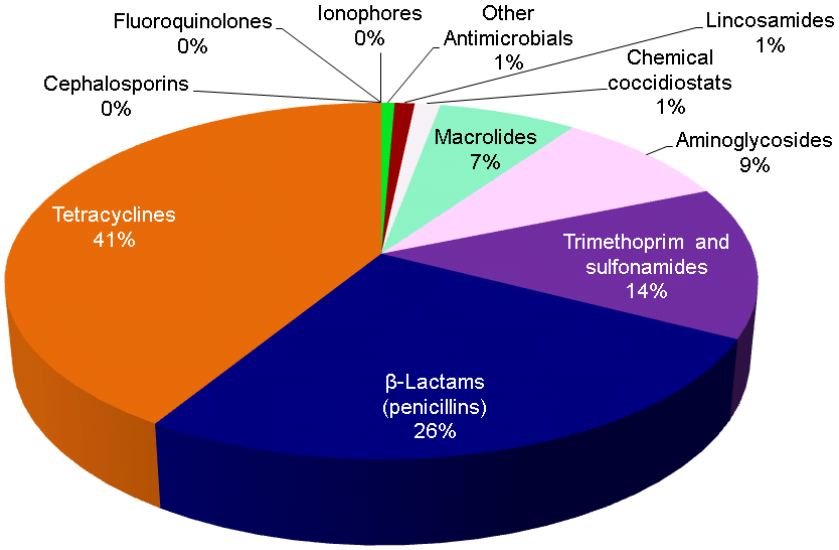
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracin, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.8. Quantity of antimicrobials (% of total kg) distributed for use in animals, via feed, by antimicrobial class, 2014



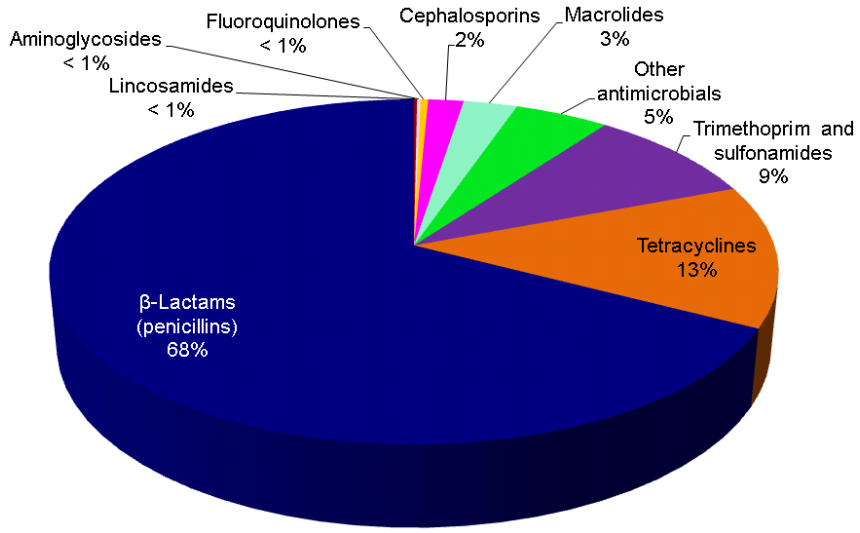
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.9. Quantity of antimicrobials (% of total kg) distributed for use in animals, via water, by antimicrobial class, 2014



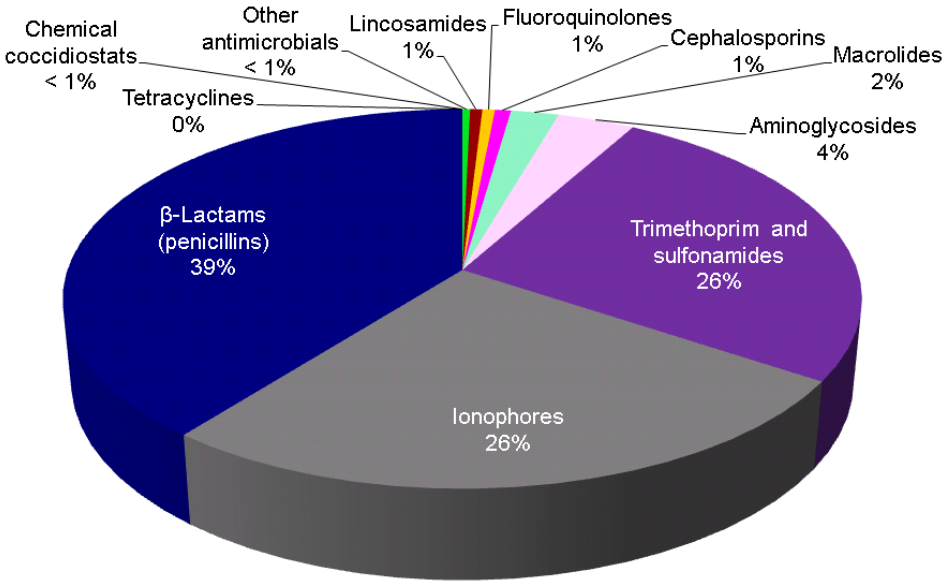
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.10. Quantity of antimicrobials (% of total kg) distributed for use in animals, via injection, by antimicrobial class, 2014



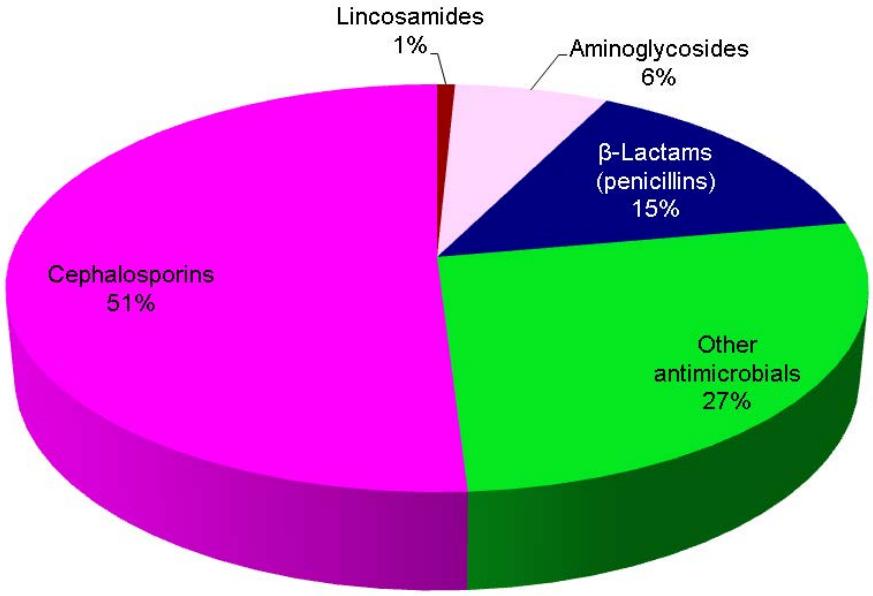
Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.11. Quantity of antimicrobials (% of total kg) distributed for use in animals, via oral/topical routes by antimicrobial class, 2014



Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

Figure 9.12. Quantity of antimicrobials (% of total kg) distributed for use in animals, for intra-mammary use, by antimicrobial class, 2014



Values do not include own use imports or active pharmaceutical ingredients used in compounding.
"Other antimicrobials" for 2014 included: avilamycin, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin, and virginiamycin.

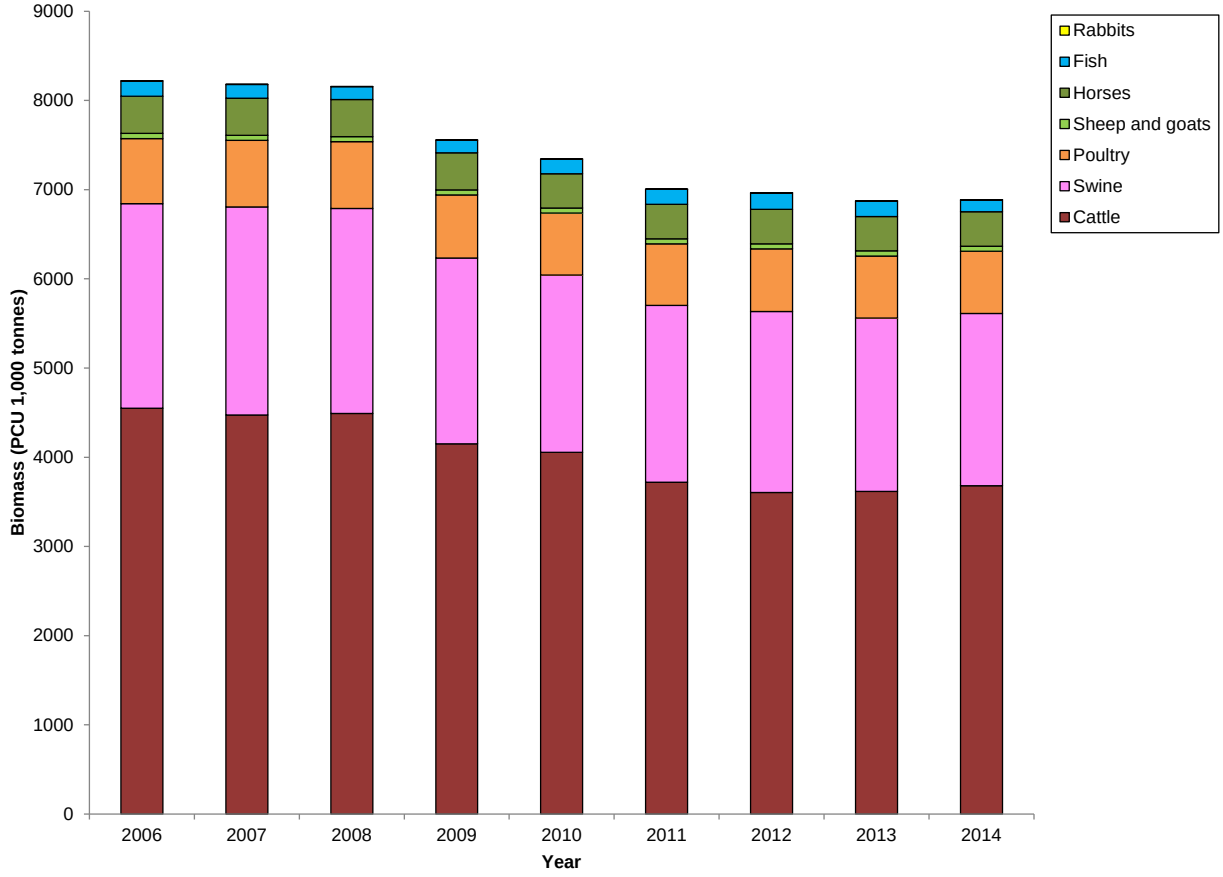
ANTIMICROBIAL SALES AND ANIMAL BIOMASS IN CANADA—THE POPULATION CORRECTION UNIT (PCU) OVER TIME

Table 9.4. Canadian population numbers and population correction unit (PCU), 2014

Animal species	Number of animals and/or kg fish	PCU (1,000 tonnes)
Cattle	8,866,523	3,680
Swine	26,488,530	1,931
Poultry	606,771,567	697
Sheep and goats	1,362,265	58
Horses	963,500	385
Fish	133,583,000	134
Rabbit	590,086	1
Total production animals		**6,886**
Cats	7,000,000	28
Dogs	6,400,000	96
Total companion Animals		**124**

For more detailed information on data sources and specific information on production stages, imports, exports, please see Table A.4 in Appendix.
The data used for live horses was from 2010; more recent data were unavailable.

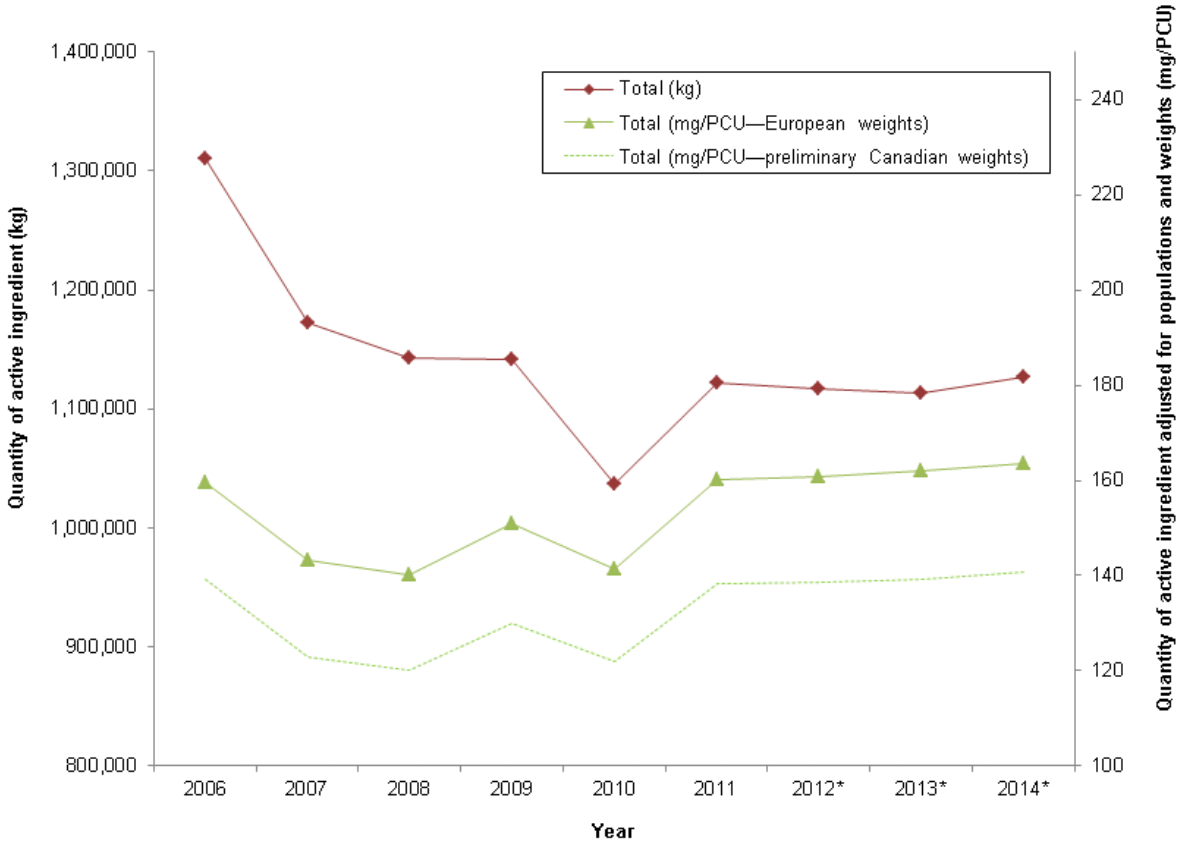
Figure 9.13. Canadian animal biomass as measured by the population correction unit (PCU) over time, using European weights and European Surveillance of Veterinary Antimicrobial Consumption production classes, 2006–2014



For 2010 to 2014, the data used for live horses was from 2010; more recent data were unavailable.
Data based on European weights and European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) production classes (no companion animals)[30].

[30] Sales of veterinary antimicrobial agents in 26 EU/EEA countries in 2012 (EMA/333921/2014). European Medicines Agency. European Surveillance of Veterinary Antimicrobial Consumption (ESVAC). Available at: www.ema.europa.eu/docs/en_GB/document_library/Report/2014/10/WC500175671.pdf. Accessed August 2015.

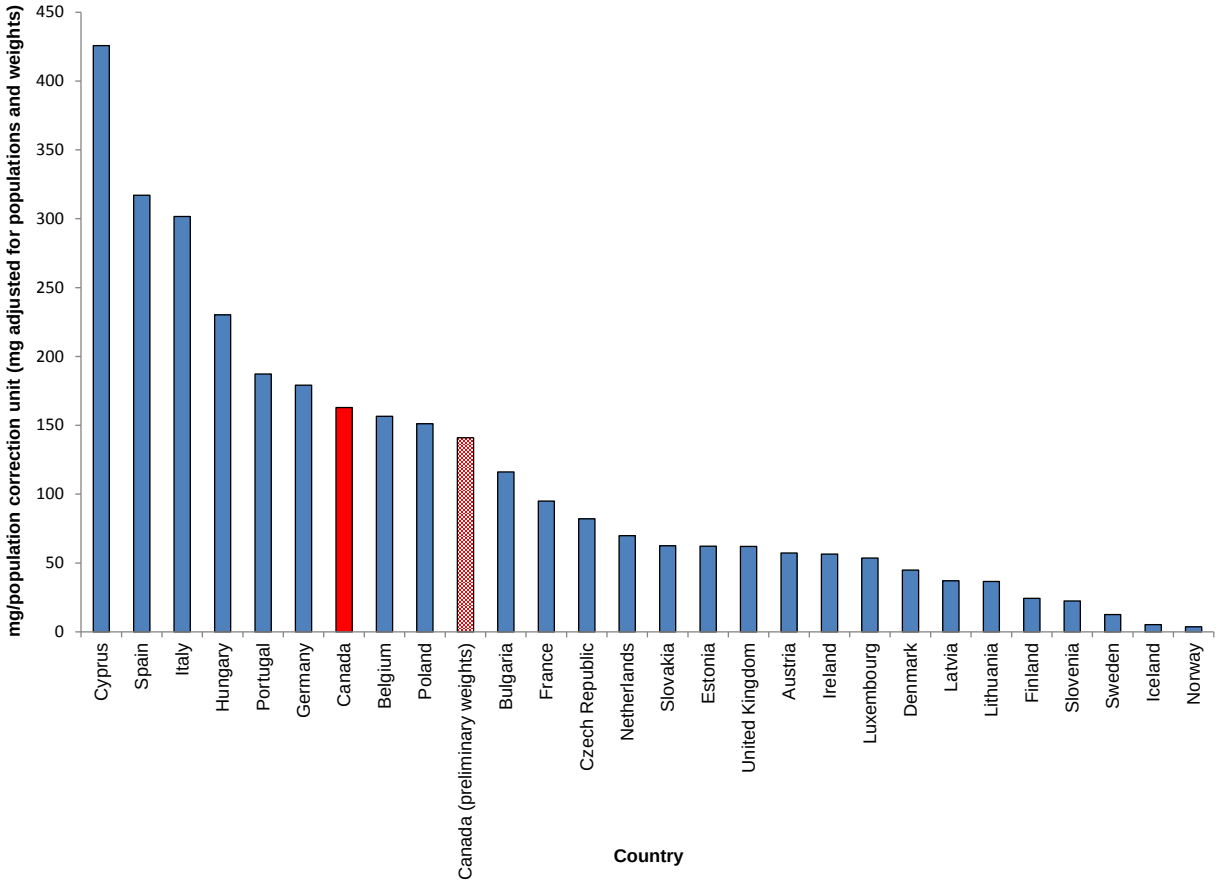
Figure 9.14. Antimicrobials distributed for use in animals over time (kg of active ingredient and mg/PCU), 2006–2014



PCU = population correction unit.
Own-use importation and active pharmaceutical ingredient importation are not included for the Canadian data.
Ionophores and chemical coccidiostats were excluded.
*Indicates data excluding antimicrobials sold for use in companion animals.
For 2010 to 2014, the data used for live horses was from 2010; more recent data were unavailable.

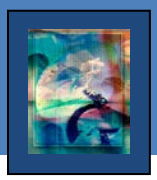
INTERNATIONAL-LEVEL DATA

Figure 9.15. Sales of antimicrobials (adjusted by populations and weights) for Canada (2014) and countries participating in the European Surveillance of Veterinary Antimicrobial Consumption network (2013)



PCU = population correction unit.
Own-use importation and active pharmaceutical ingredient importation are not included for the Canadian data.
Ionophores and chemical coccidiostats were excluded.
The PCU denominator was harmonized to the greatest extent possible with the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC)[31]. ESVAC denominator does not include beef cows, whereas in Canada beef cows are a significant population and are included. ESVAC approach excludes companion animal data from the numerator.
Data from all countries shown are using the same average weights at treatment. However, Canadian average weights in many production classes are heavier than European average weights. As per stakeholder request, based on preliminary analysis, the lighter red column for Canada indicates where Canada would rank if Canadian average weights at treatment were used in the calculations. Canadian stakeholder experts are working with CIPARS to refine this analysis.

[31] European Medicines Agency, European Surveillance of Veterinary Antimicrobial Consumption. Sales of veterinary antimicrobial agents in 26 EU/EEA countries in 2013 - Fifth ESVAC Report. (EMA/387934/2015). Available at: www.ema.europa.eu/docs/en_GB/document_library/Report/2015/10/WC500195687.pdf. Accessed October 2015.



APPENDIX—DESIGN AND METHODS

ANTIMICROBIAL RESISTANCE

HUMAN SURVEILLANCE

OBJECTIVE(S)

The objective of the *Surveillance of Human Clinical Isolates* component of CIPARS is to provide a representative and methodologically unified approach to monitor temporal variations in the prevalence of antimicrobial resistance in *Salmonella* isolated from humans.

SURVEILLANCE DESIGN

Hospital-based and private clinical laboratories culture human *Salmonella* isolates in Canada. Although reporting is mandatory through laboratory notification of reportable diseases to the National Notifiable Disease Reporting System, forwarding of *Salmonella* isolates to provincial reference laboratories is voluntary and passive. A high proportion (84% in 2001)[32] of *Salmonella* isolates are forwarded to Provincial Public Health Laboratories (PPHLs), but this proportion may vary among laboratories. The Yukon, Northwest Territories, and Nunavut, which do not have a PPHL counterpart, forward their isolates to one of the PPHLs.

Prior to 2002, PPHLs forwarded *Salmonella* isolates to the Enteric Diseases Program, National Microbiology Laboratory (NML) @ Winnipeg, Public Health Agency of Canada (PHAC), Winnipeg, Manitoba for confirmation and subtype characterization. A letter of agreement by which provinces agreed to forward all or a subset of their *Salmonella* isolates to NML @ Winnipeg for CIPARS was signed in 2002 by the PPHLs and PHAC. This agreement officially launched the surveillance program.

To ensure a statistically valid sampling plan, all human *Salmonella* isolates (outbreak-associated and non-outbreak-associated) received passively by PPHLs in Saskatchewan, Manitoba, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador were forwarded to the NML. The PPHLs in more heavily populated provinces (British Columbia,

[32] Report of the 2001 Canadian Laboratory Study, National Studies on Acute Gastrointestinal Illness, Division of Enteric, Foodborne and Waterborne Diseases, 2002.

Alberta, Ontario, and Québec) forwarded only the isolates received from the 1st to the 15th of each month. However, all human *S*. Newport and *S*. Typhi isolates were forwarded to the NML because of concerns of multidrug resistance and clinical importance, respectively.

The PPHLs were also asked to provide a defined set of data for each forwarded isolate, including serovar name, date collected, and patient age, sex, and province of residence.

RETAIL MEAT SURVEILLANCE

OBJECTIVE(S)

The objectives of CIPARS *Retail Meat Surveillance* component are to provide data on the prevalence of antimicrobial resistance and to monitor temporal variations in selected bacteria found in raw meat at the provincial/region level.

SURVEILLANCE DESIGN

Retail Meat Surveillance provides a measure of human exposure to antimicrobial-resistant bacteria via the consumption of undercooked meat. Retail food represents a logical sampling point for surveillance of antimicrobial resistance because it is the endpoint of food animal production. Through meat sample collection and testing, the retail surveillance provides a measure of human exposure to antimicrobial resistant bacteria through the consumption of meat products available for purchase by Canadian consumers. The scope of the surveillance framework can be modified as necessary (e.g., to evaluate different food commodities, bacteria, or geographic regions) and functions as a research platform for investigation of specific questions regarding antimicrobial resistance in the agri-food sector.

The unit of concern in *Retail Meat Surveillance* in 2014 was the bacterial isolate cultured from one of the commodities of interest. In this situation, the commodities were raw meat products commonly consumed by Canadians, which originated from the 3 animal species sampled in the *Abattoir Surveillance* component as well as turkey beginning in 2012. These raw meat products consisted of chicken (legs or wings [skin on]), turkey (ground), pork (chops), and beef (ground).

For ground beef, a systematic collection of extra-lean, lean, medium, and regular ground beef was performed to ensure representation of the heterogeneity of ground beef with respect to its origins (e.g., domestic vs. imported beef or raised beef cattle vs. culled dairy cattle). The meat cuts "legs or wings with skin on", "ground turkey", "pork chops", and "ground beef" were chosen on the basis of suspected high prevalences of the targeted bacterial species within and the low purchase prices of these commodities[33] and for comparability to other international retail surveillance programs .

Bacteria of interest in chicken and turkey were *Campylobacter*, *Salmonella*, and generic *E. coli*. In pork, both *Salmonella* and *E. coli* were cultured, but only isolates of *E. coli* underwent antimicrobial susceptibility testing for routine surveillance. *Salmonella* was isolated from pork

[33] Ravel A. Antimicrobial Surveillance in food at retail – Proposal for a pilot project. 2002. 13 pp.

mainly to provide recovery estimates from this commodity for other Public Health Agency of Canada programs. Because the prevalence of *Salmonella* in pork is low, antimicrobial susceptibility results are not presented on an annual basis but are pooled and presented over a multi-year period in the interest of precision. Recovery of *Campylobacter* from pork was not attempted because of the low prevalence observed in the initial stages of *Retail Meat Surveillance*. In beef, only *E. coli* was cultured and then tested for antimicrobial susceptibility given the low prevalence of *Campylobacter* and *Salmonella* in this commodity at the retail level, as determined during the early phase of the program. In turkey, *Campylobacter*, *Salmonella*, and *E. coli* were isolated from retail samples.

SAMPLING METHODS

Generally, the sampling protocol was designed to evaluate antimicrobial resistance in certain bacterial species that contaminate retail meat and to which Canadian consumers may subsequently be exposed. In 2014, it primarily involved continuous weekly submission of samples of retail meat from randomly selected geographic areas (i.e., census divisions defined by Statistics Canada), weighted by population, in each participating province.

Retail meat samples were collected in British Columbia, Prairies (a region including the provinces of Saskatchewan, Alberta, and Manitoba[34]), Ontario, and Québec. In past years, retail data have been presented for the Atlantic region (a region including the provinces of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador[35]). In 2012, due to unforeseeable delays with respect to resuming sampling, very few retail samples were collected and thus, data from the Atlantic region are not presented in the 2012 Annual Report. In the 2014 CIPARS Annual Report, previously unpublished data for 2013 and 2014 in the Atlantic region regarding *E. coli* and *Salmonella* are presented.

Data from Statistics Canada were used to define strata. This was done by using cumulative population quartiles (or thirdtiles) from a list of census divisions in a province, sorted by population in ascending order. Generally, between 15 and 18 census divisions per province/region were then chosen by means of stratified random selection and weighted by population within each stratum. The number of sampling days allocated to each stratum was also weighted by population and is summarized as follows:

BRITISH COLUMBIA

- Stratum One: 10 divisions selected, with 1 sampling day per division per year
- Stratum Two: 4 divisions selected, with 3 sampling days per division per year
- Stratum Three: 1 division selected, with 20 sampling days per year

[34] No retail sampling was conducted in Manitoba.

[35] No retail sampling was conducted in Newfoundland and Labrador.

PRAIRIES

- Stratum One: 9 divisions selected, with 2 sampling days per division per year
- Stratum Two: 5 divisions selected, with 3 sampling days per division per year
- Stratum Three: 2 divisions selected, with 5 sampling days per division per year
- Stratum Four: 1 division selected, with 7 sampling days per year

ONTARIO and QUÉBEC

- Stratum One: 10 divisions selected, with 2 sampling days per division per year
- Stratum Two: 4 divisions selected, with 5 sampling days per division per year
- Stratum Three: 2 divisions selected, with 10 sampling days per division per year
- Stratum Four 1 division selected, with 20 sampling days per year

ATLANTIC REGION

For the 3 Maritimes provinces, results are aggregated and presented at the Atlantic region level; however, sampling activities for this region were proportional to the population within each province as indicated below. Furthermore, as with the other provinces/regions sampled in the retail component, sampling within each province was proportional to the census division subpopulations and is summarized as follows:

Nova Scotia

- Stratum One: 5 divisions selected, with 1 sampling day per division per year (on average)
- Stratum Two: 4 divisions selected, with 2 sampling days per division per year
- Stratum Three: 1 division selected, with 10 sampling days per division per year

New Brunswick

- Stratum One: 5 divisions selected, with 1 sampling day per division per year (on average)
- Stratum Two: 4 divisions selected, with 2 sampling days per division per year
- Stratum Three: 2 divisions selected, with 4 sampling days per division per year (on average)

Prince Edward Island

- Stratum One: 1 division selected, with 1 sampling day per division per year
- Stratum Two: 1 division selected, with 2 sampling days per division per year

Generally, field workers in Ontario and Québec conducted sampling on a weekly basis, and those in British Columbia, the Prairie region, and the Atlantic region conducted sampling every other week. Sampling was less frequent in British Columbia, the Prairie region, and the Atlantic region because of funding constraints, limited laboratory capacity, and a desire to avoid over-sampling at particular stores. Samples were collected on Mondays or Tuesdays for submission to the laboratory by Wednesday. Samples submitted from outside Québec (with the exception of samples from the Atlantic region) were sent to the same laboratory via 24-hour courier. In the rare sampling weeks for the Atlantic region in 2014, samples from the whole Atlantic region were collected on Mondays or Tuesdays and submitted to a laboratory in Prince Edward Island within 24 hours.

In each province, 2 census divisions were sampled each sampling week. In each census division, 4 stores were selected prior to the sampling day, based on store type. Generally, 3 chain stores and 1 independent market or butcher shop were selected. An exception to this protocol was made in densely populated urban census divisions (e.g., Toronto or Montréal), where 2 chain stores and 2 independent markets or butcher shops were sampled to reflect the presumed shopping behaviour of that subpopulation. Generally speaking, from each store type, 1 sample of each commodity of interest was attempted, for a desired total of 15 meat samples (4 chicken, 4 turkey, 4 pork, and 3 beef samples) per division per sampling day[36]. When possible, specific stores were sampled only once per sampling year. In some cases due to reduced availability of certain meats and store closures etc., the desired sample yield was not achieved.

Prevalence estimates were used to determine the numbers of samples to be collected, which were based on an expected yield of 100 isolates per commodity per province per year, plus 20% to account for lost or damaged samples. Because sampling was less frequent in British Columbia, the Prairie region, and the Atlantic region than in Ontario and Québec, the target of 100 isolates per year may not have always been met in those provinces/regions.

Personal digital assistants (PDAs) were used to capture the following store and sample data:

- Type of store
- Number of cash registers (surrogate measure of store volume)
- "Sell-by" or packaging date
- "May contain previously frozen meat" label—yes or no
- Final processing in store—yes, no, or unknown
- Air chilled—yes, no, or unknown (applied to chicken samples only)
- Organic—yes, no, or unknown
- Antimicrobial free—yes, no, or unknown
- Price per kilogram

[36] At 1 store in each division (except the Atlantic region), the beef sample was not collected to minimize over-sampling of this commodity.

Individual samples were packaged in sealed zipper-type bags and placed in 16 L thermal coolers for transport. The ambient environmental temperature was used to determine the number of ice packs placed in each cooler (i.e., 1 ice pack for temperatures below 20°C and 2 ice packs for temperatures 20°C or higher). In 1 or 2 coolers per sampling day, instruments for recording temperature data[37] were used to monitor temperatures to which samples were exposed.

ABATTOIR SURVEILLANCE

OBJECTIVE(S)

The objectives of the CIPARS *Abattoir Surveillance* component are to provide nationally representative, annual antimicrobial resistance data for bacteria isolated from animals entering the food chain, and to monitor temporal variations in the prevalence of antimicrobial resistance in these bacteria.

SURVEILLANCE DESIGN

Abattoir Surveillance only includes animals that originated from premises within Canada. Established in September 2002, this component initially targeted generic *Escherichia coli* and *Salmonella* within the food animal commodities associated with the highest per capita meat consumption: beef cattle, broiler chickens, and pigs. In 2003, the component was refined to discontinue *Salmonella* isolation from beef cattle because of the low prevalence of *Salmonella* in that population. *Campylobacter* surveillance was initiated in beef cattle in late 2005 in order to include a pathogen in beef cattle surveillance and to provide data on fluoroquinolone resistance, following the approval of a fluoroquinolone for use in cattle. *Campylobacter* surveillance was also initiated in chickens in 2010 and pigs in 2012.

In the *Abattoir Surveillance* component, the unit of concern (i.e., the subject of interest) was the bacterial isolate. The bacteria of interest were isolated from the caecal contents (not carcasses) of slaughtered food animals to avoid misinterpretation related to cross-contamination and to better reflect antimicrobial resistance in bacteria that originated on the farm.

Over 90% of all food-producing animals in Canada are slaughtered in federally inspected abattoirs annually[38]. The program is based on the voluntary participation of federally inspected slaughter plants from across Canada. The sampling method was designed with the goal that, across Canada, 150 isolates of *Salmonella* and generic *E. coli* and 100 isolates of *Campylobacter* would be recovered from each of the 3 animal species over a 12 month period. These numbers

[37] Ertco Data Logger™, West Patterson, NJ, USA

[38] Agriculture and Agri-Food Canada. Red meat market information. Available at: www.agr.gc.ca/redmeat-vianderouge/index_eng.htm. Accessed September 2014.

represented a balance between acceptable statistical precision and affordability[39]. The actual number of samples collected was determined for each food animal species on the basis of the expected caecal prevalence of the bacteria in that animal species. For example, if the goal is 150 isolates and the expected bacterial prevalence was 10%, then 1,500 samples would need to be collected and submitted for bacterial isolation.

The sampling design was based on a 2-stage sampling plan, with each commodity handled separately. The first stage consisted of random selection of federally inspected slaughterhouses. The probability of an abattoir being selected was proportional to its annual slaughter volume. The second stage involved systematic selection of animals on the slaughter line. The annual number of caecal samples collected at each abattoir was proportional to its slaughter volume.

SAMPLING METHODS

To minimize shipping costs and allow each abattoir to maintain efficiency, the annual total number of samples to be collected in each abattoir was divided by 5, resulting in the number of collection periods. For each collection period, 5 to 7 caecal samples were collected within 5 days, at the convenience of the slaughterhouse staff, provided the 5 animals and associated samples originated from different groups. Sampling from different groups of animals was important to maximize diversity and avoid bias attributable to overrepresentation of particular producers. Collection periods were uniformly distributed throughout the year to avoid any bias that may have resulted from seasonal variation in bacterial prevalence and antimicrobial susceptibility test results.

Thirty-nine federally inspected slaughter plants (6 beef cattle plants, 28 poultry plants, and 15 swine plants) from across Canada participated in the 2014 CIPARS *Abattoir Surveillance* component. Samples were obtained according to a predetermined protocol, with modifications to accommodate various production-line configurations in the different plants. Protocols were designed to avoid conflict with carcass inspection methods, plant-specific Food Safety Enhancement Programs, and Health and Safety requirements. They were also designed to avoid situations of potential cross-contamination. All samples were collected by industry personnel under the oversight of the Veterinarian-in-Charge of the Canadian Food Inspection Agency.

[39] Ravel A. Development of the Canadian antimicrobial resistance surveillance system (agri-food sector) – sampling design options. Presented to the National Steering Committee on Antimicrobial Resistance in Enterics, Canada, 2001. 79 pp.

FARM SURVEILLANCE

OBJECTIVE(S)

The objectives of the CIPARS *Farm Surveillance* component are to provide data on antimicrobial use and resistance, to monitor temporal trends in the prevalence of antimicrobial resistance, to investigate associations between antimicrobial use and resistance on grower-finisher pigs, and broiler chickens, and to provide data for human health risk assessments.

SURVEILLANCE DESIGN

The *Farm Surveillance* component was the third active surveillance component implemented by CIPARS. Taken together, with the *Abattoir Surveillance* and *Retail Meat Surveillance* components, these data validate the information collected at key points along the farm-to-fork food production chain. This initiative is built on a sentinel farm framework. Questionnaires are used to collect data on farm demographics, animal health and antimicrobial use. Composite pen fecal samples are collected and submitted to laboratories for bacterial isolation and antimicrobial susceptibility testing. The bacteria of interest in broiler chickens were *Campylobacter*, *Salmonella*, and generic *E. coli* and were *Salmonella* and *E. coli* in grower-finisher pigs.

BROILER CHICKENS

The CIPARS *Farm Surveillance* broiler chicken component was initiated in April 2013 in the 4 poultry-producing provinces in Canada (British Columbia, Alberta, Ontario, and Québec). In 2014, Saskatchewan participated in the program. The Broiler *Farm Surveillance* component samples flocks at least 1 week before shipment for slaughter (i.e., pre-harvest stage). Broilers in this stage of production are proximal to the consumer. Half of the flocks sampled for the year were also sampled at the time of chick placement to determine the resistance profiles of chicks on arrival and carry-over of resistant organism from the previous flock.

GROWER-FINISHER PIGS

CIPARS *Farm Surveillance* component was initiated in 2006 in the 5 major pork-producing provinces in Canada (Alberta, Saskatchewan, Manitoba, Ontario, and Québec). The swine industry was selected as the pilot commodity for development of the *Farm Surveillance* infrastructure because the Canadian Quality Assurance (CQA®) program had been extensively implemented by the industry and because, in 2006, unlike in the other major livestock commodities, there had not been a recent outbreak of foreign animal disease in pigs. The *Farm Surveillance* component concentrates on grower-finisher pigs. Pigs in this stage of production were chosen because of their proximity to the consumer.

SAMPLING METHODS

BROILER CHICKENS

Poultry veterinarians recruited sentinel flocks to participate in this voluntary national surveillance program. The number of sentinel flocks allocated to each of the 4 participating provinces was proportional to the national total of quota-holding producers, except in the FoodNet Canada sentinel sites, where a minimum of 30 flocks were sampled. In Alberta, laboratory testing for all flocks was provided by the Alberta Agriculture and Rural Development, Agri-Food Laboratories Branch. In Saskatchewan, the Saskatchewan Ministry of Agriculture provided full financial support for 9 flocks.

The anonymity of the participating broiler producers and hatcheries supplying chicks to these producers were considered. To preserve the anonymity of participating producers, poultry veterinarians collected the samples and data and submitted coded information to Public Health Agency of Canada (PHAC). In the case of corporate veterinarians that are associated with a hatchery or processing company, 1 noncorporate supervisory veterinarian ensured confidentiality by holding the key to corporate veterinarians. This step was taken because knowing a corporate veterinarian's name could have identified the hatchery source, thereby breaking anonymity. Additionally, the Canadian Hatchery Federation (CHF) and the Canadian Poultry and Egg Processing Council ensured confidentiality by holding the key to hatcheries; only the coded information was known to PHAC.

Poultry veterinary practices were purposively selected from each province. Each veterinarian recruited a predetermined number of sentinel farm sites proportional to their practice profile and availability by use of specific inclusion and exclusion criteria. To be included, farms were required to be a Safe, Safer, Safest™ compliant quota-holding broiler operations (i.e., broilers are the major commodity reared on-site but producers may also have other animal species and/or commodities). Antibiotic-free, raised without antibiotics or organic production systems were selected proportional to the veterinarian's practice profile. Veterinarians also ensured that selected farms were also representative of all the CHF hatcheries supplying chicks and representative of the feed mills supplying feeds in the province of their practice, and were geographically distributed (i.e., not neighboring flocks). Additionally, these farms were demographically reflective of the veterinary practice and overall broiler industry profile (e.g., variety of flock management: poor to excellent performing flocks, variety in volume of chicks placed: low to high flock densities). These criteria helped ensure that the flocks enrolled were representative of most broiler flocks raised in Canada. The veterinarians were also asked to distribute their sampling visits across the year to account for seasonal variations in pathogen prevalence and diseases that may drive AMU at the hatchery and on farms.

Sentinel broiler flocks were visited during the last week of growth (chickens more than 30 days of age), once per year for sample and data collection. Four pooled fecal samples, representing one per floor quadrant with at least 10 fecal droppings were collected from randomly selected barns and floors (if multiple level/pen barn). On a trial basis, a proportion of the flocks were also visited when the chicks arrived at the barn. Using a sterile sponge, 2 environmental barn surface samples and 3 meconium samples were collected. The meconium samples were

collected from the liners (chick pads) of the boxes used to ship chicks from the hatchery to the barn.

GROWER-FINISHER PIGS

Swine veterinarians recruited sentinel herds to participate in this voluntary national surveillance program. The number of sentinel herds allocated to each of the 5 participating provinces was proportional to the national total of grower-finisher units, except in Saskatchewan, where 3 additional sentinel herds were included. Support for the 3 extra herds, was provided by the Saskatchewan Ministry of Agriculture.

To preserve the anonymity of participating producers, herd veterinarians collected the samples and data and submitted coded information to the Public Health Agency of Canada. In the case of corporate herds, noncorporate supervisory veterinarians ensured confidentiality by holding the key to corporate herd codes. This step was taken because knowing a corporate veterinarian's name could have identified the corporation associated with the herd, thereby breaking anonymity.

Veterinarians were purposively selected from the list of veterinarians practicing swine medicine in each province. Each veterinarian selected a predetermined number of sentinel farm sites by use of specific inclusion and exclusion criteria. To be included, herds were required to be CQA® validated, produce more than 2,000 market pigs per year, and be representative of the characteristics (i.e., similar production volumes and types of production systems) and geographic distribution of herds in the veterinarian's swine practice. Herds were excluded when they were regarded as organic with respect to animal husbandry, were fed edible residual material, or were raised on pasture. These criteria helped ensure that the herds enrolled were representative of most grower-finisher swine herds in Canada.

Sentinel grower-finisher herds were visited once per year for sample and data collection. Pooled fecal samples were collected from 6 pens of pigs that were close to market weight (i.e., more than 80 kg [175 lb]). Veterinarians were asked to distribute their sampling visits across the year to account for seasonal variations in pathogen prevalence and diseases that may drive AMU on farms.

SURVEILLANCE OF ANIMAL CLINICAL ISOLATES

OBJECTIVE(S)

The objective of Surveillance of Animal Clinical Isolates is to detect emerging antimicrobial resistance patterns as well as new serovar/resistance pattern combinations in *Salmonella*.

SURVEILLANCE DESIGN

This component of CIPARS relies on samples that are typically collected and submitted to veterinary diagnostic laboratories by veterinarians and/or producers. Consequently, sample

collection and submission as well as *Salmonella* isolation techniques varied among laboratories over the year.

Salmonella isolates were sent by provincial and private animal health laboratories from across the country to the *Salmonella* Typing Laboratory (STL) at the National Microbiology Laboratory (NML) @ Guelph (Ontario) with the exception of Québec, where isolates from animal health laboratories were sent to the Laboratoire d'épidémiosurveillance animale du Québec, du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec for serotyping. Isolates and serotyping results for *S*. Enteritidis and *S*. Typhimurium from Québec were then forwarded to the NML @ Guelph to perform phage typing and antimicrobial resistance testing. Isolates that were not *S*. Enteritidis or *S*. Typhimurium was also serotyped. Not all isolates received by provincial animal health laboratories were forwarded to the NML @ Guelph, with the exception of isolates received by laboratories in British Columbia, Ontario, Québec, and Prince Edward Island. Therefore, coverage may have varied considerably among provinces.

Samples submitted for testing may have been collected from sick animal, animal feed, the animal's environment, or non-diseased animals from the same herd or flock. Reported here are results from chicken, turkey, cattle, pigs, and horses. Cattle isolates could have originated from dairy cattle, milk-fed or grain-fed veal, or beef cattle. Chicken isolates were largely from layer hens or broiler chickens, but could also have been from primary layer breeders or broiler breeder birds. A proportion of the turkey isolates might have been recovered from turkey-related environmental samples.

FEED AND FEED INGREDIENTS

SAMPLING DESIGN

Data from the *Feed and Feed Ingredients* component of CIPARS were obtained from various sources, including monitoring programs of the Canadian Food Inspection Agency (CFIA) and a few isolates from provincial authorities. Information on specimen collection methods was only available for the CFIA monitoring programs.

The CFIA collects samples of animal feed under 2 different programs: Program 15A (Monitoring Inspection—*Salmonella*) and Program 15E (Directed Inspection—*Salmonella*). Under Program 15A, feeds produced at feed mills, rendering facilities, ingredient manufacturers, and on-farm facilities are sampled and tested for *Salmonella*. Although this program makes use of a random sampling process, extra attention is paid to feeds that are more likely to have a higher degree of *Salmonella* contamination, such as those that contain rendered animal products, oilseed meals, fish meals, grains, and mashes. Program 15E targets feeds or ingredients from establishments that (i) produce rendered animal products, other feeds containing ingredients in which *Salmonella* could be a concern (e.g., oilseed meal or fishmeal), or a significant volume of poultry feed; (ii) are known to have repeated problems with *Salmonella* contamination; or (iii) have identified a *Salmonella* serovar that is highly pathogenic (e.g., Typhimurium, Enteritidis, or Newport). Program 15E is a targeted program; samples are not randomly selected.

BACTERIAL ISOLATION METHODS

All samples were cultured by use of standard protocols as described below. All primary isolation of human *Salmonella* isolates was conducted by hospital-based or private clinical laboratories in participating provinces/regions. Most primary isolation of *Escherichia coli*, *Salmonella*, and *Campylobacter* from agri-food samples was conducted at the National Microbiology Laboratory (NML) @ Saint-Hyacinthe. Primary isolation for *Retail Meat Surveillance* in Prince Edward Island was conducted at the Atlantic Veterinary College, University of Prince Edward Island. Part of the primary isolation for *Farm Surveillance* was conducted at the Agri-Food Laboratory of the Alberta Agriculture and Rural Development. Samples from the CIPARS *Surveillance of Animal Clinical Isolates* component were cultured by various participating laboratories. Most primary bacterial isolation of samples from Feed and Feed Ingredients was conducted by the CFIA—Laboratory Services Division (Calgary or Ottawa).

SALMONELLA

SURVEILLANCE OF HUMAN CLINICAL ISOLATES

Hospital-based and private clinical laboratories isolated and identified *Salmonella* from human samples according to approved methods[40,41,42,43].

SURVEILLANCE OF AGRI-FOOD ISOLATES (*Retail Meat Surveillance*, *Abattoir Surveillance*, and *Farm Surveillance*)

The method used to isolate *Salmonella* was a modification of the MFLP-75 method[44]. This method allowed isolation of viable and motile *Salmonella* from fecal (*Farm Surveillance*) matter, caecal (*Abattoir Surveillance*) content, and meat (*Retail Meat Surveillance*) from agri-food samples. It is based on the ability of *Salmonella* to multiply and be motile in modified semi-solid Rappaport Vassiliadis (MSRV) medium at 42°C.

***Retail Meat Surveillance*:** depending on the sample type either 1 chicken leg[45], 1 pork chop or 25 g of ground turkey was added to 225 mL of Buffered Peptone Water (BPW). One hundred milliliters of the peptone rinse were kept for *Campylobacter* and/or *E. coli* isolation. Chicken and turkey samples were left in the remaining volume of peptone rinse and incubated at 35 ± 1°C for 24 hours. Afterward, a MSRV plate was inoculated with 0.1 mL of the rinse and

[40] Kauffman F. The Bacteriology of Enterobacteriaceae. Baltimore: Williams and Wilkins Co, 1966.
[41] Ewing WH. Edwards and Ewing's Identification of Enterobacteriaceae. 4th ed. New York: Elsevier Science Publishing Co, 1986.
[42] Le Minor L. Guidelines for the preparation of *Salmonella* antisera. Paris, France: WHO Collaborating Centre for Reference and Research on *Salmonella*, Pasteur Institute, 2001.
[43] Murray PR, Baron EJ, Pfaller MA, et al, eds. Manual of Clinical Microbiology. 8th ed. Washington DC, ASM Press, 2005.
[44] Compendium of Analytical Methods, Health Protection Branch, Methods of Microbiological Analysis of Food, Government of Canada.
[45] When legs with skin on were not available, wings with skin on or other cuts were purchased instead.

incubated at 42 ± 1°C for 24 to 72 hours. Suspect colonies were screened for purity and used to inoculate triple-sugar-iron and urea agar slants. Presumptive *Salmonella* isolates were assessed using the indole test, and their identities were verified by means of slide agglutination with *Salmonella* Poly A-I and Vi antiserum.

***Abattoir Surveillance* and *Farm Surveillance*:** a 25 g portion of each pig caecal or fecal sample and broiler pooled fecal samples were mixed with 225 mL of BPW. Chicken caecal contents were weighed and mixed with BPW at a ratio of 1:10. Environmental and chick meconium sponges were mixed with 100 mL of BPW. Samples were incubated at 35 ± 1°C for 24 hours. Afterward, the method used was the same as the one described in the *Salmonella—Retail Meat Surveillance* section.

SURVEILLANCE OF ANIMAL CLINICAL ISOLATES

Salmonella was isolated according to standard procedures, which varied among laboratories. Most methods for detecting *Salmonella* in animal clinical isolates were similar in principle and involved pre-enrichment, selective enrichment, differential and selective plating, isolation, and biochemical and serological confirmation of the selected isolates.

FEED AND FEED INGREDIENTS

Under both Canadian Food Inspection Agency programs (15A and 15E), all samples were collected aseptically and submitted for bacterial culture and isolation. For *Salmonella* isolation, MSRV medium was used.

ESCHERICHIA COLI

RETAIL MEAT SURVEILLANCE

Fifty milliliters of the peptone rinse prepared as stated in the *Salmonella—Retail Meat Surveillance* section were mixed with 50 mL of double strength EC Broth and incubated at 45 ± 1°C for 24 hours. One loopful of the mixture was then streaked onto Eosin Methylene Blue agar and incubated at 35 ± 1°C for 24 hours. Suspect colonies were screened for purity and transferred onto trypticase soy agar with 5% sheep blood. Presumptive *E. coli* colonies were assessed using Simmons citrate and indole tests. The *E. coli* isolates with negative indole test results were confirmed using a bacterial identification test kit[46].

ABATTOIR SURVEILLANCE AND FARM SURVEILLANCE

One drop of the peptone mixture prepared as earlier stated in the Surveillance of Agri-Food Isolates/*Salmonella—Abattoir Surveillance* and *Farm Surveillance* section was streaked onto MacConkey agar and incubated at 35°C for 18 to 24 hours. Suspect lactose-fermenting colonies were screened for purity and transferred onto Luria-Bertani agar. Presumptive *E. coli* colonies were assessed as in the *Retail Meat Surveillance* for *E. coli*.

[46] API® 20E system

CAMPYLOBACTER

RETAIL MEAT SURVEILLANCE

Fifty milliliters of the peptone rinse prepared as previously stated in the *Salmonella—Retail Meat Surveillance* section, were mixed with 50 mL of double-strength Bolton broth and incubated in a microaerophilic atmosphere at 42 ± 1°C for 44 to 48 hours. A loopful of broth was then streaked onto a modified Charcoal Cefoperazone Deoxycholate Agar (mCCDA) plate and incubated in a microaerophilic atmosphere at 42 ± 1°C for 24 to 72 hours. Suspect colonies were streaked onto a second mCCDA and on a Mueller Hinton agar plate. Both plates were incubated in a microaerophilic atmosphere at 42 ± 1°C for 24 to 48 hours. Presumptive *Campylobacter* colonies were identified using the following tests: Gram stain, oxidase, and catalase. A multiplex PCR (mPCR)[47] was used to speciate colonies. Specific genomic targets (hippuricase in *C. jejuni* and aspartokinase in *C. coli*) were amplified by mPCR from bacterial lysates. Products were visualized on agarose gel and identified based on their specific molecular size. An internal universal control (16s rRNA) was incorporated into the PCR method. The priming oligonucleotides used in the PCR were highly specific for *C. jejuni* or *C. coli* and will not amplify DNA present in any other *Campylobacter* spp. or non-*Campylobacter* organisms. Unidentified species of *Campylobacter* are collectively referred to in the CIPARS reports as "*Campylobacter* spp.". However, when used alone, the term "*Campylobacter*" refers to all *Campylobacter* species.

ABATTOIR SURVEILLANCE AND FARM SURVEILLANCE

One milliliter of BPW mixture prepared as previously stated in the *Salmonella—Abattoir Surveillance* and *Farm Surveillance* sections, was mixed with 9 mL of Hunt's enrichment broth (HEB) and incubated in a microaerophilic atmosphere at 35 ± 1°C for 4 hours. After this first incubation, 36 µL of sterile cefoperazone were added to the HEB tubes which were then sent back to microaerophilic incubation, this time at 42 ± 1°C for 20 to 24 hours. A loopful of HEB was then used to inoculate a mCCDA plate which was incubated at 42 ± 1°C in microaerophilic conditions for 24-72 hours. Suspect colonies were assessed as described earlier in the *Campylobacter—Retail Meat Surveillance* section.

[47] The multiplex PCR speciation of *Campylobacter jejuni* and *Campylobacter coli* was based on the following published method. Person S, KE Olsen. Multiplex PCR for identification of *Campylobacter coli* and *Campylobacter jejuni* from pure cultures and directly on stool samples. J Med Microbiol 2005; 54:1043–1047.

SEROTYPING AND PHAGE TYPING METHODS

SALMONELLA

SURVEILLANCE OF HUMAN CLINICAL ISOLATES

In general, clinical laboratories forwarded their *Salmonella* isolates to their Provincial Public Health Laboratory (PPHL) for identification and serotyping. The PPHL further forwarded *Salmonella* isolates to the National Microbiology Laboratory (NML) @ Winnipeg according to the predefined testing protocol. Isolate identities were confirmed by the NML @ Winnipeg when isolates received did not have a serovar name[48] or when inconclusive results arose during phage typing. The O or somatic antigens of the *Salmonella* isolates were serotyped by use of a slide agglutination method[49]. At the NML @ Winnipeg, *Salmonella* H or flagellar antigens were detected via slide and confirmatory tube agglutination methods. *Salmonella* isolates were maintained at room temperature between 25° and 35°C until typed.

Phage typing was performed at the NML @ Winnipeg for isolates of the following *Salmonella* serovars: Enteritidis, Heidelberg, Typhimurium, Hadar, Newport, Typhi, Paratyphi B[50], Paratyphi B var. L(+) tartrate (+), Infantis, Thompson, Oranienburg, Panama, I 4,[5],12:b:-, and 4,[5],12:i:-. For phage typing the standard technique described by Anderson and Williams[51] was followed. Isolates were streaked onto nutrient agar plates and incubated at 37°C for 18 hours. Three to 5 smooth colonies were selected and used to inoculate 4.5 mL of phage broth[52], which was then incubated for 1.5 to 2 hours in a shaking water bath at 37°C to attain bacterial growth with a turbidity equivalent to 1 McFarland standard. Phage agar plates[53] were flooded with approximately 2 mL of culture medium, and the excess liquid was removed with a Pasteur pipette. Flooded plates were allowed to dry for 15 minutes at room temperature. Afterward, approximately 10 μL of each serovar-specific typing phage was used to inoculate the bacterial lawn by means of a multiple inoculating syringe method[54]. The plates were incubated at 37°C overnight, and lytic patterns were subsequently interpreted[55].

Salmonella Enteritidis strains were phage typed with typing phages obtained from the International Centre for Enteric Phage Typing (ICEPT), Central Public Health Laboratory,

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[48] Grimont PAD, Weill F-X. Antigenic formulae of the *Salmonella* serovars. 9th ed. Paris, France: WHO Collaborating Centre for Reference and Research on Salmonella, Institut Pasteur, 2007.

[49] Ewing WH. Edwards and Ewing's Identification of Enterobacteriaceae. 4th ed. New York: Elsevier Science Publishing Co, 1986.

[50] *Salmonella* Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate (+), formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated with gastrointestinal illness.

[51] Anderson E, Williams R. Bacteriophage typing of enteric pathogens and staphylococci and its use in epidemiology. J Clin Pathol 1956; 9: 94–127.

[52] Difco™ phage broth, Difco Laboratories, Baltimore, MD; pH 6.8

[53] Difco™ phage agar, Difco Laboratories

[54] Farmer J, Hickman F, Sikes J. Automation of *Salmonella* typhi phage-typing. Lancet 1975; 2(7939): 787–790.

[55] Anderson E, Williams R. Bacteriophage typing of enteric pathogens and staphylococci and its use in epidemiology. J Clin Pathol 1956; 9: 94–127.

Colindale, United Kingdom[56]. The phage-typing protocol and phages for *S*. Typhimurium, developed by Callow[57] and further extended by Anderson[58] and Anderson and colleagues[59] were obtained from the ICEPT. The *S*. Heidelberg phage typing protocol and phages were supplied by the NML @ Winnipeg [60]. Isolates that reacted with the phages but did not conform to any recognized phage type were designated as atypical. Strains that did not react with any of the typing phages were designated as "untypable".

The Identification and Serotyping and the Phage Typing units at the NML @ Winnipeg have attained International Standards Organization (ISO) 17025 accreditation by the Standards Council of Canada. These identification and Serotyping, Phage Typing, and Antimicrobial Resistance units participate in the annual Global Food-borne Infections Network (WHO-GFN), External Quality Assurance System of the World Health Organization, the Enter-net (a European network for the surveillance of human gastrointestinal infections) proficiency program for *Salmonella*, and a strain exchange with the NML@ Guelph and NML@ Saint-Hyacinthe (*Salmonella* and *Escherichia coli*). The NML @ Winnipeg and the Centre for Foodborne, Environmental and Zoonotic Infectious Diseases have been strategic planning members of the WHO-GFN program since 2002.

SURVEILLANCE OF AGRI-FOOD, ANIMAL CLINICAL AND FEED ISOLATES

Animal clinical *Salmonella* isolates from Québec were serotyped at the Laboratoire d'épidémiosurveillance animale du Québec, du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec and were sent to the STL[61]. Isolates of *S*. Enteritidis and *S.* Typhimurium were not re-serotyped, they were only phage typed. All other *Salmonella* isolates sent to STL by MAPAQ were serotyped; *S.* Heidelberg isolates were also phage typed. All other *Salmonella* isolates tested as part of CIPARS, including clinical isolates from other provinces, were submitted to the STL for serotyping and phage typing. The serotyping method detects O or somatic antigens of the *Salmonella* isolates via slide agglutination[62]. The H or flagellar antigens were identified with a microtitre plate well precipitation method[63]. The antigenic formulae of the *Salmonella* serovars as reported by Grimont and Weill[64] were used to identify and name the serovars.

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[56] Ward L, de Sa J, Rowe B. A phage-typing scheme for *Salmonella* Enteritidis. Epidemiol Infect 1987; 99: 291–294.
[57] Callow B. A new phage typing scheme for *Salmonella* Typhimurium. J Hyg (Lond) 1959; 57: 346–359.
[58] Anderson E. The phagetyping of *Salmonella* other than *S*. Typhi. In: Van Oye E, ed. The World Problem of Salmonellosis. The Hague, The Netherlands: Dr W. Junk Publishers, 1964; 89–100.
[59] Anderson E, Ward L, de Saxe M, et al. Bacteriophage-typing designations of *Salmonella* Typhimurium. J Hyg (Lond) 1977; 78: 297–300.
[60] Demczuk W, Soule G, Clark C, et al. Phage-based typing scheme for *Salmonella* enterica serovar Heidelberg, a causative agent of food poisonings in Canada. J Clin Microbiol 2003; 41: 4279–4284.
[61] Office Internationale des Épizooties (OIÉ); All World Organisation for Animal Health, Reference Laboratory for Salmonellosis, Guelph, Ontario.
[62] Ewing WH. Edwards and Ewing's Identification of Enterobacteriaceae. 4th ed. New York: Elsevier Science Publishing Co, 1986.
[63] Shipp C, Rowe B. A mechanised microtechnique for *Salmonella* serotyping. J Clin Pathol 1980; 33: 595–597.
[64] Grimont PAD, Weill F-X. Antigenic Formulae of the *Salmonella* Serovars. 9th ed. Cedex, France: Collaborating Center for Reference and Research on Salmonella, Institut Pasteur, 2007.

For phage typing, the standard technique by Anderson and Williams[65] and described above was followed. Phage typing was performed on isolates of *S.* Enteritidis, *S.* Typhimurium, and *S.* Heidelberg; the sources of the typing phages for these 3 serovars were the same as described above for *Surveillance of Human Clinical Isolates*.

Since 1995, the STL has participated in annual inter-laboratory exchange of serotyping panels with up to 3 other laboratories. The STL began external proficiency testing of the accuracy of phage typing in 2003. Every year, the STL participates successfully in phage typing proficiency panels from the NML @ Winnipeg.

[65] Anderson E, Williams R. Bacteriophage typing of enteric pathogens and staphylococci and its use in epidemiology. J Clin Pathol 1956; 9: 94–127.

ANTIMICROBIAL SUSCEPTIBILITY TESTING METHODS

All *Salmonella* isolates of human origin were tested for antimicrobial susceptibility at the National Microbiology Laboratory (NML) @ Winnipeg and all *Salmonella* isolates of agri-food or feed origin were tested for antimicrobial susceptibility at the NML @ Guelph. The majority of *Campylobacter* and *Escherichia coli* isolates from all agri-food components were tested at the NML @ Saint-Hyacinthe. In most instances, only 1 isolate per positive sample was submitted for antimicrobial susceptibility testing. In the case of on *Farm Surveillance*—grower-finisher pigs or broiler chickens, antimicrobial susceptibility testing was performed on 3 *E. coli* isolates, and 1 *Salmonella* isolate per sample. All *E. coli* isolates from *Retail Meat Surveillance* in Prince Edward Island were processed at the Atlantic Veterinary College, University of Prince Edward Island. Whereas a portion of *E. coli* isolates from *Farm Surveillance* in Alberta and Saskatchewan were processed by the Agri-Food Laboratory Branch, Alberta Agriculture and Rural Development.

The NML @ Winnipeg is a World Health Organization Collaboration Centre for Preparedness and Response to Enteric Pathogens and their Antimicrobial Resistance. The NML @ Guelph and NML @ Saint-Hyacinthe laboratories, and Atlantic Veterinary College participate in external proficiency programs for antimicrobial susceptibility testing for *Salmonella* and *E. coli*. The NML @ Guelph and NML @ Saint-Hyacinthe laboratories participate in inter-agency proficiency programs for identification and antimicrobial susceptibility testing of *Salmonella*, *E. coli*, and *Campylobacter* with the National Antimicrobial Resistance Monitoring System, United States (NARMS). The NML @ Guelph laboratory is ISO/IEC 17025-accredited for antimicrobial sensitivity testing.

SALMONELLA AND *ESCHERICHIA COLI*

The minimum inhibitory concentration (MIC) values for *Salmonella* and *E. coli* were determined by means of the broth microdilution method[66] by use of an automated system[67]. This automated incubation and reading system uses microtitre plates containing various concentrations of dehydrated antimicrobials. The CMV3AGNF plate[68] was designed by the NARMS and contains 14 antimicrobials (see Table A.1, Antimicrobial Susceptibility Breakpoints'section).

Isolates were streaked onto a Mueller Hinton or MacConkey agar plate and incubated at 36 ± 1°C for 18 to 24 hours to obtain isolated colonies. One colony was chosen from the plate and re-streaked onto agar plates for growth. The plates were incubated at 36 ± 1°C for 18 to 24 hours. A 0.5-McFarland suspension was prepared by transferring bacterial growth from the agar plates into 5.0 mL of sterile, demineralized water. Ten microliters of the water-bacteria suspension were transferred to 10 mL of Mueller Hinton broth (MHB). This suspension was dispensed onto CMV3AGNF testing plates at 50 µL per well and the plates were sealed with adhesive plastic sheets. After an 18-hour incubation at 36 ± 1°C the plates were read automatically with the

[66] Clinical and Laboratory Standards Institute (CLSI) M7-A8
[67] Sensititre™, Automated Microbiology System, Trek™ Diagnostic Systems Ltd, West Sussex, England
[68] Sensititre™, Trek™ Diagnostic Systems Ltd, West Sussex, England

fluorometric plate reading system[69]. In accordance with standards set by the Clinical and Laboratory Standards Institute (CLSI)[70], Staphylococcus aureus ATCC 29213, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, and *Enterococcus faecalis* ATCC 29212 were used for quality assurance purposes to ensure validity of the MIC values.

CAMPYLOBACTER

The MIC values for *Campylobacter* were determined by means of the broth microdilution method[71]. The CAMPY plates[37] designed by NARMS and containing 9 dehydrated antimicrobials were used (see Table A.2, Antimicrobial Susceptibility Breakpoints'section). Colonies were streaked onto Mueller Hinton agar plates with 5% sheep blood and incubated in a microaerophilic atmosphere at 42 ± 1°C for 24 hours. A 0.5-McFarland suspension of bacterial growth was prepared by transferring selected bacterial colonies into a tube containing 5 mL of MHB. Afterward, 10 µL of the MHB were transferred to 11 mL of MHB with laked horse blood. The mixture was dispensed onto CAMPY plates at 100 µL per well. The plates were sealed with perforated adhesive plastic sheets. After a 24-hour incubation in microaerophilic atmosphere at 42 ± 1°C, plates were read using the Sensititre Vizion System[72]. *Campylobacter jejuni* ATCC 33560 was used as quality control organism. The MIC values obtained were compared with those of CLSI standards[73].

[69] ARIS™, Trek™ Diagnostic Systems Ltd, West Sussex, England
[70] CLSI M100-S24
[71] CLSI M45-A2
[72] Sensititre Vizion System™, Trek™ Diagnostic Systems Ltd, West Sussex, England
[73] CLSI M45-A2

ANTIMICROBIAL SUSCEPTIBILITY BREAKPOINTS

Table A.1. Antimicrobial susceptibility breakpoints for *Salmonella* and *Escherichia coli*; CMV3AGNF plate, 2014

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Amoxicillin-clavulanic acid	1.0/0.5–32/16	≤ 8/4	16/8	≥ 32/16
	Ceftiofur[b]	0.12–8	≤ 2	4	≥ 8
	Ceftriaxone	0.25–64	≤ 1	2	≥ 4
	Ciprofloxacin	0.015–4	≤ 0.06	0.12 – 0.5	≥ 1
II	Ampicillin	1–32	≤ 8	16	≥ 32
	Azithromycin[c]	0.12–16	≤ 16	N/A	≥ 32
	Cefoxitin	0.5–32	≤ 8	16	≥ 32
	Gentamicin	0.25–16	≤ 4	8	≥ 16
	Nalidixic acid	0.5–32	≤ 16	N/A	≥ 32
	Streptomycin[c]	2–64	≤ 32	N/A	≥ 64
	Trimethoprim-sulfamethoxazole	0.12/2.38–4/76	≤ 2/38	N/A	≥ 4/76
III	Chloramphenicol	2–32	≤ 8	16	≥ 32
	Sulfisoxazole	16–256	≤ 256	N/A	≥ 512
	Tetracycline	4–32	≤ 4	8	≥ 16
IV					

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate susceptibility. R = Resistant. N/A = Not applicable.

[a] Unless otherwise specified, CLSI M100-S24 was the reference used for all antimicrobials in the panel.
[b] CLSI VET-01-S2.
[c] No Clinical and Laboratory Standards Institute interpretive criteria for Enterobacteriaceae were available for this antimicrobial. Breakpoints were based on the distribution of minimal inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System, United States.

Table A.2. Antimicrobial susceptibility breakpoints for *Campylobacter*; CAMPY plate, 2014

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Ciprofloxacin	0.015–64	≤ 1	2	≥ 4
	Telithromycin[b]	0.015–8	≤ 4	8	≥ 16
II	Azithromycin[b]	0.015–64	≤ 2	4	≥ 8
	Clindamycin[b]	0.03–16	≤ 2	4	≥ 8
	Erythromycin	0.03–64	≤ 8	16	≥ 32
	Gentamicin[b]	0.12–32	≤ 2	4	≥ 8
	Nalidixic acid[b]	4–64	≤ 16	32	≥ 64
III	Florfenicol[b,c]	0.03–64	≤ 4	N/A	N/A
	Tetracycline	0.06–64	≤ 4	8	≥ 16
IV					

Roman numerals I to III indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate susceptibility. R = Resistant. N/A = Not applicable.

[a] CLSI M45-A2.
[b] No Clinical and Laboratory Standards Institute interpretive criteria for *Campylobacter* were available for this antimicrobial. Breakpoints were based on the distribution of minimal inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.
[c] For florfenicol, only a susceptible breakpoint has been established. In this report, we therefore only report the proportion of isolates non-susceptible.

DATA ANALYSIS

HUMAN AND AGRI-FOOD SURVEILLANCE

DATA MANAGEMENT

Laboratory data from human and agri-food surveillance components originated in 2 computer programs (NML @ Winnipeg Labware and NML @ Guelph and NML @ Saint-Hyacinthe Labware) and were subsequently transferred to a central data repository using intermediary computer software[74]. Data were then transferred to a SAS® based harmonized database[75] called the Data Extraction and Analysis (DEXA) application. Additional antimicrobial resistance variables used for analysis are derived within the DEXA application; this application is also used as a central data access point.

RECOVERY RATE

For *Retail Meat Surveillance*, *Abattoir Surveillance*, and the *Farm Surveillance* components, recovery rate was defined as the number of positive bacterial culture results divided by the total number of samples submitted for culture.

RESISTANT ISOLATES

The percentage of isolates with resistance to 1 or more antimicrobials was defined as the number of isolates resistant to at least 1 antimicrobial divided by the total number of isolates tested for each antimicrobial, multiplied by 100.

The breakpoints used for interpretation of antimicrobial susceptibility results are listed in Table A.1 and Table A.2 (see the previous section). Intermediate Minimum Inhibitory Concentration (MIC) values were categorized as susceptible for all analyses. A new ceftriaxone breakpoint was officially adopted by the CLSI in January 2010 and was applied to all CIPARS data, including historical data. A new Enterobacteriaceae plate, CMV3AGNF, was utilized beginning in January 2014. Notable changes to the new plate included the removal of kanamycin (Category II) and expansion of the number of dilutions tested for streptomycin (Category II).

RESISTANCE PATTERNS

The total number of antimicrobials in each resistance pattern was calculated by summing the number of antimicrobials to which each isolate was resistant. The most common resistance pattern may include patterns with only 1 antimicrobial. In this case, like for the most common patterns including 2 or more antimicrobials, the number of isolates reported includes only those resistant to this specific pattern (i.e., without any additional resistance to other antimicrobials).

[74] Oracle ®, Oracle Corp., Redwood Shores, CA, USA

[75] SAS® 9.3, SAS Institute Inc., Cary, NC, USA

STATISTICAL ANALYSIS

Data were analyzed with various statistical softwares[76], and outputs were exported into a spreadsheet application[77]. All tables and figures were generated with the spreadsheet application[77].

For *Farm Surveillance*, statistical analyses were performed to account for clustering of antimicrobial resistance within swine herds or chicken flocks through generalized estimating equations (GEE)[78]. All statistical models included a binary outcome, logit-link function, and exchangeable correlation structure. Null binomial response models were used to estimate the prevalence of resistance to each antimicrobial. From each null model, the intercept (β0) and 95% confidence intervals were used to calculate population-averaged (i.e., GEE) prevalence estimates with the formula [1 + exp(-β0)]-1. When the prevalence was 0%, a model was run with a single positive isolate to determine the upper confidence interval only.

PROVINCIAL INCIDENCE DATA IN HUMANS

For the provincial human incidence data, the number of *Salmonella* clinical cases in which a particular serovar was detected per 100,000 inhabitant-years was calculated by dividing the total number of isolates of each serovar reported to the National Enteric Surveillance Program (NESP) of the Public Health Agency of Canada from that province by the provincial population and then multiplying by 100,000[79].

TEMPORAL ANALYSIS

Temporal analyses were performed for selected antimicrobials. Only 1 antimicrobial per antimicrobial class was selected among those antimicrobials commonly used in the agri-food and/or human sectors. Some antimicrobials were excluded from the temporal analyses for the following reasons:

- Resistance to the antimicrobial was absent or at a very low prevalence, or the breakpoint was debatable and other antimicrobials could be used to provide a surrogate measure of resistance or intermediate susceptibility (e.g., nalidixic acid for ciprofloxacin).
- The isolate was cross-resistant to another selected antimicrobial (e.g., amoxicillin-clavulanic acid and ceftiofur).
- The antimicrobial has been banned for use in the agri-food sector, and resistance to this drug is maintained because of the use of another antimicrobial (e.g., chloramphenicol).

[76] SAS® 9.3; and Stata® 12 SE, Stata Corp., College Station, TX, USA
[77] Microsoft® Excel 2010, Microsoft Corp.
[78] PROC GENMOD, SAS® 9.3
[79] Statistics Canada, Demography Division, Demographic Estimates Section, July Population Estimates, 2013 Final Intercensal Estimate.

Logistic regression models (asymptotic or exact depending on prevalence of the outcome variable) were developed with year as an independent categorical variable. Data were analyzed with commercial software[80]. Analyses of *Farm Surveillance* data were adjusted for clustering at the herd level for grower-finisher pigs and flock level for broiler chickens. For broiler chickens, the 2014 data was compared to 2013. Components with regional or provincial temporal analysis had the current proportion of isolates resistant to a specific antimicrobial compared to those proportions observed in the previous surveillance year and 5 years previously. For components with national temporal analysis, the current proportion of isolates resistant to a specific antimicrobial were compared to those proportions observed in the previous surveillance year, 5 years previously (for comparison between components), and the first year of surveillance. In a few specific instances, the first comparison year may vary to reflect the implementation of new CIPARS components (e.g., 2006 for the *Farm Surveillance* component in grower-finisher pigs and addition of the broiler chicken *Farm Surveillance* component in 2013). For ampicillin and ceftiofur, special temporal analyses have been conducted in *E. coli* and *Salmonella* isolated from retail chicken or abattoir chickens to compare the current year's data with that of 2004 and 2006. This was due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end of the voluntary period of withdrawal respectively). These special analyses were also conducted in human *Salmonella* Heidelberg isolates because this human serovar was suspected to originate from chicken. A *P*-value less than or equal to 0.05 was considered significant for all temporal analyses.

[80] Stata ®12 SE

ANTIMICROBIAL USE

HUMAN SURVEILLANCE

Human antimicrobial use monitoring activities within the Public Health Agency of Canada (PHAC) are presented as part of the PHAC Human Antimicrobial Use Report 2014[81] and the 2016 Canadian Antimicrobial Resistance Surveillance System Report.

FARM SURVEILLANCE

FARM QUESTIONNAIRE

BROILER CHICKENS

In the Broiler chicken's *Farm Surveillance* component of CIPARS, sentinel farm data were collected through questionnaires administered by the poultry veterinarian (or designated practice staff) to the producer (or designated farm staff). The questionnaires collected information related to the hatchery and broiler farm levels. Veterinarians asked the producers for the chick delivery receipts which contain information required to fill the hatchery-level portion of the questionnaire such as breeder flock information including source origin (e.g., province of origin or imported) the age range of breeder flock source; whether the hatchery purchased the chicks as hatching eggs or chicks; the antimicrobial drugs used and routes of administration, dosage, and primary reasons (treatment, prevention, high risk breeder flock source, producer request) and secondary reasons or by disease diagnosed (avian pathogenic *E. coli*, *Enterococcus cecorum*, *Salmonella* spp., *Staphylococcus* spp., early clostridial infections and other diseases), and; all vaccines administered *in ovo* or at the time of hatch. The veterinarians or a designated staff confirmed the information by calling the hatcheries. The farm-level portion of the questionnaire was answered by using feed delivery receipts, farm records, prescriptions and/or by asking the producer. Farm demographics information (e.g., quota period, age and estimated weight of birds at the time of visit, farm/barn/floor capacity), biosecurity and animal health (i.e., vaccines administered at the farm level) were also obtained.

Producers/designated farm person were asked about antimicrobial use (AMU) via feed and water. Data were collected on each diet fed to the flock, including medicated and non-medicated feeds (non-medicated feeds did not contain antimicrobials). Information collected on each type of feed fed included the total days fed and age of flocks at the start and end of each ration. Additional information was collected for diets containing antimicrobials: active ingredient(s), their concentration(s) in the feed, and the primary reason(s) for that AMU

[81] http://healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/human-antimicrobial-use-2014-utilisation-antimicrobiens-humains/index-eng.php

(growth promotion, disease prevention, or treatment). Secondary AMU reasons or by diseases diagnosed were captured if the primary use was for disease prevention or treatment; the list for secondary reasons included the most commonly diagnosed conditions in broilers: yolk sacculitis, septicemia, musculoskeletal diseases, respiratory diseases, necrotic enteritis, coccidiosis, and other diseases (e.g., any non-bacterial etiology such as viral and metabolic).

Data collected on exposure to antimicrobials though water included active ingredient(s) in the drug(s) use, dosage (per liter of drinking water), start and end age of each water medication, the proportion of flock exposed, and the reason(s) for use. The primary reasons and secondary reasons for prevention and treatment for AMU in water were similar to those described for feed AMU. The producers were also asked if prescription was provided by a veterinarian and if the water medication is an over the counter purchase.

Based on the required components of the National Avian On-farm Biosecurity Standard[82] relevant questions were asked pertaining to the level of biosecurity. Questions on access management, animal health management and operational management were included. Data on flock health status (i.e., diagnosis of the most common bacterial and viral diseases), and vaccination administration from the time of chick placement onwards were also collected.

GROWER-FINISHER PIGS

In the grower-finisher's *Farm Surveillance* component of CIPARS, sentinel farm data were collected through questionnaires administered by the herd veterinarian (or designated staff) to the producer (or designated farm staff). The questionnaires collected data on antimicrobial use (AMU), herd demographics and animal health.

Questions pertaining to the number of pigs in the population of interest differed by management system: continuous-flow or all-in-all-out. All-in-all-out management is a production system whereby animals are moved into and out of facilities in distinct groups. By preventing the commingling of groups, the hope is to reduce the spread of diseases. Facilities are normally cleaned and disinfected thoroughly between groups of animals. This type of management is generally by room or by barn. In continuous-flow operations, animals are continually being removed and added.

The AMU questionnaire was designed to collect data for groups of pigs in the grower-finisher production phase. No data on individual pigs were collected. Six pens representative of this population were selected for the collection of fecal specimens for bacterial culture and antimicrobial susceptibility testing. Thus, in herds with all-in-all-out management, the population of interest included all pigs that entered and exited the barn in the same group as the sampled pigs. The population of interest in herds with continuous-flow management was pigs that entered the grower-finisher unit with the sampled pigs.

[82] Government of Canada. Animal biosecurity: National avian on-farm biosecurity standard. Available at: www.inspection.gc.ca/DAM/DAM-animals-animaux/STAGING/text-texte/terr_biosec_avian_standard_1375192173847_eng.pdf. Accessed September 2014.

Herd owners/managers were asked about AMU via feed, water, and injections. Data were collected on each diet fed to the specified group of pigs, including medicated and non-medicated feeds (i.e., feeds did not contain antimicrobials). Information collected on each type of feed fed during the grow-finish period included the average number of weeks each ration was fed and the associated start and end pig weights. Additional information was collected for diets (rations) containing antimicrobials: active antimicrobial ingredient(s), their concentration(s) in the feed, and the primary reason(s) for that AMU (choose one of growth promotion, disease prevention, or treatment). Under the primary reasons for AMU, disease prevention or treatment, respondents could choose any of the following secondary reasons for use in feed: respiratory disease, enteric disease, lameness or other diseases. The proportion of pigs fed each diet was also captured.

Data collected on exposure to antimicrobials through water or injection included active ingredient(s) in the drug(s) used, the reason(s) for use and the proportion of pigs exposed. The primary reasons for AMU in water included: disease prevention and disease treatment with associated secondary reasons for use being respiratory disease, enteric disease, lameness or other diseases. Only disease treatment reasons were collected for AMU administered by injection. The number of pigs exposed to AMU by water or injection was captured as categorical data with ranges of 1–25%, 26–50%, 51–75% or 76–100% of the pigs. No AMU data were collected for any production phase prior to the grower-finisher phase. Any data regarding AMU in pigs weighing less than 15 kg (33 lb) were excluded because this weight is considered below the industry standard for grower-finisher pigs.

DATA ANALYSIS

Data were entered into a PostGreSQL Database and descriptive statistics were obtained with commercially available software[83].

GROWER-FINISHER PIGS

Antimicrobial exposures were summarized for each herd. An exposure was defined as any reported use of an active ingredient by a given route of administration in 2014. Data were reported as exposure to an active ingredient by a given route of administration, as well as by exposure to an active ingredient by any administration route. These exposures were summarized by antimicrobial class. It is important to note that antimicrobial exposures through feed tend to involve larger groups of pigs and longer durations of use than antimicrobial exposures via water. Injectable antimicrobials are generally administered on an individual basis to a limited number of pigs[84].

Quantitative AMU data (dose and duration) were collected for antimicrobials administered through feed but not for antimicrobials administered through water or by injection. The amount of an antimicrobial consumed through feed was estimated from the concentration of

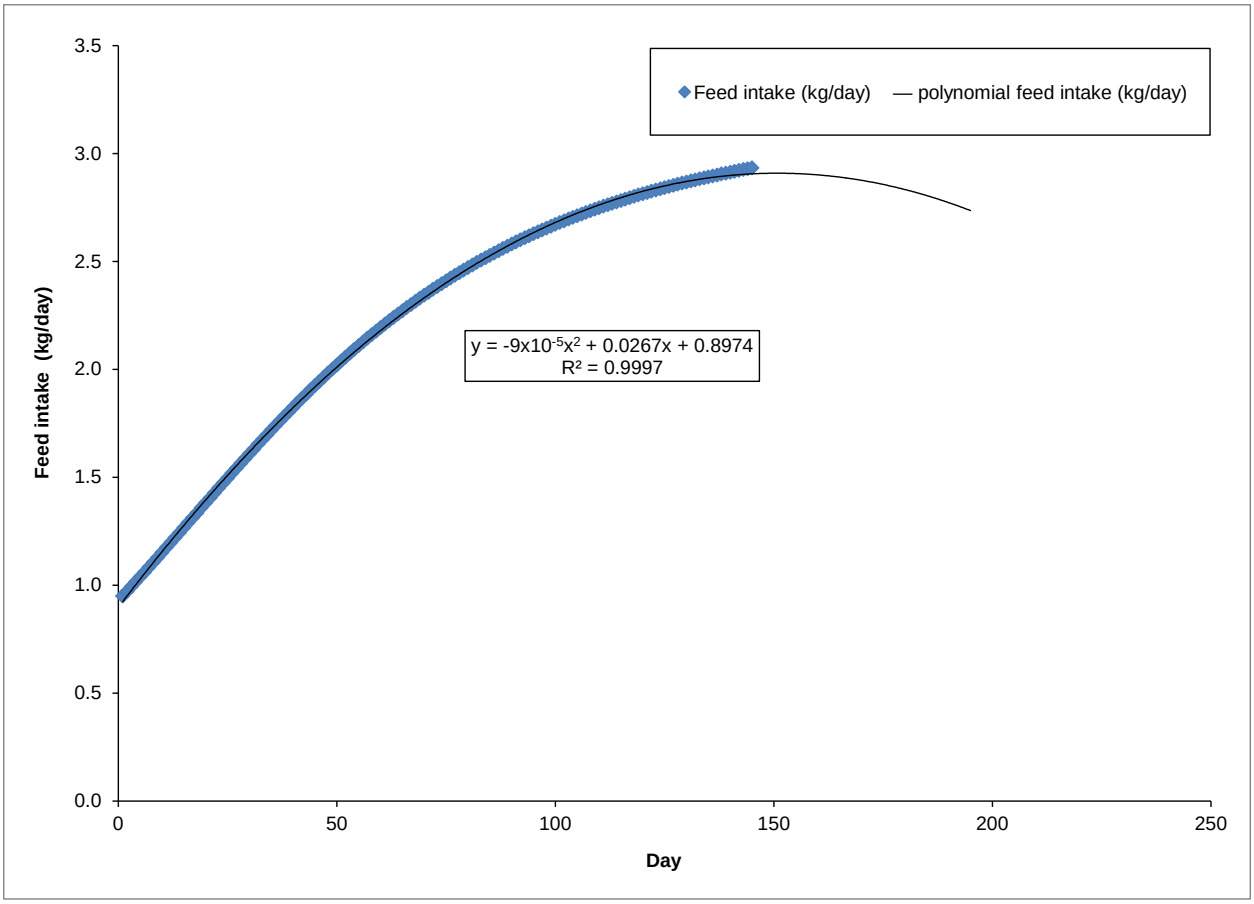
[83] Microsoft Excel® 2003 and Microsoft Access® 2003, Microsoft Corp., Redmond, WA, USA; SAS® 9.1, SAS Institute Inc., Cary, NC, USA.

[84] Version April, 2009. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed May 2013.

the antimicrobial in a given ration multiplied by the cumulative tonnes consumed over the duration of exposure. Estimates of feed intake were based on simple regression equations and integral calculus. Plots of feed consumption per day were created within Microsoft™ Excel, using National Research Council (NRC) tables (Nutrient Requirements of Swine: Eleventh Revised Edition, National Academy of Sciences, 2012) for grower-finisher pigs. Three plots were created to reflect poor (15% less protein deposition per kg feed consumed than the standard pig), medium (standard pig described by NRC), and high (15% more protein deposition than the standard pig) performance. The lightest starting weight recorded for all rations listed on a questionnaire was selected and the corresponding day on the feed consumption table was identified. The number of days the ration was fed was then added to the start day to obtain an end day for that ration. For each successive ration, the number of days the ration was fed was added to the proceeding ration end day. When the reported feeding end day went beyond the NRC table, data were extrapolated up to maximum of 50 additional days.

Regression parameters for each level of pig performance were calculated within Microsoft™ Excel by using the feed intake curve (e.g., Figure A.1). A minimum R-square value higher than 0.99 was required to be considered a good fit.

Figure A.1. Example of daily medium performing pigs feed intake (kg/day)



Feed intake (kg/day) were based on National Research Council feeding with fitted polynomial regression line generated in Microsoft™ Excel.

The area under the curve for each regression equation provided feed intake using the following formula:

$$\beta_0 t + \beta_1 t^2/2 + \beta_2 t^3/3$$

The corresponding β values come from the performance specific regression lines and the ages (t) came from the above described approach. Using PPlpgSQL code within the PostGreSQL database for each regression line (poor, medium and high performance) 2 integrals were calculated, the lower integral where "t" is the start age and the upper integral is where "t" is the end age. The difference between the upper and lower integral yielded the estimate of feed intake in kilograms per pig for that ration. For each grower-finisher herd an average daily gain (ADG) was calculated. Farms were categorized as having poor, medium, or high performance by using cut off points which were generated by partitioning the survey ADG data into thirds. High performance herds were defined as herds with an ADG more than 0.8734, medium performance herds had an ADG between 0.8734 to 0.8045, and poor performance herds had ADG less than 0.8045. Based on this categorization the appropriate regression line and integral were applied to calculate feed consumption. Feed consumption was converted from kilograms

to tonnes and multiplied by the number of pigs at risk to provide an estimate of total tonnes fed for each ration. This value was then utilized to calculate the grams of antimicrobial consumed per ration and incorporated in quantitative analyses.

BROILER CHICKENS

Antimicrobial exposures from hatching stage to end of growth or pre-harvest sampling stage (≥ 30 days) were summarized for each flock. An exposure was defined as any reported use of an active ingredient by a given route of administration. Data are reported as exposure to an active ingredient by a given route of administration, as well as by exposure to an active ingredient by any administration route. These exposures were summarized by antimicrobial class.

Estimates of feed intake were based on simple regression and integral calculus. Feed consumption estimates from the 2014 Ross 208 and 708 performance objectives, the most recent Cobb 500 and 700 Broiler Performance and Nutrition Supplement manuals, and feed company standards (Wallenstein Feeds and Nutreco-Shur Gain) were loaded into Microsoft™ Excel. From these data, the cumulative feed consumption was calculated using the average of feeding standards for the 2 most common broiler strains and the standards developed by feeding companies (i.e., non-strain specific)[85,86,87,88] for as-hatched broilers (i.e., males and females combined) and a plot of feed consumption in grams per bird per day was created.

From the broiler chicken survey the start and end age of the birds was available for each ration. Since the end day of one ration is the start day of the next an algorithm was used to prevent overlapping days for each subsequent ration. Regression parameters were calculated within Microsoft™ Excel by using the plotted feed intake curve. A minimum R-square value of > 0.99 was required to be considered a good fit therefore to obtain the best fitting regression values the feeding curve was divided into 3 segments. Feed consumption calculations based on the regression line in Figure A.2 were used if the age of the birds when they started and finished the ration was less or equal to 21 days (i.e., equivalent to brooding and early grow-out period). The regression line in Figure A.4 was used if the age of the birds when they started and finished the ration was equal or more than 35 days of age (i.e., equivalent to finisher phase or extended grow-out period in roasters). All other age ranges had feed consumption based on the regression line depicted in Figure A.3 (i.e., grow-out period). From the regression coefficients feed consumption could then be calculated using integral calculus.

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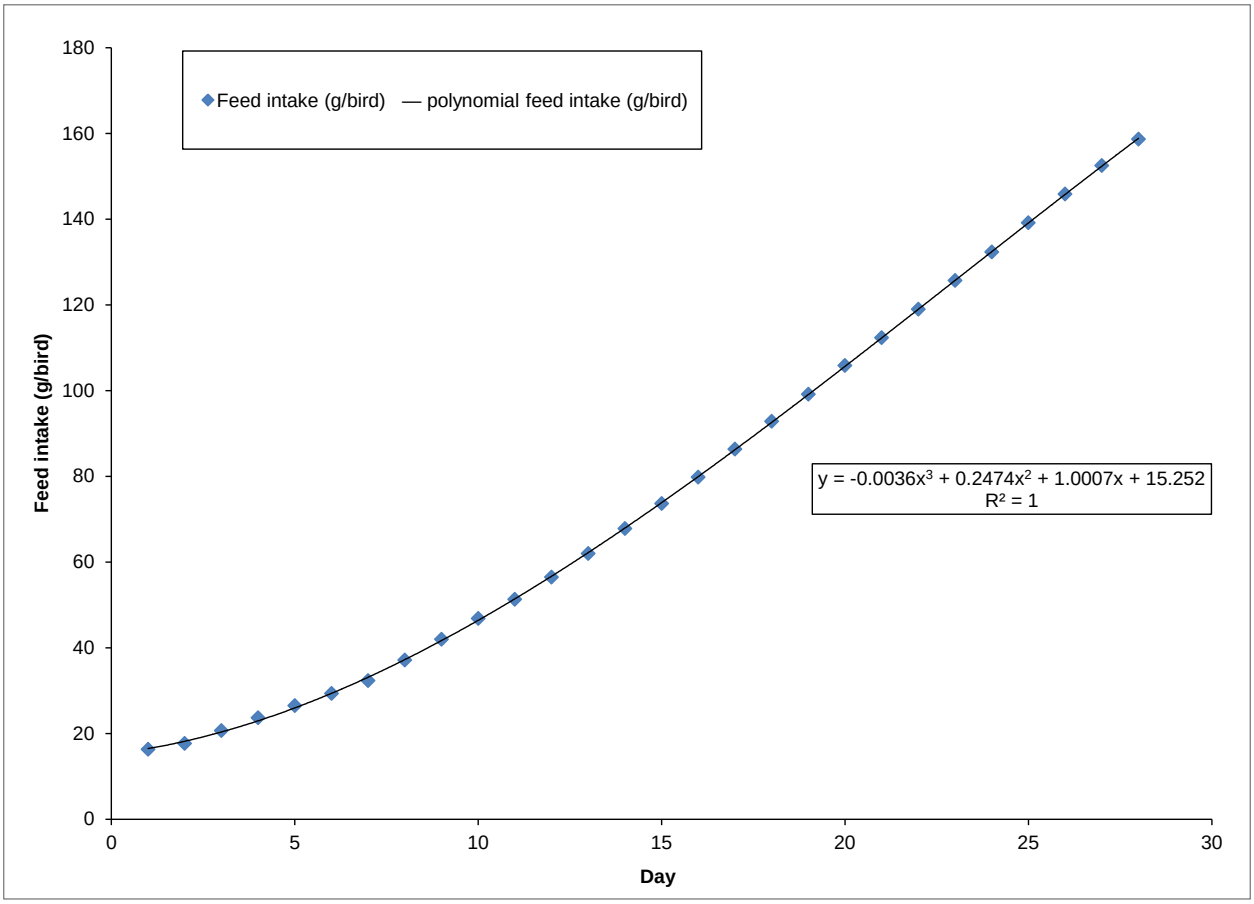
[85] Cobb-Vantress, Inc. Products: Cobb 500™. Available at: www.cobb-vantress.com/products/cobb500. Accessed September 2014.

[86] Cobb-Vantress, Inc. Products: Cobb 700™. Available at: www.cobb-vantress.com/products/cobb700. Accessed September 2014.

[87] Aviagen. Ross 308. Available at: http://en.aviagen.com/assets/Tech_Center/Ross_Broiler/Ross-308-Broiler-PO-2014-EN.pdf. Accessed November 2014.

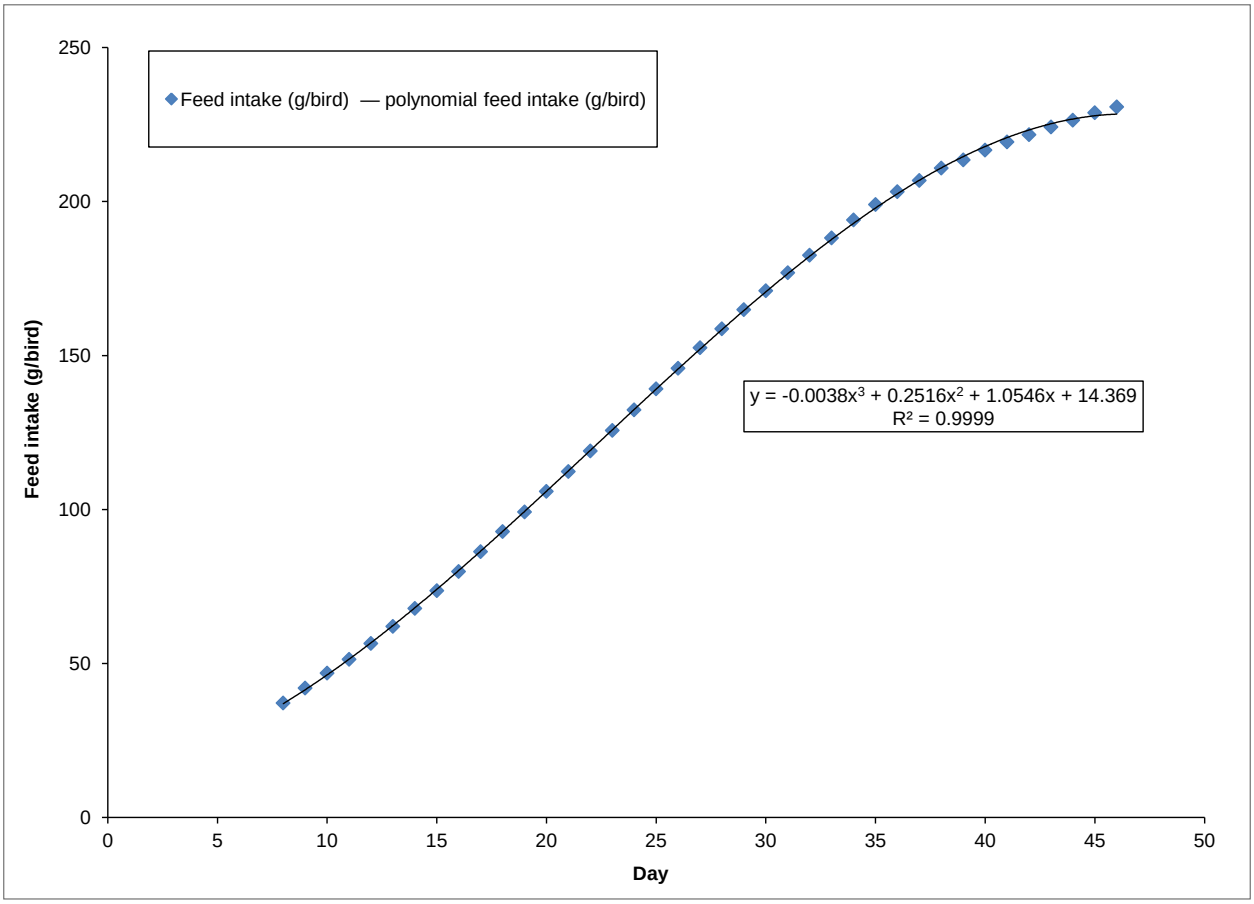
[88] Aviagen. Ross 708. Available at: http://en.aviagen.com/assets/Tech_Center/Ross_Broiler/Ross-708-Broiler-PO-2014-EN.pdf. Accessed November 2014.

Figure A.2. Segment one daily feed intake (g/day) based on common broiler chicken breeds



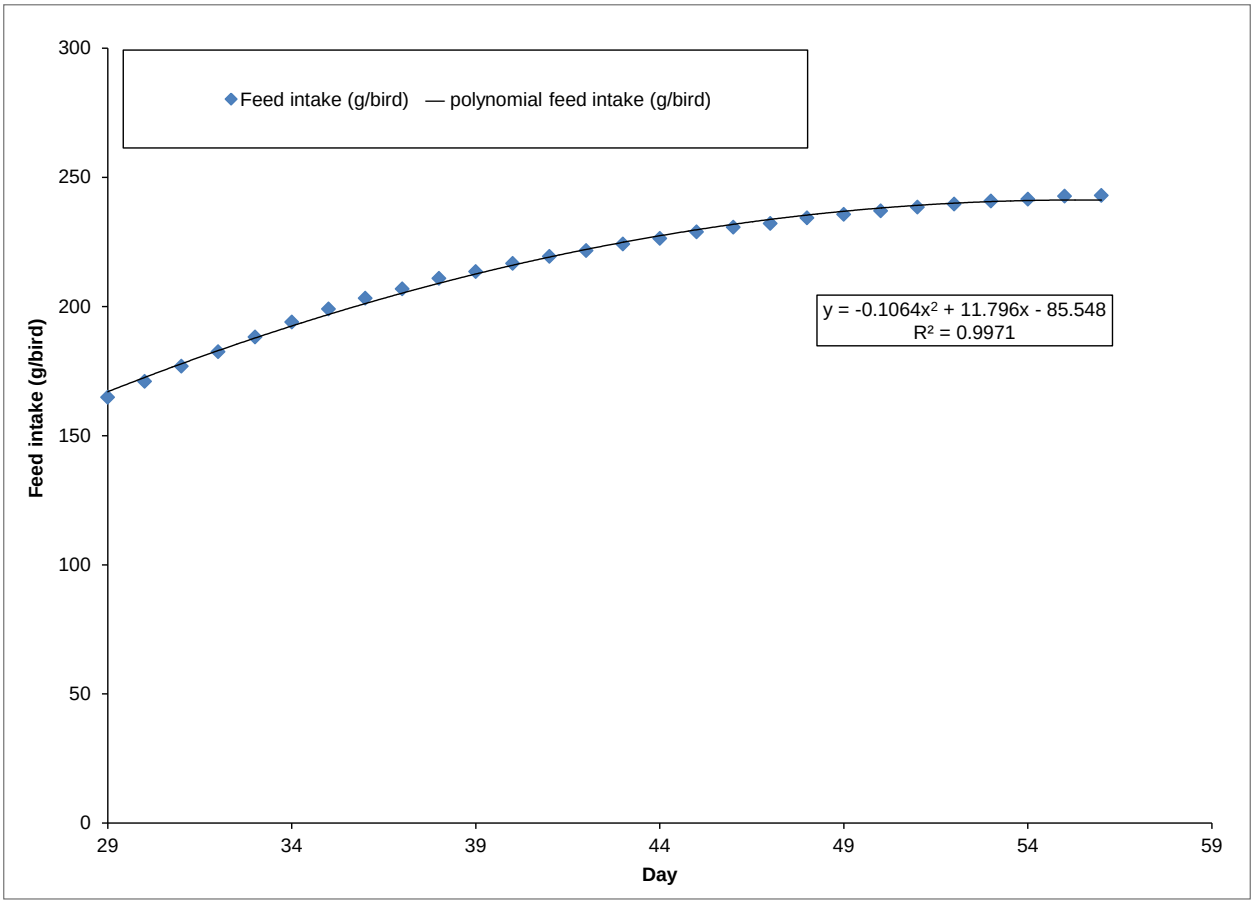
Feed intake (g/day) are based on the average consumption of the common broiler chicken breeds raised in Canada with growth curves derived from the feed standards/guidelines and the fitted polynomial regression line generated in Microsoft™ Excel.

Figure A.3. Segment two daily feed intake (g/day) based on common broiler chicken breeds



Feed intake (g/day) are based on the average consumption of common broiler chicken breeds raised in Canada with growth curves derived from the feed standards/guidelines and the fitted polynomial regression line generated in Microsoft™ Excel.

Figure A.4. Segment three daily feed intake (g/day) based on common broiler chicken breeds



Feed intake (g/day) are based on the average consumption of the common broiler chicken breeds raised in Canada with growth curves derived from the feed standards/guidelines and the fitted polynomial regression line generated in Microsoft™ Excel.

The area under the curve for each regression equation provided an estimate of feed consumption. The equations for each segment of the curve where the corresponding β values came from the regression line and the ages (t) for each ration came from the survey (as entered) were as follows.

The formula for the first and second segment polynomial was:

$\beta_0 t + \beta_1 t^2/2.0 + \beta_2 t^3/3.0 + \beta_3 t^4/4.0$

The formula for the third segment polynomial was:

$\beta_0 t\ \beta_1 t^2/2.0 + \beta_2 t^3/3.0$

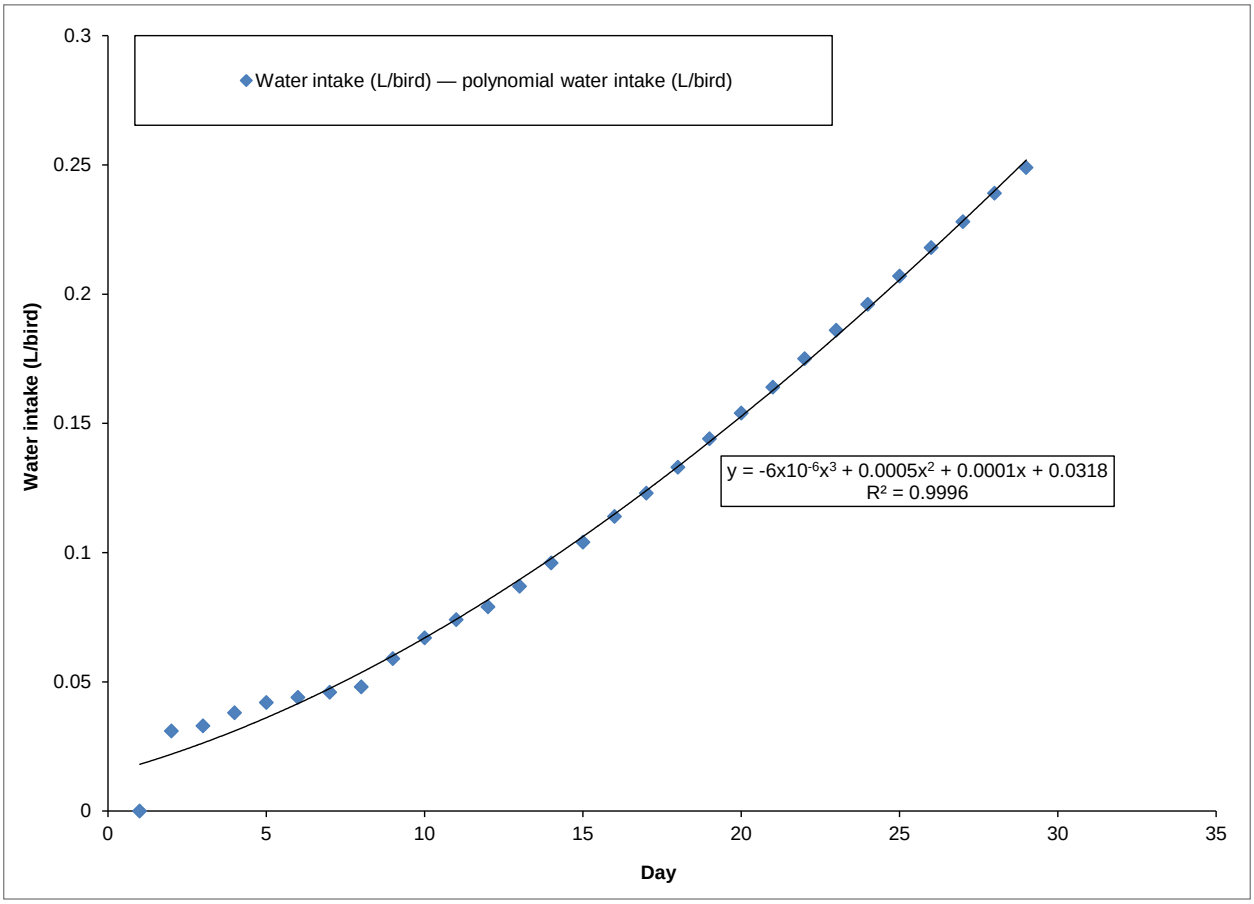
Using PLpgSQL code within the PostGreSQL database, for the applicable regression line, two integrals were calculated, the lower integral where "t" is the start age and the upper integral where "t" is the end age. The difference between the upper and lower integral yielded the estimate of feed intake in grams per bird. Feed consumption was converted from grams to tonnes and multiplied by the number of birds at risk (i.e., total birds minus half of the

cumulative mortality rate at the time of sampling) to provide an estimate of total tonnes fed for each ration. The number of birds reported were the total birds delivered in the poultry unit of concern (barn or floor) including the 2% allowance provided by the hatchery. This value was then utilized to calculate the grams of antimicrobial consumed per ration and incorporated into the quantitative analysis.

Broiler chickens—water consumption calculations: estimates of water consumption were based on simple regression and calculus. Water consumption estimates were uploaded into Microsoft ™Excel from the Nutreco Canada Inc (Revised April 4, 2011) daily water consumption chart and a plot of intake in liters/bird/day was created.

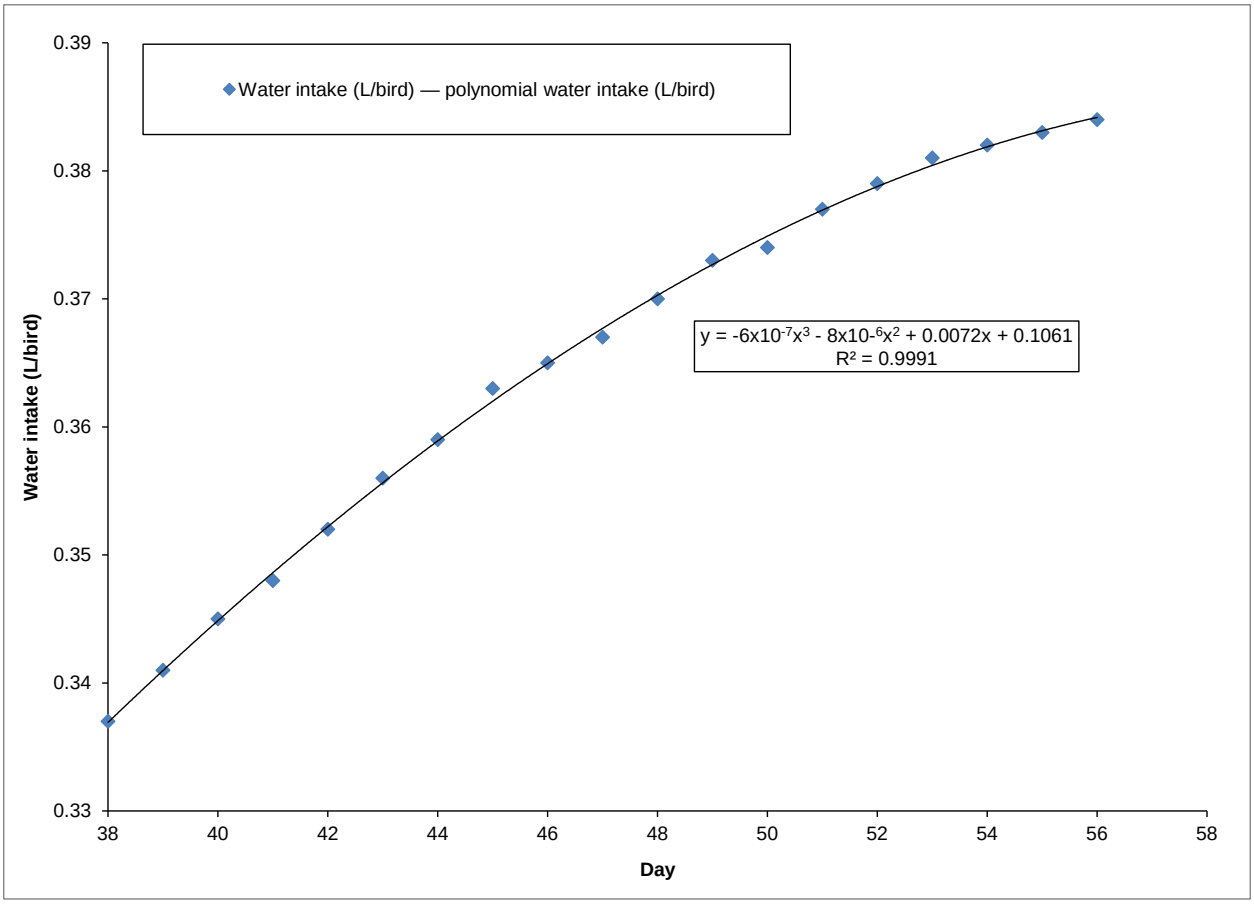
From the broiler chicken survey the start and end age of the birds was available for each water treatment. An algorithm was used to prevent any possible overlapping of age in days for consecutive water treatments with different antimicrobials in the same flock. Regression parameters were calculated within Microsoft ™Excel by using the plotted water intake curve. A minimum R-square value of more than 0.99 was required to be considered a good fit therefore to obtain the best fitting regression values the water consumption curve was divided into 3 segments. Water consumption based on the regression line in Figure A.5 was used if the age of the birds when they started and ended the water treatment was less or equal to 21 days of age. The regression line in Figure A.7 was used if the age of the birds when they started and ended the water treatment was less or equal to 38 days of age. All other age ranges had water consumption calculated from the regression line depicted in Figure A.6. From the regression coefficients the water consumption could then be calculated using integral calculus.

Figure A.5. Segment one broiler chicken daily water consumption (Liters/day)



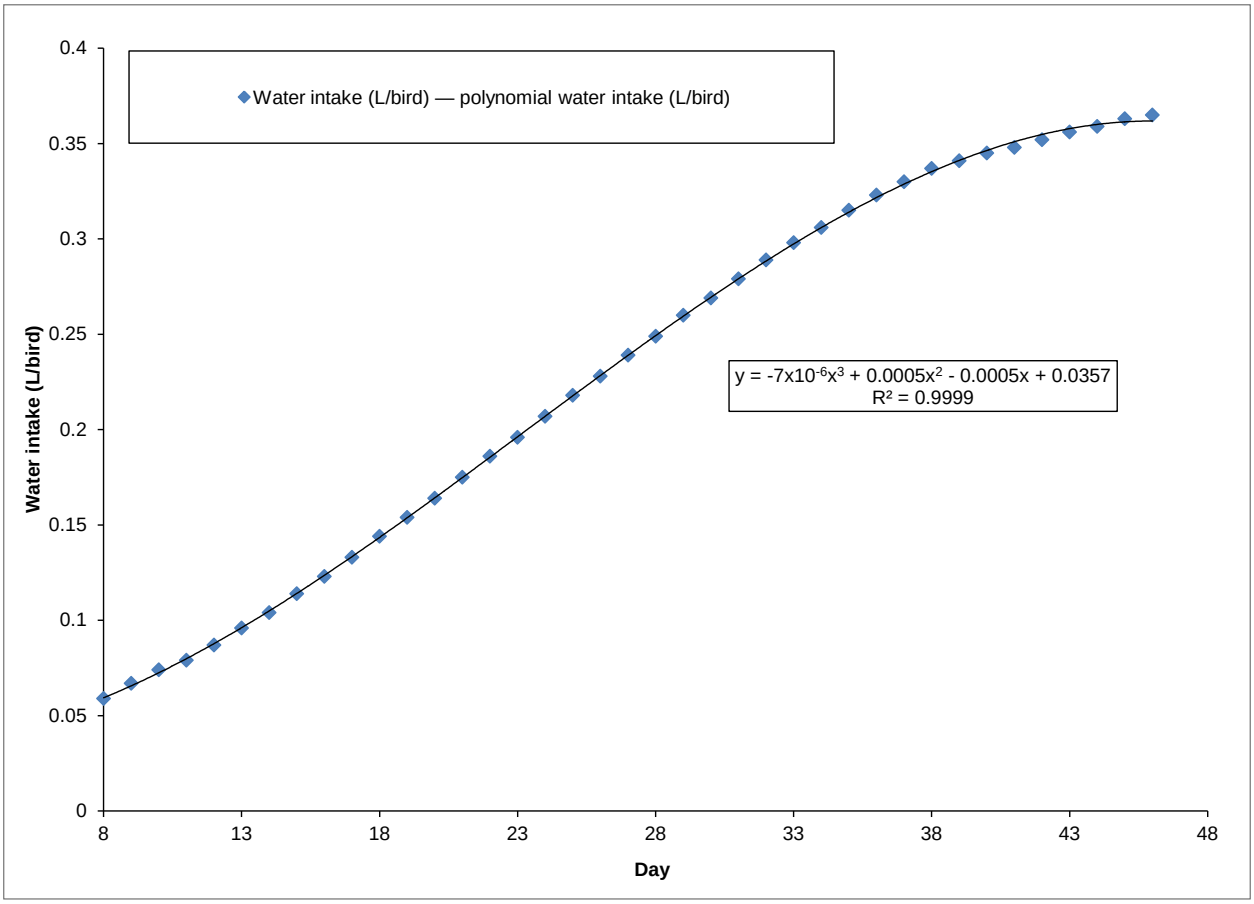
Water intake (L/day) is based the Nutreco Canada Inc. daily water consumption chart for common breeds and average performing flocks in Canada and the fitted polynomial regression lines generated in Microsoft ™Excel.

Figure A.6. Segment two broiler chicken daily water consumption (Liters/day)



Water intake (L/day) is based the Nutreco Canada Inc. daily water consumption chart for common breeds and average performing flocks in Canada and the fitted polynomial regression lines generated in Microsoft ™Excel.

Figure A.7. Segment three broiler chicken daily water consumption (Liters/day)



Water intake (L/day) is based the Nutreco Canada Inc. daily water consumption chart for common breeds and average performing flocks in Canada and the fitted polynomial regression lines generated in Microsoft ™Excel.

The area under the curve for each regression equation provided an estimate of water consumption. The equation for each segment of the curve was as follows; where the corresponding "β" values came from the regression line for each segment of the curve and the ages (t) for each treatment came from the survey (as entered).

The formula for the polynomial was:

$\beta_0 t + \beta_1 t^2/2.0 + \beta_2 t^3/3.0 + \beta_3 t^4/4.0$

Using PLpgSQL code within the PostGreSQL database, for the applicable regression line, 2 integrals were calculated, the lower integral where "t" is this the start age and the upper integral where "t" is the end age. The difference between the upper and lower integral yielded the estimate of water intake in liters per bird. Water consumption in liters/bird was then multiplied by the number of birds at risk (i.e., total birds minus half of the cumulative mortality rate at the time of sampling) to provide an estimate of total liters consumed for each treatment. This value was then utilized to calculate the grams of antimicrobial consumed per treatment and incorporated into the quantitative analysis.

QUANTITIES OF ANTIMICROBIALS DISTRIBUTED FOR SALE FOR USE IN ANIMALS AND CROPS

QUANTITIES OF ANTIMICROBIALS DISTRIBUTED FOR SALE FOR USE IN ANIMALS

As an estimate of antimicrobials used in animals, data on active ingredients distributed for sale were aggregated and provided to the Public Health Agency of Canada by the Canadian Animal Health Institute (CAHI). CAHI is the trade association representing the companies that manufacture and distribute drugs for administration to food (including fish), sporting, and companion animals in Canada. The association estimates that its members' sales represent over 90% of all sales of licensed animal pharmaceutical products in Canada[89]. CAHI coordinates electronic collection of data from its members. Data collection and analysis are performed by a third party, Impact Vet[90]. The CAHI data include information from 15 companies that manufacture antimicrobials products for use in animals in Canada, and 5 major wholesalers/distributors. The CAHI data on the distribution of antimicrobials for use in animals provide a context to interpret other data on antimicrobial use in animals generated through research and farm data collection. They also provide a means to estimate gross temporal changes in antimicrobials used in animals.

The level in the distribution chain that kilograms of active ingredients are reported to CIPARS is at the feed manufacturer/veterinary clinic/over-the-counter outlet/feed mill. Antimicrobial use was assigned to either production animal (inclusive of horses) or companion animal by the manufacturers according to label claim, and in the situation where mixed species was indicated on the label, the manufacturer assigned (estimated) the species as either companion animal or production animal based on the veterinary clinic practice profile.

These data do not represent actual antimicrobial use in a given year; rather, they reflect the volume of antimicrobials distributed by manufacturers and wholesalers. Distribution values should approximate amounts used, particularly when data from more than one year are included. However, when data from only one year are included, distribution values may vary from amounts actually used because of the time lag between distribution and actual use, as well as stockpiling of antimicrobials at various points in the distribution system. The sales data also do not account for drug wastage due to drug expiry.

The data do not include antimicrobials imported for personal use (own use importation—OUI) under the personal-use provision of the federal Food and Drugs Act and its Regulations, nor do they include imported active pharmaceutical ingredients (API), which are drugs imported in non-dosage form and compounded by a licensed pharmacist or veterinarian. The latest information from CAHI is that the lost opportunity value due to OUI and API was estimated to be 13% of total pharma sales or about $50M. The CAHI data do not include prescriptions filled by pharmacists using human labeled drugs for antimicrobials used in companion animals.

[89] Canadian Animal Health Institute. Available at: www.cahi-icsa.ca/about. Accessed August 2015.
[90] Division of AgData Ltd. Available at: http://www.agdata.net/industry_platforms/canada/impact_vet. Accessed August 2015.

Hence, the CAHI data are currently an underestimate of the true volume of antimicrobials used in animals in Canada. Also, the CAHI data do not capture what happens to the drugs after purchase; hence these data cannot provide information the actual antimicrobial use practices, such as dose, duration, reason for use, detailed species-specific information, or extra-label use.

The CAHI data include medicines sold directly to pharmacists that have a focus on dispensing for production medicine. It does not include antimicrobial agents moved from veterinarians to pharmacies and then subsequently dispensed by pharmacies. The latter distribution is captured with the veterinary clinic-level data.

CAHI provides the information in categories, with some antimicrobials not independently reported. This is based on a "3 company accounting rule" established by CAHI to comply with the European Union and the United States' anti-competition regulations. CAHI added in some cases a "90% rule" to be sure not to infringe the regulations in the United States. These accounting rules can result in changes to the categorization of specific antimicrobials over time. For 2014, the antimicrobials are categorized as per Table A.3.

QUANTITIES OF ANTIMICROBIALS DISTRIBUTED FOR SALE FOR USE IN CROPS

In addition to antimicrobial use in animals, Health Canada's Pest Management Regulatory Agency (PMRA) collects annual Canadian sales data from all pesticide manufacturers. Sales information on antimicrobial drugs registered as pesticides on food crops was provided by PMRA to CIPARS and the 2014 data are reported in the 2016 Canadian Antimicrobial Resistance Surveillance System Report.

Table A.3. Canadian Animal Health Institute's aggregation of data on antimicrobial distributed for sale for use in animals, 2014

Antimicrobial class	Ingredient
Aminoglycosides	Amikacin, apramycin, dihydrostreptomycin, gentamicin, neomycin, spectinomycin, streptomycin
β-Lactams / penicillin	Amoxicillin, ampicillin, cloxicillin, penicillin, sulbactam, clavulanic acid
Cephalosporins	Ceftiofur, cephapirin, cefovecin, cefaclor, cefadroxil
Fluoroquinolones	Enrofloxacin, difloxacin, marbofloxacin, orbifloxacin
Chemical coccidiostats	Amprolium, clopidol, decoquinate, diclazuril, narasin, nicarbazin, pyrimethamine, robenidine, zoalene
Ionophore coccidiostats	Lasalocid, maduramicin, monensin, salinomycin
Lincosamides	Clindamycin, lincomycin, pirlimycin
Macrolides	Erythromycin, gamithromycin, tilmicosan, tylosin, tulathromycin,
Tetracyclines	Chlortetracycline, oxytetracycline, tetracycline
Trimethoprim and sulfonamides	Ormethoprim, trimethoprim, sulfabenzamide, sulfacetamide, sulfadiazine, sulfadimethoxine, sulfadoxine, sulfaguanidine, sulfamerazine, sulfamethazine, sulfanilamide, sulfaquinoxaline, sulfathiazole
Other antimicrobials	Avilamycine, bacitracins, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymixin, tiamulin,

POPULATION CORRECTION UNIT IN ANIMALS

Changes in overall distribution of antimicrobials over time may reflect several things, including: true change in use practices, a change in the numbers or types of animals in the population (requiring antimicrobials), changes in disease prevalence necessitating antimicrobial use, and changes in the types of antimicrobials administered (with different potencies)As one way to adjust the sales data for the changing animal populations over time, a denominator accounting for the number of animals and their standardized weights (animal biomass) was applied. This denominator was based on the methodology currently in use by the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC)[91].

ESVAC adjusts the sales data by a population correction unit (PCU)[91] in which a PCU is a proxy for the animal biomass that is at risk of being treated with antimicrobials. The PCU has been described as "currently the best approximation of consumption, extrapolated from sales data, for changes within a country over time and comparison between countries"[92]. It is a technical measurement only; where 1 PCU = 1 kg of different categories of livestock and slaughtered animals. ESVAC methodology was applied to the greatest extent possible, however population

[91] Sales of veterinary antimicrobial agents in 26 EU/EEA countries in 2012 (EMA/333921/2014). European Medicines Agency. European Surveillance of Veterinary Antimicrobial Consumption (ESVAC). Available at: http://www.ema.europa.eu/docs/en_GB/document_library/Report/2014/10/WC500175671.pdf. Accessed August 2015.

[92] UK-VARSS 2013. UK Veterinary Antibiotic Resistance and Sales Surveillance Report. Veterinary Medicines Directorate -Government Department for the Environment, Food and Rural Affairs. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440744/VARSS.pdf. Accessed August 2015.

information collected by Statistics Canada and Agriculture and Agri-Food Canada is different in structure somewhat from the data accessed by ESVAC (Eurostat and TRACES), hence direct comparisons of PCU's or mg/PCU with ESVAC participating country data should only be made with due caution.

The PCU is calculated by multiplying the numbers of livestock and slaughtered animals in each species/production state by the theoretical (standardized) weight at the most likely time of treatment[93,94].

$$\text{PCU (kg)} = \text{number of animals} * \text{average weight of animal at treatment (kg)}$$

$$\text{AMU} = \frac{\text{Antimicrobials distributed (mg)}}{\text{PCU (kg)}}$$

National denominator data regarding the number of livestock and slaughtered animals for 2006 to 2014 were obtained from Statistics Canada, Agriculture and Agri-Food Canada, Fisheries and Oceans Canada, the Canadian Animal Health Institute, and Equine Canada websites and are detailed in Chapter 3—Antimicrobial Use in Animals—Quantities of Antimicrobials Distributed for Sale for Use in Animals.

The average weights at treatment used in these calculations, as per ESVAC, can be found in Table A.4. Canadian average weights were approximated for this surveillance reporting period, as there is discussion with industry stakeholders to determine appropriate weights in the Canadian context.

[93] Sales of veterinary antimicrobial agents in 26 EU/EEA countries in 2012 (EMA/333921/2014). European Medicines Agency. European Surveillance of Veterinary Antimicrobial Consumption (ESVAC). Available at: http://www.ema.europa.eu/docs/en_GB/document_library/Report/2014/10/WC500175671.pdf. Accessed August 2015.

[94] Trends in the sales of veterinary antimicrobial agents in nine European countries—Reporting period: 2005-2009. European Medicines Agency. European Surveillance of Veterinary Antimicrobial Consumption (ESVAC). Available at: www.ema.europa.eu/docs/en_GB/document_library/Report/2011/09/WC500112309.pdf. Accessed August 2015

Table A.4. Detailed information on population numbers, 2014

Animal Species	Animal class/production class	Production Stage	Number of Animals	ESVAC Average weight (w) at treatment or standard weight for import/export (kg)[a]	PCU (1000 tonnes)
			n	w	(n*w)/(1000 *1000) (imports subtracted)
Cattle					
	Cattle	Slaughter[b]	2,831,374	425	1,203
	Calves	Slaughter[b]	205,595	140	29
	Cattle and calves	Live cattle and calf import from the United States (US) for slaughter[c]	0	425	0
	Slaughter cattle and calves	Export for slaughter to the US[d]	739,511	425	314
	Calves	Live cattle and calf international import for feeding[c]	31,957	140	4
	Feeder cattle and calves	Export for feeding to US[e]	441,695	140	62
	Beef cows	On farm[f]	3,926,600	425	1,669
	Dairy cows	On farm[f]	959,300	425	408
	Total		8,866,523		3,680
Swine					
	Finishers	Slaughter[g]	20,335,730	65	1,322
	All swine	International import[h]	3,600	65	0
	All swine	International export[h]	4,959,900	65	322
	Sows and gilts	On farm[i]	1,196,500	240	287
	Total		26,488,530		1,931
Poultry					
	Broiler chickens	Slaughter[j]	640,630,200	1	641
	Turkey (> 6.2 to < 13.3 kg)	Slaughter[j]	20,876,341	6.5	136
	Poultry (< 185 g)	Live poutry for import[k]	32,273,861	0.2	6
	Poultry (> 185 g)	Live poutry for import[k]	38,729,701	2	77
	Poultry (< 185 g)	Export[k]	15,483,379	0.2	3
	Poultry (> 185 g)	Export[k]	785,209	2	2
	Total		606,771,567		697
Sheep and goats					
	Sheep and lamb	Slaughter[l]	756,100	20	15
	Goats	Slaughter[m]	60,265	20	1
	Sheep	International import[l]	9,800	20	0
	Sheep	International export[l]	4,000	20	0
	Ewes	On farm[n]	551,700	75	41
	Total		1,362,265		58
Horses		Living[o]	963,500	400	385
Fish					
	Finfish	Production (kg)[p]	93,656,000	N/A	94
	Shellfish	Production (kg)[p]	39,927,000	N/A	40
	Total		133,583,000		134
Rabbits		Slaughter[q]	590,086	1.4	1
Total PCU production animals					**6,886**
Cats	N/A	N/A[r, s]	7,000,000	4	28
Dogs	N/A	N/A[r, s]	6,400,000	15	96
Total PCU companion animals					**124**

See corresponding footnotes on next pages.

Table A.4. Detailed information on population numbers, 2014 (cont'd)

PCU = population correction unit.
N/A = not applicable.
Shaded data source: needs updating as data become available.
For cattle, pigs, and sheep on farm, the number of animals entered for a calendar year was the number captured on January 1st of that calendar year (this was sometimes reported in the previous year's end of year number; e.g., for sows and gilts on farm for January 1, 2014 in the Statistics Canada CANSIM table, this was reported for the second period of 2013).
For horses, data on number of horses on farm were only reported for 2006 and 2010. The assumption was that for 2014, the number was the same.

[a] As per European Surveillance of Veterinary Antimicrobial Consumption (ESVAC), unless otherwise specified. ESVAC does not include beef cows. Beef cows are included here because they are a significant animal population in Canada.
[b] Data from federal and provincial slaughter plants. Available at:.http://aimis-simia.agr.gc.ca/rp/index-eng.cfm?action=rR&pdctc=&r=105&menupos=1.02.06 and http://aimis-simia.agr.gc.ca/rp/index-eng.cfm?action=rR&pdctc=&r=111&menupos=1.02.06. Accessed March 12, 2015.
[c] Available at: http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/red-meat-and-livestock/red-meat-market-information-canadian-industry/imports-and-exports/livestock-imported-from-the-united-states/?id=1415860000006. Accessed Dec. 3, 2015.
[d] Includes steers, heifers, cows, and bulls. Available at: http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/red-meat-and-livestock/red-meat-market-information-canadian-industry/imports-and-exports/?id=1415860000005. Accessed March 24, 2015
[e] Available at: http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/red-meat-and-livestock/red-meat-market-information-canadian-industry/imports-and-exports/?id=1415860000005. Accessed March 24, 2015.
[f] Table 003-0032. Data for January 1st. Available at: http://www5.statcan.gc.ca/cansim/a05. Accessed March 24, 2015.
[g] Agriculture and Agri-Food Canada (Report A005C). Available at: http://aimis-simia.agr.gc.ca/rp/index-eng.cfm?menupos=1.02.06&pdctc=&action=pR&LANG=EN&r=93. Accessed April 13, 2015.
[h] Added for periods I and II. Statistics Canada (CANSIM 003-0102). Available at: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030102&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=. Accessed April 13, 2015.
[i] Number of animals recorded on period II for 2014. Statistics Canada (CANSIM 003-0100). Available at: www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/prim51a-eng.htm. Accessed April 13, 2015.
[j] Live weight; for turkeys mature birds were included. Agriculture and Agri-Food Canada (Poultry Slaughter - Report 001). Available at: http://aimis-simia.agr.gc.ca/rp/index-eng.cfm?action=pR&r=1&pdctc=. Accessed April 14, 2015.
[k] Included all poultry. Agriculture and Agri-Food Canada (Poultry and Egg Trade Balance Report). Available at: http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/poultry-and-eggs/poultry-and-egg-market-information-canadian-industry/imports-and-exports/statistics-canada-poultry-and-egg-trade-reports/2014-poultry-and-egg-trade-balance-reports/?id=1426000524082. Accessed April 14, 2015.
[l] Statistics Canada (CANSIM 003-0028). Available at: www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030028&tabMode=dataTable&srchLan=-1&p1=-1&p2=9. Accessed September 2, 2015.
[m] Added numbers from federally and provincially inspected establishments. Agriculture and Agri-Food Canada (Annual Goats Slaughtered in Federally and Provincially Inspected Establishments in Canada). Available at: http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/red-meat-and-livestock/red-meat-market-information-canadian-industry/by-sector-reports/sheep-lambs-and-goats/goat-slaughtered-in-canada/?id=1415860000044#2014. Accessed April 17, 2015.
[n] Number of animals recorded on January 1st, 2013 Statistics Canada (CANSIM 003-0031). Available at: www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030031&tabMode=dataTable&srchLan=-1&p1=-1&p2=9. Accessed April 17, 2015.

Table A.4. Detailed information on population numbers, 2014 (cont'd)

[o] Available at: www.equinecanada.ca/industry/index.php?option=com_content&view=section&id=103&Itemid=559&lang=en. Accessed December 3, 2015.

[p] Table 003-0001. Available at: www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030001&pattern=aquaculture&tabMode=dataTable&srchLan=-1&p1=1&p2=49. Accessed December 3, 2015.

[q] Federal and provincial slaughter. Available at: http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/red-meat-and-livestock/red-meat-and-livestock-market-information/supply-sheets-by-species/rabbit-industry-at-a-glance/?id=1415860000120. Accessed December 3, 2015.

[r] Companion Animal Health. Canadian Animal Health Institute. Available at: http://www.cahi-icsa.ca/companion-animal-health/. Accessed August 21, 2015.

[s] Average weights for cats and dogs from ANSES, 2012. French Agency for Food. Environmental and Occupational Health & Safety (ANSES) - French Agency for Veterinary Medicinal Products (ANMV). Sales survey of Veterinary Medicinal Products containing Antimicrobials in France - 2012. Volumes and estimated exposure of animals to antimicrobials. Oct. 2013. Available at: http://www.anses.fr/sites/default/files/documents/ANMV-Ra-Antibiotiques_2012EN.pdf. Accessed on September 2, 2015.

Detailed inclusions and exclusions for the PCU denominator: As per ESVAC, exported animals were added to the PCU, whereas imported animals were subtracted, based on the ESVAC assumption that animals are treated in their country of origin. However, it was noted that in the Canadian context, this would vary depending upon the production stage that is crossing the border. For the purposes of calculating the PCU, production animal species with the largest populations were included, using the same production classes as ESVAC, with the exception that we additionally included beef cows (not included by ESVAC). Species currently excluded from our PCU calculations include game animals (e.g., moose), "pocket" companion animals (e.g., hamsters, guinea pigs, pet birds), reptiles, and amphibians. For some production stages, import and export data for poultry are included in a different structure before and after 2009, based on the data available from Statistics Canada. The total number of cattle slaughtered per year as provided/accessed was not stratified by type of cattle (beef versus cull dairy); hence it was assumed that the total slaughtered includes all cattle types (including cull dairy).

PROVINCIAL STRATIFICATION OF THE NUMERATOR AND DENOMINATOR

There may be subsequent distribution of antimicrobials across provincial borders after being distributed to the veterinary clinics (in particular the movement of medicated feed—for example, anecdotal information was that New Brunswick has a negligible feed-mill industry, they generally purchase their medicated feed from Québec), hence caution should be applied when interpreting the quantities of antimicrobials distributed for sale within each province. An effort was made to calculate a PCU at the provincial-level, however there is ongoing discussion with industry stakeholders regarding the inter-provincial movement of animals. As inter-provincial export data is not available for all species in all provinces/regions, provincial/regional calculations of PCU will be postponed pending further discussion.

OVERALL DISCUSSION OF STRENGTHS AND LIMITATIONS

The CAHI data provides a rough measure of antimicrobials distributed for sale for all animal species, including those not covered by CIPARS farm-level surveillance (with appropriate caveats regarding OUI/API). With respect to the PCU, as stated in the United Kingdom's surveillance report on antimicrobials sold for use in animals , the population is an important denominator, as the greater the number of animals, the greater the potential need for antimicrobial therapy. The PCU metric currently does not take into account the lifespan of the animal, which may affect the interpretation of the quantities of antimicrobials administered to animals. Also, use of a static standard weight may not reflect an industry shift in production affecting the average weights of animals treated, related to weather, trade, or other reasons. Measures of antimicrobial use as reported by broad categories and by a PCU denominator do not account for the individual potencies of the drugs that make up the category. For example, a decrease in the mg/PCU reported for a given year could potentially reflect a switch to using a more potent drug, as opposed to reflecting a decrease in the actual exposure of animals to antimicrobials. The CAHI data should be interpreted as one measure describing antimicrobials used in animals, strong caution should be applied with making inferences to any use practice for a particular animal species. CIPARS continues to work to improve this measure and other appropriate measures, to best reflect antimicrobial use in the Canadian context.

ANTIMICROBIAL CLASSIFICATION

CATEGORIZATION OF ANTIMICROBIALS BASED ON IMPORTANCE IN HUMAN IMPORTANCE

Categories of antimicrobials used in this report were taken from the document Categorization of Antimicrobial Drugs Based on Importance in Human Medicine[95] by Health Canada's Veterinary Drugs Directorate (Table A.5). Antimicrobials are considered to be of Very High Importance in Human Medicine (Category I) when they are essential for the treatment of serious bacterial infections and there is no or limited availability of alternative antimicrobials for effective treatment. These antimicrobials include amoxicillin-clavulanic acid, ceftiofur[96], ceftriaxone, ciprofloxacin, telithromycin, and colistin. Antimicrobials of High Importance in Human Medicine (Category II) consist of those that can be used to treat a variety of infections, including serious infections, and for which alternatives are generally available. Bacteria resistant to antimicrobials of this category are generally susceptible to Category I antimicrobials, which could be used as alternatives. Antimicrobials of Medium Importance in Human Medicine (Category III) are used in the treatment of bacterial infections for which alternatives are generally available. Infections caused by bacteria resistant to these antimicrobials can, in general, be treated with Category II or I antimicrobials. Antimicrobials of Low Importance in Human Medicine (Category IV) are currently not used in human medicine.

[95] Health Canada. 2009. Categorization of Antimicrobial Drugs Based on Importance in Human Medicine. Version April, 2009. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed September 2014.

[96] Ceftiofur is licensed for use in animals only. Resistance to ceftiofur is generally detected in combination with resistance to amoxicillin-clavulanic acid, cefoxitin, ampicillin and ceftriaxone (A2C-AMP-CRO resistance pattern).

Table A.5. Categorization of antimicrobial drugs based on importance in human medicine class, 2014

Category of importance in human medicine		Antimicrobial class
I	Very high importance	Carbapenems Cephalosporins – the third and fourth-generations Fluoroquinolones Glycopeptides Glycylcyclines Ketolides Lipopeptides Monobactams Nitroimidazoles (metronidazole) Oxazolidinones Penicillin-β-lactamase inhibitor combinations Polymyxins (colistin) Therapeutic agents for tuberculosis (e.g. ethambutol, isoniazid, pyrazinamide, and rifampin)
II	High importance	Aminoglycosides (except topical agents) Cephalosporins – the first and second-generations (including cephamycins) Fusidic acid Lincosamides Macrolides Penicillins Quinolones (except fluoroquinolones) Streptogramins Trimethoprim-sulfamethoxazole
III	Medium importance	Aminocyclitols Aminoglycosides (topical agents) Bacitracins Fosfomycin Nitrofurans Phenicols Sulfonamides Tetracyclines Trimethoprim
IV	Low importance	Flavophospholipols Ionophores

Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

LIST OF ANTIMICROBIALS FROM THE FARM SWINE QUESTIONNAIRE

Table A.6. List of antimicrobials from the Farm Swine questionnaire database for each ATCvet class, 2014

ATCvet class		Antimicrobial
I	Third-generation cephalosporins (QJ01DD)	Ceftiofur (QJ01DD90)
	Fluoroquinolones	Enrofloxacin (QJ01MA90)
II	Amphenicols (QJ01BA)	Florfenicol (QJ01BA90)
	Penicillins with extended spectrum (QJ01CA)	Ampicillin (QJ01CA01)
		Amoxicillin (QJ01CA04)
	β-Lactamase sensitive penicillins (QJ01CE)	Penicillin (QJ01CE01)
	Combination of sulfadoxine and trimethoprim (QJ01E	Trimethoprim-sulfadoxine (QJ01EW13)
	Macrolides (QJ01FA)	Erythromycin (QJ01FA01)
		Tylosin (QJ01FA90)
		Tilmicosin (QJ01FA91)
		Tulathromycin (QJ01FA94)
	Lincosamides (QJ01FF)	Lincomycin (QJ01FF02)
	Streptogramins (QJ01FG)	Virginiamycin (QJ01FG90)
	Other aminoglycosides (QJ01GB)	Neomycin (QJ01GB05)
	Combinations of antibacterials (QJ01RA)	Penicillin-streptomycin (QJ01RA01)
		Chlortetracycline-sulfamethazine-penicillin (QJ01RA90)
		Oxytetracycline-neomycin (QJ01RA90)
		Tetracycline-neomycin (QJ01RA90)
		Lincomycin-spectinomycin (QJ01RA94)
	Other antibacterials (QJ01XX)	Spectinomycin (QJ01XX04)
III	Tetracyclines (QJ01AA)	Chlortetracycline (QJ01AA03)
		Oxytetracycline (QJ01AA06)
		Tetracycline (QJ01AA07)
		Chlortetracycline, combinations (QJ01AA53)
	Sulfonamides (QJ01EQ)	Combinations of sulfonamides (QJ01EQ30)
	Pleuromutilins (QJ01XQ)	Tiamulin (QJ01XQ01)
	Other antibacterials (QJ01XX)	Bacitracin (QJO1XX10)
IV	No ATCvet code	Bambermycin (No ATCvet code)
	Pyranes and hydropyranes (QP51AH)	Salinomycin (QP51AH01)

ATC = Anatomical Therapeutic Chemical.

Roman numerals I to IV indicate categories of importance to human medicine as outlined by the Veterinary Drugs Directorate.

The ATCvet system for classification of veterinary medicines is based on the same overall principles as the ATC system for substances used in human medicine. This system is a tool for exchanging and comparing data on drug use in veterinary medicine at international, national or local levels[97].

[97] World Health Organization Collaborating Center for Drug Statistics Methodology. Available at: www.whocc.no/atcddd. Accessed September 2014.

ABBREVIATIONS

CANADIAN PROVINCES, TERRITORIES, AND REGIONS

PROVINCES

BC British Columbia

AB Alberta

SK Saskatchewan

MB Manitoba

ON Ontario

QC Québec

NB New Brunswick

NS Nova Scotia

PE Prince Edward Island

NL Newfoundland and Labrador

TERRITORIES

YT Yukon

NT Northwest Territories

NU Nunavut

REGIONS

Prairies: AB, SK, MB

Maritimes: NB, NS, PE

Atlantic: NB, NS, PE, NL

In 2014, not all provinces are represented in each surveillance component for the Prairies and the Atlantic region.

ANTIMICROBIALS

AMC Amoxicillin-clavulanic acid

AMP Ampicillin

AZM Azithromycin

CHL Chloramphenicol

CIP Ciprofloxacin

CLI Clindamycin

CRO Ceftriaxone

ERY Erythromycin

FLR Florfenicol

FOX Cefoxitin

GEN Gentamicin

KAN Kanamycin

NAL Nalidixic acid

SSS Sulfisoxazole

STR Streptomycin

SXT Trimethoprim-sulfamethoxazole

TEL Telithromycin

TET Tetracycline

TIO Ceftiofur

IMPORTANT RESISTANCE PATTERNS

A2C-AMP Amoxicillin-clavulanic acid, cefoxitin, ceftiofur, and ampicillin

ACSSuT Ampicillin, chloramphenicol, streptomycin, sulfisoxazole, and tetracycline

ACKSSuT Ampicillin, chloramphenicol, kanamycin, streptomycin, sulfisoxazole, and tetracycline

AKSSuT Ampicillin, kanamycin, streptomycin, sulfisoxazole, and tetracycline

DISEASES

APP *Actinobacillus pleuropneumoniae*

APEC Avian pathogenic *Escherichia coli*

CAV Chicken Anemia Virus

IBDV Infectious Bursal Disease Virus

IBV Infectious Bronchitis Virus

PCVAD Porcine Circovirus Associated Disease

PRRS Porcine Reproductive and Respiratory Syndrome

TGE Transmissible gastroenteritis

OTHERS

G/TPD or g/TCD Grams per thousand pig-days or grams per thousand chicken-days

VDD Veterinary Drugs Directorate, Health Canada

SUMMARY OF DESIGN AND METHODS CHANGES

ANTIMICROBIAL RESISTANCE

Table A.7. Changes implemented to the CIPARS antimicrobial use components, 2002–2014

Year	Component	Province / region	Species	Selected bacteria				Design	Methods
				Escherichia coli	*Salmonella*	*Campylobacter*	*Enterococcus*		
2014	*Retail Surveillance*	British Columbia Prairies Ontario Québec Atlantic	Beef	✓				Data presented are stratified regionally (British Columbia, Prairies, Ontario, Québec, and Atlantic).	Resistance to kanamycin is no longer reported due to its removal from the Enterobacteriacea Gram-negative plate (CMV3AGNF). Additionally, the number of dilutions tested for streptomycin and sulfisoxazole were increased and decreased, respectively.
			Chicken	✓	✓	✓			
			Pork	✓					
			Turkey	✓	✓	✓			
	Farm Surveillance	British Columbia Prairies Ontario Québec	Chickens	✓	✓	✓		Saskatchewan participated in the program; data aggregated with Alberta (Prairies).	Statistical analyses were limited to comparison of 2014 results for selected antimicrobials with: 1) 2013 results, 2) 2010 (or 5 years previous) for components with regional results (human, retail, and farm) and abattoir (for comparison between components) 3) the first year of surveillance for components (abattoir) with national results shown.
		Prairies Ontario Québec	Pigs	✓	✓				The CIPARS *Farm Surveillance* grower-finisher pig component began reporting regional and national antimicrobial use at the farm level.

Table A.7. Changes implemented to the CIPARS antimicrobial use components, 2002–2014 (cont'd)

Year	Component	Province / region	Species	Selected bacteria				Design	Methods
				Escherichia coli	*Salmonella*	*Campylobacter*	*Enterococcus*		
2013	*Farm Surveillance*	British Columbia Alberta Ontario Québec	Chickens	✓	✓	✓		Implementation of the CIPARS farm component in broiler chickens of the 4 major poultry producing provinces.	
		Alberta Saskatchewan Manitoba Ontario Québec	Pigs	✓	✓				
	Surveillance of Human Clinical Isolates	Across provinces	Humans		✓				Adoption of a lower breakpoint for ciprofloxacin (≥ 1 µg/mL; CLSI M100-S22) than in past years (≥ 4 µg/mL) for both *Salmonella* and *E. coli.* Ciprofloxacin's new breakpoint was applied to all data, including historical data.Then, the term "reduced susceptibility to ciprofloxacin" was dropped.
	Retail Surveillance	British Columbia Saskatchewan Ontario Québec Maritimes	Beef	✓					
			Chicken	✓	✓	✓			
			Pork	✓					
			Turkey	✓	✓	✓		Surveillance of *Salmonella, E. coli* and *Campylobacter* isolates in retail turkey was started in January.	
2012	*Abattoir Surveillance*	Across provinces	Beef cattle	✓		✓		Surveillance of *Campylobacter* in pigs at the abattoir was started in January.	
			Chickens	✓	✓	✓			
			Pigs	✓	✓	✓			
	Farm Surveillance	Alberta Saskatchewan Manitoba Ontario Québec	Pigs	✓	✓				
	Surveillance of animal clinical Isolates	Across provinces	Bovine		✓				
			Chickens		✓				
			Pigs		✓				
			Turkeys		✓				
	Feed and Feed Ingredients	Across provinces			✓				
2011	*Surveillance of Human Clinical Isolates*	Across provinces	Humans		✓			Human serovars : Newport added as a separate category.	The CMV2AGNF susceptibility testing plate has replaced the CMV1AGNF plate for *Salmonella* and *E. coli* . Amikacin was removed and azithromycin was included in the panel.
	Farm Surveillance	Alberta Saskatchewan Manitoba Ontario Québec	Pigs				✗	Bacterial culture and antimicrobial susceptibility testing of *Enterococcus* isolates from pigs were discontinued as of January.	

Table A.7. Changes implemented to the CIPARS antimicrobial use components, 2002–2014 (cont'd)

Year	Component	Province / region	Species	Selected bacteria				Design	Methods
				Escherichia coli	*Salmonella*	*Campylobacter*	*Enterococcus*		
	Surveillance of Human Clinical Isolates	Across provinces	Humans		✓			Isolates classified as "Other serovars" category were not tested or reported, but stored for future AMR testing. Only the 7 serovars of interest had antimicrobial susceptibility testing.	Half of the *Salmonella* Enteritidis submitted by the most populated provinces (British Columbia, Alberta, Ontario, and Québec) during the first 15 days of the month were tested.
2010	*Retail Surveillance*	British Columbia Saskatchewan Ontario Québec Maritimes	Beef	✓				Bacterial culture and antimicrobial susceptibility testing of *Enterococcus* in chicken isolates discontinued as of January (no vancomycin resistance was detected since the program began in 2003).	A new ceftriaxone breakpoint was officially adopted by the CLSI in January 2010. It was applied to all data, including historical data. A new genus- and species-specific multiplex PCR method was used in replacement of the standard method (biochemical tests) to perform identification and speciation of *Campylobacter.*
			Chicken	✓	✓	✓	✗		
			Pork	✓					
	Abattoir Surveillance	Across provinces	Beef cattle	✓		✓		Bacterial culture and antimicrobial susceptibility testing of *Campylobacter* isolates from abattoir chickens was initiated in January.	
			Chickens	✓	✓	✓			
			Pigs	✓	✓				
	Surveillance of Human Clinical Isolates	Across provinces	Humans		✓			Human serovars: Newport not presented as a separate category; now included with the "other serovars".	
	Retail Surveillance	British Columbia Saskatchewan Ontario Québec Maritimes	Beef	✓				First full surveillance year in the Maritimes.	The CMV3AGPF susceptibility testing plate has replaced the CMV2AGPF plate for all *Enterococcus* isolates.
2009			Chicken	✓	✓	✓	✓		
			Pork	✓					
	Farm Surveillance	Alberta Saskatchewan Manitoba Ontario Québec	Pigs	✓	✓		✓	Sample collection from pigs on entry to the Grower-Finisher unit was terminated. Changed from 3 herd visits per year to 1 annual visit to collect fecal samples from close-to-market pigs.	
	Surveillance of Human Clinical Isolates	Across provinces	Humans		✓			Human serovars: Paratyphi A and B reported as a separate category along with Enteritidis, Heidelberg, Newport, Typhi, Typhimurium, and Other Serovars.	The ceftriaxone resistance breakpoint was changed to ≥ 4 µg/mL (CLSI M100-S20) for all *Salmonella* and *Escherichia coli* isolates. Quinupristin-dalfopristin was reclassified as Category II antimicrobial (High Importance in Human Medicine, Veterinary Drugs Directorate, Health Canada) for all *Enterococcus* isolates. Application of a more sensitive *Campylobacter* recovery method in abattoir beef cattle isolates. Quinupristin-dalfopristin reclassified as category II for all *Enterococcus* isolates.
2008	*Retail Surveillance*	British Columbia Saskatchewan Ontario Québec Maritimes (pilot)	Beef	✓				First surveillance year in British Columbia. Pilot surveillance also began in the Maritimes region in September 2008.	
			Chicken	✓	✓	✓	✓		
			Pork	✓					

Table A.7. Changes implemented to the CIPARS antimicrobial use components, 2002–2014 (cont'd)

Year	Component	Province / region	Species	Selected bacteria				Design	Methods
				Escherichia coli	*Salmonella*	*Campylobacter*	*Enterococcus*		
2007	*Retail Surveillance*	British Columbia (pilot) Saskatchewan Ontario Québec	Beef	✓				Implementation of pilot retail surveillance in British Columbia.	Retail surveillance: Enhancement to the *Salmonella* recovery method yielded higher recovery rates than in prior years. For antimicrobial susceptibility testing of *Enterococcus*, bacitracin was removed and tigecycline removed from the panel. New resistance breakpoints were adopted for lincomycin (from ≥ 32 to ≥ 8 µg/mL) and kanamycin (from ≥ 512 to ≥ 1,024 µg/mL).
			Chicken	✓	✓	✓	✓		
			Pork	✓					
	Surveillance of animal clinical Isolates	Across provinces	Bovine		✓			Publication of surveillance findings from clinical isolates from horses.	
			Chickens		✓				
			Pigs		✓				
			Turkeys		✓				
			Horses		✓				
	Feed and Feed Ingredients	Across provinces	Not available		✓			*Feed and Feed Ingredients* presented as a separate surveillance component.	
2006	*Retail Surveillance*	Saskatchewan Ontario Québec	Beef	✓					The NARMS CAMPY plate has replaced the disk diffusion method (Etest) for antimicrobial susceptibility testing of *Campylobacter*.
			Chicken	✓	✓	✓	✓		
			Pork	✓	✓				
	Abattoir Surveillance	Across provinces	Beef cattle	✓		✓		Abattoir surveillance of *Campylobacter* from beef cattle was started in January.	
			Chickens	✓	✓				
			Pigs	✓	✓				
	Farm Surveillance	Alberta Saskatchewan Manitoba Ontario Québec	Pigs	✓	✓		✓	Implementation of the CIPARS farm component in grower-finisher pigs of the 5 major pork producing provinces.	
2005	*Retail Surveillance*	Saskatchewan Ontario Québec	Beef	✓				Addition of Saskatchewan to the retail component.	Antimicrobial susceptibility testing of *Salmonella* and *E. coli* was fully performed by the NARMS CMV1AGNF plate in January.
			Chicken	✓	✓	✓	✓		
			Pork	✓	✓				
	Abattoir Surveillance	Across provinces	Beef cattle	✓		✓		Pilot surveillance of *Campylobacter* from beef cattle started in late 2005.	
			Chickens	✓	✓				
			Pigs	✓	✓				
	Surveillance of Human Clinical Isolates	Across provinces	Humans		✓				Antimicrobial susceptibility testing of human *Salmonella* was performed by the NARMS CMV7CNCD from January to April and the CMV1AGNF from April to December.
2004	*Abattoir Surveillance*	Across provinces	Beef cattle	✓	✗			*Salmonella* isolation discontinued because of its low prevalence in beef cattle.	
			Chickens	✓	✓				
			Pigs	✓	✓				
	Retail Surveillance	Ontario Québec	Beef	✓				There is a systematic rotational selection of extra lean, lean, regular, and medium ground beef.	
			Chicken	✓	✓	✓	✓		
			Pork	✓					

Table A.7. Changes implemented to the CIPARS antimicrobial use components, 2002–2014 (cont'd)

Year	Component	Province / region	Species	Selected bacteria				Design	Methods
				Escherichia coli	*Salmonella*	*Campylobacter*	*Enterococcus*		
2003	*Surveillance of Human Clinical Isolates*	Across provinces	Humans		✓			Implementation of the CIPARS human component. Antimicrobial susceptibility testing done on all serovars but they were classified and reported into the following categories: Enteritidis, Heidelberg, Newport, Typhi, Typhimurium, and Other Serovars.	Susceptibility testing of *Campylobacter* and *Enterococcus* was performed with the disk diffusion method using the ETest® methodology (AB Biodisk, Solna, Sweden) and the NARMS CMV5ACDC plate respectively.
	Retail Surveillance	Ontario Québec	Beef	✓				Implementation of the CIPARS *Retail Surveillance* component in Ontario and Québec.	
			Chicken	✓	✓	✓	✓		
			Pork	✓					
2002	*Surveillance of Human Clinical Isolates*	Across provinces	Humans					Agreement signed with the Provinces to send all (or a subset) of *Salmonella* isolates to CIPARS. Data were not available for reporting that year.	
	Abattoir Surveillance	Across provinces	Beef cattle	✓	✓			Implementation of the first active suveillance component of CIPARS.	Antimicrobial susceptibility testing of *Salmonella* and *E. coli* was performed by the CMV7CNCD plate (Sensititre™), NARMS, United States.
			Chickens	✓	✓				
			Pigs	✓	✓				
	Surveillance of animal clinical Isolates	Across provinces	Cattle		✓			Implementation of the first passive suveillance components of CIPARS.	
			Chickens		✓				
			Pigs		✓				
			Turkeys		✓				
			Feed and Feed Ingredients		✓				

ANTIMICROBIAL USE

Table A.8. Changes implemented to the CIPARS antimicrobial use components, 2003–2014

Year	Component	Province / region	Population exposed	Reporting metrics	Dosage information	Design	Methods
2014	*Quantities of antimicrobials distributed for sale for use in crops*	National	Crops			The 2014 data are reported in the 2016 Canadian Antimicrobial Resistance Surveillance System Report.	
	Quantities of antimicrobials distributed for sale for use in animals	National	Production animal (including horses) / companion animals	1) kg active ingredient stratified by route of administration 2) mg/population correction unit for companion animal data			Stratification of the data into route of administration by the Canadian Animal Health Institute (CAHI). Application of biomass denominator for the companion animal distribution data.
	Farm AMU surveillance in pigs/chickens	National Prairies Ontario Québec	Grower-finisher pigs/broiler chickens	1) mg active ingredient adjusted for population and weight 2) median g of active ingredients/1,000 pig-days or /1,000 chicken-days 3) Percentage of herds reporting antimicrobial use			The CIPARS *Farm Surveillance* grower-finisher pig component began reporting regional and national antimicrobial use at the farm level. Two new metrics are used in grower-finisher pigs and broiler chickens to present data on antimicrobial use.
	Human antimicrobial use surveillance	National Provincial Regional	Canadians			Human antimicrobial use data no longer reported in CIPARS report.	
2013	*Quantities of antimicrobials distributed for sale for use in crops*	National	Crops			For the first time, Health Canada's Pest Management Regulatory Agency (PMRA) collects annual Canadian sales data from all pesticide manufacturers. Sales information on antimicrobial drugs registered as pesticides on food crops was provided by PMRA to CIPARS.	
	Farm AMU surveillance in broiler chickens	British Columbia Alberta Ontario Québec	Number of chicks placed and number of grown broilers (> 30 days of grow-out period)	Farm count data for AMU by class, category of importance to human medicine, and reason for use	Chick stage: inclusion rate in hatchery medications administered via in-ovo or subcutaneous. Broilers: inclusion rate in feed and water.	Implementation of the CIPARS farm component in broiler chickens of the 4 major poultry producing provinces.	Antimicrobial consumption estimates were based on the concentration of antimicrobials by tonnes of feed (or volume of water) over the duration of feed (or water) administration. Feed and water consumption estimates were based on current standards for the prevalent broiler strains.
2011	*Human antimicrobial use surveillance—physician diagnosis*	National Provincial Regional	Canadians	1) Total diagnoses/10,000 inhabitants 2) Total antimicrobial recommendations/10,000 inhabitants 3) Percentage diagnoses with antimicrobial recommendations		Enhancement of the *Human antimicrobial use surveillance* component. The design is based on a sample of physicians providing antimicrobial recommendation information for every patient in a 48-hour period four times a year.	Analysis based on the Canadian Disease and Therapeutic Index (CDTI) purchased from IMS Health Canada Inc.
	Human antimicrobial use surveillance—hospital purchases	National Provincial	Canadians	1) Defined Daily Doses (DDD)/1,000 inhabitant-days 2) Total cost/1,000 inhabitant-days 3) Total cost per unit of antimicrobials 4) Total active ingredient (kg)		Enhancement of the *Human antimicrobial use surveillance* component. The design is based on a purchasing information for a number of Canadian hospitals extrapolated to all hospitals in Canada.	Analysis based on the Canadian Drugstore and Hospital Purchases Audit (CDH) purchased from IMS Health Canada Inc.
	Quantities of antimicrobials distributed for sale for use in animals	National	A national animal biomass denominator was calculated as per the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC)	1) Total of active ingredients (kg) (national and provincial; production animal, and companion animal); 2) mg/PCU (where PCU=population correction unit, a measure of animal biomass)			Stratification of CAHI data into production & companion animal; stratification by province; extraction of cephalosporins back into separate category; application of biomass denominator to national-level data.

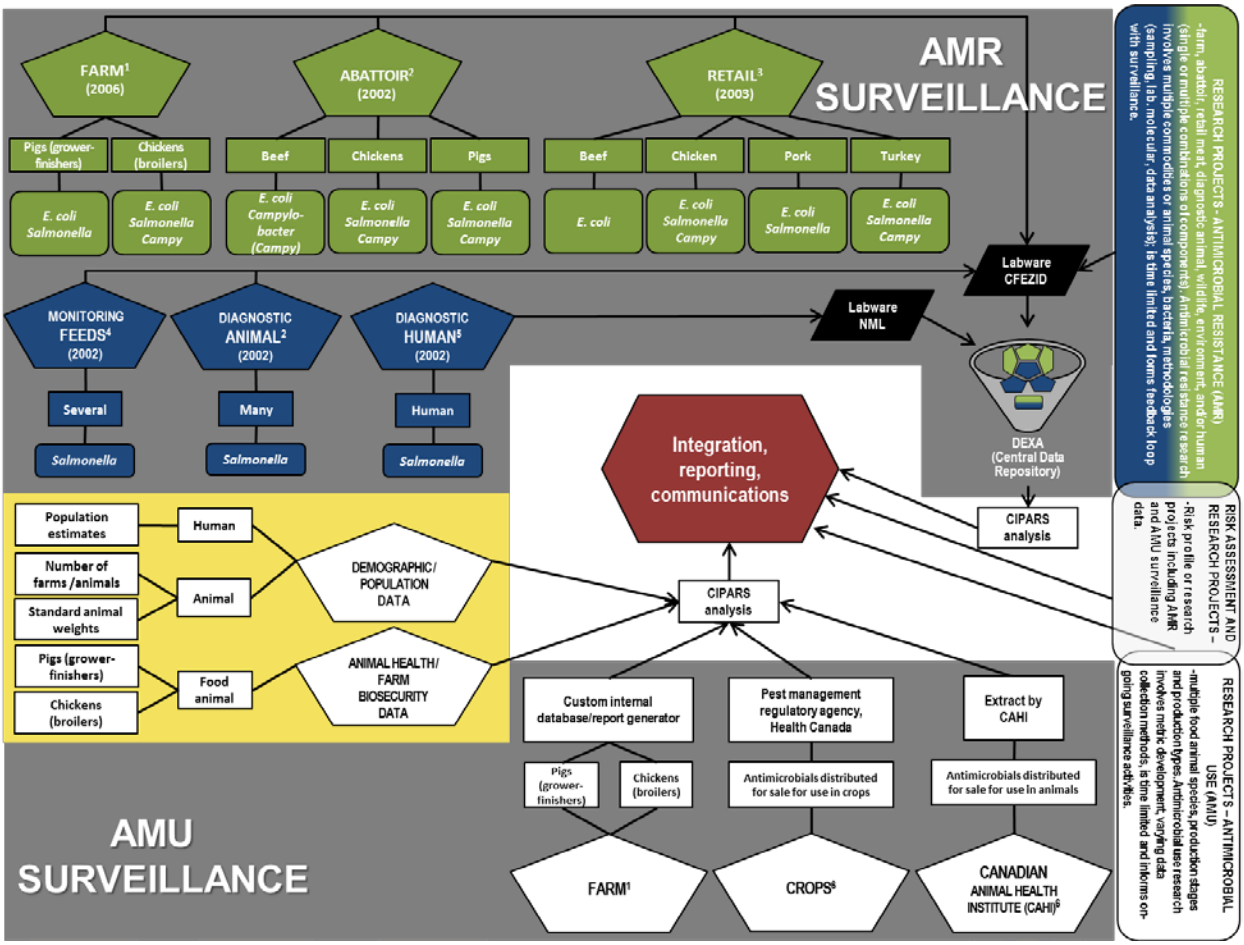
Table A.8. Changes implemented to the CIPARS antimicrobial use components, 2003–2014 (cont'd)

Year	Component	Province / region	Population exposed	Reporting metrics	Dosage information	Design	Methods
2009	*Farm AMU surveillance in pigs*	Alberta Saskatchewan Manitoba Ontario Québec	Number of grower-finisher pigs at start and end of grow, mortalities and culls	Farm count data for antimicrobial use by class, category of importance to human medicine, and reason for use	Inclusion rate in feed (g/tonne)	Annual and Sampling Day questionnaires were complied into a single Sampling Day Questionnaire which is applied once/herd/year.	Inclusion rate in feed ONLY; no dosage information collected for water or injections
2008	*Quantities of antimicrobials distributed for sale for use in animals*	National	N/A				CAHI has a "3 company accounting rule" to comply with the EU & the US' anti-competition regulations. CAHI added in some cases a "90% rule" to be sure not to infringe upon the regulations in the US. These accounting rules can result in changes to the categorization of specific antimicrobials over time.
2007	*Human antimicrobial use surveillance—pharmacy sale*	National Provincial	Canadians	1) Prescriptions/1,000 inhabitants 2) Defined daily doses (DDDs)/1,000 inhabitant-days 3) Total cost/1,000 inhabitant-days 4) Total active ingredients (kg)			Data are now available separately for Newfoundland & Labrador and Prince Edward Island.
	Farm AMU surveillance in pigs	Alberta Saskatchewan Manitoba Ontario Québec	Number of grower-finisher pigs at start and end of grow, mortalities and culls	Farm count data for AMU by class, category of importance to human medicine, and reason for use	Inclusion rate in feed and water (not collected for injections)		Questionnaire was refined to improve data quality and compliance.
2006	*Farm AMU surveillance in pigs*	Alberta Saskatchewan Manitoba Ontario Québec	Number of grower-finisher pigs at start and end of grow, mortalities and culls	Farm count data for AMU by class, category of importance to human medicine, and reason for use	Inclusion rate in feed and water (not collected for injections)	Implementation of the CIPARS farm component in grower-finisher pigs of the 5 major porc producing provinces.	Antimicrobial use in feed, water, and injection information was collected through 1 annual and 3 sampling day questionnaires/ herd/year.
	Quantities of antimicrobials distributed for sale for use in animals	National	N/A	1) Total of active ingredients (kg)	NA	Implementation of surveillance of manufacturer and distributor-level data for antimicrobials used in animals as provided by the Canadian Animal Health Institute (CAHI)	
2003	*Human antimicrobial use surveillance—pharmacy sale*	National	Canadians	1) Prescriptions/1,000 inhabitants 2) Defined daily doses (DDDs)/1,000 inhabitant-days 3) Total cost/1,000 inhabitant-days 4) Total active ingredients (kg)		Implementation of the *Human antimicrobial use surveillance* component. The design is based on a number of canadian pharmacies dispensing oral prescriptions extrapolated to all pharmacies in Canada.	Analysis based on the Canadian CompuScript (CCS) purchased from IMS Health Canada Inc.

N/A = not applicable.
NA = not available.

SUMMARY OF CIPARS SAMPLES AND DATA FLOW

Figure A.8. Summary of the CIPARS samples and data flow, 2014



= Active surveillance; primary data, primarily for prevalence estimation. = Passive surveillance; secondary data, primarily for AMR detection.
CFEZID = Centre for Food-borne, Environmental and Zoonotic Infectious Diseases. **NML** = National Microbiology Laboratory.

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