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CANADIAN INTEGRATED PROGRAM FOR ANTIMICROBIAL RESISTANCE SURVEILLANCE (CIPARS) ANNUAL REPORT

CHAPTER 2. ANTIMICROBIAL RESISTANCE



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

—Public Health Agency of Canada

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ABATTOIR SURVEILLANCE

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NATIONAL ANTIMICROBIAL RESISTANCE MONITORING SYSTEM FOR ENTERIC BACTERIA (NARMS)

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PREAMBLE

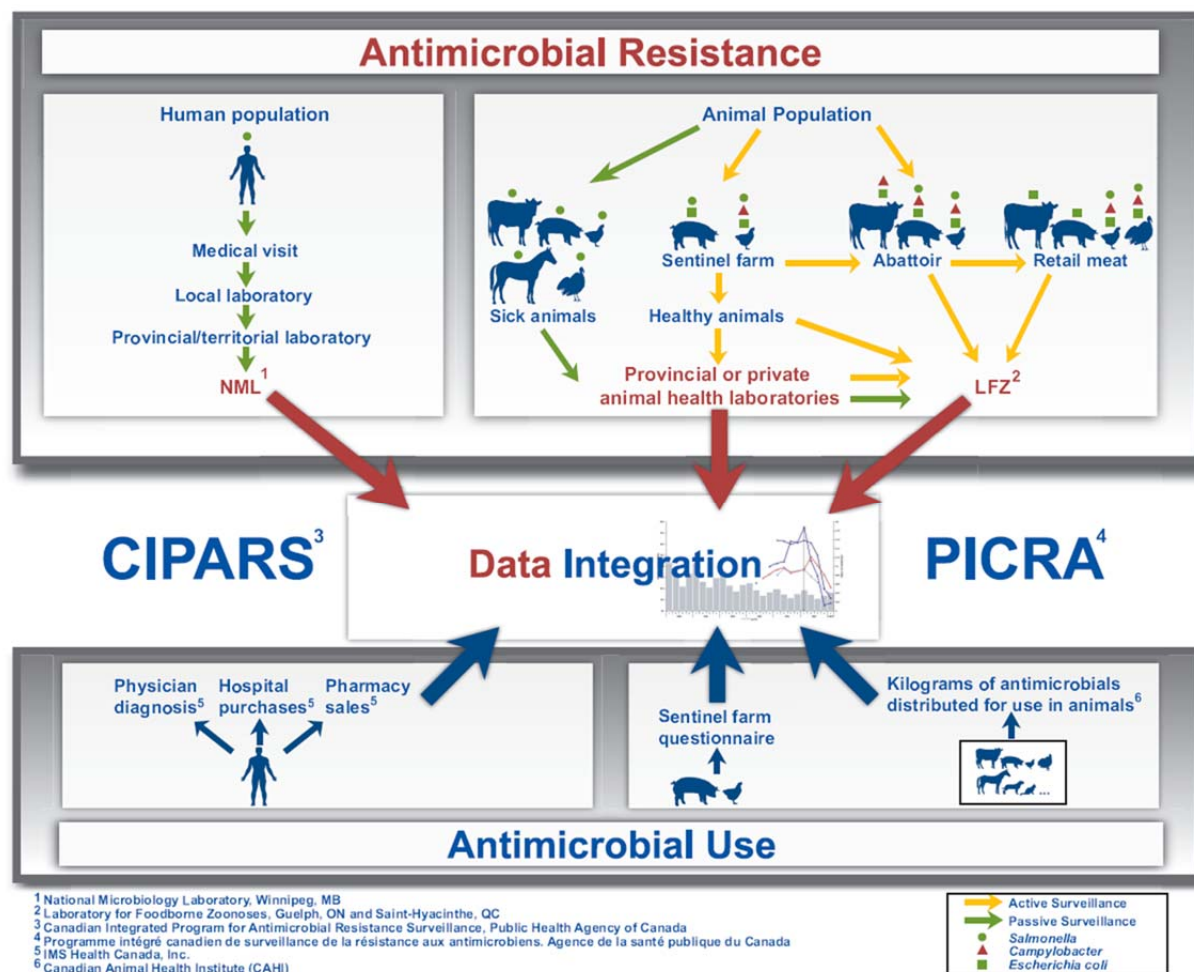
ABOUT CIPARS

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.

During 2012, CIPARS held discussions on alternative methods of analyzing and presenting the surveillance data to adjust for different data closure dates, and to maximize the integration of existing data. The Annual Report will be released in a Chapter format to improve the timeliness of the data release and consists of four chapters: Chapter 1 – Design and Methods, Chapter 2 – Antimicrobial Resistance, Chapter 3 – Antimicrobial Use, and Chapter 4 – Integrated Findings and Discussion. Chapter 1 includes detailed information on the design and methods used by CIPARS to obtain and analyze the AMR and AMU data, including two summary tables describing changes that have been implemented since the beginning of the program. Chapter 2 and 3 present results for AMR and AMU, respectively, with each one including a section presenting the top key findings. Chapter 4 aims to bring together some of the results across surveillance components, over time and regions, and across host/bacterial species in an integrated manner and includes interpretation of this integration.

CIPARS SURVEILLANCE COMPONENTS

Figure 1. Diagram of CIPARS surveillance components in 2013



...working towards the preservation of effective antimicrobials for humans and animals...

HOW TO READ THIS CHAPTER

This chapter highlights the most notable antimicrobial resistance (AMR) findings across the different surveillance components of CIPARS for 2013. These findings are presented by component (human, farm, abattoir, retail, clinical animal, and feed and feed-ingredients) to facilitate comparison of resistance patterns across humans, different animal species, and bacterial species. The figures and tables have been grouped by component in separate subsections for the same purpose. Further integration of these findings across the AMR components is presented in the *2013 Annual Report – Chapter 4. Integrated Findings and Discussion*.

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 are resistant to select antimicrobials since the beginning of CIPARS (2003) or the year surveillance was implemented in a new component, host species, bacteria or location. For consistency across the components, statistical analyses were limited to comparison of 2013 results for selected antimicrobials with: 1) 2012 results and 2) the first year of surveillance (2003 or later).

To facilitate the assessment of significant results at a glance, all significant differences found have been highlighted in blue (or underlined) in data tables underneath the temporal figures (see footnotes for more details, e.g. Figure 9). Finally, for all statistical analyses, a P -value ≤ 0.05 was used to indicate a significant difference between years. All statistically significant results are marked by the use of the word “significant” in the text. All other findings presented without this word should be considered as non-statistically significant and should be interpreted with caution.

For *S. Heidelberg* and *E. coli* isolates obtained from chicken (abattoir and retail) and human *S. Heidelberg* isolates, ceftiofur and ampicillin resistance for 2013 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 *Farm surveillance*, multiple samples are collected from each herd or flock, therefore, where temporal comparisons are made, the AMR data have been adjusted for clustering within the herd.

Temporal variations in the data from *Surveillance of Animal Clinical Isolates* and *Feed and Feed Ingredients* were not investigated as provision of isolates from passive surveillance were unequal across years and 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 figure was presented instead.

NATIONAL OR PROVINCIAL/REGIONAL PREVALENCE ESTIMATES

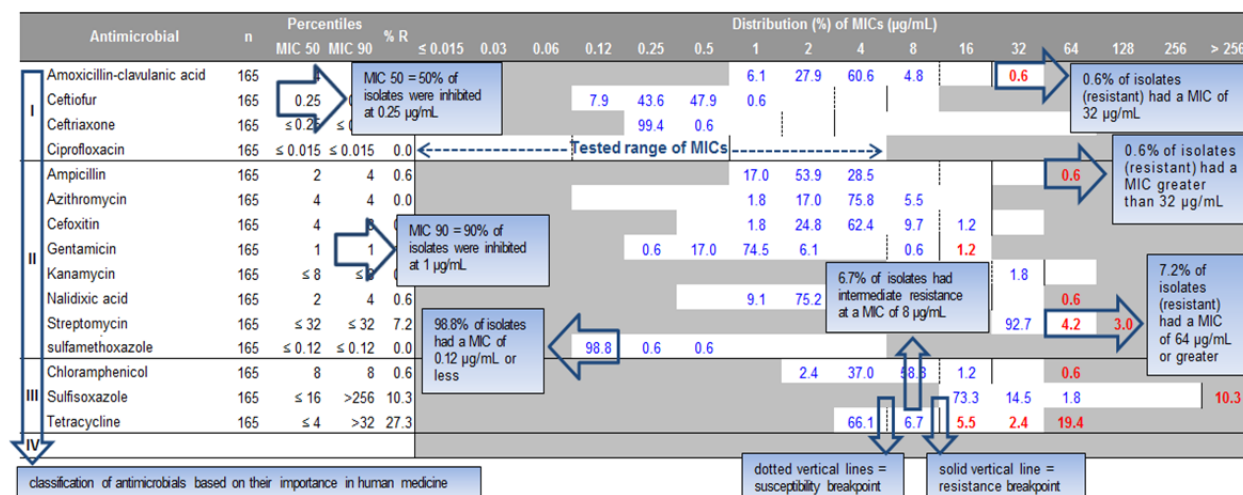
Data for humans, farm (broiler chickens) and retail surveillance components are presented at the provincial/regional level. Data for farm (swine), abattoir, animal clinical isolates, and feed and feed-ingredients are presented nationally with no provincial or regional breakdown.

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-coloured numbers indicate the percentage of isolates that were susceptible to the antimicrobial according to the predefined susceptibility breakpoint
- Red-coloured 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.

HOW TO READ MINIMUM INHIBITORY CONCENTRATION TABLES (cont'd)



ABBREVIATIONS

ANTIMICROBIALS AND SOME IMPORTANT RESISTANCE PATTERNS

ANTIMICROBIALS

AMC Amoxicillin-clavulanic acid

AMK Amikacin

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

ANTIMICROBIAL 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

...working towards the preservation of effective antimicrobials for humans and animals...

ABBREVIATIONS (cont'd)

CANADIAN PROVINCES, TERRITORIES, AND REGION

PROVINCES

BC British Columbia

AB Alberta

SK Saskatchewan

MB Manitoba

ON Ontario

QC Québec

NB New Brunswick⁹

NS Nova Scotia⁹

PEI Prince Edward Island⁹

NL Newfoundland and Labrador

TERRITORIES

YT Yukon

NT Northwest Territories

NU Nunavut

⁹ The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

SUMMARY – THE TOP KEY FINDINGS

Humans

- The proportion of non-typhoidal *Salmonella* infections susceptible to all antimicrobials remained stable with 74% of isolates in 2013 compared to 76% in 2012.
- Resistance to gentamicin is increasing among *S. Heidelberg* (3% in 2013 compared to < 1% in 2012) and *S. Newport* (3% in 2013 compared to 0 in 2012).
- Resistance to ciprofloxacin among *S. Typhi* human infections continues to increase with 18% in 2013 compared to 10% observed in 2012.

Abattoir

- Resistance to ciprofloxacin in *Campylobacter* from abattoir chicken significantly increased from 4% (4/111) in 2010 to 14% (19/138) in 2013.
- All *S. Enteritidis* isolates from abattoir chicken were susceptible to all antimicrobials tested.
- The percentage of *E. coli* isolates from abattoir cattle with resistance to 4 or 5 classes of antimicrobials has risen from 1% in 2012 to 8% in 2013 and resistance to 1 class of antimicrobials has dropped from 19% in 2012 to 9% in 2013.

Retail Meat

- Ciprofloxacin resistance in *Campylobacter* from chicken significantly increased to 26% in 2013 in British Columbia compared to 2012 (8%).
- In Ontario, ceftiofur resistance among *Salmonella* from chicken was significantly lower in 2013 (22%) than 2004 (45%). In Québec, resistance to ceftiofur was significantly higher in 2013 among both *Salmonella* (30%) and *E. coli* (24%) compared to 2006 (5% and 6%, respectively).
- In Québec, a single *E. coli* isolate from beef was resistant to 7 (all) classes of antimicrobials tested with the following pattern: ACSSuT-AZM-TIO-CRO-CIP-NAL-SXT.

On Farm:**Grower-Finisher Pigs**

- Although not statistically significant, there was an increase in ampicillin resistance in *Salmonella* isolates from 25% to 40% between 2012 and 2013. Historically, over the last 7 years, ampicillin resistance has been $\leq 35\%$.
- In *Salmonella*, the patterns containing the highest number of antimicrobials were ACKSSuT-A2C-CRO and ACSSuT-A2C-CRO-SXT
- In *E. coli*, resistance to ceftiofur was significantly lower in 2013 (1%) than in 2012 (2%)
- *E. coli* resistance to streptomycin was also significantly lower in 2013 (34%) than in 2006 (37%) or 2012 (44%).
- Similar to 2012, ampicillin resistance in *E. coli* was significantly lower in 2013 (31%) than in 2006 (35%).

On Farm:**Broiler Chickens**

- In *Salmonella*, the pattern containing the highest number of antimicrobials was A2C-AMP-CRO-STR-TET detected at both chick placement and preharvest.
- In *E. coli*, the pattern containing the highest number of antimicrobial was A2C-ACSSuT-CRO-GEN-SXT and A2C-AMP detected at both sampling period.
- In *Campylobacter*, overall resistance to ciprofloxacin was 16% and the pattern containing the highest number of antimicrobials was CIP-NAL-TET.

Integration of data across human, animal species and bacteria will be presented in *Chapter 4. Integrated Findings and Discussion*.

HUMAN SURVEILLANCE

KEY FINDINGS

The Provincial Public Health Laboratories forwarded a total of 3,612 *Salmonella* isolates (185 serovars) to the National Microbiology Laboratory, Public Health Agency of Canada. Of these isolates antimicrobial susceptibility testing was performed for 3,159 isolates. The remaining isolates are stored for future susceptibility testing.

SALMONELLA (n = 3,159)

Susceptibility testing was routinely carried out on 8 serovars: Enteritidis, Heidelberg, 4,[5],12:i:-, Newport, Paratyphi A, Paratyphi B, Typhi and Typhimurium (2,062 isolates). Summary results only are presented for other serovars (1,097 isolates).

The most commonly isolated serovars in 2013 were Enteritidis (24%, 746/3,159), Heidelberg (13%, 418/3,159), and Typhimurium (12%, 384/3,159). Although the proportion of Enteritidis isolates has decreased significantly since 2011 (38%, 361/2,510), the overall proportion of Enteritidis isolates has increased significantly since 2003 (12%, 352/3,041) (Figure 2).

The proportion of Heidelberg isolates has declined slightly between 2010 and 2013 following an increase from 2008 to 2010 (Figure 2). Similarly, the proportion Typhimurium isolates has decreased to 24% from a high of 38% in 2011 (Figure 2). No dramatic increases in the other top serovars were observed over this time; therefore, increases in the proportion of less common serovars have occurred from 2011 and 2013.

Ten percent (311/3,159) of isolates were recovered from blood. Typhoidal isolates (*S. Typhi*, *S. Paratyphi A*, and *S. Paratyphi B*) accounted for a large proportion of these isolates from blood (41%, 129/311). Recovery from urine occurred for 180/3,159 (6%) of isolates. In contrast to isolation from blood, typhoidal isolates accounted for a very small proportion of isolates from urine (2%, 3/180). The proportion of isolates recovered from blood, urine, and other sample types varied by serovar, as seen in Figure 3.

Age information was available for 63% (1,997/3,159) of all isolates in 2013. Patients aged 30 to 49 years were the most commonly represented age group in the dataset (22%, 449/1,997). The age group with the fewest isolates in the dataset was patients 13 to 17 years (4%, 83/1,997). Although the focus of this report is resistance (or lack of resistance) among *Salmonella* isolated from humans, as a reference, provincial incidence rates for all *Salmonella* infections (regardless of resistance pattern), broken down by specific serovars, can be found in Figure 4. More details

on the incidence of *Salmonella* and other enteric pathogens in Canada are available through the National Enteric Surveillance Program (NESP)¹⁰.

In 2013, 74% of all non-typhoidal *Salmonella* isolates were susceptible to all antimicrobials tested, compared to 76% in 2012. Resistance to the antimicrobials streptomycin, sulfisoxazole and tetracycline significantly increased in 2013 (12%, 12%, and 14%, respectively) compared to 2012 (9%, 9% and 11%, respectively). Although no significant changes were observed, there were more isolates with azithromycin resistance in 2013 (24 isolates) compared to 2012 (16), with higher numbers observed in British Columbia, Alberta, Québec, New Brunswick, and Newfoundland and Labrador.

ENTERITIDIS (n = 746)

The most common phage types (PTs) recovered in 2013 were: PT 8 (38%, 281/746), PT 13a (15%, 111/746) and PT 13 (9%, 65/746). The proportion of PT 8 and 13a isolates have increased dramatically since 2007, when they represented 19% (177/909) and 1% (9/909) of Enteritidis isolates, respectively. Conversely, the proportion of PT 13 isolates over this same time frame has declined from a high of 31% (285/909) in 2007.

In 2013, 4% of Enteritidis isolates were recovered from blood (32/746), which was an increase from 3% in 2012 (37/1,184). Two percent of isolates in 2013 were recovered from urine (16/746), which was a decrease from 3% (40/1,184) in 2012. In 2013, the proportion of isolates recovered from blood and urine have slowly increased (2%, 7/352) since 2003 (1%, 3/352). No significant increases in resistance to any of the tested antimicrobials were seen between 2012 and 2013 at the National level. Only a single change in resistance was seen at the provincial level:

Ceftiofur

- Increase in British Columbia from 0% (0/178) in 2012 to 3% (3/88) in 2013

The majority of Enteritidis isolates in 2013 were pan-susceptible (84%, 625/746). Where resistance was present, the most common pattern was NAL (resistance to nalidixic acid alone resistance) (10%, 74/746), attributable to PT ATEN-16 (39%, 29/74) and PT 1 (32%, 24/74). The pattern involving the greatest number of antimicrobials was A2C-AMP-CHL-FOX-TIO-CRO-KAN-NAL-STR-TET (1 PT 33 isolate from British Columbia).

HEIDELBERG (n = 418)

The most common PTs recovered were: PT 19 (44%, 186/418), PT 29 (26%, 109/418) and PT 26 (4%, 18/418). PTs 29 and 26 increased slightly compared to 2012, while PT 19 decreased compared to a peak seen in 2012 (54%, 298/555). An overall increase in PT 29 has occurred over the 2009 to 2013 time frame.

¹⁰ Public Health Agency of Canada. 2014. National Enteric Surveillance Program. Available at: www.nml-inm.gc.ca/NESP-PNSME/index-eng.htm. Accessed December 2014.

A large increase in the proportion of isolates recovered from blood occurred between 2012 and 2013 (10% to 15%, 55/554 to 63/418). Historically (since 2003), the proportion of isolations from blood has fluctuated between 8 and 12%. The proportion of isolates recovered from urine increased significantly from 5% (25/554) in 2012 to 8% (33/418) in 2013. Since 2003, the overall proportion of Heidelberg isolates recovered from urine has increased slightly to the high observed in 2013.

Comparisons were made between the proportion of resistant isolates seen in 2013 to the proportion seen in 2012. Comparisons were also made between 2013 and 2006, due to the voluntary withdrawal of ceftiofur use at chicken hatcheries in Québec during this year. All analyses were performed at the national and provincial levels for each antimicrobial tested. The significant results observed were:

Amoxicillin-clavulanic acid

- Increase in Ontario from 16% (35/222) in 2012 to 30% (44/147) in 2013

Ceftiofur

- Increase from 13% (57/430) in 2006 to 31% (129/418) in 2013
- Decrease in British Columbia from 64% (25/39) in 2012 to 30% (9/30) in 2013
- Increase in Ontario from 16% (35/222) in 2012 to 30% (44/147) in 2013
- Increase in Nova Scotia from 24% (8/32) in 2012 to 58% (15/26) in 2013
- For all surveillance years combined, resistance to ceftiofur was high among PT 4, PT 29, and PT 41 isolates, with 94% (51/54), 89% (670/749), and 61% (113/184) resistance, respectively. These three phage types account for > 74% of ceftiofur resistance seen among Heidelberg isolates. In contrast, susceptibility to ceftiofur was observed in 99% of PT 26 (208/211) isolates and 98% of PT 19 isolates (1,969/2,015). Therefore, ceftiofur resistance among Heidelberg isolates is driven by the proportion of these phage types in the population.

Ceftriaxone (common resistance mechanism as ceftiofur resistance)

- Decrease in British Columbia from 67% (26/39) in 2012 to 30% (9/30) in 2013
- Increase in Ontario from 16% (35/222) in 2012 to 30% (44/147) in 2013
- Increase in Nova Scotia from 25% (8/32) in 2012 to 58% (15/26) in 2013

Ampicillin

- Decrease from 45% (250/556) in 2004 to 33% (139/418) in 2013
- Decrease in British Columbia from 74% (29/39) in 2012 to 50% (15/30) in 2013
- Increase in Nova Scotia from 25% (8/32) in 2012 to 65% (17/26) in 2013

Cefoxitin

- Increase in Ontario from 16% (35/222) in 2012 to 30% (44/147) in 2013

- Increase in Nova Scotia from 25% (8/32) in 2012 to 58% (15/26) in 2013

Kanamycin

- Increase from < 1% (3/555) in 2012 to 2% (9/414) in 2013

Gentamicin

- Increase from < 1% (3/555) in 2012 to 3% (11/414) in 2013
- Increase in Ontario from < 1% (1/222) in 2012 to 3% (5/147) in 2013

In 2013, 59% (248/418) of Heidelberg isolates and 91% (169/186) of PT 19 isolates were pan-susceptible. Among isolates displaying some resistance, the most common pattern was A2C-AMP-CRO (31%, 128/418). The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-STR-TET (1 PT 29 isolate from Nova Scotia). While in previous years the top two resistance patterns have been A2C-AMP-CRO and AMP (resistance to ampicillin alone), in 2013 the GEN-STR-SSS pattern was observed as the second most common resistance pattern, representing 2% of Heidelberg isolates.

The proportion of Heidelberg isolates from patients aged 70 or older increased significantly between 2012 and 2013, from 19/555 (3%) to 33/418 (8%) (Figure 5). However, 8% falls within the historical levels seen within this age group (3% to 14% of isolates).

NEWPORT (n = 174)

The most common PTs recovered were: PT 9 (18%, 31/174), PT 14b (13%, 23/174), and PT 13 (9%, 16/174). The proportion of PT 9 isolates out of all Newport isolates has remained relatively stable since 2007. In contrast, the proportion of PT 14b isolates has increased overall from 2009 to 2013, and a large increase in PT 13 isolates was seen from 2012 to 2013 (3% to 9%, 4/149 to 16/174).

Three percent (6/174) of Newport isolates were recovered from blood in 2013; a slight increase from 2% (3/149) in 2012, but not statistically significant. Seven percent (12/174) of isolates were recovered from urine, which is an increase from the low of 2% (4/149) seen in 2012, but again, not statistically significant.

Ciprofloxacin resistance was observed for the first time in this serovar: 1 isolate in Alberta (PT 13, ACKSSuT-A2C-AZM-CRO-CIP-GEN-NAL-SXT) and 1 isolate in Prince Edward Island (PT 15, CIP-KAN). Resistance to azithromycin was also observed for the first time in Newport isolates. Two isolates were from patients in Québec with resistance to AZM (resistance to azithromycin only), while 2 isolates were recovered in Alberta with the following resistance patterns: ACSSuT-A2C-AXM-CRO-SXT and ACKSSuT-A2C-AZM-CRO-CIP-GEN-NAL-SXT.

Gentamicin resistance was observed in 5 isolates when only 1 isolate had been previously observed in each of the years 2003, 2005, and 2008. Four of these isolates were identified in Alberta.

The majority of Newport isolates in 2013 were pan-susceptible (87%, 152/174). The most common resistance pattern observed was ACSSuT-A2C-CRO (5%, 8/174), which was also the

most common pattern observed in 2012 (5%, 8/149). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-AZM-CRO-CIP-GEN-NAL-SXT (1 PT 13 isolate from Alberta).

PARATYPHI A (n = 34) AND PARATYPHI B¹¹ (n = 9)

Eighty-five percent (29/34) of the Paratyphi A isolates were recovered from blood samples, while 11% (1/9) of the Paratyphi B isolates were recovered from blood (11%). Resistance to nalidixic acid decreased significantly from 2012 (93%, 27/29) to 2013 (72%, 31/43). The most common resistance pattern was CIP-NAL, present in 7 Paratyphi A isolates. One Paratyphi A isolate from Manitoba displayed the FOX-CHL-CIP-NAL pattern, and 1 Paratyphi B isolate from Québec had the ACSSuT pattern. Ciprofloxacin resistance was identified in 8 Paratyphi A isolates when previously only 1 isolate had been identified in 2010. The proportion of Paratyphi A and B isolates from patients aged 5 to 12 increased significantly between 2012 and 2013, from 2/29 (7%) to 11/43 (26%), which is well above the historical range (0% to 16%) (Figure 6).

TYPHI (n = 131)

The most common phage types recovered were PT E1 (28%, 37/131), PT UVS (I+IV) (21%, 27/131), and PT E9 var. (11%, 15/131). Seventy-five percent (99/131) of isolates were recovered from blood samples; a proportion that has increased dramatically since surveillance initiation in 2003, when this proportion was 40% (51/127). Recovery of *S. Typhi* from urine remained low in 2013 (2%, 3/131).

A significant increase in ciprofloxacin resistance occurred in British Columbia from 2012 to 2013 (3%, 1/33 to 26%, 7/27).

The most common resistance pattern was resistance to NAL (resistance to nalidixic acid alone) (50%, 65/131), followed by resistance to CIP-NAL (19/131). Interestingly, the AMP-CHL-NAL-STR-SSS-SXT pattern which was found in 15% (22/144) of isolates in 2012 was less prevalent in 2013, representing 7/131 (5%) isolates. Two isolates in 2013 from Ontario were resistant to ACSSuT-NAL-SXT.

The proportion of cases aged less than 5 years declined significantly between 2012 and 2013 (10%, 15/144 to 4%, 5/131).

TYPHIMURIUM (n = 384)

The most common PTs recovered were PT 10 (12%, 46/384), PT 104 (12%, 46/384) and PT 108 (10%, 37/384). The proportion of PT 10 isolates in 2013 was greater than in any previous surveillance year, and has increased significantly from the 2% of Typhimurium isolates seen in 2003 (13/605). The proportion of PT 104 isolates has followed the opposite trajectory from PT

¹¹ *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. However, there were no Paratyphi B isolates received for susceptibility testing in 2012.

10, with a significant overall decrease from 2003 to 2013 (24%, 146/605 in 2003). The proportion of PT 108 isolates has ranged from 15% (71/453) in 2010 to 33% (214/358) in 2007, with no discernable trend over time.

Three percent (10/384) of Typhimurium isolates in 2013 were recovered from blood samples, which is within the historical range (low of 1% in 2010, high of 3% in 2008). The proportion of isolates recovered from urine in 2013 was 3% (11/384), which is the highest proportion seen in CIPARS data.

Similar to 2012, the most common resistance pattern was resistance to ACSSuT (12%, 47/384). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-CIP-NAL-SXT (1 PT 193 isolate from Alberta). Historically, resistance to ACSSuT has been linked mainly to PT 104. However, since 2010 there has been a marked increase among isolates resistant to ACSSuT comprising of PT 104b since 2010. In 2013, 34% (23/67) of all ACSSuT resistant isolates were PT104b while PT 104 represented 33% (22/67). In addition, the percentage of all PT 104 Typhimurium isolates susceptible to all antimicrobials has been increasing over time, with 0% (0/55) observed in 2009 and 33% (15/46) observed in 2013.

The proportion of Typhimurium isolates from patients aged 13 to 17 decreased significantly between 2012 and 2013, from 19/378 (5%) to 9/384 (2%) (Figure 7). In contrast, the proportion of isolates from patients aged 30 to 49 increased significantly, from 34/378 (9%) to 52/332 (16%) (Figure 7).

4,[5],12:i:- (n = 166)

The most common PTs recovered were PT 193 (42%, 70/166), PT U291 (14%, 23/166) and PT 191 (10%, 16/166). A dramatic increase in PT 193 isolations has occurred over 2003 (2%, 1/42) to 2013, with the most dramatic increase occurring from 2011 (9%, 25/122) to 2013.

Two percent (2/166) of isolates were recovered from each of blood and urine isolates in 2013. This is a low for CIPARS 4,[5],12:i:- isolates with the exception of 2003, when 0/42 isolates were recovered from either specimen source.

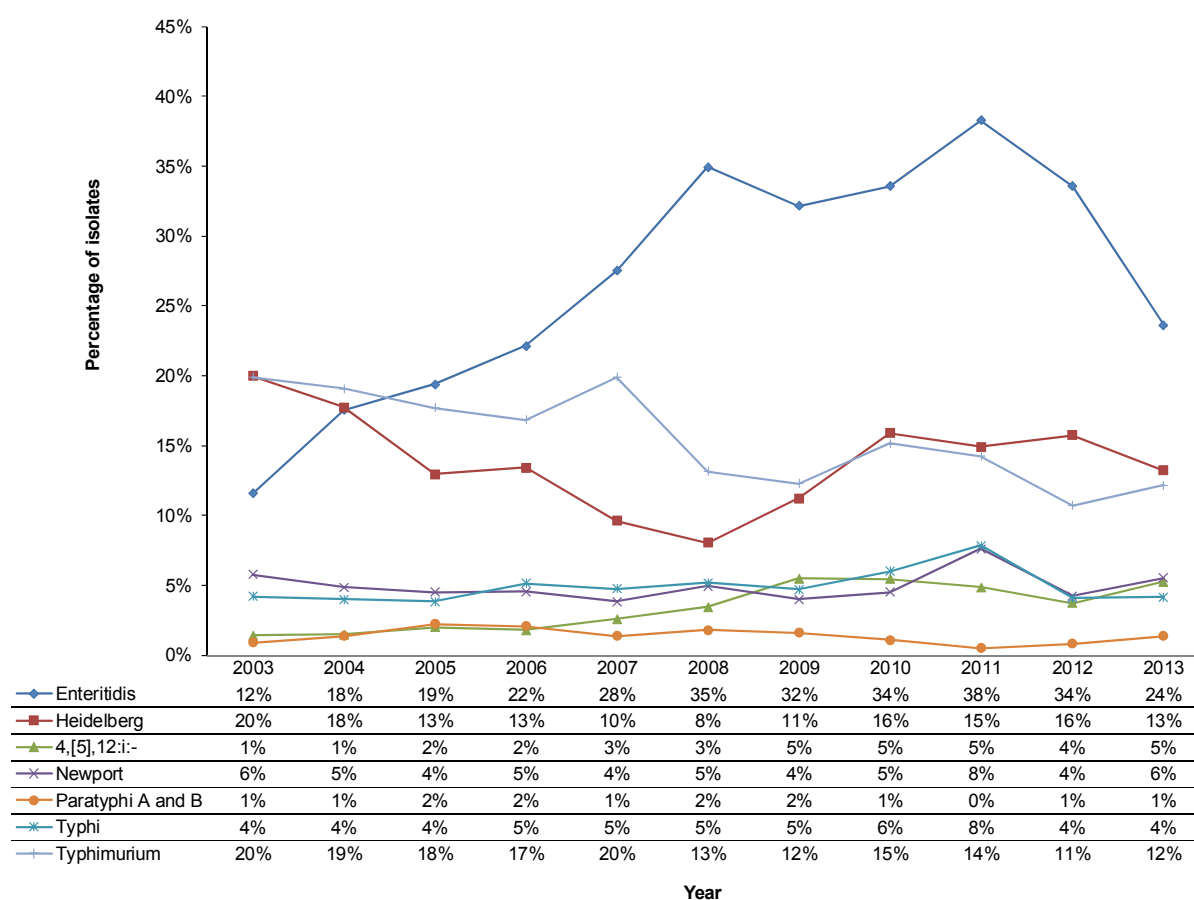
Overall, significant changes were observed among the following antimicrobials between 2012 and 2013:

- Ampicillin resistance increased from 34% (44/131) in 2012 to 51% (84/166) in 2013. Resistance to ampicillin in 2013 was also significantly higher than resistance in 2004 (15%, 7/46) and 2006 (26%, 15/57)
- Streptomycin resistance increased from 31% (41/131) in 2012 to 47% (78/166) in 2013. This increase may be attributed to an increase in Ontario from 22% (13/59) to 58% (38/65).
- Sulfisoxazole resistance increased from 31% (40/131) in 2012 to 48% (79/166) in 2013. This increase may be attributed to an increase in Ontario from 20% (12/59) to 58% (38/65).
- Tetracycline resistance increased from 43% (56/131) in 2012 to 61% (101/166) in 2013. This may be attributed to an increase in Ontario from 29% (17/59) to 62% (40/65).

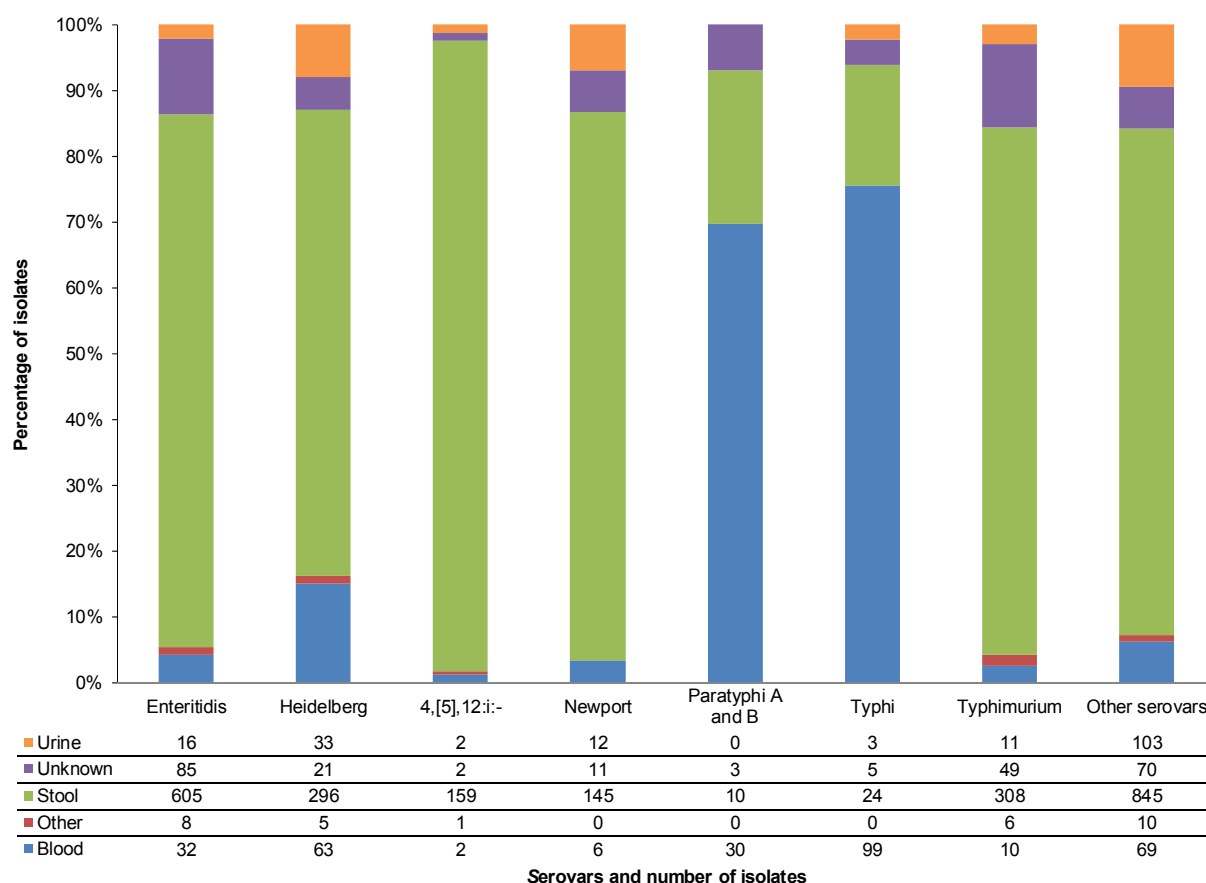
The most common resistance pattern was AMP-STR-SSS-TET (36%, 60/166), an increase from (25%, 31/122) in 2012. Similar to 2012, the second most common resistance pattern was resistance to TET (resistance to tetracycline alone) (14%, 24/166) in 2013, an increase from 9% (11/122) in 2012. The pattern involving the greatest number of antimicrobials was ACKSSuT-TIO-CRO-GEN-SXT (1 PT 193 isolate in Manitoba).

When looking at AMP-STR-SSS-TET resistance with or without resistance to additional antimicrobials, levels of resistance have significantly increased between 2012 (29%, 38/131) and 2013 (42%, 70/166). This increase appears to be driven by presence of PT 193 which has been increasing over time and has high levels of resistance to these antimicrobials (89%, 62/70 isolates in 2013).

A significant increase in the proportion of cases aged 30 to 49 occurred between 2012 and 2013, from 16/131 (12%) in 2012 to 37/166 (22%) in 2013 (Figure 8).

Figure 2. Proportional representation of human *Salmonella* isolates

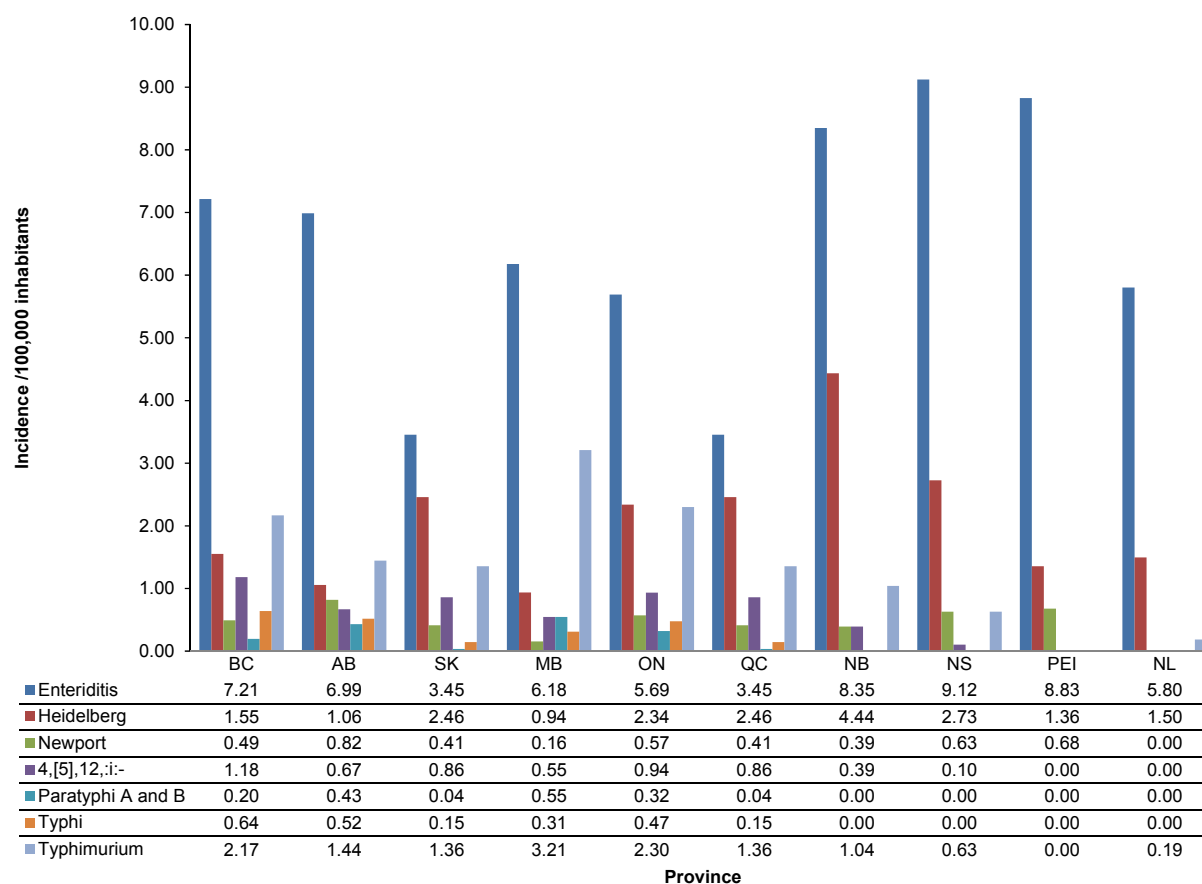
Salmonella Paratyphi B does not include *S. Paratyphi* B var. L (+) tartrate (+), formerly called *S. Paratyphi* var. Java. The biotype of *S. Paratyphi* B included here is tartrate (-) and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate (+) is commonly associated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

Figure 3. Proportion of human *Salmonella* serovars from all sample sources

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 4. Provincial incidence rates for specific human *Salmonella* serovars



Provincial abbreviations are defined in the section *How To Read This Chapter*.

No *S. 4,[5],12,:i:-* isolates were received from Prince Edward Island or Newfoundland and Labrador.

No *S. Paratyphi A* or *B* isolates were received from New Brunswick, Nova Scotia, Prince Edward Island, or Newfoundland and Labrador.

No *S. Typhi* isolates were received from New Brunswick, Nova Scotia, Prince Edward Island, or Newfoundland and Labrador.

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.

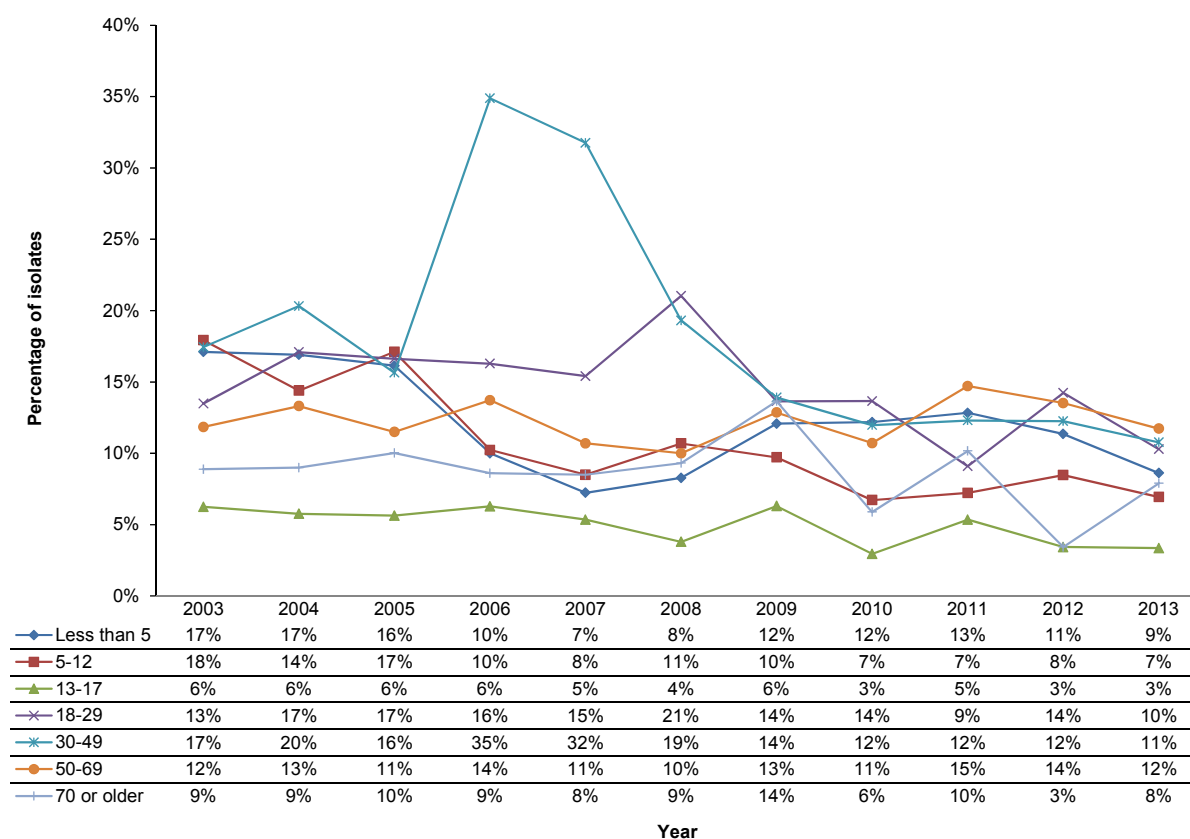
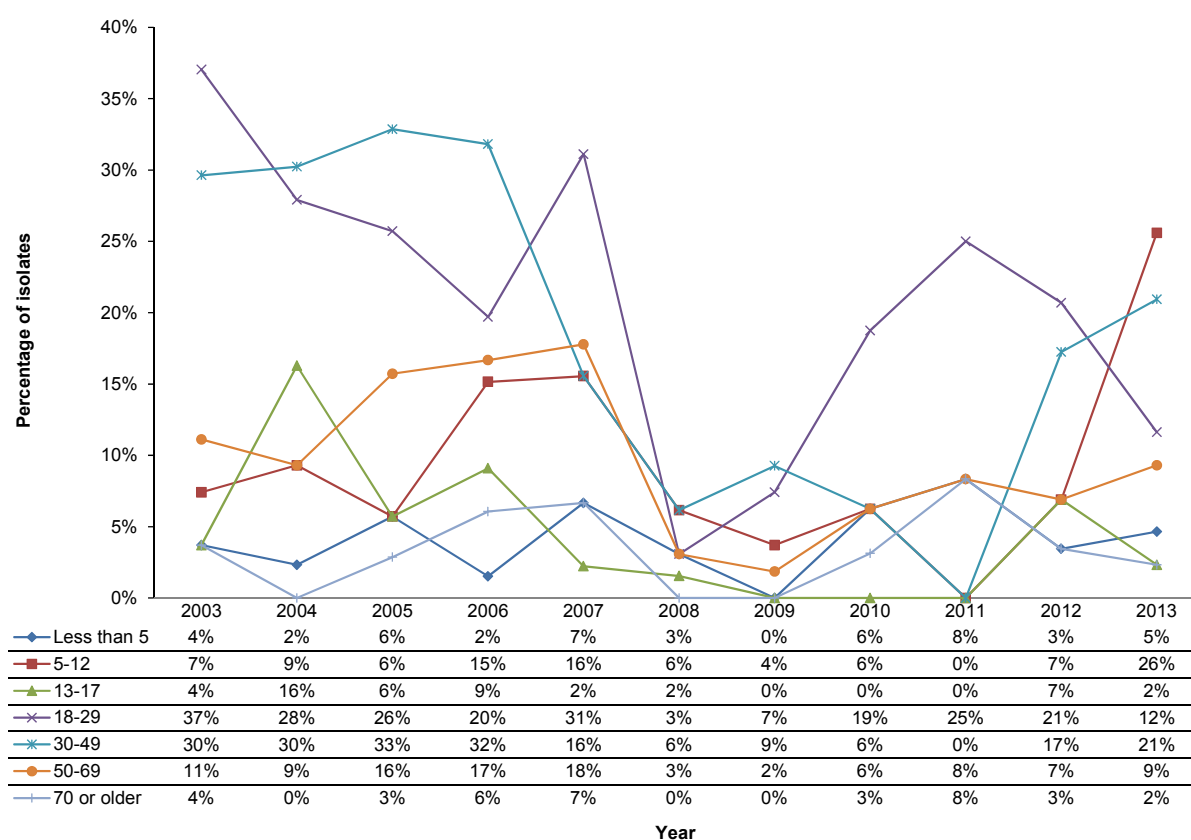
Figure 5. Temporal variations of age groups represented within *Salmonella* Heidelberg isolates

Figure 6. Temporal variations of age groups represented within *Salmonella* Paratyphi A and B isolates



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

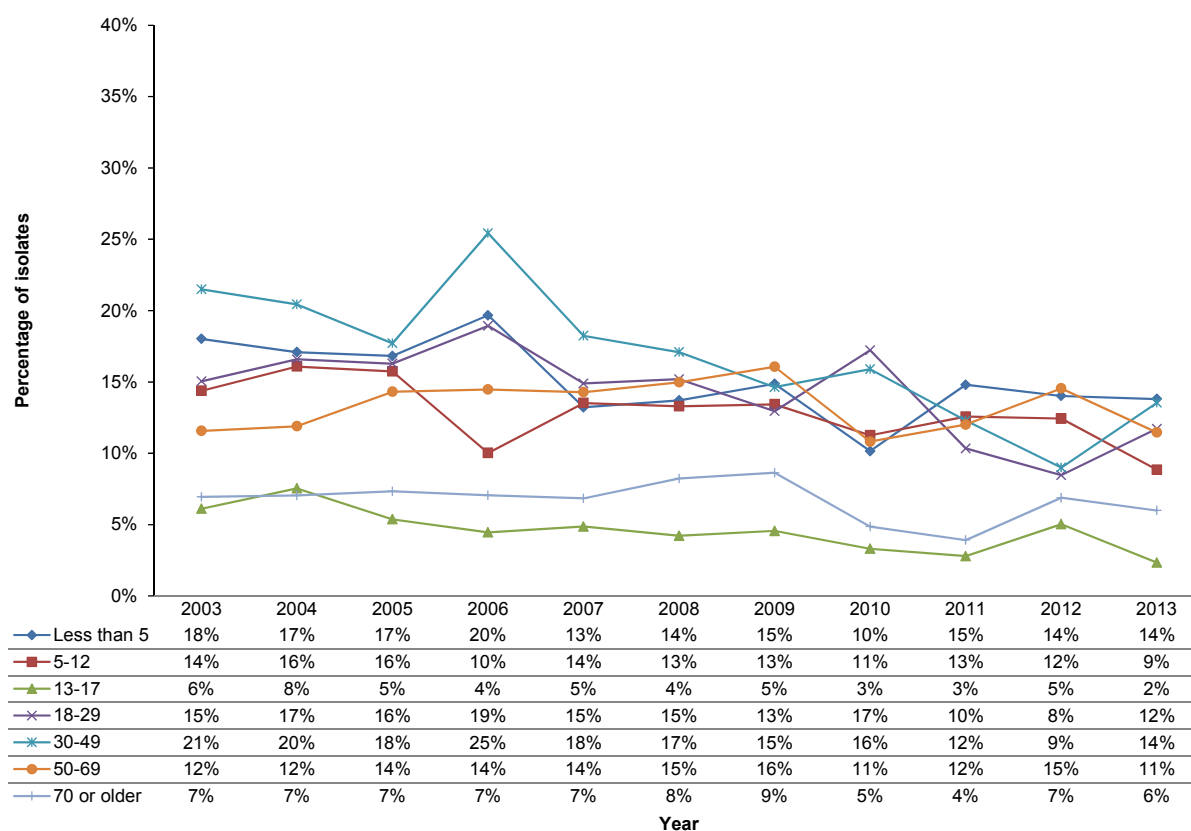
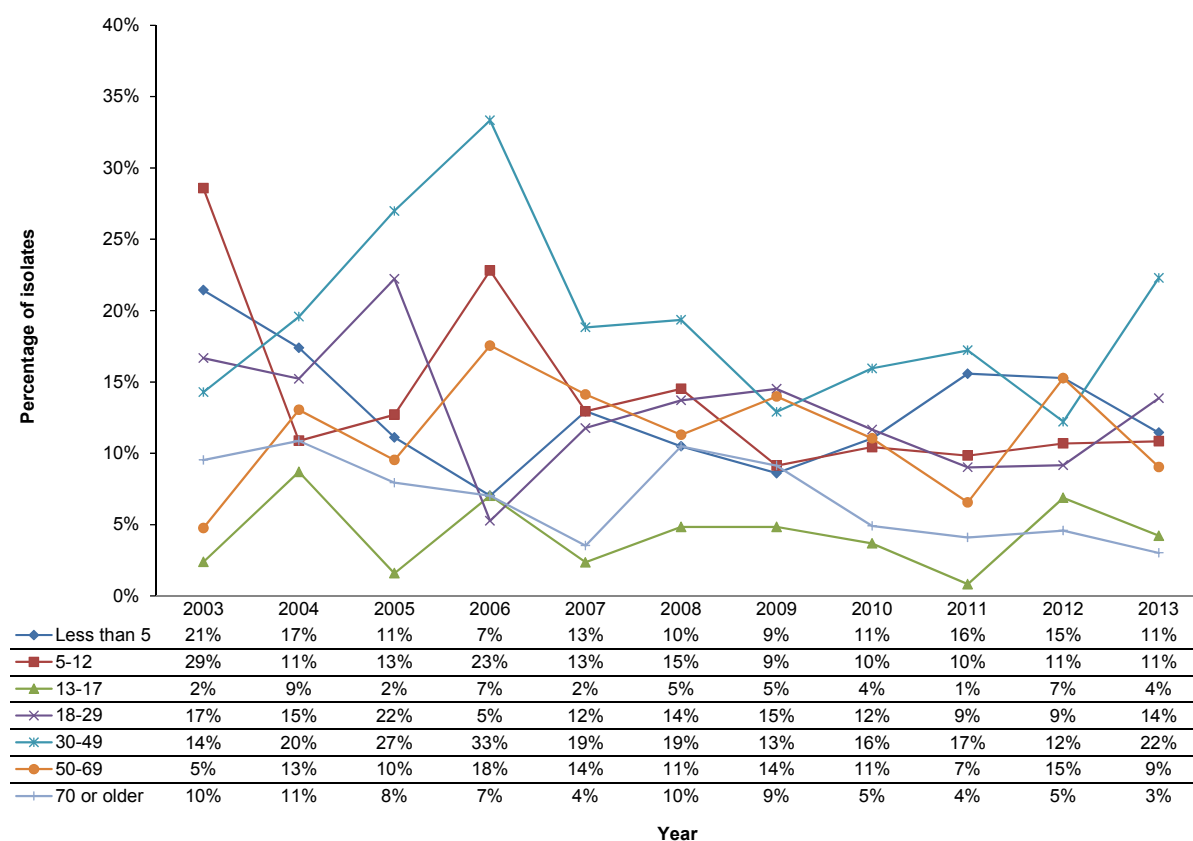
Figure 7. Temporal variations of age groups represented within *Salmonella* Typhimurium isolates

Figure 8. Temporal variations of age groups represented within *Salmonella* 4,[5],12:i:- isolates

MULTICLASS RESISTANCE

Table 1. Number of antimicrobial classes in resistance patterns of *Salmonella* serovars

Province / 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	Phenicol	Quinolones		Tetracycline
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	88 (44.2)	73	9	4	1	1		1	2	3	2	2	3	2	2		1		4	10	5
Heidelberg	30 (15.1)	13	15	2				2	2	15	9	9	9	9							2
Typhi	27 (13.6)	3	22	2											1	1	1	1	7	24	
Typhimurium	25 (12.6)	17	1	2	5			3	6	6	1	1	1	1	7	2		4			7
Newport	18 (9)	15			3			3	3	3	3	3	3	3	3			3			3
4,[5],12:i:-	7 (3.5)		2		5			5	5					5							7
Paratyphi A and B	4 (2.0)		4																	4	
Total	199 (100)	121	53	10	14	1		6	18	32	15	15	16	15	18	3	2	12	7	38	24
Alberta																					
Enteritidis	74 (30.6)	64	6	2	2				2	3					4	2			1	7	2
Typhimurium	46 (19)	28	1	2	13	2	2	4	16	15	1	1	1	1	15	3		13	2	2	18
Heidelberg	36 (14.9)	16	13	7				3	4	7	13	12	12	12	3					1	4
4,[5],12:i:-	31 (12.8)	7	13	3	8		1	1	11	10	1	1	1	1	11	1		1			22
Typhi	26 (10.7)	7	14		5				3	5					5	4		4	5	17	2
Newport	23 (9.5)	18		3		2	4	1	5	5	2	2	2	2	2	2	2	2	1	1	5
Paratyphi A and B	6 (2.5)		6																3	6	
Total	242 (100)	140	53	17	28	4	10	10	44	51	16	16	16	16	40	12	2	20	12	34	53
Saskatchewan																					
Enteritidis	57 (48.7)	52	5																1	5	
Typhimurium	29 (24.8)	20	3	5	1			4	4	2					5	1	1				3
Heidelberg	11 (9.4)	5	6							6	6	6	6	6							
4,[5],12:i:-	10 (8.5)	4	6							3	3	3	3	3							3
Newport	6 (5.1)	6																			
Paratyphi A and B	2 (1.7)	1	1																1	1	
Typhi	2 (1.7)		2																1	2	
Total	117 (100)	88	23	5	1			4	4	11	9	9	9	9	5	1	1		3	8	6
Manitoba																					
Enteritidis	81 (48.5)	68	9	2	2		1	1	2						2	2	1		1	13	2
Typhimurium	46 (27.5)	31		5	9	1	1	1	15	11	1	1	1	1	15	1		8	1	1	10
Heidelberg	14 (8.4)	11	3							3	3	3	3	3							
4,[5],12:i:-	14 (8.4)	9	1		4		1	1	4	5	1	2	1	2	4	1		1			4
Paratyphi A and B	5 (3.0)		2	3											2	2		1	1	3	2
Typhi	5 (3.0)	4	1																	1	
Newport	2 (1.2)	2																			
Total	167 (100)	125	16	10	15	1	3	2	20	21	5	6	6	6	23	6	1	10	3	18	18
Ontario																					
Enteritidis	190 (26.1)	158	28	3	1				1	4	1	1	1	1	2	1			2	27	5
Typhimurium	164 (22.5)	119	7	5	32	1	1	5	37	33	1	1	1	1	38	3		29	2	3	35
Heidelberg	147 (20.2)	91	48	8			5	2	7	44	44	44	44	44	8	2		1			4
Newport	80 (11)	72	1	2	5		1		6	6	4	4	4	4	6	1		4			5
4,[5],12:i:-	65 (8.9)	20	4	5	36		1	7	38	40	1	2	1	2	38	3	1	4		2	40
Typhi	60 (8.2)	8	41	1	8	2			10	9					10	9		7	9	52	4
Paratyphi A and B	23 (3.2)	8	15																3	15	
Total	729 (100)	476	144	24	82	3	8	14	99	136	51	52	51	52	102	19	1	45	16	103	93

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

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Table 1. Number of antimicrobial classes in resistance patterns of *Salmonella* serovars (cont'd)

Province / 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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Québec																					
Heidelberg	112 (34)	76	28	8			2	1	6	28	26	27	26	27	6	1		2			5
Enteritidis	75 (22.8)	57	13	5					1						4	4			4	13	5
Typhimurium	61 (18.5)	33	1	5	19	3		7	23	23	2	2	1	2	26	5	2	21		3	24
Newport	35 (10.6)	30	2	1	2				2	3	2	3	2	3	2	1	2	2			2
4,[5],12:i:-	32 (9.7)	7	4	1	20		1	2	20	20	1	1	1	1	21		1			1	23
Typhi	11 (3.3)	5	5	1													1		1	6	
Paratyphi A and B	3 (0.9)		2		1				1	1					1			1		2	1
Total	329 (100)	208	55	21	42	3	3	10	53	75	31	33	30	33	60	11	6	26	5	25	60
New Brunswick																					
Enteritidis	64 (54.2)	60	3	1											1	1			1	4	1
Heidelberg	39 (33.1)	26	12	1			1		1	11	11	11	11	11	1		1				
Typhimurium	8 (6.8)	4		2	2			1	3	2	1	1		1	4			1	1		3
4,[5],12:i:-	4 (3.4)	3	1																		1
Newport	3 (2.5)	3																			
Total	118 (100)	96	16	4	2		1	1	4	13	12	12	11	12	6	1	1	1	2	4	5
Nova Scotia																					
Enteritidis	88 (70.4)	75	9	1	3				3	3					4	1			1	11	4
Heidelberg	26 (20.8)	9	14	3					3	17	16	15	15	15	2	2					1
Newport	6 (4.8)	6																			
Typhimurium	4 (3.2)	4																			
4,[5],12:i:-	1 (0.8)	1																			
Total	125 (100)	95	23	4	3				6	20	16	15	15	15	6	3			1	11	5
Prince Edward Island																					
Enteritidis	13 (81.3)	13																			
Heidelberg	2 (12.5)	1	1							1	1	1	1	1							
Newport	1 (6.3)			1				1											1		
Total	16 (100)	14	1	1				1		1	1	1	1	1					1		
Newfoundland and Labrador																					
Enteritidis	16 (80.0)	15	1																	1	
4,[5],12:i:-	2 (10.0)		1	1				1		1	1	1	1	1			1				1
Heidelberg	1 (5.0)		1							1	1	1	1	1							
Typhimurium	1 (5.0)	1																			
Total	20 (100)	16	3	1				1		2	2	2	2	2			1			1	1
TOTAL	2,062 (100)	1379	387	97	187	12	25	49	248	362	158	161	157	161	260	56	15	114	50	242	265

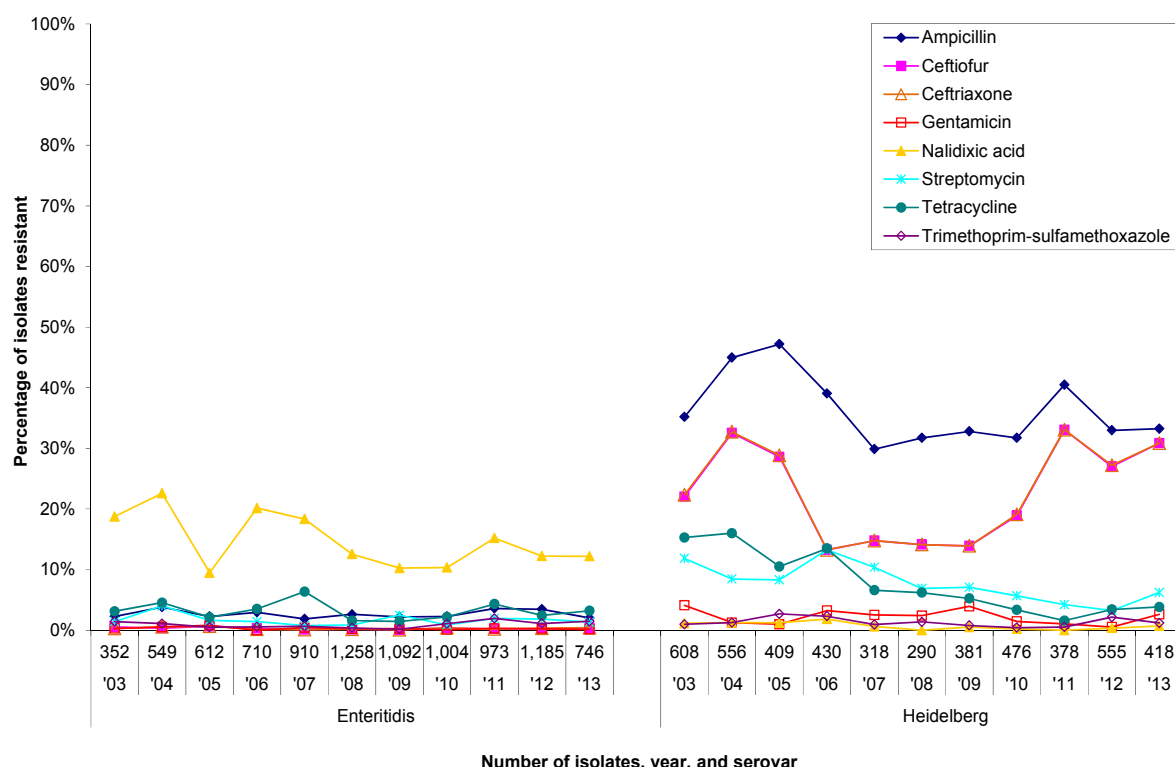
Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

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TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

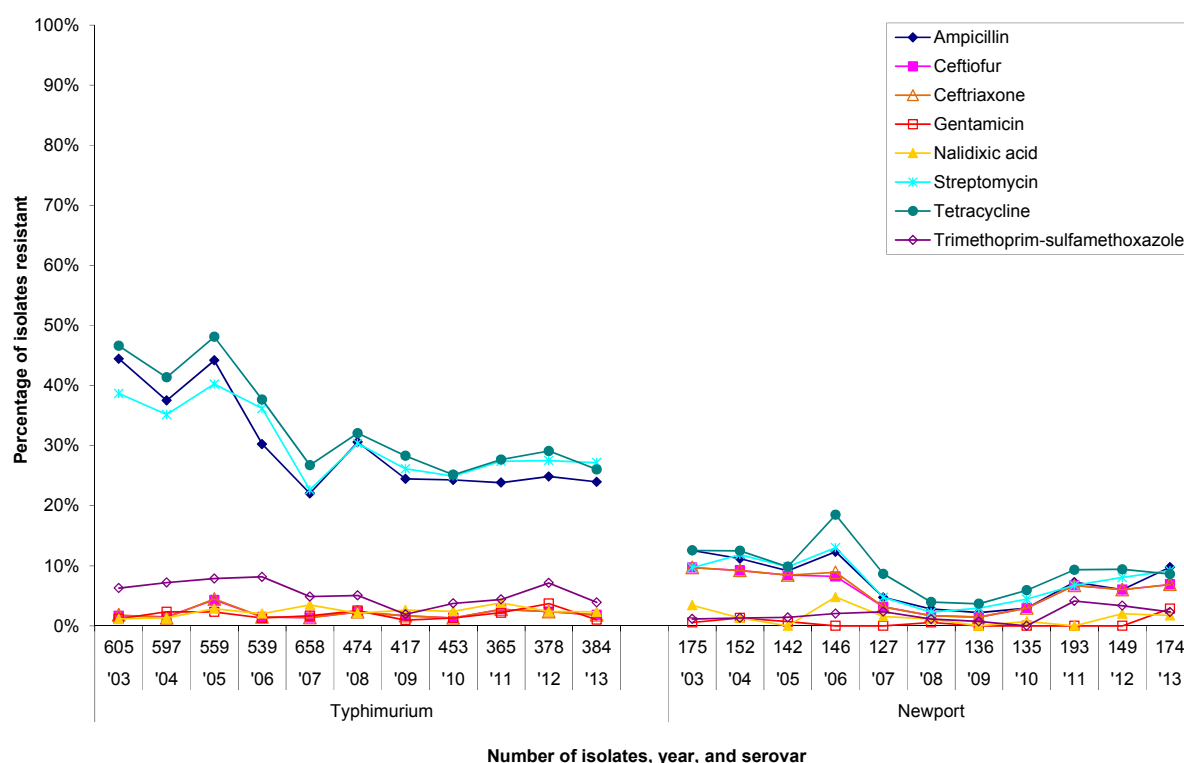
Figure 9. Temporal variations in resistance of *Salmonella* serovars from humans



Serovar	Enteritidis											Heidelberg										
	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Number of isolates	352	549	612	710	910	1,258	1,092	1,004	973	1,185	746	608	556	409	430	318	290	381	476	378	555	418
Antimicrobial																						
Ampicillin	2%	4%	2%	3%	2%	3%	2%	2%	4%	3%	2%	35%	45%	47%	39%	30%	32%	33%	32%	40%	33%	33%
Ceftiofur	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	22%	33%	29%	13%	15%	14%	14%	19%	33%	27%	31%
Ceftriaxone	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	22%	33%	29%	13%	15%	14%	14%	19%	33%	27%	31%
Gentamicin	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	4%	1%	1%	3%	3%	2%	4%	1%	1%	1%	3%
Nalidixic acid	19%	23%	9%	20%	18%	13%	10%	10%	15%	12%	12%	1%	1%	1%	2%	1%	0%	1%	0%	0%	0%	1%
Streptomycin	1%	4%	2%	1%	1%	1%	2%	1%	2%	2%	1%	12%	8%	8%	13%	10%	7%	7%	6%	4%	3%	6%
Tetracycline	3%	5%	2%	4%	6%	2%	1%	2%	4%	2%	3%	15%	16%	11%	13%	7%	6%	5%	3%	2%	3%	4%
Trimethoprim-sulfamethoxazole	1%	1%	0%	1%	1%	0%	0%	1%	2%	1%	1%	1%	1%	3%	2%	1%	1%	1%	0%	1%	2%	1%

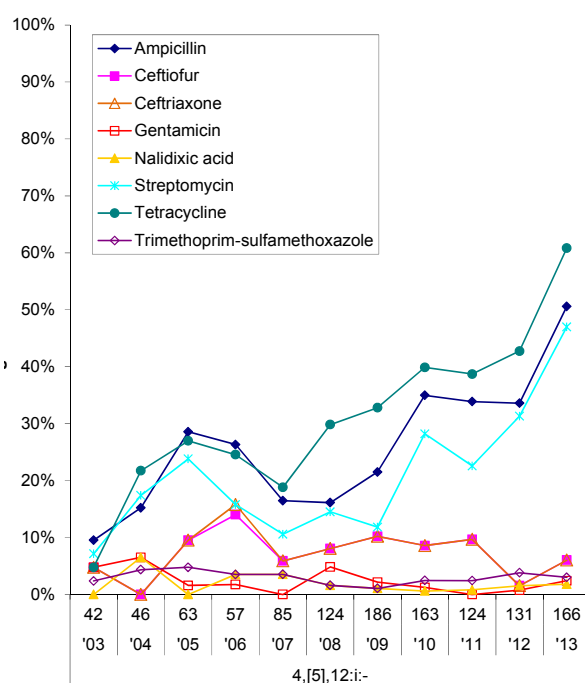
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicates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

Additional temporal analyses for ampicillin and ceftiofur were conducted for *Salmonella* Heidelberg. These two 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 9. Temporal variations in resistance of *Salmonella* serovars from humans (cont'd)

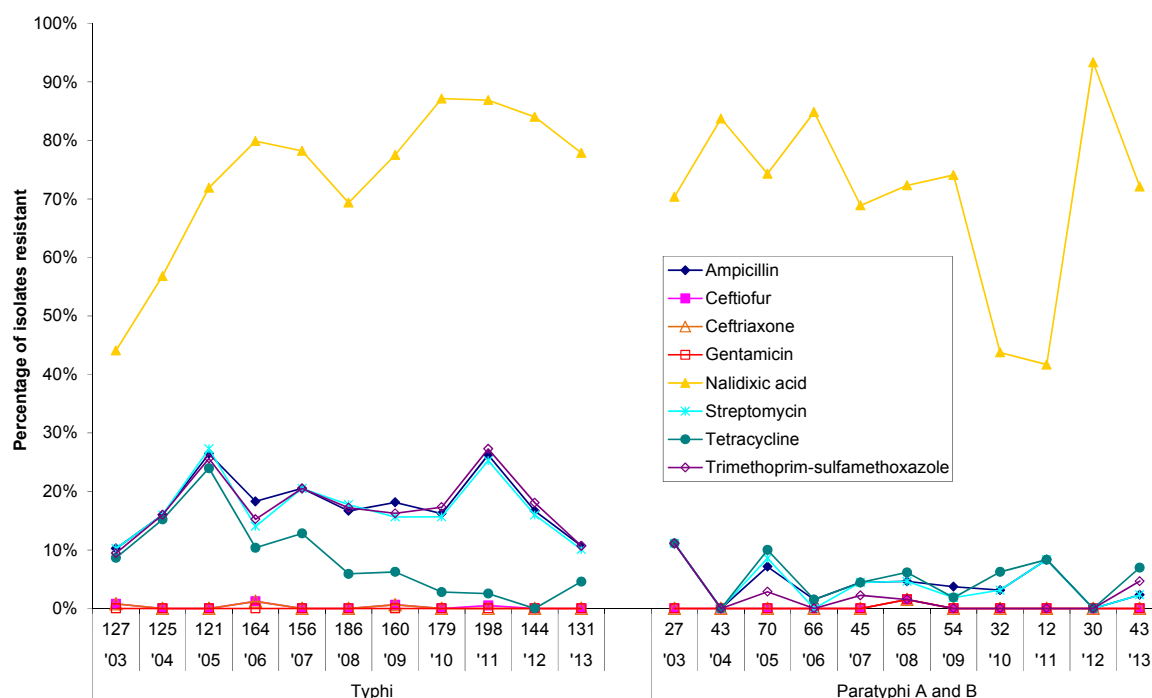
Serovar	Typhimurium											Newport										
Year	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Number of isolates	605	597	559	539	658	474	417	453	365	378	384	175	152	142	146	127	177	136	135	193	149	174
Antimicrobial																						
Ampicillin	44%	38%	44%	30%	22%	31%	24%	24%	24%	25%	24%	13%	11%	9%	12%	5%	3%	2%	3%	7%	6%	10%
Ceftiofur	2%	2%	4%	1%	1%	2%	2%	1%	3%	2%	2%	10%	9%	8%	8%	3%	2%	1%	3%	7%	6%	7%
Ceftriaxone	2%	1%	4%	1%	1%	2%	2%	1%	3%	2%	2%	10%	9%	8%	9%	3%	2%	1%	3%	7%	6%	7%
Gentamicin	1%	2%	2%	1%	2%	3%	1%	1%	2%	4%	1%	1%	1%	1%	0%	0%	1%	0%	0%	0%	0%	3%
Nalidixic acid	1%	1%	3%	2%	3%	2%	3%	2%	4%	2%	2%	3%	1%	0%	5%	2%	1%	0%	1%	0%	2%	2%
Streptomycin	39%	35%	40%	36%	23%	30%	26%	25%	27%	28%	27%	10%	12%	10%	13%	5%	2%	3%	4%	7%	8%	9%
Tetracycline	47%	41%	48%	38%	27%	32%	28%	25%	28%	29%	26%	13%	13%	10%	18%	9%	4%	4%	6%	9%	9%	9%
Trimethoprim-sulfamethoxazole	6%	7%	8%	8%	5%	5%	2%	4%	4%	7%	4%	1%	1%	1%	2%	2%	1%	1%	0%	4%	3%	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 first and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 9. Temporal variations in resistance of *Salmonella* serovars from humans (cont'd)

Number of isolates, year, and serovar												
Serovar	4,[5],12:i:-											
Year	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	
Number of isolates	42	46	63	57	85	124	186	163	124	131	166	
Antimicrobial												
Ampicillin	10%	15%	29%	26%	16%	16%	22%	35%	34%	34%	51%	
Cefotiofur	5%	0%	10%	14%	6%	8%	10%	9%	10%	2%	6%	
Ceftriaxone	5%	0%	10%	16%	6%	8%	10%	9%	10%	2%	6%	
Gentamicin	5%	7%	2%	2%	0%	5%	2%	1%	0%	1%	2%	
Nalidixic acid	0%	7%	0%	4%	4%	2%	1%	1%	1%	2%	2%	
Streptomycin	7%	17%	24%	16%	11%	15%	12%	28%	23%	31%	47%	
Tetracycline	5%	22%	27%	25%	19%	30%	33%	40%	39%	43%	61%	
Trimethoprim-sulfamethoxazole	2%	4%	5%	4%	4%	2%	1%	2%	2%	4%	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 first and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 9. Temporal variations in resistance of *Salmonella* serovars from humans (cont'd)

Number of isolates, year, and serovar

Serovar	Typhi											Paratyphi A and B										
Year	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Number of isolates	127	125	121	164	156	186	160	179	198	144	131	27	43	70	66	45	65	54	32	12	30	43
Antimicrobial																						
Ampicillin	10%	16%	26%	18%	21%	17%	18%	16%	26%	17%	11%	11%	0%	7%	2%	4%	5%	4%	3%	8%	0%	2%
Cefotiofur	1%	0%	0%	1%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
Ceftriaxone	1%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
Gentamicin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
Nalidixic acid	44%	57%	72%	80%	78%	69%	78%	87%	87%	84%	78%	70%	84%	74%	85%	69%	72%	74%	44%	42%	93%	72%
Streptomycin	10%	16%	27%	14%	21%	18%	16%	16%	25%	16%	10%	11%	0%	9%	0%	4%	5%	2%	3%	8%	0%	2%
Tetracycline	9%	15%	24%	10%	13%	6%	6%	3%	3%	0%	5%	11%	0%	10%	2%	4%	6%	2%	6%	8%	0%	7%
Trimethoprim-sulfamethoxazole	9%	16%	26%	15%	21%	17%	16%	17%	27%	18%	11%	11%	0%	3%	0%	2%	2%	0%	0%	0%	0%	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 first and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

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. However, there were no Paratyphi B isolates received for antimicrobial susceptibility testing in 2012.

MINIMUM INHIBITORY CONCENTRATIONS

Table 2. Distribution of minimum inhibitory concentrations among *Salmonella* Enteritidis

Antimicrobial	n	Percentiles			Distribution (%) of MICs (µg/mL)															
		MIC 50	MIC 90	% R	≤ 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	746	≤ 1	2	0.4							83.8	13.7	0.7	1.5			0.4			
Ceftiofur	746	1	1	0.4					0.1	0.5	95.2	3.6	0.1		0.4					
Ceftriaxone	746	≤ 0.25	≤ 0.25	0.4					99.1	0.4	0.1					0.4				
Ciprofloxacin	746	0.03	0.25	1.5	28.2	56.4	1.7	1.2	6.7	4.3	0.5	0.9								
II Ampicillin	746	≤ 1	2	2.0							63.8	33.4	0.5	0.3			2.0			
Azithromycin	746	4	8	0.3								2.3	81.2	15.8	0.4	0.3				
Cefoxitin	746	2	4	0.5							0.8	75.7	20.5	2.3	0.1	0.1	0.4			
Gentamicin	746	0.50	0.50	0.1					20.4	74.1	5.2	0.1				0.1				
Kanamycin	738	≤ 8	≤ 8	0.1											99.2	0.7			0.1	
Nalidixic acid	746	4	> 32	12.2							0.3	13.1	66.4	6.4	1.6	0.7	11.5			
Streptomycin	746	≤ 32	≤ 32	1.3								0.7	0.4			97.6	0.3	1.1		
Trimethoprim-sulfamethoxazole	746	≤ 0.12	≤ 0.12	1.5					97.5	0.9	0.1				1.5					
III Chloramphenicol	746	8	8	0.5								0.1	10.1	88.5	0.8		0.5			
Sulfisoxazole	746	32	64	2.5											2.3	75.3	19.6	0.3		2.5
Tetracycline	746	≤ 4	≤ 4	3.2									96.6	0.1			3.2			
IV																				

Table 3. Distribution of minimum inhibitory concentrations among *Salmonella* Heidelberg

Antimicrobial	n	Percentiles			Distribution (%) of MICs (µg/mL)															
		MIC 50	MIC 90	% R	≤ 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	418	≤ 1	> 32	30.9							66.0	0.7		1.4	1.0	2.6	28.2			
Ceftiofur	418	1	> 8	30.9						17.7	50.7	0.7				30.9				
Ceftriaxone	418	≤ 0.25	16	30.9					69.1						0.2	24.4	4.8	0.7	0.7	
Ciprofloxacin	418	≤ 0.015	≤ 0.015	0.0	95.7	2.6	0.5	0.5	0.7											
II Ampicillin	418	≤ 1	> 32	33.3							65.1	1.2	0.5			0.2	33.0			
Azithromycin	418	4	4	0.2									93.8	6.0		0.2				
Cefoxitin	418	2	> 32	30.6							26.8	38.5	3.6	0.5		17.5	13.2			
Gentamicin	418	0.50	1	2.6					3.3	84.4	9.3				0.2	2.4				
Kanamycin	414	≤ 8	≤ 8	2.2											96.9	1.0			2.2	
Nalidixic acid	418	4	4	0.7							8.1	89.7	1.4				0.7			
Streptomycin	418	≤ 32	≤ 32	6.2										0.2	0.7	92.8	1.7	4.5		
Trimethoprim-sulfamethoxazole	418	≤ 0.12	≤ 0.12	1.2					98.3	0.5					1.2					
III Chloramphenicol	418	8	8	0.7								4.8	94.0	0.5			0.7			
Sulfisoxazole	418	32	64	4.8											9.3	72.2	13.6			4.8
Tetracycline	418	≤ 4	≤ 4	3.8									96.2				3.8			
IV																				

Table 4. Distribution of minimum inhibitory concentrations among *Salmonella* Newport

	Antimicrobial	n	Percentiles			Distribution (%) of MICs (µg/mL)																
			MIC 50	MIC 90	% R	≤ 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	174	≤ 1	2	6.3							89.7	0.6	0.6	2.9		2.9	3.4				
	Ceftiofur	174	1	1	6.9					1.1	9.8	82.2					6.9					
	Ceftriaxone	174	≤ 0.25	≤ 0.25	6.9					92.0	1.1						4.0	1.7	0.6		0.6	
	Ciprofloxacin	174	≤ 0.015	0.03	1.1	85.6	10.9			1.7	0.6		0.6			0.6						
II	Ampicillin	174	≤ 1	2	9.8							87.4	2.9						9.8			
	Azithromycin	174	4	4	2.3								4.0	87.4	6.3			2.3				
	Cefoxitin	174	2	4	6.3							3.4	79.9	9.8	0.6			2.9	3.4			
	Gentamicin	174	0.50	1	2.9						87.4	9.2	0.6					2.9				
	Kanamycin	172	≤ 8	≤ 8	1.2										97.7	1.2		0.6		0.6		
	Nalidixic acid	174	4	4	1.7								39.7	56.9	0.6	1.1			1.7			
	Streptomycin	174	≤ 32	≤ 32	9.2											0.6		90.2	2.3		6.9	
	Trimethoprim-sulfamethoxazole	174	≤ 0.12	≤ 0.12	2.3				96.6	1.1					0.6	1.7						
	Chloramphenicol	174	8	8	6.3								0.6	42.5	50.6				6.3			
III	Sulfisoxazole	174	32	64	7.5											5.7	63.2	23.0	0.6		7.5	
	Tetracycline	174	≤ 4	≤ 4	8.6									90.8	0.6				8.6			
IV																						

Table 5. Distribution of minimum inhibitory concentrations among *Salmonella* Paratyphi A and B

	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	43	2	2	0.0							23.3	72.1	2.3		2.3					
	Ceftiofur	43	1	1	0.0						9.3	86.0	4.7								
	Ceftriaxone	43	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	43	0.50	1	18.6	23.3	4.7				53.5	18.6									
II	Ampicillin	43	2	4	2.3							18.6	65.1	11.6	2.3				2.3		
	Azithromycin	43	8	8	0.0								2.3	46.5	48.8	2.3					
	Cefoxitin	43	4	8	2.3							4.7	14.0	48.8	30.2			2.3			
	Gentamicin	43	≤ 0.25	0.50	0.0					72.1	23.3	4.7									
	Kanamycin	43	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	43	> 32	> 32	72.1								7.0	18.6	2.3				72.1		
	Streptomycin	43	≤ 32	≤ 32	2.3												97.7			2.3	
	Trimethoprim-sulfamethoxazole	43	≤ 0.12	0.25	4.7				81.4	9.3	4.7				4.7						
	III	Chloramphenicol	43	8	16	4.7								2.3	86.0		7.0	2.3	2.3		
		Sulfisoxazole	43	32	64	7.0											7.0	53.5	30.2	2.3	7.0
Tetracycline		43	≤ 4	8	7.0									88.4	4.7		2.3	4.7			
IV																					

Table 6. Distribution of minimum inhibitory concentrations among *Salmonella* Typhi

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	131	≤ 1	4	0.0							89.3		1.5	8.4	0.8									
	Ceftiofur	131	1	1	0.0					0.8	39.7	58.0	1.5												
	Ceftriaxone	131	≤ 0.25	≤ 0.25	0.0					96.9	3.1														
	Ciprofloxacin	131	0.25	2	17.6	19.1	1.5		6.1	33.6	22.1	6.9	1.5	0.8	8.4										
II	Ampicillin	131	≤ 1	>32	10.7							86.3	3.1												
	Azithromycin	131	4	8	1.5								11.5	77.9	9.2			1.5							
	Cefoxitin	131	4	8	0.0							16.8	16.0	32.8	32.1	2.3									
	Gentamicin	131	0.5	0.5	0.0					37.4	61.8	0.8													
	Kanamycin	124	≤ 8	≤ 8	0.0											100.0									
	Nalidixic acid	131	>32	>32	77.9								16.0	4.6	0.8	0.8		0.8	77.1						
	Streptomycin	129	≤ 32	64	10.1											0.8	2.3	86.8	0.8		9.3				
	Trimethoprim-sulfamethoxazole	131	≤ 0.12	>4	10.7					87.8	1.5					10.7									
III	Chloramphenicol	131	8	16	9.2									28.2	61.1	1.5			9.2						
	Sulfisoxazole	131	32	> 256	12.2												14.5	58.0	14.5	0.8				12.2	
	Tetracycline	131	≤ 4	≤ 4	4.6										95.4				4.6						
IV																									

Table 7. Distribution of minimum inhibitory concentrations among *Salmonella* Typhimurium

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	384	≤ 1	16	1.8								71.9	4.2	0.8	8.3	13.0	0.3	1.6			
Ceftiofur	384	1	1	1.8						6.0	90.1	1.8	0.3			1.8					
Ceftriaxone	384	≤ 0.25	≤ 0.25	1.8					97.7	0.5					0.3	1.0	0.5				
Ciprofloxacin	384	≤ 0.015	0.03	1.6		74.5	19.8	1.6	0.3	1.3	1.0	1.6									
II Ampicillin	384	≤ 1	>32	24.0								65.6	9.9	0.5			0.3	23.7			
Azithromycin	384	4	8	0.8									3.6	85.2	9.9	0.5	0.8				
Cefoxitin	384	2	4	1.3							4.4	78.4	13.3	2.3	0.3	0.5	0.5	0.8			
Gentamicin	384	0.5	1	1.0					2.9	79.7	14.8	1.3	0.3		0.5	0.5					
Kanamycin	373	≤ 8	≤ 8	6.7											92.2	0.8	0.3		6.7		
Nalidixic acid	384	4	4	2.3								26.3	67.2	2.3	1.8			2.3			
Streptomycin	383	≤ 32	>64	27.1												1.0	71.8	7.0	20.1		
Trimethoprim-sulfamethoxazole	384	≤ 0.12	0.25	3.9					76.8	17.2	1.8	0.3			3.9						
III Chloramphenicol	384	8	> 32	19.8									12.5	66.1	1.6	0.3	19.5				
Sulfisoxazole	384	32	> 256	28.6												6.3	58.1	7.0			28.6
Tetracycline	384	≤ 4	> 32	26.0									73.2	0.8		11.7	14.3				
IV																					

Table 8. Distribution of minimum inhibitory concentrations in *Salmonella* 4,[5],12:i:-

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	166	4	8	4.8								44.6	4.8	9.6	34.9	1.2		4.8			
Ceftiofur	166	1	1	6.0						8.4	83.1	2.4				6.0					
Ceftriaxone	166	≤ 0.25	≤ 0.25	6.0						92.2	1.8					4.2	0.6		1.2		
Ciprofloxacin	166	≤ 0.015	0.03	0.0		68.7	28.3			0.6	2.4										
II Ampicillin	166	> 32	> 32	50.6								44.0	3.6	1.2		0.6		50.6			
Azithromycin	166	4	4	1.8									4.8	88.6	4.8		1.8				
Cefoxitin	166	2	4	4.8							3.6	81.9	7.8	1.8			0.6	4.2			
Gentamicin	166	0.50	1	2.4					1.2	79.5	16.3	0.6					2.4				
Kanamycin	166	≤ 8	≤ 8	7.2											92.8				7.2		
Nalidixic acid	166	4	4	1.8								19.9	76.5	1.8				1.8			
Streptomycin	166	≤ 32	> 64	47.0													53.0	1.2	45.8		
Trimethoprim-sulfamethoxazole	166	≤ 0.12	0.25	3.0					88.6	8.4					3.0						
III Chloramphenicol	166	8	8	3.6									13.3	82.5	0.6			3.6			
Sulfisoxazole	166	64	> 256	47.6													44.0	8.4			47.6
Tetracycline	166	> 32	> 32	60.8									39.2					60.8			
IV																					

RETAIL MEAT SURVEILLANCE

KEY FINDINGS

BEEF

ESCHERICHIA COLI (n = 286)

As in previous years, resistance levels of category I β -lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) remained low (< 4%) in beef *E. coli* isolates in 2013 with the exception of British Columbia where category I β -lactam resistance ranged between 6% (amoxicillin-clavulanic acid) and 9% (ceftriaxone and ceftiofur) (Table 9). One isolate (1%, 1/79) from Québec was resistant to all 7 classes of antimicrobials tested (Table 9) and had the ACSSuT-AZM-TIO-CRO-CIP-NAL-SXT resistance pattern.

CHICKEN

SALMONELLA (n = 264)

Across all provinces sampled, the top 3 chicken *Salmonella* serovars were *S. Heidelberg*, *S. Kentucky*, and *S. Enteritidis* as in previous years. Regional differences in serovar distribution were observed in 2013 with *S. Enteritidis* being the most common serovar in both British Columbia (46%, 15/33) and Saskatchewan (33%, 14/43) unlike Ontario and Québec where the most common serovar was *S. Heidelberg* (46%, 43/94 and 39%, 37/94 respectively) (Table 10). No *S. Enteritidis* was recovered in Ontario and only a single isolate (1%, 1/94) of *S. Enteritidis* was recovered in Québec.

All *S. Enteritidis* isolates were susceptible to all antimicrobials tested in 2013. No ciprofloxacin or nalidixic acid resistance was observed in 2013 (Table 10). Across all provinces¹² sampled, resistance levels of category I β -lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) (25%, 65/264) remained similar to levels in 2012 (26%, 80/307). Resistance to ceftiofur was significantly lower (22%, 21/94) in 2013 than 2004 (45%, 25/55) in Ontario (Figure 11). Resistance to ceftiofur was significantly higher (30%, 28/94) in 2013 than 2006 (5%, 4/77) in Québec (Figure 11). Resistance to gentamicin was significantly higher (6%, 6/94) in 2013 in Ontario compared to 2012 (0%; no resistance) (Figure 11).

¹² At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

ESCHERICHIA COLI (n = 358)

Ciprofloxacin resistance was observed in a single (1%, 1/117) chicken *E. coli* isolate in Québec (Table 11). Resistance levels of category I β -lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) remain similar to those in 2012 across all provinces¹³ sampled. Resistance to ceftiofur was significantly higher (58%, 38/65) in 2013 than 2012 (40%, 33/82) and 2007 (29%, 12/42) in British Columbia (Figure 12). Resistance to ceftiofur was significantly higher (19%, 12/62) in 2013 than 2005 (4%, 3/81) in Saskatchewan (Figure 12). Resistance to ceftiofur was significantly higher (24%, 28/117) in 2013 than 2006 (6%, 8/135) in Québec (Figure 12). Resistance to gentamicin was significantly higher (19%, 12/62) in 2013 than 2005 (6%, 5/81) in Saskatchewan (Figure 12). Resistance to gentamicin was significantly higher (24%, 27/114) in 2013 than 2012 (12%, 13/107) and 2003 (7%, 9/136) in Ontario (Figure 12).

CAMPYLOBACTER (n = 220)

In 2013, ciprofloxacin resistance was significantly higher in British Columbia (26%, 15/57) compared to 2012 (8%, 6/73) and 2007 (4%, 1/28) (Figure 13). Ciprofloxacin resistance remains at a similar level in Saskatchewan (4%, 1/24) compared to 2012 (5%, 2/40) (Figure 13). In isolates from Ontario, ciprofloxacin resistance has decreased in 2013 (8%, 7/84) compared to 2012 (16%, 14/88) but this decline is not significant (Figure 13). Ciprofloxacin resistance remains at a low, similar level in Québec (4%, 2/54) compared to 2012 (3%, 2/79) (Figure 13). Telithromycin resistance was relatively low in *Campylobacter* isolates from Ontario (2%, 2/84) and Québec (2%, 1/54) in 2013 (Table 12); this is similar to levels in recent previous years.

PORK*ESCHERICHIA COLI* (n = 221)

In 2013, category I β -lactam amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur resistance levels in pork *E. coli* isolates remained at low (3%, 6/221), similar levels compared to 2012 (3%, 6/199) (Table 13 and Figure 14).

TURKEY

No temporal variation figures are presented as 2013 was only the second full year for retail ground turkey sampling.

SALMONELLA (n = 150)

The distribution of *Salmonella* serovars varies greatly by province in the second full year of retail surveillance of ground turkey (Table 14). No ciprofloxacin or nalidixic acid resistance was

¹³ At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

observed (Table 14). Category I β -lactam (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) resistance levels in turkey *Salmonella* isolates were quite variable ranging from a low of 4% (1/27) in Saskatchewan to a high of 38% (11/29) in Ontario (Table 14).

ESCHERICHIA COLI (n = 352)

No ciprofloxacin or nalidixic acid resistance was observed in turkey *E. coli* isolates (Table 15). In 2013, resistance levels of category I β -lactams (amoxicillin-clavulanic acid, ceftriaxone, and ceftiofur) in turkey *E. coli* isolates ranged from 3% in Saskatchewan (2/59) and Ontario (4/119) to 7% in British Columbia (5/67) and Québec (7/107) (Table 15).

CAMPYLOBACTER (n = 76)

One isolate (4%, 2/20) from Ontario was resistant to telithromycin in 2013 (Table 16). Ciprofloxacin resistance was observed in 32% (9/28) of isolates from British Columbia, 20% (1/5) isolate from Saskatchewan and 13% (2/16) of isolates from Québec. No ciprofloxacin resistance was observed in turkey *Campylobacter* isolates in Ontario in 2013 (Table 16) which was similar to 2012.

MULTICLASS RESISTANCE

Table 9. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from beef

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	47 (16.4)	34	5	5	3		3	1	6	6	3	4	3	4	8	1		1		1	10
Saskatchewan	54 (18.9)	38	9	5	2			1	6	4	2	1	1	1	5	1		1		1	13
Ontario	106 (37.1)	78	11	12	5		2		13	7	1	1	1	1	13	2		4			25
Québec	79 (27.6)	63	5	9	1	1		1	9	5		1		1	7	3	1	2	1	1	15
TOTAL	286 (100)	213	30	31	11	1	5	3	34	22	6	7	5	7	33	7	1	8	1	3	63

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 10. Number of antimicrobial classes in resistance patterns of *Salmonella* from chicken

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														
		0	1	2-3	4-5	6-7	Aminoglycosides			β-Lactams					Folate pathway inhibitors		Macrolides	Phenicol	Quinolones		Tetracyclines
							GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	15 (45.5)	15																			
Kentucky	8 (24.2)	1	1	6					6	6	6	6	5	6							7
Heidelberg	5 (15.2)	1	3	1						4	3	4	3	4							1
Agona	1 (3.0)			1						1		1			1						1
Cubana	1 (3.0)	1																			
4,5,12:i:-	1 (3.0)	1																			
Schwarzengrund	1 (3.0)	1																			
Typhimurium	1 (3.0)	1																			
Total	33 (100)	21	4	8					6	11	9	11	8	10	1						9
Saskatchewan																					
Enteritidis	14 (32.6)	14																			
Heidelberg	7 (16.3)	4	2	1				1	1	2	2	2	2	2							1
Infantis	6 (14.0)	5	1							1	1	1	1	1							
Kentucky	5 (11.6)		1	4					4	3	3	3	3	3							4
Schwarzengrund	5 (11.6)	5																			
Thompson	3 (7.0)	1	2						2												
Kiambu	1 (2.3)	1																			
Stanley	1 (2.3)	1																			
Typhimurium	1 (2.3)	1																			
Total	43 (100)	32	6	5				1	7	6	6	6	6	6							5
Ontario																					
Heidelberg	43 (45.7)	27	11	5				2	6	14	11	11	11	11	4						
Kentucky	30 (31.9)	7	2	21					21	6	6	6	5	6							22
Thompson	5 (5.3)	4	1							1	1	1	1	1							
Infantis	2 (2.1)		1		1			1	2	2	2	2	2	2	1			1			1
Livingstone	2 (2.1)			2					2						2						2
Schwarzengrund	2 (2.1)	1		1											1						1
Less common serovars	10 (10.6)	3	1	6				3	2	4	1	1	1	1	5						5
Total	94 (100)	42	16	35	1		6	2	34	24	21	21	20	21	13			1			31
Québec																					
Heidelberg	37 (39.4)	19	17	1				1	1	1	16	16	16	16	1						
Kentucky	24 (25.5)	3	2	19						19	6	6	6	6							21
Thompson	7 (7.4)	6		1				1	1						1						
Infantis	5 (5.3)	1	1		3			3	3	4	4	4	4	4	3			3			3
Hadar	4 (4.3)			4					4												4
Braenderup	2 (2.1)	1	1																		1
6,7:-:1,5	2 (2.1)	2																			
Typhimurium	2 (2.1)			2				1							2						2
Typhimurium var. 5-	2 (2.1)			2				1	1						2						2
Less common serovars	9 (9.6)	7	2							2	2	2	2	2							
Total	94 (100)	39	23	29	3		7	1	29	28	28	28	28	28	9			3			33
Maritimes																					
Heidelberg	24 (55.8)	11	11	2				2	2	12	10	10	10	10	2						
Kentucky	7 (16.3)	1	1	5					5	2	2	2	2	2							5
Thompson	4 (9.3)	3	1							1	1	1	1	1							
Ohio	2 (4.7)	2																			
Enteritidis	1 (2.3)	1																			
4,5,12:i:-	1 (2.3)	1																			
8,20:-:z6	1 (2.3)			1					1												1
Kiambu	1 (2.3)	1																			
Litchfield	1 (2.3)	1																			
Typhimurium var. 5-	1 (2.3)			1											1						1
Total	43 (100)	21	13	9			2	8	15	13	13	13	13	13	3						7
TOTAL	307 (100)	155	62	86	4		15	4	84	84	77	79	75	78	26			4			85

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 11. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chicken

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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	65 (18.2)	9	18	23	14	1	5	3	26	48	40	39	40	38	24	7		7		2	32
Saskatchewan	62 (17.3)	21	9	25	7		12	4	20	21	13	13	12	12	19	2		4		5	27
Ontario	114 (31.8)	25	26	43	18	2	27	13	52	42	27	27	27	25	58	24		7		2	62
Québec	117 (32.7)	10	15	66	25	1	32	17	68	63	29	29	29	28	71	30	1	8	1	5	71
TOTAL	358 (100)	65	68	157	64	4	76	37	166	174	109	108	108	103	172	63	1	26	1	14	192

Antimicrobial abbreviations are defined in the *How To Read This Chapter*.

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

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 12. Number of antimicrobial classes in resistance patterns of *Campylobacter* from chicken

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	Phenicol	Quinolones	Tetracyclines			
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET	
British Columbia																
Campylobacter jejuni	48 (84.2)	28	11	9									9	9		20
Campylobacter spp.	5 (8.8)	2		3									3	3		3
Campylobacter coli	4 (7.0)	1	2	1									3	3		1
Total	57 (100)	31	13	13									15	15		24
Saskatchewan																
Campylobacter jejuni	22 (88.0)	9	13													13
Campylobacter coli	3 (12.0)		3										1	1		2
Total	25 (100)	9	16										1	1		15
Ontario																
Campylobacter jejuni	69 (82.1)	29	35	5				1		1		3	3		3	38
Campylobacter coli	10 (11.9)	4	2	3	1			1		4		5	5		2	1
Campylobacter spp.	5 (6.0)	2	2	1											2	2
Total	84 (100)	35	39	9	1			2		5		8	8		7	41
Québec																
Campylobacter jejuni	49 (90.7)	17	28	4								4	4		1	31
Campylobacter coli	3 (5.6)	1			2			1		2		2	2		1	2
Campylobacter spp.	2 (3.7)		2													2
Total	54 (100)	18	30	4	2			1		2		6	6		2	35
TOTAL	220 (100)	93	98	26	3			3		7		14	14		25	115

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 13. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pork

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	38 (17.2)	26	5	6	1		1		4	4	3	3	3	3	5	1		2			9
Saskatchewan	29 (13.1)	16	6	6	1			2	3	4	1	1	1	1	3	2		1			11
Ontario	102 (46.2)	61	11	19	11		3	3	17	21	2	3	3	2	18	6		4		2	38
Québec	52 (23.5)	27	6	16	3			1	6	14					8	6		3		1	23
TOTAL	221 (100)	130	28	47	16		4	6	30	43	6	7	7	6	34	15		10		3	81

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 14. Number of antimicrobial classes in resistance patterns of *Salmonella* from turkey

Province or region / serovar	Number (%) of isolates	Number of isolates resistant by antimicrobial class and antimicrobial																					
		Number of isolates by number of antimicrobial classes in the resistance pattern					Aminoglycosides			β-Lactams					Folate pathway inhibitors		Macrolides	Phenicol	Quinolones		Tetracyclines		
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET		
British Columbia																							
Kentucky	6 (16.7)	6								6	5	5	5	4	5								6
Newport	6 (16.7)	5	1				1				1											1	
Reading	5 (13.9)	5																					
Schwarzengrund	5 (13.9)	3	2				2													2			
Enteritidis	4 (11.1)	4																					
Liverpool	4 (11.1)	4																					
Hadar	3 (8.3)	3					1	3													1	3	
Anatum	1 (2.8)	1					1	1													1	1	
Johannesburg	1 (2.8)	1																					
Mbandaka	1 (2.8)	1																					
Total	36 (100)	23	13				3	12	6	5	5	4	5	4								13	
Saskatchewan																							
Schwarzengrund	7 (25.9)	7																					
Heidelberg	6 (22.2)	4	1	1				2	1	2	2	1	1	1	2							1	
Reading	6 (22.2)	6																					
Anatum	1 (3.7)	1					1	1													1	1	
Cubana	1 (3.7)	1																					
Derby	1 (3.7)	1								1											1	1	
4,5,12:i:-	1 (3.7)	1								1	1											1	1
Meleagridis	1 (3.7)	1																					
Muenchen	1 (3.7)	1															1						1
Newport	1 (3.7)	1					1				1											1	1
Senftenberg	1 (3.7)	1					1	1															
Total	27 (100)	19	6	2				5	1	5	5	1	1	1	1	6						6	

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 14. Number of antimicrobial classes in resistance patterns of *Salmonella* from turkey (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															
		0	1	2-3	4-5	6-7	Aminoglycosides			β-Lactams					Folate pathway inhibitors		Macrolides	Phenicol	Quinolones		Tetracyclines
							GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Ontario																					
Heidelberg	14 (48.3)	6	6	2			2		2	7	6	6	5	6	2						1
Agona	3 (10.3)		1	2						2	2	2	2	2	2						2
Indiana	3 (10.3)				3				3	3	3	3	3	3	3			3			3
Hadar	2 (6.9)			2					2	1											2
Muenchen	2 (6.9)	1		1					1							1					1
Enteritidis	1 (3.4)	1																			
4,5,12:i:-	1 (3.4)				1				1	1						1					1
Saintpaul	1 (3.4)	1																			
Senftenberg	1 (3.4)			1			1			1											
Thompson	1 (3.4)	1																			
Total	29 (100)	10	7	8	4		3		9	15	11	11	10	11	9			3			10
Québec																					
Heidelberg	20 (34.5)	13	4	3			3		3	5	4	4	4	4	2						1
Schwarzengrund	12 (20.7)	3		9			4	4	7	1	1	1	1	1	9						9
Agona	9 (15.5)		5	4						3	3	3	3	3	4						7
Worthington	3 (5.2)	2		1			1		1						1						1
Albany	2 (3.4)		2							2	2	2	2	2							
Hadar	2 (3.4)			2					2												2
Muenster	2 (3.4)	2																			
Saintpaul	2 (3.4)	2																			
Less common serovars	6 (10.3)	2	2	2			1		2						2	1					2
Total	58 (100)	24	13	21			9	4	15	11	10	10	10	10	18	1					22
Maritimes																					
Heidelberg	5 (27.8)	3	2							2	2	2	2	2							
Hadar	3 (16.7)			3					3	1											3
Orion var. 15+ 34+	2 (11.1)			2			2		2	2											2
Panama	2 (11.1)	2																			
Agona	1 (5.6)			1			1		1						1						
Albany	1 (5.6)		1				1														
Rough:f,g,s:-	1 (5.6)		1							1	1	1	1	1							
Kentucky	1 (5.6)			1					1												1
Saintpaul	1 (5.6)	1																			
Typhimurium var. 5-	1 (5.6)				1				1	1					1			1			1
Total	18 (100)	6	4	7	1		4		8	7	3	3	3	3	2			1			7
TOTAL	97 (100)	43	23	30	1		15	4	25	25	19	19	18	19	22	1		1			30

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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".

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 15. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from turkey

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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	67 (18.9)	28	14	19	6		9	5	21	19	5	3	2	2	17	3		2			28
Saskatchewan	59 (16.6)	22	11	21	5		6	7	21	16	2	2	2	2	14	4				1	28
Ontario	119 (33.5)	32	31	40	16		13	15	36	30	4	3	4	3	37	11		3		1	78
Québec	107 (30.1)	30	18	48	11		16	11	38	34	6	7	6	6	42	10		3			69
TOTAL	352 (100)	112	74	128	38		44	38	116	99	17	15	14	13	110	28		8		4	203

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 16. Number of antimicrobial classes in resistance patterns of *Campylobacter* from turkey

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		Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET	
British Columbia																
Campylobacter jejuni	19 (67.9)	12	6	1										3	3	5
Campylobacter coli	7 (25.0)	1	1	5										5	5	6
Campylobacter spp.	2 (7.1)	1		1										1	1	1
Total	28 (100)	14	7	7										9	9	12
Saskatchewan																
Campylobacter jejuni	5 (100)	1	3	1										1	1	4
Total	5 (100)	1	3	1										1	1	4
Ontario																
Campylobacter jejuni	19 (70.4)	6	13													13
Campylobacter coli	7 (25.9)	2	4	1				1		1		1	1			4
Campylobacter spp.	1 (3.7)	1														1
Total	27 (100)	8	18	1				1		1		1	1			18
Québec																
Campylobacter jejuni	12 (75.0)	3	8	1										1	1	9
Campylobacter coli	4 (25.0)	3	1											1	1	
Total	16 (100)	6	9	1										2	2	9
TOTAL	29 (100)	8	14	7										8	8	20

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

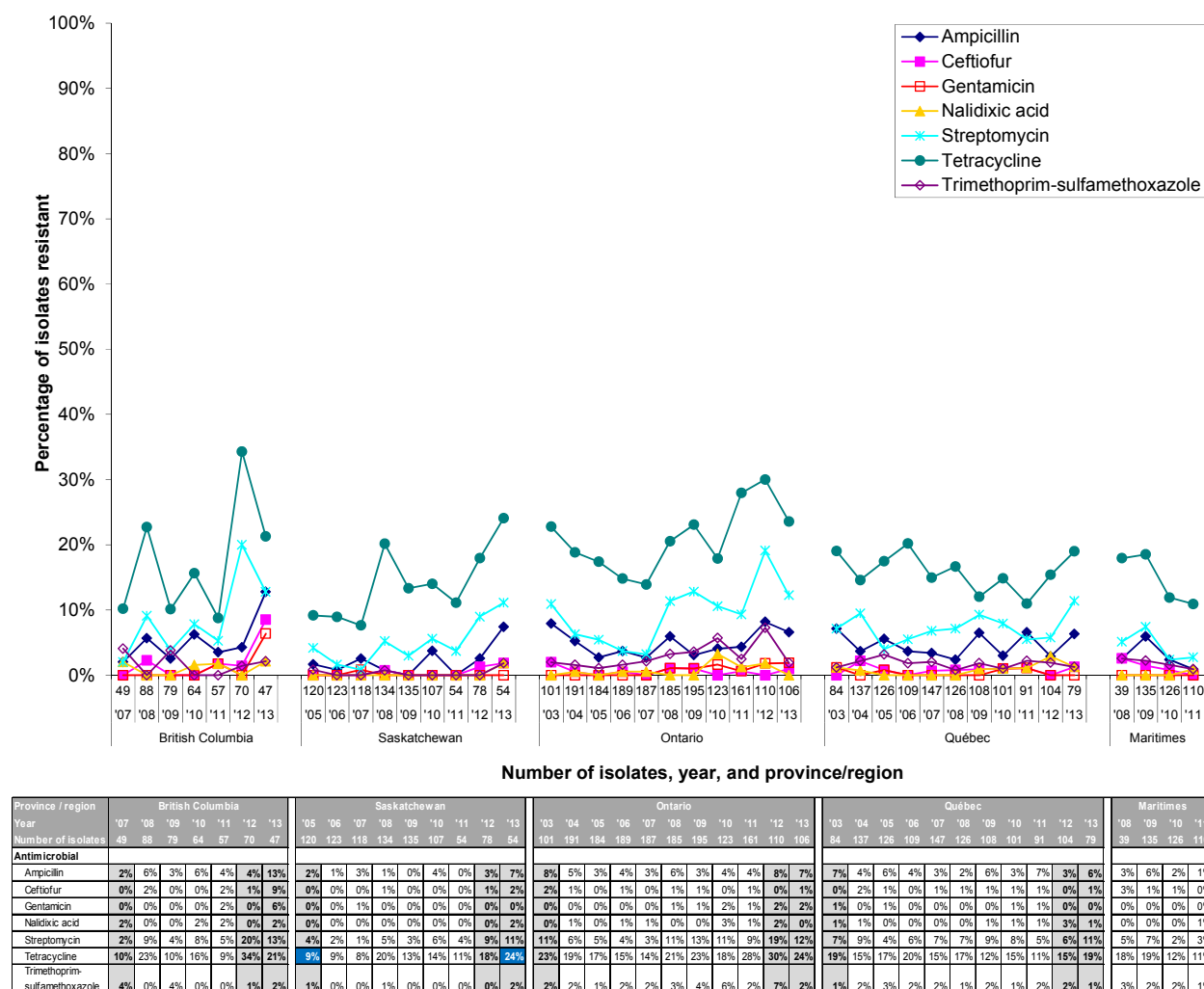
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.

Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

Figure 10. Temporal variations in resistance of *Escherichia coli* isolates from beef

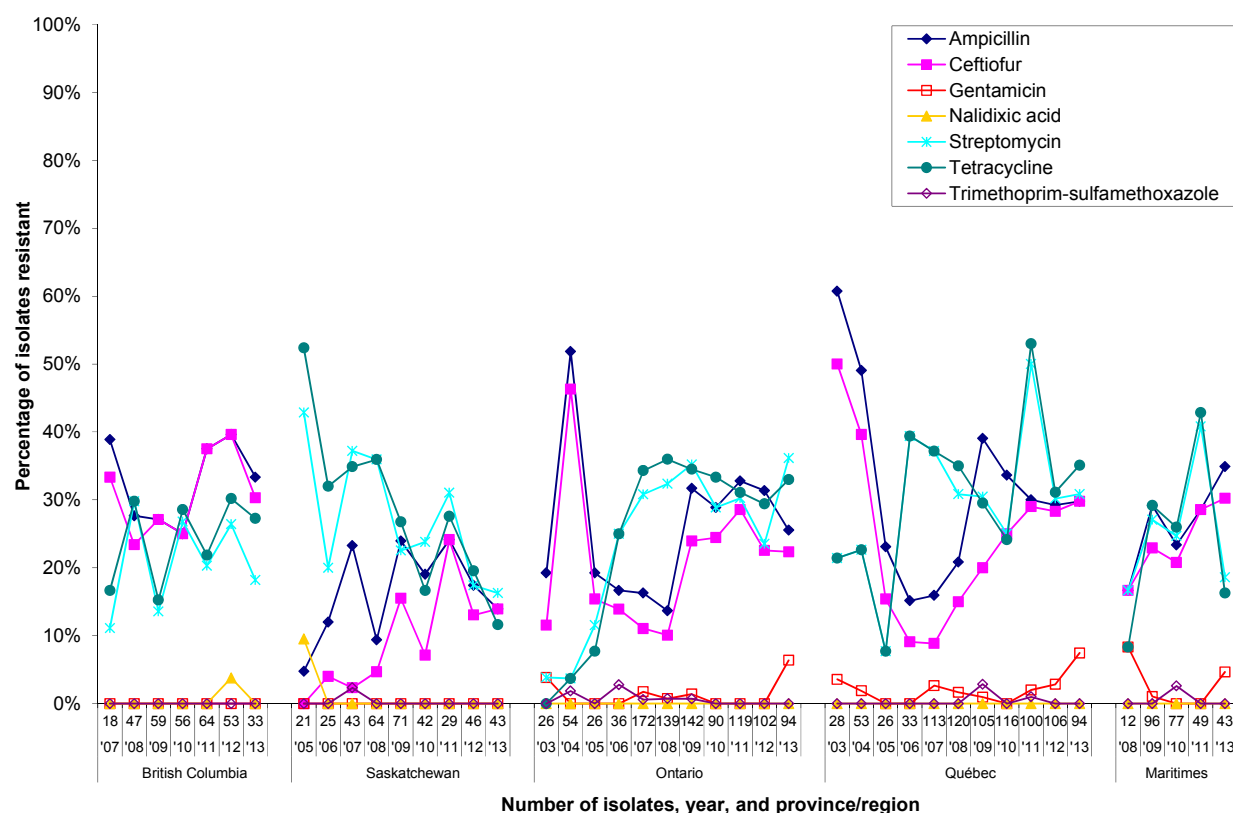


For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicates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

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

The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Figure 11. Temporal variations in resistance of *Salmonella* isolates from chicken

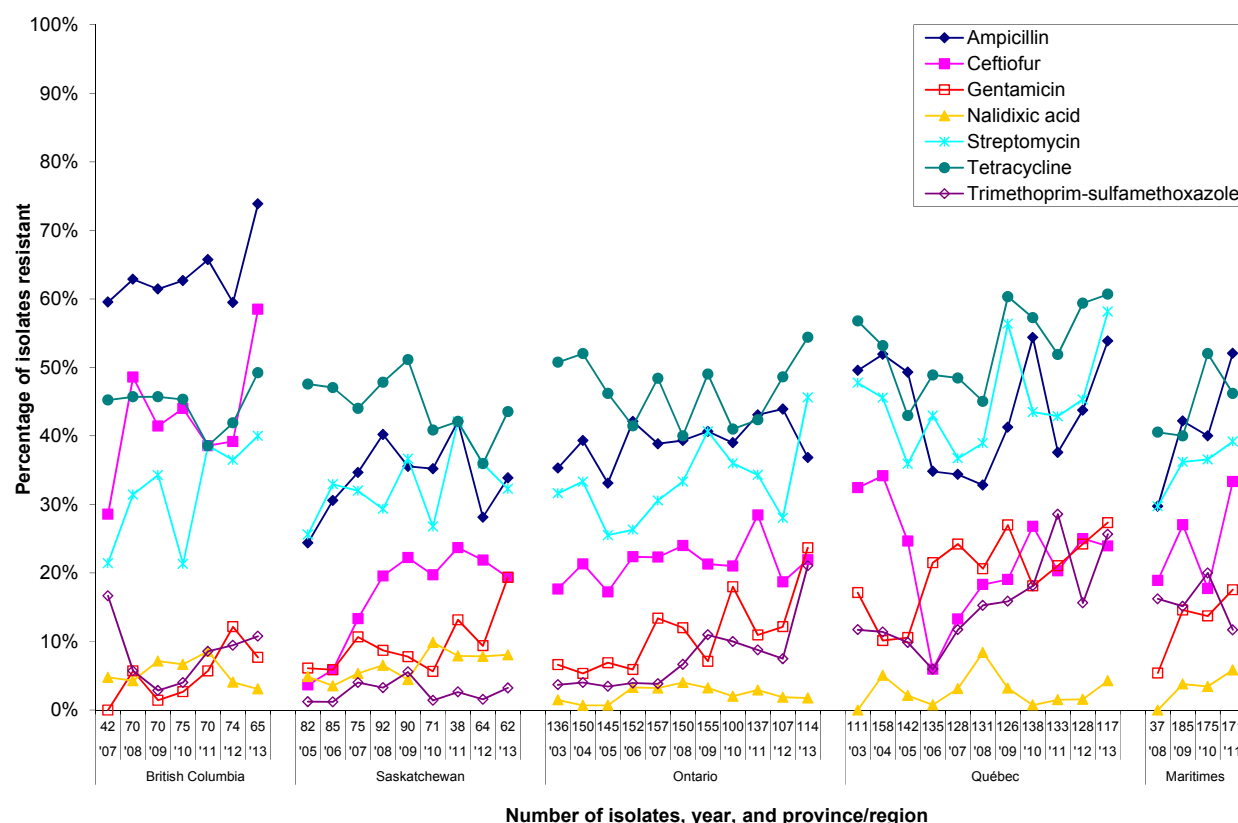
Province / region	British Columbia							Saskatchewan							Ontario													Québec													Maritimes				
Year	'07	'08	'09	'10	'11	'12	'13	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'08	'09	'10	'11	'13		
Number of isolates	18	47	59	56	64	53	33	21	25	43	64	71	42	29	46	43	26	54	26	36	172	139	142	90	119	102	94	28	53	26	33	113	120	105	116	100	106	94	12	96	77	49	43		
Antimicrobial																																													
Ampicillin	39%	28%	27%	25%	38%	40%	33%	5%	12%	23%	9%	24%	19%	24%	17%	14%	19%	52%	19%	17%	16%	14%	32%	29%	33%	31%	26%	61%	49%	23%	15%	16%	21%	39%	34%	30%	29%	30%	17%	29%	23%	29%	35%		
Ceftriaxone	33%	23%	27%	25%	38%	40%	30%	0%	4%	2%	5%	15%	7%	24%	13%	14%	12%	46%	15%	14%	11%	10%	24%	24%	29%	23%	22%	50%	40%	15%	9%	15%	20%	25%	29%	28%	30%	17%	23%	21%	29%	30%			
Gentamicin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	2%	1%	1%	0%	0%	0%	6%	4%	2%	0%	0%	3%	2%	1%	0%	2%	3%	7%	8%	1%	0%	0%	5%		
Nalidixic acid	0%	0%	0%	0%	0%	4%	0%	10%	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%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%		
Streptomycin	11%	30%	14%	27%	20%	26%	18%	43%	20%	37%	36%	23%	24%	31%	17%	16%	4%	4%	12%	25%	31%	32%	35%	29%	30%	24%	36%	21%	23%	8%	39%	37%	31%	30%	25%	50%	30%	31%	17%	27%	25%	41%	19%		
Tetracycline	17%	30%	15%	29%	22%	30%	27%	52%	32%	35%	36%	27%	17%	28%	20%	12%	0%	4%	8%	25%	34%	36%	35%	33%	31%	29%	33%	21%	23%	8%	39%	37%	35%	30%	24%	53%	31%	35%	8%	29%	26%	43%	16%		
Trimethoprim-sulfamethoxazole	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	2%	0%	3%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	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 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

Additional temporal analyses for ampicillin and ceftiofur were conducted for *Salmonella* isolates from Ontario and Québec. These two 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 Maritimes in 2012, data are not presented for this year in the interest of precision..

The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Figure 12. Temporal variations in resistance of *Escherichia coli* isolates from chicken

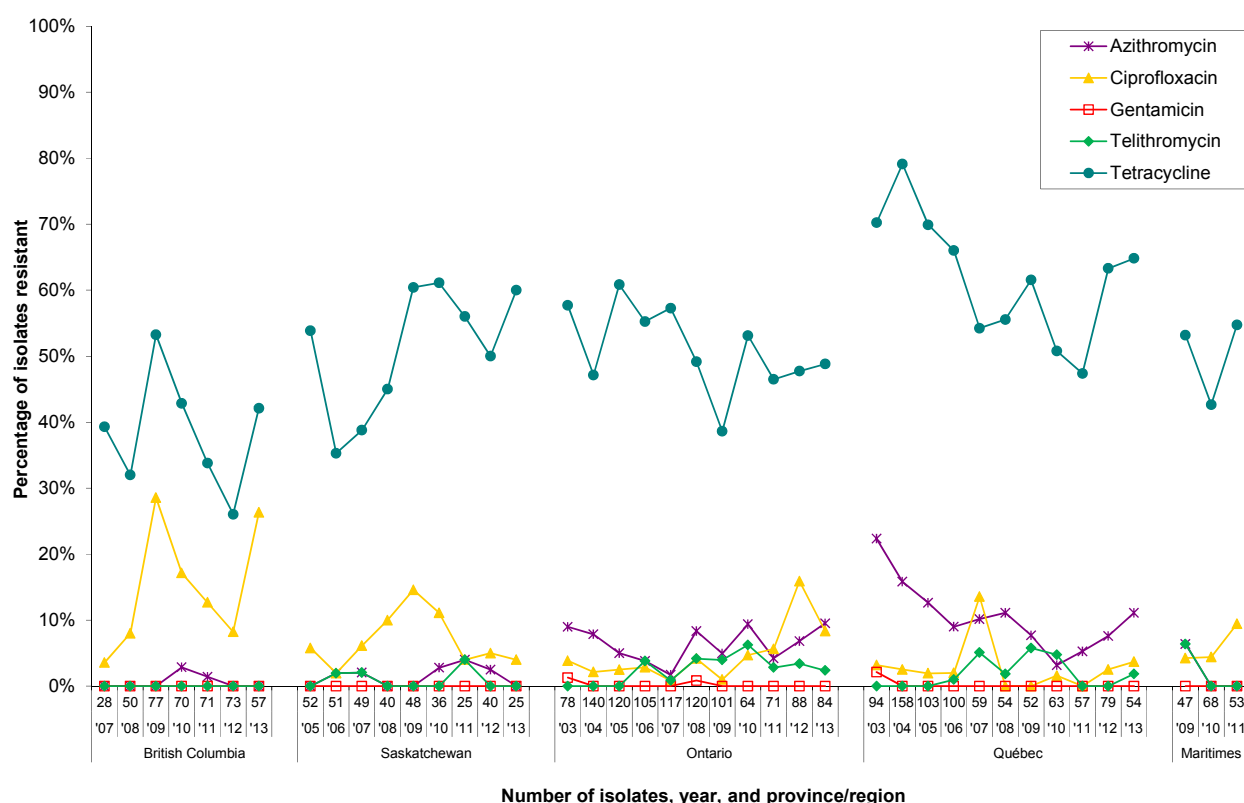
Province / region	British Columbia													Saskatchewan													Ontario													Québec													Maritimes				
Year	'07	'08	'09	'10	'11	'12	'13	'07	'08	'09	'10	'11	'12	'13	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'08	'09	'10	'11								
Number of isolates	42	70	70	75	70	74	65	82	85	75	92	90	71	38	64	62	136	150	145	152	157	150	155	100	137	107	114	111	158	142	135	128	131	126	138	133	128	117	37	185	175	171															
Antimicrobial																																																									
Ampicillin	60%	63%	61%	63%	66%	69%	74%	24%	31%	35%	40%	36%	35%	42%	28%	34%	35%	39%	33%	42%	39%	39%	41%	39%	43%	44%	37%	35%	39%	33%	42%	34%	33%	41%	54%	38%	44%	54%	30%	42%	40%	52%															
Ceftiofur	29%	49%	41%	44%	39%	39%	58%	4%	8%	13%	20%	22%	20%	24%	22%	19%	18%	21%	17%	22%	22%	24%	21%	21%	28%	19%	22%	32%	34%	25%	6%	13%	18%	19%	27%	20%	25%	24%	19%	27%	18%	33%															
Gentamicin	0%	6%	1%	3%	6%	12%	8%	6%	6%	11%	9%	8%	6%	13%	9%	10%	5%	4%	5%	7%	4%	10%	8%	8%	8%	7%	5%	7%	6%	13%	12%	7%	18%	11%	12%	24%	17%	10%	11%	21%	24%	21%	27%	18%	21%	24%	27%										
Nalidixic acid	5%	4%	7%	7%	9%	4%	3%	5%	4%	5%	7%	4%	10%	8%	8%	8%	1%	1%	1%	3%	3%	4%	3%	2%	3%	2%	2%	0%	5%	2%	1%	3%	6%	3%	1%	2%	2%	4%	0%	4%	3%	6%															
Streptomycin	21%	31%	34%	21%	39%	36%	40%	26%	33%	32%	29%	37%	27%	42%	36%	32%	32%	33%	26%	26%	31%	33%	41%	36%	34%	28%	46%	48%	46%	36%	43%	37%	39%	56%	43%	43%	45%	58%	30%	36%	37%	39%															
Tetracycline	45%	46%	46%	45%	39%	42%	49%	48%	47%	44%	48%	51%	41%	42%	36%	44%	51%	52%	46%	41%	48%	40%	49%	41%	42%	49%	54%	57%	53%	43%	49%	48%	45%	60%	57%	52%	58%	61%	41%	40%	52%	46%															
Trimethoprim-sulfamethoxazole	17%	6%	3%	4%	9%	9%	11%	1%	1%	4%	3%	6%	1%	3%	2%	3%	4%	4%	3%	4%	4%	7%	11%	10%	9%	7%	21%	12%	11%	10%	6%	12%	15%	16%	18%	29%	16%	26%	16%	15%	20%	12%															

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 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given province/region and antimicrobial.

Additional temporal analyses for ampicillin and ceftiofur were conducted for *E. coli* isolates from Ontario and Québec. These two 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 Maritimes in 2012, data are not presented for this year in the interest of precision.

The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island. At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Figure 13. Temporal variations in resistance of *Campylobacter* isolates from chicken

Province / region	British Columbia							Saskatchewan							Ontario										Québec										Maritimes											
Year	'07	'08	'09	'10	'11	'12	'13	'07	'08	'09	'10	'11	'12	'13	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'09	'10	'11
Number of isolates	28	50	77	70	71	73	57	52	51	49	40	48	36	25	40	25	78	140	120	105	117	120	101	64	71	88	84	94	158	103	100	59	54	52	63	57	79	54	47	68	53					
Antimicrobial																																														
Azithromycin	0%	0%	0%	3%	1%	0%	0%	0%	2%	2%	0%	0%	3%	4%	3%	0%	9%	8%	5%	4%	2%	8%	5%	9%	4%	7%	10%	22%	16%	13%	9%	10%	11%	8%	3%	5%	8%	11%	6%	0%	0%					
Ciprofloxacin	4%	8%	29%	17%	13%	8%	26%	6%	2%	6%	10%	15%	11%	4%	5%	4%	4%	2%	3%	3%	1%	4%	1%	5%	6%	16%	8%	3%	3%	2%	2%	14%	0%	0%	2%	0%	3%	4%	4%	4%	9%					
Gentamicin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	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%	0%	0%	2%	2%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	1%	4%	4%	6%	3%	3%	2%	0%	0%	0%	1%	5%	2%	6%	5%	0%	0%	2%	6%	0%	0%					
Tetracycline	39%	32%	53%	43%	34%	26%	42%	54%	35%	39%	45%	60%	61%	56%	50%	60%	58%	47%	61%	55%	57%	49%	39%	53%	46%	48%	49%	70%	79%	70%	66%	54%	56%	62%	51%	47%	63%	65%	53%	43%	55%					

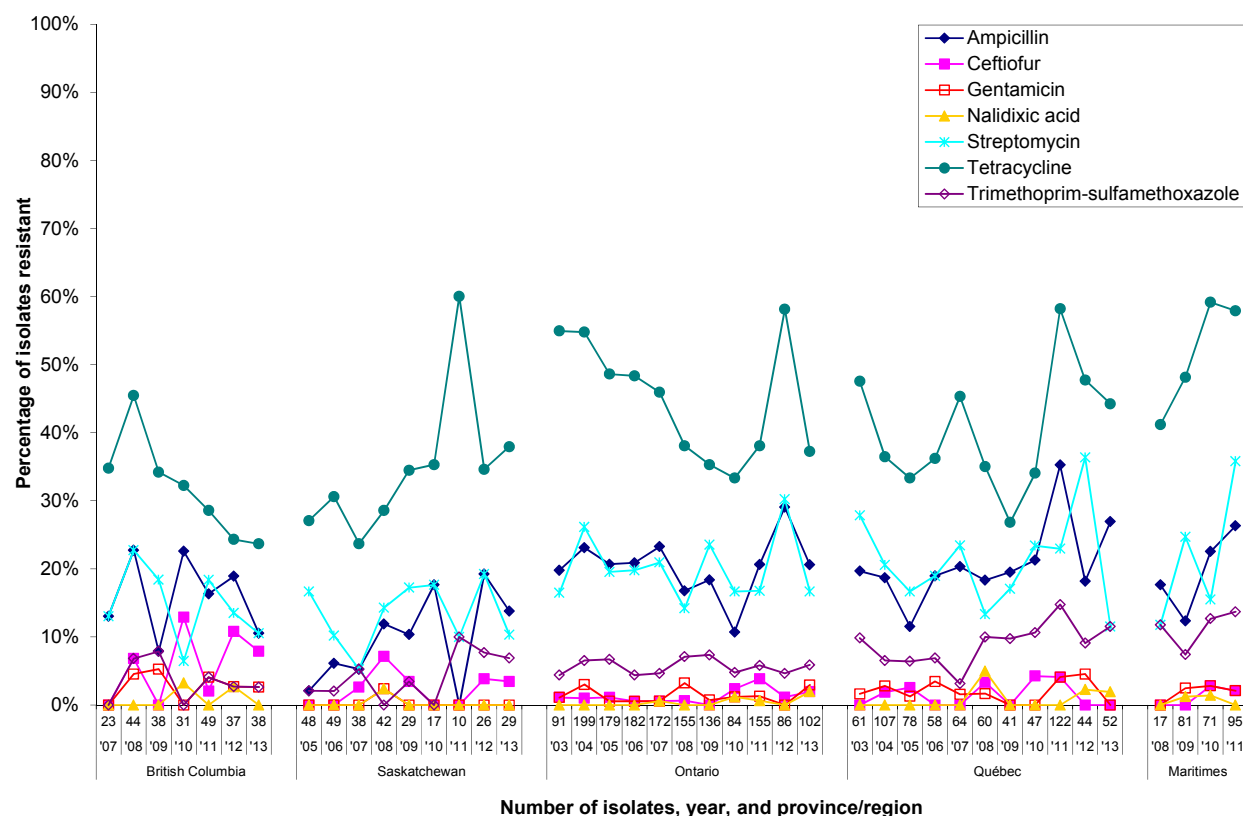
For the temporal analyses by province/region, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first and the previous surveillance year (grey areas). The presence 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 Maritimes in 2012, data are not presented for this year in the interest of precision. Data for this region will be presented again in 2013.

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

The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

At the time this chapter was published, with the exception of *Salmonella*, all data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Figure 14. Temporal variations in resistance of *Escherichia coli* isolates from pork

Province / region	British Columbia							Saskatchewan							Ontario										Québec										Maritimes														
Year	'07	'08	'09	'10	'11	'12	'13	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Number of isolates	23	44	38	31	49	37	38	48	49	38	42	29	17	10	26	29	91	199	179	182	172	155	136	84	155	86	102	61	107	78	58	64	60	41	47	122	44	52	17	81	71	95							
Antimicrobial																																																	
Ampicillin	13%	23%	8%	23%	16%	19%	11%	2%	6%	5%	12%	10%	18%	0%	19%	14%	20%	23%	21%	21%	23%	17%	18%	11%	21%	29%	21%	20%	19%	12%	19%	20%	18%	20%	21%	35%	18%	27%	18%	12%	23%	26%							
Ceftiofur	0%	7%	0%	13%	2%	11%	8%	0%	0%	3%	7%	3%	0%	0%	4%	3%	1%	1%	1%	1%	1%	0%	2%	4%	1%	2%	0%	2%	3%	0%	0%	3%	0%	4%	4%	0%	0%	0%	0%	3%	2%								
Gentamicin	0%	5%	5%	0%	4%	3%	3%	0%	0%	0%	2%	0%	0%	0%	0%	0%	1%	3%	1%	1%	3%	1%	1%	1%	0%	3%	2%	3%	1%	3%	2%	2%	0%	0%	4%	5%	0%	0%	2%	3%	2%								
Nalidixic acid	0%	0%	0%	3%	0%	3%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	1%	1%	1%	0%	2%	0%	0%	0%	0%	5%	0%	0%	0%	2%	2%	0%	1%	1%	0%								
Streptomycin	13%	23%	18%	6%	18%	14%	11%	17%	10%	5%	14%	17%	18%	10%	19%	10%	16%	26%	20%	20%	21%	14%	24%	17%	17%	30%	17%	28%	21%	17%	19%	23%	13%	17%	23%	23%	36%	12%	12%	25%	15%	36%							
Tetracycline	35%	45%	34%	32%	29%	24%	24%	27%	31%	24%	29%	34%	35%	60%	35%	38%	55%	55%	49%	48%	46%	38%	35%	33%	38%	58%	37%	48%	38%	33%	36%	45%	35%	27%	34%	58%	48%	44%	41%	48%	59%	58%							
Trimethoprim-sulfamethoxazole	0%	7%	8%	0%	4%	3%	3%	2%	2%	5%	0%	3%	0%	10%	8%	7%	4%	7%	4%	5%	7%	7%	5%	6%	5%	6%	10%	7%	6%	7%	3%	10%	10%	11%	15%	9%	12%	12%	7%	13%	14%								

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 and the previous surveillance year (grey areas). 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 Maritimes in 2012, data are not presented for this year in the interest of precision.

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MINIMUM INHIBITORY CONCENTRATIONS

Table 17. Distribution of minimum inhibitory concentrations among *Escherichia coli* from beef

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)																
			MIC 50	MIC 90	% R	≤ 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	British Columbia	47	4	8	6.4							4.3	6.4	72.3	10.6		4.3	2.1			
		Saskatchewan	54	4	8	3.7								18.5	66.7	11.1			3.7			
		Ontario	106	4	8	0.9							3.8	18.9	61.3	14.2	0.9		0.9			
		Québec	79	4	8	0.0							2.5	29.1	55.7	11.4	1.3					
	Ceftiofur	British Columbia	47	0.50	1	8.5			6.4	27.7	55.3	2.1				6.4	2.1					
		Saskatchewan	54	0.50	0.50	1.9			1.9	37.0	57.4	1.9				1.9						
		Ontario	106	0.50	0.50	0.9			7.5	20.8	68.9	1.9					0.9					
		Québec	79	0.50	0.50	1.3			5.1	44.3	48.1		1.3				1.3					
	Ceftriaxone	British Columbia	47	≤ 0.25	0.50	8.5				89.4	2.1					4.3	2.1	2.1				
		Saskatchewan	54	≤ 0.25	≤ 0.25	1.9				96.3		1.9					1.9					
		Ontario	106	≤ 0.25	≤ 0.25	0.9				99.1							0.9					
		Québec	79	≤ 0.25	≤ 0.25	1.3				98.7										1.3		
	Ciprofloxacin	British Columbia	47	≤ 0.015	≤ 0.015	0.0	97.9			2.1												
		Saskatchewan	54	≤ 0.015	≤ 0.015	0.0	90.7	7.4	1.9													
		Ontario	106	≤ 0.015	≤ 0.015	0.0	95.3	4.7														
		Québec	79	≤ 0.015	≤ 0.015	1.3	96.2	2.5								1.3						
II	Ampicillin	British Columbia	47	4	> 32	12.8							4.3	42.6	40.4				12.8			
		Saskatchewan	54	4	4	7.4							1.9	46.3	44.4			1.9	5.6			
		Ontario	106	4	4	6.6							15.1	33.0	44.3	0.9			6.6			
		Québec	79	2	8	6.3							8.9	41.8	39.2	3.8			6.3			
	Azithromycin	British Columbia	47	4	8	0.0								10.6	76.6	12.8						
		Saskatchewan	54	4	8	0.0								7.4	74.1	18.5						
		Ontario	106	4	8	0.0							0.9	19.8	68.9	10.4						
		Québec	79	4	8	1.3							2.5	21.5	60.8	12.7	1.3	1.3				
	Cefoxitin	British Columbia	47	4	8	6.4								27.7	51.1	14.9		2.1	4.3			
		Saskatchewan	54	4	8	1.9								14.8	64.8	16.7	1.9		1.9			
		Ontario	106	4	8	0.9							0.9	18.9	61.3	17.0	0.9		0.9			
		Québec	79	4	4	0.0							2.5	25.3	63.3	7.6	1.3					
	Gentamicin	British Columbia	47	0.50	1	6.4					70.2	21.3	2.1				2.1	4.3				
		Saskatchewan	54	0.50	1	0.0				1.9	50.0	44.4	1.9	1.9								
		Ontario	106	0.50	1	1.9				1.9	63.2	30.2	2.8				0.9	0.9				
		Québec	79	0.50	1	0.0					58.2	38.0	3.8									
III	Kanamycin	British Columbia	47	≤ 8	≤ 8	2.1										97.9			2.1			
		Saskatchewan	54	≤ 8	≤ 8	1.9										98.1			1.9			
		Ontario	106	≤ 8	≤ 8	0.0										98.1	1.9					
		Québec	79	≤ 8	≤ 8	1.3										98.7				1.3		
	Nalidixic acid	British Columbia	47	2	4	2.1							6.4	80.9	10.6				2.1			
		Saskatchewan	54	2	4	1.9							7.4	77.8	13.0			1.9				
		Ontario	106	2	4	0.0							13.2	73.6	13.2							
		Québec	79	2	4	1.3							10.1	78.5	7.6	2.5			1.3			
	Streptomycin	British Columbia	47	≤ 32	> 64	12.8											87.2	2.1	10.6			
		Saskatchewan	54	≤ 32	64	11.1											88.9	1.9	9.3			
		Ontario	106	≤ 32	64	12.3											87.7	4.7	7.5			
		Québec	79	≤ 32	64	11.4											88.6	5.1	6.3			
	Trimethoprim-sulfamethoxazole	British Columbia	47	≤ 0.12	≤ 0.12	2.1			91.5	6.4						2.1						
		Saskatchewan	54	≤ 0.12	≤ 0.12	1.9			96.3	1.9						1.9						
		Ontario	106	≤ 0.12	≤ 0.12	1.9			95.3	2.8						1.9						
		Québec	79	≤ 0.12	≤ 0.12	1.3			98.7							1.3						
IV	Chloramphenicol	British Columbia	47	8	8	2.1								29.8	68.1			2.1				
		Saskatchewan	54	8	8	1.9									38.9	51.9	7.4		1.9			
		Ontario	106	8	8	3.8							1.9	43.4	48.1	2.8		3.8				
		Québec	79	4	8	2.5							2.5	53.2	36.7	5.1		2.5				
	Sulfisoxazole	British Columbia	47	≤ 16	> 256	17.0										76.6	6.4			17.0		
		Saskatchewan	54	≤ 16	32	9.3										74.1	16.7			9.3		
		Ontario	106	≤ 16	> 256	12.3										67.9	19.8			12.3		
		Québec	79	≤ 16	32	8.9										74.7	16.5			8.9		
	Tetracycline	British Columbia	47	≤ 4	> 32	21.3								72.3	6.4			21.3				
		Saskatchewan	54	≤ 4	> 32	24.1								75.9			3.7	1.9	18.5			
		Ontario	106	≤ 4	> 32	23.6								76.4			1.9	3.8	17.9			
		Québec	79	≤ 4	> 32	19.0								78.5	2.5			19.0				

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Table 18. Distribution of minimum inhibitory concentrations among *Salmonella* from chicken

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)															
			MIC 50	MIC 90	% R	≤ 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	British Columbia	33	≤ 1	> 32	27.3							66.7		3.0	3.0		12.1	15.2		
		Saskatchewan an	43	≤ 1	> 32	14.0							83.7	2.3				14.0			
		Ontario	94	≤ 1	> 32	22.3							73.4	1.1		3.2		6.4	16.0		
		Québec	94	≤ 1	> 32	29.8							70.2					9.6	20.2		
		Maritimes	43	≤ 1	> 32	30.2							65.1				4.7	2.3	27.9		
	Ceftiofur	British Columbia	33	1	> 8	30.3					6.1	60.6			3.0	3.0		27.3			
		Saskatchewan an	43	1	> 8	14.0					20.9	65.1						14.0			
		Ontario	94	1	> 8	22.3					35.1	41.5	1.1					22.3			
		Québec	94	1	> 8	29.8				1.1	33.0	35.1	1.1					29.8			
		Maritimes	43	1	> 8	30.2					25.6	44.2						30.2			
Ceftriaxone	British Columbia	33	≤ 0.25	16	33.3					66.7				6.1	3.0	18.2	6.1				
	Saskatchewan an	43	≤ 0.25	8	14.0					86.0						4.7	4.7	2.3	2.3		
	Ontario	94	≤ 0.25	16	22.3					77.7						4.3	9.6	8.5			
	Québec	94	≤ 0.25	16	29.8					70.2						3.2	20.2	6.4			
	Maritimes	43	≤ 0.25	16	30.2					69.8							27.9	2.3			
Ciprofloxacin	British Columbia	33	≤ 0.015	0.03	0.0	78.8	21.2														
	Saskatchewan an	43	≤ 0.015	0.03	0.0	88.4	11.6														
	Ontario	94	≤ 0.015	≤ 0.015	0.0	90.4	9.6														
	Québec	94	≤ 0.015	0.03	0.0	87.2	12.8														
	Maritimes	43	≤ 0.015	≤ 0.015	0.0	100.0															
II	Ampicillin	British Columbia	33	≤ 1	> 32	33.3						60.6	6.1						33.3		
		Saskatchewan an	43	≤ 1	> 32	14.0						79.1	7.0					14.0			
		Ontario	94	≤ 1	> 32	25.5						70.2	4.3					25.5			
		Québec	94	≤ 1	> 32	29.8						68.1	2.1					29.8			
		Maritimes	43	≤ 1	> 32	34.9						62.8	2.3					34.9			
	Azithromycin	British Columbia	33	4	4	0.0						15.2	81.8	3.0							
		Saskatchewan an	43	4	8	0.0						4.7	79.1	16.3							
		Ontario	94	4	8	0.0						12.8	73.4	12.8	1.1						
		Québec	94	4	4	0.0					1.1	12.8	80.9	5.3							
		Maritimes	43	4	8	0.0						2.3	83.7	11.6	2.3						
	Cefoxitin	British Columbia	33	2	32	24.2						12.1	51.5	9.1		3.0	18.2	6.1			
		Saskatchewan an	43	2	32	14.0						11.6	65.1	9.3			7.0	7.0			
		Ontario	94	2	32	21.3						27.7	44.7	4.3	1.1	1.1	14.9	6.4			
		Québec	94	2	32	29.8						25.5	36.2	7.4	1.1		23.4	6.4			
		Maritimes	43	2	32	30.2						32.6	30.2	7.0			23.3	7.0			
	Gentamicin	British Columbia	33	0.50	1	0.0				27.3	60.6	6.1	3.0	3.0							
		Saskatchewan an	43	0.50	0.50	0.0				37.2	53.5	4.7	4.7								
		Ontario	94	0.50	1	6.4				29.8	57.4	6.4				1.1	5.3				
		Québec	94	0.50	1	7.4				25.5	56.4	8.5	1.1		1.1	2.1	5.3				
		Maritimes	43	0.50	1	4.7				4.7	76.7	14.0					4.7				
Kanamycin	British Columbia	33	≤ 8	≤ 8	0.0									100.0							
	Saskatchewan an	43	≤ 8	≤ 8	2.3									97.7				2.3			
	Ontario	94	≤ 8	≤ 8	2.1									95.7	2.1		1.1	1.1			
	Québec	94	≤ 8	≤ 8	1.1									98.9				1.1			
	Maritimes	43	≤ 8	≤ 8	0.0									100.0							
Nalidixic acid	British Columbia	33	4	8	0.0						27.3	57.6	15.2								
	Saskatchewan an	43	4	4	0.0						23.3	74.4	2.3								
	Ontario	94	4	4	0.0						1.1	36.2	60.6	2.1							
	Québec	94	4	4	0.0						1.1	41.5	56.4	1.1							
	Maritimes	43	4	4	0.0						25.6	72.1	2.3								
Streptomycin	British Columbia	33	≤ 32	> 64	18.2										81.8	3.0	15.2				
	Saskatchewan an	43	≤ 32	64	16.3										83.7	7.0	9.3				
	Ontario	94	≤ 32	> 64	36.2										63.8	17.0	19.1				
	Québec	94	≤ 32	> 64	30.9										69.1	11.7	19.1				
	Maritimes	43	≤ 32	64	18.6										81.4	16.3	2.3				
Trimethoprim-sulfamethoxazole	British Columbia	33	≤ 0.12	≤ 0.12	0.0				100.0												
	Saskatchewan an	43	≤ 0.12	≤ 0.12	0.0				100.0												
	Ontario	94	≤ 0.12	≤ 0.12	0.0				94.7	5.3											
	Québec	94	≤ 0.12	≤ 0.12	0.0				96.8	3.2											
	Maritimes	43	≤ 0.12	≤ 0.12	0.0				100.0												
III	Chloramphenicol	British Columbia	33	8	8	0.0								39.4	60.6						
		Saskatchewan an	43	8	8	0.0									30.2	69.8					
		Ontario	94	8	8	1.1						3.2	31.9	61.7	2.1		1.1				
		Québec	94	8	8	3.2						3.2	39.4	54.3			3.2				
		Maritimes	43	8	8	0.0								30.2	69.8						
	Sulfisoxazole	British Columbia	33	32	64	3.0										15.2	60.6	21.2			3.0
		Saskatchewan an	43	32	64	0.0										14.0	72.1	14.0			
		Ontario	94	32	> 256	13.8										26.6	54.3	5.3			13.8
		Québec	94	32	64	9.6										28.7	53.2	8.5			9.6
		Maritimes	43	32	64	7.0										30.2	55.8	7.0			7.0
Tetracycline	British Columbia	33	≤ 4	> 32	27.3								72.7				27.3				
	Saskatchewan an	43	≤ 4	> 32	11.6								88.4				11.6				
	Ontario	94	≤ 4	> 32	33.0								67.0			1.1	31.9				
	Québec	94	≤ 4	> 32	35.1								64.9				35.1				
	Maritimes	43	≤ 4	> 32	16.3								83.7				16.3				
IV																					

The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

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Table 19. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chicken

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)																
			MIC 50	MIC 90	% R	≤ 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	British Columbia	65	32	> 32	61.5										7.7	21.5	9.2			30.8	30.8
		Saskatchewan	62	4	> 32	21.0							3.2	12.9	41.9	19.4	1.6		8.1	12.9		
		Ontario	114	4	> 32	23.7							1.8	21.1	33.3	17.5	2.6		8.8	14.9		
		Québec	117	8	> 32	24.8								11.1	35.0	25.6	3.4		8.5	16.2		
	Ceftiofur	British Columbia	65	8	> 8	58.5				6.2	24.6	9.2			1.5		23.1	35.4				
		Saskatchewan	62	0.50	8	19.4				22.6	53.2	3.2			1.6		14.5	4.8				
		Ontario	114	0.50	8	21.9				1.8	21.1	50.9	2.6		1.8		13.2	8.8				
		Québec	117	0.50	8	23.9				0.9	20.5	50.4	3.4		0.9		16.2	7.7				
	Ceftriaxone	British Columbia	65	8	16	60.0				33.8	1.5	3.1	1.5				13.8	36.9	7.7	1.5		
		Saskatchewan	62	≤ 0.25	16	21.0				79.0							4.8	14.5	1.6			
		Ontario	114	≤ 0.25	16	23.7				76.3							6.1	14.9	2.6			
		Québec	117	≤ 0.25	16	24.8				75.2							5.1	17.1	2.6			
	Ciprofloxacin	British Columbia	65	≤ 0.015	≤ 0.015	0.0	92.3	4.6			3.1											
		Saskatchewan	62	≤ 0.015	0.03	0.0	85.5	6.5		3.2	4.8											
		Ontario	114	≤ 0.015	≤ 0.015	0.0	95.6	2.6			1.8											
		Québec	117	≤ 0.015	0.03	0.9	89.7	4.3	1.7		3.4		0.9									
II	Ampicillin	British Columbia	65	> 32	> 32	73.8								10.8	15.4						73.8	
		Saskatchewan	62	4	> 32	33.9							6.5	33.9	25.8						33.9	
		Ontario	114	4	> 32	36.8							6.1	24.6	28.1	4.4					36.8	
		Québec	117	> 32	> 32	53.8							3.4	23.9	18.8						53.8	
	Azithromycin	British Columbia	65	4	4	0.0								21.5	70.8	7.7						
		Saskatchewan	62	4	8	0.0								19.4	69.4	11.3						
		Ontario	114	4	8	0.0							0.9	17.5	68.4	13.2						
		Québec	117	4	8	0.9							2.6	18.8	64.1	13.7			0.9			
	Cefoxitin	British Columbia	65	> 32	> 32	61.5								3.1	24.6	10.8			6.2	55.4		
		Saskatchewan	62	4	> 32	19.4								12.9	43.5	21.0	3.2		3.2	16.1		
		Ontario	114	4	> 32	23.7								9.6	48.2	18.4			5.3	18.4		
		Québec	117	4	> 32	24.8							0.9	6.8	48.7	17.1	1.7		4.3	20.5		
	Gentamicin	British Columbia	65	1	8	7.7					40.0	44.6		3.1	4.6				7.7			
		Saskatchewan	62	1	> 16	19.4					1.6	33.9	41.9	1.6		1.6		1.6	17.7			
		Ontario	114	1	> 16	23.7						43.0	31.6	0.9		0.9		7.0	16.7			
		Québec	117	1	> 16	27.4					0.9	35.0	33.3	0.9		2.6		5.1	22.2			
Kanamycin	British Columbia	65	≤ 8	≤ 8	4.6											93.8		1.5			4.6	
	Saskatchewan	62	≤ 8	16	6.5											88.7	4.8				6.5	
	Ontario	114	≤ 8	64	11.4											85.1	3.5		1.8		9.6	
	Québec	117	≤ 8	> 64	14.5											81.2	2.6	1.7			14.5	
Nalidixic acid	British Columbia	65	2	4	3.1							9.2	72.3	15.4						3.1		
	Saskatchewan	62	2	4	8.1							4.8	75.8	11.3				1.6	6.5			
	Ontario	114	2	4	1.8							7.0	77.2	14.0					1.8			
	Québec	117	2	4	4.3							0.9	8.5	70.9	15.4				4.3			
Streptomycin	British Columbia	65	≤ 32	> 64	40.0													60.0	10.8	29.2		
	Saskatchewan	62	≤ 32	> 64	32.3													67.7	9.7	22.6		
	Ontario	114	≤ 32	> 64	45.6													54.4	18.4	27.2		
	Québec	117	64	> 64	58.1													41.9	14.5	43.6		
Trimethoprim-sulfamethoxazole	British Columbia	65	≤ 0.12	> 4	10.8				78.5	7.7	1.5	1.5				10.8						
	Saskatchewan	62	≤ 0.12	0.25	3.2				83.9	6.5	3.2	1.6	1.6			3.2						
	Ontario	114	≤ 0.12	> 4	21.1				65.8	9.6	3.5					21.1						
	Québec	117	≤ 0.12	> 4	25.6				60.7	7.7	6.0					25.6						
III	Chloramphenicol	British Columbia	65	8	> 32	10.8								1.5	24.6	60.0	3.1			10.8		
		Saskatchewan	62	8	8	6.5								3.2	37.1	51.6	1.6			6.5		
		Ontario	114	8	16	6.1								2.6	36.8	49.1	5.3			6.1		
		Québec	117	8	8	6.8								2.6	32.5	56.4	1.7			6.8		
	Sulfisoxazole	British Columbia	65	32	> 256	36.9												47.7	15.4			36.9
		Saskatchewan	62	32	> 256	30.6												48.4	19.4	1.6		30.6
		Ontario	114	> 256	> 256	50.9												35.1	13.2	0.9		50.9
		Québec	117	> 256	> 256	60.7												29.9	9.4			60.7
	Tetracycline	British Columbia	65	≤ 4	> 32	49.2									50.8				4.6	44.6		
		Saskatchewan	62	≤ 4	> 32	43.5									56.5				1.6	41.9		
		Ontario	114	> 32	> 32	54.4									45.6				4.4	50.0		
		Québec	117	> 32	> 32	60.7									39.3				6.0	54.7		
	IV																					

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Table 20. Distribution of minimum inhibitory concentrations among *Campylobacter* from chicken

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
I	Oprofloxacin	<i>Campylobacter coli</i>	British Columbia	2	16	16	50.0				50.0							50.0			
	Oprofloxacin	<i>Campylobacter coli</i>	Saskatchewan	3	0.125	0.125	0.0			33.3	66.7										
	Oprofloxacin	<i>Campylobacter coli</i>	Ontario	7	0.125	16	14.3			42.9	14.3	28.6									
	Oprofloxacin	<i>Campylobacter coli</i>	Québec	3	0.25	16	33.3				33.3	33.3									
	Oprofloxacin	<i>Campylobacter jejuni</i>	British Columbia	50	0.125	0.125	6.0			32.0	60.0	2.0									
	Oprofloxacin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.125	0.125	6.7			43.3	50.0										
	Oprofloxacin	<i>Campylobacter jejuni</i>	Ontario	52	0.125	0.25	5.8			32.7	46.2	15.4					6.7				
	Oprofloxacin	<i>Campylobacter jejuni</i>	Québec	51	0.125	0.25	2.0			29.4	41.2	27.5					1.9	3.8			
	Oprofloxacin	<i>Campylobacter spp.</i>	British Columbia	21	0.064	0.25	9.5			52.4	28.6	9.5					2.0				
	Oprofloxacin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.125	0.25	0.0			42.9	42.9	14.3					4.8	4.8			
	Oprofloxacin	<i>Campylobacter spp.</i>	Ontario	28	0.125	16	35.7			25.0	32.1	7.1									
	Oprofloxacin	<i>Campylobacter spp.</i>	Québec	24	0.125	0.25	0.0			29.2	58.3	12.5					10.7	7.1	17.9		
	Telithromycin	<i>Campylobacter coli</i>	British Columbia	2	1	1	0.0				50.0			50.0							
	Telithromycin	<i>Campylobacter coli</i>	Saskatchewan	3	2	2	0.0							33.3	66.7						
	Telithromycin	<i>Campylobacter coli</i>	Ontario	7	2	16	14.3				28.6	14.3					28.6				
	Telithromycin	<i>Campylobacter coli</i>	Québec	3	2	4	0.0										66.7	33.3			
	Telithromycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.5	1	0.0				8.0	72.0	20.0								
	Telithromycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.5	1	0.0				23.3	43.3	26.7	3.3							
	Telithromycin	<i>Campylobacter jejuni</i>	Ontario	52	0.5	2	3.8				15.4	44.2	25.0	11.5							
	Telithromycin	<i>Campylobacter jejuni</i>	Québec	51	0.5	2	0.0				7.8	43.1	25.5	15.7	5.9						
II	Telithromycin	<i>Campylobacter spp.</i>	British Columbia	21	0.5	1	0.0				28.6	42.9	19.0	9.5							
	Telithromycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.5	2	0.0				28.6	42.9	14.3	14.3							
	Telithromycin	<i>Campylobacter spp.</i>	Ontario	28	0.5	2	0.0				14.3	39.3	32.1	7.1	3.6						
	Telithromycin	<i>Campylobacter spp.</i>	Québec	24	1	4	0.0				16.7	25.0	37.5	8.3	4.2						
	Azithromycin	<i>Campylobacter coli</i>	British Columbia	2	0.064	0.064	0.0		50.0	50.0											
	Azithromycin	<i>Campylobacter coli</i>	Saskatchewan	3	0.125	0.125	0.0				33.3	66.7									
	Azithromycin	<i>Campylobacter coli</i>	Ontario	7	0.064	> 64	14.3				57.1	28.6									
	Azithromycin	<i>Campylobacter coli</i>	Québec	3	0.125	0.125	0.0					100.0									
	Azithromycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.064	0.064	0.0			34.0	64.0	2.0									
	Azithromycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.064	0.125	3.3	3.3	30.0	56.7	6.7										
	Azithromycin	<i>Campylobacter jejuni</i>	Ontario	52	0.064	0.064	3.8			38.5	55.8	1.9									
	Azithromycin	<i>Campylobacter jejuni</i>	Québec	51	0.064	0.125	5.9	3.9	39.2	39.2	11.8										
	Azithromycin	<i>Campylobacter spp.</i>	British Columbia	21	0.032	0.064	0.0	9.5	47.6	38.1	4.8										
	Azithromycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.032	0.064	0.0			57.1	42.9										
	Azithromycin	<i>Campylobacter spp.</i>	Ontario	28	0.032	0.5	7.1	7.1	50.0	17.9	14.3		3.6								
	Azithromycin	<i>Campylobacter spp.</i>	Québec	24	0.064	> 64	12.5		29.2	58.3											
	Clindamycin	<i>Campylobacter coli</i>	British Columbia	2	0.5	0.5	0.0					50.0	50.0								
	Clindamycin	<i>Campylobacter coli</i>	Saskatchewan	3	0.25	0.5	0.0					66.7	33.3								
	Clindamycin	<i>Campylobacter coli</i>	Ontario	7	0.25	16	28.6					57.1	14.3								
	Clindamycin	<i>Campylobacter jejuni</i>	Québec	3	1	8	33.3						33.3	33.3							
	Clindamycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.125	0.25	0.0			6.0	58.0	34.0	2.0								
	Clindamycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.125	0.25	0.0			3.3	70.0	23.3									
	Clindamycin	<i>Campylobacter jejuni</i>	Ontario	52	0.125	0.25	0.0			7.7	50.0	36.5	1.9								
	Clindamycin	<i>Campylobacter jejuni</i>	Québec	51	0.125	0.5	0.0			2.0	64.7	19.6	7.8								
	Clindamycin	<i>Campylobacter spp.</i>	British Columbia	21	0.125	0.25	0.0			9.5	47.6	33.3	4.8	4.8							
	Clindamycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.25	0.5	0.0				28.6	57.1	14.3								
	Clindamycin	<i>Campylobacter spp.</i>	Ontario	28	0.125	0.5	7.1			21.4	39.3	28.6	3.6								
	Clindamycin	<i>Campylobacter spp.</i>	Québec	24	0.125	4	4.2			12.5	45.8	25.0	4.2								
	Erythromycin	<i>Campylobacter coli</i>	British Columbia	2	1	1	0.0					50.0		50.0							
	Erythromycin	<i>Campylobacter coli</i>	Saskatchewan	3	1	2	0.0					33.3		33.3	33.3						
	Erythromycin	<i>Campylobacter coli</i>	Ontario	7	1	> 64	14.3					28.6	14.3	14.3	28.6						
	Erythromycin	<i>Campylobacter coli</i>	Québec	3	2	2	0.0														
	Erythromycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.25	0.5	0.0					76.0	24.0								
	Erythromycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.25	0.5	3.3			3.3	76.7	13.3	3.3								
	Erythromycin	<i>Campylobacter jejuni</i>	Ontario	52	0.25	0.5	3.8			5.8	53.8	32.7	3.8								
	Erythromycin	<i>Campylobacter jejuni</i>	Québec	51	0.5	1	5.9				49.0	33.3	7.8	3.9							
	Erythromycin	<i>Campylobacter spp.</i>	British Columbia	21	0.25	0.5	0.0			4.8	81.0	9.5									
	Erythromycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.25	0.5	0.0			14.3	57.1	28.6									
	Erythromycin	<i>Campylobacter spp.</i>	Ontario	28	0.25	1	7.1			7.1	50.0	25.0	10.7								
	Erythromycin	<i>Campylobacter spp.</i>	Québec	24	0.5	> 64	12.5			4.2	29.2	41.7	12.5								

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Table 20. Distribution of minimum inhibitory concentrations among *Campylobacter* from chicken (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
I	Gentamicin	<i>Campylobacter coli</i>	British Columbia	2	0.5	0.5	0.0					100.0								
	Gentamicin	<i>Campylobacter coli</i>	Saskatchewan	3	1	1	0.0						100.0							
	Gentamicin	<i>Campylobacter coli</i>	Ontario	7	1	1	0.0					42.9	57.1							
	Gentamicin	<i>Campylobacter coli</i>	Québec	3	1	2	0.0						66.7	33.3						
	Gentamicin	<i>Campylobacter jejuni</i>	British Columbia	50	1	1	0.0					40.0	60.0							
	Gentamicin	<i>Campylobacter jejuni</i>	Saskatchewan	30	1	1	0.0					23.3	76.7							
	Gentamicin	<i>Campylobacter jejuni</i>	Ontario	52	1	1	0.0					48.1	51.9							
	Gentamicin	<i>Campylobacter jejuni</i>	Québec	51	0.5	1	0.0			2.0		54.9	43.1							
	Gentamicin	<i>Campylobacter</i> spp.	British Columbia	21	0.5	1	0.0					71.4	28.6							
	Gentamicin	<i>Campylobacter</i> spp.	Saskatchewan	7	1	1	0.0					42.9	57.1							
	Gentamicin	<i>Campylobacter</i> spp.	Ontario	28	0.5	1	0.0					57.1	39.3	3.6						
	Gentamicin	<i>Campylobacter</i> spp.	Québec	24	0.5	1	0.0					58.3	41.7							
II	Nalidixic acid	<i>Campylobacter coli</i>	British Columbia	2	> 64	> 64	50.0									50.0				50.0
	Nalidixic acid	<i>Campylobacter coli</i>	Saskatchewan	3	8	16	0.0								33.3	33.3	33.3			
	Nalidixic acid	<i>Campylobacter coli</i>	Ontario	7	8	> 64	14.3								42.9	14.3	28.6			14.3
	Nalidixic acid	<i>Campylobacter coli</i>	Québec	3	8	> 64	33.3								33.3	33.3				33.3
	Nalidixic acid	<i>Campylobacter jejuni</i>	British Columbia	50	≤ 4	8	6.0								62.0	32.0				6.0
	Nalidixic acid	<i>Campylobacter jejuni</i>	Saskatchewan	30	≤ 4	8	6.7								80.0	13.3				6.7
	Nalidixic acid	<i>Campylobacter jejuni</i>	Ontario	52	≤ 4	8	5.8								67.3	26.9				5.8
	Nalidixic acid	<i>Campylobacter jejuni</i>	Québec	51	8	8	2.0								45.1	52.9				2.0
	Nalidixic acid	<i>Campylobacter</i> spp.	British Columbia	21	≤ 4	16	9.5								57.1	28.6	4.8		4.8	4.8
	Nalidixic acid	<i>Campylobacter</i> spp.	Saskatchewan	7	≤ 4	8	0.0								57.1	42.9				
	Nalidixic acid	<i>Campylobacter</i> spp.	Ontario	28	8	> 64	35.7								46.4	17.9			3.6	32.1
	Nalidixic acid	<i>Campylobacter</i> spp.	Québec	24	≤ 4	8	0.0								83.3	16.7				
III	Florfenicol	<i>Campylobacter coli</i>	British Columbia	2	2	2	0.0					50.0	50.0							
	Florfenicol	<i>Campylobacter coli</i>	Saskatchewan	3	1	1	0.0					100.0								
	Florfenicol	<i>Campylobacter coli</i>	Ontario	7	1	2	0.0					71.4	28.6							
	Florfenicol	<i>Campylobacter coli</i>	Québec	3	1	2	0.0					33.3	33.3	33.3						
	Florfenicol	<i>Campylobacter jejuni</i>	British Columbia	50	1	1	0.0			2.0		10.0	88.0							
	Florfenicol	<i>Campylobacter jejuni</i>	Saskatchewan	30	1	1	0.0					16.7	83.3							
	Florfenicol	<i>Campylobacter jejuni</i>	Ontario	52	1	1	0.0					9.6	86.5	3.8						
	Florfenicol	<i>Campylobacter jejuni</i>	Québec	51	1	2	0.0					7.8	76.5	15.7						
	Florfenicol	<i>Campylobacter</i> spp.	British Columbia	21	1	1	0.0						90.5	9.5						
	Florfenicol	<i>Campylobacter</i> spp.	Saskatchewan	7	1	2	0.0					14.3	71.4	14.3						
	Florfenicol	<i>Campylobacter</i> spp.	Ontario	28	1	1	0.0					3.6	96.4							
	Florfenicol	<i>Campylobacter</i> spp.	Québec	24	1	2	0.0					12.5	75.0	12.5						
IV	Tetracycline	<i>Campylobacter coli</i>	British Columbia	2	1	1	0.0					50.0	50.0							
	Tetracycline	<i>Campylobacter coli</i>	Saskatchewan	3	0.5	> 64	33.3			33.3		33.3								33.3
	Tetracycline	<i>Campylobacter coli</i>	Ontario	7	0.5	> 64	42.9			42.9		14.3							14.3	28.6
	Tetracycline	<i>Campylobacter coli</i>	Québec	3	8	> 64	33.3						33.3			33.3				33.3
	Tetracycline	<i>Campylobacter jejuni</i>	British Columbia	50	0.25	64	26.0			18.0	50.0	4.0	2.0					2.0	16.0	8.0
	Tetracycline	<i>Campylobacter jejuni</i>	Saskatchewan	30	32	> 64	53.3			20.0	26.7							6.7	20.0	26.7
	Tetracycline	<i>Campylobacter jejuni</i>	Ontario	52	0.5	> 64	46.2			21.2	21.2	9.6	1.9					15.4	30.8	
	Tetracycline	<i>Campylobacter jejuni</i>	Québec	51	64	> 64	66.7			9.8	9.8	5.9	5.9		2.0			29.4	37.3	
	Tetracycline	<i>Campylobacter</i> spp.	British Columbia	21	0.25	64	28.6			19.0	38.1	4.8	9.5					4.8	19.0	4.8
	Tetracycline	<i>Campylobacter</i> spp.	Saskatchewan	7	0.5	> 64	42.9			42.9		14.3							28.6	14.3
	Tetracycline	<i>Campylobacter</i> spp.	Ontario	28	32	> 64	53.6			14.3	21.4	7.1	3.6					17.9	14.3	21.4
	Tetracycline	<i>Campylobacter</i> spp.	Québec	24	64	> 64	58.3			12.5	25.0	4.2						12.5		45.8

Table 21. Distribution of minimum inhibitory concentrations among *Escherichia coli* from pork

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)																
			MIC 50	MIC 90	% R	≤ 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	British Columbia	38	4	8	7.9								18.4	55.3	18.4		2.6	5.3			
		Saskatchewan	29	4	8	3.4						3.4	6.9	65.5	20.7			3.4				
		Ontario	102	4	8	2.9						2.0	21.6	45.1	28.4		1.0	2.0				
		Québec	52	4	8	0.0						1.9	17.3	51.9	26.9	1.9						
	Ceftiofur	British Columbia	38	0.50	1	7.9				18.4	71.1	2.6				2.6	5.3					
		Saskatchewan	29	0.50	0.50	3.4				31.0	62.1	3.4					3.4					
		Ontario	102	0.50	0.50	2.0			1.0	48.0	48.0			1.0	1.0	1.0						
		Québec	52	0.50	0.50	0.0			3.8	38.5	55.8	1.9										
	Ceftriaxone	British Columbia	38	≤ 0.25	≤ 0.25	7.9				92.1							7.9					
		Saskatchewan	29	≤ 0.25	≤ 0.25	3.4				96.6								3.4				
		Ontario	102	≤ 0.25	≤ 0.25	2.9				97.1						2.0	1.0					
		Québec	52	≤ 0.25	≤ 0.25	0.0				100.0												
	Ciprofloxacin	British Columbia	38	≤ 0.015	≤ 0.015	0.0	100.0															
		Saskatchewan	29	≤ 0.015	0.03	0.0	89.7	10.3														
		Ontario	102	≤ 0.015	≤ 0.015	0.0	96.1	2.0		2.0												
		Québec	52	≤ 0.015	≤ 0.015	0.0	96.2	1.9		1.9												
II	Ampicillin	British Columbia	38	4	> 32	10.5							5.3	28.9	52.6	2.6			10.5			
		Saskatchewan	29	2	> 32	13.8							3.4	48.3	31.0	3.4			13.8			
		Ontario	102	2	> 32	20.6							3.9	47.1	26.5	2.0			20.6			
		Québec	52	4	> 32	26.9							7.7	34.6	23.1	3.8	3.8		26.9			
	Azithromycin	British Columbia	38	4	8	0.0							5.3	10.5	73.7	10.5						
		Saskatchewan	29	4	8	0.0								20.7	65.5	13.8						
		Ontario	102	4	4	0.0								19.6	71.6	7.8	1.0					
		Québec	52	4	4	0.0					1.9	1.9		19.2	67.3	7.7	1.9					
	Cefoxitin	British Columbia	38	4	16	7.9								2.6	60.5	23.7	5.3		7.9			
		Saskatchewan	29	4	8	3.4								17.2	55.2	20.7	3.4		3.4			
		Ontario	102	4	8	2.9								25.5	57.8	13.7		1.0	2.0			
		Québec	52	4	8	0.0								34.6	48.1	15.4	1.9					
	Gentamicin	British Columbia	38	1	2	2.6				2.6	47.4	39.5	7.9				2.6					
		Saskatchewan	29	0.50	1	0.0					69.0	27.6	3.4									
		Ontario	102	0.50	1	2.9					57.8	34.3	4.9				1.0	2.0				
		Québec	52	0.50	1	0.0				1.9	55.8	40.4	1.9									
III	Kanamycin	British Columbia	38	≤ 8	≤ 8	0.0										100.0						
		Saskatchewan	29	≤ 8	≤ 8	6.9										93.1			6.9			
		Ontario	102	≤ 8	≤ 8	2.9										96.1	1.0		2.9			
		Québec	52	≤ 8	≤ 8	1.9										98.1			1.9			
	Nalidixic acid	British Columbia	38	2	2	0.0							7.9	86.8	5.3							
		Saskatchewan	29	2	4	0.0							10.3	79.3	10.3							
		Ontario	102	2	4	2.0							13.7	70.6	13.7				2.0			
		Québec	52	2	4	1.9							17.3	65.4	13.5	1.9			1.9			
	Streptomycin	British Columbia	38	≤ 32	64	10.5											89.5	5.3	5.3			
		Saskatchewan	29	≤ 32	> 64	10.3											89.7		10.3			
		Ontario	102	≤ 32	> 64	16.7											83.3	3.9	12.7			
		Québec	52	≤ 32	64	11.5											88.5	5.8	5.8			
Trimethoprim-sulfamethoxazole	British Columbia	38	≤ 0.12	≤ 0.12	2.6				92.1	5.3					2.6							
	Saskatchewan	29	≤ 0.12	≤ 0.12	6.9				93.1						6.9							
	Ontario	102	≤ 0.12	0.25	5.9				85.3	6.9	1.0	1.0			5.9							
	Québec	52	≤ 0.12	> 4	11.5				86.5		1.9				11.5							
IV	Chloramphenicol	British Columbia	38	8	8	5.3								21.1	73.7		5.3					
		Saskatchewan	29	8	8	3.4							3.4	37.9	55.2			3.4				
		Ontario	102	8	8	3.9								45.1	50.0		1.0	2.9	1.0			
		Québec	52	8	8	5.8							5.8	38.5	50.0			5.8				
	Sulfisoxazole	British Columbia	38	≤ 16	> 256	13.2											71.1	15.8			13.2	
		Saskatchewan	29	≤ 16	> 256	10.3											69.0	20.7			10.3	
		Ontario	102	≤ 16	> 256	17.6											67.6	14.7			17.6	
		Québec	52	≤ 16	> 256	15.4											80.8	3.8			15.4	
	Tetracycline	British Columbia	38	≤ 4	> 32	23.7									76.3			2.6	21.1			
		Saskatchewan	29	≤ 4	> 32	37.9									62.1			3.4	34.5			
		Ontario	102	≤ 4	> 32	37.3									62.7			2.0	35.3			
		Québec	52	≤ 4	> 32	44.2									55.8			3.8	40.4			

Table 22. Distribution of minimum inhibitory concentrations in *Salmonella* from turkey

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)															
			MIC 50	MIC 90	% R	≤ 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	British Columbia	36	≤ 1	> 32	13.9						75.0	11.1								
		Saskatchewan an	27	≤ 1	8	3.7						81.5		3.7	7.4	3.7	3.7				
		Ontario	29	4	> 32	37.9						48.3		3.4	10.3		10.3	27.6			
		Québec	58	≤ 1	> 32	17.2						77.6	3.4		1.7			17.2			
		Maritimes	18	≤ 1	> 32	16.7						55.6	5.6		11.1	11.1		16.7			
	Ceftiofur	British Columbia	36	1	> 8	13.9					13.9	63.9	8.3				13.9				
		Saskatchewan an	27	1	1	3.7					11.1	81.5	3.7				3.7				
		Ontario	29	1	> 8	37.9					24.1	37.9					37.9				
		Québec	58	1	> 8	17.2					17.2	65.5					17.2				
		Maritimes	18	1	> 8	16.7					5.6	77.8					16.7				
	Ceftriaxone	British Columbia	36	≤ 0.25	8	13.9					86.1					5.6	8.3				
		Saskatchewan an	27	≤ 0.25	≤ 0.25	3.7					96.3						3.7				
		Ontario	29	≤ 0.25	32	37.9					62.1					3.4	13.8	13.8	6.9		
		Québec	58	≤ 0.25	32	17.2					82.8						5.2	12.1			
		Maritimes	18	≤ 0.25	32	16.7					83.3						5.6	5.6	5.6		
	Ciprofloxacin	British Columbia	36	≤ 0.015	0.03	0.0	77.8	22.2													
		Saskatchewan an	27	≤ 0.015	0.03	0.0	77.8	22.2													
		Ontario	29	≤ 0.015	≤ 0.015	0.0	93.1	6.9													
		Québec	58	≤ 0.015	0.03	0.0	87.9	12.1													
		Maritimes	18	≤ 0.015	≤ 0.015	0.0	94.4	5.6													
II	Ampicillin	British Columbia	36	≤ 1	> 32	16.7						72.2	8.3	2.8						16.7	
		Saskatchewan an	27	≤ 1	> 32	18.5						74.1	7.4						18.5		
		Ontario	29	> 32	> 32	51.7						44.8	3.4						51.7		
		Québec	58	≤ 1	> 32	19.0						75.9	5.2						19.0		
		Maritimes	18	≤ 1	> 32	38.9						61.1							38.9		
	Azithromycin	British Columbia	36	4	8	0.0						5.6	19.4	50.0	25.0						
		Saskatchewan an	27	4	8	0.0							3.7	77.8	18.5						
		Ontario	29	4	8	0.0							17.2	69.0	10.3	3.4					
		Québec	58	4	8	0.0							5.2	75.9	17.2	1.7					
		Maritimes	18	4	8	0.0							5.6	83.3	11.1						
	Cefoxitin	British Columbia	36	4	32	11.1						19.4	27.8	36.1	2.8	2.8	8.3	2.8			
		Saskatchewan an	27	2	4	3.7						11.1	59.3	25.9				3.7			
		Ontario	29	2	> 32	34.5						24.1	34.5	3.4		3.4	17.2	17.2			
		Québec	58	2	> 32	17.2						8.6	55.2	17.2	1.7		6.9	10.3			
		Maritimes	18	2	> 32	16.7						11.1	55.6	16.7			5.6	11.1			
	Gentamicin	British Columbia	36	0.50	0.50	8.3					27.8	63.9				2.8	5.6				
		Saskatchewan an	27	0.50	> 16	18.5					22.2	51.9	7.4			3.7	14.8				
		Ontario	29	0.50	> 16	10.3					31.0	51.7	3.4	3.4			10.3				
		Québec	58	0.50	> 16	15.5					19.0	62.1	3.4				15.5				
		Maritimes	18	0.50	> 16	22.2					16.7	55.6	5.6			5.6	16.7				
Kanamycin	British Columbia	36	≤ 8	≤ 8	0.0									100.0							
	Saskatchewan an	27	≤ 8	≤ 8	3.7									96.3					3.7		
	Ontario	29	≤ 8	≤ 8	0.0									100.0							
	Québec	58	≤ 8	16	6.9									89.7	1.7	1.7			6.9		
	Maritimes	18	≤ 8	≤ 8	0.0									100.0							
Nalidixic acid	British Columbia	36	4	4	0.0							44.4	52.8	2.8							
	Saskatchewan an	27	4	4	0.0							18.5	74.1	7.4							
	Ontario	29	4	4	0.0							20.7	79.3								
	Québec	58	4	4	0.0							34.5	63.8	1.7							
	Maritimes	18	4	4	0.0							22.2	77.8								
Streptomycin	British Columbia	36	≤ 32	> 64	33.3											66.7	13.9	19.4			
	Saskatchewan an	27	≤ 32	> 64	18.5											81.5	3.7	14.8			
	Ontario	29	≤ 32	> 64	31.0											69.0	6.9	24.1			
	Québec	58	≤ 32	> 64	25.9											74.1	10.3	15.5			
	Maritimes	18	≤ 32	> 64	44.4											55.6	33.3	11.1			
Trimethoprim-sulfamethoxazole	British Columbia	36	≤ 0.12	≤ 0.12	0.0					100.0											
	Saskatchewan an	27	≤ 0.12	≤ 0.12	0.0					96.3	3.7										
	Ontario	29	≤ 0.12	≤ 0.12	0.0					96.6	3.4										
	Québec	58	≤ 0.12	≤ 0.12	1.7					91.4	5.2	1.7			1.7						
	Maritimes	18	≤ 0.12	≤ 0.12	0.0					100.0											
III	Chloramphenicol	British Columbia	36	8	8	0.0							2.8	36.1	58.3	2.8					
		Saskatchewan an	27	8	8	0.0								14.8	85.2						
		Ontario	29	8	> 32	10.3								24.1	65.5				10.3		
		Québec	58	8	8	0.0								13.8	84.5	1.7					
		Maritimes	18	8	8	5.6								33.3	61.1				5.6		
	Sulfisoxazole	British Columbia	36	32	> 256	11.1										8.3	66.7	13.9			11.1
		Saskatchewan an	27	32	> 256	22.2										14.8	44.4	18.5			22.2
		Ontario	29	32	> 256	31.0										17.2	48.3	3.4			31.0
		Québec	58	32	> 256	31.0										20.7	46.6	1.7			31.0
		Maritimes	18	32	> 256	11.1										27.8	44.4	16.7			11.1
	Tetracycline	British Columbia	36	≤ 4	> 32	36.1								63.9			2.8	33.3			
		Saskatchewan an	27	≤ 4	> 32	22.2								77.8				22.2			
		Ontario	29	≤ 4	> 32	34.5								65.5			3.4	31.0			
		Québec	58	≤ 4	> 32	37.9								62.1			1.7	36.2			
		Maritimes	18	≤ 4	> 32	38.9								61.1			5.6	33.3			
	IV																				

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Table 23. Distribution of minimum inhibitory concentrations in *Escherichia coli* from turkey

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
I	Amoxicillin-clavulanic acid	British Columbia	67	4	16	7.5						3.0	11.9	47.8	26.9	3.0	3.0	4.5			
		Saskatchewan	59	4	16	3.4						1.7	11.9	57.6	18.6	6.8	1.7	1.7			
		Ontario	119	4	8	3.4						2.5	19.3	45.4	27.7	1.7	2.5	0.8			
		Québec	107	4	8	5.6						0.9	20.6	43.0	29.0	0.9	2.8	2.8			
	Ceftiofur	British Columbia	67	0.50	1	3.0				17.9	70.1	6.0	1.5	1.5	1.5	1.5					
		Saskatchewan	59	0.50	0.50	3.4				1.7	22.0	71.2	1.7		1.7	1.7					
		Ontario	119	0.50	0.50	2.5				2.5	33.6	58.0	2.5	0.8		2.5					
		Québec	107	0.50	0.50	5.6				26.2	64.5	2.8		0.9	1.9	3.7					
	Ceftriaxone	British Columbia	67	≤ 0.25	≤ 0.25	4.5				92.5		1.5	1.5	1.5		3.0					
		Saskatchewan	59	≤ 0.25	≤ 0.25	3.4				96.6						3.4					
		Ontario	119	≤ 0.25	≤ 0.25	2.5				95.8	0.8		0.8		0.8	1.7					
		Québec	107	≤ 0.25	≤ 0.25	6.5				92.5			0.9		0.9	3.7	1.9				
	Ciprofloxacin	British Columbia	67	≤ 0.015	≤ 0.015	0.0	92.5	4.5		3.0											
		Saskatchewan	59	≤ 0.015	≤ 0.015	0.0	94.9	1.7		3.4											
		Ontario	119	≤ 0.015	≤ 0.015	0.0	99.2			0.8											
		Québec	107	≤ 0.015	≤ 0.015	0.0	98.1	1.9													
	Ampicillin	British Columbia	67	4	> 32	28.4						4.5	29.9	37.3				28.4			
		Saskatchewan	59	4	> 32	27.1						3.4	35.6	32.2	1.7			27.1			
		Ontario	119	4	> 32	25.2						5.9	42.0	26.1	0.8			25.2			
		Québec	107	4	> 32	31.8						6.5	32.7	27.1	1.9			31.8			
	Azithromycin	British Columbia	67	4	4	0.0						3.0	20.9	67.2	9.0						
		Saskatchewan	59	4	4	0.0						3.4	27.1	64.4	5.1						
		Ontario	119	4	4	0.0						4.2	26.9	60.5	8.4						
		Québec	107	4	4	0.0						3.7	21.5	68.2	6.5						
	Cefoxitin	British Columbia	67	4	8	3.0							10.4	52.2	31.3	3.0		3.0			
		Saskatchewan	59	4	8	3.4							10.2	69.5	16.9			3.4			
		Ontario	119	4	8	3.4						0.8	26.9	55.5	13.4		1.7	1.7			
		Québec	107	4	8	5.6							6.5	70.1	16.8	0.9	2.8	2.8			
	Gentamicin	British Columbia	67	1	> 16	13.4					40.3	41.8	1.5		3.0	1.5	11.9				
		Saskatchewan	59	0.50	16	10.2					1.7	50.8	30.5		6.8	5.1	5.1				
		Ontario	119	0.50	16	10.9					1.7	49.6	34.5	0.8	2.5	1.7	9.2				
		Québec	107	0.50	> 16	15.0					1.9	56.1	16.8	5.6	1.9	2.8	3.7	11.2			
	Kanamycin	British Columbia	67	≤ 8	≤ 8	7.5									91.0	1.5		7.5			
		Saskatchewan	59	≤ 8	> 64	11.9									88.1			11.9			
		Ontario	119	≤ 8	> 64	12.6									85.7	1.7		12.6			
		Québec	107	≤ 8	64	10.3									88.8	0.9		9.3			
	Nalidixic acid	British Columbia	67	2	4	3.0						4.5	74.6	17.9				3.0			
		Saskatchewan	59	2	4	1.7						1.7	8.5	78.0	8.5	1.7		1.7			
		Ontario	119	2	4	0.8						11.8	77.3	10.1				0.8			
		Québec	107	2	4	0.0						13.1	76.6	9.3	0.9						
	Streptomycin	British Columbia	67	≤ 32	> 64	31.3											68.7	11.9	19.4		
		Saskatchewan	59	≤ 32	> 64	35.6											64.4	15.3	20.3		
		Ontario	119	≤ 32	> 64	30.3											69.7	10.1	20.2		
		Québec	107	≤ 32	> 64	35.5											64.5	19.6	15.9		
	Trimethoprim-sulfamethoxazole	British Columbia	67	≤ 0.12	0.25	4.5				88.1	7.5					4.5					
		Saskatchewan	59	≤ 0.12	0.25	6.8				86.4	6.8					6.8					
		Ontario	119	≤ 0.12	0.25	9.2				83.2	7.6					9.2					
		Québec	107	≤ 0.12	1	9.3				77.6	11.2	0.9	0.9			9.3					
III	Chloramphenicol	British Columbia	67	8	8	3.0								38.8	56.7	1.5		3.0			
		Saskatchewan	59	8	8	0.0							3.4	45.8	49.2	1.7					
		Ontario	119	8	8	2.5							1.7	37.0	58.8		0.8	1.7			
		Québec	107	8	8	2.8							2.8	39.3	49.5	5.6		2.8			
	Sulfisoxazole	British Columbia	67	≤ 16	> 256	25.4										61.2	13.4			25.4	
		Saskatchewan	59	≤ 16	> 256	23.7										57.6	16.9	1.7		23.7	
		Ontario	119	≤ 16	> 256	31.1										56.3	12.6			31.1	
		Québec	107	32	> 256	39.3										41.1	17.8	1.9		39.3	
	Tetracycline	British Columbia	67	≤ 4	> 32	41.8								58.2			6.0	35.8			
		Saskatchewan	59	≤ 4	> 32	47.5								52.5			3.4	44.1			
		Ontario	119	> 32	> 32	65.5								34.5			12.6	52.9			
		Québec	107	> 32	> 32	64.5								35.5			11.2	53.3			
	IV																				

Table 24. Distribution of minimum inhibitory concentrations in *Campylobacter* from turkey

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
I	Oprofloxacin	<i>Campylobacter coli</i>	British Columbia	2	16	16	50.0				50.0							50.0			
	Oprofloxacin	<i>Campylobacter coli</i>	Saskatchewan	3	0.125	0.125	0.0			33.3	66.7										
	Oprofloxacin	<i>Campylobacter coli</i>	Ontario	7	0.125	16	14.3			42.9	14.3	28.6									
	Oprofloxacin	<i>Campylobacter coli</i>	Québec	3	0.25	16	33.3				33.3	33.3									
	Oprofloxacin	<i>Campylobacter jejuni</i>	British Columbia	50	0.125	0.125	6.0			32.0	60.0	2.0									
	Oprofloxacin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.125	0.125	6.7			43.3	50.0										
	Oprofloxacin	<i>Campylobacter jejuni</i>	Ontario	52	0.125	0.25	5.8			32.7	46.2	15.4					6.7				
	Oprofloxacin	<i>Campylobacter jejuni</i>	Québec	51	0.125	0.25	2.0			29.4	41.2	27.5					1.9	3.8			
	Oprofloxacin	<i>Campylobacter spp.</i>	British Columbia	21	0.064	0.25	9.5			52.4	28.6	9.5					2.0				
	Oprofloxacin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.125	0.25	0.0			42.9	42.9	14.3					4.8	4.8			
	Oprofloxacin	<i>Campylobacter spp.</i>	Ontario	28	0.125	16	35.7			25.0	32.1	7.1									
	Oprofloxacin	<i>Campylobacter spp.</i>	Québec	24	0.125	0.25	0.0			29.2	58.3	12.5					10.7	7.1	17.9		
	Telithromycin	<i>Campylobacter coli</i>	British Columbia	2	1	1	0.0				50.0			50.0							
	Telithromycin	<i>Campylobacter coli</i>	Saskatchewan	3	2	2	0.0							33.3	66.7						
	Telithromycin	<i>Campylobacter coli</i>	Ontario	7	2	16	14.3				28.6	14.3									
	Telithromycin	<i>Campylobacter coli</i>	Québec	3	2	4	0.0								66.7	33.3					
	Telithromycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.5	1	0.0				8.0	72.0	20.0								
	Telithromycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.5	1	0.0				23.3	43.3	26.7	3.3							
	Telithromycin	<i>Campylobacter jejuni</i>	Ontario	52	0.5	2	3.8				15.4	44.2	25.0	11.5							
	Telithromycin	<i>Campylobacter jejuni</i>	Québec	51	0.5	2	0.0				7.8	43.1	25.5	15.7	5.9						
	Telithromycin	<i>Campylobacter spp.</i>	British Columbia	21	0.5	1	0.0				28.6	42.9	19.0	9.5							
	Telithromycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.5	2	0.0				28.6	42.9	14.3	14.3							
	Telithromycin	<i>Campylobacter spp.</i>	Ontario	28	0.5	2	0.0				14.3	39.3	32.1	7.1	3.6						
	Telithromycin	<i>Campylobacter spp.</i>	Québec	24	1	4	0.0				16.7	25.0	37.5	8.3	4.2						
II	Azithromycin	<i>Campylobacter coli</i>	British Columbia	2	0.064	0.064	0.0		50.0	50.0											
	Azithromycin	<i>Campylobacter coli</i>	Saskatchewan	3	0.125	0.125	0.0				33.3	66.7									
	Azithromycin	<i>Campylobacter coli</i>	Ontario	7	0.064	> 64	14.3			57.1	28.6										
	Azithromycin	<i>Campylobacter coli</i>	Québec	3	0.125	0.125	0.0					100.0									
	Azithromycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.064	0.064	0.0			34.0	64.0	2.0									
	Azithromycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.064	0.125	3.3	3.3	30.0	56.7	6.7										
	Azithromycin	<i>Campylobacter jejuni</i>	Ontario	52	0.064	0.064	3.8			38.5	55.8	1.9									
	Azithromycin	<i>Campylobacter jejuni</i>	Québec	51	0.064	0.125	5.9	3.9	39.2	39.2	11.8										
	Azithromycin	<i>Campylobacter spp.</i>	British Columbia	21	0.032	0.064	0.0	9.5	47.6	38.1	4.8										
	Azithromycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.032	0.064	0.0			57.1	42.9										
	Azithromycin	<i>Campylobacter spp.</i>	Ontario	28	0.032	0.5	7.1	7.1	50.0	17.9	14.3		3.6								
	Azithromycin	<i>Campylobacter spp.</i>	Québec	24	0.064	> 64	12.5		29.2	58.3											
	Clindamycin	<i>Campylobacter coli</i>	British Columbia	2	0.5	0.5	0.0					50.0	50.0								
	Clindamycin	<i>Campylobacter coli</i>	Saskatchewan	3	0.25	0.5	0.0					66.7	33.3								
	Clindamycin	<i>Campylobacter coli</i>	Ontario	7	0.25	16	28.6				57.1	14.3									
	Clindamycin	<i>Campylobacter jejuni</i>	Québec	3	1	8	33.3					33.3	33.3								
	Clindamycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.125	0.25	0.0			6.0	58.0	34.0	2.0								
	Clindamycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.125	0.25	0.0			3.3	70.0	23.3									
	Clindamycin	<i>Campylobacter jejuni</i>	Ontario	52	0.125	0.25	0.0			7.7	50.0	36.5	1.9								
	Clindamycin	<i>Campylobacter jejuni</i>	Québec	51	0.125	0.5	0.0			2.0	64.7	19.6	7.8		2.0	3.9					
	Clindamycin	<i>Campylobacter spp.</i>	British Columbia	21	0.125	0.25	0.0			9.5	47.6	33.3	4.8	4.8							
	Clindamycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.25	0.5	0.0				28.6	57.1	14.3								
	Clindamycin	<i>Campylobacter spp.</i>	Ontario	28	0.125	0.5	7.1			21.4	39.3	28.6	3.6								
	Clindamycin	<i>Campylobacter spp.</i>	Québec	24	0.125	4	4.2			12.5	45.8	25.0	4.2								
	Erythromycin	<i>Campylobacter coli</i>	British Columbia	2	1	1	0.0					50.0		50.0							
	Erythromycin	<i>Campylobacter coli</i>	Saskatchewan	3	1	2	0.0					33.3		33.3	33.3						
	Erythromycin	<i>Campylobacter coli</i>	Ontario	7	1	> 64	14.3					28.6	14.3	14.3	28.6						
	Erythromycin	<i>Campylobacter coli</i>	Québec	3	2	2	0.0								33.3	66.7					
	Erythromycin	<i>Campylobacter jejuni</i>	British Columbia	50	0.25	0.5	0.0					76.0	24.0								
	Erythromycin	<i>Campylobacter jejuni</i>	Saskatchewan	30	0.25	0.5	3.3			3.3	76.7	13.3	3.3								
	Erythromycin	<i>Campylobacter jejuni</i>	Ontario	52	0.25	0.5	3.8			5.8	53.8	32.7	3.8								
	Erythromycin	<i>Campylobacter jejuni</i>	Québec	51	0.5	1	5.9				49.0	33.3	7.8	3.9							
	Erythromycin	<i>Campylobacter spp.</i>	British Columbia	21	0.25	0.5	0.0			4.8	81.0	9.5			4.8						
	Erythromycin	<i>Campylobacter spp.</i>	Saskatchewan	7	0.25	0.5	0.0			14.3	57.1	28.6									
	Erythromycin	<i>Campylobacter spp.</i>	Ontario	28	0.25	1	7.1			7.1	50.0	25.0	10.7								
	Erythromycin	<i>Campylobacter spp.</i>	Québec	24	0.5	> 64	12.5			4.2	29.2	41.7	12.5								

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Table 24. Distribution of minimum inhibitory concentrations in *Campylobacter* from turkey (cont'd)

Antimicrobial	Species	Province / region	n	Percentiles			Distribution (%) of MICs (µg/mL)													
				MIC 50	MIC 90	% R	≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
II	Gentamicin	<i>Campylobacter coli</i>	British Columbia	2	0.5	0.5	0.0					100.0								
	Gentamicin	<i>Campylobacter coli</i>	Saskatchewan	3	1	1	0.0						100.0							
	Gentamicin	<i>Campylobacter coli</i>	Ontario	7	1	1	0.0					42.9	57.1							
	Gentamicin	<i>Campylobacter coli</i>	Québec	3	1	2	0.0							66.7	33.3					
	Gentamicin	<i>Campylobacter jejuni</i>	British Columbia	50	1	1	0.0					40.0	60.0							
	Gentamicin	<i>Campylobacter jejuni</i>	Saskatchewan	30	1	1	0.0					23.3	76.7							
	Gentamicin	<i>Campylobacter jejuni</i>	Ontario	52	1	1	0.0					48.1	51.9							
	Gentamicin	<i>Campylobacter jejuni</i>	Québec	51	0.5	1	0.0				2.0	54.9	43.1							
	Gentamicin	<i>Campylobacter</i> spp.	British Columbia	21	0.5	1	0.0					71.4	28.6							
	Gentamicin	<i>Campylobacter</i> spp.	Saskatchewan	7	1	1	0.0					42.9	57.1							
	Gentamicin	<i>Campylobacter</i> spp.	Ontario	28	0.5	1	0.0					57.1	39.3	3.6						
	Gentamicin	<i>Campylobacter</i> spp.	Québec	24	0.5	1	0.0					58.3	41.7							
	Nalidixic acid	<i>Campylobacter coli</i>	British Columbia	2	> 64	> 64	50.0									50.0				50.0
	Nalidixic acid	<i>Campylobacter coli</i>	Saskatchewan	3	8	16	0.0								33.3	33.3	33.3			
	Nalidixic acid	<i>Campylobacter coli</i>	Ontario	7	8	> 64	14.3								42.9	14.3	28.6			14.3
	Nalidixic acid	<i>Campylobacter coli</i>	Québec	3	8	> 64	33.3								33.3	33.3				33.3
	Nalidixic acid	<i>Campylobacter jejuni</i>	British Columbia	50	≤ 4	8	6.0								62.0	32.0				6.0
	Nalidixic acid	<i>Campylobacter jejuni</i>	Saskatchewan	30	≤ 4	8	6.7								80.0	13.3				6.7
	Nalidixic acid	<i>Campylobacter jejuni</i>	Ontario	52	≤ 4	8	5.8								67.3	26.9				5.8
	Nalidixic acid	<i>Campylobacter jejuni</i>	Québec	51	8	8	2.0								45.1	52.9				2.0
	Nalidixic acid	<i>Campylobacter</i> spp.	British Columbia	21	≤ 4	16	9.5								57.1	28.6	4.8		4.8	4.8
	Nalidixic acid	<i>Campylobacter</i> spp.	Saskatchewan	7	≤ 4	8	0.0								57.1	42.9				
	Nalidixic acid	<i>Campylobacter</i> spp.	Ontario	28	8	> 64	35.7								46.4	17.9			3.6	32.1
	Nalidixic acid	<i>Campylobacter</i> spp.	Québec	24	≤ 4	8	0.0								83.3	16.7				
III	Florfenicol	<i>Campylobacter coli</i>	British Columbia	2	2	2	0.0						50.0	50.0						
	Florfenicol	<i>Campylobacter coli</i>	Saskatchewan	3	1	1	0.0						100.0							
	Florfenicol	<i>Campylobacter coli</i>	Ontario	7	1	2	0.0						71.4	28.6						
	Florfenicol	<i>Campylobacter coli</i>	Québec	3	1	2	0.0					33.3	33.3	33.3						
	Florfenicol	<i>Campylobacter jejuni</i>	British Columbia	50	1	1	0.0				2.0	10.0	88.0							
	Florfenicol	<i>Campylobacter jejuni</i>	Saskatchewan	30	1	1	0.0					16.7	83.3							
	Florfenicol	<i>Campylobacter jejuni</i>	Ontario	52	1	1	0.0					9.6	86.5	3.8						
	Florfenicol	<i>Campylobacter jejuni</i>	Québec	51	1	2	0.0					7.8	76.5	15.7						
	Florfenicol	<i>Campylobacter</i> spp.	British Columbia	21	1	1	0.0						90.5	9.5						
	Florfenicol	<i>Campylobacter</i> spp.	Saskatchewan	7	1	2	0.0					14.3	71.4	14.3						
	Florfenicol	<i>Campylobacter</i> spp.	Ontario	28	1	1	0.0					3.6	96.4							
	Florfenicol	<i>Campylobacter</i> spp.	Québec	24	1	2	0.0					12.5	75.0	12.5						
	Tetracycline	<i>Campylobacter coli</i>	British Columbia	2	1	1	0.0						50.0	50.0						
	Tetracycline	<i>Campylobacter coli</i>	Saskatchewan	3	0.5	> 64	33.3			33.3		33.3								33.3
	Tetracycline	<i>Campylobacter coli</i>	Ontario	7	0.5	> 64	42.9			42.9	14.3								14.3	28.6
	Tetracycline	<i>Campylobacter coli</i>	Québec	3	8	> 64	33.3							33.3		33.3				33.3
	Tetracycline	<i>Campylobacter jejuni</i>	British Columbia	50	0.25	64	26.0			18.0	50.0	4.0	2.0					2.0	16.0	8.0
	Tetracycline	<i>Campylobacter jejuni</i>	Saskatchewan	30	32	> 64	53.3			20.0	26.7							6.7	20.0	26.7
	Tetracycline	<i>Campylobacter jejuni</i>	Ontario	52	0.5	> 64	46.2			21.2	21.2	9.6	1.9					15.4	30.8	
	Tetracycline	<i>Campylobacter jejuni</i>	Québec	51	64	> 64	66.7			9.8	9.8	5.9	5.9		2.0			29.4	37.3	
	Tetracycline	<i>Campylobacter</i> spp.	British Columbia	21	0.25	64	28.6			19.0	38.1	4.8	9.5					4.8	19.0	4.8
	Tetracycline	<i>Campylobacter</i> spp.	Saskatchewan	7	0.5	> 64	42.9			42.9		14.3							28.6	14.3
	Tetracycline	<i>Campylobacter</i> spp.	Ontario	28	32	> 64	53.6			14.3	21.4	7.1	3.6					17.9	14.3	21.4
	Tetracycline	<i>Campylobacter</i> spp.	Québec	24	64	> 64	58.3			12.5	25.0	4.2						12.5		45.8
IV																				

RECOVERY RESULTS

Table 25. Retail Meat Surveillance recovery rates

CIPARS Component /	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted						
Animal species			<i>Escherichia coli</i>	<i>Salmonella</i>	<i>Campylobacter</i>	<i>Enterococcus</i>			
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					
	Saskatchewan	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					
	Ontario	2003	66%	101/154	2%	2/84	3%	2/76	91%
		2004	80%	190/237					69/76
		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					
	Québec	2003	57%	84/147	0%	0/33	0%	0/33	80%
		2004	56%	137/245					28/35
		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	58%	104/180					
	Maritimes	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 ^e	TBD						

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 Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

TBD = To be determined

^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.

^d Due to an unforeseeable pause in retail sampling in the Maritimes 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 chapter.

^e At the time this chapter was published, all recovery data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 25. Retail Meat Surveillance recovery rates (cont'd)

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			<i>Escherichia coli</i>	<i>Salmonella</i>	<i>Campylobacter</i>	<i>Enterococcus</i>				
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			
	Saskatchewan	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		
	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		
	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		
	Maritimes	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 ^e	TBD		TBD		TBD			

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 Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

TBD = To be determined

^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 Maritime provinces, 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 Maritimes 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 chapter.

^e At the time this chapter was published, all recovery data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

Table 25. Retail Meat Surveillance recovery rates (cont'd)

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted								
			<i>Escherichia coli</i>	<i>Salmonella</i>	<i>Campylobacter</i>	<i>Enterococcus</i>					
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					
	Saskatchewan	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					
	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					
		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					
	Maritimes	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 ^e	TBD	TBD	TBD						
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			
	Saskatchewan	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			
	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			
	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			

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).

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^d Due to an unforeseeable pause in retail sampling in the Maritimes 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 chapter.

^e At the time this chapter was published, all recovery data from the Maritimes region were pending entry into the CIPARS laboratory software and central data repository. These data will be presented in future publications as soon as a technical solution is available.

ABATTOIR SURVEILLANCE

KEY FINDINGS

BEEF CATTLE

ESCHERICHIA COLI (n = 64)

Three percent of *E. coli* isolates (2/64) were resistant to nalidixic acid in 2013, and in 2012 only 1 isolate (1%, 1/165) was resistant to this antimicrobial. Prior to 2012, the previous occurrence of this resistance in CIPARS Abattoir surveillance was 1 isolate (less than 1%, 1/167) in 2004 (Figure 15).

Six percent (4/64) of isolates were resistant to ampicillin. Although low, this is the highest level seen since 2004 and is significantly higher than in 2012 (1%, 2/165) (Figure 15).

Ceftiofur resistance remains at zero for *E. coli* isolates from beef cattle.

Five percent of isolates (3/64) were resistant to trimethoprim-sulfamethoxazole which is significantly higher than in 2012 (0%, 0/165) (Figure 15). The previous high was 1% (1/119) in 2009 (Figure 15).

The percentage of isolates with resistance to 4 or 5 classes of antimicrobials has risen from 1% (1/165) in 2012 to 8% (5/64) in 2013 and resistance to 1 class of antimicrobials has dropped from 19% (32/165) in 2012 to 9% (6/64) in 2013 (Table 26).

CAMPYLOBACTER (n = 59)

The slight increase in resistance to ciprofloxacin that was observed from 2011 (1%, 1/108) to 2012 (5%, 8/152) continued into 2013 (5%, 3/59) (Figure 16).

CHICKENS

SALMONELLA (n = 107)

Recovery of *Salmonella* in chickens continued to decline to 16% (105/672) from a peak of 28% (234/851) in 2008. This is similar to levels from the first 3 years of the program (2003 to 2005) (Table 42).

All *S. Enteritidis* isolates were susceptible to all antimicrobials tested (Table 28).

The decrease in the proportion of isolates resistant to ampicillin and ceftiofur between 2011 (36% 50/140 and 31% 43/140, respectively) and 2012 (24%, 30/126 and 20%, 25/126, respectively) was maintained in 2013, (21%, 22/107 and 19%, 20/107, respectively). However,

resistance to ceftiofur was significantly higher in 2013 (19%, 20/107) than in 2006 (10%, 19/187) (Figure 17).

Resistance to streptomycin and tetracycline was significantly higher in 2013 (41%, 44/107 and 39%, 42/107, respectively) than in 2003 (24%, 30/126 and 19%, 14/126, respectively) (Figure 17).

The Livingstone serovar was the 4th most common in 2013 and all 8 isolates were resistant to 2 or 3 classes of antimicrobials (Table 28).

The percentage of isolates classified as “Less common serovars” increased from 12% of isolates (12/104) in 2012 to 20% of isolates (21/107) in 2013 indicating more diversity in this population (Table 28).

ESCHERICHIA COLI (n = 174)

Resistance to nalidixic acid was at a high of 8% (14/173) in 2012 but returned to a more typical 4% (7/174) in 2013 (Figure 18).

Resistance to tetracycline was significantly lower in 2013 (49%, 85/174) than in 2003 (69%, 106/153) (Figure 18).

Resistance to trimethoprim-sulfamethoxazole was significantly higher in 2013 (18%, 31/174) than in 2003 (8%, 12/153) (Figure 18).

CAMPYLOBACTER (n = 138)

Resistance to ciprofloxacin significantly increased from 4% (4/111) in 2010 to 14% (19/138) in 2013 (Figure 19).

PIGS

SALMONELLA (n = 181)

Resistance to trimethoprim-sulfamethoxazole was significantly higher in 2013 (7%, 13/181) than in 2003 (2%, 8/391) (Figure 20).

ESCHERICHIA COLI (n = 171)

Resistance to tetracycline was significantly lower in 2013 (74%, 127/171) than in 2012 (84%, 154/184) (Figure 21).

CAMPYLOBACTER (n = 254)

Thirty-two percent (79/248) of *C. coli* isolates were resistant to 4 or 5 classes of antimicrobials (Table 33).

MULTICLASS RESISTANCE

Table 26. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from beef cattle

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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Beef cattle	64	47	6	6	5	1		7	4					10	3		4		2	17	

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

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

Table 27. Number of antimicrobial classes in resistance patterns of *Campylobacter* from beef cattle

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		Phenicol	Quinolones		Tetracyclines			
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET			
<i>Campylobacter jejuni</i>	50 (84.7)	21	27	2												2	2	29
<i>Campylobacter coli</i>	9 (15.3)	2	6	1												1	1	7
Total	59 (100)	23	33	3												3	3	36

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

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

Table 28. Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens

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	Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET	
Kentucky	40 (37.4)	9	4	27				27	16	16	16	16	16								27	
Heidelberg	15 (14.0)	12	3						3	3	3	3	3									
Enteritidis	14 (13.1)	14																				
Livingstone	8 (7.5)			8					8						8						8	
Anatum	3 (2.8)	2	1						1													
Infantis	3 (2.8)	3																				
Kiambu	3 (2.8)	1	2												2	2						
Less common serovars	21 (19.6)	12	1	8			1		8	3	1	1	1	1	5						7	
Total	107 (100)	53	11	43			1		44	22	20	20	20	20	15	2					42	

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 29. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chickens

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	Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Chickens	174	48	21	69	33		20	29	79	68	35	36	35	36	78	31		5		7	86

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 30. Number of antimicrobial classes in resistance patterns of *Campylobacter* from chickens

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		Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET	
<i>Campylobacter jejuni</i>	123 (89.1)	67	41	14	1			3	2	4	4		16	16	49	
<i>Campylobacter coli</i>	12 (8.7)	6	4	1	1			2	2	2	2		1	1	4	
<i>Campylobacter</i> spp.	3 (2.2)	2		1					1	1	1		2	3	1	
Total	138 (100)	73	47	15	3			5	5	7	7		19	20	54	

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 31. Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Derby	48 (26.5)	5	9	33	1		2	1	27	4	1	1	1	1	32	6		1			41
Typhimurium var. 5-	19 (10.5)	2	5	12			4	12	12						12	1		9			16
Infantis	18 (9.9)	13	3		2		1	1	2	4	3	3	3	3	2	1		2			3
Bovismorbificans	11 (6.1)	6	2		3				3	5					3						3
Typhimurium	11 (6.1)	1	1	1	8		2	9	8						9	2		7			9
Brandenburg	10 (5.5)	8	2																		2
Give	10 (5.5)	8	1		1			1	2	1	1	1	1	1	1			1			1
London	9 (5.0)	9																			
Berta	6 (3.3)	2	4																		4
Schwarzengrund	6 (3.3)	5	1												1	1					
4,5,12:i:-	5 (2.8)	2			3		2	3	3						3						3
Uganda	4 (2.2)	4																			
Less common serovars	24 (13.3)	18	1	4	1		3	3	1						3	1	1	1			6
Total	181 (100)	83	29	38	31		3	13	60	39	5	5	5	5	66	12	1	21			88

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 32. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pigs

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Pigs	171	28	30	80	33		5	29	69	66	3	2	3	2	67	19	1	28		1	127

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 33. Number of antimicrobial classes in resistance patterns of *Campylobacter* from pigs

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		Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN		TEL		CLI		FLR	CIP	NAL	TET
<i>Campylobacter coli</i>	248 (97.6)	35	63	71	79				100		110			33	33	196
<i>Campylobacter</i> spp.	4 (1.6)	1	1	2							1				3	1
<i>Campylobacter jejuni</i>	2 (0.8)		1	1							1	1				2
Total	254 (100)	36	65	74	79				100		112			33	36	199

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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.

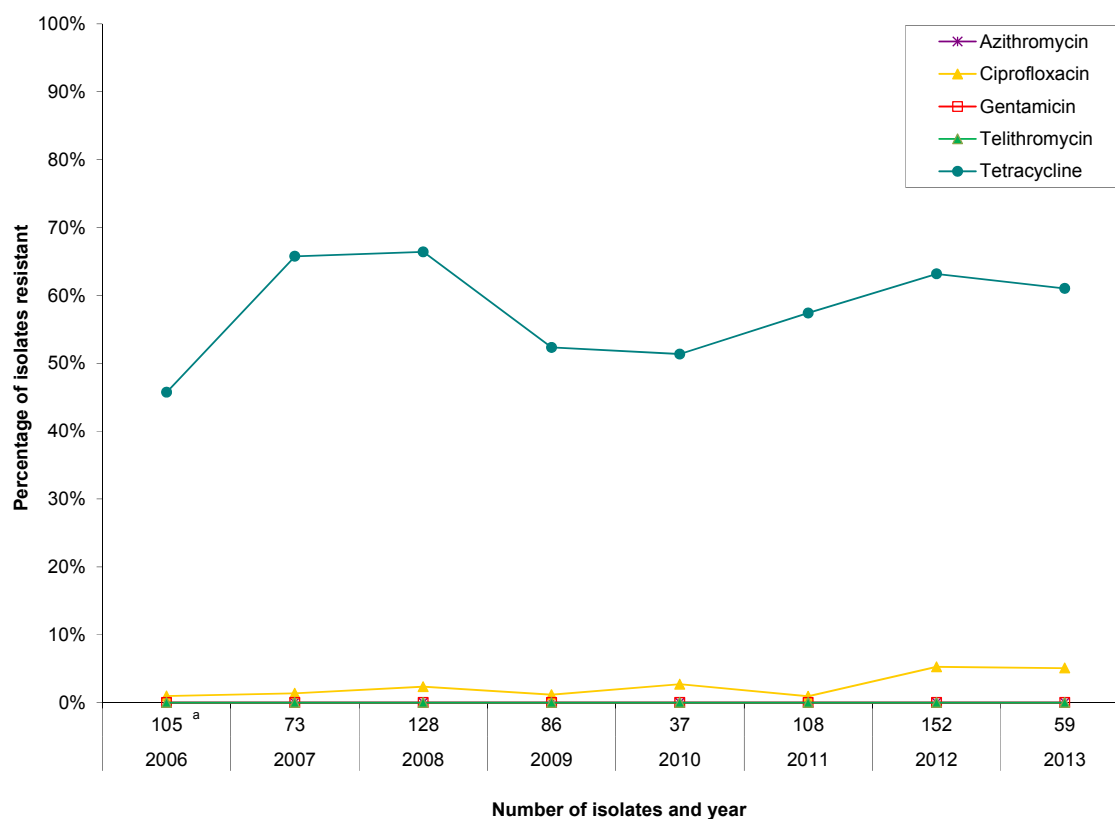
TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

Figure 15. Temporal variations in resistance of *Escherichia coli* isolates from beef cattle



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

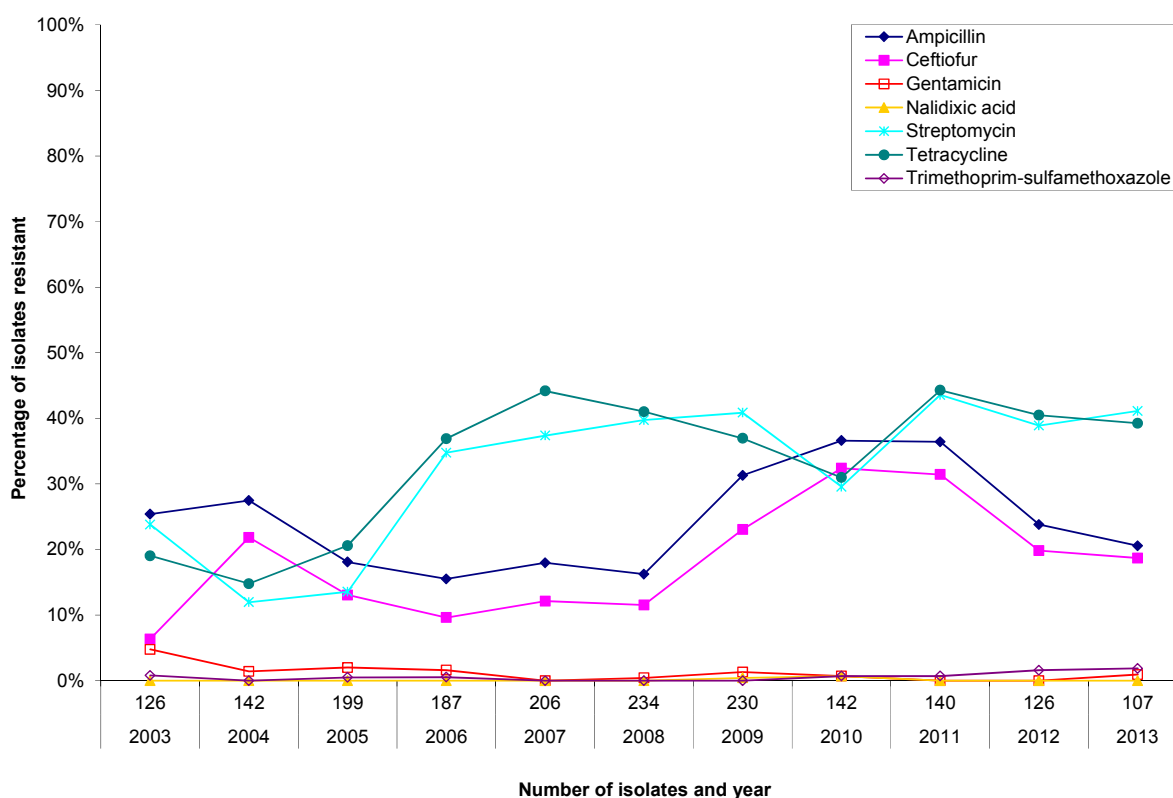
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicates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

Figure 16. Temporal variations in resistance of *Campylobacter* isolates from beef cattle

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

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

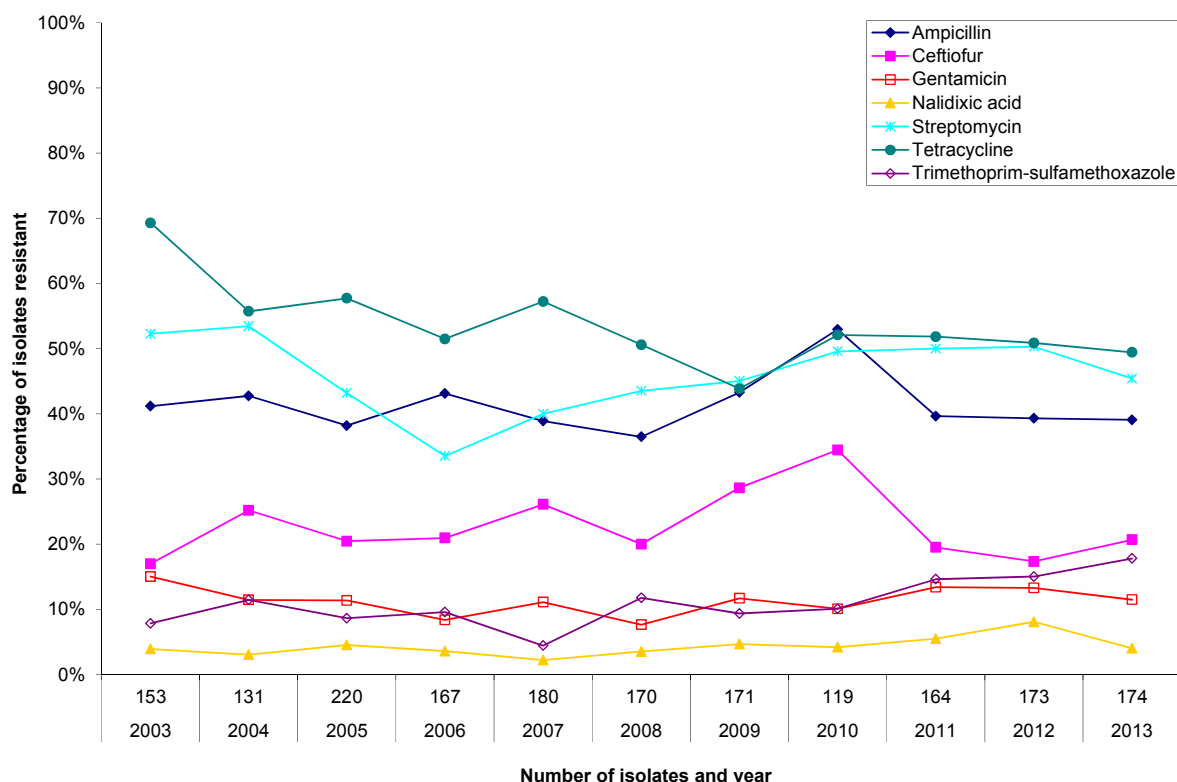
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicates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

Figure 17. Temporal variations in resistance of *Salmonella* isolates from chickens

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of isolates	126	142	199	187	206	234	230	142	140	126	107
Antimicrobial											
Ampicillin	25%	<u>27%</u>	18%	16%	18%	16%	31%	37%	36%	24%	<u>21%</u>
Ceftiofur	6%	22%	13%	<u>10%</u>	12%	12%	23%	32%	31%	20%	<u>19%</u>
Gentamicin	5%	1%	2%	2%	0%	0%	1%	1%	0%	0%	1%
Nalidixic acid	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
Streptomycin	24%	12%	14%	35%	37%	40%	41%	30%	44%	39%	41%
Tetracycline	19%	15%	21%	37%	44%	41%	37%	31%	44%	40%	39%
Trimethoprim-sulfamethoxazole	1%	0%	1%	1%	0%	0%	0%	1%	1%	2%	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 first and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

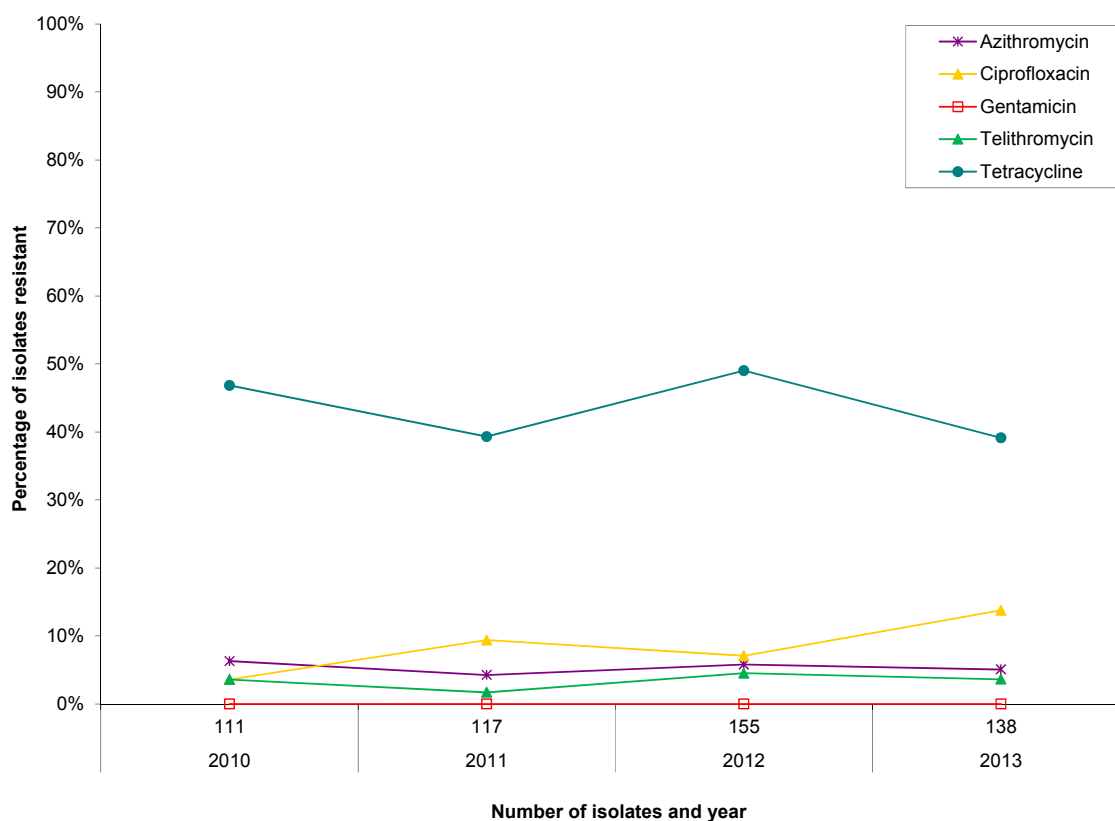
Additional temporal analyses for ampicillin and ceftiofur were conducted for *Salmonella* isolates from Ontario and Québec. These two antimicrobials and years (2004 and 2006) were selected due to a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2007 (start and end 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 18. Temporal variations in resistance of *Escherichia coli* isolates from chickens

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of isolates	153	131	220	167	180	170	171	119	164	173	174
Antimicrobial											
Ampicillin	41%	43%	38%	43%	39%	36%	43%	53%	40%	39%	39%
Ceftiofur	17%	25%	20%	21%	26%	20%	29%	34%	20%	17%	21%
Gentamicin	15%	11%	11%	8%	11%	8%	12%	10%	13%	13%	11%
Nalidixic acid	4%	3%	5%	4%	2%	4%	5%	4%	5%	8%	4%
Streptomycin	52%	53%	43%	34%	40%	44%	45%	50%	50%	50%	45%
Tetracycline	69%	56%	58%	51%	57%	51%	44%	52%	52%	51%	49%
Trimethoprim-sulfamethoxazole	8%	11%	9%	10%	4%	12%	9%	10%	15%	15%	18%

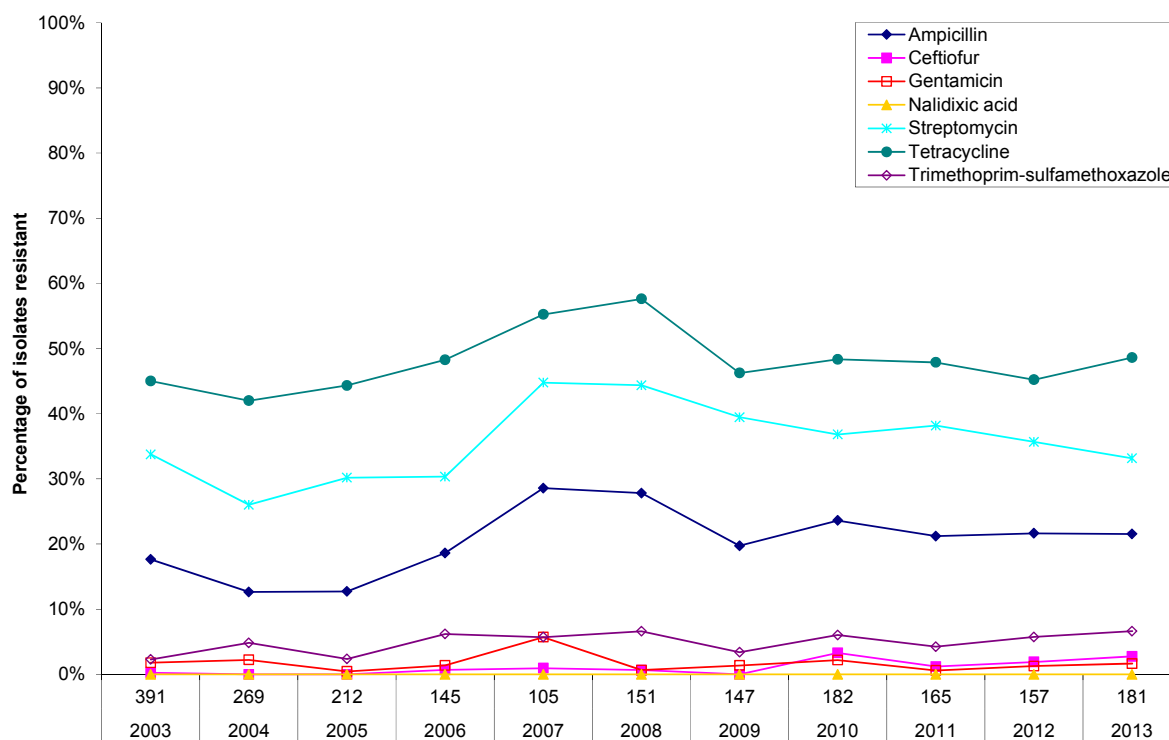
For the temporal analyses, the proportion (%) of isolates resistant to a specific antimicrobial over the current year has been compared to the proportion (%) of isolates resistant to the same antimicrobial during the first and the previous surveillance year (grey areas). The presence of blue areas indicates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

Additional temporal analyses for ampicillin and ceftiofur were conducted for *E. coli* isolates from Ontario and Québec. These two 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 19. Temporal variations in resistance of *Campylobacter* isolates from chickens

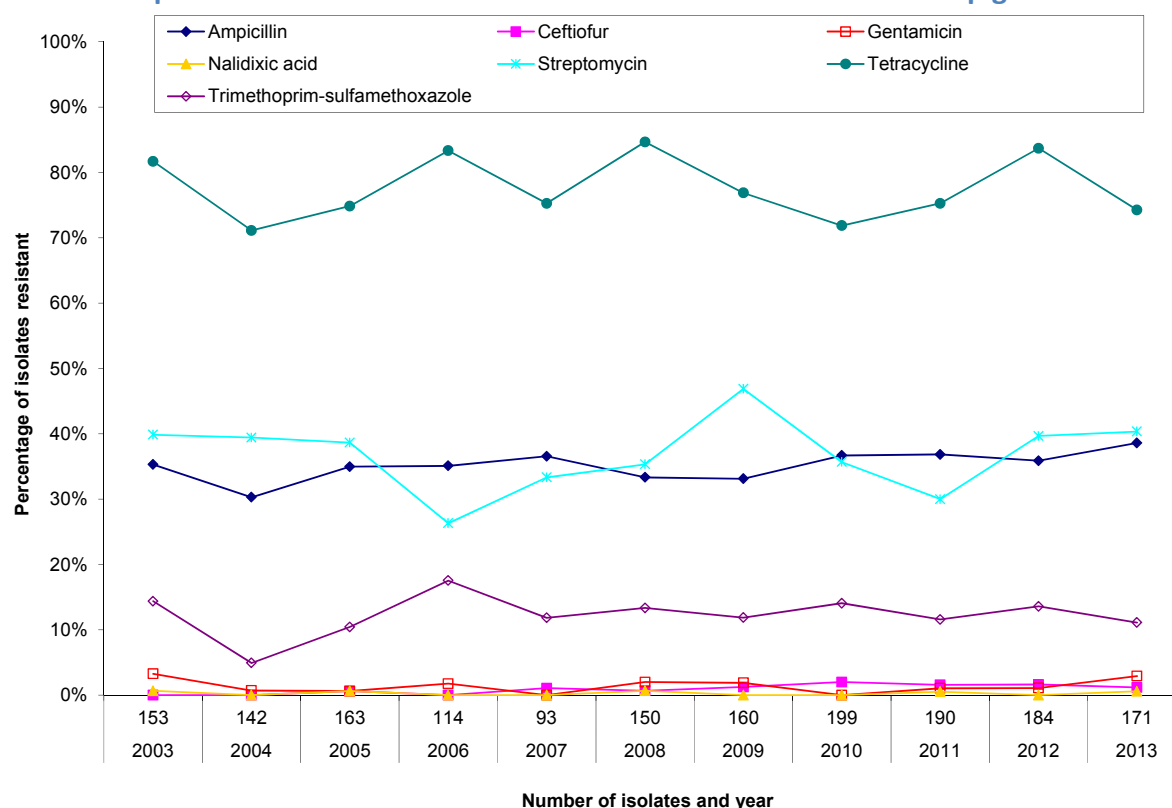
Year	2010	2011	2012	2013
Number of isolates	111	117	155	138
Antimicrobial				
Azithromycin	6%	4%	6%	5%
Ciprofloxacin	4%	9%	7%	14%
Gentamicin	0%	0%	0%	0%
Telithromycin	4%	2%	5%	4%
Tetracycline	47%	39%	49%	39%

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 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 20. Temporal variations in resistance of *Salmonella* isolates from pigs

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of isolates	391	269	212	145	105	151	147	182	165	157	181
Antimicrobial											
Ampicillin	18%	13%	13%	19%	29%	28%	20%	24%	21%	22%	22%
Ceftiofur	0%	0%	0%	1%	1%	1%	0%	3%	1%	2%	3%
Gentamicin	2%	2%	0%	1%	6%	1%	1%	2%	1%	1%	2%
Nalidixic acid	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Streptomycin	34%	26%	30%	30%	45%	44%	39%	37%	38%	36%	33%
Tetracycline	45%	42%	44%	48%	55%	58%	46%	48%	48%	45%	49%
Trimethoprim-sulfamethoxazole	2%	5%	2%	6%	6%	7%	3%	6%	4%	6%	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 first and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

Figure 21. Temporal variations in resistance of *Escherichia coli* isolates from pigs

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

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 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

MINIMUM INHIBITORY CONCENTRATIONS

Table 34. Distribution of minimum inhibitory concentrations among *Escherichia coli* from beef cattle

	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	64	4	8	0.0						1.6	21.9	60.9	15.6							
	Ceftiofur	64	0.50	0.50	0.0			4.7	34.4	59.4	1.6										
	Ceftriaxone	64	≤ 0.25	≤ 0.25	0.0				100.0												
	Ciprofloxacin	64	≤ 0.015	≤ 0.015	0.0	96.9			3.1												
II	Ampicillin	64	2	4	6.3						7.8	45.3	40.6					6.3			
	Azithromycin	64	4	4	0.0							17.2	76.6	6.3							
	Cefoxitin	64	4	8	0.0						4.7	12.5	67.2	14.1	1.6						
	Gentamicin	64	0.50	1	1.6			1.6	60.9	35.9							1.6				
	Kanamycin	64	≤ 8	≤ 8	0.0									100.0							
	Nalidixic acid	64	2	4	3.1						9.4	70.3	15.6	1.6				3.1			
	Streptomycin	64	≤ 32	64	10.9												89.1	6.3	4.7		
	Trimethoprim-sulfamethoxazole	64	≤ 0.12	≤ 0.12	4.7			90.6	4.7					4.7							
	Chloramphenicol	64	8	8	6.3							4.7	21.9	64.1	3.1			6.3			
III	Sulfisoxazole	64	≤ 16	> 256	15.6									70.3	14.1					15.6	
	Tetracycline	64	≤ 4	> 32	26.6								68.8	4.7	3.1	3.1	20.3				
IV																					

Table 35. Distribution of minimum inhibitory concentrations among *Campylobacter* from beef cattle

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	<i>Campylobacter coli</i>	9	0.125	64	11.1				66.7	22.2									11.1
Ciprofloxacin	<i>Campylobacter jejuni</i>	50	0.125	0.25	4.0			18.0	64.0	14.0						4.0			
Telithromycin	<i>Campylobacter coli</i>	9	4	4	0.0								33.3	66.7					
Telithromycin	<i>Campylobacter jejuni</i>	50	1	2	0.0					2.0	28.0	54.0	14.0		2.0				
II Azithromycin	<i>Campylobacter coli</i>	9	0.125	0.25	0.0				88.9	11.1									
Azithromycin	<i>Campylobacter jejuni</i>	50	0.032	0.064	0.0	2.0	60.0	30.0	8.0										
Clindamycin	<i>Campylobacter coli</i>	9	1	1	0.0					11.1	22.2	66.7							
Clindamycin	<i>Campylobacter jejuni</i>	50	0.125	0.25	0.0			6.0	68.0	26.0									
Erythromycin	<i>Campylobacter coli</i>	9	2	2	0.0							22.2	77.8						
Erythromycin	<i>Campylobacter jejuni</i>	50	0.5	0.5	0.0				2.0	42.0	48.0	8.0							
Gentamicin	<i>Campylobacter coli</i>	9	1	1	0.0						22.2	77.8							
Gentamicin	<i>Campylobacter jejuni</i>	50	1	1	0.0					16.0	78.0	6.0							
Nalidixic acid	<i>Campylobacter coli</i>	9	16	> 64	11.1										33.3	55.6			11.1
Nalidixic acid	<i>Campylobacter jejuni</i>	50	≤ 4	8	4.0									74.0	22.0				4.0
III Florfenicol	<i>Campylobacter coli</i>	9	2	2	0.0							22.2	77.8						
Florfenicol	<i>Campylobacter jejuni</i>	50	1	2	0.0					6.0	84.0	10.0							
Tetracycline	<i>Campylobacter coli</i>	9	> 64	> 64	77.8						11.1	11.1							77.8
Tetracycline	<i>Campylobacter jejuni</i>	50	32	> 64	58.0				22.0	12.0	6.0	2.0				4.0	6.0	26.0	22.0
IV																			

Table 36. Distribution of minimum inhibitory concentrations among *Salmonella* from chickens

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	107	≤ 1	> 32	18.7						77.6	1.9				1.9	0.9	17.8			
Ceftiofur	107	1	> 8	18.7				0.9	29.0	48.6	2.8				18.7					
Ceftriaxone	107	≤ 0.25	16	18.7				81.3							13.1	4.7	0.9			
Ciprofloxacin	107	≤ 0.015	≤ 0.015	0.0	90.7	7.5	1.9													
II Ampicillin	107	≤ 1	> 32	20.6						72.9	4.7	1.9					20.6			
Azithromycin	107	4	8	0.0					0.9	14.0	65.4	19.6								
Cefoxitin	107	2	32	18.7					0.9	18.7	45.8	15.9				15.9	2.8			
Gentamicin	107	0.50	1	0.9				17.8	72.0	9.3					0.9					
Kanamycin	107	≤ 8	≤ 8	0.0										100.0						
Nalidixic acid	107	4	4	0.0						1.9	45.8	49.5	2.8							
Streptomycin	107	≤ 32	> 64	41.1												58.9	12.1	29.0		
Trimethoprim-sulfamethoxazole	107	≤ 0.12	≤ 0.12	1.9				91.6	5.6	0.9				1.9						
III Chloramphenicol	107	8	8	0.0							4.7	37.4	57.0		0.9					
Sulfisoxazole	107	32	> 256	14.0											14.0	49.5	21.5	0.9		14.0
Tetracycline	107	≤ 4	> 32	39.3								60.7					39.3			
IV																				

Table 37. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chickens

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	174	4	32	20.1							12.6	43.1	21.8	2.3	12.6	7.5				
Ceftiofur	174	0.50	> 8	20.7				0.6	21.8	50.0	6.3	0.6			9.8	10.9				
Ceftriaxone	174	≤ 0.25	16	20.7					76.4	0.6	2.3				4.6	12.1	2.9	1.1		
Ciprofloxacin	174	≤ 0.015	≤ 0.015	0.0	92.5	3.4		4.0												
II Ampicillin	174	4	> 32	39.1						5.2	25.9	28.7	1.1				39.1			
Azithromycin	174	4	8	0.0						1.1	22.4	60.9	15.5							
Cefoxitin	174	4	> 32	20.1							5.2	51.1	21.8	1.7	3.4	16.7				
Gentamicin	174	0.50	16	11.5				4.0	48.3	33.9	0.6	0.6		1.1	2.3	9.2				
Kanamycin	174	≤ 8	> 64	16.7										81.6	1.7			16.7		
Nalidixic acid	174	2	4	4.0					0.6	11.5	72.4	11.5					4.0			
Streptomycin	174	≤ 32	> 64	45.4												54.6	13.8	31.6		
Trimethoprim-sulfamethoxazole	174	≤ 0.12	> 4	17.8				70.1	10.3	1.7				17.8						
III Chloramphenicol	174	8	8	2.9							2.9	36.2	54.6		3.4		2.9			
Sulfisoxazole	174	32	> 256	44.8											44.8	9.8		0.6	44.8	
Tetracycline	174	≤ 4	> 32	49.4								50.6					7.5	42.0		
IV																				

Table 38. Distribution of minimum inhibitory concentrations among *Campylobacter* from chickens

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	<i>Campylobacter coli</i>	12	0.125	0.5	8.3				25.0	41.7	16.7	8.3				8.3			
Ciprofloxacin	<i>Campylobacter jejuni</i>	123	0.125	8	13.0				16.3	54.5	15.4	0.8				4.1	8.9		
Ciprofloxacin	<i>Campylobacter</i> spp.	3	4	4	66.7				33.3						66.7				
Telithromycin	<i>Campylobacter coli</i>	12	1	16	16.7					41.7	8.3	8.3	25.0			16.7			
Telithromycin	<i>Campylobacter jejuni</i>	123	0.5	2	2.4					8.9	48.8	29.3	9.8		0.8	2.4			
Telithromycin	<i>Campylobacter</i> spp.	3	4	4	0.0					33.3					66.7				
II Azithromycin	<i>Campylobacter coli</i>	12	0.125	> 64	16.7		8.3	41.7	33.3										16.7
Azithromycin	<i>Campylobacter jejuni</i>	123	0.064	0.125	3.3	1.6	38.2	37.4	18.7	0.8									3.3
Azithromycin	<i>Campylobacter</i> spp.	3	0.25	> 64	33.3				33.3	33.3									33.3
Clindamycin	<i>Campylobacter coli</i>	12	0.25	8	16.7				50.0	16.7	16.7					8.3	8.3		
Clindamycin	<i>Campylobacter jejuni</i>	123	0.125	0.25	1.6			13.8	52.8	26.8	3.3			1.6	1.6				
Clindamycin	<i>Campylobacter</i> spp.	3	0.25	16	33.3				33.3	33.3						33.3			
Erythromycin	<i>Campylobacter coli</i>	12	0.5	> 64	16.7					41.7	25.0	16.7							16.7
Erythromycin	<i>Campylobacter jejuni</i>	123	0.25	1	3.3				2.4	49.6	36.6	8.1							3.3
Erythromycin	<i>Campylobacter</i> spp.	3	4	> 64	33.3					33.3				33.3					33.3
Gentamicin	<i>Campylobacter coli</i>	12	0.5	1	0.0					8.3	50.0	41.7							
Gentamicin	<i>Campylobacter jejuni</i>	123	1	1	0.0				1.6	0.8	40.7	56.9							
Gentamicin	<i>Campylobacter</i> spp.	3	2	2	0.0						33.3	66.7							
Nalidixic acid	<i>Campylobacter coli</i>	12	≤ 4	16	8.3										58.3	25.0	8.3		8.3
Nalidixic acid	<i>Campylobacter jejuni</i>	123	≤ 4	> 64	13.0										56.9	30.1		0.8	12.2
Nalidixic acid	<i>Campylobacter</i> spp.	3	> 64	> 64	100.0													33.3	66.7
III Florfenicol	<i>Campylobacter coli</i>	12	1	2	0.0						8.3	75.0	16.7						
Florfenicol	<i>Campylobacter jejuni</i>	123	1	1	0.0						4.9	86.2	8.9						
Florfenicol	<i>Campylobacter</i> spp.	3	1	2	0.0						33.3	33.3	33.3						
Tetracycline	<i>Campylobacter coli</i>	12	0.5	> 64	33.3					33.3	25.0	8.3							33.3
Tetracycline	<i>Campylobacter jejuni</i>	123	0.25	> 64	39.8				22.0	28.5	4.1	2.4	0.8	2.4		0.8	3.3	14.6	21.1
Tetracycline	<i>Campylobacter</i> spp.	3	0.25	32	33.3					66.7							33.3		
IV																			

...working towards the preservation of effective antimicrobials for humans and animals...

Table 39. Distribution of minimum inhibitory concentrations among *Salmonella* isolates from pigs

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	181	≤ 1	16	2.8								72.9	6.1	2.8	6.1	9.4	1.1	1.7			
Ceftiofur	181	1	2	2.8					1.1	24.3	64.1	7.7				2.8					
Ceftriaxone	181	≤ 0.25	≤ 0.25	2.8					96.7	0.6						1.1	0.6	1.1			
Ciprofloxacin	181	≤ 0.015	0.03	0.0		87.3	10.5	2.2													
II																					
Ampicillin	181	≤ 1	> 32	21.5								69.6	6.6	1.7		0.6		21.5			
Azithromycin	181	4	8	0.6						0.6	0.6	7.7	69.6	18.2	2.8	0.6					
Cefoxitin	181	2	8	2.8						0.6	12.7	44.2	31.5	7.7	0.6	0.6	2.2				
Gentamicin	181	0.50	1	1.7					19.9	68.5	9.9				1.7						
Kanamycin	181	≤ 8	≤ 8	7.2											92.8			7.2			
Nalidixic acid	181	4	4	0.0							0.6	40.9	54.1	4.4							
Streptomycin	181	≤ 32	> 64	33.1												66.9	5.5	27.6			
Trimethoprim-sulfamethoxazole	181	≤ 0.12	0.25	6.6					74.6	16.0	2.8				6.6						
III																					
Chloramphenicol	181	8	> 32	11.6								1.1	22.1	61.3	3.9	0.6	11.0				
Sulfisoxazole	181	64	> 256	36.5											11.0	32.0	20.4				36.5
Tetracycline	181	≤ 4	> 32	48.6									51.4			4.4	44.2				
IV																					

Table 40. Distribution of minimum inhibitory concentrations among *Escherichia coli* isolates from pigs

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	171	4	8	1.8								1.8	15.8	39.8	37.4	3.5	0.6	1.2			
Ceftiofur	171	0.50	0.50	1.2					1.8	34.5	59.1	2.9	0.6		0.6	0.6					
Ceftriaxone	171	≤ 0.25	≤ 0.25	1.2					98.2		0.6					0.6	0.6				
Ciprofloxacin	171	≤ 0.015	≤ 0.015	0.0		96.5	0.6	0.6	1.2	0.6	0.6										
II																					
Ampicillin	171	4	> 32	38.6								4.1	28.1	26.9	1.2	1.2		38.6			
Azithromycin	171	4	8	0.6								1.8	17.0	70.2	10.5		0.6				
Cefoxitin	171	4	8	1.8								0.6	13.5	63.7	18.7	1.8		1.8			
Gentamicin	171	0.50	1	2.9					7.0	59.6	30.4					0.6	2.3				
Kanamycin	171	≤ 8	> 64	17.0											82.5	0.6		1.2	15.8		
Nalidixic acid	171	2	4	0.6								11.1	74.3	12.9	0.6	0.6		0.6			
Streptomycin	171	≤ 32	> 64	40.4													59.6	16.4	24.0		
Trimethoprim-sulfamethoxazole	171	≤ 0.12	> 4	11.1					70.2	16.4	1.2	0.6	0.6		11.1						
III																					
Chloramphenicol	171	8	> 32	16.4								1.8	29.8	50.3		1.8	6.4	9.9			
Sulfisoxazole	171	≤ 16	> 256	39.2												53.2	7.0	0.6			39.2
Tetracycline	171	> 32	> 32	74.3									24.0	1.8		0.6	6.4	67.3			
IV																					

Table 41. Distribution of minimum inhibitory concentrations among *Campylobacter* from pigs

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	<i>Campylobacter coli</i>	248	0.125	16	13.3		0.4	9.3	44.4	30.2	2.4			2.4	9.7	1.2					
	Ciprofloxacin	<i>Campylobacter jejuni</i>	2	0.125	0.125	0.0				100.0												
	Ciprofloxacin	<i>Campylobacter</i> spp.	4	0.25	0.25	0.0			25.0	25.0	50.0											
	Telithromycin	<i>Campylobacter coli</i>	248	4	16	40.3				5.7	3.6	11.7	26.6	5.2	6.9	40.3						
	Telithromycin	<i>Campylobacter jejuni</i>	2	8	8	0.0					50.0				50.0							
	Telithromycin	<i>Campylobacter</i> spp.	4	1	2	0.0				25.0		50.0	25.0									
II	Azithromycin	<i>Campylobacter coli</i>	248	0.5	> 64	49.2		0.4	19.8	25.0	4.4	0.8	0.4					0.4	48.8			
	Azithromycin	<i>Campylobacter jejuni</i>	2	> 64	> 64	50.0		50.0											50.0			
	Azithromycin	<i>Campylobacter</i> spp.	4	0.125	0.5	0.0			50.0	25.0		25.0										
	Clindamycin	<i>Campylobacter coli</i>	248	4	16	44.4				4.4	9.3	10.5	3.6	7.7	20.2	23.4	14.5	6.5				
	Clindamycin	<i>Campylobacter jejuni</i>	2	8	8	50.0				50.0						50.0						
	Clindamycin	<i>Campylobacter</i> spp.	4	0.5	> 16	25.0				25.0	25.0							25.0				
	Erythromycin	<i>Campylobacter coli</i>	248	4	> 64	49.2					6.1	8.5	27.0	7.7	1.2	0.4		2.0	1.2			
	Erythromycin	<i>Campylobacter jejuni</i>	2	> 64	> 64	50.0					50.0								50.0			
	Erythromycin	<i>Campylobacter</i> spp.	4	1	2	0.0					25.0	25.0	25.0	25.0								
	Gentamicin	<i>Campylobacter coli</i>	248	1	1	0.0						3.2	89.1	7.3	0.4							
	Gentamicin	<i>Campylobacter jejuni</i>	2	1	1	0.0						50.0	50.0									
	Gentamicin	<i>Campylobacter</i> spp.	4	1	1	0.0						50.0										
	Nalidixic acid	<i>Campylobacter coli</i>	248	8	> 64	13.3									24.6	55.2	6.9		1.6			
	Nalidixic acid	<i>Campylobacter jejuni</i>	2	≤ 4	≤ 4	0.0									100.0							
	Nalidixic acid	<i>Campylobacter</i> spp.	4	> 64	> 64	75.0									25.0				25.0			
	III	Florfenicol	<i>Campylobacter coli</i>	248	1	2	0.0						17.3	62.1	19.4	1.2						
Florfenicol		<i>Campylobacter jejuni</i>	2	1	1	0.0							100.0									
Florfenicol		<i>Campylobacter</i> spp.	4	1	1	0.0						25.0	75.0									
Tetracycline		<i>Campylobacter coli</i>	248	> 64	> 64	79.0				0.4	6.1	5.2	2.8	3.6	0.4	2.4	7.7	8.1	13.3			
Tetracycline		<i>Campylobacter jejuni</i>	2	64	64	100.0													100.0			
IV	Tetracycline	<i>Campylobacter</i> spp.	4	8	16	25.0					25.0				50.0	25.0						

Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

RECOVERY RESULTS

Table 42. Abattoir surveillance recovery rates

CIPARS Component/ Animal species	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted					
		<i>Escherichia coli</i>		<i>Salmonella</i>		<i>Campylobacter</i>	<i>Enterococcus</i>
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
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
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

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.

FARM SURVEILLANCE

KEY FINDINGS

GROW-FINISHER PIGS

SALMONELLA (n = 99)

No significant temporal variations were detected in the percentages of *Salmonella* isolates with resistance to the selected antimicrobials between 2013 and 2012 or between 2013 and 2006 (Figure 22).

Although it was not statistically significant, there was an increase in ampicillin resistance from 25% to 40% between 2012 and 2013 (Figure 22). Historically, over the last 7 years, ampicillin resistance has been equal to 35% or less (Figure 22).

No isolates had resistance to greater than 5 classes of antimicrobials (Table 43). Three isolates had resistance to 10 antimicrobials and 5 antimicrobial classes (Table 43). This included 1 Typhimurium var. 5- with an ACKSSuT-A2C-CRO pattern, 1 Mbandaka and 1 Livingston both with the ACSSuT-A2C-CRO-SXT pattern.

ESCHERICHIA COLI (n = 1,573)¹⁴

Resistance to ampicillin was significantly lower in 2013 (31%) than in 2006 (35%) (Figure 23).

Resistance to streptomycin was also significantly lower in 2013 (34%) than in 2006 (37%), or in 2012 (44%) (Figure 23). The percentage of isolates with resistance to ceftiofur was significantly lower in 2013 (1%) than in 2012 (2%) (Figure 23).

No isolates had resistance to greater than 6 classes of antimicrobials (Table 44). Four isolates had resistance to 12 antimicrobials and 6 antimicrobial classes (Table 44). The pattern detected in all 4 of these isolates was A2C-AMP-AZM-CHL-CRO-KAN-SSS-STR-SXT-TET.

¹⁴ Up to 3 generic *E. coli* isolates per positive sample were kept for analysis. The expected number of total isolates was 1,602 (534 x 3) but only 1,573 isolates were collected for antimicrobials susceptibility testing leaving a difference of 29 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

Farm Surveillance in broiler chickens was implemented in April 2013, thus the temporal figures presented in other surveillance components (or *Farm Surveillance* in pigs) are not yet available. The figures included in this section present adjusted prevalence rates of resistance (with lower and upper confidence intervals). The data were adjusted for clustering to account for multiple samples collected per farm. Chick placement (chick pads or environmental swabs) and preharvest results are both presented.

SALMONELLA (n = 280)

Chick placement (n = 51)

Across all provinces sampled, the top 3 *Salmonella* serovars were Kentucky, Enteritidis, and Senftenberg (Table 45). Only 1 Heidelberg isolate was isolated (Québec). Provincial differences in serovar distribution were noted with Enteritidis being the most common serovar in British Columbia (71%, 12/17 isolates) and Kentucky in the rest of the provinces sampled: Alberta (50%, 5/10), Ontario (93%, 12/13), and Québec (73%, 8/11) (Table 45). Differences in serovar distribution were also observed in isolates from the 2 types of samples (Table 46). Kentucky was the most common serovar from any sample type, chick pads (57%, 24/42 isolates), environmental swabs (44%, 4/9) (Table 46). Ninety-three percent (14/15) of the Enteritidis were isolated from chick pad samples but all the isolates, including 1 from the environment were susceptible to all antimicrobial tested (Table 46).

No ciprofloxacin and nalidixic acid resistance were observed in any serovar (Figure 24).

Provincial differences in the proportion of ceftiofur resistant isolates were noted: British Columbia (18%), Alberta (35%), Ontario (58%), and Québec (0%) (Figure 24). Although not statistically significant, the proportion of resistance to Category I and II β -lactam antimicrobials, except cefoxitin, was slightly higher in environmental isolates (33%) compared to chick pads isolates (26%) (Figure 25). Since the total number of isolates was small, caution in interpreting these results is recommended.

No isolate was resistant to 6 or 7 classes of antimicrobials. Only 1 isolate was resistant to 4 or 5 antimicrobial classes and 19 isolates were resistant to 2 or 3 antimicrobial classes (Table 45 and Table 46). The patterns containing the highest number of antimicrobials were A2C-AMP-CRO-STR-TET and A2C-AMP-CRO. The A2C-AMP-CRO-STR-TET pattern was also the most common in chick placement isolates (n = 7), followed by STR-TET (n = 6).

Preharvest (n = 229)

Across all provinces sampled, the top 3 *Salmonella* serovars were Kentucky, Enteritidis, and Heidelberg (Table 49). No Enteritidis isolate was recovered in Québec (Table 49). Provincial differences in serovar distribution were observed at preharvest, with Enteritidis being the most common serovar in British Columbia (46%, 31/68) and Kentucky in all other provinces sampled: Alberta (29%, 7/24), Ontario (54%, 35/65), and Québec (50%, 36/72) (Table 49). These results were similar to chick placement (Table 45).

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

No ciprofloxacin resistance was observed in any serovar (Table 49). Nalidixic acid resistance was observed in 4 Kentucky isolates (4%, 4/89) from British Columbia (Table 49). Across all provinces sampled, ceftiofur resistance was 22% and provincial differences were also observed: British Columbia (18%), Alberta (32%), Ontario (43%), and Québec (4%) (Figure 28). Overall, 23% of isolates exhibited resistance to most of the β -lactams (ampicillin, amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone) but a lower proportion (18%) of isolates were resistant to ceftiofur (Table 49). Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens on farm at pre-harvest is also presented in Table 49. No isolate was resistant to 6 or 7 antimicrobial classes (Table 49). Six isolates were resistant to 4 or 5 classes of antimicrobials and 84 isolates were resistant to 2 or 3 classes of antimicrobials (Table 49). The patterns containing the highest number of antimicrobials were A2C-ACSSuT-CRO and A2C-AMP-CRO-STR-TET. The STR-TET was the most common pattern (n = 40), followed by A2C-AMP-CRO-STR-TET (n=21) and A2C-AMP-CRO (n = 13).

ESCHERICHIA COLI (n = 576)

Chick placement (n = 191)

Overall, generic *E. coli*¹⁵ was recovered in 81% of the samples (Table 60). Nalidixic acid resistance was observed in 4% (adjusted prevalence) of chick pads isolates and 2% of environmental isolates (Figure 27).

Provincial differences in the proportion of ceftiofur resistant isolates were observed: British Columbia (67%), Alberta (68%), Ontario (17%) and Québec (21%) (Figure 26). Sample type differences in the proportion of ceftiofur resistance was also noted: chick pads (44%) and environmental (25%) (Figure 27).

No isolate was resistant to 6 or 7 antimicrobial classes (Table 47 and Table 48). Fifty isolates were resistant to 4 or 5 antimicrobial classes and 67 isolates were resistant to 2 or 3 antimicrobial classes (Table 47 and Table 48). The patterns presenting the highest number of antimicrobials were A2C-AMP and A2C-ACSSUT-CRO-GEN-SXT. The A2C-AMP pattern was the most common pattern observed.

Preharvest (n = 385)

Only 1 chicken *E. coli* isolate, recovered from Ontario was resistant to ciprofloxacin (Table 50). Resistance to azithromycin was detected in 1 isolate from Ontario and 1 isolate from Québec (Table 50). As in placement, resistance to nalidixic acid was noted in 4% of samples: British Columbia (10%), Alberta (8%), Ontario (2%), and Québec (1%) (Figure 29). Across all provinces, resistance to ceftiofur was 30% and provincial differences were also observed: British Columbia (61%), Alberta (42%), Ontario (13%), and Québec (17%) (Figure 29). As in *Salmonella*, the proportion of *E. coli* resistant to β -lactam antimicrobials varied depending on the antimicrobial (ampicillin: 61%, amoxicillin-clavulanic acid: 32%, ceftriaxone, ceftiofur: 32%, and ceftiofur: 30%) (Table 50).

¹⁵ Consisted of normal avian gut, environmental commensals, and avian pathogenic *E. coli* responsible for yolk sacculitis and septicemic diseases. As in other components, isolates were not further characterized.

No isolate was resistant to 6 or 7 antimicrobial classes (Table 50). Ninety isolates were resistant to 4 or 5 antimicrobial classes and 161 isolates were resistant to 2 or 3 antimicrobial classes (Table 50). As in placement, the patterns presenting the highest number of antimicrobials were A2C-ACSSUT-CRO-GEN-SXT and A2C-AMP. The latter pattern (n = 34) was the most common one.

CAMPYLOBACTER (n = 81)

Chick placement

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

Preharvest (n = 81)

Overall resistance to ciprofloxacin was 16% and resistant isolates were largely from these 2 provinces: British Columbia (30%), Ontario (20%) (Figure 30). Ciprofloxacin resistance was observed in only 1 isolate in Québec and no ciprofloxacin resistance was noted in Alberta (Figure 30). No azithromycin and telithromycin resistance were observed (Figure 30). No isolates were resistant to 4 or 7 antimicrobial classes (Table 51). Sixteen isolates were resistant to 2 or 3 antimicrobial classes and 35 isolates were resistant to 1 antimicrobial class (Table 51). The pattern presenting the highest number of antimicrobials was CIP-NAL-TET (n = 16).

MULTICLASS RESISTANCE

Table 43. Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
National																					
Typhimurium var. 5-Derby	25 (25.3)		7	1	17			1	17	18	2	2	2	2	17	2		16			25
Infantis	19 (19.2)	2	1	14	2				16	2					16						16
4,5,12:i:-	10 (10.1)	9	1																		1
Brandenburg	9 (9.1)				9			6	9	9					9	1	1				9
California	8 (8.1)	5			3					3					3			3			3
Schwarzengrund	6 (6.1)	4	1	1			2	2	2						1						1
4,12:i:-	4 (4.0)	4																			
4,12:i:-	3 (3.0)	3																			
Livingstone	3 (3.0)		2		1				1	1					1						3
Ohio	3 (3.0)			2	1				3	1	1	1	1	1	3	1		1			3
Less common serovars	2 (2.0)	1			1			1	1	1		1		1	1	1					1
	7 (7.1)	3	1	1	2		1		2	3	2	2	2	2	4	3		2			2
Total	99 (100)	31	13	19	36		3	10	51	38	5	6	5	6	55	8	1	22			64

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 44. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from pigs

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	Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET	
Pigs	1,573	260	322	703	284	4	16	197	535	489	22	21	18	18	714	210	14	319		5	1186	

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 45. Number of antimicrobial classes in resistance patterns of *Salmonella* from chicks and barn environment at chick placement, by province

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	Phenicol	Quinolones		Tetracyclines					
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET					
British Columbia																										
Enteritidis	12 (70.6)	12																								
Kentucky	3 (17.6)	3					3			3	3	3	3	3								3				
4,5,12:i:-	1 (5.9)	1																								
Tennessee	1 (5.9)						1								1						1					
Total	17 (100)	13	3	1						4	3	3	3	3	3	1						1	4			
Alberta																										
Kentucky	5 (50.0)	5					5			5	5	5	2	5								5				
Enteritidis	3 (30.0)	3																								
Senftenberg	2 (20.0)	2																								
Total	10 (100)	5	5						5	5	5	5	2	5								5				
Ontario																										
Kentucky	12 (93.3)	6	2	4						4	6	6	6	4	6								4			
Senftenberg	1 (7.7)	1					1	1	1											1						1
Total	13 (100)	6	2	5						1	1	5	6	6	6	4	6	1						5		
Québec																										
Kentucky	8 (72.7)	2					6	6													8					
Give	2 (18.2)	2																								
Heidelberg	1 (9.1)	1																								
Total	11 (100)	3	2	6						6											8					
National																										
Kentucky	28 (54.9)	6	4	18						18	14	14	14	9	14								20			
Enteritidis	15 (29.4)	15																								
Senftenberg	3 (5.9)	2	1			1		1											1						1	
Give	2 (3.9)	2																								
Heidelberg	1 (2.0)	1																								
4,5,12:i:-	1 (2.0)	1																								
Tennessee	1 (2.0)						1								1						1	1				
Total	51 (100)	27	4	19	1	1		1	20	14	14	14	9	14	2						1	22				

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 46. Number of antimicrobial classes in resistance patterns of *Salmonella* from chicks and barn environment at chick placement

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														
		0	1	2–3	4–5	6–7	Aminoglycosides			β-Lactams					Folate pathway inhibitors		Macrolides	Phenicol	Quinolones		Tetracyclines
							GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Chick pads																					
Kentucky	24 (57.1)	6	3	15					15	11	11	11	8	11							17
Enteritidis	14 (33.3)	14																			
Give	2 (4.8)	2																			
4,5,12:i:-	1 (2.4)	1																			
Senftenberg	1 (2.4)			1			1	1	1						1						1
Total	42 (100)	23	3	16			1	1	16	11	11	11	8	11	1						18
Environmental																					
Kentucky	4 (44.4)		1	3					3	3	3	3	1	3							3
Senftenberg	2 (22.2)	2																			
Enteritidis	1 (11.1)	1																			
Heidelberg	1 (11.1)	1																			
Tennessee	1 (11.1)			1					1						1			1			1
Total	9 (100)	4	1	3	1				4	3	3	3	1	3	1			1			4
All sample types																					
Kentucky	28 (54.9)	6	4	18					18	14	14	14	9	14							20
Enteritidis	15 (29.4)	15																			
Senftenberg	3 (5.9)	2	1				1	1	1						1						1
Give	2 (3.9)	2																			
Heidelberg	1 (2.0)	1																			
4,5,12:i:-	1 (2.0)	1																			
Tennessee	1 (2.0)			1					1						1			1			1
Total	51 (100)	27	4	19	1		1	1	20	14	14	14	9	14	2			1			22

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 47. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chicks and barn environment at chick placement, by province

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														
		0	1	2–3	4–5	6–7	Aminoglycosides			β-Lactams					Folate pathway inhibitors		Macrolides	Phenicol	Quinolones		Tetracyclines
							GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	43 (22.5)	9	14	10	10		6	2	9	33	24	29	24	29	16	3		1		1	19
Alberta	31 (16.2)	1	9	11	10		12	4	10	25	21	21	21	21	12	2		2		2	19
Ontario	64 (33.5)	13	13	25	13		16	1	18	32	11	12	11	11	23	10		5		1	39
Québec	53 (27.7)	9	6	21	17		23	4	28	24	12	11	12	11	32	10		6		2	35
National	191 (100)	32	42	67	50		57	11	65	114	68	73	68	72	83	25		14		6	112

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 48. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chicks and barn environment at chick placement

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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Chick pads	129 (67.5)	17	29	45	38		45	8	45	83	52	56	52	56	58	18		10		5	79
Environmental	62 (32.5)	15	13	22	12		12	3	20	31	16	17	16	16	25	7		4		1	33
Total	191 (100)	32	42	67	50		57	11	65	114	68	73	68	72	83	25		14		6	112

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 49. Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens on farm at pre-harvest

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														
		0	1	2–3	4–5	6–7	Aminoglycosides			β-Lactams					Folate pathway inhibitors		Macrolides	Phenicol	Quinolones		Tetracyclines
							GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	31 (45.6)	31																			
Cubana	13 (19.1)	13																			
Kentucky	11 (16.2)			7	4				11	11	11	11	10	11					4		11
4,5,12:i:-	7 (10.3)	4	3							3	3	3	3	3							
Liverpool	3 (4.4)	3																			
Infantis	2 (2.9)	2																			
Braenderup	1 (1.5)	1																			
Total	68 (100)	54	3	7	4				11	14	14	14	13	14					4		11
Alberta																					
Kentucky	7 (29.2)			7					7	7	7	7	7	7							7
Schwarzengrund	4 (16.7)	4																			
Cubana	3 (12.5)	3																			
Infantis	3 (12.5)	2	1							1	1	1	1	1							
Enteritidis	2 (8.3)	2																			
4,5,12:i:-	2 (8.3)			1	1				2	2					2						1
Hadar	1 (4.2)			1					1												1
Anatum	1 (4.2)			1					1						1						
Mbandaka var. 14+	1 (4.2)	1																			
Total	24 (100)	12	1	10	1				11	10	8	8	8	8	3						9
Ontario																					
Kentucky	35 (53.8)	10	9	16					16	22	22	22	12	22							16
Heidelberg	21 (32.3)	15		6					4	3	3	3	3	3	3	3		3			2
Enteritidis	2 (3.1)	2																			
Hadar	2 (3.1)			2					2												2
Less common serovars	5 (7.7)	1	1	2	1				3	4	3	3	3	3	2			1			2
Total	65 (100)	28	10	26	1				25	29	28	28	18	28	5	3		4			22
Québec																					
Kentucky	36 (50.0)		2	34			1		34	1	1	1	1	1	1						36
Ohio	7 (9.7)	7																			
Give	6 (8.3)	6																			
Heidelberg	5 (6.9)	2	2	1					1	1	1	1	1	1	2	2					
Litchfield	4 (5.6)	4																			
Schwarzengrund	4 (5.6)	1		3					1						3						3
8,20:-z6	2 (2.8)		1	1					1												2
Infantis	2 (2.8)	2																			
Less common serovars	6 (8.3)	3	1	2					1	1	1	1	1	1	1	1					2
Total	72 (100)	25	6	41			1		38	3	3	3	3	3	7	3					43
National																					
Kentucky	89 (38.9)	10	11	64	4		1		68	41	41	41	30	41	1				4		70
Enteritidis	35 (15.3)	35																			
Heidelberg	26 (11.4)	17	2	7					5	4	4	4	4	4	5	5		3			2
Cubana	16 (7.0)	16																			
4,5,12:i:-	9 (3.9)	4	3	1	1				2	5	3	3	3	3	2						1
Infantis	8 (3.5)	6	2							2	2	2	2	2							
Schwarzengrund	8 (3.5)	5		3					1						3						3
Ohio	7 (3.1)	7																			
Give	6 (2.6)	6																			
Less common serovars	25 (10.9)	13	2	9	1				9	4	3	3	3	3	4	1		1			9
Total	229 (100)	119	20	84	6		1		85	56	53	53	42	53	15	6		4		4	85

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 50. Number of antimicrobial classes in resistance patterns of *Escherichia coli* from chickens on farm at preharvest

Province / 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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
British Columbia	94 (24.4)	8	30	33	23	8	9	36	83	57	59	57	57	27	5		1		9	38	
Alberta	60 (15.6)	14	6	24	16	6	13	31	41	29	28	28	25	17	4		4		5	32	
Ontario	120 (31.2)	29	28	41	22	12	10	44	59	18	17	18	16	49	28	1	8	1	2	55	
Quebec	111 (28.8)	6	13	63	29	25	12	72	53	21	19	20	19	84	45	1	17		1	67	
National	385 (100)	57	77	161	90	51	44	183	236	125	123	123	117	177	82	2	30	1	17	192	

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 51. Number of antimicrobial classes in resistance patterns of *Campylobacter* from chicken on farm at preharvest

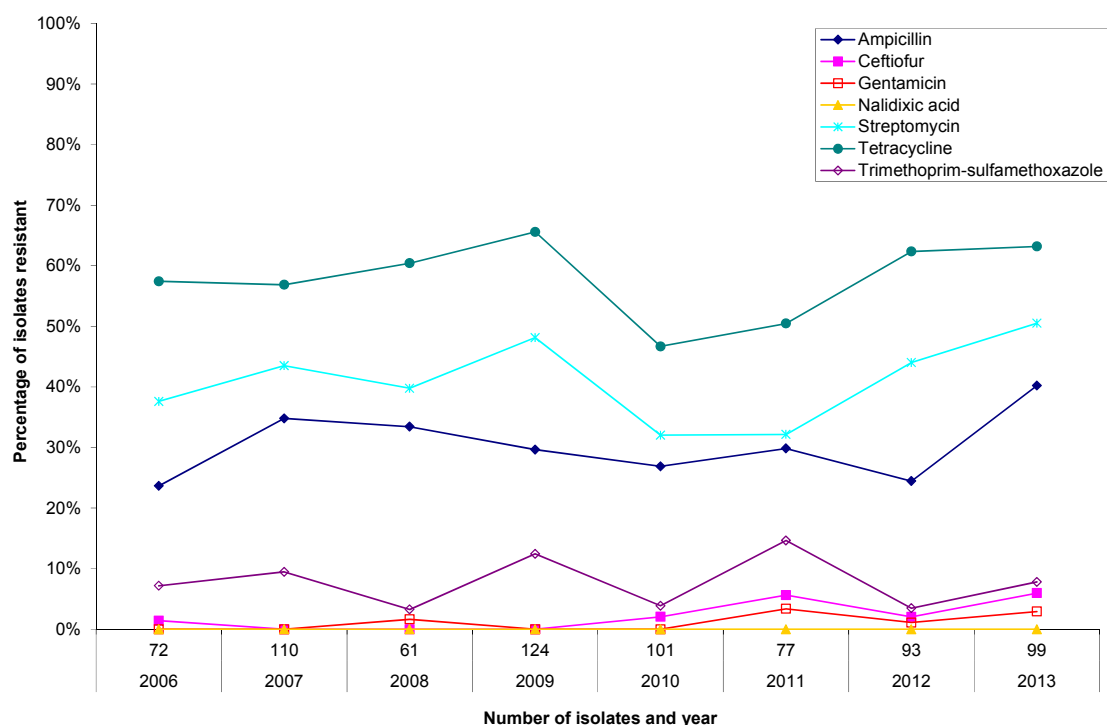
Province or region / species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial									
							Aminoglycosides	Ketolides	Lincosamides	Macrolides	Phenicol	Quinolones	Tetracyclines			
		0	1	2-3	4-5	6-7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET	
Alberta																
Campylobacter coli	0 (0)															
Campylobacter jejuni	15 (100)	6	9													9
Total	15 (100)	6	9													9
British Columbia																
Campylobacter coli	0 (0)															
Campylobacter jejuni	27 (100)	11	5	11									11	11		16
Total	27 (100)	11	5	11									11	11		16
Ontario																
Campylobacter coli	1 (5.0)	1														
Campylobacter jejuni	19 (95.0)	8	7	4									4	4		11
Total	20 (100)	9	7	4									4	4		11
Québec																
Campylobacter coli	4 (21.1)		3	1									1	1		4
Campylobacter jejuni	15 (78.9)	4	11													11
Total	19 (100)	4	14	1									1	1		15
National																
Campylobacter coli	5 (6.2)	1	3	1									1	1		4
Campylobacter jejuni	76 (93.8)	29	32	15									15	15		47
Total	81 (100)	30	35	16									16	16		51

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

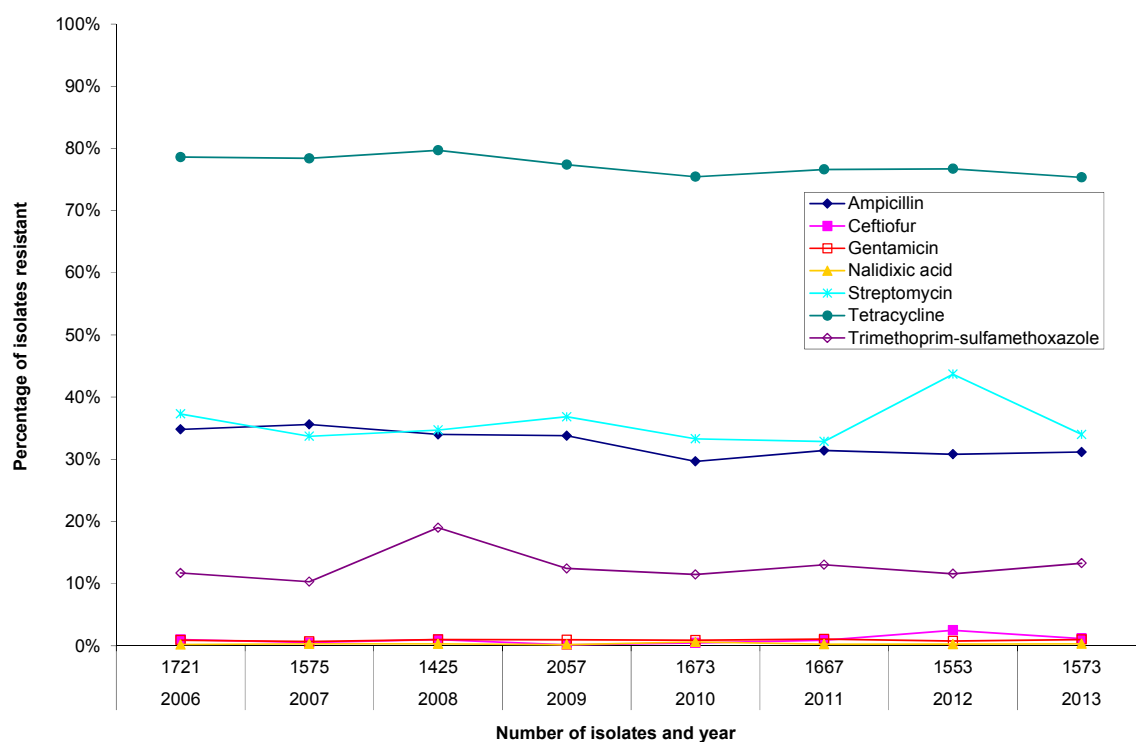
TEMPORAL ANTIMICROBIAL RESISTANCE SUMMARY

Figure 22. Temporal variations in resistance of *Salmonella* isolates from pigs



Year	2006	2007	2008	2009	2010	2011	2012	2013
Number of isolates	72	110	61	124	101	77	93	99
Antimicrobial								
Ampicillin	24%	35%	33%	30%	27%	30%	25%	40%
Ceftiofur	1%	0%	0%	0%	2%	6%	2%	6%
Gentamicin	0%	0%	2%	0%	0%	3%	1%	3%
Nalidixic acid	0%	0%	0%	0%	0%	0%	0%	0%
Streptomycin	38%	44%	40%	48%	32%	32%	46%	50%
Tetracycline	57%	57%	60%	66%	47%	50%	61%	63%
Trimethoprim-sulfamethoxazole	7%	9%	3%	12%	4%	15%	4%	8%

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 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

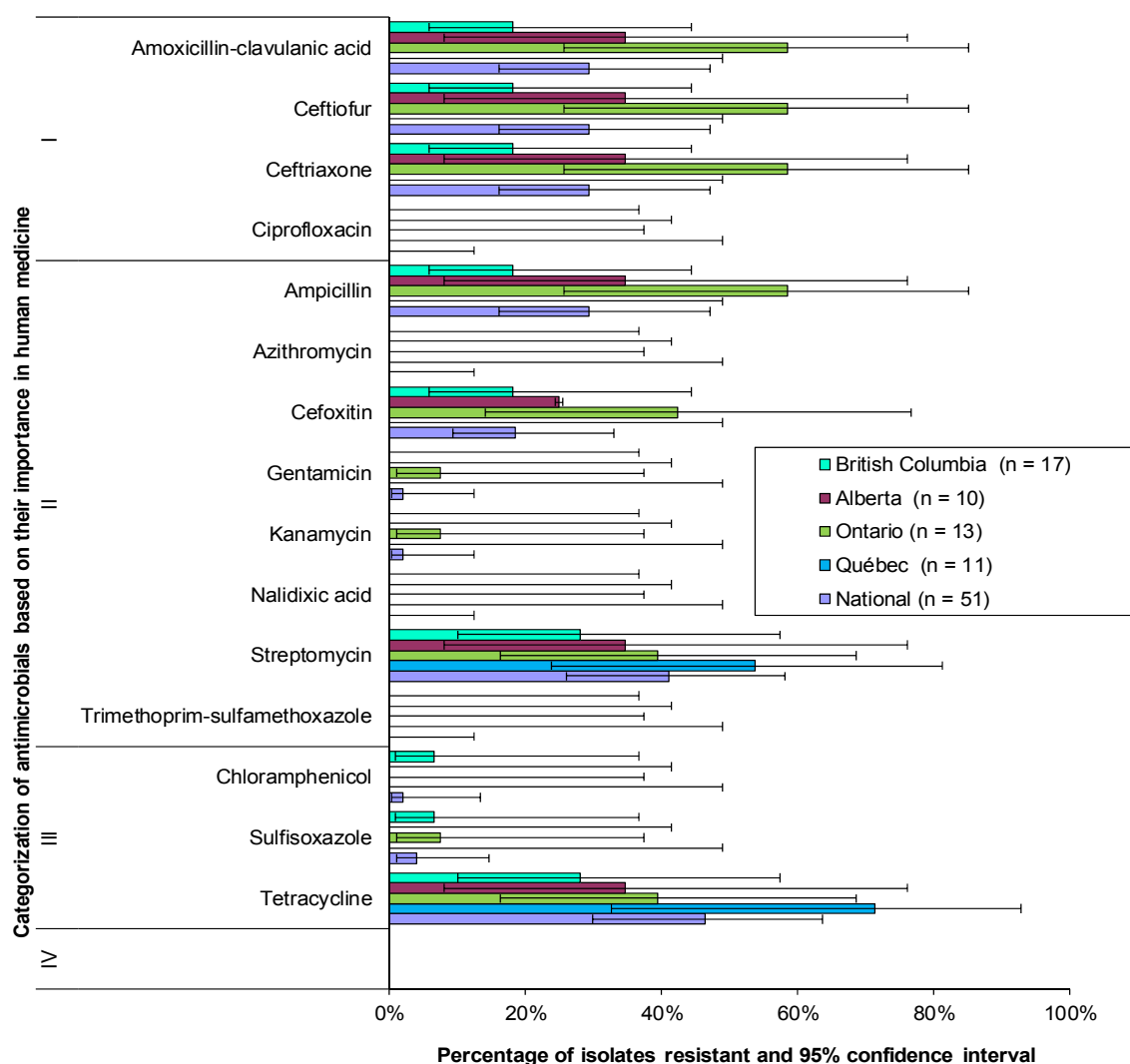
Figure 23. Temporal variations in resistance of *Escherichia coli* isolates from pigs

Year	2006	2007	2008	2009	2010	2011	2012	2013
Number of isolates	1,721	1,575	1,425	2,057	1,673	1,667	1,553	1,573
Antimicrobial								
Ampicillin	35%	36%	34%	34%	30%	31%	31%	31%
Ceftiofur	1%	1%	1%	0%	0%	1%	2%	1%
Gentamicin	1%	1%	1%	1%	1%	1%	1%	1%
Nalidixic acid	0%	0%	0%	0%	0%	0%	0%	0%
Streptomycin	37%	34%	35%	37%	33%	33%	44%	34%
Tetracycline	79%	78%	80%	77%	75%	77%	77%	75%
Trimethoprim-sulfamethoxazole	12%	11%	19%	12%	11%	13%	12%	13%

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 and the previous surveillance year (grey areas). The presence of blue areas indicates significant differences ($P \leq 0.05$) for a given antimicrobial.

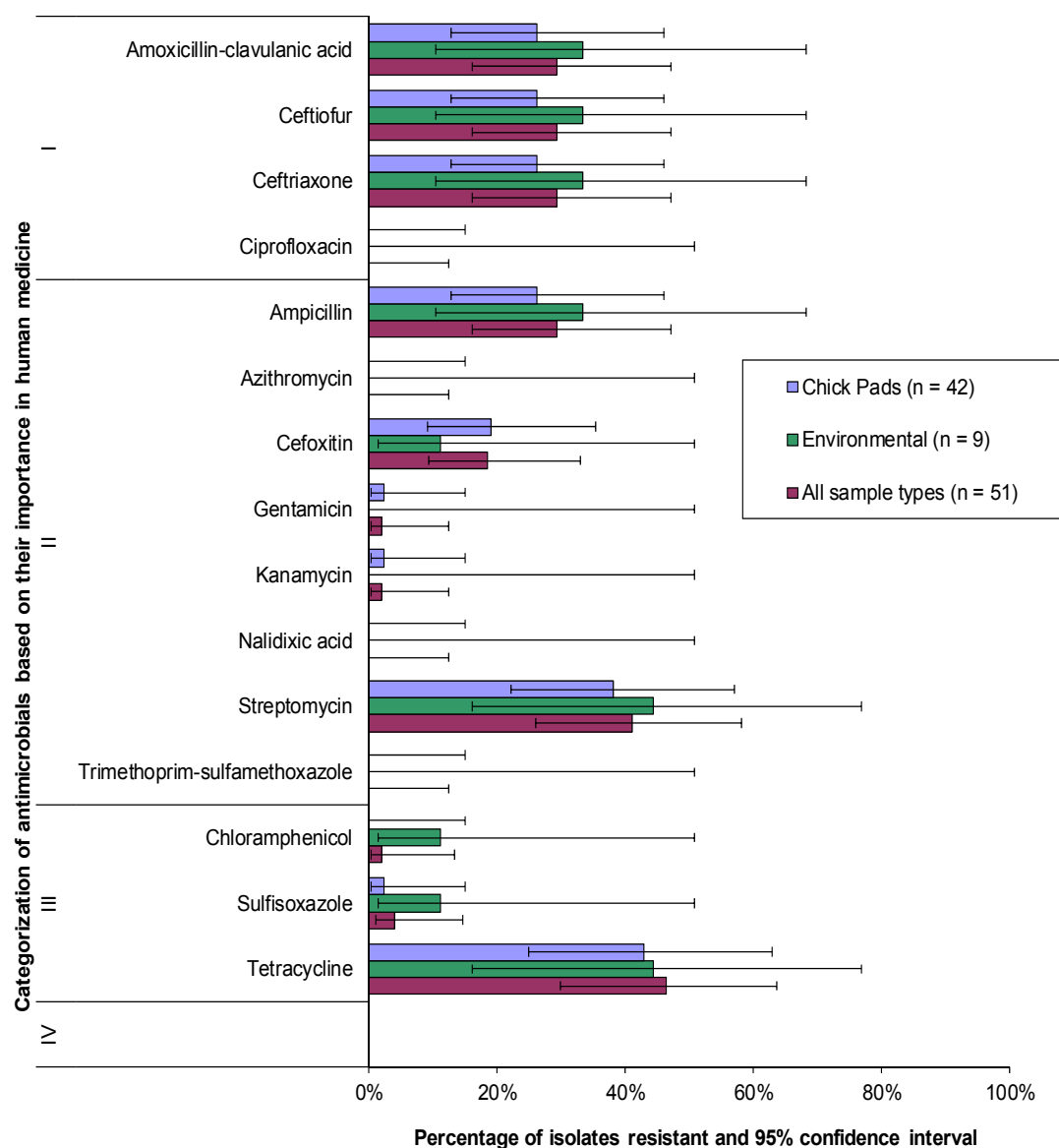
ANTIMICROBIAL RESISTANCE SUMMARY

Figure 24. Resistance of *Salmonella* isolates from chickens at chick placement, by province



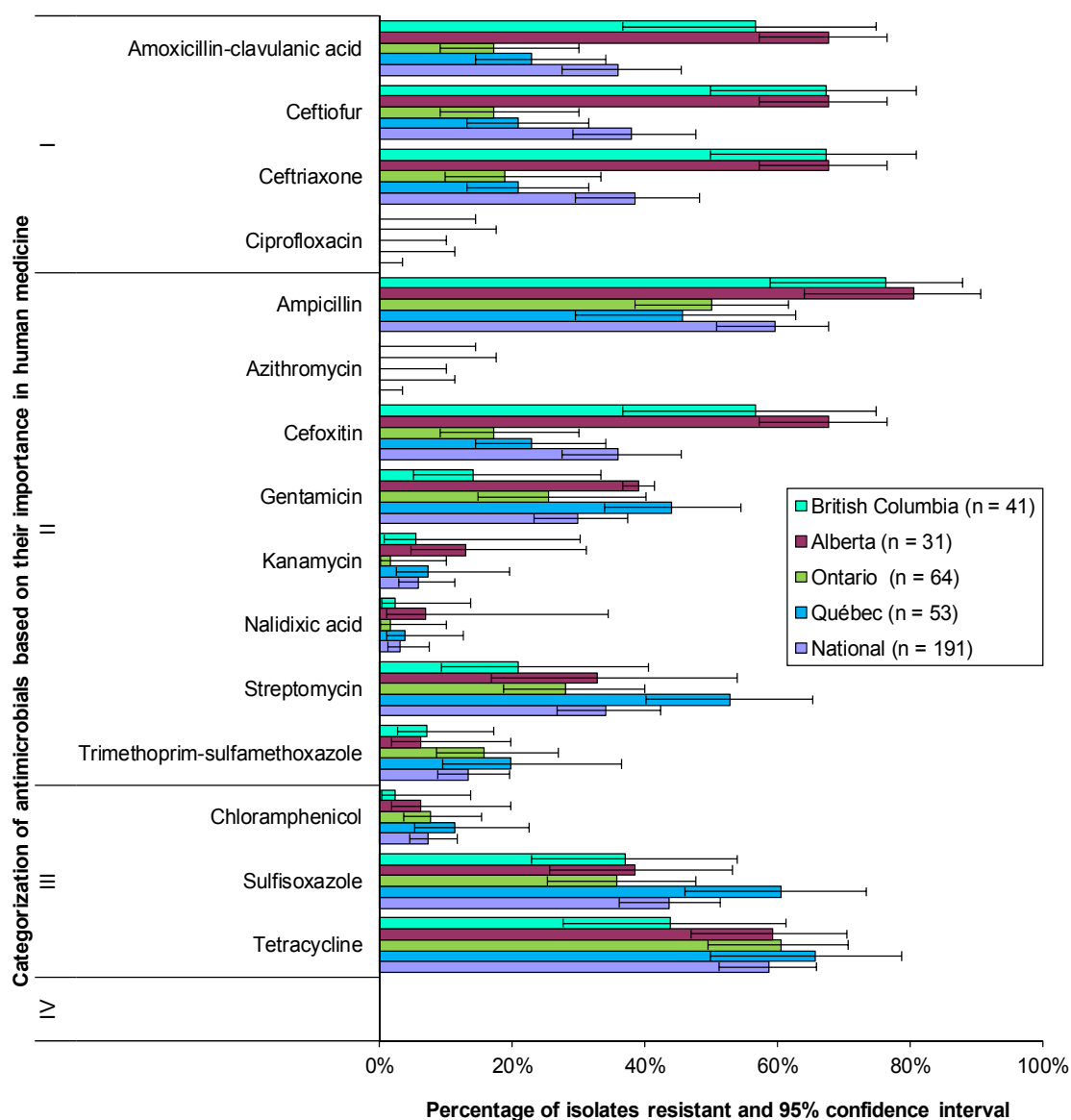
Province/region	British Columbia	Alberta	Ontario	Québec	National
Number of isolates	17	10	13	11	51
Antimicrobial					
Ampicillin	18%	35%	58%	0%	29%
Ceftiofur	18%	35%	58%	0%	29%
Gentamicin	0%	0%	8%	0%	2%
Nalidixic acid	0%	0%	0%	0%	0%
Streptomycin	28%	35%	39%	54%	41%
Tetracycline	28%	35%	39%	71%	46%
Trimethoprim-sulfamethoxazole	0%	0%	0%	0%	0%

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

Figure 25. Resistance of *Salmonella* isolates from chicks and barn environment at chick placement

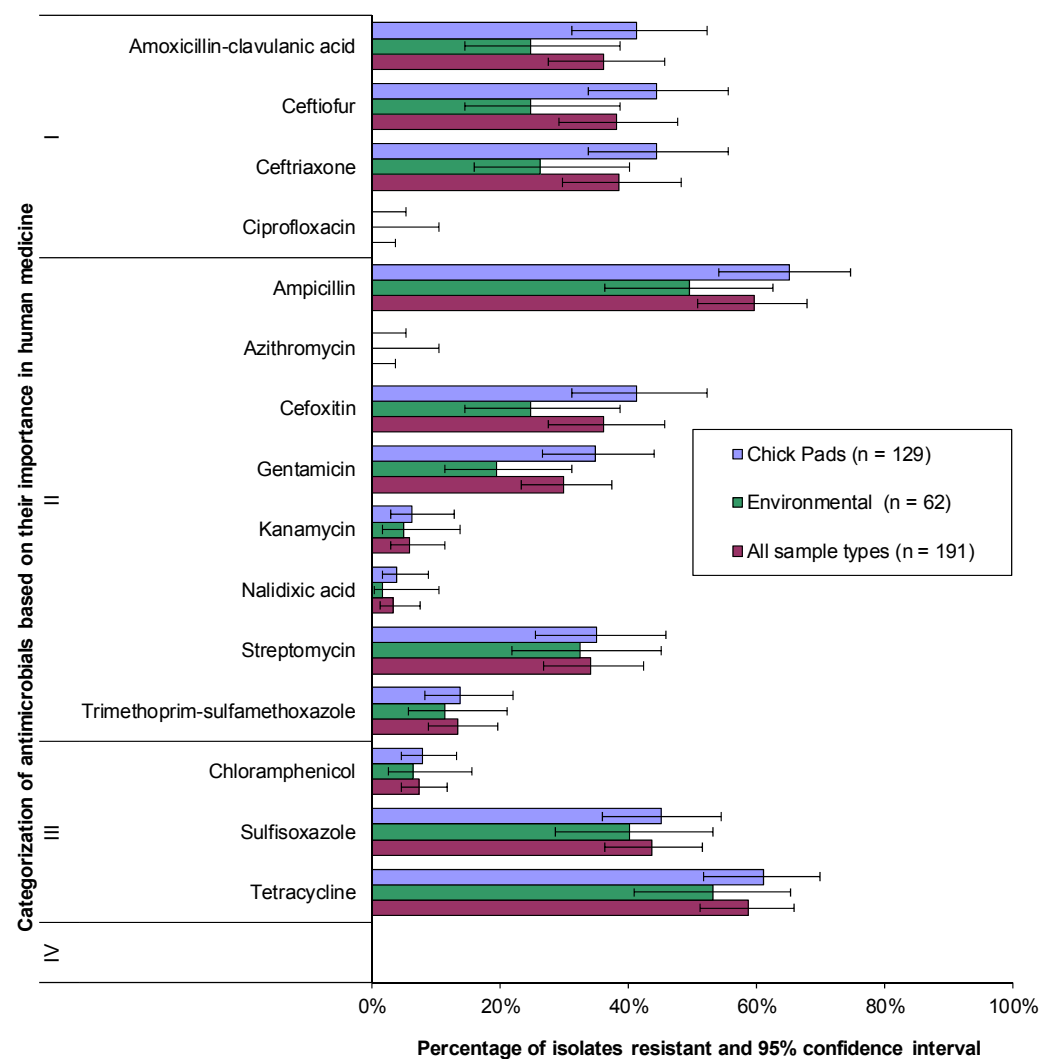
Sample type	Chick pads	Environmental	All sample types
Number of isolates	42	9	51
Antimicrobial			
Ampicillin	26%	33%	29%
Ceftiofur	26%	33%	29%
Gentamicin	2%	0%	2%
Nalidixic acid	0%	0%	0%
Streptomycin	38%	44%	41%
Tetracycline	43%	44%	46%
Trimethoprim-sulfamethoxazole	0%	0%	0%

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

Figure 26. Resistance of *Escherichia coli* isolates from chick at placement, by province

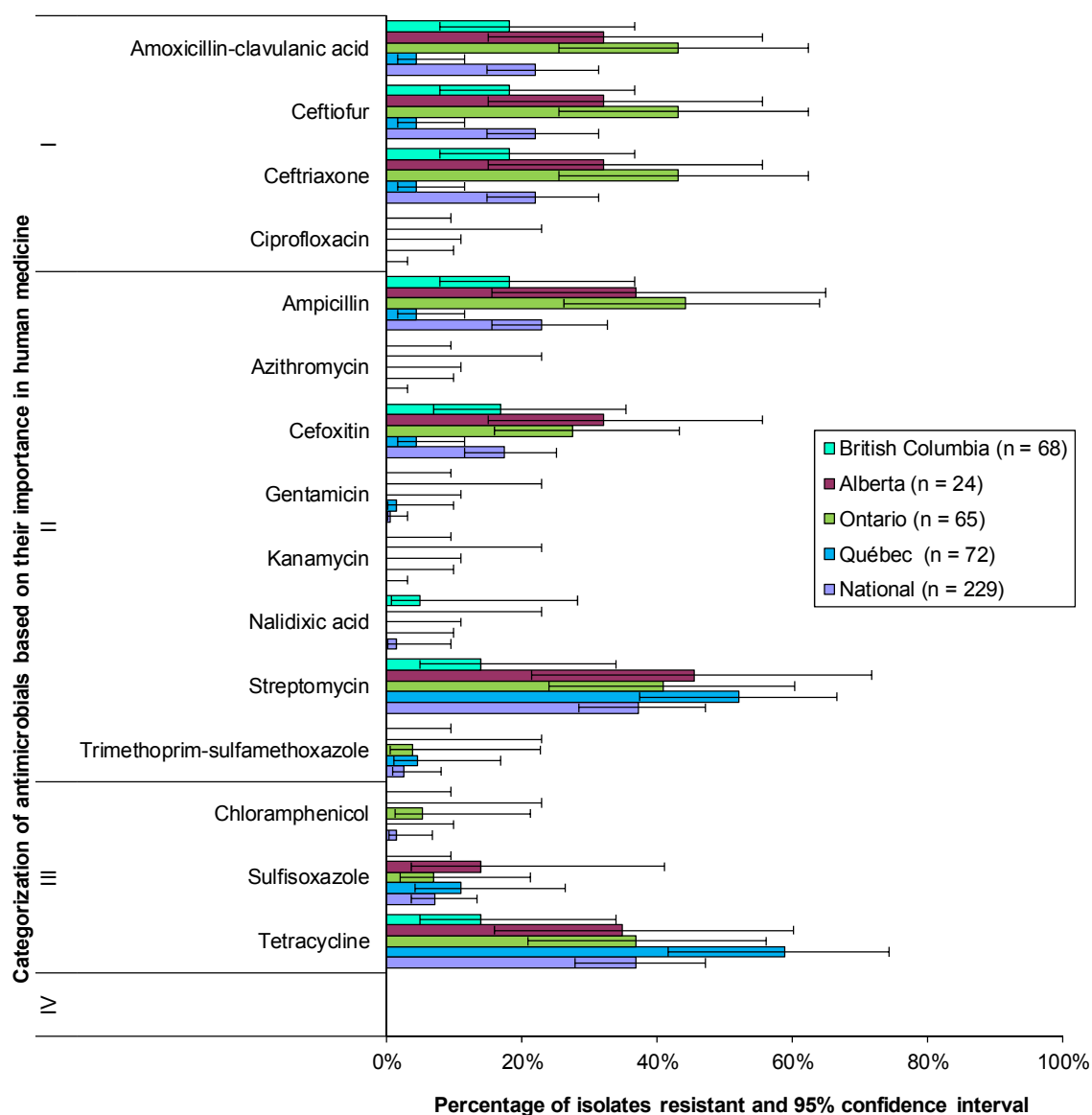
Province/region	British Columbia	Alberta	Ontario	Québec	National
Number of isolates	43	31	64	53	191
Antimicrobial					
Ampicillin	75%	81%	50%	46%	60%
Ceftiofur	67%	68%	17%	21%	38%
Gentamicin	14%	39%	25%	44%	30%
Nalidixic acid	2%	7%	2%	4%	3%
Streptomycin	21%	33%	28%	53%	34%
Tetracycline	44%	59%	61%	66%	59%
Trimethoprim-sulfamethoxazole	7%	6%	16%	20%	13%

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

Figure 27. Resistance of *Escherichia coli* isolates from chickens at chick placement

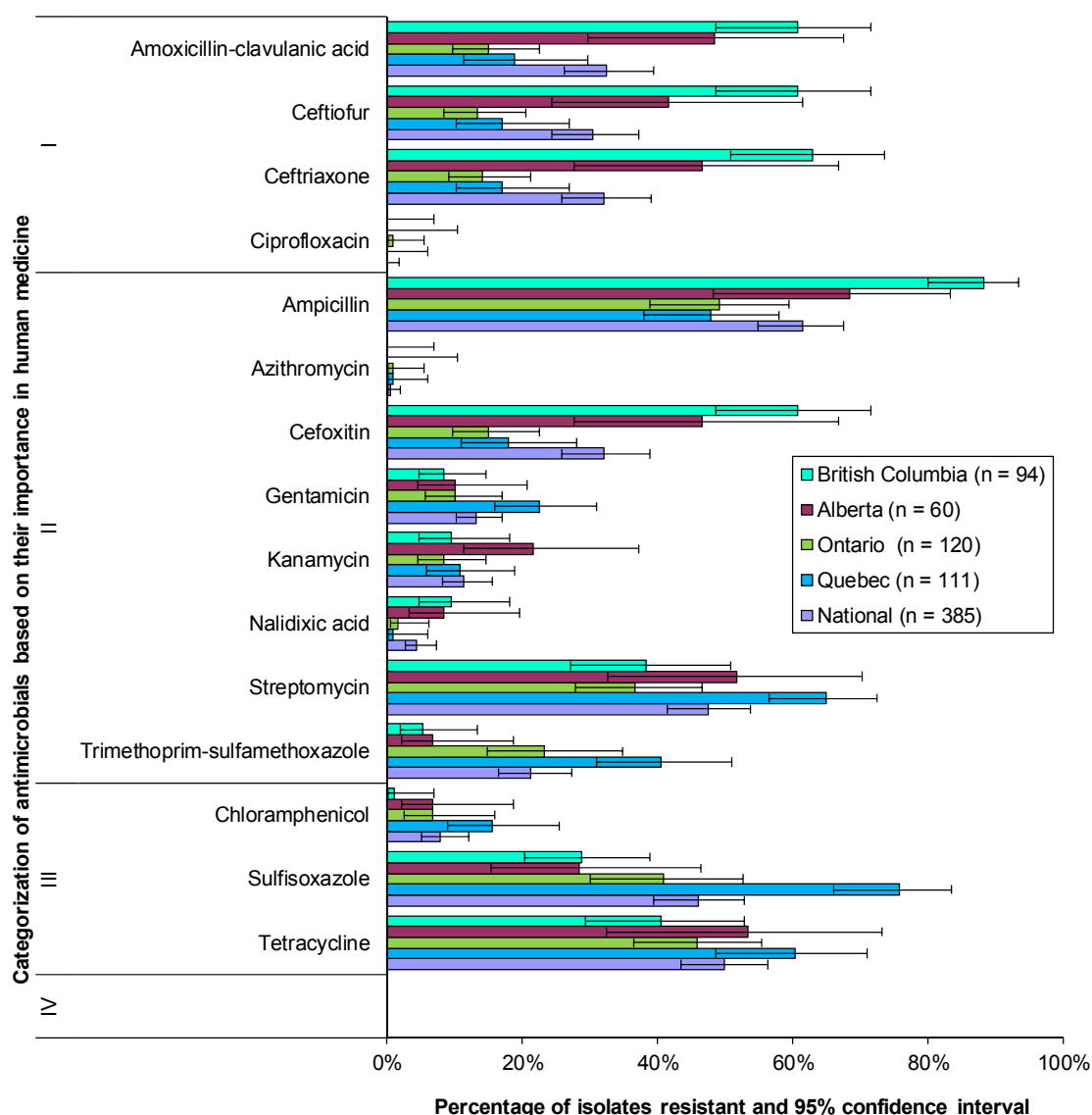
Sample type	Chick pads	Environmental	All sample types
Number of isolates	129	62	191
Antimicrobial			
Ampicillin	65%	49%	60%
Ceftiofur	44%	25%	38%
Gentamicin	35%	19%	30%
Nalidixic acid	4%	2%	3%
Streptomycin	35%	32%	34%
Tetracycline	61%	53%	59%
Trimethoprim-sulfamethoxazole	14%	11%	13%

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

Figure 28. Resistance of *Salmonella* isolates from chickens at preharvest

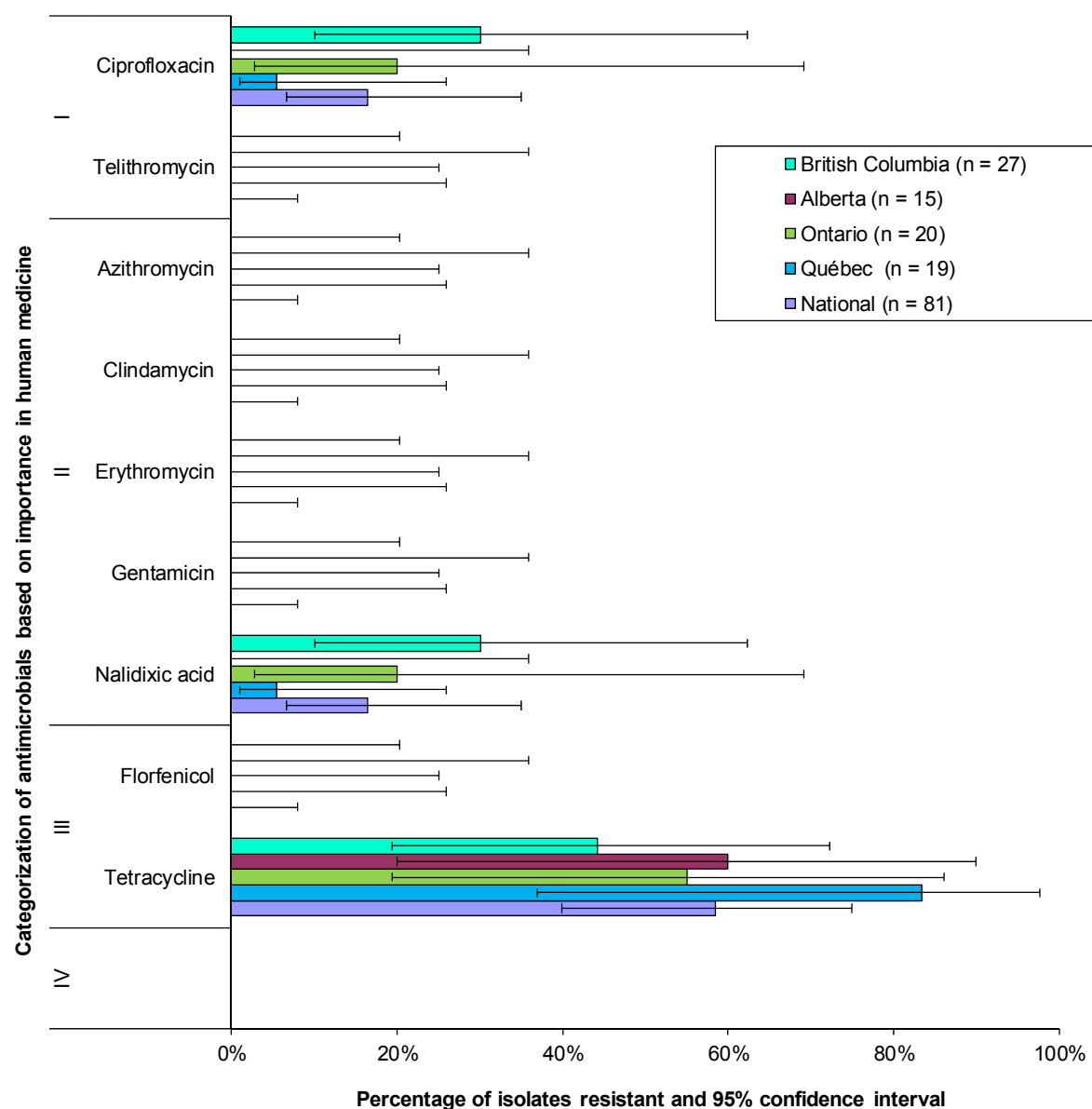
Province/region	British Columbia	Alberta	Ontario	Québec	National
Number of isolates	68	24	65	72	229
Antimicrobial					
Ampicillin	18%	37%	44%	4%	23%
Ceftiofur	18%	32%	43%	4%	22%
Gentamicin	0%	0%	0%	1%	< 1%
Nalidixic acid	6%	0%	0%	0%	1%
Streptomycin	14%	45%	41%	52%	37%
Tetracycline	14%	35%	37%	59%	37%
Trimethoprim-sulfamethoxazole	0%	0%	4%	5%	3%

This figure summarizes the proportion (% , adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial at the national level and by province/region for the 2013 sampling year.

Figure 29. Resistance of *Escherichia coli* isolates from chickens at preharvest

Province/region	British Columbia	Alberta	Ontario	Québec	National
Number of isolates	94	60	120	111	385
Antimicrobial					
Ampicillin	88%	68%	49%	48%	61%
Ceftiofur	61%	42%	13%	17%	30%
Gentamicin	8%	10%	10%	23%	13%
Nalidixic acid	10%	8%	2%	1%	4%
Streptomycin	38%	52%	37%	65%	48%
Tetracycline	40%	53%	46%	60%	50%
Trimethoprim-sulfamethoxazole	5%	7%	23%	41%	21%

The figure above summarizes the proportion (% , adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial by province/region for the 2013 sampling year.

Figure 30. Resistance of *Campylobacter* isolates from chickens at preharvest

Province/region	British Columbia	Alberta	Ontario	Québec	National
Number of isolates	27	15	20	19	81
Antimicrobial					
Azithromycin	0%	0%	0%	0%	0%
Ciprofloxacin	30%	0%	20%	5%	16%
Gentamicin	0%	0%	0%	0%	0%
Telithromycin	0%	0%	0%	0%	0%
Tetracycline	44%	60%	55%	83%	59%

The figure above summarizes the proportion (% , adjusted to account for multiple samples per flock) of isolates resistant to a specific antimicrobial by province/region for the 2013 sampling year.

MINIMUM INHIBITORY CONCENTRATIONS

Table 52. Distribution of minimum inhibitory concentrations among *Salmonella* from pigs

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	99	≤ 1	16	5.1						59.6	2.0	7.1	21.2	5.1			5.1			
Ceftiofur	99	1	1	6.1					11.1	80.8	2.0				6.1					
Ceftriaxone	99	≤ 0.25	≤ 0.25	6.1					93.9				1.0	1.0	3.0	1.0				
Ciprofloxacin	99	≤ 0.015	0.03	0.0	84.8	14.1	1.0													
II Ampicillin	99	1	> 32	38.4						53.5	8.1							38.4		
Azithromycin	99	4	8	1.0						1.0	8.1	66.7	23.2			1.0				
Cefoxitin	99	2	8	5.1						7.1	52.5	27.3	7.1	1.0		2.0	3.0			
Gentamicin	99	0.5	1	3.0				13.1	64.6	19.2					3.0					
Kanamycin	99	≤ 8	> 64	10.1										89.9				10.1		
Nalidixic acid	99	4	4	0.0							29.3	64.6	5.1	1.0						
Streptomycin	99	64	> 64	51.5												48.5	8.1	43.4		
Trimethoprim-sulfamethoxazole	99	≤ 0.12	0.5	8.1				69.7	18.2	4.0				8.1						
III Chloramphenicol	99	8	> 32	22.2								15.2	59.6	3.0			22.2			
Sulfisoxazole	99	> 256	> 256	55.6											9.1	24.2	11.1			55.6
Tetracycline	99	> 32	> 32	64.6								35.4			2.0	12.1	50.5			
IV																				

Percent of isolates resistant are not adjusted for clustering.

Table 53. Distribution of minimum inhibitory concentrations among *Escherichia coli* from pigs

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	1,573	4	8	1.4						1.7	20.5	44.8	29.6	2.0	0.4	1.0				
Ceftiofur	1,573	0.5	0.5	1.1				2.2	40.6	54.8	1.0	0.1	0.2	0.3	0.8					
Ceftriaxone	1,573	≤ 0.25	≤ 0.25	1.3					98.3	0.1			0.1	0.3	0.8	0.1	0.1			
Ciprofloxacin	1,573	≤ 0.015	≤ 0.015	0.0	98.0	1.6	0.3		0.1											
II Ampicillin	1,573	2	> 32	31.1						6.0	34.6	25.8	1.7	0.8	0.3	30.8				
Azithromycin	1,573	4	8	0.9					0.1	1.0	16.7	69.2	11.8	0.3	0.9					
Cefoxitin	1,573	4	8	1.1					0.1	0.3	19.8	63.1	14.6	1.0	0.3	0.8				
Gentamicin	1,573	0.5	1	1.0				4.4	65.5	27.0	1.5			0.6	0.4	0.6				
Kanamycin	1,573	≤ 8	> 64	12.5										87.3	0.1		0.4	12.1		
Nalidixic acid	1,573	2	4	0.3						0.3	13.9	74.5	10.9	0.1		0.2	0.1			
Streptomycin	1,573	≤ 32	> 64	34.0												66.0	14.8	19.2		
Trimethoprim-sulfamethoxazole	1,573	≤ 0.12	> 4	13.4				70.9	12.8	2.2	0.7			13.4						
III Chloramphenicol	1,573	8	32	20.3							2.2	31.8	42.7	3.1	11.0	9.3				
Sulfisoxazole	1,573	16	> 256	45.4											50.4	4.1	0.1			45.4
Tetracycline	1,573	> 32	> 32	75.4									24.3	0.3	0.3	5.5	69.6			
IV																				

Percent of isolates resistant are not adjusted for clustering.

Table 54. Distribution of minimum inhibitory concentrations among *Salmonella* from chick at placement

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)																
			MIC 50	MIC 90	% R	≤ 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	British Columbia	17	≤ 1	> 32	17.6							82.4						17.6			
		Alberta	10	≤ 1	> 32	50.0							50.0					10.0	40.0			
		Ontario	13	≤ 1	> 32	46.2							53.8					15.4	30.8			
		Québec	11	≤ 1	≤ 1	0.0							100.0									
	Ceftiofur	British Columbia	17	1	> 8	17.6							82.4				17.6					
		Alberta	10	1	> 8	50.0					10.0	40.0				10.0	40.0					
		Ontario	13	1	> 8	46.2					46.2	7.7				7.7	38.5					
		Québec	11	0.5	1	0.0						63.6	36.4									
	Ceftriaxone	British Columbia	17	≤ 0.25	16	17.6					82.4						11.8	5.9				
		Alberta	10	≤ 0.25	16	50.0					50.0					30.0	20.0					
		Ontario	13	≤ 0.25	16	46.2					53.8				7.7	15.4	23.1					
		Québec	11	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	British Columbia	17	≤ 0.015	0.03	0.0	64.7	35.3														
		Alberta	10	≤ 0.015	≤ 0.015	0.0	100.0															
		Ontario	13	≤ 0.015	≤ 0.015	0.0	100.0															
		Québec	11	≤ 0.015	≤ 0.015	0.0	100.0															
II	Ampicillin	British Columbia	17	≤ 1	> 32	17.6							76.5	5.9					17.6			
		Alberta	10	≤ 1	> 32	50.0							50.0						50.0			
		Ontario	13	≤ 1	> 32	46.2							53.8						46.2			
		Québec	11	≤ 1	≤ 1	0.0							100.0									
	Azithromycin	British Columbia	17	4	8	0.0								5.9	76.5	17.6						
		Alberta	10	4	4	0.0								40.0	60.0							
		Ontario	13	4	4	0.0								46.2	53.8							
		Québec	11	4	4	0.0								18.2	72.7	9.1						
	Cefoxitin	British Columbia	17	2	32	17.6								76.5	5.9				17.6			
		Alberta	10	4	32	20.0								40.0	10.0		30.0	20.0				
		Ontario	13	4	32	30.8							15.4	30.8	7.7		15.4	30.8				
		Québec	11	2	2	0.0							36.4	63.6								
	Gentamicin	British Columbia	17	0.5	1	0.0					41.2	41.2	17.6									
		Alberta	10	0.5	0.5	0.0					20.0	80.0										
		Ontario	13	≤ 0.25	0.5	7.7					61.5	30.8							7.7			
		Québec	11	0.5	1	0.0					45.5	27.3	27.3									
Kanamycin	British Columbia	17	≤ 8	≤ 8	0.0										100.0							
	Alberta	10	≤ 8	≤ 8	0.0										100.0							
	Ontario	13	≤ 8	≤ 8	7.7										92.3				7.7			
	Québec	11	≤ 8	≤ 8	0.0										100.0							
Nalidixic acid	British Columbia	17	4	8	0.0								41.2	47.1	11.8							
	Alberta	10	4	4	0.0								40.0	60.0								
	Ontario	13	2	4	0.0								61.5	38.5								
	Québec	11	2	4	0.0								63.6	36.4								
Streptomycin	British Columbia	17	32	> 64	23.5												76.5	5.9	17.6			
	Alberta	10	32	64	50.0												50.0	40.0	10.0			
	Ontario	13	32	> 64	38.5												61.5	15.4	23.1			
	Québec	11	64	> 64	54.5												45.5	36.4	18.2			
Trimethoprim-sulfamethoxazole	British Columbia	17	≤ 0.12	≤ 0.12	0.0				94.1	5.9												
	Alberta	10	≤ 0.12	≤ 0.12	0.0				100.0													
	Ontario	13	≤ 0.12	≤ 0.12	0.0				100.0													
	Québec	11	≤ 0.12	≤ 0.12	0.0				100.0													
III	Chloramphenicol	British Columbia	17	8	8	5.9									23.5	70.6			5.9			
		Alberta	10	4	8	0.0								10.0	70.0	20.0						
		Ontario	13	4	4	0.0									100.0							
		Québec	11	4	8	0.0									72.7	27.3						
	Sulfisoxazole	British Columbia	17	32	64	5.9												52.9	41.2			5.9
		Alberta	10	≤ 16	32	0.0												50.0	50.0			
		Ontario	13	32	32	7.7												7.7	84.6			7.7
		Québec	11	32	32	0.0												27.3	72.7			
	Tetracycline	British Columbia	17	4	> 32	23.5										76.5				23.5		
		Alberta	10	4	> 32	50.0										50.0				50.0		
		Ontario	13	4	> 32	38.5										61.5				38.5		
		Québec	11	> 32	> 32	72.7										27.3				72.7		
	IV																					

Table 55. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chicks and barn environment at placement

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)																			
			MIC 50	MIC 90	% R	≤ 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	British Columbia	43	32	> 32	55.8								2.3	23.3	18.6		9.3	46.5						
		Alberta	31	32	> 32	67.7								6.5	16.1	6.5	3.2	48.4	19.4						
		Ontario	64	8	> 32	17.2								4.7	42.2	34.4	1.6	1.6	15.6						
		Québec	53	8	> 32	22.6						5.7	3.8	37.7	18.9	11.3	3.8	18.9							
	Ceftiofur	British Columbia	43	8	> 8	67.4				2.3	2.3	25.6	2.3			18.6	48.8								
		Alberta	31	8	> 8	67.7				3.2	16.1	12.9			29.0	38.7									
		Ontario	64	0.5	8	17.2						12.5	68.8	1.6	7.8	9.4									
		Québec	53	0.5	8	20.8				1.9	22.6	49.1	5.7	15.1	5.7										
	Ceftriaxone	British Columbia	43	16	32	67.4				27.9	2.3	2.3			9.3	39.5	14.0	4.7							
		Alberta	31	16	16	67.7						32.3			6.5	54.8	6.5								
		Ontario	64	≤ 0.25	16	18.8						81.3			1.6	4.7	10.9	1.6							
		Québec	53	≤ 0.25	8	20.8						77.4	1.9			11.3	9.4								
	Ciprofloxacin	British Columbia	43	≤ 0.015	≤ 0.015	0.0	95.3	2.3			2.3														
		Alberta	31	≤ 0.015	≤ 0.015	0.0	93.5			6.5															
		Ontario	64	≤ 0.015	≤ 0.015	0.0	95.3	3.1			1.6														
		Québec	53	≤ 0.015	≤ 0.015	0.0	94.3	1.9			3.8														
II	Ampicillin	British Columbia	43	> 32	> 32	76.7								4.7	18.6					76.7					
		Alberta	31	> 32	> 32	80.6						3.2	16.1					80.6							
		Ontario	64	4	> 32	50.0								23.4	26.6			50.0							
		Québec	53	4	> 32	45.3						1.9	24.5	24.5	3.8			45.3							
	Azithromycin	British Columbia	43	4	4	0.0						20.9	74.4	2.3	2.3										
		Alberta	31	4	4	0.0						12.9	77.4	9.7											
		Ontario	64	4	4	0.0						7.8	87.5	4.7											
		Québec	53	4	8	0.0				1.9	7.5	77.4	13.2												
	Cefoxitin	British Columbia	43	> 32	> 32	55.8								4.7	37.2	2.3			4.7	51.2					
		Alberta	31	> 32	> 32	67.7								3.2	19.4	9.7			12.9	54.8					
		Ontario	64	4	> 32	17.2								9.4	50.0	23.4			1.6	15.6					
		Québec	53	4	> 32	22.6						1.9	9.4	50.9	15.1			5.7	17.0						
	Gentamicin	British Columbia	43	0.5	> 16	14.0						55.8	27.9	2.3			2.3	11.6							
		Alberta	31	1	> 16	38.7						3.2	25.8	29.0			3.2	6.5	32.3						
		Ontario	64	1	> 16	25.0								48.4	26.6			7.8	17.2						
		Québec	53	2	> 16	43.4				1.9	22.6	24.5	5.7	1.9			17.0	26.4							
Kanamycin	British Columbia	43	≤ 8	≤ 8	4.7										90.7	4.7			4.7						
	Alberta	31	≤ 8	> 64	12.9										80.6	6.5			12.9						
	Ontario	64	≤ 8	≤ 8	1.6										92.2	6.3			1.6						
	Québec	53	≤ 8	16	7.5										84.9	7.5			7.5						
Nalidixic acid	British Columbia	43	2	4	2.3								11.6	72.1	14.0			2.3							
	Alberta	31	2	4	6.5										83.9	9.7			6.5						
	Ontario	64	2	4	1.6								1.6	79.7	17.2			1.6							
	Québec	53	2	4	3.8								7.5	77.4	11.3			3.8							
Streptomycin	British Columbia	43	≤ 32	64	20.9												79.1	11.6	9.3						
	Alberta	31	≤ 32	> 64	32.3												67.7	16.1	16.1						
	Ontario	64	≤ 32	> 64	28.1												71.9	10.9	17.2						
	Québec	53	64	> 64	52.8												47.2	18.9	34.0						
Trimethoprim-sulfamethoxazole	British Columbia	43	≤ 0.12	0.25	7.0				69.8	20.9	2.3					7.0									
	Alberta	31	≤ 0.12	0.5	6.5				74.2	12.9	3.2	3.2			6.5										
	Ontario	64	≤ 0.12	> 4	15.6				71.9	10.9	1.6			15.6											
	Québec	53	0.25	> 4	18.9				47.2	24.5	9.4			18.9											
III	Chloramphenicol	British Columbia	43	4	8	2.3								65.1	30.2	2.3			2.3						
		Alberta	31	4	8	6.5								67.7	25.8			6.5							
		Ontario	64	8	8	7.8						1.6	43.8	46.9			7.8								
		Québec	53	4	32	11.3								52.8	32.1	3.8	1.9	9.4							
	Sulfisoxazole	British Columbia	43	32	> 256	37.2										46.5	16.3			37.2					
		Alberta	31	≤ 16	> 256	38.7										51.6	6.5	3.2			38.7				
		Ontario	64	≤ 16	> 256	35.9										51.6	10.9			1.6	35.9				
		Québec	53	> 256	> 256	60.4										39.6					60.4				
	Tetracycline	British Columbia	43	≤ 4	> 32	44.2								55.8			7.0	37.2							
		Alberta	31	> 32	> 32	61.3								35.5	3.2			61.3							
		Ontario	64	> 32	> 32	60.9								39.1			6.3	54.7							
		Québec	53	> 32	> 32	66.0								34.0			13.2	52.8							
	IV																								

Table 56. Distribution of minimum inhibitory concentrations among *Salmonella* from chicken at preharvest

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)															
			MIC 50	MIC 90	% R	≤ 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	68	≤ 1	> 32	20.6						79.4						2.9	17.6			
	Alberta	24	≤ 1	> 32	33.3						58.3		8.3				8.3	25.0			
	Ontario	65	≤ 1	> 32	43.1						55.4				1.5		7.7	35.4			
	Québec	72	≤ 1	1	4.2						93.1	2.8					1.4	2.8			
Ceftiofur	British Columbia	68	1	16	20.6					7.4	69.1	2.9				20.6					
	Alberta	24	1	> 8	33.3					16.7	50.0					33.3					
	Ontario	65	1	> 8	43.1					1.5	27.7	27.7			10.8	32.3					
	Québec	72	0.5	1	4.2					2.8	58.3	34.7				4.2					
Ceftriaxone	British Columbia	68	≤ 0.25	16	20.6					79.4					1.5	17.6	1.5				
	Alberta	24	≤ 0.25	16	33.3					66.7						29.2	4.2				
	Ontario	65	≤ 0.25	16	43.1					56.9				1.5	20.0	20.0		1.5			
	Québec	72	≤ 0.25	≤ 0.25	4.2					95.8							4.2				
Ciprofloxacin	British Columbia	68	≤ 0.015	0.03	0.0	79.4	14.7			5.9											
	Alberta	24	≤ 0.015	≤ 0.015	0.0	100.0															
	Ontario	65	≤ 0.015	≤ 0.015	0.0	96.9	3.1														
	Québec	72	≤ 0.015	≤ 0.015	0.0	95.8	4.2														
Ampicillin	British Columbia	68	≤ 1	> 32	20.6						76.5	2.9						20.6			
	Alberta	24	≤ 1	> 32	41.7						58.3							41.7			
	Ontario	65	≤ 1	> 32	44.6						52.3	3.1						44.6			
	Québec	72	≤ 1	1	4.2						91.7	4.2						4.2			
Azithromycin	British Columbia	68	4	8	0.0						4.4	77.9	17.6								
	Alberta	24	4	8	0.0						12.5	70.8	16.7								
	Ontario	65	4	8	0.0						3.1	16.9	67.7	12.3							
	Québec	72	4	4	0.0						1.4	13.9	77.8	6.9							
Cefoxitin	British Columbia	68	2	32	19.1						8.8	61.8	7.4	1.5	1.5	13.2	5.9				
	Alberta	24	4	32	33.3						8.3	37.5	20.8			29.2	4.2				
	Ontario	65	2	32	27.7						29.2	24.6	3.1		15.4	24.6	3.1				
	Québec	72	2	4	4.2					2.8	29.2	51.4	12.5				4.2				
Gentamicin	British Columbia	68	0.5	0.5	0.0					32.4	58.8	7.4	1.5								
	Alberta	24	0.5	1	0.0					25.0	54.2	20.8									
	Ontario	65	0.5	0.5	0.0					30.8	64.6	4.6									
	Québec	72	0.5	1	1.4					20.8	65.3	12.5					1.4				
Kanamycin	British Columbia	68	≤ 8	≤ 8	0.0										100.0						
	Alberta	24	≤ 8	≤ 8	0.0										100.0						
	Ontario	65	≤ 8	≤ 8	0.0										100.0						
	Québec	72	≤ 8	≤ 8	0.0										100.0						
Nalidixic acid	British Columbia	68	4	8	5.9						44.1	44.1	5.9				5.9				
	Alberta	24	2	4	0.0						54.2	45.8									
	Ontario	65	2	4	0.0						53.8	46.2									
	Québec	72	2	4	0.0						1.4	55.6	41.7	1.4							
Streptomycin	British Columbia	68	≤ 32	64	16.2											83.8	11.8	4.4			
	Alberta	24	32	64	45.8											54.2	20.8	25.0			
	Ontario	65	32	> 64	38.5											61.5	23.1	15.4			
	Québec	72	64	> 64	52.8											47.2	29.2	23.6			
Trimethoprim-sulfamethoxazole	British Columbia	68	≤ 0.12	0.25	0.0					100.0											
	Alberta	24	≤ 0.12	≤ 0.12	0.0					100.0											
	Ontario	65	≤ 0.12	≤ 0.12	4.6					93.8	1.5				4.6						
	Québec	72	≤ 0.12	≤ 0.12	4.2					95.8					4.2						
Chloramphenicol	British Columbia	68	32	64	0.0							1.5	23.5	73.5	1.5						
	Alberta	24	4	8	0.0							4.2	45.8	50.0							
	Ontario	65	4	8	6.2							7.7	49.2	35.4	1.5			6.2			
	Québec	72	4	8	0.0							2.8	58.3	38.9							
Sulfisoxazole	British Columbia	68	≤ 16	64	0.0											13.2	58.8	27.9			
	Alberta	24	32	> 256	12.5											4.2	75.0	8.3			12.5
	Ontario	65	32	64	7.7											15.4	64.6	12.3			7.7
	Québec	72	32	64	9.7											25.0	54.2	11.1			9.7
Tetracycline	British Columbia	68	≤ 4	> 32	16.2									83.8				16.2			
	Alberta	24	≤ 4	> 32	37.5									62.5				37.5			
	Ontario	65	≤ 4	> 32	33.8									66.2				33.8			
	Québec	72	> 32	> 32	59.7									40.3				59.7			
IV																					

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Table 57. Distribution of minimum inhibitory concentrations among *Escherichia coli* from chickens at preharvest

Antimicrobial	Province/region	n	Percentiles			Distribution (%) of MICs (µg/mL)																						
			MIC 50	MIC 90	% R	≤ 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	British Columbia	94	32	> 32	60.6							1.1	12.8	22.3	3.2	27.7	33.0										
		Alberta	60	8	> 32	48.3							6.7	26.7	16.7	1.7	31.7	16.7										
		Ontario	120	8	32	15.0							13.3	30.0	37.5	4.2	9.2	5.8										
		Québec	111	8	> 32	18.9							9.0	36.0	32.4	3.6	8.1	10.8										
	Ceftiofur	British Columbia	94	8	>8	60.6				3.2	20.2	3.2	10.6	2.1	24.5	36.2												
		Alberta	60	1	>8	41.7				25.0	23.3	5.0		5.0	21.7	20.0												
		Ontario	120	0.5	8	13.3				27.5	54.2	3.3	0.8	0.8	5.8	7.5												
		Québec	111	0.5	8	17.1				18.0	61.3	2.7	0.9		8.1	9.0												
	Ceftriaxone	British Columbia	94	8	32	62.8				23.4	1.1	6.4	6.4	2.1	16.0	33.0	7.4	2.1	2.1									
		Alberta	60	≤ 0.25	32	46.7				51.7		1.7			10.0	23.3	13.3											
		Ontario	120	≤ 0.25	8	14.2				85.0		0.8		0.8	4.2	8.3	0.8											
		Québec	111	≤ 0.25	16	17.1				80.2	0.9	1.8			1.8	10.8	4.5											
	Ciprofloxacin	British Columbia	94	≤ 0.015	0.06	0.0	86.2	3.2	2.1			6.4	2.1															
		Alberta	60	≤ 0.015	0.03	0.0	88.3	1.7			3.3	5.0	1.7															
		Ontario	120	≤ 0.015	≤ 0.015	0.8	94.2	3.3	0.8				0.8															
		Québec	111	≤ 0.015	≤ 0.015	0.0	94.6	4.5			0.9																	
II	Ampicillin	British Columbia	94	> 32	> 32	88.3							6.4	4.3	1.1					88.3								
		Alberta	60	> 32	> 32	68.3							3.3	11.7	16.7					68.3								
		Ontario	120	8	> 32	49.2							5.8	22.5	20.8	1.7					49.2							
		Québec	111	4	> 32	47.7							3.6	24.3	23.4	0.9					47.7							
	Azithromycin	British Columbia	94	4	8	0.0						1.1	18.1	66.0	14.9													
		Alberta	60	4	4	0.0							16.7	80.0	3.3													
		Ontario	120	4	8	0.8						0.8	12.5	70.0	15.8					0.8								
		Québec	111	4	8	0.9						0.9	21.6	54.1	21.6	0.9			0.9									
	Cefoxitin	British Columbia	94	> 32	> 32	60.6						1.1	22.3	16.0			8.5	52.1										
		Alberta	60	8	> 32	46.7						11.7	30.0	11.7			3.3	43.3										
		Ontario	120	4	> 32	15.0						11.7	55.0	16.7	1.7	1.7	13.3											
		Québec	111	4	> 32	18.0						6.3	44.1	28.8	2.7			18.0										
	Gentamicin	British Columbia	94	0.5	8	8.5				6.4	51.1	22.3	4.3	2.1	5.3	2.1	6.4											
		Alberta	60	0.5	2	10.0				6.7	45.0	33.3	5.0		3.3	6.7												
		Ontario	120	0.5	8	10.0				5.8	52.5	30.0	0.8	0.8	2.5	7.5												
		Québec	111	1	> 16	22.5				0.9	47.7	25.2	2.7	0.9	4.5	18.0												
Kanamycin	British Columbia	94	≤ 8	16	9.6										87.2	3.2					9.6							
	Alberta	60	≤ 8	> 64	21.7										76.7	1.7					21.7							
	Ontario	120	≤ 8	16	8.3										89.2	2.5			0.8	7.5								
	Québec	111	≤ 8	> 64	10.8										82.0	3.6	3.6			10.8								
Nalidixic acid	British Columbia	94	2	16	9.6						11.7	64.9	12.8	1.1	1.1	8.5												
	Alberta	60	2	4	8.3						15.0	66.7	8.3	1.7	1.7	6.7												
	Ontario	120	2	4	1.7						10.0	69.2	19.2			1.7												
	Québec	111	2	4	0.9						4.5	75.7	18.9		0.9													
Streptomycin	British Columbia	94	≤ 32	> 64	38.3												61.7	11.7	26.6									
	Alberta	60	64	> 64	51.7												48.3	23.3	28.3									
	Ontario	120	≤ 32	> 64	36.7												63.3	11.7	25.0									
	Québec	111	64	> 64	64.9												35.1	21.6	43.2									
Trimethoprim-sulfamethoxazole	British Columbia	94	≤ 0.12	0.25	5.3				77.7	14.9	2.1				5.3													
	Alberta	60	≤ 0.12	0.5	6.7				80.0	6.7	3.3	1.7	1.7	6.7														
	Ontario	120	≤ 0.12	> 4	23.3				63.3	5.8	5.0	0.8	1.7	23.3														
	Québec	111	0.5	> 4	40.5				32.4	17.1	6.3	2.7	0.9		40.5													
III	Chloramphenicol	British Columbia	94	8	8	1.1							3.2	40.4	54.3	1.1			1.1									
		Alberta	60	8	8	6.7								40.0	53.3			6.7										
		Ontario	120	8	8	6.7							0.8	45.8	45.0	1.7	2.5	4.2										
		Québec	111	8	> 32	15.3							2.7	30.6	38.7	12.6	3.6	11.7										
	Sulfisoxazole	British Columbia	94	≤ 16	> 256	28.7										54.3	17.0					28.7						
		Alberta	60	≤ 16	> 256	28.3												61.7	8.3	1.7					28.3			
		Ontario	120	≤ 16	> 256	40.8												52.5	5.0	1.7					40.8			
		Québec	111	> 256	> 256	75.7												16.2	7.2			0.9					75.7	
	Tetracycline	British Columbia	94	4	> 32	40.4										59.6					40.4							
		Alberta	60	32	> 32	53.3										45.0	1.7			3.3	50.0							
		Ontario	120	≤ 4	> 32	45.8										54.2			2.5	43.3								
		Québec	111	> 32	> 32	60.4										39.6			3.6	56.8								
	IV																											

Table 58. Distribution of minimum inhibitory concentrations among *Campylobacter* from chicken on farm at preharvest

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
I	Ciprofloxacin	Campylobacter coli	British Columbia	0	0	0	0.0														
	Ciprofloxacin	Campylobacter coli	Alberta	0	0	0	0.0														
	Ciprofloxacin	Campylobacter coli	Ontario	1	0.12	0.12	0.0				100.0										
	Ciprofloxacin	Campylobacter coli	Québec	4	0.25	16	25.0					75.0						25.0			
	Ciprofloxacin	Campylobacter jejuni	British Columbia	27	0.12	16	40.7			7.4	48.1	3.7						40.7			
	Ciprofloxacin	Campylobacter jejuni	Alberta	15	0.12	0.12	0.0			6.7	93.3										
	Ciprofloxacin	Campylobacter jejuni	Ontario	19	0.12	16	21.1			15.8	42.1	21.1						21.1			
	Ciprofloxacin	Campylobacter jejuni	Québec	15	0.12	0.12	0.0			6.7	93.3										
	Telithromycin	Campylobacter coli	British Columbia	0	0	0	0.0														
	Telithromycin	Campylobacter coli	Alberta	0	0	0	0.0														
	Telithromycin	Campylobacter coli	Ontario	1	0.25	0.25	0.0				100.0										
Telithromycin	Campylobacter coli	Québec	4	2	4	0.0							75.0	25.0							
Telithromycin	Campylobacter jejuni	British Columbia	27	0.5	1	0.0						59.3	40.7								
Telithromycin	Campylobacter jejuni	Alberta	15	0.5	2	0.0						53.3	33.3	13.3							
Telithromycin	Campylobacter jejuni	Ontario	19	1	2	0.0				5.3	26.3	47.4	21.1								
Telithromycin	Campylobacter jejuni	Québec	15	1	1	0.0						33.3	66.7								
II	Azithromycin	Campylobacter coli	British Columbia	0	0	0	0.0														
	Azithromycin	Campylobacter coli	Alberta	0	0	0	0.0														
	Azithromycin	Campylobacter coli	Ontario	1	0.03	0.03	0.0		100.0												
	Azithromycin	Campylobacter coli	Québec	4	0.12	0.12	0.0				100.0										
	Azithromycin	Campylobacter jejuni	British Columbia	27	0.03	0.06	0.0			55.6	44.4										
	Azithromycin	Campylobacter jejuni	Alberta	15	0.06	0.12	0.0			20.0	66.7	13.3									
	Azithromycin	Campylobacter jejuni	Ontario	19	0.03	0.06	0.0			63.2	36.8										
	Azithromycin	Campylobacter jejuni	Québec	15	0.03	0.06	0.0			60.0	40.0										
	Clindamycin	Campylobacter coli	British Columbia	0	0	0	0.0														
	Clindamycin	Campylobacter coli	Alberta	0	0	0	0.0														
	Clindamycin	Campylobacter coli	Ontario	1	0.25	0.25	0.0					100.0									
III	Clindamycin	Campylobacter coli	Québec	4	4	4	0.0						25.0		75.0						
	Clindamycin	Campylobacter jejuni	British Columbia	27	0.12	0.25	0.0			7.4	81.5	11.1									
	Clindamycin	Campylobacter jejuni	Alberta	15	0.12	0.25	0.0			26.7	60.0	13.3									
	Clindamycin	Campylobacter jejuni	Ontario	19	0.12	0.25	0.0			21.1	52.6	26.3									
	Clindamycin	Campylobacter jejuni	Québec	15	0.12	0.12	0.0			13.3	80.0	6.7									
	Erythromycin	Campylobacter coli	British Columbia	0	0	0	0.0														
	Erythromycin	Campylobacter coli	Alberta	0	0	0	0.0														
	Erythromycin	Campylobacter coli	Ontario	1	0.25	0.25	0.0					100.0									
	Erythromycin	Campylobacter coli	Québec	4	1	2	0.0							75.0	25.0						
	Erythromycin	Campylobacter jejuni	British Columbia	27	0.5	0.5	0.0					40.7	55.6	3.7							
	Erythromycin	Campylobacter jejuni	Alberta	15	0.5	1	0.0						86.7	13.3							
Erythromycin	Campylobacter jejuni	Ontario	19	0.25	1	0.0					57.9	5.3	36.8								
Erythromycin	Campylobacter jejuni	Québec	15	0.25	0.5	0.0					60.0	40.0									
IV	Gentamicin	Campylobacter coli	British Columbia	0	0	0	0.0														
	Gentamicin	Campylobacter coli	Alberta	0	0	0	0.0														
	Gentamicin	Campylobacter coli	Ontario	1	0.5	0.5	0.0					100.0									
	Gentamicin	Campylobacter coli	Québec	4	1	1	0.0						100.0								
	Gentamicin	Campylobacter jejuni	British Columbia	27	0.5	1	0.0					51.9	48.1								
	Gentamicin	Campylobacter jejuni	Alberta	15	1	1	0.0					26.7	73.3								
	Gentamicin	Campylobacter jejuni	Ontario	19	1	1	0.0					47.4	52.6								
	Gentamicin	Campylobacter jejuni	Québec	15	1	1	0.0					33.3	66.7								
	Nalidixic acid	Campylobacter coli	British Columbia	0	0	0	0.0														
	Nalidixic acid	Campylobacter coli	Alberta	0	0	0	0.0														
	Nalidixic acid	Campylobacter coli	Ontario	1	8	8	0.0									100.0					
Nalidixic acid	Campylobacter coli	Québec	4	8	> 64	25.0									75.0				25.0		
Nalidixic acid	Campylobacter jejuni	British Columbia	27	4	> 64	40.7									51.9	7.4			40.7		
Nalidixic acid	Campylobacter jejuni	Alberta	15	4	4	0.0									100.0						
Nalidixic acid	Campylobacter jejuni	Ontario	19	4	> 64	21.1									57.9	21.1			21.1		
Nalidixic acid	Campylobacter jejuni	Québec	15	4	4	0.0									100.0						
V	Florfenicol	Campylobacter coli	British Columbia	0	0	0	0.0														
	Florfenicol	Campylobacter coli	Alberta	0	0	0	0.0														
	Florfenicol	Campylobacter coli	Ontario	1	1	1	0.0						100.0								
	Florfenicol	Campylobacter coli	Québec	4	1	2	0.0						75.0	25.0							
	Florfenicol	Campylobacter jejuni	British Columbia	27	1	1	0.0					3.7	96.3								
	Florfenicol	Campylobacter jejuni	Alberta	15	1	1	0.0						100.0								
	Florfenicol	Campylobacter jejuni	Ontario	19	1	1	0.0						100.0								
	Florfenicol	Campylobacter jejuni	Québec	15	1	1	0.0						100.0								
	Tetracycline	Campylobacter coli	British Columbia	0	0	0	0.0														
	Tetracycline	Campylobacter coli	Alberta	0	0	0	0.0														
	Tetracycline	Campylobacter coli	Ontario	1	0.25	0.25	0.0					100.0									
Tetracycline	Campylobacter coli	Québec	4	> 64	> 64	100.0														100.0	
Tetracycline	Campylobacter jejuni	British Columbia	27	32	> 64	59.3				3.7	3.7	22.2	11.1			7.4	7.4	40.7	3.7		
Tetracycline	Campylobacter jejuni	Alberta	15	> 64	> 64	60.0				33.3	6.7					6.7	20.0	33.3			
Tetracycline	Campylobacter jejuni	Ontario	19	64	> 64	57.9				21.1		10.5	10.5			5.3	26.3	26.3			
Tetracycline	Campylobacter jejuni	Québec	15	64	> 64	73.3				26.7							40.0	33.3			
VI																					

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RECOVERY RESULTS

Table 59. Farm Surveillance recovery rates in grower-finisher pigs

CIPARS Component /		Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted						
Animal species			<i>Escherichia coli</i>		<i>Salmonella</i>		<i>Campylobacter</i>		<i>Enterococcus</i>
Pigs	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				

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).

Table 60. Farm Surveillance recovery rates in broiler chickens

CIPARS									
Component /	Province / region	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted						
Animal species			<i>Escherichia coli</i>		<i>Salmonella</i>		<i>Campylobacter</i>		<i>Enterococcus</i>
Chickens (Placement)	British Columbia	2013	72%	43/60	28%	17/60			
	Alberta	2013	89%	31/35	29%	29/35			
	Ontario	2013	85%	64/75	17%	13/75			
	Québec	2013	82%	53/65	17%	11/65			
	National	2013	81%	191/235	22%	51/235			
Chickens (Preharvest)	British Columbia	2013	98%	94/96	71%	68/96	28%	27/96	
	Alberta	2013	100%	60/60	40%	24/60	25%	15/60	
	Ontario	2013	100%	120/120	54%	65/120	17%	20/120	
	Québec	2013	99%	111/112	64%	72/112	17%	19/112	
	National	2013	99%	385/388	59%	229/388	20%	81/388	

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).

SURVEILLANCE OF ANIMAL CLINICAL ISOLATES

KEY FINDINGS

CATTLE

SALMONELLA (n = 248)

Typhimurium var. 5- was the most common serovar recovered from cattle (32%, 79/248) (Table 61). Eleven isolates (14%) were resistant to 6 antimicrobial classes; 10 of these were resistant to all classes except the macrolides and 1 isolate demonstrated resistance to azithromycin (macrolide) but was not resistant to the quinolones (Table 61).

The second most common serotype observed in cattle was Dublin (23%, 56/248). Thirteen *S. Dublin* isolates (23%) demonstrated resistance to 6 antimicrobial classes (all except the macrolides) (Table 61).

CHICKENS

SALMONELLA (n = 182)

Heidelberg was the most common serovar from chickens (24%, 43/182); just 1 isolate was resistant to more than 1 antimicrobial class (Table 62).

There were 39 isolates of *S. Enteritidis* from chickens and none were resistant to any of the antimicrobials tested (Table 62).

One *S. Indiana* isolate was recovered from chickens and was resistant to 5 antimicrobial classes (ACSSuT pattern) (Table 62).

Sixty-four percent (117/182) of all *Salmonella* isolates from chickens were non-resistant (Table 62).

PIGS

SALMONELLA (n = 296)

Two isolates from pigs (1 *S. Mbandaka* and 1 *S. Workthington*) demonstrated resistance to 6 antimicrobial classes (all except the quinolones); the resistance pattern was ACKSSuT-A2C-AZM-CRO-SXT (Table 63). No quinolone resistance was observed in any clinical isolates from pigs (Table 63).

TURKEYS

SALMONELLA (n = 66)

Three Indiana isolates were resistant to all antimicrobial classes except the quinolones; the resistance pattern was ACKSSuT-A2C-AZM-CRO-GEN-SXT (Table 64).

No resistance to quinolone antimicrobials was observed in any isolates from turkeys in 2013 (Table 64).

HORSES

SALMONELLA (n = 18)

No Heidelberg isolates were reported from horses in 2013 (Table 65).

One Give isolate demonstrated resistance to 4 antimicrobial classes (ACSSuT-A2C-CRO-SXT) and 2 Typhimurium isolates were resistant to tetracycline (Table 65).

MULTICLASS RESISTANCE

Table 61. Number of antimicrobial classes in resistance patterns of *Salmonella* from cattle

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Typhimurium var. 5-	79 (31.9)				68	11	1	35	69	79	53	53	53	53	79	6	1	61		10	79
Dublin	56 (22.6)	2	3	1	37	13	2	13	48	45	45	44	37	42	54			50		16	51
Typhimurium	32 (12.9)	11		2	19			5	19	19	6	7	7	7	21	5		18			21
Cerro	23 (9.3)				23																
4,5,12i:-	7 (2.8)	3			4			1	4	4	1	1	1	1	4	1		1			4
Kentucky	7 (2.8)				7																
Heidelberg	5 (2.0)				5																
Infantis	5 (2.0)				5																
Thompson	5 (2.0)			1					1						1						1
Less common serovars	29 (11.7)	23	1	1	4			1	4	5	4	3	5	3	5	2		5			4
Total	248 (100)	83	4	5	132	24	3	55	145	152	109	108	103	106	164	14	1	135	26		160

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 62. Number of antimicrobial classes in resistance patterns of *Salmonella* from chickens

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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Heidelberg	43 (23.6)	23	19	1				1		1	19	19	19	19	19	1					
Enteritidis	39 (21.4)	39																			
Kentucky	32 (17.6)	8	3	21					21	17	17	17	15	17							21
Typhimurium	22 (12.1)	21	1								1	1	1	1	1						
Senftenberg	6 (3.3)	2		4			4	4	4							4					4
Infantis	4 (2.2)	4																			
Muenchen	4 (2.2)	1		3			2									3					3
Less common serovars	32 (17.6)	19	5	7	1		4	2	10	4	1	2		2	6			1			6
Total	182 (100)	117	28	36	1		11	6	36	41	38	39	35	39	14			1			34

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 63. Number of antimicrobial classes in resistance patterns of *Salmonella* from pigs

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	Phenicol	Quinolones		Tetracyclines
		0	1	2-3	4-5	6-7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Typhimurium	83 (28.0)	4	5	11	63		4	22	64	66	2	1	1	1	73	26	4	50			76
Derby	39 (13.2)	12	4	20	3			2	21	3					22	1					25
Typhimurium var. 5-	39 (13.2)	1	4	5	29			6	31	30					31	1		29			36
Infantis	19 (6.4)	16	1	2				1	1							1					3
4,12:i:-	17 (5.7)	1	3		13		2	4	13	13					13	2		7			16
Brandenburg	13 (4.4)	6	4	3				1		2		1		1	1	1					6
4,5,12:i:-	10 (3.4)	1	2	1	6			4	6	6					7			1			9
Mbandaka	10 (3.4)	3		6		1	2	2	7	1	1	1	1	1	6	1	1				7
Heidelberg	9 (3.0)			9					9						9						9
Agona	7 (2.4)	4	1	1	1		1	1	2	1					2			1			3
Less common serovars	50 (16.9)	20	6	11	12	1	3	8	19	16	7	7	7	7	24	9	2	9			24
Total	296 (100)	68	30	69	127	2	12	51	173	138	10	10	9	10	188	42	7	98			214

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 64. Number of antimicrobial classes in resistance patterns of *Salmonella* from turkeys

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	Phenicol	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Heidelberg	8 (12.1)	1		6	1		7	3	4	4	1	1	1	1	4						5
Muenchen	8 (12.1)	1		7			3		2						7						6
Indiana	7 (10.6)	1			3	3	4	2	6	6	6	6	6	6	6	4	3	6			6
Liverpool	7 (10.6)	7																			
Albany	4 (6.1)			4			4	1	3	3	2	3	2	3	2						1
Bredeney	4 (6.1)		3	1			4	2	1	1		1		1							
Montevideo	4 (6.1)			4			3	2	2	4	1	1	1	1							
Senftenberg	4 (6.1)			4			4	4	4	4											
Agona	3 (4.5)	1		2			1		1	1	1	1	1	1	2						1
Schwarzengrund	3 (4.5)			3			1	1	3						3						3
Enteritidis	2 (3.0)	2																			
Hadar	2 (3.0)			2					2												2
Litchfield	2 (3.0)		1	1			1		1	1	1	1	1	1	1						
Less common serovars	8 (12.1)	5	2		1		1		1	3	2	2	2	2	1						1
Total	66 (100)	18	6	34	5	3	15	30	27	14	16	14	16	26	4	3	6				25

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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 65. Number of antimicrobial classes in resistance patterns of *Salmonella* from horses

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	Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET	
Typhimurium	6 (33.3)	4	2																		2	
Infantis	4 (22.2)	4																				
Give	2 (11.1)	1		1				1	1	1	1	1	1	1	1		1			1		
4,5,12:b:-	2 (11.1)	2																				
Newport	2 (11.1)	2																				
Hartford	1 (5.6)	1																				
4,5,12:i:-	1 (5.6)	1																				
Total	18 (100)	15	2	1				1	1	1	1	1	1	1	1		1			3		

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 66. Distribution of minimum inhibitory concentrations among *Salmonella* from cattle

Antimicrobial	n	Percentiles			Distribution (%) of MICs (µg/mL)															
		MIC 50	MIC 90	% R	≤ 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	248	16	> 32	44.0							36.7	1.6	1.2	9.3	7.3	15.7	28.2			
Ceftiofur	248	1	> 8	42.7		0.4			17.3		35.5	2.4	1.6	4.0	38.7					
Ceftriaxone	248	≤ 0.25	32	43.5					56.0			0.4	4.4	0.4	6.9	25.4	5.6	0.8		
Ciprofloxacin	248	≤ 0.015	0.12	0.0	60.5	28.2	0.8	2.4	4.4	3.6										
II Ampicillin	248	> 32	> 32	61.3							35.1	2.8	0.8					61.3		
Azithromycin	248	4	16	0.4							0.8	3.2	62.5	16.9	16.1	0.4				
Cefoxitin	248	4	> 32	41.5							10.9	31.0	10.5	5.2	0.8	5.6	35.9			
Gentamicin	248	0.50	1	1.2				12.9	69.8		15.7	0.4			0.4	0.8				
Kanamycin	248	≤ 8	> 64	22.2										77.8				22.2		
Nalidixic acid	248	4	> 32	10.5							0.4	35.1	42.3	11.7			10.5			
Streptomycin	248	> 64	> 64	58.5												41.5	5.6	52.8		
Trimethoprim-sulfamethoxazole	248	0.25	0.50	5.6		49.6	35.5	5.6	3.6					5.6						
III Chloramphenicol	248	> 32	> 32	54.4							1.6	16.5	27.0		0.4	0.4	54.0			
Sulfisoxazole	248	> 256	> 256	66.1											6.5	21.4	6.0			66.1
Tetracycline	248	> 32	> 32	64.5								35.5				4.4	60.1			
IV																				

Table 67. Distribution of minimum inhibitory concentrations among *Salmonella* from chickens

Antimicrobial	n	Percentiles			Distribution (%) of MICs (µg/mL)															
		MIC 50	MIC 90	% R	≤ 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	182	≤ 1	> 32	20.9							75.3	2.2		0.5	1.1	1.6	19.2			
Ceftiofur	182	1	> 8	21.4		0.5			14.8		62.1	1.1			21.4					
Ceftriaxone	182	≤ 0.25	16	21.4					78.6					1.1	16.5	3.3		0.5		
Ciprofloxacin	182	≤ 0.015	0.03	0.0	85.7	13.7	0.5													
II Ampicillin	182	≤ 1	> 32	22.5							70.9	5.5	1.1				22.5			
Azithromycin	182	4	8	0.0						0.5		7.1	77.5	14.8						
Cefoxitin	182	2	32	19.2							13.7	47.3	15.9	2.2	1.6	17.0	2.2			
Gentamicin	182	0.50	1	6.0				23.1	64.8	4.9	0.5	0.5				6.0				
Kanamycin	182	≤ 8	≤ 8	3.3										96.7			0.5	2.7		
Nalidixic acid	182	4	4	0.0							1.6	39.6	57.1	1.1	0.5					
Streptomycin	182	≤ 32	64	19.8												80.2	9.9	9.9		
Trimethoprim-sulfamethoxazole	182	≤ 0.12	≤ 0.12	0.0		98.9	1.1													
III Chloramphenicol	182	8	8	0.5							1.6	29.7	66.5		1.6		0.5			
Sulfisoxazole	182	32	64	7.7											10.4	66.5	15.4			7.7
Tetracycline	182	≤ 4	> 32	18.7								81.3				0.5	18.1			
IV																				

Table 68. Distribution of minimum inhibitory concentrations among *Salmonella* from pigs

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	296	2	16	3.4							48.3	5.7	2.0	10.5	30.1	1.4	2.0			
Ceftiofur	296	1	1	3.4				0.3	7.1	84.5	4.7			0.3	3.0					
Ceftriaxone	296	≤ 0.25	≤ 0.25	3.4					96.6				0.3		0.7	2.0	0.3			
Ciprofloxacin	296	≤ 0.015	≤ 0.015	0.0	92.9	5.7	1.4													
II Ampicillin	296	2	> 32	46.6						46.3	6.8	0.3				0.3	46.3			
Azithromycin	296	4	8	2.4							0.7	68.6	26.4	2.0		2.4				
Cefoxitin	296	2	4	3.0						4.1	46.3	42.6	4.1			0.7	2.4			
Gentamicin	296	0.50	1	4.1				6.1	73.3	14.9	1.0			0.7	2.7	1.4				
Kanamycin	296	≤ 8	> 64	17.2										82.8			0.7	16.6		
Nalidixic acid	296	4	4	0.0						1.4	45.3	49.3	4.1							
Streptomycin	296	64	> 64	58.4												41.6	11.8	46.6		
Trimethoprim-sulfamethoxazole	296	≤ 0.12	> 4	14.2				68.9	16.9				0.3	13.9						
III Chloramphenicol	296	8	> 32	33.1							0.3	6.4	57.8	2.4	0.3	32.8				
Sulfisoxazole	296	> 256	> 256	63.5										1.4	20.6	13.9	0.7			63.5
Tetracycline	296	> 32	> 32	72.3								27.4	0.3	0.3	12.5	59.5				
IV																				

Table 69. Distribution of minimum inhibitory concentrations among *Salmonella* from turkeys

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	66	≤ 1	> 32	21.2							56.1	3.0		7.6	12.1		21.2			
Ceftiofur	66	1	> 8	24.2					6.1	69.7					24.2					
Ceftriaxone	66	≤ 0.25	32	24.2					75.8						6.1	10.6	1.5	6.1		
Ciprofloxacin	66	≤ 0.015	≤ 0.015	0.0	97.0	3.0														
II Ampicillin	66	2	> 32	40.9						50.0	9.1						40.9			
Azithromycin	66	4	8	4.5							9.1	75.8	10.6			4.5				
Cefoxitin	66	4	> 32	21.2						6.1	34.8	36.4	1.5			9.1	12.1			
Gentamicin	66	16	> 16	50.0				7.6	39.4	1.5	1.5			3.0	47.0					
Kanamycin	66	≤ 8	> 64	22.7										72.7		4.5	12.1	10.6		
Nalidixic acid	66	4	4	0.0							40.9	59.1								
Streptomycin	66	≤ 32	> 64	45.5												54.5	18.2	27.3		
Trimethoprim-sulfamethoxazole	66	≤ 0.12	≤ 0.12	6.1				92.4	1.5					6.1						
III Chloramphenicol	66	8	8	9.1							24.2	66.7					9.1			
Sulfisoxazole	66	32	> 256	39.4										4.5	47.0		9.1			39.4
Tetracycline	66	≤ 4	> 32	37.9								62.1					37.9			
IV																				

Table 70. Distribution of minimum inhibitory concentrations among *Salmonella* from horses

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	18	≤ 1	≤ 1	5.6							94.4						5.6			
Ceftiofur	18	1	1	5.6					44.4	50.0					5.6					
Ceftriaxone	18	≤ 0.25	≤ 0.25	5.6					94.4						5.6					
Ciprofloxacin	18	≤ 0.015	≤ 0.015	0.0	100.0															
II Ampicillin	18	≤ 1	≤ 1	5.6						94.4							5.6			
Azithromycin	18	4	4	0.0								94.4	5.6							
Cefoxitin	18	2	4	5.6						38.9	33.3	22.2				5.6				
Gentamicin	18	0.50	0.50	0.0				22.2	72.2	5.6										
Kanamycin	18	≤ 8	≤ 8	0.0										100.0						
Nalidixic acid	18	4	4	0.0							44.4	55.6								
Streptomycin	18	≤ 32	≤ 32	5.6												94.4		5.6		
Trimethoprim-sulfamethoxazole	18	≤ 0.12	≤ 0.12	5.6				94.4						5.6						
III Chloramphenicol	18	8	8	5.6							27.8	66.7					5.6			
Sulfisoxazole	18	32	64	5.6										5.6	72.2		16.7			5.6
Tetracycline	18	≤ 4	> 32	16.7								83.3					16.7			
IV																				

SURVEILLANCE OF FEED AND FEED INGREDIENTS

KEY FINDINGS

SALMONELLA (n = 32)

One Senftenberg and 1 Mbandaka serovar demonstrated resistance to 3 antimicrobial classes; no resistance to Category I antimicrobials was detected (Table 71). Sixty-nine percent (22/32) of isolates had no information about the intended use of the feed product; 4 isolates (13%) were from feed intended for dairy cattle, 2 (6%) each for beef cattle and fish, and 1 (3%) each for goats and swine. Among the 2 feed isolates that demonstrated resistance, the *S. Senftenberg* isolate was intended for fish and the *S. Mbandaka* 1 was intended for dairy cattle.

MULTICLASS RESISTANCE

Table 71. Number of antimicrobial classes in resistance patterns of *Salmonella* from feed and feed ingredients

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	Phenicol	Quinolones		Tetracyclines	
		0	1	2–3	4–5	6–7	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	AZM	CHL	CIP	NAL	TET
Senftenberg	5 (15.6)	4		1				1							1						1
Montevideo	4 (12.5)	4																			
Infantis	3 (9.4)	3																			
Johannesburg	2 (6.3)	2																			
Mbandaka	2 (6.3)	1		1				1							1						1
Newport	2 (6.3)	2																			
Soerenga	2 (6.3)	2																			
Agona	1 (3.1)	1																			
Anatum var. 15+	1 (3.1)	1																			
Berta	1 (3.1)	1																			
Cerro	1 (3.1)	1																			
4,5,12:b:-	1 (3.1)	1																			
Ohio var. 14+	1 (3.1)	1																			
Oranienburg	1 (3.1)	1																			
Orion var. 15+ 34+	1 (3.1)	1																			
Schwarzengrund	1 (3.1)	1																			
Tennessee var. 14+	1 (3.1)	1																			
Typhimurium	1 (3.1)	1																			
Urbana	1 (3.1)	1																			
Total	32 (100)	30		2				2							2						2

Antimicrobial abbreviations are defined in the section *How To Read This Chapter*.

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

Table 72. Distribution of minimum inhibitory concentrations among *Salmonella* from feed and feed ingredients

	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
I	Amoxicillin-clavulanic acid	32	≤ 1	≤ 1	0.0							100.0								
	Ceftiofur	32	1	1	0.0					28.1	71.9									
	Ceftriaxone	32	≤ 0.25	≤ 0.25	0.0					100.0										
	Ciprofloxacin	32	≤ 0.015	≤ 0.015	0.0	93.8	6.3													
II	Ampicillin	32	≤ 1	≤ 1	0.0						100.0									
	Azithromycin	32	4	8	0.0							6.3	75.0	18.8						
	Cefoxitin	32	2	4	0.0							12.5	46.9	40.6						
	Gentamicin	32	0.50	0.50	0.0				18.8	71.9	9.4									
	Kanamycin	32	≤ 8	≤ 8	0.0									100.0						
	Nalidixic acid	32	4	4	0.0							40.6	59.4							
	Streptomycin	32	≤ 32	≤ 32	6.3												93.8	6.3		
	Trimethoprim-sulfamethoxazole	32	≤ 0.12	≤ 0.12	0.0				93.8	6.3										
	Chloramphenicol	32	8	8	0.0								25.0	75.0						
III	Sulfisoxazole	32	32	64	6.3										6.3	56.3	28.1	3.1		6.3
	Tetracycline	32	≤ 4	≤ 4	6.3									93.8				6.3		
IV																				