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Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)

Annual Report

2010

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

Canada

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

—Public Health Agency of Canada

Également disponible en français sous le titre :

Programme intégré canadien de surveillance de la résistance aux antimicrobiens (PICRA) 2010 – Rapport Annuel

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This publication can be made available in alternative formats upon request.

Publication date: September 2014

Cat.: HP2-4/2010E-PDF

ISSN: 1925-9859

Pub.: 140290

Suggested Citation

Government of Canada. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2010 Annual Report. Public Health Agency of Canada, Guelph, Ontario, 2014.

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These acknowledgements are intended to identify and thank the numerous individuals and organizations that have contributed to the success of CIPARS 2010.

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Retail Meat Surveillance Participants

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

- University of Prince Edward Island, Atlantic Veterinary College (Carol McClure, J.T. McClure, Anne Muckle, Matthew Saab, and Cynthia Mitchell)
- Prince Edward Island Food Technology Centre
- Centre for Coastal Health

We also thank the following health unit managers, public health inspectors, and environmental health officers: Lucy Beck, Darrell Belanger, Shaun Malakoe, Sharlene Lively, Doug Quibell, Shawna Scafe, Matthew Shumaker, Greg Thibault.

Abattoir-Industry Participants

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

Farm Surveillance Participants

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

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

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

We are also grateful to the Canadian Animal Health Institute (CAHI) for sharing information on the distribution of antimicrobials for use in animals with CIPARS.

We would also like to thank the following individuals and organizations for their contribution to CIPARS 2010.

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Executive Summary

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) tracks temporal and regional trends in antimicrobial use and antimicrobial resistance in selected species of enteric bacteria obtained at different stages of food production and from human clinical laboratory submissions. This information supports the creation and evaluation of policies to contain antimicrobial resistance and to better manage antimicrobial use in human medicine, veterinary medicine, and agricultural sectors.

A major focus for CIPARS are the Category I antimicrobials (as classified by the Veterinary Drugs Directorate; Health Canada). These Category I drugs are of very high importance to human medicine, and are used in humans to treat serious infections, and often as a last resort. Examples of Category I drugs include ciprofloxacin and third-generation cephalosporins (ceftriaxone/ceftiofur). Category I antimicrobials should not be used in an extra-label manner for mass medication in food-producing animals.

Resistance to Category I antimicrobials across bacterial species is relatively high in chicken, compared to beef cattle or pigs (Table 1). The evolution and increase in resistance to Category I antimicrobials ceftiofur/ceftriaxone in bacteria isolated from chicken and the regional differences in resistance of chicken *Campylobacter* isolates across the country, are of public health concern. CIPARS continues to follow trends of concern and publicly report the findings for policy change or voluntary initiatives within the agri-food industry. CIPARS is continually evolving to provide a better understanding of the relationships between antimicrobial use and antimicrobial resistance in Canada.

Antimicrobial resistance surveillance in bacteria from sick people involves the monitoring of 7 *Salmonella* serovars, or strains: Enteritidis, Heidelberg, I 4,[5],12:i:-, Paratyphi A and Paratyphi B, Typhi, and Typhimurium. Among the 2,296 isolates tested for susceptibility testing in 2010, the 3 most commonly detected *Salmonella* serovars were Enteritidis, Heidelberg, and Typhimurium. There was provincial variation in the prevalence of resistance to Category I drugs (amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone). Isolates of *S*. Heidelberg with ceftiofur resistance were significantly higher in 2010 (19%, 90/476), than in 2006 (13%, 57/430). Additionally, the percentage of human clinical *Salmonella* Typhi isolates that were resistant to nalidixic acid was significantly higher in 2010 (87%, 156/179) than the percentages observed since the beginning of the program in 2003 (44%, 56/127).

In beef cattle, samples were collected for isolation of *Escherichia coli* (abattoir, retail)*, Campylobacter (*abattoir), and *Salmonella* isolates from sick cattle were also tested for susceptibility. In general, the prevalence of resistance to Category I antimicrobials remains low[1] (less than 2%) in isolates from healthy cattle and meat. Of the clinical *Salmonella* isolates from cattle, 18% (26/143) were resistant to the Category I drugs amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone.

Samples from chicken(s) were collected for isolation of *Salmonella*, *E. coli*, and *Campylobacter*. The percentage of retail chicken samples with *Campylobacter* resistant to ciprofloxacin was significantly higher in British Columbia (17%, 12/70) than in Québec (2%, 1/63) in 2010. Abattoir surveillance of chickens indicated that 4% (4/111) of *Campylobacter* isolates were resistant to ciprofloxacin. Since 2008, there has been an increase in the percentage of *E. coli* and *Salmonella* resistance to ceftiofur found in abattoir chicken isolates. In retail chicken, *Salmonella* with resistance to Category I drugs (amoxicillin-clavulanic acid, ceftiofur, ceftriaxone) ranged from 7% (3/42) to 25% (29/116) across the provinces. In Ontario, ceftiofur resistance among *Salmonella* isolates from retail meat was significantly lower in 2010 (24%, 22/90) than in 2004 (46%, 25/54). All provinces had retail chicken *E. coli* isolates with resistance to Category I drugs (amoxicillin-clavulanic acid, ceftiofur, ceftriaxone) and prevalence of resistance ranging from 21% (37/175) to 48% (36/75). In Québec, *E. coli* resistant to ceftiofur was significantly higher in 2010 (27%, 37/138) than in 2006 (6%, 8/135). Saskatchewan has a similar trend of ceftiofur resistance, with an increase in the percentage of *E. coli* isolates resistant from 2005 (4%, 3/81) to 2010 (20%, 14/71).

In clinical *Salmonella* isolates from turkeys, 40% (12/30) of isolates were resistant to Category I drugs (amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone).

[1] Thresholds for prevalence of resistance to Category I antimicrobials were arbitrarily assigned as follows: low (less than 2%); mod (2-8%); high (greater than 8%) for the purpose of priority setting and adopted here (CIPARS Priority Setting Working Group).

In pigs, samples to isolate *Salmonella*, *E. coli*, and *Enterococcus* were collected. In general, with the exception of *E. coli* from retail pork in British Columbia [resistance to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone 13% (4/31)], the prevalence of resistance to Category I antimicrobials from swine remains low to moderate[1] (less than 7%) in isolates from healthy pigs and pork.

Antimicrobial use in humans was evaluated using the Canadian CompuScript Data, IMS Health Canada Inc.. In 2010, the total amount of active pharmaceutical ingredients used in humans (outpatient use) was 199,850.84 kg. Category I antimicrobials represented a high proportion (17%, 3.06/18.30) of the total DDDs/inhabitant-days. The most frequently dispensed Category I antimicrobials were ciprofloxacin, metronidazole, amoxicillin and enzyme inhibitor, and moxifloxacin. Oral antimicrobial consumption was highest in Newfoundland and Labrador and lowest in Québec. Total amounts of oral antimicrobials dispensed in Canadian retail pharmacies in 2009 were compared to the total outpatient antimicrobial use in 32 European countries. Canada ranked 15th out of 33 countries classified by increasing level of total antimicrobial consumption.

Antimicrobial use in animals is provided from two sources - CIPARS farm surveillance in grower-finisher swine herds across Canada and the Canadian Animal Health Institute (CAHI). In 2010, the only Category I antimicrobial used in grower-finisher pig herds was injectable ceftiofur (24% of herds, 22/90). The reported use of ceftiofur in 2010 represented a 3% and 5% increase compared with use in 2008 (21% of herds, 20/95) and 2009 (19% of herds, 18/95), respectively. Ceftiofur was used in the treatment of respiratory diseases, enteric diseases, lameness and other unspecified conditions. In 2010, the total kilograms of antimicrobials distributed for sale by CAHI member companies decreased by 14% relative to the 2006 total and decreased by 6% relative to the 2009 total. In terms of Category I antimicrobials, the quantity of fluoroquinolones distributed for use in animals in 2010 decreased by 36% relative to the 2006 total and increased by 1% relative to the 2009 total. CIPARS is working on developing an animal biomass denominator to indicate whether changes in the reported volume of antimicrobials distributed could be explained by changes in livestock populations in Canada.

[1] Thresholds for prevalence of resistance to Category I antimicrobials were arbitrarily assigned as follows: low (less than 2%); mod (2-8%); high (greater than 8%) for the purpose of priority setting and adopted here (CIPARS Priority Setting Working Group).

Summary of antimicrobials resistance surveillance findings for bacterial isolates from humans and the agri-food sector, 2010.

Species	Bacterial species	Number (%) of isolates resistant				
		Resistance to 1 or more antimicrobial classes	Resistance to 4 or more antimicrobial classes[a]	Resistance to Category I[b] antimicrobials	Resistance to NAL or reduced susceptibility to CIP	Number of different resistance patterns / number of isolates resistant
Surveillance of Human Clinical Isolates						
Human	*Salmonella*	703/2,296 (31%)	301/2,296 (13%)	AMC: 113/2,296 (5%) TIO: 114/2,296 (5%) CRO: 115/2,296 (5%) CIP: 8/2,296 (< 1%)	NAL: 285/2,296 (12%) RSCIP: 280/2,296 (12%)	82/703
Retail Meat Surveillance						
Beef	*Escherichia coli*	81/521 (16%)	12/521 (2%)	AMC: 2/521 (< 1%) TIO: 2/521 (< 1%) CRO: 2/521 (< 1%) CIP: 3/521 (1%)	NAL: 6/521 (1%) RSCIP: 3/521 (1%)	26/81
Chicken	*Salmonella*	172/381 (45%)	1/381 (< 1%)	AMC: 83/381 (22%) TIO: 84/381 (22%) CRO: 84/381 (22%)		20/172
	Escherichia coli	422/559 (75%)	86/559 (15%)	AMC: 155/559 (28%) TIO: 136/559 (24%) CRO: 156/559 (28%)	NAL: 21/559 (4%) RSCIP: 21/559 (4%)	95/422
	Campylobacter	167/301 (55%)	3/301 (1%)	CIP: 23/301 (8%) TEL: 7/301 (2%)	N/A	11/167
Pork	*Escherichia coli*	118/250 (47%)	23/250 (9%)	AMC: 12/250 (5%) TIO: 10/250 (4%) CRO: 11/250 (4%)	NAL: 3/250 (1%) RSCIP: 2/250 (1%)	45/118
Abattoir Surveillance						
Beef cattle	*Escherichia coli*	12/77 (16%)	1/77 (1%)			6/12
	Campylobacter	19/37 (51%)		CIP: 1/37 (3%)	N/A	2/19
Chickens	*Salmonella*	71/142 (50%)	3/142 (2%)	AMC: 46/142 (32%) TIO: 46/142 (32%) CRO: 46/142 (32%)	NAL: 1/142 (1%) RSCIP: 1/142 (1%)	12/71
	Escherichia coli	95/119 (80%)	21/119 (18%)	AMC: 46/119 (39%) TIO: 41/119 (34%) CRO: 45/119 (38%)	NAL: 5/119 (4%) RSCIP: 5/119 (4%)	43/95
	Campylobacter	57/111 (51%)	1/111 (1%)	CIP: 4/111 (4%) TEL: 4/111 (4%)	N/A	7/57
Pork	*Salmonella*	99/182 (54%)	30/182 (16%)	AMC: 6/182 (3%) TIO: 6/182 (3%) CRO: 6/182 (3%)		30/99
	Escherichia coli	165/199 (83%)	41/199 (21%)	AMC: 4/199 (2%) TIO: 4/199 (2%) CRO: 4/199 (2%)		44/165
Farm Surveillance						
Pigs	*Salmonella*	69/101 (68%)	29/101 (29%)	AMC: 2/101 (2%) TIO: 2/101 (2%) CRO: 2/101 (2%)		19/69
	Escherichia coli	1,402/1,673 (84%)	299/1,673 (18%)	AMC: 10/1,673 (1%) TIO: 8/1,673 (< 1%) CRO: 9/1,673 (< 1%)	NAL: 10/1,673 (1%) RSCIP: 7/1,421 (< 1%)	84/1,402
	Enterococcus	1,489/1,549 (96%)	363/1,549 (23%)	CIP: 26/1,549 (2%)	N/A	87/1,489
Surveillance of Animal Clinical Isolates						
Cattle	*Salmonella*	81/143 (57%)	74/143 (52%)	AMC: 26/143 (18%) TIO: 26/143 (18%) CRO: 26/143 (18%)	NAL: 2/143 (1%) RSCIP: 2/143 (1%)	19/81
Chickens	*Salmonella*	114/342 (33%)	7/342 (2%)	AMC: 47/342 (14%) TIO: 47/342 (14%) CRO: 47/342 (14%)	NAL: 1/342 (< 1%) RSCIP: 1/342 (< 1%)	25/114
Pigs	*Salmonella*	173/235 (74%)	82/235 (35%)	AMC: 16/235 (7%) TIO: 14/235 (6%) CRO: 14/235 (6%)	RSCIP: 1/235 (< 1%)	51/173
Turkeys	*Salmonella*	25/30 (83%)	3/30 (10%)	AMC: 12/30 (40%) TIO: 12/30 (40%) CRO: 12/30 (40%)		13/25
Horses	*Salmonella*	8/14 (57%)	7/14 (50%)		RSCIP: 3/14 (21%)	4/8
Feed and Feed Ingredients						
	Salmonella					

Blank cells represent values equal to zero (0%).
AMC = Amoxicillin-clavulanic acid. CIP = Ciprofloxacin. CRO = Ceftriaxone. N/A = Not applicable. NAL = Nalidixic acid. RSCIP = Reduced susceptibility to ciprofloxacin. TEL = Telithromycin. TIO = Ceftiofur.
[a] Resistance to 3 or more antimicrobials for *Campylobacter* isolates and resistance to 6 or more for *Enterococcus* isolates.
[b] Categorization of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate of Health Canada (Appendix A).

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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 and resistance in selected bacteria from humans, animals, and animal-derived food sources across Canada. This information supports (i) the creation of evidence-based policies for antimicrobial use 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. This publication represents the 9th annual CIPARS report released by the Government of Canada under the coordination of the Public Health Agency of Canada.

CIPARS Objectives

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

CIPARS 2010 Activities

In 2010, CIPARS included 2 passive and 3 active antimicrobial resistance surveillance components, as well as antimicrobial use surveillance in humans and animals (Figure 1).

Surveillance of Antimicrobial Resistance

- *Surveillance of Human Clinical Isolates* involved passive surveillance of human clinical *Salmonella* isolates recovered at the provincial/territorial level. All human *Salmonella* isolates received by the Provincial Public Health Laboratories (PPHLs) in Saskatchewan, Manitoba, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador were forwarded to the National Microbiology Laboratory for further typing and antimicrobial susceptibility testing. The PPHLs in more populated provinces (British Columbia, Alberta, Ontario, and Québec) forwarded only the isolates received from the 1st to the 15th of each month. However, all human isolates of *S*. Typhi and S. Newport were forwarded to the National Microbiology Laboratory.
- *Retail Meat Surveillance* involved active sample collection and antimicrobial susceptibility testing of generic *Escherichia coli*,[1] *Salmonella*, and *Campylobacter* in retail chicken, and of *E. coli* in retail beef and *Salmonella* and *E. coli* in retail pork from British Columbia, Saskatchewan, Ontario, Québec, and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island). As of January 1, 2010, no attempt has been made to isolate *Enterococcus* from retail-level chicken samples as no vancomycin-resistant enterococci, which are strains of particular public health concern, have been detected in retail isolates since CIPARS began

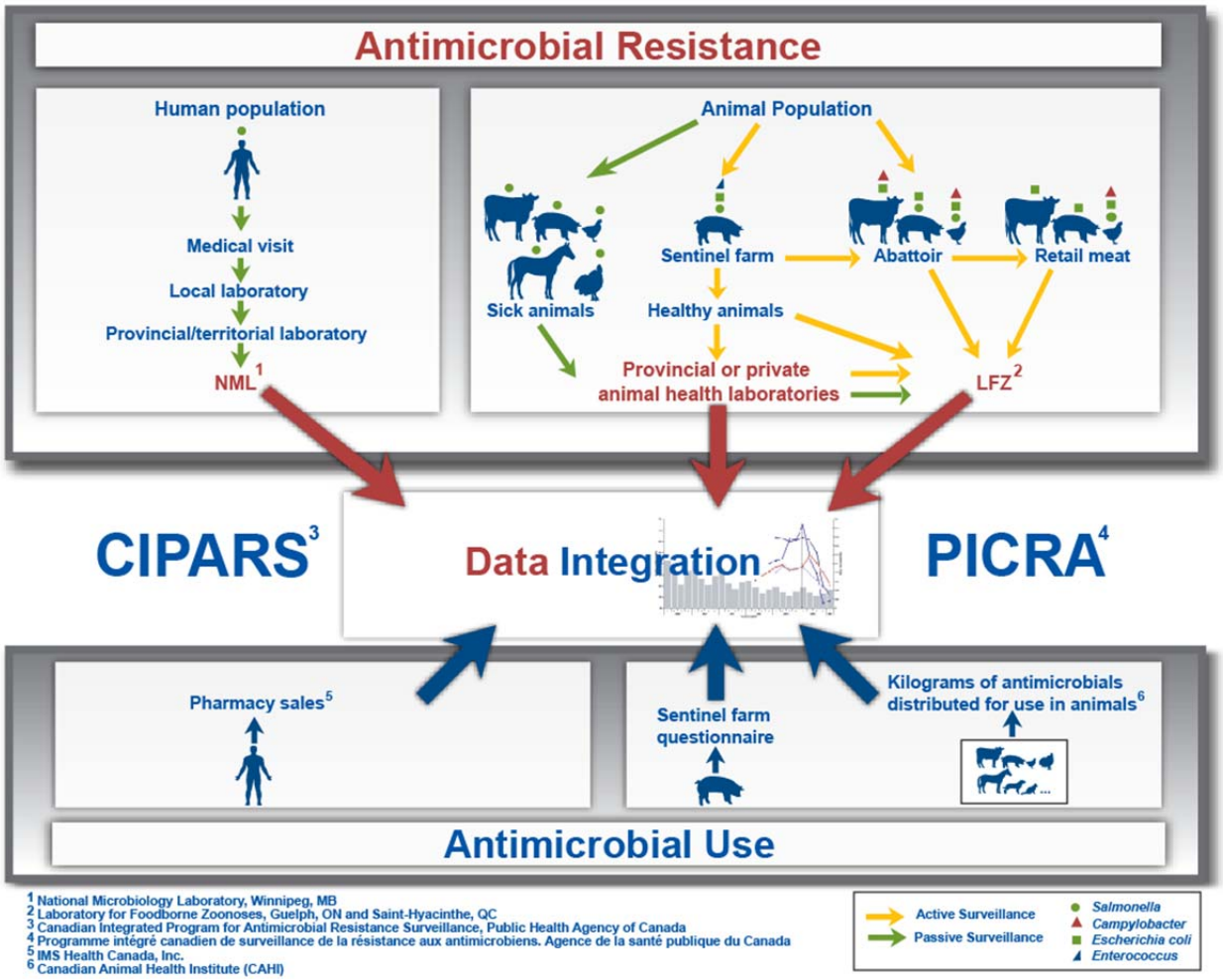
[1] *Escherichia coli* were identified by use of biochemical tests. No attempt was made to distinguish pathogenic strains of *E. coli* from non-pathogenic strains.

- *Abattoir Surveillance* involved active sample collection of caecal content from healthy chickens, pigs and cattle from across Canada that are entering the food chain. Antimicrobial susceptibility testing is carried out on isolates of *Salmonella* (chickens and pigs), *Campylobacter* (chickens and cattle), and generic *E. coli* (chickens, pigs, and cattle).
- *Farm Surveillance* involved swine herds in the 5 major pork-producing provinces in Canada (Alberta, Saskatchewan, Manitoba, Ontario, and Québec). A sentinel farm framework was used to organize the active collection of pooled fecal samples from pigs and the isolation of generic *E. coli*, *Enterococcus*, and *Salmonella* isolates for antimicrobial susceptibility testing.
- *Surveillance of Animal Clinical Isolates* involved passive surveillance of clinical *Salmonella* isolates from animals in multiple provinces. Samples were originally submitted by veterinarians or producers to private or provincial laboratories for diagnostic purposes. *Salmonella* isolates may or may not have been forwarded to the Laboratory for Foodborne Zoonoses (LFZ) for further characterization and antimicrobial susceptibility testing. Hence, the isolates were not obtained randomly and may not represent true estimates of clinical *Salmonella* prevalence by province. Additionally, some isolates may have been recovered from animal feed, the animal's environment or from non-diseased animals in the same herd. Cattle isolates could be from dairy cattle, milk-fed or grain-fed veal, or beef cattle. Chicken isolates were largely from layer hens or broiler chickens, but could also have been from primary layer breeders or broiler breeder birds. Pig isolates may also have originated from animal feed, the animal's environment, or non-diseased animals from the same herd. A proportion of the turkey isolates might have been recovered from turkey-related environmental samples.
- *Salmonella* isolates recovered from *Feed and Feed Ingredients* samples were obtained from Government and Industry Monitoring programs and from passive surveillance.

Surveillance of Antimicrobial Use

- Antimicrobial use surveillance in humans included data obtained from the Canadian CompuScript and provided by IMS Health Canada, Inc. for 2000 through 2010. This dataset contains information on prescriptions dispensed for oral consumption by Canadian retail pharmacies.
- Antimicrobial use surveillance in pigs included herd demographic and antimicrobial use data obtained through questionnaires applied through of the *Farm Surveillance* component of CIPARS. The herd veterinarian (or designated practice staff) administered the questionnaire to the producer (or designated farm staff), who provided information on antimicrobials administered through feed, water, and injection within each herd; pig health status; and farm characteristics.
- Antimicrobial use surveillance in animals included data obtained from the Canadian Animal Health Institute and analysed by Impact Vet for 2006 through 2010. This dataset contains information on the total kilograms of antimicrobials distributed by Canadian companies for use in food (including fish), sporting, and companion animals.

Figure 1. Diagram of CIPARS surveillance components in 2010.



What's New in the 2010 Report

Changes to CIPARS Antimicrobial Resistance Surveillance Component

- The antimicrobial susceptibility testing protocol of the human clinical isolates was modified and now focuses on 7 *Salmonella* serovars: Enteritidis, Heidelberg, Paratyphi A and B, Typhi, Typhimurium, and I 4,[5],12:i:-. Consequently, isolates belonging to the "Other Serovars" category were not tested and reported within the *Surveillance of Human Clinical Isolates* section. Isolates within the "Other Serovars" category have been stored for future susceptibility testing.
- Bacterial culture and antimicrobial susceptibility testing of *Enterococcus* isolates from retail chicken meat was discontinued as of January 1, 2010 as no vancomycin-resistant enterococci isolates, have been detected. Antimicrobial resistance surveillance of this bacterial species at the retail level may be reintroduced at a later date.
- Bacterial culture and antimicrobial susceptibility testing of *Campylobacter* isolates from abattoir chickens was initiated in January 2010.

Methodological Changes

- A molecular method (genus- and species-specific multiplex PCR) was used in replacement of the standard method (biochemical tests) for all *Campylobacter* isolates to perform identification and speciation. One of the previous biochemical tests performed, the hippurate hydrolysis test, can be used for distinguishing *C. jejuni* from *C. coli*, although occasionally, some strains of *C. jejuni* may be misidentified as *C. coli*. For that reason, a multiplex PCR methodology is now used for *Campylobacter* speciation. In addition, the entire multiplex PCR procedure identifies presumptive positive colonies within 4 hours and has proven to be a highly specific and sensitive method for the identification of *C. jejuni* and *C. coli* isolated from a variety of sources.
- Half of the *Salmonella* Enteritidis human clinical isolates submitted by the most populated provinces (British Columbia, Alberta, Ontario, and Québec) during the first 15 days of the month were tested due to the high number of isolates submitted by their provincial public health laboratories. The other half of the isolates have been stored for future testing.

Important Notes

Antimicrobial Groupings

- Category of importance in human medicine: Antimicrobials were categorized on the basis of importance in human medicine (Veterinary Drugs Directorate, Health Canada; categories revised in April 2009).[1]
  - Category of importance in human medicine: Antimicrobials have been categorized on the basis of importance in human medicine in accordance with the classification system of the VDD, Health Canada (categories revised in April 2009; Appendix A).
    - All Category I antimicrobials (Very High Importance in Human Medicine) are highlighted throughout the report. These antimicrobials include amoxicillin-clavulanic

[1] Version April, 2009. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed on May 2013.

acid, ceftiofur,[1] ceftriaxone, ciprofloxacin, daptomycin, linezolid, telithromycin, and vancomycin.

  - Antimicrobials are generally listed first according to this classification and then alphabetically.

- Standard Anatomic Therapeutic Chemical class: For human antimicrobial use data, antimicrobials have been classified using the World Health Organization's international standard Anatomic Therapeutic Chemical (ATC) class system[2] in addition to the category of importance in human medicine.
- Canadian Animal Health Institute aggregate class: Data on the distribution of antimicrobial use in animals were provided to CIPARS by the Canadian Animal Health Institute (CAHI) in aggregate antimicrobial classes as presented in this report.

Labels and Particular Highlights Regarding Certain Antimicrobials

- "Reduced susceptibility": Reduced susceptibility to ciprofloxacin[3] is highlighted in this report. It was defined as a minimum inhibitory concentration (MIC)[4] from 0.125 to 2 µg/mL for *Salmonella* and *E. coli*.
- "Non-susceptible": For daptomycin and florfenicol, the expression "non-susceptible" is used instead of "resistant" because these antimicrobials do not have a referenced resistance breakpoint (Appendix A).
- "Selected antimicrobials": In the temporal variations analyses, the selected antimicrobials were chosen to represent the different antimicrobial structural classes (for the complete list of exclusion criteria, please see Appendix A). For *Salmonella* and *E. coli* isolates, selected antimicrobials included ampicillin, ceftiofur, gentamicin, nalidixic acid, streptomycin, tetracycline, and trimethoprim-sulfamethoxazole. For *Campylobacter* isolates, selected antimicrobials included azithromycin, florfenicol, gentamicin, nalidixic acid, and tetracycline. For *Enterococcus* isolates, selected antimicrobials included ciprofloxacin, erythromycin, gentamicin, quinupristin-dalfopristin, streptomycin, tetracycline, and tylosin. It should be noted that resistance to these antimicrobials does not necessarily imply equal resistance to other antimicrobials from the same class.
- Resistance to nalidixic acid (a quinolone) is highlighted for *Salmonella* and *E. coli*. Additionally, we have highlighted isolates with reduced susceptibility or resistance to ciprofloxacin (a fluoroquinolone) but no resistance to nalidixic acid.[5] These latter isolates may have different genetic determinants of resistance than isolates with both nalidixic acid resistance and reduced susceptibility or resistance to ciprofloxacin.
- Joint reduced susceptibility to ciprofloxacin (or resistance to nalidixic acid) and resistance to ceftriaxone, a third-generation cephalosporin, is also highlighted for *Salmonella* or *E. coli*.

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[1] Ceftiofur is licensed for use in animals only. Resistance to ceftiofur is generally detected in combination with resistance to amoxicillin-clavulanic acid, cefoxitin, ampicillin and ceftriaxone (A2C-AMP-CRO resistance pattern).

[2] World Health Organization. The Anatomical Therapeutic Chemical Classification System with Defined Daily Doses (ATC/DDD). Available at: www.who.int/classifications/atcddd/en/. Accessed May 2013.

[3] The current CLSI resistance breakpoint for this antimicrobial and the one adopted in this report is greater than or equal to 4 µg/mL. However, the Danish Integrated Antimicrobial Resistance Monitoring and Research Program (DANMAP) has used a resistance breakpoint of greater than or equal to 0.125 µg/mL for both *Salmonella* spp. and indicator *E. coli* since 2004 and for pathogenic *E. coli* since 2006. The DANMAP also introduced European Committee on Antimicrobial Susceptibility Testing epidemiological cutoff values in their 2007 report. Because of the clinical importance of ciprofloxacin and a desire to present results in a format comparable with those of DANMAP, the term "reduced susceptibility" is used for ciprofloxacin MICs from 0.125 to 2 µg/mL. To obtain resistance estimates comparable to those from DANMAP, the percentage of *E. coli* and *Salmonella* isolates in this report with reduced susceptibility must be added to the percentage of isolates resistant to ciprofloxacin.

[4] MIC is the lowest concentration of an antimicrobial that inhibits visible bacterial growth after incubation.

[5] "Fluoroquinolone-susceptible strains of *Salmonella* that test resistant to nalidixic acid may be associated with clinical failure or delayed response in fluoroquinolone-treated patients with extra-intestinal salmonellosis. Extra-intestinal isolates of *Salmonella* should also be tested for resistance to nalidixic acid. For isolates that test susceptible to fluoroquinolones and resistant to nalidixic acid, the physician should be informed that the isolate may not be eradicated by fluoroquinolone treatment." (CLSI M100-S16).

Additional Notes

- Temporal variations: In general, temporal variations in the percentage of isolates resistant to the selected antimicrobials were identified by comparing results for 2010 with those for 2003 (the year most surveillance components of CIPARS began) and with those for the previous year (2009).
    - For data regarding *Retail Meat Surveillance* in Saskatchewan, 2005 was the first year of surveillance. For data regarding the swine *Farm Surveillance* component, 2006 was the first year of surveillance.
    - Temporal variations in data from the *Surveillance of Animal Clinical Isolates* (or in *Feed and Feed Ingredients*) program were not investigated because the intensity of passive surveillance was unequal across years and regions.
    - For data on ceftiofur and ampicillin resistance in *S*. Heidelberg and *E. coli* isolates obtained from chicken (abattoir and retail) and *S*. Heidelberg isolates from humans, the years of comparison were 2004 and 2006 because of changes in ceftiofur use in early 2005[1] and in 2007 in chicken hatcheries in Québec. For retail chicken, comparisons using those reference years were limited to Ontario and Québec.
- In the statistical analyses, a *P*-value ≤ 0.05 was used to indicate a significant difference between years and among provinces.
- With the exception of *Enterococcus faecalis* and *E. faecium*, no attempt was made to identify the species of *Enterococcus* recovered from CIPARS samples. Unidentified species of enterococci are collectively referred to in this report as "other *Enterococcus* spp." However, when used alone, the term "*Enterococcus*" refers to all enterococci, including *E. faecalis* and *E. faecium*. Similarly, *Campylobacter coli* and *C. jejuni* were the only species of *Campylobacter* that were specifically identified; unidentified species are collectively referred to as "other *Campylobacter* spp." When used alone, the term "*Campylobacter*" refers to all species of *Campylobacter*, including *C. coli* and *C. jejuni*.
- The most common resistance pattern: Throughout the report, "the most common resistance pattern" may include patterns with only 1 antimicrobial. In this case, like for the most common patterns including 2 or more antimicrobials, the number of isolates reported includes only those resistant to this specific pattern (i.e. without any additional resistance to other antimicrobials).
- Human antimicrobial use figures are only provided for individual antimicrobial classes whose trends in consumption were not consistent with previous years. More detailed tables and figures are provided to demonstrate provincial trends of individual antimicrobials.
- The total cost of prescriptions in Canada for humans has been adjusted to account for inflation values across Canada.
- *Surveillance of Animal Clinical Isolates* and antimicrobial resistance figures: Confidence intervals are not displayed for this component because samples were not obtained randomly and may not have represented independent observations. Therefore, the data may not represent the true prevalence of antimicrobial resistance, but can be used to highlight the occurrence of emerging or re-emerging resistance.

[1] Public Health Agency of Canada. *Salmonella* Heidelberg Ceftiofur-Related Resistance in Human and Retail Chicken Isolates. Available at: www.phac-aspc.gc.ca/cipars-picra/heidelberg/heidelberg-eng.php. Accessed May 2013.

Section One – Antimicrobial Resistance

Humans

Salmonella

Throughout 2010, the Provincial Public Health Laboratories forwarded a total of 3,420 *Salmonella* isolates (193 serovars) to the National Microbiology Laboratory, Public Health Agency of Canada, Winnipeg, Manitoba for phage typing and susceptibility testing (see Appendix A – Methods, Antimicrobial Resistance). No *Salmonella* isolates were identified as having been submitted by the territories (Yukon, Northwest Territories, or Nunavut) to CIPARS in 2010, directly or through Public Health Laboratories. However, some of these isolates could have been labeled as being forwarded by a province and not a territory.

Antimicrobial resistance results are presented by province because of differences in isolate submission protocols between more populated and less populated provinces (Appendix A – Methods). Results are also presented by province because of variation among provinces in antimicrobial use and in prevailing strains and antimicrobial resistance patterns of *Salmonella*.

Because isolation of *Salmonella* from blood or urine specimens suggests patients had an invasive infection that was likely treated with antimicrobials, particular attention was paid to isolates from these specimen sources. Such specimens may have been submitted because of treatment failure, which could not be verified because patient records were not available. Therefore, isolates recovered from these specimens were potentially more likely to be resistant to multiple antimicrobials than isolates from other types of specimens.

Summary results are provided for the 3 most commonly isolated *Salmonella* serovars in Canada (Enteritidis, Heidelberg, and Typhimurium). Although the agri-food sector is not a source of *Salmonella* Typhi, *S*. Paratyphi A, or *S*. Paratyphi B,[1] data for these serovars are also presented because they each cause severe disease in humans.[2] Due to its emergence among human clinical cases and presence in the agri-food sector, summary data is also provided for *S.* I 4,[5],12:i:- isolates. Final analysis was conducted on 2,296 isolates.

Compared with proportions in other age groups, the greatest proportion of *Salmonella* isolates was from human patients aged 30 to 49 years (16%, 356/ 2,296; Table C.1, Appendix C). Ontario was the province from which the largest proportion of isolates was received (34%, 777/2,296).

Salmonella Enteritidis

(n = 995)

Provincial incidence rates of *Salmonella* Enteritidis varied from 2.83 to 13.36 (median = 5.94) cases per 100,000 inhabitant-years (see Appendix A for formula). The most common phage types (PTs) were PT 8 (38%, 379/995), PT 13a (18%, 180/995), PT 13 (9%, 91/995), and PT 1 (8%, 83/995). Two percent (21/995) of isolates were recovered from blood and 2% (16/995) were recovered from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 1 and Table B.1, Appendix B. Less than 1% (3/995) of *S*. Enteritidis isolate were resistant to amoxicillin-clavulanic acid. Less than 1% (4/995) of were

[1] 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 is associated with more severe, typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate+ is commonly associated with gastroenteritis.

[2] Public Health Agency of Canada, Material Safety Data Sheet – Infectious Substances. Available at: www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/msds133e-eng.php and www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/msds134e-eng.php. Accessed May 2013.

each resistant to ceftiofur and ceftriaxone. Reduced susceptibility to ciprofloxacin was detected in 11% (106/995) of isolates. Resistance to nalidixic acid was detected in 10% (103/995) of the isolates. None of the isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Table C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 13% (132/995) of *S*. Enteritidis isolates. Resistance to 4 or more antimicrobial classes was detected in 2% (18/995) of isolates. The most common resistance pattern was NAL (9%, 92/995). This resistance pattern was mainly detected among PT 1 isolates (83%, 76/92). One isolate (PT 1) had reduced susceptibility to ciprofloxacin, resistance to nalidixic acid, and resistance to ceftriaxone. Less than 1% (4/995) of isolates (2 PT 5b, 1 PT 13a, and 1 atypical) had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid. The patterns involving the greatest number of antimicrobials among isolates were AMC-AMP-FOX-TIO-CRO (1 PT8 and 1 PT 34), AMC-AMP-TIO-CRO-NAL (1 atypical), AMP-NAL-SSS-TET-SXT (1 PT 1), AMP-CHL-NAL-STR-SSS (1 PT 1) and CHL-NAL-STR-SSS-TET-SXT (1 atypical).

Nineteen percent (4/21) of blood isolates and 2 of 16 urine isolates were resistant to 1 or more antimicrobial classes. NAL (1 PT 1 and 1 PT 4) was the most common resistance pattern found in 2 of these blood isolates and NAL (PT 1) and AMP (PT 13a) were each found in the urine isolates. One blood isolate had resistance to AMC-AMP-FOX-TIO-CRO.

Temporal Variations: Results are presented in Figure 2. The percentage of *S*. Enteritidis isolates with trimethoprim-sulfamethoxazole resistance was significantly higher in 2010 (1%, 11/995) than in 2009 (less than 1%, 2/1,092). The percentage of isolates with streptomycin resistance was significantly lower in 2010 (1%, 9/995) than in 2009 (2%, 27/1,092). The percentage of isolates with nalidixic acid resistance was significantly lower in 2010 (10%, 103/995) than in 2003 (19%, 66/352). Between 2010 and 2009, or between 2010 and 2003 no other significant temporal variations were detected in the percentages of *S*. Enteritidis isolates with resistance to selected antimicrobials.

The percentage of human clinical isolates of *Salmonella* Enteritidis that were resistant to trimethoprim-sulfamethoxazole resistance was significantly higher in 2010 (1%, 11/995) than in 2009 (less than 1%, 2/1,092). The percentage of isolates with nalidixic acid resistance was significantly lower in 2010 (10%, 103/995) than in 2003 (19%, 66/352).

Table 1. Resistance to antimicrobials in *Salmonella* Enteritidis isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 135	n = 110	n = 61	n = 98	n = 292	n = 112	n = 70	n = 75	n = 19	n = 23	%
I	Amoxicillin-clavulanic acid	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ceftiofur	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ceftriaxone	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ampicillin	4 (3)	3 (3)	1 (2)	3 (3)	5 (2)	2 (2)	1 (1)	2 (3)	1 (5)	1 (4)	2
	Cefoxitin	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	1 (1)	2 (3)	0 (0)	0 (0)	0 (0)	< 1
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	< 1
	Kanamycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	< 1
	Nalidixic acid	9 (7)	9 (8)	4 (7)	2 (2)	38 (13)	25 (22)	5 (7)	8 (11)	1 (5)	2 (9)	12
	Streptomycin	2 (1)	1 (1)	0 (0)	3 (3)	3 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Trimethoprim-sulfamethoxazole	2 (1)	0 (0)	1 (2)	1 (1)	6 (2)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	1
III	Chloramphenicol	0 (0)	1 (1)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Sulfisoxazole	4 (3)	2 (2)	1 (2)	3 (3)	8 (3)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Tetracycline	6 (4)	3 (3)	1 (2)	3 (3)	7 (2)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	3
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Province abbreviations are defined in Appendix D.
[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces, whereas percentages in the text represent crude estimates (see Appendix A).

Salmonella Heidelberg

(n = 476)

Provincial incidence rates of *Salmonella* Heidelberg varied from 0.59 to 4.22 (median = 2.20) cases per 100,000 inhabitant-years. The most common phage types were PT 19 (43%, 206/476), PT 29 (12%, 58/476), PT 26 (7%, 34/476), and PT 2 (6%, 28/476). Twelve percent (56/476) of isolates were cultured from blood and 4% (19/476) were cultured from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 2 and Table B.2, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was each detected in 19% (89/476, 90/476, and 91/476, respectively) of *S*. Heidelberg isolates. Reduced susceptibility to ciprofloxacin was detected in less than 1% (1/476). Resistance to nalidixic acid was detected in less than 1% (1/476). No isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Table C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 35% (166/476) of *S*. Heidelberg isolates. Resistance to 4 or more antimicrobial classes was detected in less than 1% (1/476). The most common resistance pattern was A2C-AMP-CRO (16%, 77/476) of isolates. This resistance pattern was mainly detected among PT 29 (56%, 43/77) from Ontario (44%, 19/43). One isolate (PT 19) had reduced susceptibility to ciprofloxacin and resistance to ceftriaxone. The pattern involving the greatest number of antimicrobials among isolates was ACSSuT-A2C-CRO-GEN (1 PT 19).

Forty-one percent (23/56) of blood isolates and 9 of 19 urine isolates were resistant to 1 or more antimicrobial classes. The most common resistance pattern among blood isolates was A2C-AMP-CRO and was detected in 20% (11/56) of the isolates (7 PT 29, 2 PT 19, and 2 PT 41). The most common resistance pattern among urine isolates was AMP, detected in 3 of 19 isolates (PT 19, PT 1, and PT 2).

Temporal Variations: Results are presented in Figure 2. The percentage of *S*. Heidelberg isolates with resistance to gentamicin was significantly lower in 2010 (1%, 7/476) than in 2009 (4%, 15/381). The

percentage of isolates with resistance to ceftiofur was significantly higher in 2010 (19%, 90/476) than in 2006 (13%, 57/430).[1] The percentage of isolates with resistance to ampicillin was significantly lower in 2010 (32%, 151/476) than in 2006 (39%, 168/430).[1] Similarly, the percentage of isolates resistant to each of ampicillin and ceftiofur was significantly lower in 2010 (32%, 151/476 and 19%, 90/476, respectively) than in 2004 (45%, 250/556 and 33%, 181/556, respectively).[1] The percentage of isolates with resistance to gentamicin, streptomycin, and tetracycline was significantly lower in 2010 (1%, 7/476; 6%, 27/476; and 3%, 16/476, respectively) than in 2003 (4%, 25/608; 12%, 72/608; and 15% 93/608, respectively). Between 2010 and 2009 or between 2010 and 2003 no other significant temporal variations were detected in the percentages of *S*. Heidelberg isolates with resistance to selected antimicrobials.

The percentage of human clinical *S*. Heidelberg isolates with resistance to gentamicin was significantly lower in 2010 (1%, 7/476) than in 2009 (4%, 15/381). The percentage of isolates with resistance to ceftiofur was significantly higher in 2010 (19%, 90/476) than in 2006 (13%, 57/430).[1] The percentage of isolates with resistance to ampicillin was significantly lower in 2010 (32%, 151/476) than in 2006 (39%, 168/430).[1] Similarly, the percentage of isolates resistant to each of ampicillin and ceftiofur was significantly lower in 2010 (32%, 151/476 and 19%, 90/476, respectively) than in 2004 (45%, 250/556 and 33%, 181/556, respectively).[1] The percentage of isolates with resistance to gentamicin, streptomycin, and tetracycline was significantly lower in 2010 (1%, 7/476; 6%, 27/476; and 3%, 16/476, respectively) than in 2003 (4%, 25/608; 12%, 72/608; and 15% 93/608, respectively).

Table 2. Resistance to antimicrobials in *Salmonella* Heidelberg isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 31	n = 73	n = 10	n = 25	n = 157	n = 129	n = 28	n = 14	n = 6	n = 3	%
I	Amoxicillin-clavulanic acid	15 (48)	5 (7)	1 (10)	5 (20)	32 (20)	27 (21)	2 (7)	2 (14)	0 (0)	0 (0)	19
I	Ceftiofur	16 (52)	5 (7)	1 (10)	5 (20)	32 (20)	27 (21)	2 (7)	2 (14)	0 (0)	0 (0)	20
I	Ceftriaxone	16 (52)	6 (8)	1 (10)	5 (20)	32 (20)	27 (21)	2 (7)	2 (14)	0 (0)	0 (0)	20
I	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Ampicillin	17 (55)	11 (15)	1 (10)	6 (24)	53 (34)	50 (39)	7 (25)	4 (29)	1 (17)	1 (33)	33
II	Cefoxitin	15 (48)	5 (7)	1 (10)	5 (20)	32 (20)	27 (21)	2 (7)	2 (14)	0 (0)	0 (0)	19
II	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	2 (2)	1 (4)	2 (14)	0 (0)	0 (0)	1
II	Kanamycin	0 (0)	0 (0)	0 (0)	0 (0)	4 (3)	0 (0)	1 (4)	2 (14)	0 (0)	0 (0)	1
II	Nalidixic acid	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Streptomycin	0 (0)	1 (1)	0 (0)	0 (0)	12 (8)	8 (6)	4 (14)	2 (14)	0 (0)	0 (0)	6
II	Trimethoprim-sulfamethoxazole	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
III	Chloramphenicol	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
III	Sulfisoxazole	0 (0)	2 (3)	0 (0)	0 (0)	6 (4)	3 (2)	1 (4)	2 (14)	0 (0)	0 (0)	3
III	Tetracycline	2 (6)	4 (5)	0 (0)	0 (0)	4 (3)	2 (2)	1 (4)	3 (21)	0 (0)	0 (0)	3
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Province abbreviations are defined in Appendix D.
[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces, whereas percentages in the text represent crude estimates (see Appendix A).

[1] 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Salmonella Paratyphi A and Paratyphi B

(n = 30)

The combined provincial incidence rates of *Salmonella* Paratyphi A and *S*. Paratyphi B[1] varied from 0 to 0.27 (median = 0.09) cases per 100,000 inhabitant-years. No cases were reported in Manitoba, New Brunswick, Prince Edward Island, or Newfoundland and Labrador. Phage typing is not applicable to *S*. Paratyphi A isolates. Among all 18 isolates of *S*. Paratyphi B, phage types included Dundee var. 2 (7/18), atypical (5/18), Dundee (3/18), 3b var. 2 (1/18), Battersea (1/18), and Worksop (1/18). Ten of 12 *S*. Paratyphi A isolates were cultured from blood and none were cultured from urine. Five of the 18 *S*. Paratyphi B isolates were cultured from blood and none from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 3 and Table B.3, Appendix B. Resistance to ciprofloxacin was detected in 1 of the 12 Paratyphi A isolates.[1] Reduced susceptibility to ciprofloxacin was detected in 11 Paratyphi A and in 2 of the Paratyphi B isolates. Resistance to nalidixic acid was detected in all 12 Paratyphi A isolates and in 1 of the Paratyphi B isolates. None of the *S*. Paratyphi A and *S*. Paratyphi B isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, amikacin, gentamicin, kanamycin, or trimethoprim-sulfamethoxazole. None of the *S*. Paratyphi A isolates were resistant to ampicillin, streptomycin, chloramphenicol, sulfisoxazole, or tetracycline. None of the Paratyphi B isolates were resistant to ciprofloxacin or cefoxitin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Table C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in the 12 *S*. Paratyphi A isolates and in 2 of 18 *S*. Paratyphi B isolates. Resistance to 4 or more antimicrobial classes was detected in 1 *S*. Paratyphi B isolate. The most common resistance pattern was NAL among *S*. Paratyphi A (10/12), and was NAL (1 PT Dundee var. 2) and ACSSuT (1 PT 3b var. 2) among *S*. Paratyphi B isolates. Six percent (1/18) of Paratyphi B isolates had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid (PT Battersea). The patterns involving the greatest number of antimicrobials among *S*. Paratyphi A isolates were FOX-NAL and CIP-NAL and among *S*. Paratyphi B isolates was ACSSuT (1 PT 3b var. 2).

Eleven of the 15 blood isolates were resistant to 1 or more antimicrobial classes. The most common resistance pattern among blood isolates was NAL, which was detected in 9 of the 15 isolates (incomplete phage type information as no phage typing is carried out on Paratyphi A isolates).

Temporal Variations: Results are presented in Figure 2. Between 2010 and 2009, no significant temporal variations were detected in the percentages of *S*. Paratyphi A or *S*. Paratyphi B isolates with resistance to selected antimicrobials. Similarly, no significant temporal variations were detected between 2010 and 2003 for *S*. Paratyphi A or *S*. Paratyphi B isolates.

There were no significant temporal variations detected in the percentages of human clinical *Salmonella* Paratyphi A or *S*. Paratyphi B isolates with resistance to selected antimicrobials between 2010 and 2009, or between 2010 and 2003.

[1] *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. *Salmonella* Paratyphi B var. L (+) tartrate+ isolates were not tested for susceptibility in 2010.

Table 3. Resistance to antimicrobials in *Salmonella* Paratyphi A and Paratyphi B isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 2	n = 2	n = 1	n = 0	n = 18	n = 5	n = 0	n = 2	n = 0	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
	Ceftiofur	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
	Ceftriaxone	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
	Ciprofloxacin	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		1 (50)			2
II	Amikacin	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
	Ampicillin	1 (50)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			4
	Cefoxitin	0 (0)	0 (0)	0 (0)		1 (6)	0 (0)		0 (0)			4
	Gentamicin	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
	Kanamycin	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
	Nalidixic acid	1 (50)	2 (100)	0 (0)		8 (44)	1 (20)		1 (50)			44
	Streptomycin	1 (50)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			4
	Trimethoprim-sulfamethoxazole	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			0
III	Chloramphenicol	1 (50)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			4
	Sulfisoxazole	1 (50)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			4
	Tetracycline	1 (50)	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)			4
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Province abbreviations are defined in Appendix D.
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. *Salmonella* Paratyphi B var. L (+) tartrate+ isolates were not submitted for susceptibility testing in 2010.
No *S*. Paratyphi A or *S*. Paratyphi B isolates were received from Manitoba, New Brunswick, Prince Edward Island, and Newfoundland and Labrador.
[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces, whereas percentages in the text represent crude estimates (see Appendix A).

Salmonella Typhi

(n = 179)

Provincial incidence rates of *Salmonella* Typhi detection in humans varied from 0 to 1.46 cases (median = 0.58) per 100,000 inhabitant-years. No cases were reported in New Brunswick or Newfoundland and Labrador. The most common phage types recovered were PT E1 (41%, 73/179), PT E9 var. (17%, 29/179), and PT UVS (I+IV) (12%, 22179). A total of 20 isolates (11%) were untypable. Seventy-three percent (131/179) of isolates were cultured from blood and 1% (2/179) of isolates were cultured from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 4 and Table B.4, Appendix B. Resistance to ciprofloxacin was detected in 4% (7/179) of *S*. Typhi isolates. Reduced susceptibility to ciprofloxacin was detected in 81% (145/179). Resistance to nalidixic acid was detected in 87% (156/179) of isolates. None of the isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, amikacin, cefoxitin, gentamicin, or kanamycin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Table C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 87% (156/179) of *S*. Typhi isolates. Resistance to 4 or more antimicrobial classes was detected in 17% (30/179). The most common resistance pattern was NAL (66%, 118/179). This resistance pattern was mainly detected among PT E1 (53%, 63/118), PT E9 var. (9%, 11/118), and UVS (I + IV) (15%, 18/118). Less than 1% (1/179) of the isolates (PT E1) had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid. The pattern involving the greatest number of antimicrobials among isolates was ACSSuT-NAL-SXT (4 untypable isolates) and AMP-CIP-NAL-STR-SSS-TET-SXT (1 untypable isolate).

Resistance to 1 or more antimicrobial classes was detected in 86% (113/131) of blood isolates. Resistance to 4 or more antimicrobial classes was detected in 14% (18/131) of blood isolates. In blood isolates, the most common resistance pattern was NAL, which was detected in 67% (88/131) of isolates. This resistance pattern was mainly detected among PT E1 (51%, 45/88). None of the blood isolates had reduced susceptibility to ciprofloxacin and were susceptible to nalidixic acid. Resistance to 1 or more antimicrobial classes was detected in both of the urine isolates. Resistance to 4 or more antimicrobial classes was detected in 1 of 2 urine isolates. There were no isolates with reduced susceptibility to ciprofloxacin and susceptible to nalidixic acid. The pattern involving the greatest number of antimicrobials among blood and urine isolates were ACSSuT-NAL-SXT (2 isolates) and AMP-CHL-NAL-STR-SSS-SXT (1 isolate) respectively.

Temporal Variations: Results are presented in Figure 2. The percentage of *S*. Typhi isolates that were resistant to nalidixic acid was significantly higher in 2010 (87%, 156/179) than in 2009 (78%, 124/160). In addition, the percentage of isolates resistant to nalidixic acid was significantly higher in 2010 (87%, 156/179) than in 2003 (44%, 56/127). The percentage of isolates resistant to tetracycline was significantly lower in 2010 (3%, 5/179) than in 2003 (9%, 11/127). Between 2010 and 2009, or between 2010 and 2003 no other significant temporal variations were detected in the percentages of *S*. Typhi isolates with resistance to selected antimicrobials.

The percentage of human clinical *Salmonella* Typhi isolates that were resistant to nalidixic acid was significantly higher in 2010 (87%, 156/179) than in 2009 (78%, 124/160). Similarly, the percentage of isolates resistant to nalidixic acid was significantly higher in 2010 (87%, 156/179) than in 2003 (44%, 56/127). The percentage of isolates resistant to tetracycline was significantly lower in 2010 (3%, 5/179) than in 2003 (9%, 11/127).

Table 4. Resistance to antimicrobials in *Salmonella* Typhi isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 33	n = 20	n = 2	n = 13	n = 91	n = 18	n = 0	n = 1	n = 1	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ceftiofur	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ceftriaxone	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ciprofloxacin	0 (0)	1 (5)	0 (0)	0 (0)	5 (5)	1 (6)		0 (0)	0 (0)		4
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ampicillin	5 (15)	5 (25)	0 (0)	3 (23)	15 (16)	1 (6)		0 (0)	0 (0)		16
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Kanamycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Nalidixic acid	29 (88)	19 (95)	2 (100)	12 (92)	80 (88)	12 (67)		1 (100)	1 (100)		87
	Streptomycin	5 (15)	5 (25)	0 (0)	3 (23)	14 (15)	1 (6)		0 (0)	0 (0)		16
	Trimethoprim-sulfamethoxazole	5 (15)	5 (25)	0 (0)	3 (23)	17 (19)	1 (6)		0 (0)	0 (0)		17
III	Chloramphenicol	5 (15)	4 (20)	0 (0)	3 (23)	17 (19)	1 (6)		0 (0)	0 (0)		17
	Sulfisoxazole	5 (15)	5 (25)	0 (0)	3 (23)	17 (19)	1 (6)		0 (0)	0 (0)		17
	Tetracycline	0 (0)	1 (5)	0 (0)	3 (23)	1 (1)	0 (0)		0 (0)	0 (0)		2
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Province abbreviations are defined in Appendix D.
No *S*. Typhi isolates were received from New Brunswick or Newfoundland and Labrador.

Salmonella Typhimurium

(n = 453)

The provincial incidence rates of *Salmonella* Typhimurium detection in humans varied from 0 to 5.16 (median = 1.83) cases per 100,000 inhabitant-years. The most common phage types recovered were PT 170 (30%, 135/453), PT atypical (11%, 49/453), PT 104 (8%, 38/453), PT 10 (4%, 19/453), PT UT2 (4%, 19/453), PT 193 (4% 18/453), and PT U302 (4% 17/453). Two percent (10/453) of isolates were cultured from blood, and 2% (11/453) were cultured from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 5 and Table B.5 (Appendix B). Resistance to amoxicillin-clavulanic acid was detected in 2% (8/453) of *S*. Typhimurium isolates. Resistance to each of ceftiofur and ceftriaxone was detected in 1% (6/453) of isolates. Three percent (13/453) had reduced susceptibility to ciprofloxacin. Resistance to nalidixic acid was detected in 2% (11/453) isolates. None of the isolates were resistant to ciprofloxacin and amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Table C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 32% (146/453) of *S*. Typhimurium isolates. Resistance to 4 or more antimicrobial classes was detected in 24% (108/453). The most common resistance pattern was ACSSuT (9%, 41/453) and most isolates with this pattern were PT 104 (51%, 21/41). One isolate (PT UT1) had reduced susceptibility to ciprofloxacin, resistance to nalidixic acid, and resistance to ceftriaxone. Less than 1% (2/453) of isolates had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid (1 PT atypical and 1 UT1). The patterns involving the greatest number of antimicrobials among isolates were A2C-AMP-CRO-CHL-KAN-NAL-SSS-TET-SXT (1 PT UT1), ACSSuT-A2C-CRO-SXT (2 PT 193), ACKSSuT-GEN-NAL-SXT (1 PT 120), and ACSSuT-A2C-CRO (1 PT U320).

Resistance to 1 or more antimicrobial classes was detected in 7 of 10 blood isolates. Resistance to 4 or more antimicrobial classes was detected in 6 of 10 blood isolates. In blood isolates, the patterns involving the greatest number of antimicrobials were ACKSSuT-GEN-SXT (1 PT U302), and ACSSuT (2 PT 104, 2 PT 104a, and 1 PT UT1). Resistance to 1 or more antimicrobial classes was detected in 7 of 11 urine isolates. Resistance to 4 or more antimicrobial classes was detected in 4 of 11 urine isolates. In urine isolates, the patterns involving the greatest number of antimicrobials was ACKSSuT (2 PT U302).

Temporal Variations: Results are presented in Figure 2. The percentage of *S*. Typhimurium isolates with resistance to streptomycin and tetracycline was significantly lower in 2010 (25%, 113/453 and 25%, 114/453, respectively) than in 2003 (39%, 234/605 and 47%, 282/605, respectively). The percentage of isolates resistant to ampicillin was significantly lower in 2010 (24%, 110/453) than in 2003 (44%, 269/605).

The percentage of human clinical *Salmonella* Typhimurium isolates with resistance to streptomycin and tetracycline was significantly lower in 2010 (25%, 113/453 and 25%, 113/453, respectively) than in 2003 (39%, 234/605 and 47%, 282/605, respectively). The percentage of isolates resistant to ampicillin was significantly lower in 2010 (24%, 110/453) than in 2006 (30%, 163/539).[1] Similarly, resistance to ampicillin was significantly lower in 2010 (24%, 110/453) than in 2004 (38%, 224/597).[1]

[1] 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Table 5. Resistance to antimicrobials in *Salmonella* Typhimurium isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 35	n = 49	n = 54	n = 15	n = 190	n = 73	n = 15	n = 17	n = 0	n = 5	%
I	Amoxicillin-clavulanic acid	0 (0)	1 (2)	0 (0)	0 (0)	4 (2)	3 (4)	0 (0)	0 (0)		0 (0)	2
	Ceftiofur	0 (0)	1 (2)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)		0 (0)	2
	Ceftriaxone	0 (0)	1 (2)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)		0 (0)	2
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0
	Ampicillin	11 (31)	21 (43)	5 (9)	4 (27)	47 (25)	15 (21)	3 (20)	3 (18)		1 (20)	26
	Cefoxitin	0 (0)	1 (2)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)		0 (0)	2
	Gentamicin	1 (3)	0 (0)	0 (0)	0 (0)	2 (1)	2 (3)	1 (7)	0 (0)		0 (0)	1
	Kanamycin	6 (17)	14 (29)	0 (0)	4 (27)	17 (9)	8 (11)	1 (7)	1 (6)		0 (0)	12
	Nalidixic acid	0 (0)	2 (4)	1 (2)	0 (0)	5 (3)	2 (3)	1 (7)	0 (0)		0 (0)	3
	Streptomycin	12 (34)	17 (35)	5 (9)	1 (7)	52 (27)	22 (30)	1 (7)	3 (18)		0 (0)	27
	Trimethoprim-sulfamethoxazole	2 (6)	2 (4)	1 (2)	0 (0)	5 (3)	6 (8)	1 (7)	0 (0)		0 (0)	4
III	Chloramphenicol	7 (20)	8 (16)	3 (6)	0 (0)	45 (24)	12 (16)	1 (7)	3 (18)		0 (0)	19
	Sulfisoxazole	13 (37)	23 (47)	4 (7)	4 (27)	54 (28)	23 (32)	2 (13)	3 (18)		0 (0)	30
	Tetracycline	11 (31)	19 (39)	5 (9)	4 (27)	50 (26)	19 (26)	2 (13)	4 (24)		0 (0)	27
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Province abbreviations are defined in Appendix D.
No *S.* Typhimurium isolates were received from Prince Edward Island.
[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces, whereas percentages in the text represent crude estimates (see Appendix A).

Salmonella I 4,[5],12:i:-

(n = 163)

Provincial incidence rates of *Salmonella* I 4,[5],12:i:- varied from 0.20 to 1.88 (median = 0.78) cases per 100,000 inhabitant-years. The most common phage types were PT 191 (28%, 45/163), PT 191a (17%, 28/163), PT 193 (17%, 28/163), and atypical (15%, 24/163). Four percent (6/163) of isolates were cultured from blood and 3% (5/163) were cultured from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 6 and Table B.6, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 8% (13/163) of S. I 4,[5],12:i:- isolates. Resistance to ceftiofur and to ceftriaxone was each detected in 9% (14/163) of isolates. Reduced susceptibility to ciprofloxacin was detected in 1% (2/163) of isolates. Resistance to nalidixic acid was detected in 1% (1/163) of isolates. No isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Table C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 55% (89/163) of *S.* I 4,[5],12:i:- isolates. Resistance to 4 or more antimicrobial classes was detected in 22% (36/163). The most common resistance pattern was TET (18%, 29/163) of isolates. This resistance pattern was mainly detected among PT 191a (79%, 23/29) from Alberta (52%, 12/23). One percent (1/163) of isolates (PT 193) had reduced susceptibility to ciprofloxacin and resistance to ceftriaxone. One percent (1/163) of isolates (PT 193) had reduced susceptibility to ciprofloxacin but no resistance to nalidixic acid. The patterns involving the greatest number of antimicrobials among isolates were AMP-GEN-NAL-STR-SSS-TET (1 PT UT6), ACKSSuT (3 PT U302 and 1 PT110b), ACKSSuT-SXT (1 PT 110b), ACSSuT-A2C-CRO (1 PT 193), and ACSSuT-TIO-CRO-GEN (1 PT 193).

Three of six blood isolates and 3 of 5 urine isolates were resistant to 1 or more antimicrobial classes. The most common resistance pattern, AMP-STR, was both detected in blood isolates (3 PT 191) and in urine isolates (2 PT 191).

Temporal Variations: Results are presented in Figure 2. The percentage of *S*. I 4,[5],12:i:- isolates with resistance to streptomycin was significantly higher in 2010 (28%, 46/163) than in 2009 (12%, 22/186). Similarly resistance to streptomycin and tetracycline was significantly higher in 2010 (28%, 46/163 and 40%, 65/163, respectively) than in 2003 (7%, 3/42 and 5%, 2/42, respectively). In addition, the percentage of isolates resistant to each of ampicillin and ceftiofur was significantly higher in 2010 (35%, 57/163 and 9%, 14/163, respectively) than in 2004 (15%, 7/46 and 0%, 0/46, respectively).[1] Between 2010 and 2009, or between 2010 and 2003 no other significant temporal variations were detected in the percentages of *S*. I 4,[5],12:i:- isolates with resistance to selected antimicrobials.

The percentage of human clinical *Salmonella* I 4,[5],12:i:- isolates with resistance to streptomycin was significantly higher in 2010 (28%, 46/163) than in 2009 (12%, 22/186). Similarly resistance to streptomycin and tetracycline was significantly higher in 2010 (28%, 46/163 and 40%, 65/163, respectively) than in 2003 (7%, 3/42 and 5%, 2/42, respectively). In addition, the percentage of isolates resistant to each of ampicillin and ceftiofur was significantly higher in 2010 (35%, 57/163 and 9%, 14/163, respectively) than in 2004 (15%, 7/46 and 0%, 0/46, respectively).[1]

Table 6. Resistance to antimicrobials in *Salmonella* I 4,[5],12:i:- isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 16	n = 35	n = 15	n = 22	n = 29	n = 34	n = 8	n = 2	n = 1	n = 1	%
I	Amoxicillin-clavulanic acid	2 (13)	3 (9)	0 (0)	2 (9)	3 (10)	1 (3)	1 (13)	0 (0)	0 (0)	1 (100)	8
	Ceftiofur	2 (13)	3 (9)	0 (0)	2 (9)	4 (14)	1 (3)	1 (13)	0 (0)	0 (0)	1 (100)	9
	Ceftriaxone	2 (13)	3 (9)	0 (0)	2 (9)	4 (14)	1 (3)	1 (13)	0 (0)	0 (0)	1 (100)	9
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ampicillin	6 (38)	6 (17)	0 (0)	8 (36)	10 (34)	24 (71)	2 (25)	0 (0)	0 (0)	1 (100)	37
	Cefoxitin	2 (13)	3 (9)	0 (0)	2 (9)	3 (10)	1 (3)	1 (13)	0 (0)	0 (0)	1 (100)	8
	Gentamicin	0 (0)	1 (3)	0 (0)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1
	Kanamycin	0 (0)	0 (0)	0 (0)	0 (0)	1 (3)	6 (18)	0 (0)	0 (0)	0 (0)	0 (0)	5
	Nalidixic acid	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Streptomycin	6 (38)	2 (6)	0 (0)	6 (27)	7 (24)	24 (71)	1 (13)	0 (0)	0 (0)	0 (0)	31
	Trimethoprim-sulfamethoxazole	1 (6)	0 (0)	0 (0)	0 (0)	1 (3)	2 (6)	0 (0)	0 (0)	0 (0)	0 (0)	3
III	Chloramphenicol	2 (13)	0 (0)	0 (0)	0 (0)	3 (10)	4 (12)	0 (0)	0 (0)	0 (0)	0 (0)	6
	Sulfisoxazole	6 (38)	2 (6)	0 (0)	0 (0)	7 (24)	25 (74)	1 (13)	0 (0)	0 (0)	0 (0)	29
	Tetracycline	8 (50)	17 (49)	6 (40)	4 (18)	6 (21)	23 (68)	1 (13)	0 (0)	0 (0)	0 (0)	43
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Province abbreviations are defined in Appendix D.
[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces, whereas percentages in the text represent crude estimates (see Appendix A).

[1] 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Table 7. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates; *Surveillance of Human Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	135 (53.6)	122	8	1	4					2	4					4	2			9	6
Typhimurium	35 (13.9)	22		2	11			1	6	12	11					13	2	7			11
Typhi	33 (13.1)	4	24		5					5	5					5	5	5		29	
Heidelberg	31 (12.3)	14	1		15	1					17	15	16	15	16						2
I 4,[5],12:i:-	16 (6.3)	6	4		4	2				6	6	2	2	2	2	6	1	2			8
Paratyphi A and B	2 (0.8)		1		1					1	1					1		1		1	1
Total	**252 (100)**	**168**	**38**	**3**	**40**	**3**		**1**	**6**	**26**	**44**	**17**	**18**	**17**	**18**	**29**	**10**	**15**		**39**	**28**
Alberta																					
Enteritidis	110 (38.1)	98	8	1	3					1	3	1	1	1	1	2		1		9	3
Heidelberg	73 (25.3)	61	3	4	3	2				1	11	5	6	5	5	2					4
Typhimurium	49 (17.0)	23	1	5	17	3			14	17	21	1	1	1	1	23	2	8		2	19
I 4,[5],12:i:-	35 (12.1)	15	14	1	4	1		1		2	6	3	3	3	3	2				1	17
Typhi	20 (6.9)	1	14			5				5	5					5	5	4	1	19	1
Paratyphi A and B	2 (0.7)		2																	2	
Total	**289 (100)**	**198**	**42**	**11**	**27**	**11**		**1**	**14**	**26**	**46**	**10**	**11**	**10**	**10**	**34**	**7**	**13**	**1**	**33**	**44**
Saskatchewan																					
Enteritidis	61 (42.7)	55	5	1							1					1	1			4	1
Typhimurium	54 (37.8)	48		1	5					5	5					4	1	3		1	5
I 4,[5],12:i:-	15 (10.5)	9	6																		6
Heidelberg	10 (7.0)	9			1						1	1	1	1	1						
Typhi	2 (1.4)		2																	2	
Paratyphi A and B	1 (0.7)	1																			
Total	**143 (100)**	**122**	**13**	**2**	**6**					**5**	**7**	**1**	**1**	**1**	**1**	**5**	**2**	**3**		**7**	**12**
Manitoba																					
Enteritidis	98 (56.6)	93	1		4					3	3		1		1	3	1			2	3
Heidelberg	25 (14.5)	19	1		5						6	5	5	5	5						
I 4,[5],12:i:-	22 (12.7)	10	4	6	2					6	8	2	2	2	2						4
Typhimurium	15 (8.7)	11			4				4	1	4					4					4
Typhi	13 (7.5)	1	9			3				3	3					3	3	3		12	3
Total	**173 (100)**	**134**	**15**	**6**	**15**	**3**			**4**	**13**	**24**	**7**	**8**	**7**	**8**	**10**	**4**	**3**		**14**	**14**
Ontario																					
Enteritidis	292 (37.6)	245	39	5	2	1				3	5					8	6	2		38	7
Typhimurium	190 (24.5)	129	4	9	31	17		2	17	52	47	4	3	3	3	54	5	45		5	50
Heidelberg	157 (20.2)	95	24	3	30	5		2	4	12	53	32	32	32	32	6	2	3		1	4
Typhi	91 (11.7)	11	57	7	2	14				14	15					17	17	17	5	80	1
I 4,[5],12:i:-	29 (3.7)	18	1		8	2		1	1	7	10	3	4	3	4	7	1	3			6
Paratyphi A and B	18 (2.3)	10	7	1										1						8	
Total	**777 (100)**	**508**	**132**	**25**	**73**	**39**		**5**	**22**	**88**	**130**	**39**	**39**	**39**	**39**	**92**	**31**	**70**	**5**	**132**	**68**

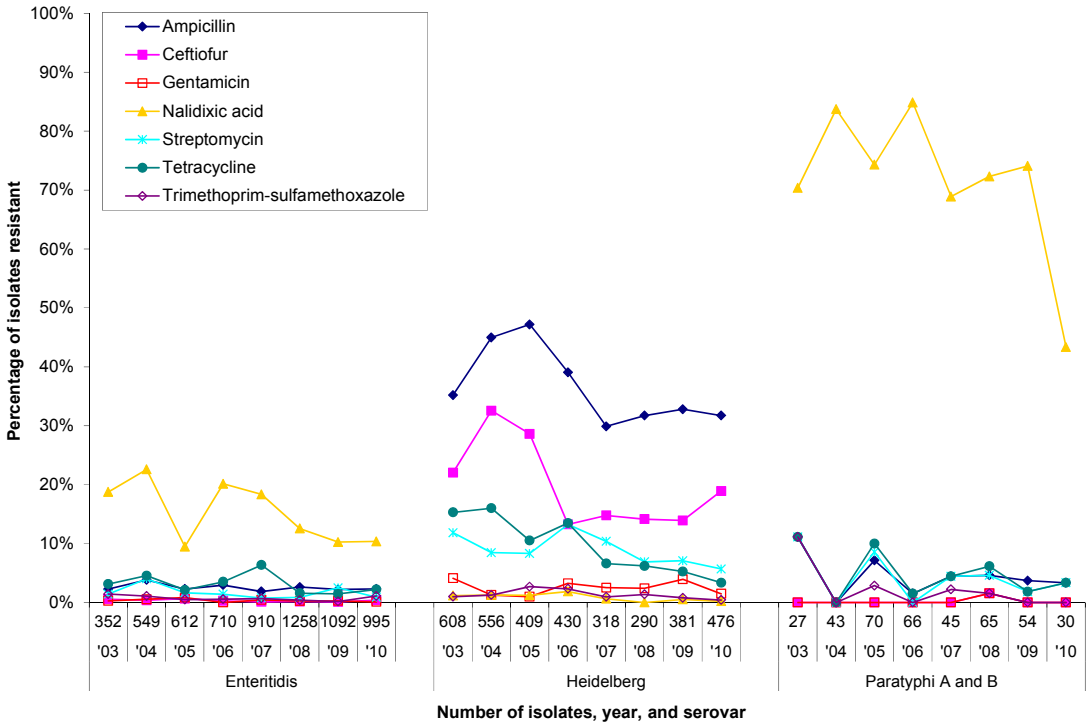
Antimicrobial abbreviations are defined in Appendix D.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate+, formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate- and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate+ is commonly associated with gastrointestinal illness. *Salmonella* Paratyphi B var. L (+) tartrate+ isolates were not tested for susceptibility in 2010.

Table 7 (continued). Number of antimicrobial classes in resistance patterns of *Salmonella* isolates; *Surveillance of Human Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Québec																					
Heidelberg	129 (34.8)	77	17	8	25	2		2		8	50	27	27	27	27	3					2
Enteritidis	112 (30.2)	85	24		3						2	2	2	1	2	1	1			25	2
Typhimurium	73 (19.7)	45	3	10	6	9		2	8	22	15	3	2	2	2	23	6	12		2	19
I 4,[5],12:i:-	34 (9.2)	15	14	1	4	1			6	24	24	1	1	1	1	25	2	4			23
Typhi	18 (4.9)	6	10	1		1				1	1					1	1	1	1	12	
Paratyphi A and B	5 (1.3)	4	1																	1	
Total	**371 (100)**	**232**	**69**	**20**	**38**	**13**		**4**	**14**	**55**	**92**	**33**	**32**	**31**	**32**	**53**	**10**	**17**	**1**	**40**	**46**
New Brunswick																					
Enteritidis	70 (57.9)	62	8								1			2						5	
Heidelberg	28 (23.1)	20	2	4	1	1		1	1	4	7	2	2	2	2	1					1
Typhimurium	15 (12.4)	12		1	2			1	1	1	3					2	1	1		1	2
I 4,[5],12:i:-	8 (6.6)	6			2					1	2	1	1	1	1	1					1
Total	**121 (100)**	**100**	**10**	**5**	**5**	**1**		**2**	**2**	**6**	**13**	**3**	**3**	**5**	**3**	**4**	**1**	**1**		**6**	**4**
Nova Scotia																					
Enteritidis	75 (67.6)	65	10								2									8	
Typhimurium	17 (15.3)	13		1	3				1	3	3					3		3			4
Heidelberg	14 (12.6)	8	2		3	1		2	2	2	4	2	2	2	2	2					3
I 4,[5],12:i:-	2 (1.8)	2																			
Paratyphi A and B	2 (1.8)	1	1																1	1	
Typhi	1 (0.9)		1																	1	
Total	**111 (100)**	**89**	**14**	**1**	**6**	**1**		**2**	**3**	**5**	**9**	**2**	**2**	**2**	**2**	**5**		**3**	**1**	**10**	**7**
Prince Edward Island																					
Enteritidis	19 (70.4)	17	2								1									1	
Heidelberg	6 (22.2)	5	1								1										
I 4,[5],12:i:-	1 (3.7)	1																			
Typhi	1 (3.7)		1																	1	
Total	**27 (100)**	**23**	**4**								**2**									**2**	
Newfoundland and Labrador																					
Enteritidis	23 (71.9)	21	1		1			1	1		1									2	
Typhimurium	5 (15.6)	4	1								1										
Heidelberg	3 (9.4)	2	1								1										
I 4,[5],12:i:-	1 (3.1)				1						1	1	1	1	1						
Total	**32 (100)**	**27**	**3**		**2**			**1**	**1**		**4**	**1**	**1**	**1**	**1**					**2**	

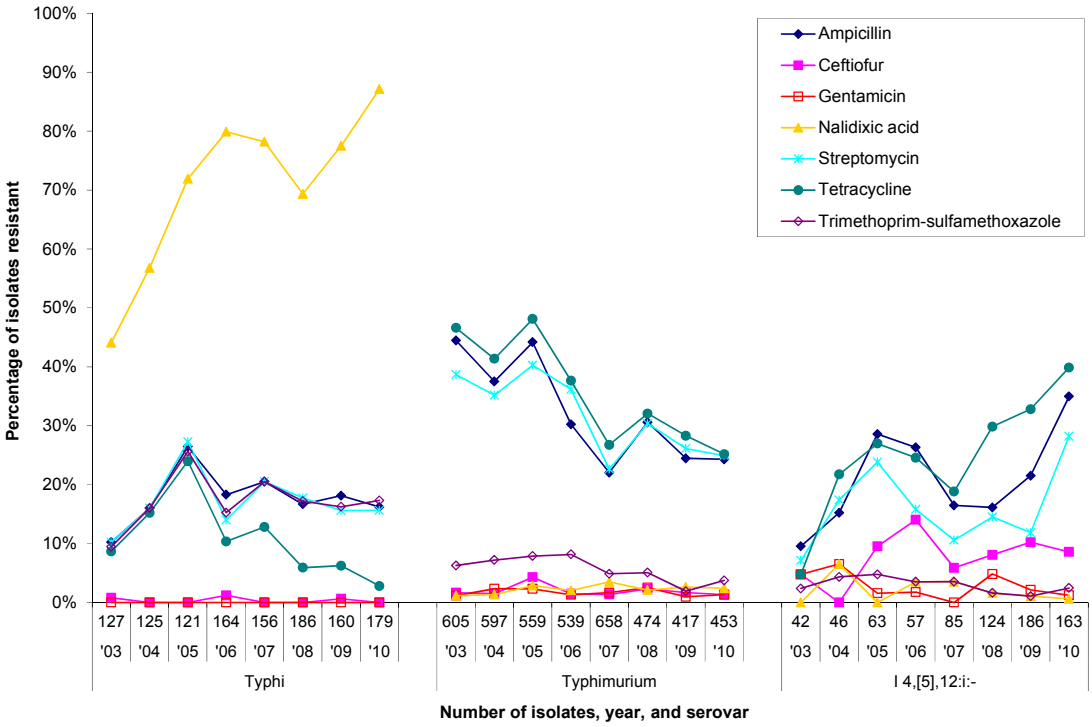
Antimicrobial abbreviations are defined in Appendix D.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
Salmonella Paratyphi B does not include *S*. Paratyphi B var. L (+) tartrate+, formerly called *S*. Paratyphi var. Java. The biotype of *S*. Paratyphi B included here is tartrate- and associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate+ is commonly associated with gastrointestinal illness. *Salmonella* Paratyphi B var. L (+) tartrate+ isolates were not tested for susceptibility in 2010.

Figure 2. Temporal variation in resistance to selected antimicrobials in human *Salmonella* serovars; *Surveillance of Human Clinical Isolates*, 2003–2010.



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. *Salmonella* Paratyphi B var. L (+) tartrate+ isolates were not tested for susceptibility in 2010.

Figure 2 (continued). Temporal variation in resistance to selected antimicrobials in human *Salmonella* serovars; *Surveillance of Human Clinical Isolates*, 2003–2010.



Beef Cattle

Salmonella

Surveillance of Animal Clinical Isolates[1]

(n = 143)

Note: Cattle isolates could have originated from dairy cattle, milk-fed or grain-fed veal, or beef cattle. Isolates may also have originated from animal feed, the animal's environment, or non-diseased animals from the same herd.

Serovars: Results are presented in Table 8 and Table C.3, Appendix C. The most common *Salmonella* serovars were Typhimurium (34%, 48/143), Typhimurium (27%, 39/143), and Enteritidis (8%, 11/143). These 3 serovars accounted for 68% (97/143) of isolates.

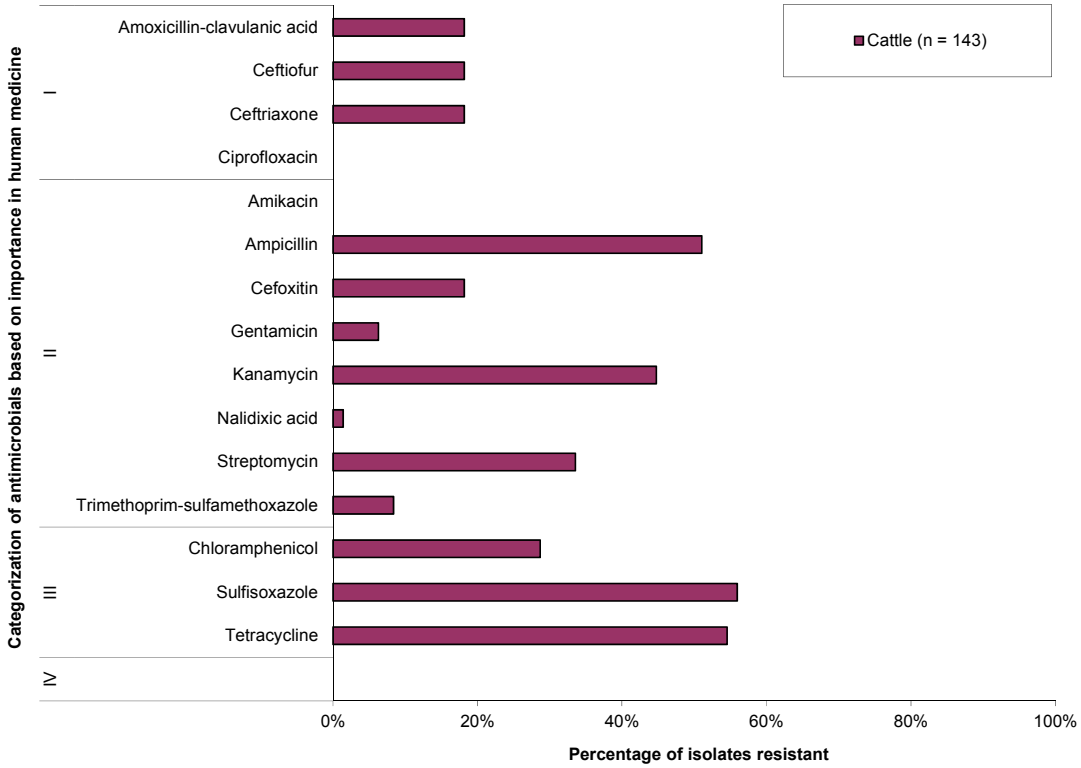
Antimicrobial Resistance: Results are presented in Figure 3, Table 8, Table B.7, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was each detected in 18% (26/143) of the isolates. One percent (2/143) of isolates had reduced susceptibility to ciprofloxacin. Resistance to nalidixic acid was detected in 1% (2/143) of isolates. None of the isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 8 and in Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 57% (81/143) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 52% (74/143) of the isolates (45 *S*. Typhimurium var. 5-, 17 *S*. Typhimurium, 6 *S*. Dublin, 3 *S*. I 4,[5],12:i:-, 2 *S*. Brandenburg, 1 *S*. Enteritidis). The most common resistance patterns were ACKSSuT (11%, 16/143), A2C-AMP-CRO-KAN-SSS-TET (10%, 15/143), AMP-KAN-SSS-TET (6%, 9/143), and ACSSuT (6%, 8/143). The patterns involving the greatest number of antimicrobials were ACKSSuT-A2C-CRO-GEN (1 *S*. Dublin and 1 *S*. Enteritidis isolate) and ACKSSuT-A2C-CRO-SXT (2 *S*. Typhimurium isolates).

In 2010, the most common resistance patterns were ACKSSuT (11%, 16/143), A2C-AMP-CRO-KAN-SSS-TET (10%, 15/143), AMP-KAN-SSS-TET (6%, 9/143), and ACSSuT (6%, 8/143) in clinical cattle isolates of *Salmonella*. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was each detected in 18% (26/143) of the isolates. The pattern involving the greatest number of antimicrobials were ACKSSuT-A2C-CRO-GEN (1 *S*. Dublin and 1 *S*. Enteritidis) and ACKSSuT-A2C-CRO-SXT (2 *S*. Typhimurium).

[1] The distribution of *Salmonella* isolates across provinces is presented in Table C.6, Appendix C.

Figure 3. Resistance to antimicrobials in *Salmonella* isolates from cattle; *Surveillance of Animal Clinical Isolates*, 2010.



Confidence intervals are not displayed for animal clinical data because samples were not obtained randomly and may not represent independent observations and true estimates of the prevalence.

Table 8. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from cattle, *Surveillance of Animal Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Typhimurium var. 5-	48 (33.6)	2		1	45				45	22	45	15	15	15	15	46	1	15			46
Typhimurium	39 (27.3)	20		2	17				10	17	15	2	2	2	2	19	8	16		2	18
Enteritidis	11 (7.7)	10			1			1	1	1	1	1	1	1	1	1		1			1
Dublin	6 (4.2)				6			6	6	1	6	6	6	6	6	6		6			6
Heidelberg	5 (3.5)	5																			
I 4,[5],12:i:-	5 (3.5)	2			3				2	3	3	1	1	1	1	3	1	3			3
Infantis	4 (2.8)	4																			
Mbandaka	4 (2.8)	2		2						2						2					2
Muenster	3 (2.1)	3																			
Less common serovars	18 (12.6)	14	2		2			2		2	3	1	1	1	1	3	2				2
Total	**143 (100)**	**62**	**2**	**5**	**74**			**9**	**64**	**48**	**73**	**26**	**26**	**26**	**26**	**80**	**12**	**41**		**2**	**78**

Antimicrobial abbreviations are defined in Appendix D.
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."

Escherichia coli

Retail Meat Surveillance

(n = 521)

(British Columbia [n = 64], Saskatchewan [n = 107], Ontario [n = 123], Québec [n = 101],

Maritimes [n = 126])

Recovery: *Escherichia coli* isolates were recovered from 61% (521/860) of retail beef samples. Province/region-specific percentages of beef samples from which *E. coli* isolates were recovered were as follows: British Columbia, 51% (64/125); Saskatchewan, 80% (107/134); Ontario, 69% (123/177); Québec, 45% (101/223); and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 69% (126/183; Table C.5, Appendix C).

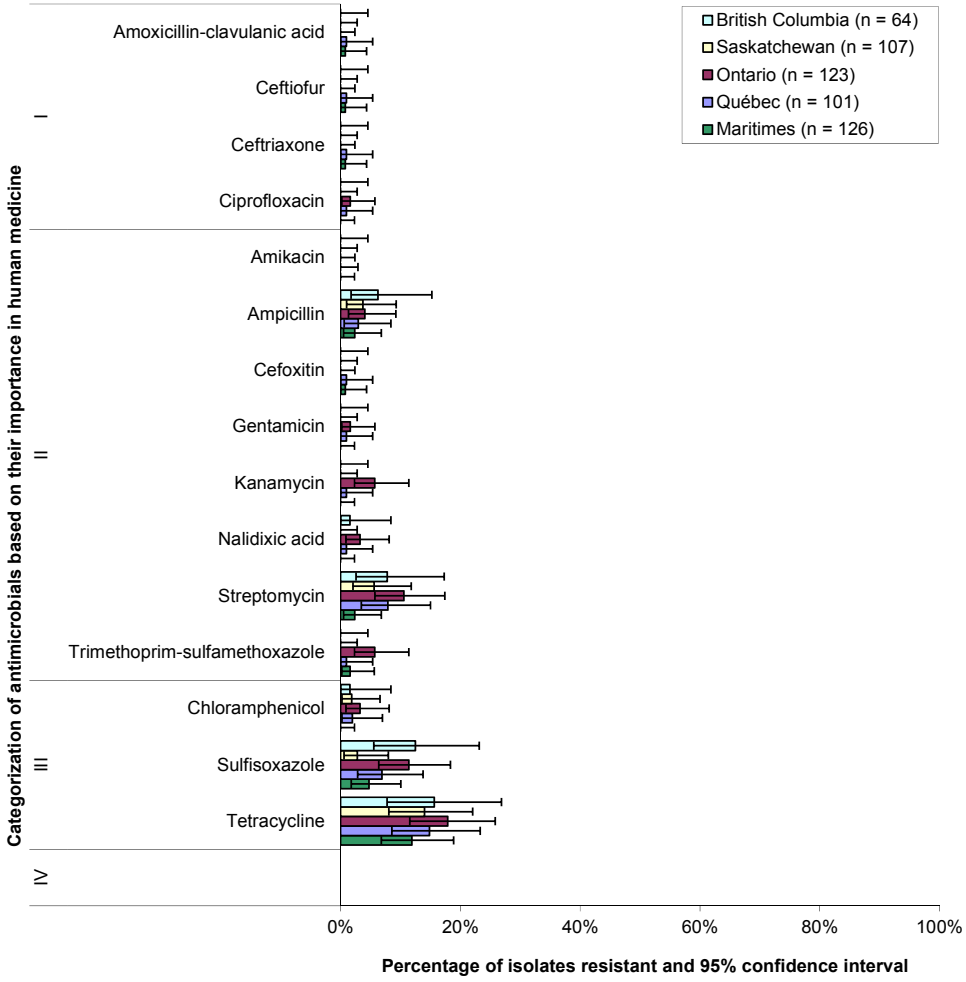
Antimicrobial Resistance: Results are presented in Figure 4, Table 9, and Table B.8, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 1% (1/101) of *E. coli* isolates from Québec and 1% (1/126) of isolates from the Maritimes. Resistance to ceftiofur and ceftriaxone were each detected in 1% (1/101) of isolates from Québec and 1% (1/126) of isolates from the Maritimes. Resistance to ciprofloxacin was detected in 2% (2/123) of isolates from Ontario and 1% (1/101) of isolates from Québec Two percent (1/64) of *E. coli* isolates from British Columbia and 2% (2/123) of isolates from Ontario had reduced susceptibility to ciprofloxacin. Resistance to nalidixic acid was detected in 2% (1/64) of *E. coli* isolates from British Columbia, 3% (4/123) of isolates from Ontario, and 1%(1/101) of isolates from Québec. There were no significant differences among the provinces/region in percentages of isolates with resistance to any of the antimicrobials tested. No isolates from any province were resistant to amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 9 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 17% (11/64) of *E. coli* isolates from British Columbia, 14% (15/107) of isolates from Saskatchewan, 19% (23/123) of isolates from Ontario, 17% (17/101) of isolates from Québec, and 12% (15/126) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 5% (3/64) of *E. coli* isolates from British Columbia, 2% (2/107) of isolates from Saskatchewan, 4% (5/123) of isolates from Ontario, 1% (1/101) of isolates from Québec, and 1% (1/126) of isolates from the Maritimes. Among the isolates from all 5 provinces/region, the most common resistance patterns were TET (5%, 26/521) and STR-SSS-TET (2%, 10/521). The pattern involving the greatest number of antimicrobials was ACKSSuT-CIP-GEN-NAL-SXT (1 isolate from Ontario).

Temporal Variations: Results are presented in Figure 5. The percentage of *E. coli* isolates from Ontario with nalidixic acid resistance was significantly higher in 2010 (3%, 4/123) than in 2009 when no (0%, 0/195) nalidixic acid resistance was observed. In other provinces/regions, there was no significant temporal variation in the percentages of isolates resistant to selected antimicrobials.

In 2010, the percentage of *Escherichia coli* isolates from retail beef with resistance to ciprofloxacin was 2% (2/123) of isolates from Ontario and 1% (1/101) of isolates from Québec. Resistance to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone were each detected in 1% (1/101) of isolates from Québec and 1% (1/126) of isolates from the Maritimes. The percentage of isolates from Ontario with nalidixic acid resistance was significantly higher (3%, 4/123) than in 2009 when no (0%, 0/195) nalidixic acid resistance was observed. The pattern involving the greatest number of antimicrobials was ACKSSuT-CIP-GEN-NAL-SXT (1 isolate from Ontario).

Figure 4. Resistance to antimicrobials in *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2010.



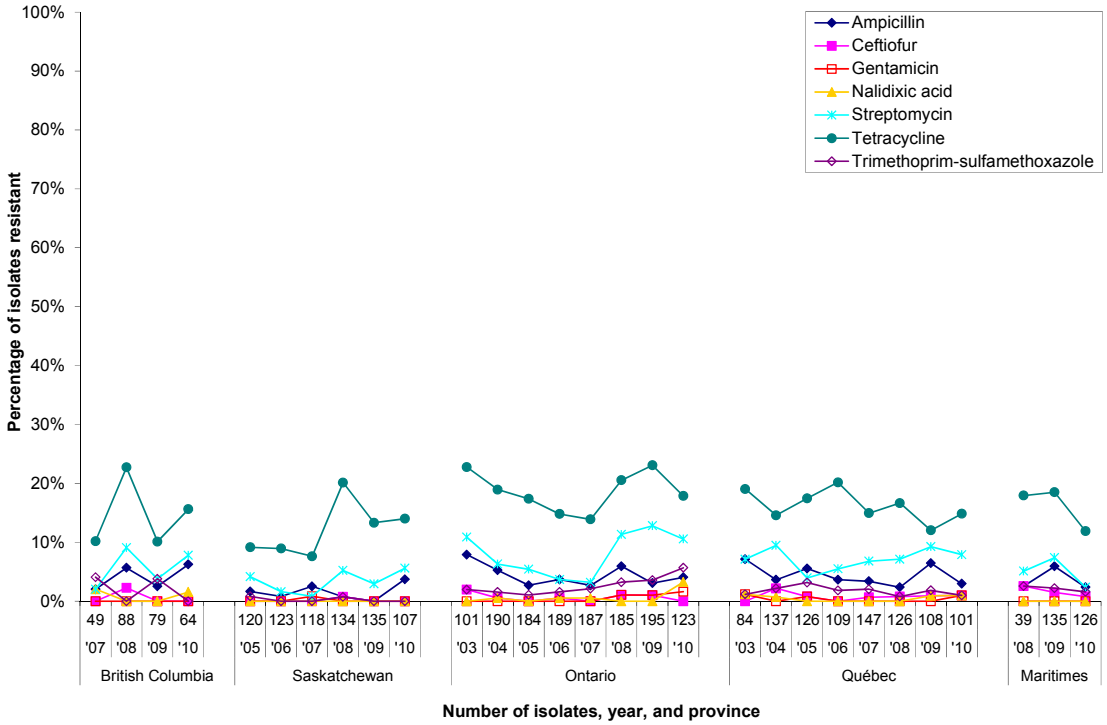
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 9. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia	64 (12.3)	53	2	6	3					5	4					8		1		1	10
Saskatchewan	107 (20.5)	92	7	6	2					6	4					3		2			15
Ontario	123 (23.6)	100	6	12	3	2		2	7	13	5					14	7	4	2	4	22
Québec	101 (19.4)	84	5	11	1			1	1	8	3	1	1	1	1	7	1	2	1	1	15
Maritimes	126 (24.2)	111	7	7	1					3	3	1	1	1	1	6	2				15

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

Figure 5. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2003–2010.



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

Abattoir Surveillance

(n = 77)[1]

Recovery: *Escherichia coli* isolates were recovered from 97% (77/79) of beef cattle caecal samples (Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 6, Table 10, and Table B.9, Appendix B. None of the *E. coli* isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, gentamicin, kanamycin, nalidixic acid, or trimethoprim-sulfamethoxazole. Additionally, none of the isolates had reduced susceptibility to ciprofloxacin.

Antimicrobial Resistance Patterns: Results are presented in Table 10 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 16% (12/77) of isolates. Resistance to 4 or more antimicrobial classes was detected in 1% (1/77) of isolates. The most common resistance patterns were SSS-TET (6%, 5/77), STR-SSS-TET (3%, 2/77) and TET (3%, 2/77). The pattern involving the greatest number of antimicrobials among isolates was CHL-STR-SSS-TET.

Temporal Variations: Results are presented in Figure 7. The percentage of *E. coli* isolates with tetracycline resistance was significantly lower in 2010 (14%, 11/77) than in 2009 (30%, 36/119) or 2003 (29%, 44/153), and streptomycin resistance was significantly lower in 2010 (5%, 4/77) than in 2009 (17%, 21/119).

[1] In 2010, the number of samples received from abattoir beef cattle was much lower than anticipated due to a 55% drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.

In 2010, resistance to 1 or more antimicrobials was detected in 16% (12/77) of *Escherichia coli* isolates from abattoir collected caecal samples from beef cattle. The most common resistance patterns were SSS-TET (6%, 5/77), STR-SSS-TET (3%, 2/77) and TET (3%, 2/77). The pattern involving the greatest number of antimicrobials among isolates was CHL-STR-SSS-TET. Resistance to 4 or more antimicrobial classes was detected in 1% (1/77) of isolates. The percentage of *E. coli* isolates with tetracycline resistance was significantly lower in 2010 (14%, 11/77) than in 2009 (30% 36/119) or 2003 (29%, 44/153), and streptomycin resistance was significantly lower in 2010 (5%, 4/77) than in 2009 (17%, 21/119).

Figure 6. Resistance to antimicrobials in *Escherichia coli* isolates from beef cattle; *Abattoir Surveillance*, 2010.

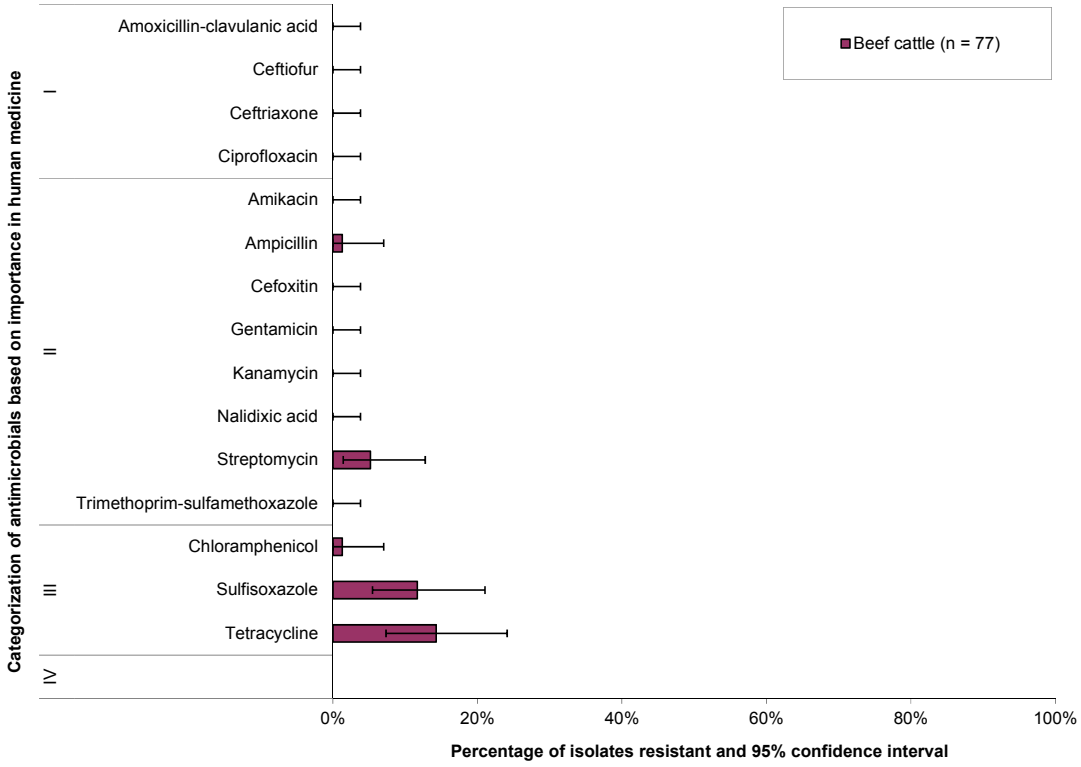
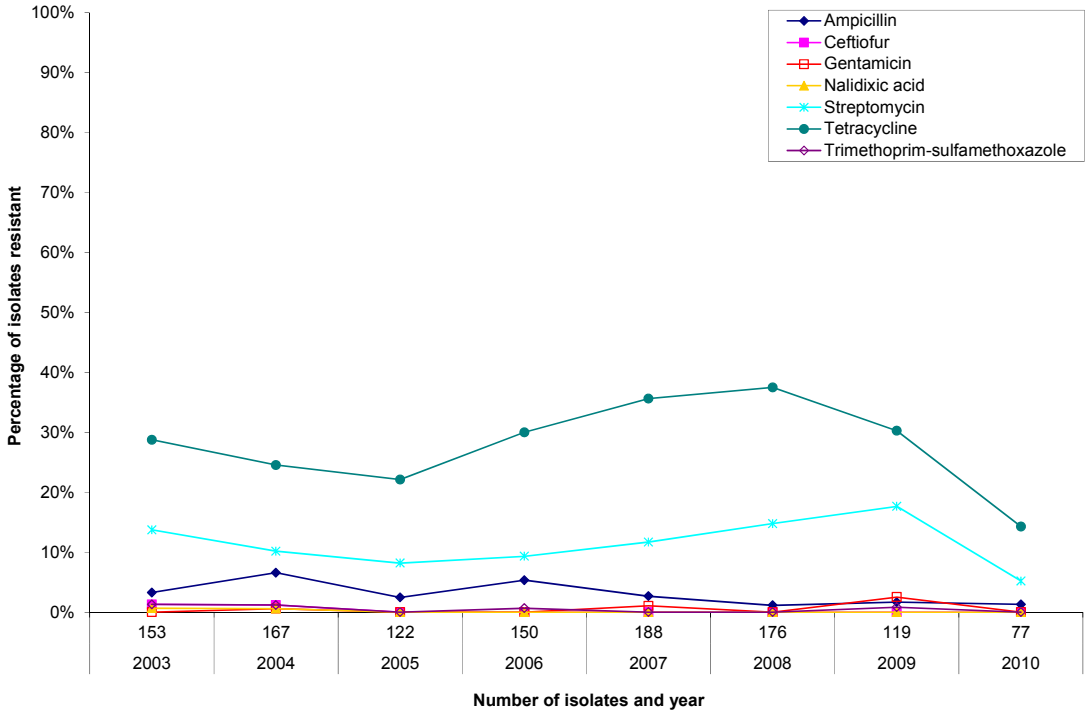


Table 10. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from beef cattle; *Abattoir Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Beef cattle	77	65	2	9	1					4	1					9		1			11

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

Figure 7. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from beef cattle; *Abattoir Surveillance*, 2003–2010.



In 2010, the number of samples received from abattoir beef cattle was much lower than anticipated due to a 55% drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.

Campylobacter

Abattoir Surveillance

(n = 37)[1]

Recovery: *Campylobacter* isolates were recovered from 53% (37/70) of beef cattle caecal samples (Table C.5, Appendix C). Seventy-three percent (27/37) of the remaining isolates were *C. jejuni*, 24% (9/37) were *C. coli*, and 3% (1/37) were other *Campylobacter* spp.

Antimicrobial Resistance: Results are presented in Figure 8, Table 11, and Table B.10, Appendix B. Resistance to ciprofloxacin was detected in 4% (1/27) of *C. jejuni* isolates. None of the isolates were resistant to telithromycin, azithromycin, clindamycin, erythromycin, or gentamicin. Additionally, none of the isolates were non-susceptible to florfenicol.[2]

Antimicrobial Resistance Patterns: Results are presented in Table 11.Resistance to 1 or more antimicrobial classes was detected in 51% (19/37) of *Campylobacter* isolates. None of the isolates were resistant to 4 or more antimicrobial classes. The most common resistance pattern was TET (49%, 18/37). The pattern involving the greatest number of antimicrobials was CIP-NAL-TET (1 *C. jejuni)*.

Temporal Variations: Results are presented in Figure 9. There were no significant temporal variations in resistance to selected antimicrobials in *Campylobacter* isolates.

In 2010, resistance to 1 or more antimicrobial classes was detected in 51% (19/37) of *Campylobacter* isolates recovered from abattoir caecal samples from beef cattle. Resistance to ciprofloxacin was detected in 4% (1/27) of *C. jejuni* isolates. The most common resistance pattern was TET (49%, 18/37). The pattern involving the greatest number of antimicrobials was CIP-NAL-TET (1 *C. jejuni*).

[1] In 2010, the number of samples received from abattoir beef cattle was much lower than anticipated due to a 55% drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.

[2] A referenced resistance breakpoint has not been established for this antimicrobial. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression “non-susceptible” was used instead of “resistant” in the text.

Figure 8. Resistance to antimicrobials in *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2010.

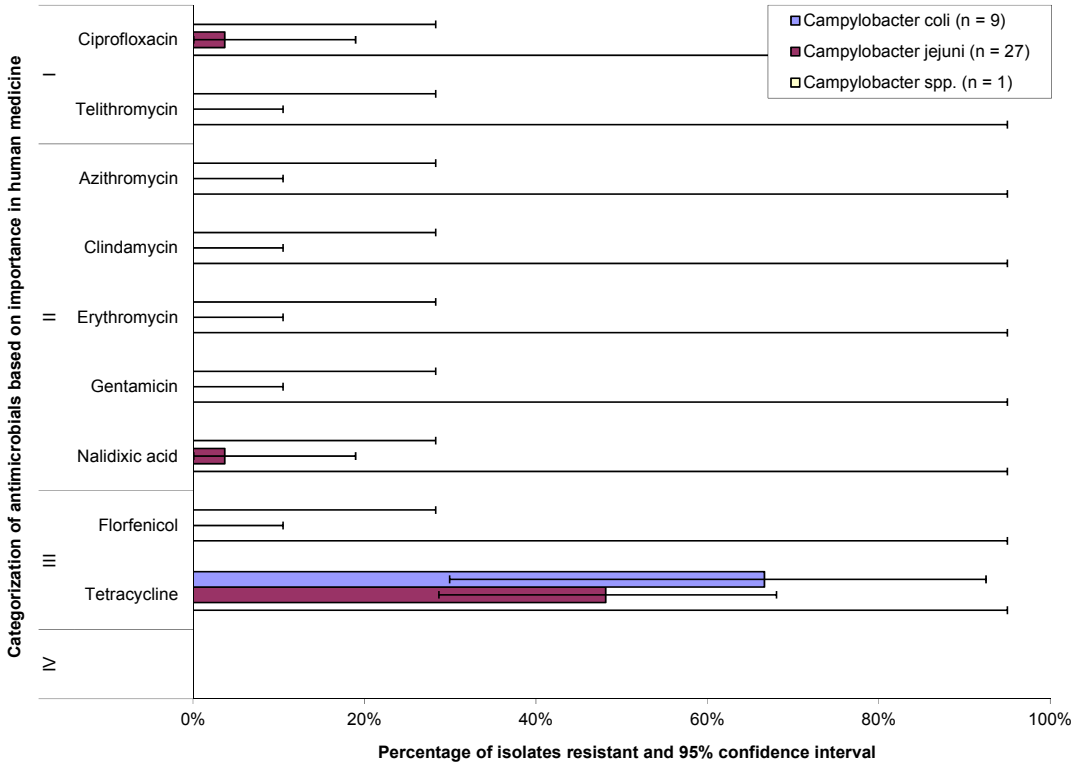
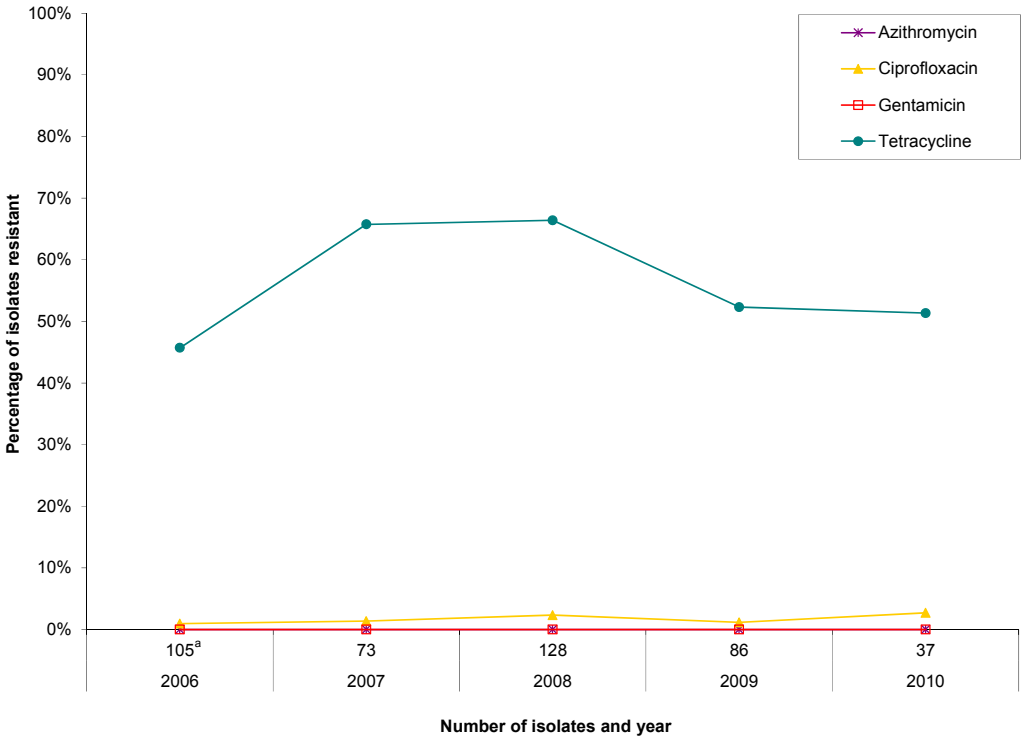


Table 11. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2010.

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial							
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
Campylobacter jejuni	27 (73.0)	14	12	1									1	1	13
Campylobacter coli	9 (24.3)	3	6												6
Campylobacter spp.	1 (2.7)	1													
Total	**37 (100)**	**18**	**18**	**1**									**1**	**1**	**19**

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

Figure 9. Temporal variation in resistance to selected antimicrobials in *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2006–2010.



In 2010, the number of samples received from abattoir beef cattle was much lower than anticipated due to a 55% drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.

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

Chickens

Salmonella

Retail Meat Surveillance

(n = 381)

(British Columbia [n = 56], Saskatchewan [n = 42], Ontario [n = 90], Québec [n = 116],

Maritimes [n = 77])

Recovery: *Salmonella* isolates were recovered from 38% (381/1,015) of retail chicken samples. Province/region-specific percentages of chicken samples from which isolates were recovered were as follows: British Columbia, 34% (56/165); Saskatchewan, 32% (42/132); Ontario, 39% (90/232); Québec, 39% (116/296), and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 41% (77/190; Table C.5 in Appendix C).

Serovars: Results are presented in Table 12 and Table C.3, Appendix C. The most common *Salmonella* serovars recovered from retail chicken were Heidelberg (28%, 106/381), Kentucky (26%, 100/381), Enteritidis (16%, 60/381), and Hadar (6%, 23/381). In British Columbia the most common *Salmonella* serovars were Enteritidis (43%, 24/56) and Kentucky (32%, 18/56). In Saskatchewan the most common *Salmonella* serovars were Enteritidis (26%, 11/42) and Heidelberg (19%, 8/42). In Ontario, the most common *Salmonella* serovars were Kentucky (34%, 31/90) and Heidelberg (20%, 18/90). In Québec, the most common *Salmonella* serovars were Heidelberg (42%, 49/116) and Kentucky (25%, 29/116). In the Maritimes, the most common *Salmonella* serovars were Heidelberg (35%, 27/77) and Kentucky (26%, 20/77).

Antimicrobial Resistance: Results are presented in Figure 10, Table 12, and Table B.11, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 23% (13/56) of *Salmonella* isolates from British Columbia, 7% (3/42) of isolates from Saskatchewan, 24% (22/90) of isolates from Ontario, 25% (29/116) of isolates from Québec and 21% (16/77) of isolates from the Maritimes. Resistance to ceftiofur and ceftriaxone was detected in 25% (14/56) of *Salmonella* isolates from British Columbia, 7% (3/42) of isolates from Saskatchewan, 24% (22/90) of isolates from Ontario, 25% (29/116) of isolates from Québec and 21% (16/77) of isolates from the Maritimes. There were no significant differences among the provinces/region in percentages of resistant isolates for any of the antimicrobials tested. No resistance to ciprofloxacin, amikacin, gentamicin, kanamycin, or nalidixic acid was observed for any province/region. Reduced susceptibility to ciprofloxacin was not observed.

Antimicrobial Resistance Patterns: Results are presented in Table 12 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 36% (20/56) of *Salmonella* isolates from British Columbia, 36% (15/42) of isolates from Saskatchewan, 50% (45/90) of isolates from Ontario, 47% (55/116) of isolates from Québec, and 48% (37/77) of isolates from Maritimes. Resistance to 4 or more antimicrobial classes was detected in 1% (1/90) isolates from Ontario (*S*. Indiana). This *S*. Indiana isolate from Ontario also had the pattern involving the greatest number of antimicrobials and was ACSSuT-A2C-CRO. Among isolates from all 5 provinces/region, the most common resistance patterns were STR-TET (13%, 50/381), A2C-AMP-CRO (11%, 42/381), and A2C-AMP-CRO-STR-TET (7%, 25/381).

Temporal Variations: Results are presented in Figure 11. In Saskatchewan, the percentage of *Salmonella* isolates resistant to tetracycline (17%, 7/42) in 2010 was significantly lower than in 2005 (52%, 11/21). In Ontario, the percentages of *Salmonella* isolates resistant to ceftiofur (24%, 22/90) and ampicillin (29%, 26/90) were significantly lower in 2010 than in 2004 (46%, 25/54 and 52%, 28/54), respectively.[1] In

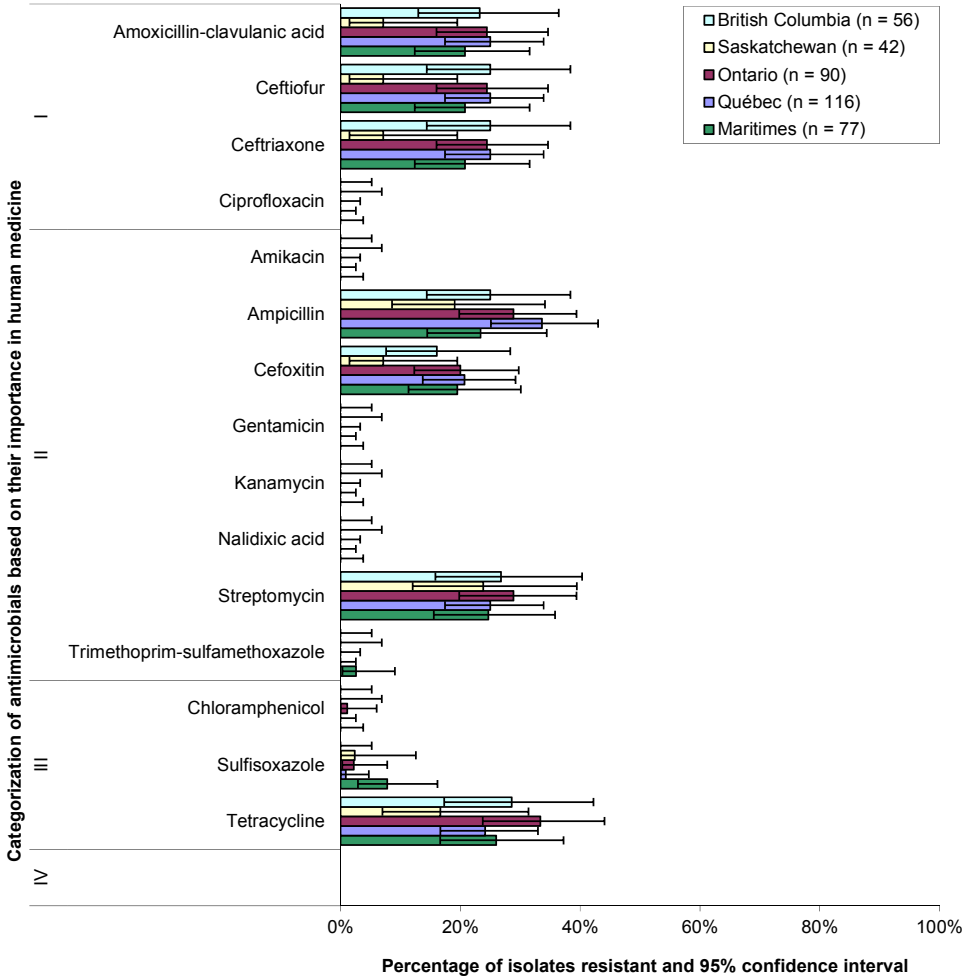
[1] For Ontario and Québec only: 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

2010 in Ontario, the percentage of *Salmonella* isolates resistant to streptomycin (29%, 26/90) was significantly higher than in 2003 (4% 1/26). In Québec the percentage of *Salmonella* isolates resistant to ampicillin (34%, 39/116) was significantly higher in 2010 than in 2006 (15%, 5/33).[1]

In 2010, resistance to amoxicillin-clavulanic acid was detected in 23% (13/56) of *Salmonella* isolates from British Columbia, 7% (3/42) of isolates from Saskatchewan, 24% (22/90) of isolates from Ontario, 25% (29/116) of isolates from Québec and 21% (16/77) of isolates from the Maritimes. Ceftiofur and ceftriaxone resistance was detected in 25% (14/56) of isolates from British Columbia, 7% (3/42) of isolates from Saskatchewan, 24% (22/90) of isolates from Ontario, 25% (29/116) of isolates from Québec and 21% (16/77) of isolates from the Maritimes. No resistance or reduced susceptibility to ciprofloxacin was detected. In Ontario, the percentage of isolates resistant to ceftiofur (24%, 22/90) was significantly lower in 2010 than in 2004 (46%, 25/54).[1] Resistance to 4 or more antimicrobial classes was detected in 1% (1/90) isolates from Ontario (*S.* Indiana); this isolate also exhibited the resistance pattern with the greatest number of antimicrobials ACSSuT-A2C-CRO.

[1] For Ontario and Québec only: 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Figure 10. Resistance to antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2010.



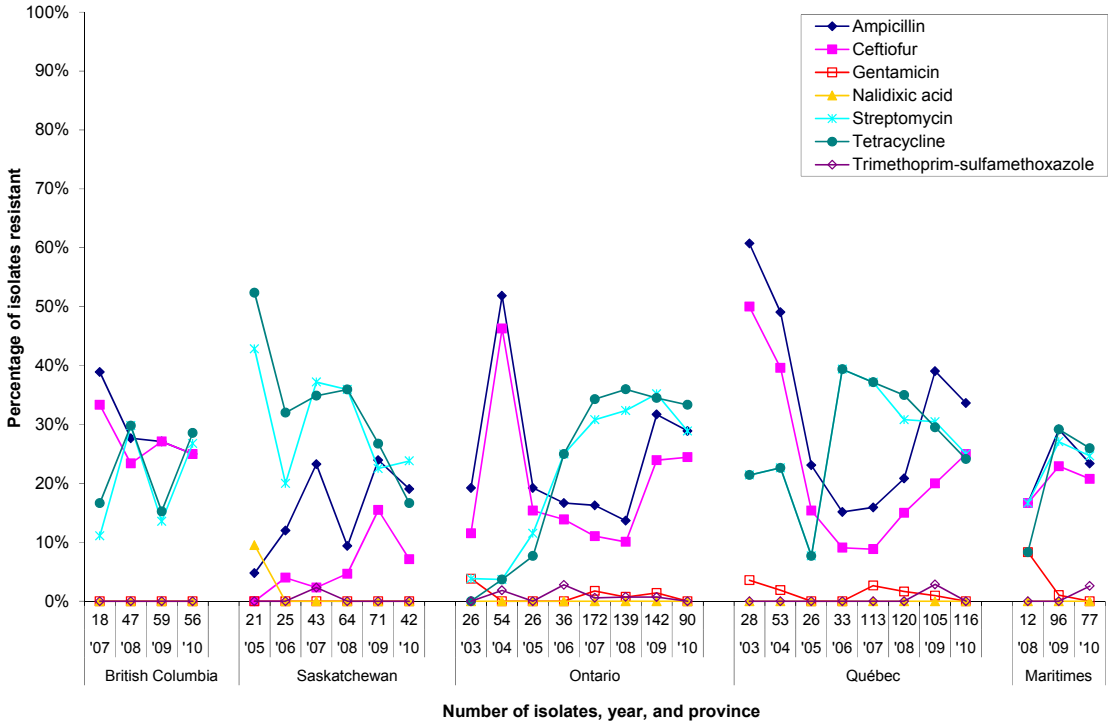
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 12. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	24 (42.9)	24																			
Kentucky	18 (32.1)	1	3	14						14	12	11	12	7	12						15
Heidelberg	4 (7.1)	2	2								2	2	2	2	2						
Hadar	3 (5.4)	2		1						1											1
Less common serovars	7 (12.5)	7																			
Total	**56 (100)**	**36**	**5**	**15**						**15**	**14**	**13**	**14**	**9**	**14**						**16**
Saskatchewan																					
Enteritidis	11 (26.2)	11																			
Heidelberg	8 (19.0)	3	3	2						2	5	1	1	1	1						
Hadar	3 (7.1)			3						3											3
Braenderup	2 (4.8)	2																			
Kentucky	2 (4.8)			2						2	1	1	1	1	1						2
Kiambu	2 (4.8)	2																			
Mbandaka	2 (4.8)	2																			
Schwarzengrund	2 (4.8)	2																			
Thompson	2 (4.8)		1	1						2						1					
Typhimurium	2 (4.8)	2																			
Agona	1 (2.4)			1						1	1										1
Albany	1 (2.4)	1																			
I 4,[5],12:i:-	1 (2.4)		1																		1
IIIa 23:g,z51:-	1 (2.4)	1																			
Infantis	1 (2.4)	1																			
Montevideo	1 (2.4)		1								1	1	1	1	1						
Total	**42 (100)**	**27**	**6**	**9**						**10**	**8**	**3**	**3**	**3**	**3**	**1**					**7**
Ontario																					
Kentucky	31 (34.4)	11	2	18						18	12	12	12	8	12						18
Heidelberg	18 (20.0)	9	8	1							8	4	4	4	4	1					1
Hadar	9 (10.0)		2	7						7											9
Enteritidis	6 (6.7)	6																			
Typhimurium	6 (6.7)	6																			
Schwarzengrund	5 (5.6)	4	1								1	1	1	1	1						
Typhimurium var. 5-	4 (4.4)	4																			
Thompson	3 (3.3)	2	1								1	1	1	1	1						
Kiambu	2 (2.2)	2																			
Less common serovars	6 (6.7)	1	4		1					1	4	4	4	4	4	1		1			2
Total	**90 (100)**	**45**	**18**	**26**	**1**					**26**	**26**	**22**	**22**	**18**	**22**	**2**		**1**			**30**
Québec																					
Heidelberg	49 (42.2)	29	18	2						2	20	10	10	9	10						
Kentucky	29 (25.0)	8	1	20						20	10	10	10	8	10						21
Enteritidis	7 (6.0)	7																			
Hadar	4 (3.4)			4						4											4
Albany	3 (2.6)	1	2								2	2	2	2	2						
Litchfield	3 (2.6)	2	1								1	1	1	1	1						
Thompson	3 (2.6)	2	1								1	1	1		1						
Less common serovars	18 (15.5)	12	3	3						3	5	5	5	4	5	1					3
Total	**116 (100)**	**61**	**26**	**29**						**29**	**39**	**29**	**29**	**24**	**29**	**1**					**28**
Maritimes																					
Heidelberg	27 (35.1)	16	9	2						3	7	6	6	6	6	3	2				
Kentucky	20 (26.0)	4	2	14						12	7	6	6	5	6	1					14
Enteritidis	12 (15.6)	12																			
Albany	4 (5.2)		4								4	4	4	4	4						
Hadar	4 (5.2)			4						4											4
Less common serovars	10 (13.0)	8		2												2					2
Total	**77 (100)**	**40**	**15**	**22**						**19**	**18**	**16**	**16**	**15**	**16**	**6**	**2**				**20**

Antimicrobial abbreviations are defined in Appendix D.
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.

Figure 11. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2003–2010.



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

Abattoir Surveillance

(n = 142)

Recovery: *Salmonella* isolates were recovered from 24% (142/599) of chicken caecal samples (Table C.5, Appendix C).

Serovars: Results are presented in Table 13 and Table C.3, Appendix C. The most common *Salmonella* serovars were Kentucky (42%, 59/142), Heidelberg (21%, 30/142), and Enteritidis (18%, 25/142). These 3 serovars accounted for 80% (114/142) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 12, Table 13, and Table B.12, Appendix B. The percentage of *Salmonella* isolates resistant to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone was 32% each (46/142 each). Reduced susceptibility to ciprofloxacin was detected in 1% (1/142) of isolates and resistance to nalidixic acid was detected in 1% (1/142) of isolates. None of the isolates were resistant to ciprofloxacin, amikacin, or kanamycin.

Antimicrobial Resistance Patterns: Results are presented in Table 13 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 50% (71/142) of isolates. Resistance to 4 or more antimicrobial classes was detected in 2% (3/142) of the isolates (1 *S*. Kentucky, 1 *S*. Indiana, and 1 *S*. Infantis). The most common resistance patterns were A2C-AMP-CRO (13%, 18/142), A2C-AMP-CRO-STR-TET (11%, 15/142), and STR-TET (11%, 15/142). One percent of isolates (1 *S*. Kentucky) was resistant to both ceftriaxone and nalidixic acid and also had reduced susceptibility to ciprofloxacin. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-GEN (1 *S*. Infantis isolate).

Temporal Variations: Results are presented in Figure 10. The percentages of *Salmonella* isolates with resistance to tetracycline were significantly higher in 2010 (30%, 42/142) than in 2003 (24%, 30/126). The percentage of isolates with resistance to ceftiofur was significantly higher in 2010 (32%, 46/142) than in 2006 (10%, 18/187) and 2004 (22%, 31/142).[1] In addition, the percentage of isolates with resistance to ampicillin was significantly higher in 2010 (37%, 52/142) than in 2006 (16%, 29/187).[1] However, the percentage of isolates with resistance to streptomycin was significantly lower in 2010 (30%, 42/142) than in 2009 (41%, 94/230). There were no other significant temporal variations detected in the percentage of isolates with resistance to other selected antimicrobials.

In 2010, 13% (18/142) of *Salmonella* isolates from abattoir chickens had an A2C-AMP-CRO resistance pattern and 14% had an A2C-AMP-CRO-STR-TET resistance pattern. The percentage of isolates with resistance to ceftiofur was significantly higher in 2010 (32%, 46/142) than in 2006 (10%, 18/187) and 2004 (22%, 31/142). The percentage of isolates with resistance to ampicillin was significantly higher in 2010 (37%, 52/142) than in 2006 (16%, 29/187). However, the percentage of isolates with resistance to streptomycin was significantly lower in 2010 (30%, 42/142) than in 2009 (41%, 94/230).

[1] 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Figure 12. Resistance to antimicrobials in *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2010.

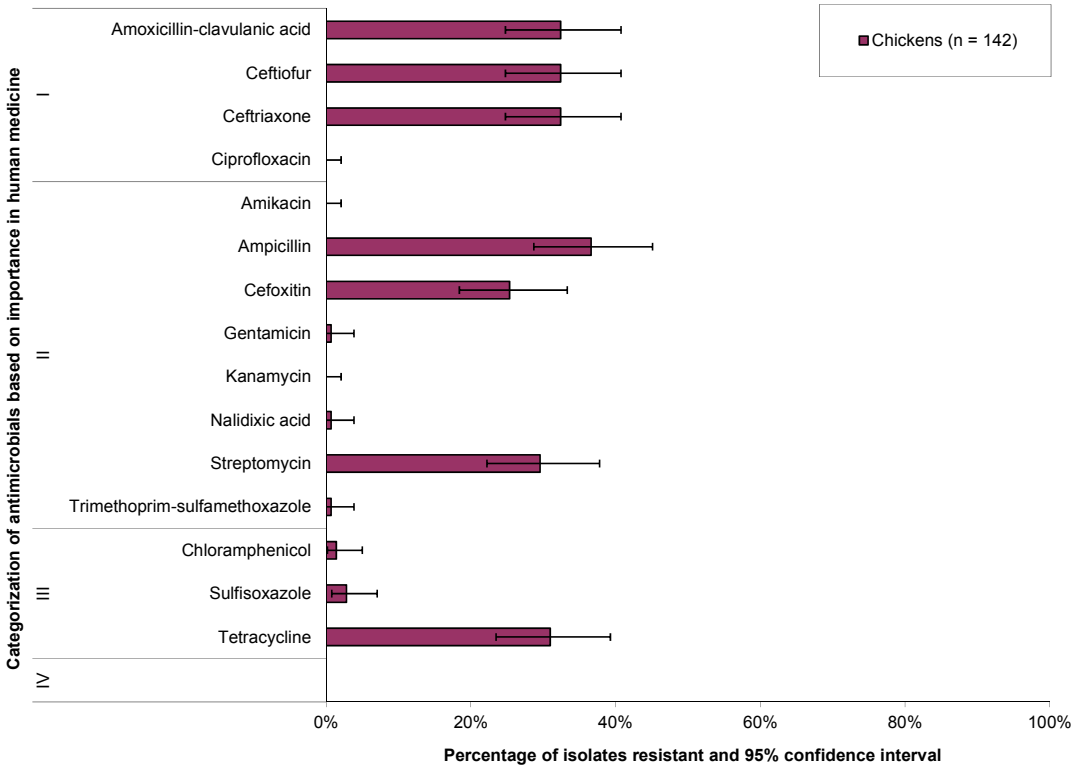
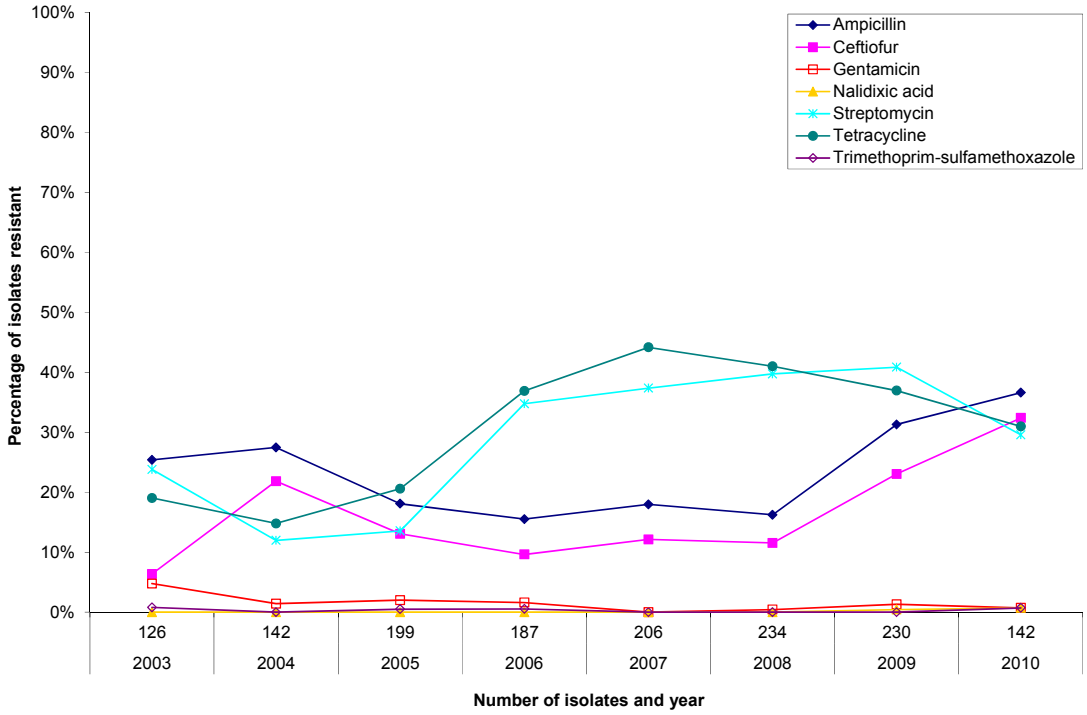


Table 13. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from chicken; *Abattoir Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Kentucky	59 (41.5)	14	9	35	1					36	31	31	31	21	31					1	38
Heidelberg	30 (21.1)	13	17								16	10	10	10	10	1	1				
Enteritidis	25 (17.6)	25																			
Typhimurium	6 (4.2)	6																			
Litchfield	4 (2.8)	4																			
Hadar	3 (2.1)	1		2						2											2
Less common serovars	15 (10.6)	8	3	2	2			1		4	5	5	5	5	5	3		2			4
Total	**142 (100)**	**71**	**29**	**39**	**3**			**1**		**42**	**52**	**46**	**46**	**36**	**46**	**4**	**1**	**2**		**1**	**44**

Antimicrobial abbreviations are defined in Appendix D.
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."

Figure 13. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2003–2010.



Surveillance of Animal Clinical Isolates[1]

(n = 342)

Note: The chicken isolates were largely from layer hens and broiler chickens, but could also have been from primary layer breeders or broiler breeder birds. A proportion of the isolates might have been recovered from chicken-related environmental samples.

Serovars: Results are presented in Table 14 and Table C.3, Appendix C. The most common *Salmonella* serovars were Enteritidis (33%, 114/342), Heidelberg (28%, 95/342), and Kentucky (20%, 68/342). These 3 serovars account for 81% (277/342) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 14, Table 14, and Table B.13, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was detected in 14% (47/342) of isolates. Less than 1% (1/342) of isolates had reduced susceptibility to ciprofloxacin. Resistance to nalidixic acid was detected in less than 1% (1/342) of isolates. None of the isolates were resistant to ciprofloxacin or amikacin.

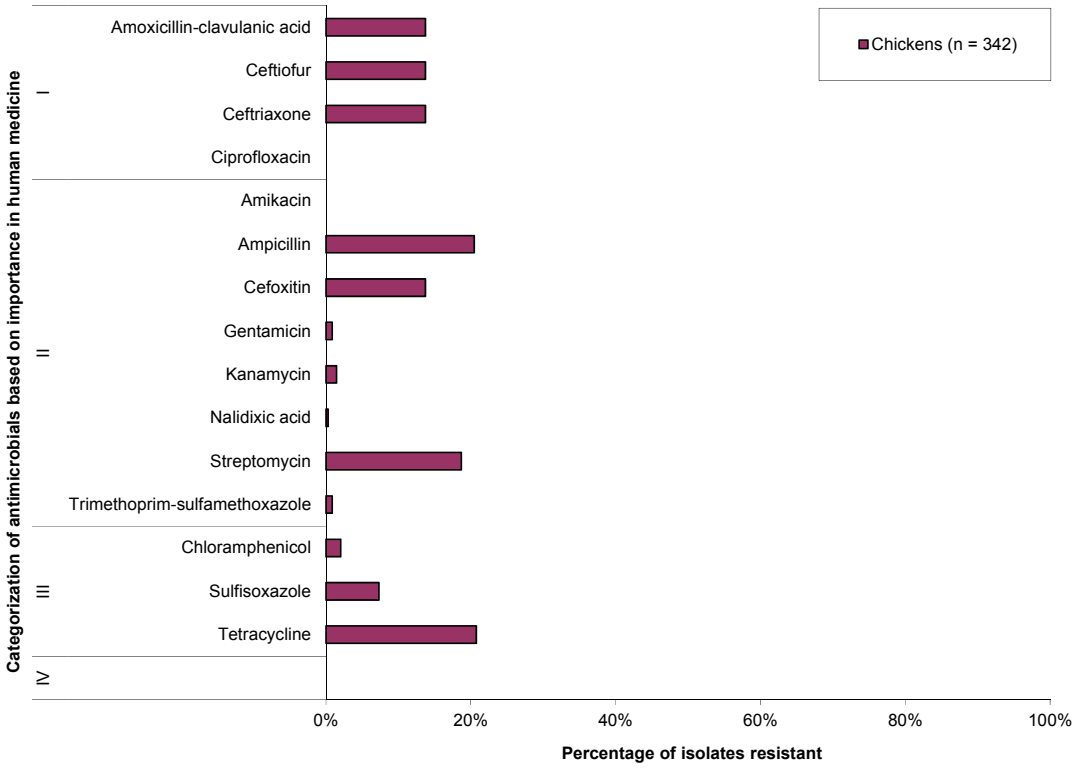
Antimicrobial Resistance Patterns: Results are presented in Table 14 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 33% (114/342) of the isolates. Resistance to 4 or more antimicrobial classes was detected in 2% (7/342) of the isolates (3 *S*. Typhimurium, 2 *S*. Agona, 1 *S*. Enteritidis, and 1 *S*. Indiana). The most common resistance patterns were STR-TET (7%, 23/342), A2C-AMP-CRO (6%, 20/342), and A2C-AMP-CRO-STR-TET (5%, 18/342). Sixty percent (12/20) of the isolates with the A2C-AMP-CRO and 1 of the 18 isolates with the A2C-AMP-CRO-STR-TET resistance pattern were *S*. Heidelberg. The remaining 17 of the 18 isolates with the A2C-AMP-CRO-STR-

[1] The distribution of *Salmonella* isolates across provinces is presented in Table C.6, Appendix C.

TET resistance pattern were all *S*. Kentucky. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (2 *S*. Agona isolates).

In 2010, resistance to 1 or more antimicrobial classes was detected in 33% (114/342) of chicken clinical *Salmonella* isolates. Resistance to nalidixic acid was detected in less than 1% (1/342) of isolates. Resistance to 4 or more antimicrobial classes was detected in 2% (7/342) of the isolates (3 *S*. Typhimurium, 2 *S*. Agona, 1 *S*. Enteritidis, and 1 *S*. Indiana). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (2 *S*. Agona).

Figure 14. Resistance to antimicrobials in *Salmonella* isolates from chicken; *Surveillance of Animal Clinical Isolates*, 2010.



Confidence intervals are not displayed for animal clinical data because samples were not obtained randomly and may not represent independent observations and true estimates of the prevalence.

Table 14. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from chickens; *Surveillance of Animal Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Enteritidis	114 (33.3)	110	2	1	1			1		1	2	1	1	1	1	2		1		1	2
Heidelberg	95 (27.8)	63	24	8					1	4	30	13	13	13	13	4					5
Kentucky	68 (19.9)	16	10	42						38	26	26	26	26	26						47
Typhimurium	13 (3.8)	10			3				1	3	3					3	1	3			3
Mbandaka	9 (2.6)	2		7						7						7					7
I 4,[5],12:i:-	8 (2.3)	6	1	1					1		1	1	1	1	1						1
Less common serovars	35 (10.2)	21	3	8	3			2	2	11	8	6	6	6	6	9	2	3			6
Total	**342 (100)**	**228**	**40**	**67**	**7**			**3**	**5**	**64**	**70**	**47**	**47**	**47**	**47**	**25**	**3**	**7**		**1**	**71**

Antimicrobial abbreviations are defined in Appendix D.
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."

Escherichia coli

Retail Meat Surveillance

(n = 559)

(British Columbia [n = 75], Saskatchewan [n = 71], Ontario [n = 100], Québec [n = 138],

Maritimes [n = 175])

Recovery: *Escherichia coli* isolates were recovered from 91% (560/617) of retail chicken samples.[1] Province/region-specific percentages of chicken samples from which isolates were recovered were as follows: British Columbia, 89% (75/84); Saskatchewan, 90% (71/79); Ontario, 86% (100/116); Québec, 93% (138/148); and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 93% (176/190; Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 15, Table 15, and Table B.14, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 48% (36/75) of *E. coli* isolates from British Columbia, 23% (16/71) of isolates from Saskatchewan, 24% (24/100) of isolates from Ontario, 30% (42/138) of isolates from Québec, and 21% (37/175) of isolates from the Maritimes. Resistance to ceftiofur was detected in 44% (33/75) of *E. coli* isolates from British Columbia, 20% (14/71) of isolates from Saskatchewan, 21% (21/100) of isolates from Ontario, 27% (37/138) of isolates from Québec, and 18% (31/175) of isolates from the Maritimes. Resistance to ceftriaxone was detected in 48% (36/75) of *E. coli* isolates from British Columbia, 23% (16/71) of isolates from Saskatchewan, 24% (24/100) of isolates from Ontario, 31% (43/138) of isolates from Québec, and 21% (37/175) of isolates from the Maritimes. Reduced susceptibility to ciprofloxacin was detected in 7% (5/75) of *E. coli* isolates from British Columbia, 10% (7/71) of isolates from Saskatchewan, 2% (2/100) of isolates from Ontario, 1% (1/138) of isolates from Québec, and 3% (6/175) of isolates from the Maritimes. Resistance to nalidixic acid was detected in 7% (5/75) of *E. coli* isolates from British Columbia, 10% (7/71) of isolates from Saskatchewan, 2% (2/100) of isolates from Ontario, 1% (1/138) of isolates from Québec, and 3% (6/175) of isolates from the Maritimes. The percentage of isolates resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, and ampicillin were significantly higher in British Columbia than in Saskatchewan, Ontario and Maritimes. The percentage of isolates resistant to cefoxitin was significantly higher in British Columbia than in all the other provinces/region. The percentage of isolates resistant to gentamicin was significantly higher in Ontario and Québec than in British Columbia. The percentage of isolates resistant to streptomycin was significantly higher in Québec than in British Columbia. The percentage of isolates resistant to trimethoprim-sulfamethoxazole and sulfisoxazole were significantly higher in Québec and the Maritimes than in British Columbia and Saskatchewan. No isolates from any province were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 15 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 77% (58/75) of *E. coli* isolates from British Columbia, 72% (51/71) of isolates from Saskatchewan, 71% (71/100) of isolates from Ontario, 83% (114/138) of isolates from Québec and 73% (128/175) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 13% (10/75) of *E. coli* isolates from British Columbia, 3% (2/71) of isolates from Saskatchewan, 9% (9/100) of isolates from Ontario, 18% (25/138) of isolates from Québec and 23% (40/175) of isolates from the Maritimes. Among the isolates from all 5 provinces/region, the most common resistance patterns were A2C-AMP-CRO (8%, 46/559), TET (6%, 35/559), and AMP-TET (3%, 19/559). Two percent (12/559) of isolates had reduced susceptibility to ciprofloxacin and resistance to ceftriaxone and 2% (12/559) of isolates had resistance to nalidixic acid and ceftriaxone. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-GEN-NAL-SXT (1 isolate from the Maritimes).

Temporal Variations: Results are presented in Figure 16. The percentage of *E. coli* isolates resistant to ceftiofur was significantly higher in 2010 (20%, 14/71) than 2005 (4%, 3/81) in Saskatchewan and was

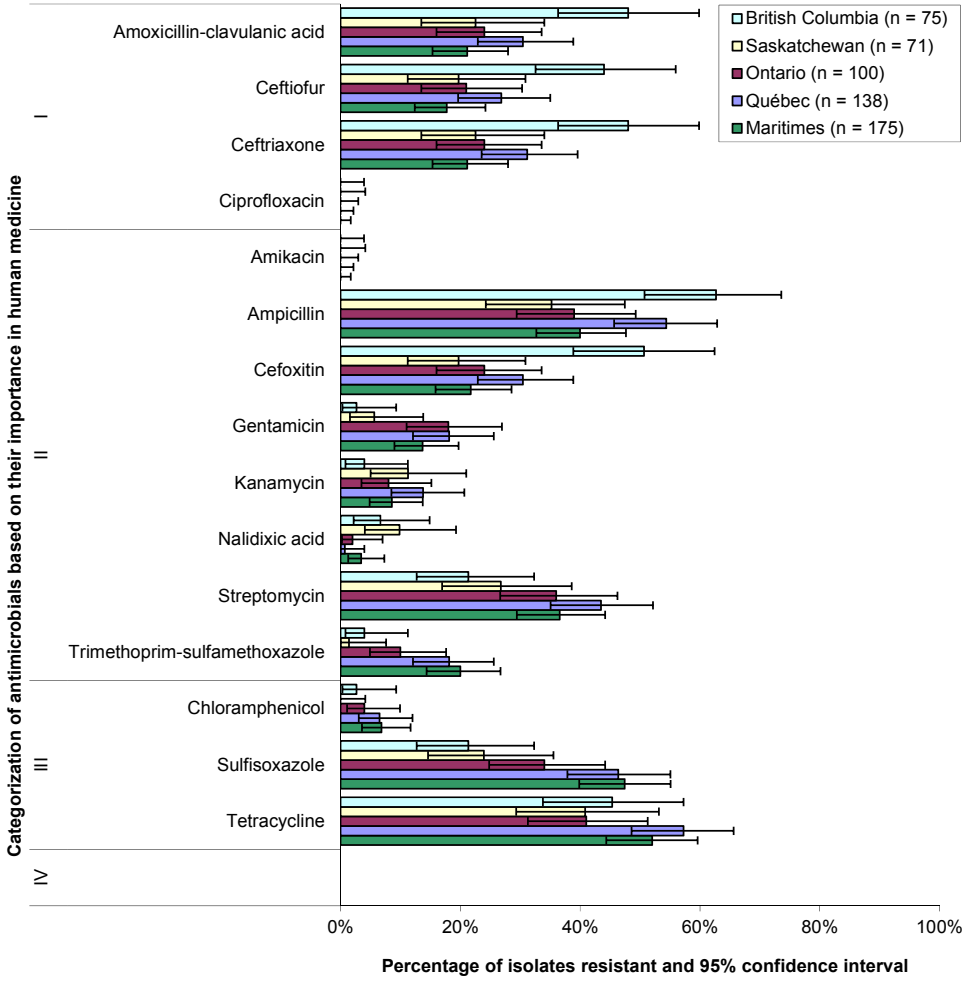
[1] One isolate from the Maritimes could not be tested after freezing, leaving 559 isolates available for antimicrobial susceptibility testing.

significantly higher in 2010 (27%, 37/138) than 2006 (6%, 8/135) in Québec.[1] The percentage of *E. coli* isolates from the Maritimes with ceftiofur resistance was significantly lower in 2010 (18%, 31/175) than in 2009 (27%, 50/185). The percentage of *E. coli* isolates from Québec with ampicillin resistance was significantly higher in 2010 (54%, 75/138) than in 2006 (35%, 47/135).[1] The percentage of *E. coli* isolates from Ontario resistant to gentamicin was significantly higher in 2010 (18%, 18/100) than in 2003 (7%, 9/136) and 2009 (7%, 11/155). The percentage of isolates from Québec with resistance to streptomycin was significantly lower in 2010 (43%, 60/138) than in 2009 (56%, 71/126). The percentage of isolates from British Columbia with resistance to trimethoprim-sulfmethoxazole was significantly lower in 2010 (4%, 3/75) than in 2009 (17%, 7/42). The percentage of isolates from the Maritimes with resistance to tetracycline was significantly higher in 2010 (52%, 91/175) than in 2009 (40%, 74/185).

In 2010, resistance to amoxicillin-clavulanic acid was detected in 48% (36/75) of *Escherichia coli* isolates from British Columbia, 23% (16/71) of isolates from Saskatchewan, 24% (24/100) of isolates from Ontario, 30% (42/138) of isolates from Québec, and 21% (37/175) of isolates from the Maritimes. Resistance to ceftiofur was detected in 44% (33/75) of isolates from British Columbia, 20% (14/71) of isolates from Saskatchewan, 21% (21/100) of isolates from Ontario, 27% (37/138) of isolates from Québec, and 18% (31/175) of isolates from the Maritimes. Resistance to ceftriaxone was detected in 48% (36/75) of isolates from British Columbia, 23% (16/71) of isolates from Saskatchewan, 24% (24/100) of isolates from Ontario, 31% (43/138) of isolates from Québec, and 21% (37/175) of isolates from the Maritimes. Reduced susceptibility to ciprofloxacin was detected in 7% (5/75) of isolates from British Columbia, 10% (7/71) of isolates from Saskatchewan, 2% (2/100) of isolates from Ontario, less than 1% (1/138) of isolates from Québec, and 3% (6/175) of isolates from the Maritimes. The percentage of isolates resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, and ampicillin were significantly higher in British Columbia than in Saskatchewan, Ontario and the Maritimes in 2010. The percentage of isolates resistant to ceftiofur was significantly higher in 2010 (20%, 14/71) than 2005 (4%, 3/81) in Saskatchewan and was significantly higher in 2010 (27%, 37/138) than 2006 (6%, 8/135) in Québec.[1] The percentage of isolates from the Maritimes with ceftiofur resistance was significantly lower in 2010 (18%, 31/175) than in 2009 (27%, 50/185).

[1] For Ontario and Québec only: 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Figure 15. Resistance to antimicrobials in *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2010.



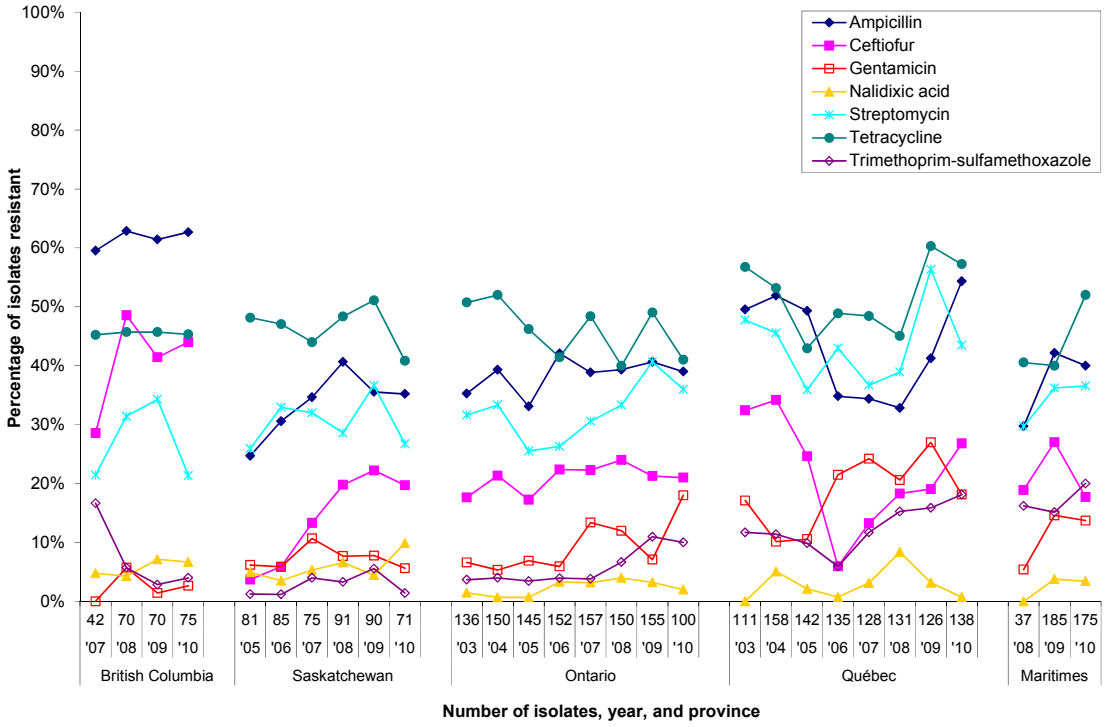
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 15. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia	75 (13.4)	17	25	23	10			2	3	16	47	36	36	38	33	16	3	2		5	34
Saskatchewan	71 (12.7)	20	17	32	2			4	8	19	25	16	16	14	14	17	1			7	29
Ontario	100 (17.9)	29	22	40	9			18	8	36	39	24	24	24	21	34	10	4		2	41
Québec	138 (24.7)	24	25	64	25			25	19	60	75	42	43	42	37	64	25	9		1	79
Maritimes	175 (31.3)	47	29	59	39	1		24	15	64	70	37	37	38	31	83	35	12		6	91

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

Figure 16. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2003–2010.



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

Abattoir Surveillance

(n = 119)

Recovery: *Escherichia coli* isolates were recovered from 99% (119/120) of abattoir chicken caecal samples (Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 17, Table 16, and Table B.15, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone was detected in 38% (46/119), 34% (41/119) and 39% (45/119) of the *E. coli* isolates, respectively. Reduced susceptibility to ciprofloxacin was detected in 4% (5/119). Resistance to nalidixic acid was detected in 4% (5/119) of isolates. None of the isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 16 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 80% (95/119) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 18% (21/119) of the isolates. The most common resistance patterns were A2C-AMP-CRO (9%, 11/119), and TET (7%, 8/119). The patterns involving the greatest number of antimicrobials were ACKSSuT-A2C-CRO-GEN and AKSSuT-A2C-CRO-NAL-SXT.

Temporal Variations: Results are presented in Figure 18. In 2010, the percentage of *E. coli* isolates with resistance to ceftiofur was significantly higher (34%, 41/119) than in 2006 (21%, 35/167) and significantly lower to tetracycline (52%, 62/119) than in 2003 (69%, 106/153).

In 2010, 4% (5/119) of *Escherichia coli* isolates recovered from abattoir collected caecal samples from chickens had reduced susceptibility to ciprofloxacin and resistance to nalidixic acid was detected in 4% (5/119) of isolates. The most common resistance pattern was A2C-AMP-CRO detected in 9% (11/119) of samples. Resistance to ceftiofur was significantly higher in 2010 (34%, 41/119) than in 2006 (21%, 35/167).

Figure 17. Resistance to antimicrobials in *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2010.

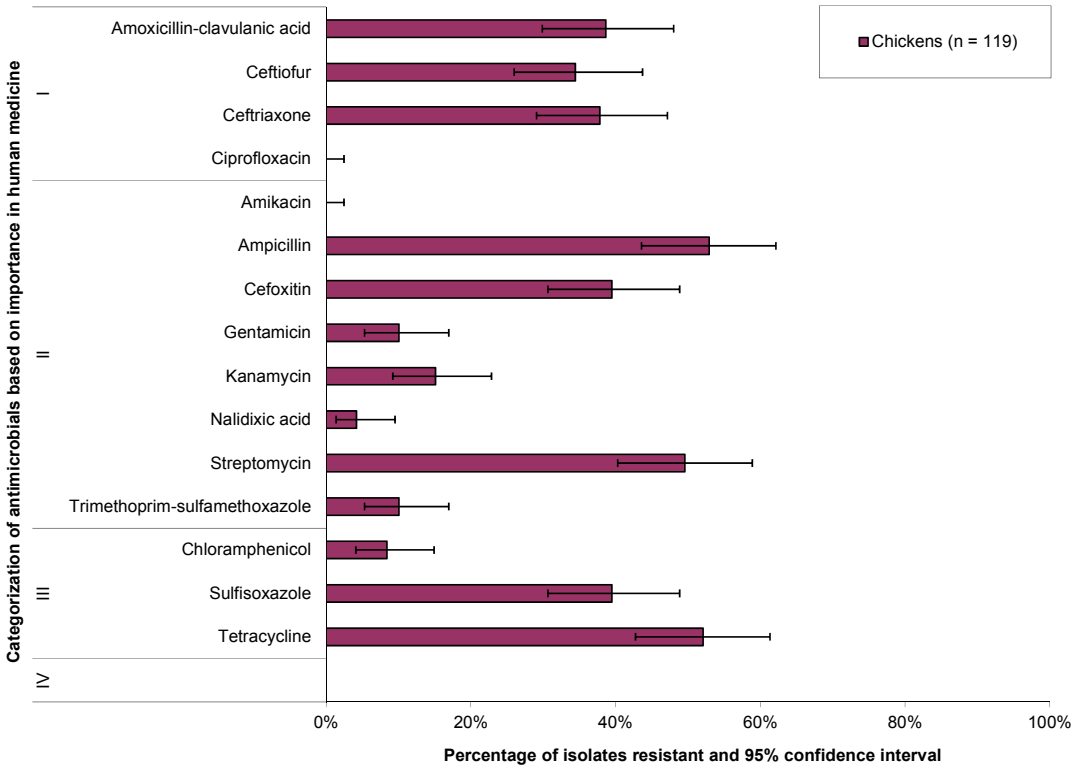
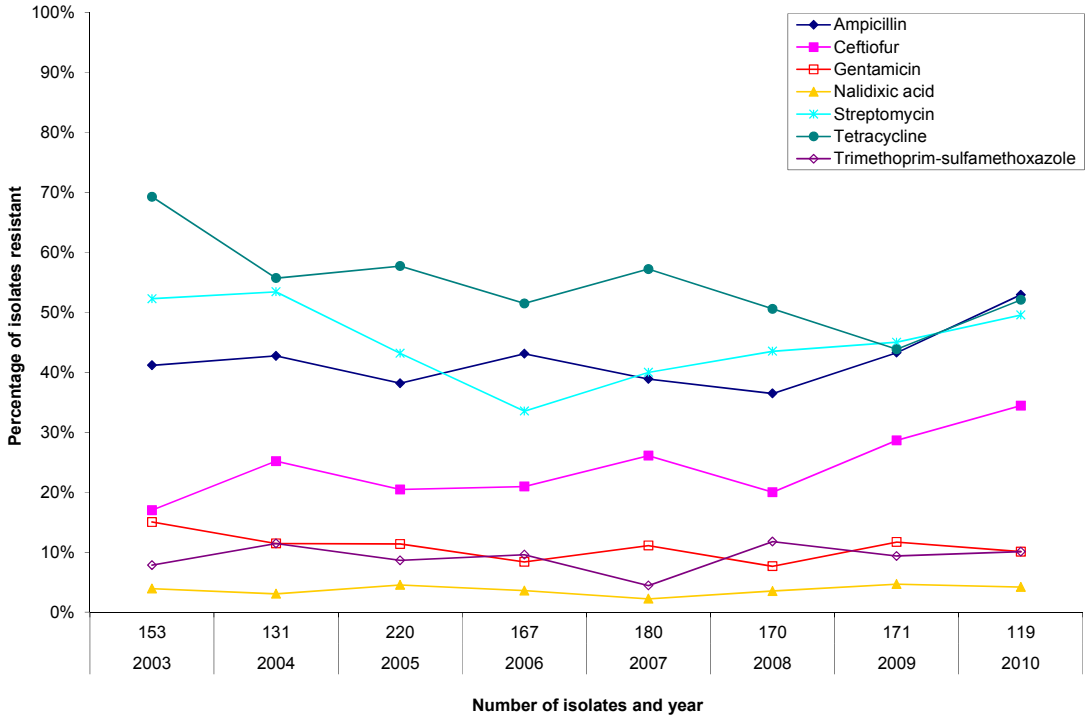


Table 16. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Chickens	119	24	21	53	21			12	18	59	63	46	45	47	41	47	12	10		5	62

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

Figure 18. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2003–2010.



Campylobacter

Retail Meat Surveillance

(n = 301)

(British Columbia [n = 70], Saskatchewan [n = 36], Ontario [n = 64], Québec [n = 63],

Maritimes [n = 68])

Recovery: *Campylobacter* isolates were recovered from 30% (304/1,015) of retail chicken samples.[1] Province/region-specific percentages of chicken samples from which isolates were recovered were as follows: British Columbia, 42% (70/165); Saskatchewan, 28% (37/132); Ontario, 28% (64/232); Québec, 21% (63/296); and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 37% (70/190); Table C.5, Appendix C). Ninety-one percent (275/301) of the isolates were *C. jejuni*, 6% (18/301) were *C. coli*, and 3% (8/301) were *Campylobacter* spp.

Antimicrobial Resistance: Results are presented in Figure 19, Figure 20, Table 17, and Table B.16, Appendix B. Resistance to ciprofloxacin was detected in 17% (12/70) of *Campylobacter* isolates from British Columbia, 11% (4/36) of isolates from Saskatchewan, 5% (3/64) of isolates from Ontario, 2% (1/63) of isolates from Québec and 4% (3/68) of isolates from the Maritimes. Resistance to ciprofloxacin was detected in 17% (3/18) of *C. coli* isolates, in 5% (15/275) of *C. jejuni* isolates and 62% (5/8) of other *Campylobacter* spp. Resistance to telithromycin was detected in 6% (4/64) of isolates from Ontario and 5% (3/63) of isolates from Québec. Resistance to telithromycin was detected in 6% (1/18) of *C. coli* isolates and 2% (6/275) of *C. jejuni* isolates. Resistance to telithromycin was not detected in other *Campylobacter* spp. The percentage of isolates resistant to ciprofloxacin and nalidixic acid were significantly higher in British Columbia than in Québec. The percentage of isolates resistant to ciprofloxacin and nalidixic acid were also significantly higher in *Campylobacter* spp. than in *C. jejuni*. No isolates were resistant to gentamicin or non susceptible to florfenicol.[2]

Antimicrobial Resistance Patterns: Results are presented in Table 17. Resistance to 1 or more antimicrobial classes was detected in 51% (36/70) of *Campylobacter* isolates from British Columbia, 69% (25/36) of isolates from Saskatchewan, 63% (40/64) of isolates from Ontario, 56% (35/63) of isolates from Québec and 46% (31/68) of isolates from the Maritimes. Resistance to 4 or more antimicrobials was detected in 3% (2/64) of *Campylobacter* isolates from Ontario and 2% (1/63) of isolates from Québec. Among the isolates from all 5 provinces/region, the most common resistance patterns were TET (43%, 130/301), CIP-NAL-TET (4%, 12/301), and CIP-NAL (4%, 11/301). The pattern involving the greatest number of antimicrobials was AZM-CLI-ERY-TEL-TET (2 *C. jejuni* isolates from Ontario and 1 *C. jejuni* isolate from Québec).

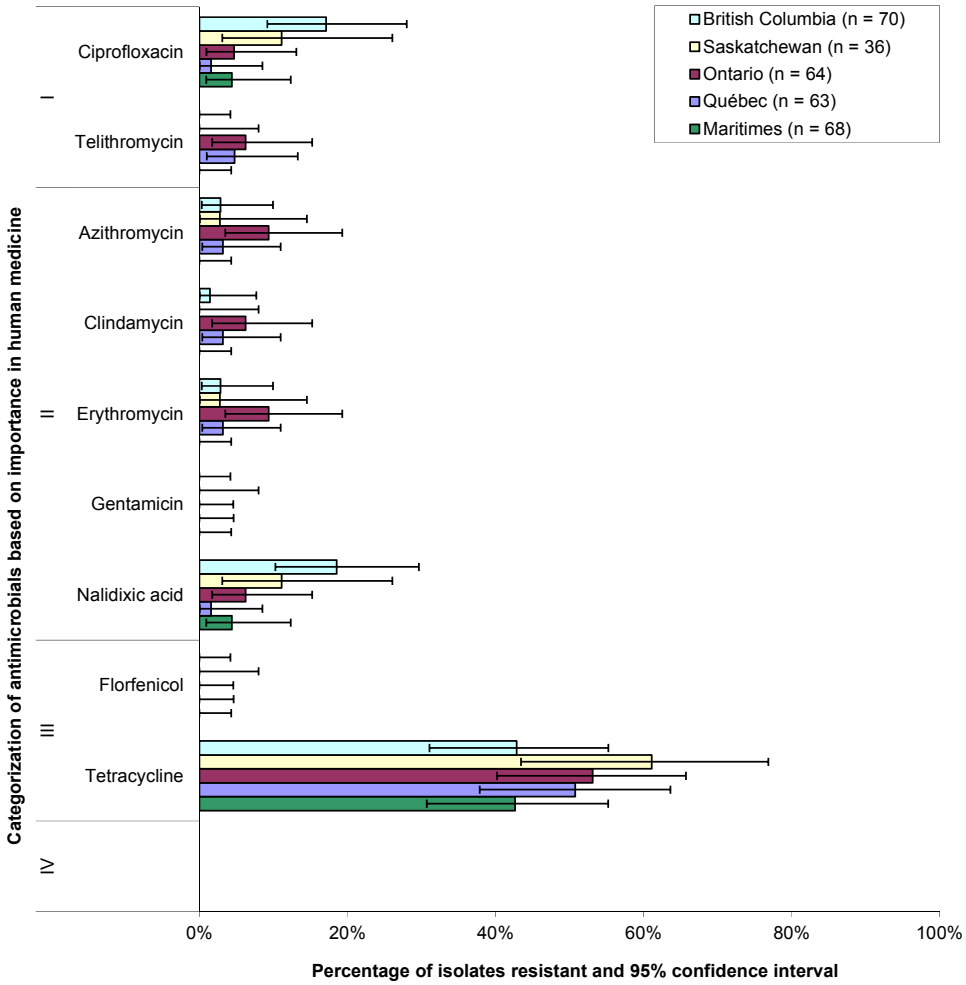
Temporal Variations: Results are presented in Figure 21. The percentage of *Campylobacter* isolates resistant to azithromycin in Québec was significantly lower in 2010 (3%, 2/63) than in 2003 (22%, 21/94). The percentage of isolates from Québec with resistance to tetracycline was significantly lower in 2010 (51%, 32/63) than in 2003 (70%, 66/94).

[1] Two isolates from Maritimes (region) and one isolate from Saskatchewan could not be tested after freezing leaving 301 isolates available for antimicrobial susceptibility testing.

[2] A referenced resistance breakpoint has not been established for this antimicrobial. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression “non-susceptible” was used instead of “resistant” in the text.

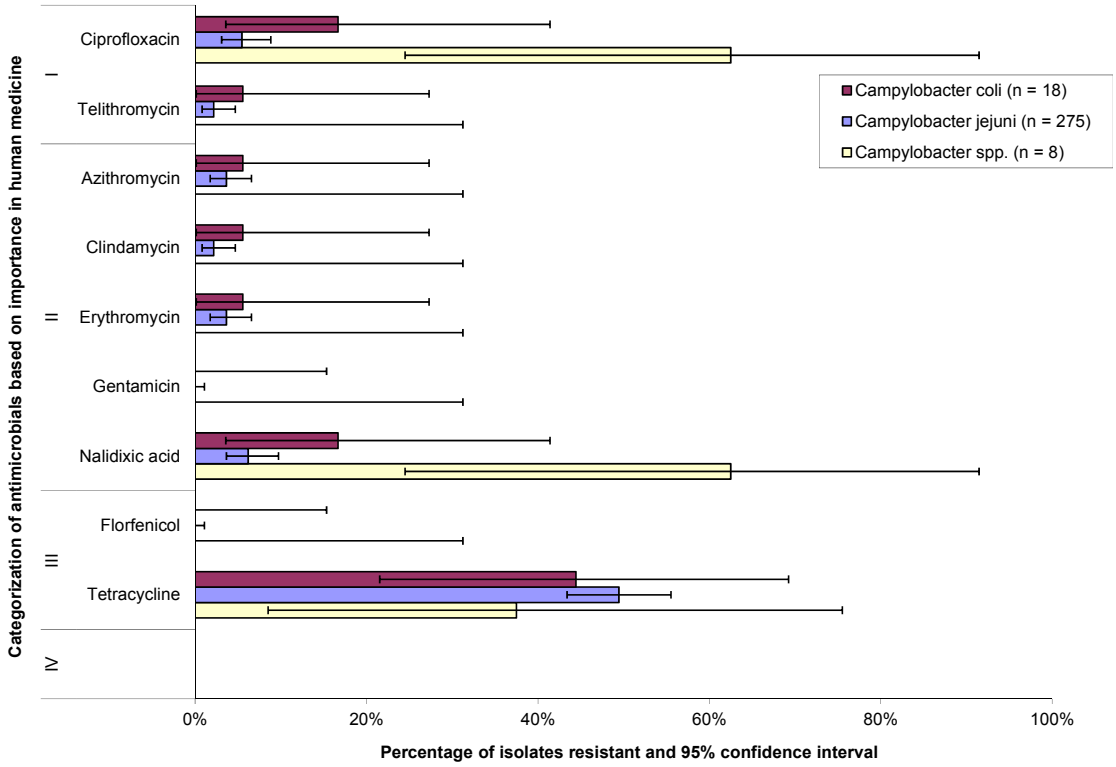
In 2010, resistance to ciprofloxacin was detected in 17% (12/70) of *Campylobacter* isolates from British Columbia, 11% (4/36) of isolates from Saskatchewan, 5% (3/64) of isolates from Ontario, 2% (1/63) of isolates from Québec and 4% (3/68) of isolates from the Maritimes. Telithromycin resistance was detected in 6% (4/64) of isolates from Ontario and 5% (3/63) of isolates from Québec. The percentage of isolates resistant to ciprofloxacin and nalidixic acid were significantly higher in British Columbia than in Québec in 2010. Resistance to 4 or more antimicrobials was detected in 3% (2/64) of *Campylobacter* isolates from Ontario and 2% (1/63) of isolates from Québec. The pattern with the greatest number of antimicrobials was AZM-CLI-ERY-TEL-TET (2 *C. jejuni* isolates from Ontario and 1 *C. jejuni* isolate from Québec).

Figure 19. Resistance to antimicrobials in *Campylobacter* isolates from chicken, by province/region; *Retail Meat Surveillance*, 2010.



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

Figure 20. Resistance to antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2010.



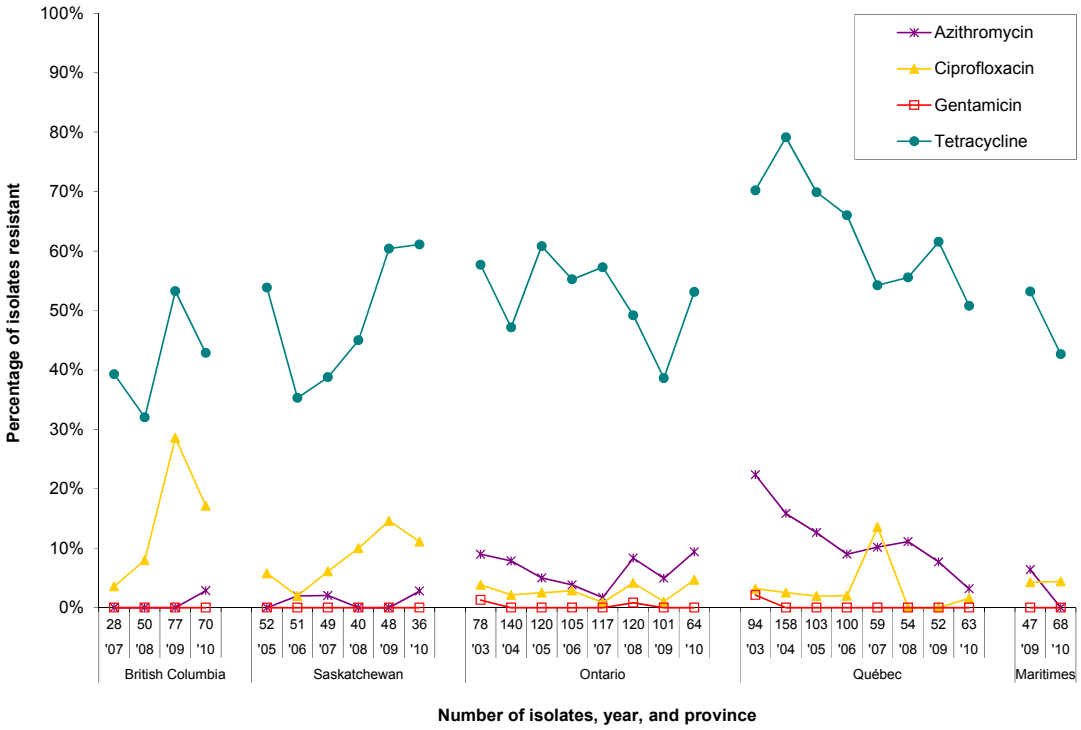
Campylobacter spp. includes unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table 17. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2010.

Province or region / species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial							
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
British Columbia															
Campylobacter jejuni	62 (88.6)	31	23	8					1	2	2		9	10	26
Campylobacter coli	4 (5.7)	2	1	1									1	1	2
Campylobacter spp.	4 (5.7)	1	2	1									2	2	2
Total	**70 (100)**	**34**	**26**	**10**					**1**	**2**	**2**		**12**	**13**	**30**
Saskatchewan															
Campylobacter jejuni	34 (94.4)	11	21	2						1	1		3	3	21
Campylobacter spp.	2 (5.6)		2										1	1	1
Total	**36 (100)**	**11**	**23**	**2**						**1**	**1**		**4**	**4**	**22**
Ontario															
Campylobacter jejuni	58 (90.6)	22	29	5	2			4	4	6	6		2	3	31
Campylobacter coli	6 (9.4)	2	4										1	1	3
Total	**64 (100)**	**24**	**33**	**5**	**2**			**4**	**4**	**6**	**6**		**3**	**4**	**34**
Québec															
Campylobacter jejuni	58 (92.1)	26	31		1			2	1	1	1				31
Campylobacter coli	4 (6.3)	2	1	1				1	1	1	1				1
Campylobacter spp.	1 (1.6)		1										1	1	
Total	**63 (100)**	**28**	**33**	**1**	**1**			**3**	**2**	**2**	**2**		**1**	**1**	**32**
Maritimes															
Campylobacter jejuni	63 (92.6)	35	28										1	1	27
Campylobacter coli	4 (5.9)	2	1	1									1	1	2
Campylobacter spp.	1 (1.5)		1										1	1	
Total	**68 (100)**	**37**	**30**	**1**									**3**	**3**	**29**

Antimicrobial abbreviations are defined in Appendix D.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.
Campylobacter spp. includes unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Figure 21. Temporal variation in resistance to selected antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2003–2010.



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

Abattoir Surveillance

(n = 111)

Recovery: *Campylobacter* isolates were recovered from 19% (111/599) of chicken caecal samples (Table C.5, Appendix C). Eight-nine percent (99/111) of the isolates were *C. jejuni* and 11% (12/111) were *C. coli*.

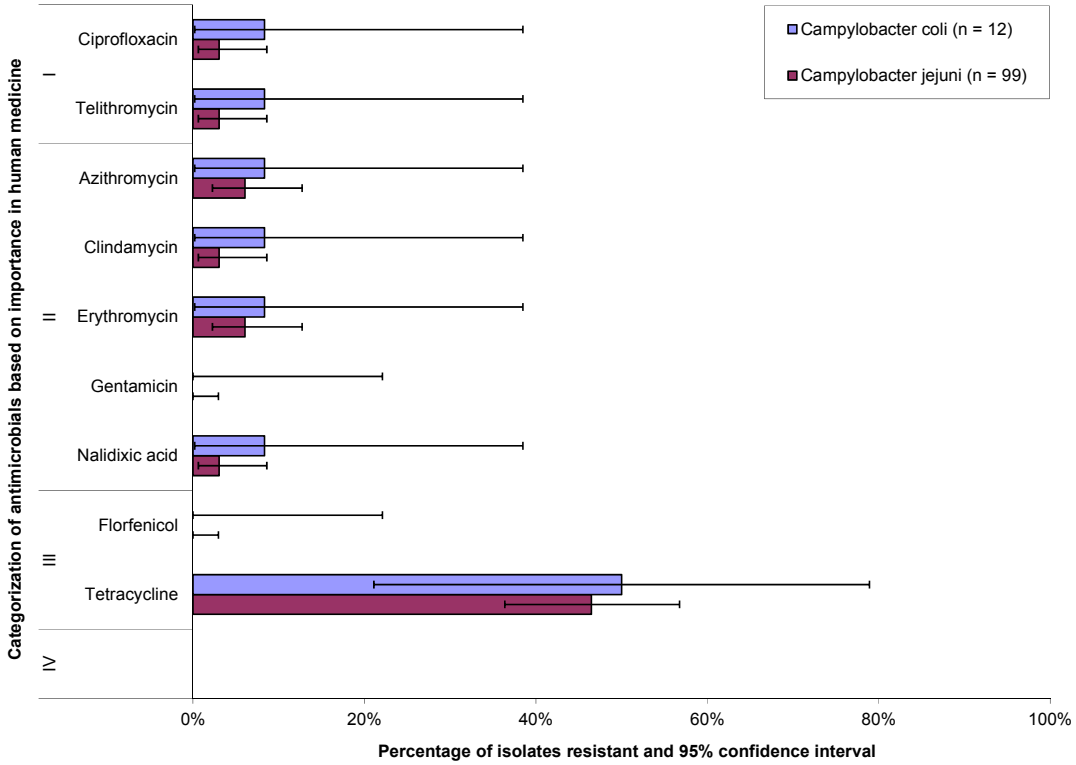
Antimicrobial Resistance: Results are presented in Figure 22, Table 18, and Table B.17, Appendix B. Resistance to each of ciprofloxacin and telithromycin was detected in 3% (1/12) and 3% (3/99) of *C. coli* and *C. jejuni* isolates respectively. None of the isolates were resistant to gentamicin or non-resistant to florfenicol.[1]

Antimicrobial Resistance Patterns: Results are presented in Table 18 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 51% (57/111) of *Campylobacter* isolates. One isolate (1%, 1/111) was resistant to 4 or more antimicrobial classes (*C. coli*). The most common resistance patterns were TET (41%, 46/111), CIP-NAL-TET (3%, 3/111) and AZM-CHL-ERY-TEL (3%, 3/111). The pattern involving the greatest number of antimicrobials was AZM-CLI-ERY-TEL-TET (1 *C. coli*).

[1] A referenced resistance breakpoint has not been established for this antimicrobial. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression “non-susceptible” was used instead of “resistant” in the text.

In 2010, resistance to 1 or more antimicrobial classes was detected in 51% (57/111) of *Campylobacter* isolates recovered from abattoir collected caecal samples from chickens. Resistance to ciprofloxacin was detected in 3% (1/12) and 3% (3/99) of *C. coli* and *C. jejuni* isolates, respectively. Resistance to 4 or more antimicrobial classes was detected in 1% (1/111) of isolates and the pattern with the greatest number of antimicrobials was AZM-CLI-ERY-TEL-TET (1%, 1/111).

Figure 22. Resistance to antimicrobials in *Campylobacter* isolates from chicken; *Abattoir Surveillance*, 2010.



No *Campylobacter* spp. isolates were recovered in 2010.

Table 18. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from chickens; *Abattoir Surveillance*, 2010.

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial							
							Aminoglycosides	Ketolides	Lincosamides	Macrolides		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6–7	GEN	TEL	CLI	AZM	ERY	FLR	CIP	NAL	TET
Campylobacter jejuni	99 (89.2)	49	42	8				3	3	6	6		3	3	46
Campylobacter coli	12 (10.8)	5	6		1			1	1	1	1		1	1	6
Total	**111 (100)**	**54**	**48**	**8**	**1**			**4**	**4**	**7**	**7**		**4**	**4**	**52**

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

Pigs

Salmonella

Abattoir Surveillance

(n = 182)

Recovery: *Salmonella* isolates were recovered from 44% (182/410) of pig caecal samples (Table C.5, Appendix C).

Serovars: Results are presented in Table 19 and Table C.3, Appendix C.The most common *Salmonella* serovars were Derby (20%, 36/182), Infantis (12%, 22/182), and Typhimurium var. 5- (12%, 21/182). These 3 serovars accounted for 43% (79/182) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 23, Table 19, and Table B.18, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone was each detected in 3% (6/182) of *Salmonella*. None of the isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid. Additionally, none of the isolates had reduced susceptibility to ciprofloxacin.

Antimicrobial Resistance Patterns: Results are presented in Table 19 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 54% (99/182) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 16% (30/182) of the isolates (13 *S*. Typhimurium var. 5-, 10 *S*. Typhimurium, 2 *S*. Infantis, 1 *S*. I 4,[5],12:i:-, 1 *S.* Bovismorbificans, 1 *S*. Give, 1 *S*. Mbandaka and 1 *S*. Schwarzengrund, isolates). The most common resistance patterns were STR-SSS-TET (13%, 23/182), ACSSuT (8%, 14/182), and TET (7%, 12/182). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO (1 *S*. Schwarzengrund isolate).

Temporal Variations: Results are presented in Figure 24. Percentages of *Salmonella* isolates with resistance to ceftiofur were significantly higher in 2010 (3%, 6/182) than 2009 (0%, 0/147) and 2003 (less than 1%, 1/391). Resistance to trimethoprim-sulfamethoxazole was significantly higher in 2010 (6%, 11/182) than 2003 (2%, 9/391).

In 2010, 3% (6/182) of *Salmonella* isolates recovered from abattoir caecal samples from pigs were resistant to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone and the pattern with the greatest number of antimicrobials was ACSSuT-A2C-CRO in 1 *S*. Schwarzengrund isolate. Resistance to ceftiofur was significantly higher in 2010 (3%, 6/182) than 2009 (0%, 0/147) and 2003 (less than 1%, 9/391). Resistance trimethoprim-sulfamethoxazole was significantly higher in 2010 (6%, 11/182) than 2003 (2%, 9/391).

Figure 23. Resistance to antimicrobials in *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2010.

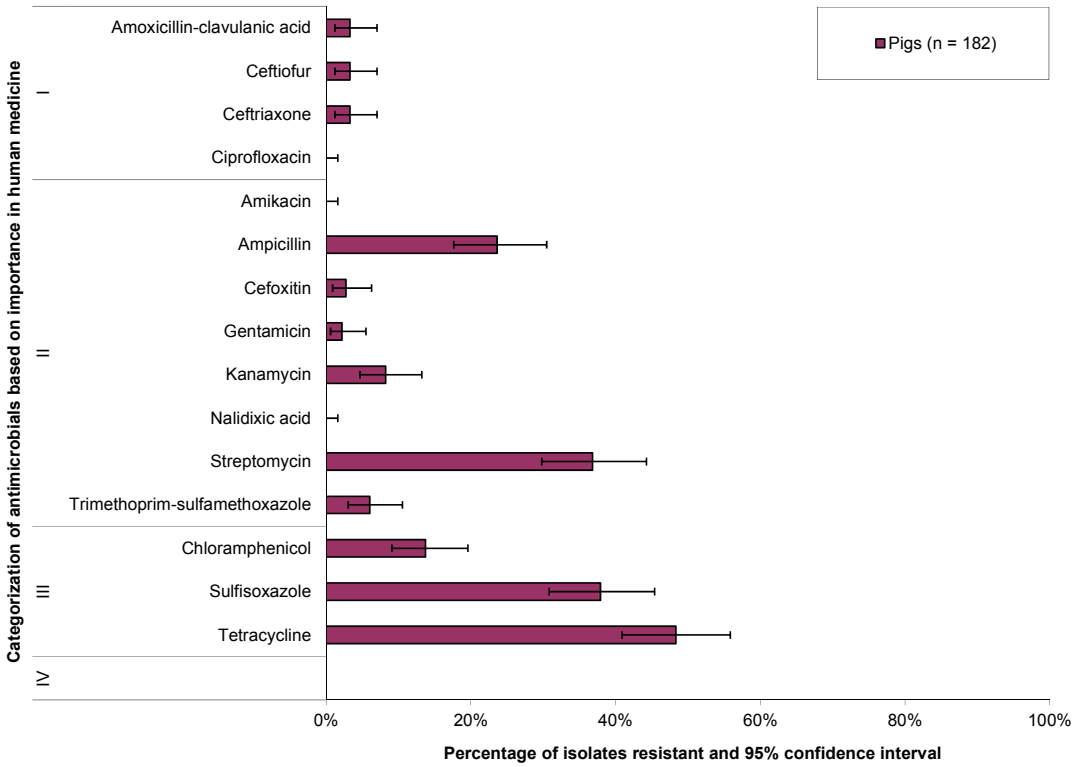
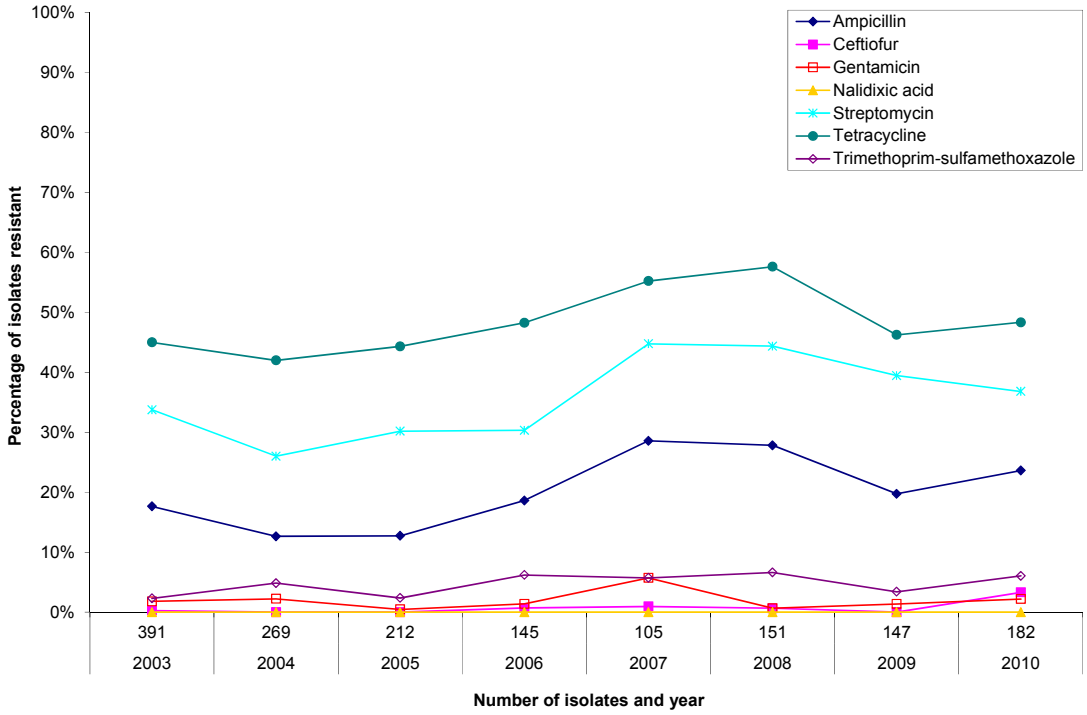


Table 19. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Derby	36 (19.8)	7	6	23					1	22	1					25	4				25
Infantis	22 (12.1)	16	4		2				2	1	5	3	3	3	3	2	2				2
Typhimurium var. 5-	21 (11.5)	1	1	6	13				5	16	15	2	1	1	1	18	4	12			19
Typhimurium	16 (8.8)	2	1	3	10					11	12					11		9			13
Brandenburg	15 (8.2)	11	1	3					1	1	1							1			4
Worthington	13 (7.1)	7	6																		6
Schwarzengrund	11 (6.0)	7		3	1					4	1	1	1	1	1	4		1			4
Mbandaka	6 (3.3)	2		3	1			3	3	4	1					4					4
Agona	5 (2.7)	4		1												1					1
Give	4 (2.2)	3			1				1	1						1		1			1
Ohio	4 (2.2)	3		1				1	1		1										1
Less common serovars	29 (15.9)	20	1	6	2				1	7	6		1		1	3	1	1			8
Total	**182 (100)**	**83**	**20**	**49**	**30**		**4**		**15**	**67**	**43**	**6**	**6**	**5**	**6**	**69**	**11**	**25**			**88**

Antimicrobial abbreviations are defined in Appendix D.
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."

Figure 24. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2003–2010.



Farm Surveillance[1]

(n = 101)

Recovery: *Salmonella* isolates were recovered from 18% (101/569) of pig fecal samples (Table C.5, Appendix C).

Serovars: Results are presented in Table 20 and Table C.3, Appendix C. The most common *Salmonella* serovars were Typhimurium var. 5- (31%, 31/101), Derby (19%,19/101) and Infantis (14%,14/101). These 3 serovars accounted for 63% (64/101) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 25, Table 20, and Table B.19, Appendix B. Two percent (2/101) of the *Salmonella* isolates were resistant to amoxicillin-clavulanic acid (1 *S*. Ohio, 1 *S*. Typhimurium var. 5-), ceftiofur (1 *S*. Ohio, 1 *S*. Typhimurium var. 5-), or ceftriaxone (1 *S*. Ohio, 1 *S*. Typhimurium var. 5-). None of the *Salmonella* isolates were resistant to, amikacin,gentamicin, or nalidixic acid. Additionally, none of the isolates had reduced susceptibility to ciprofloxacin.

Antimicrobial Resistance Patterns: Results are presented in Table 20 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 68% (69/101) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 29% (29/101) of the isolates (23 *S*. Typhimurium var. 5-, 3 *S*. Typhimurium, 2 *S*.Ohio and1 *S*. I 4,[5],12:i:-). The most common resistance patterns were TET (14%, 14/101), ACSSuT (12%, 12/101), and ACKSSuT (11%, 11/101). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO (1 *S*. Ohio).

[1] The percentages provided in the text and in the figures and tables were adjusted to account for clustering within herds, whereas proportions represent unadjusted values (see Appendix A).

Temporal Variations: Results are presented in Figure 26. The percentage of *Salmonella* isolates with resistance to STR or TET or SXT was significantly lower in 2010 [STR 32% (45/101), TET 47% (55/101), SXT 4% (3/101)] than in 2009 [(STR 48% (55/124), TET 66% (84/124), SXT 12% (15/124)]. No other significant temporal variations were detected in the percentages of *Salmonella* isolates with resistance to the selected antimicrobials between 2010 and 2009 or between 2010 and 2006.

In 2010, 2% of *Salmonella* isolates recovered from on farm pig fecal samples were resistant to at least one Category I antimicrobial. There was a significant decrease in resistance detected to STR, TET and SXT between 2010 [STR 32% (45/101), TET 47% (55/101), SXT 4% (3/101)] and 2009 [STR 48% (55/124), TET 66% (84/124), SXT 12% (15/124)].

Figure 25. Resistance to antimicrobials in *Salmonella* isolates from pigs; *Farm Surveillance*, 2010.

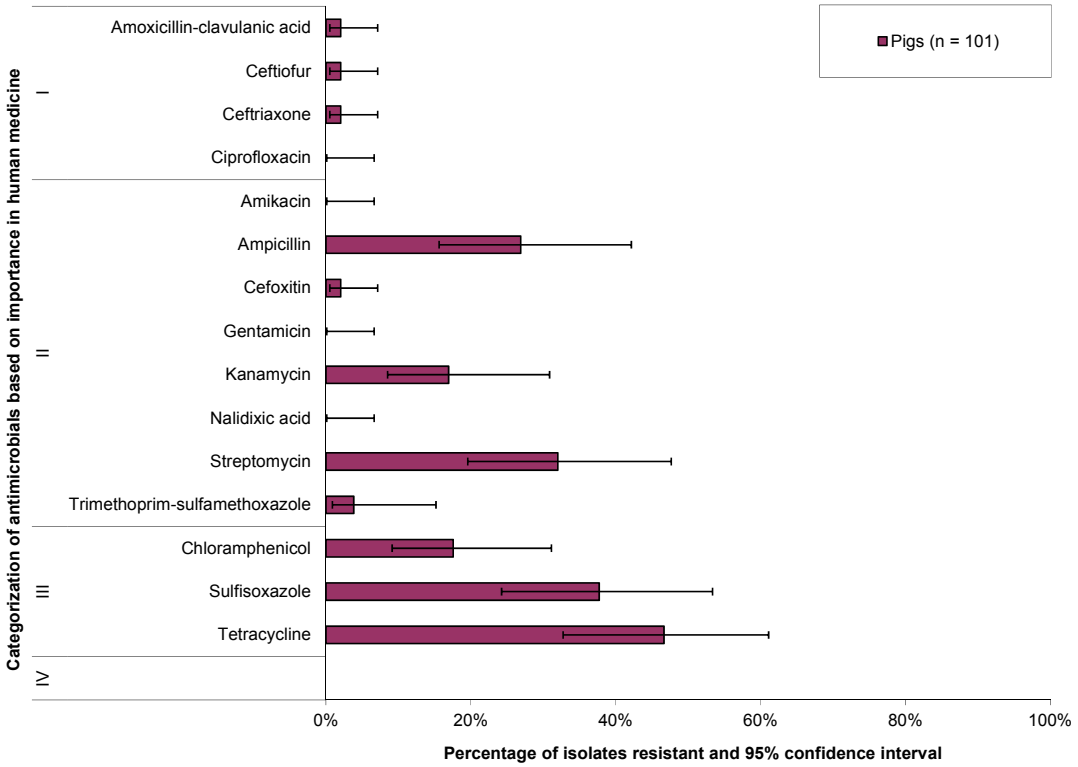
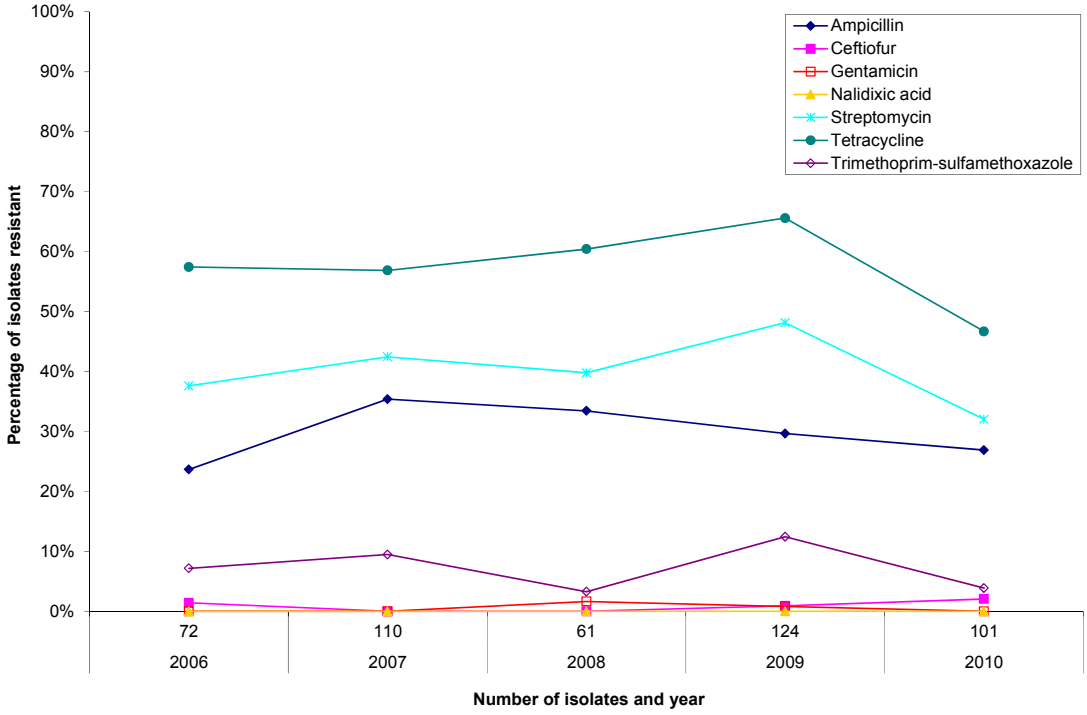


Table 20. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Farm Surveillance*, 2010.

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		Phenicols	Quinolones	Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Typhimurium var. 5-	31 (30.7)	2	1	5	23				12	22	27	1	1	1	1	24	2	20			26
Derby	19 (18.8)	1	3	15					3	15						15					8
Infantis	14 (13.9)	11	3																		3
Brandenburg	11 (10.9)	6	5																		5
I 4,[5],12:i:-	6 (5.9)	1	3	1	1					2	1					1					5
Typhimurium	4 (4.0)			1	3				3	3	3					4	1	4			3
Bovismorbificans	2 (2.0)	2																			
Manhattan	2 (2.0)	2																			
Mbandaka	2 (2.0)	1		1						1						1					1
Ohio	2 (2.0)				2				1	2	1	1	1	1	1	2		2			2
Less common serovars	8 (7.9)	6		2												2					2
Total	**101 (100)**	**32**	**15**	**25**	**29**				**19**	**45**	**32**	**2**	**2**	**2**	**2**	**49**	**3**	**26**			**55**

Antimicrobial abbreviations are defined in Appendix D.
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."

Figure 26. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from pigs; *Farm Surveillance*, 2006–2010.



Surveillance of Animal Clinical Isolates[1]

(n = 235)

Note: Pig isolates may also have originated from animal feed, the animal's environment, or non-diseased animals from the same herd.

Serovars: Results are presented in Table 21 and Table C.3, Appendix C. The most common *Salmonella* serovars in pig clinical isolates were Typhimurium (32%, 75/235), Derby (16%, 38/235), and Typhimurium var. 5- (12%, 28/235). These 3 isolates accounted for 60% (141/235) of *Salmonella* isolates.

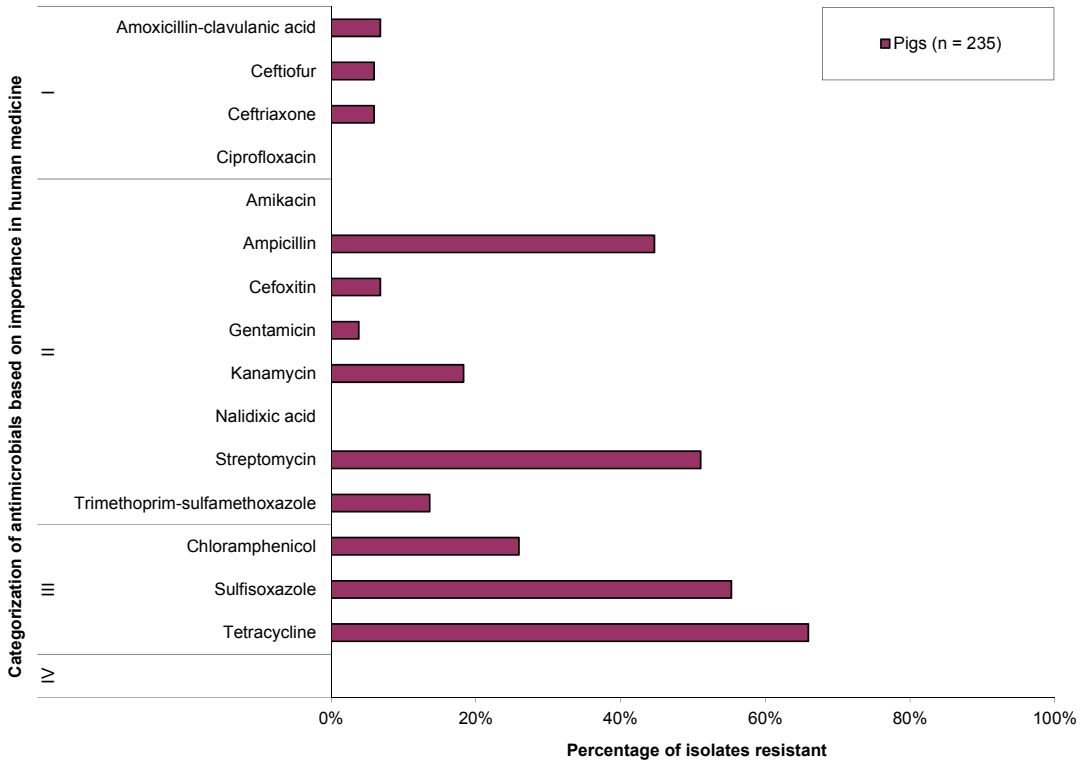
Antimicrobial Resistance: Results are presented in Figure 27, Table 21, and Table B.20, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 7% (16/235) of *Salmonella* isolates. Resistance to ceftiofur and ceftriaxone was detected in 6% (14/235) of isolates. Less than 1% (1/235) of isolates had reduced susceptibility to ciprofloxacin. None of the isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid.

Antimicrobial Resistance Patterns: Results are presented in Table 21 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 74% (173/235) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 35% (82/235) of the isolates (40 *S*. Typhimurium, 17 *S*. Typhimurium var. 5-, 12 *S*. I 4,[5],12:i:-, 3 *S*. I 6,8:r:-, 2 *S*. Derby, 1 *S*. Brandenburg, 1 *S*. Mbandaka, 1 *S*. Agona, 1 *S*. Schwarzengrund, 1 *S*. Johannesburg, 1 *S*. I 6, 7:-:1,w, 1 *S*. Krefeld, and 1 *S*. Newport). The most common resistance patterns were ACSSuT (10%, 23/235), STR-SSS-TET (9%, 21/235), TET (6%, 15/235), ACKSSuT (6%, 14/235), and AMP-STR-SSS-TET (5%, 12/235). Less than 1% (1/235) of isolates had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid. The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO-SXT (1 *S*. Typhimurium isolate).

For 2010, resistance to ceftiofur and ceftriaxone (6%, 14/235) was detected in clinical *Salmonella* isolates from pigs. Less than 1% (1/235) of isolates had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid. The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO-SXT (1 *S*. Typhimurium).

[1] The distribution of *Salmonella* isolates across provinces is presented in Table C.6, Appendix C.

Figure 27. Resistance to antimicrobials in *Salmonella* isolates from pigs; *Surveillance of Animal Clinical Isolates*, 2010.



Confidence intervals are not displayed for animal clinical data because samples were not obtained randomly and may not represent independent observations and true estimates of the prevalence.

Table 21. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs, by serovar; *Surveillance of Animal Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Typhimurium	75 (31.9)	7	8	20	40			2	20	45	55	5	4	4	4	54	27	31			66
Derby	38 (16.2)	12	4	20	2				1	22	2	1	1	2	1	22	1				25
Typhimurium var. 5-	28 (11.9)	2	4	5	17			3	4	21	18	2	1	1	1	21	2	17			21
I 4,[5],12:i:-	15 (6.4)	3			12			1	5	12	12					12	2	5			12
Infantis	15 (6.4)	10	2	3					2	1	3	2	2	3	2	1		1			2
Brandenburg	8 (3.4)	5		2	1				2		1					1		1			3
Mbandaka	8 (3.4)	3		4	1			2	3	1	1					3					5
Agona	6 (2.6)	2	1	2	1				1	1	2	2	2	2	2	3		1			3
Less common serovars	42 (17.9)	18	8	8	8			1	5	17	11	4	4	4	4	13		5			18
Total	**235 (100)**	**62**	**27**	**64**	**82**			**9**	**43**	**120**	**105**	**16**	**14**	**16**	**14**	**130**	**32**	**61**			**155**

Antimicrobial abbreviations are defined in Appendix D.
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."

Escherichia coli

Retail Meat Surveillance

(n = 250)

(British Columbia [n = 31], Saskatchewan [n = 17], Ontario [n = 84], Québec [n = 47],

Maritimes [n = 71])

Recovery: *Escherichia coli* isolates were recovered from 25% (253/1,018) of retail pork samples.[1] Province-specific percentages of pork samples from which isolates were recovered were as follows: British Columbia, 19% (31/166); Saskatchewan, 12% (17/142); Ontario, 38% (84/224); Québec, 16% (47/296); and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 39% (74/190; Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 28, Table 22, and Table B.21, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 13% (4/31) of *E. coli* isolates from British Columbia, 2% (2/84) of isolates from Ontario, 6% (3/47) of isolates from Québec and 4% (3/71) isolates from the Maritimes. Resistance to ceftiofur was detected in 13% (4/31) of *E. coli* isolates from British Columbia, 2% (2/84) of isolates from Ontario, 4% (2/47) of isolates from Québec and 3% (2/71) isolates from the Maritimes. Resistance to ceftriaxone was detected in 13% (4/31) of *E. coli* isolates from British Columbia, 2% (2/84) of isolates from Ontario, 6% (3/47) of isolates from Québec and 3% (2/71) isolates from the Maritimes. Resistance to ceftiofur, ceftriaxone and amoxicillin-clavulanic acid was not detected in any isolates from Saskatchewan. Resistance for ciprofloxacin or amikacin was not detected in any isolates from any province/region. Reduced susceptibility to ciprofloxacin was detected in 3% (1/31) of isolates from British Columbia and in 1% (1/84) of isolates from Ontario. Resistance to nalidixic acid was detected in 3% (1/31) of *E. coli* isolates from British Columbia, 1% (1/84) of isolates from Ontario and 1% (1/71) of isolates from the Maritimes. The percentage of isolates resistant to tetracycline was significantly higher in the Maritimes than in Ontario. There were no significant differences across provinces/region for all the other antimicrobials.

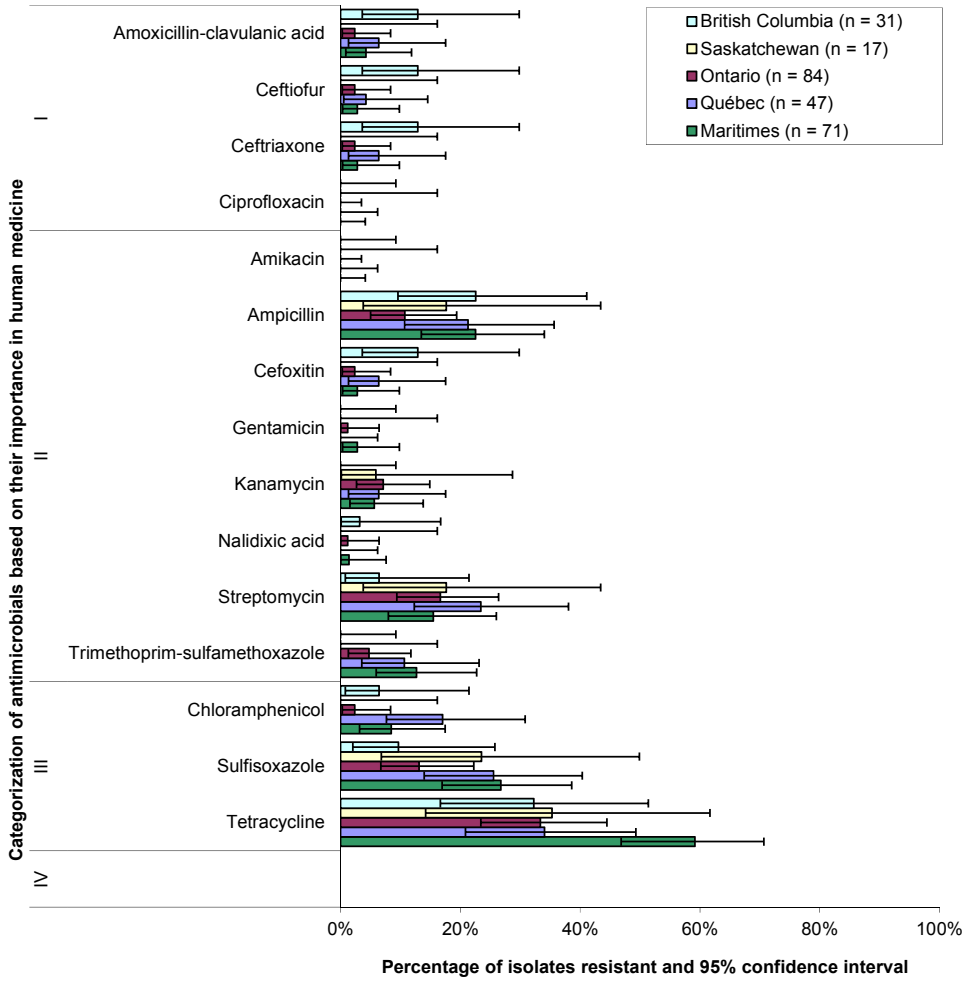
Antimicrobial Resistance Patterns: Results are presented in Table 22 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 39% (12/31) of *E. coli* isolates from British Columbia, 41% (7/17) of isolates from Saskatchewan, 36% (30/84) of isolates from Ontario, 45% (21/47) of isolates from Québec and in 68% (48/71) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 4% (2/31) of isolates from British Columbia, 6% (1/17) of isolates from Saskatchewan, 8% (7/84) of isolates from Ontario, 13% (6/47) of isolates from Québec and in 10% (7/71) of isolates from the Maritimes. Among the isolates from all 5 provinces/region, the most common resistance patterns were TET (12%, 31/250), STR-TET (4%, 9/250) and AMP-TET (3%, 8/250). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-GEN (1 isolate from Ontario).

Temporal Variations: Results are presented in Figure 29. The percentage of isolates from Ontario with resistance to tetracycline was significantly lower in 2010 (33%, 28/84) than in 2003 (54%, 49/90).

[1] Three isolates from the Maritimes region could not be tested after freezing leaving 250 isolates available for antimicrobial susceptibility testing.

In 2010, resistance to amoxicillin-clavulanic acid was detected in 13% (4/31) of *Escherichia coli* isolates from British Columbia, 2% (2/84) of isolates from Ontario, 6% (3/47) of isolates from Québec and 4% (3/71) isolates from the Maritimes. Ceftiofur resistance was detected in 13% (4/31) of isolates from British Columbia, 2% (2/84) of isolates from Ontario, 4% (2/47) of isolates from Québec and 3% (2/71) isolates from the Maritimes. Resistance to ceftriaxone was detected in 13% (4/31) of isolates from British Columbia, 2% (2/84) of isolates from Ontario, 6% (3/47) of isolates from Québec and 3% (2/71) isolates from the Maritimes. Reduced susceptibility to ciprofloxacin was detected in 3% (1/31) of isolates from British Columbia and in 1% (1/84) of isolates from Ontario. Tetracycline resistance was significantly higher in the Maritimes than in Ontario in 2010. The percentage of isolates from Ontario with resistance to tetracycline was significantly lower in 2010 (33%, 28/84) than in 2003 (54%, 49/90). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-GEN observed in 1 isolate from Ontario.

Figure 28. Resistance to antimicrobials in *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2010.



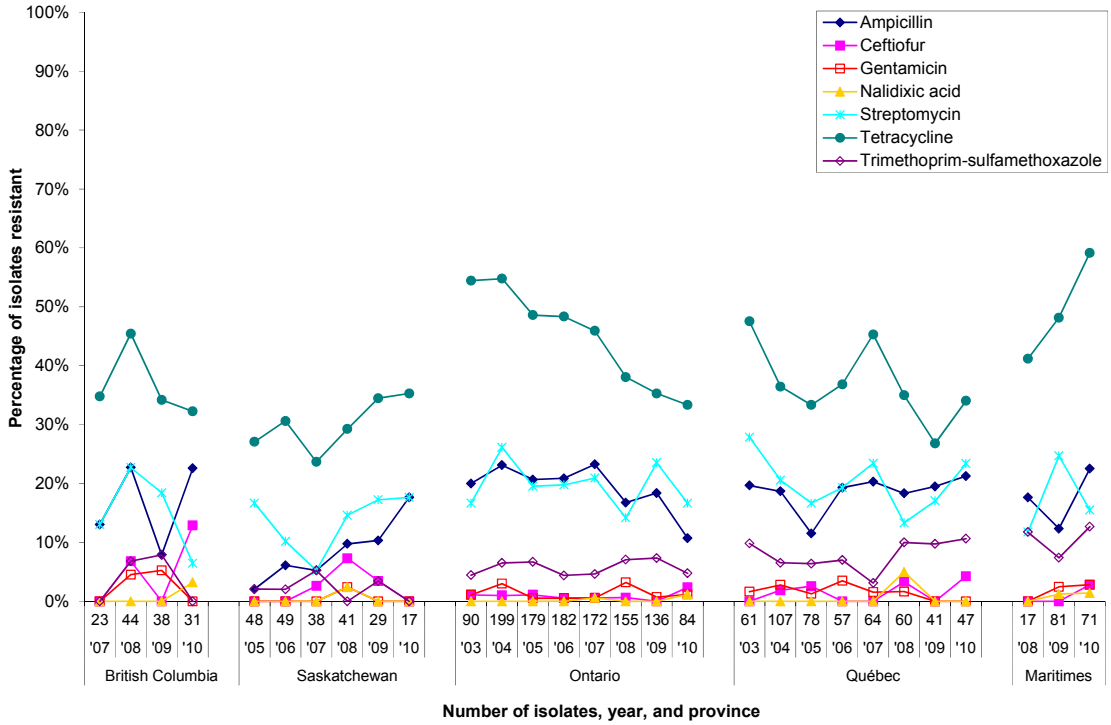
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 22. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia	31 (12.4)	19	5	5	2					2	7	4	4	4	4	3		2		1	10
Saskatchewan	17 (6.8)	10	3	3	1				1	3	3					4					6
Ontario	84 (33.6)	54	13	10	7		1		6	14	9	2	2	2	2	11	4	2		1	28
Québec	47 (18.8)	26	3	12	6				3	11	10	3	3	3	2	12	5	8			16
Maritimes	71 (28.4)	23	19	22	7			2	4	11	16	3	2	2	2	19	9	6		1	42

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

Figure 29. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2003–2010.



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

Abattoir Surveillance

(n = 199)

Recovery: *Escherichia coli* isolates were recovered from 99% (199/203) of pig caecal samples (Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 30, Table 23, and Table B.22, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone was each detected in 2% (4/199) of *E. coli* isolates. None of the isolates were resistant to ciprofloxacin, amikacin, gentamicin, or nalidixic acid, or had reduced susceptibility to ciprofloxacin.

Antimicrobial Resistance Patterns: Results are presented in Table 23 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 83% (165/199) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 21% (41/199) of the isolates. The most common resistance patterns were TET (10%, 20/199) and AMP-TET (5%, 10/199). The patterns involving the greatest number of antimicrobials were AKSSuT-A2C-CRO and A2C-AMP-CRO-STR-SSS-TET-SXT (1 isolate each).

Temporal Variations: Results are presented in Figure 31. In 2010, the percentage of isolates detected as resistant to streptomycin (36%, 71/199) were significantly lower than 2009 (47%, 75/160) and significantly lower to tetracycline (72%, 143/199) than 2003 (82%, 125/153).

In 2010, resistance to amoxicillin-clavulanic acid, ceftiofur and ceftriaxone was each detected in 2% (4/199) of *Escherichia coli* isolates recovered from abattoir collected caecal samples from pigs. Resistance to 1 or more antimicrobial classes was detected in 83% (165/199) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 21% (41/199) of isolates. The patterns involving the greatest number of antimicrobials were AKSSuT-A2C-CRO and A2C-AMP-CRO-STR-SSS-TET-SXT (1 isolate each). There were significant decreases in the percentage of *E. coli* isolates resistant to streptomycin between 2010 (36%, 71/199) and 2009 (47%, 75/160) and resistant to tetracycline between 2010 (72%, 143/199) and 2003 (82%, 125/153).

Figure 30. Resistance to antimicrobials in *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2010.

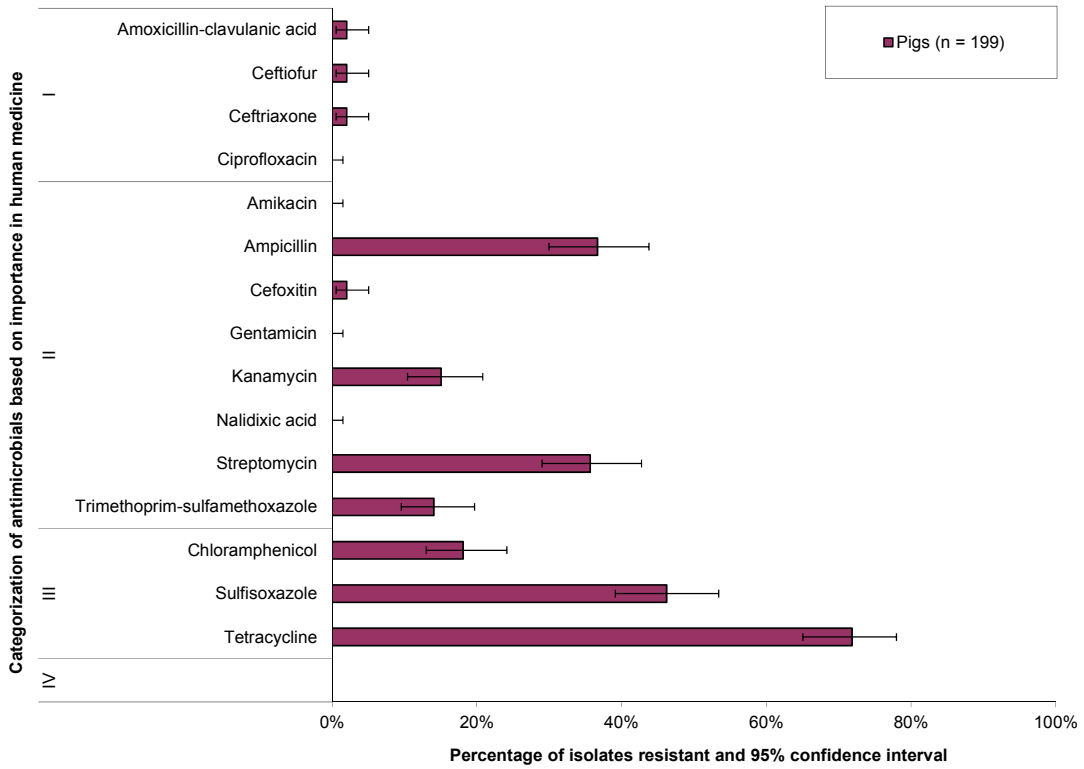
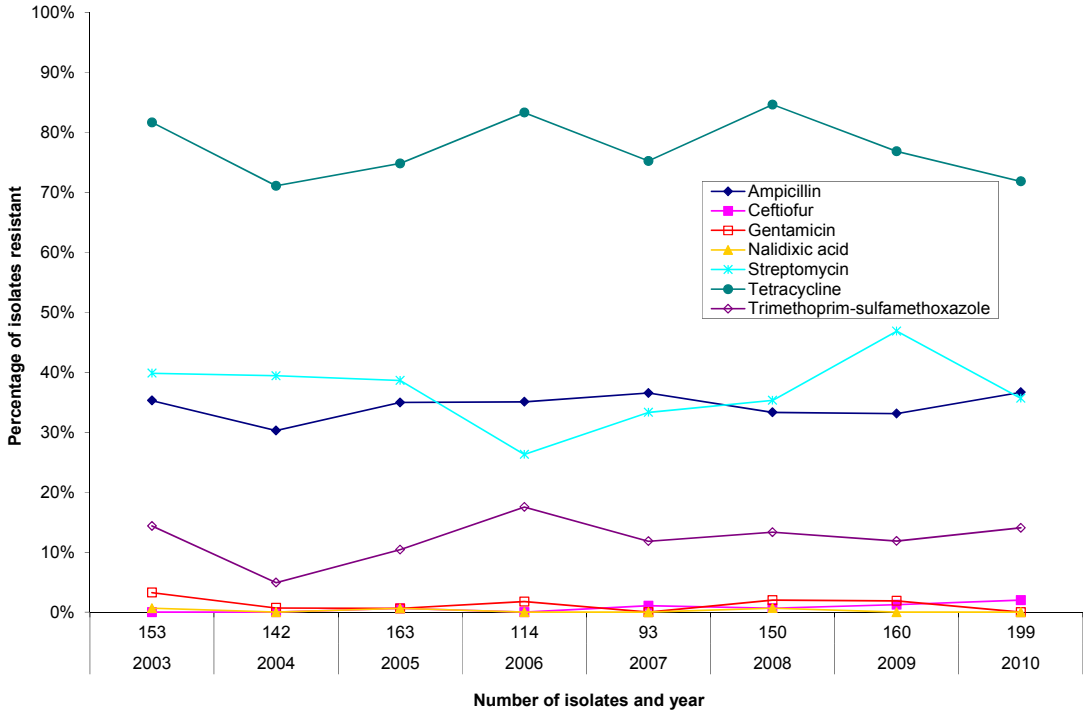


Table 23. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Pigs	199	34	36	88	41				30	71	73	4	4	4	4	92	28	36			143

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

Figure 31. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2003–2010.



Farm Surveillance[1]

(n = 1,673)

Recovery: *Escherichia coli* isolates were recovered from 99% (566/569) of fecal samples from pigs (Table C.5, Appendix C). Up to 3 isolates per positive sample were kept for analysis[2].

Antimicrobial Resistance: Results are presented in Figure 32 and Table B.23, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in less than 1% (10/1,673) of *E. coli* isolates. Resistance to ceftiofur and resistance to ceftriaxone were detected in less than 1% (8/1,673) and 1% (9/1,673) of isolates, respectively. Less than 1% (10/1,673) of isolates were resistant to nalidixic acid. None of the isolates were resistant to, ciprofloxacin, or amikacin. Reduced susceptibility to ciprofloxacin was detected in less than 1% (7/1,673) of isolates.

Antimicrobial Resistance Patterns: Results are presented in Table 24 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 84% (1,402/1,673) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 18% (299/1,673) of the isolates. The most common resistance patterns were TET (15%, 246/1,673), CHL-SSS-TET (5%, 92/1673), AMP-TET (5%, 83/1,673), and SSS-TET (5%, 83/1,673). Reduced susceptibility to CIP and resistance to NAL was

[1] The percentages provided in the text and in the figures and tables were adjusted to account for clustering within herds, whereas proportions represent unadjusted values (see Appendix A).

[2] Up to 3 generic *E. coli* isolates per positive sample were kept for analysis. The expected number of total isolates was 1,698 (566 x 3) but only 1,673 isolates were collected for antimicrobials susceptibility testing leaving a difference of 25 isolates. The difference resulted from 5 samples with only 1 isolate cultured (10 isolates not cultured) and 15 samples with only 2 isolates cultured (15 isolates not cultured). 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.

detected in 4% (6/1,673) of the isolates. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (less than 1%, 1/1,673).

Temporal Variations: Results are presented in Figure 33 The percentage of *E. coli* isolates with resistance to NAL was significantly higher in 2010 (0.6%, 10/1,673) than in 2009 (0.2%, 4/2,057). The percentage of isolates with resistance to NAL was also significantly higher in 2010 (0.6% (10/1,673) than in 2006 (0.2% (3/1,721). The percentage of isolates with resistance to AMP was significantly lower in 2010 (30%, 503/1,673) than in 2006 (AMP 35%, 564/1,721). No other significant temporal variations were detected in the percentages of *E. coli* isolates with resistance to the selected antimicrobials between 2010 and 2009 or between 2010 and 2006

In 2010, resistance to ceftiofur and resistance to ceftriaxone were each detected in less than 1% (8/1,673 and 9/1,673 respectively) of *Escherichia coli* isolates from on farm pig fecal samples. Less than 1% (10/1,673) of isolates were resistant to nalidixic acid. None of the isolates were resistant to ciprofloxacin but reduced susceptibility to ciprofloxacin was detected in less than 1% (7/1,673) of isolates. Resistance to nalidixic acid was significantly higher in 2010 (0.6%, 10/1,673) than in 2009 (0.2%, 4/2,057) or 2006 (0.2%, 3/1,721). Resistance to ampicillin was significantly lower in 2010 (30%, 503/1,673) than in 2006 (35%, 564/1,721).

Figure 32. Resistance to antimicrobials in *Escherichia coli* isolates from pigs; *Farm Surveillance*, 2010.

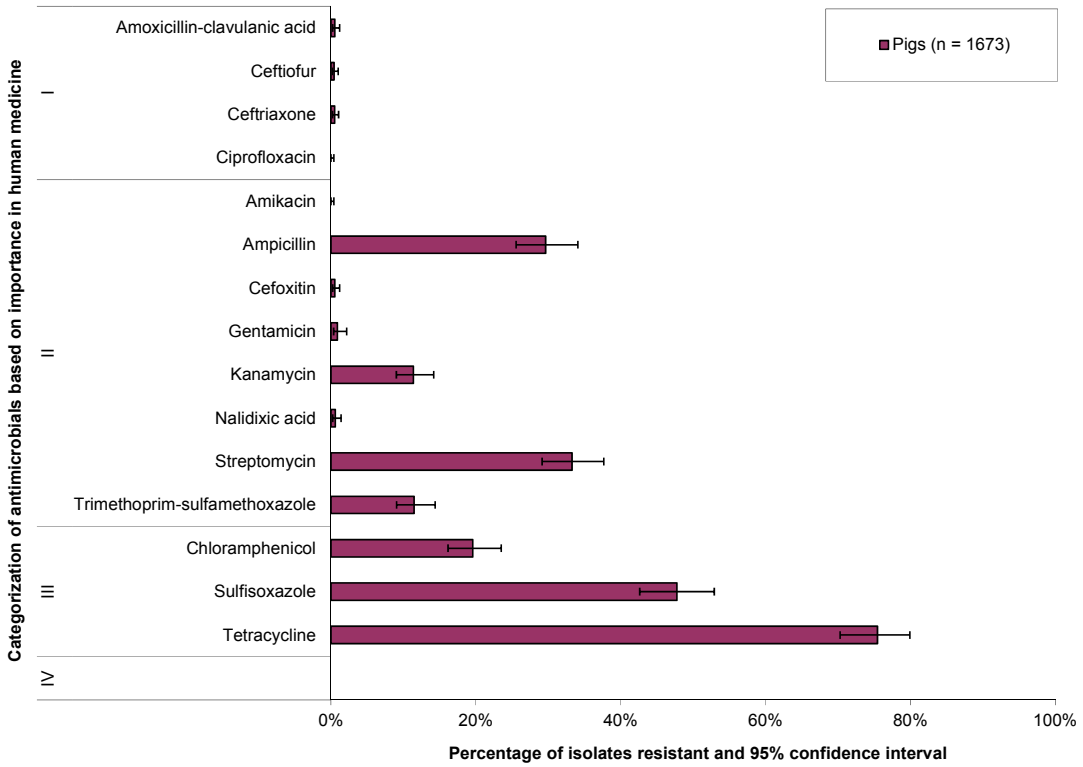
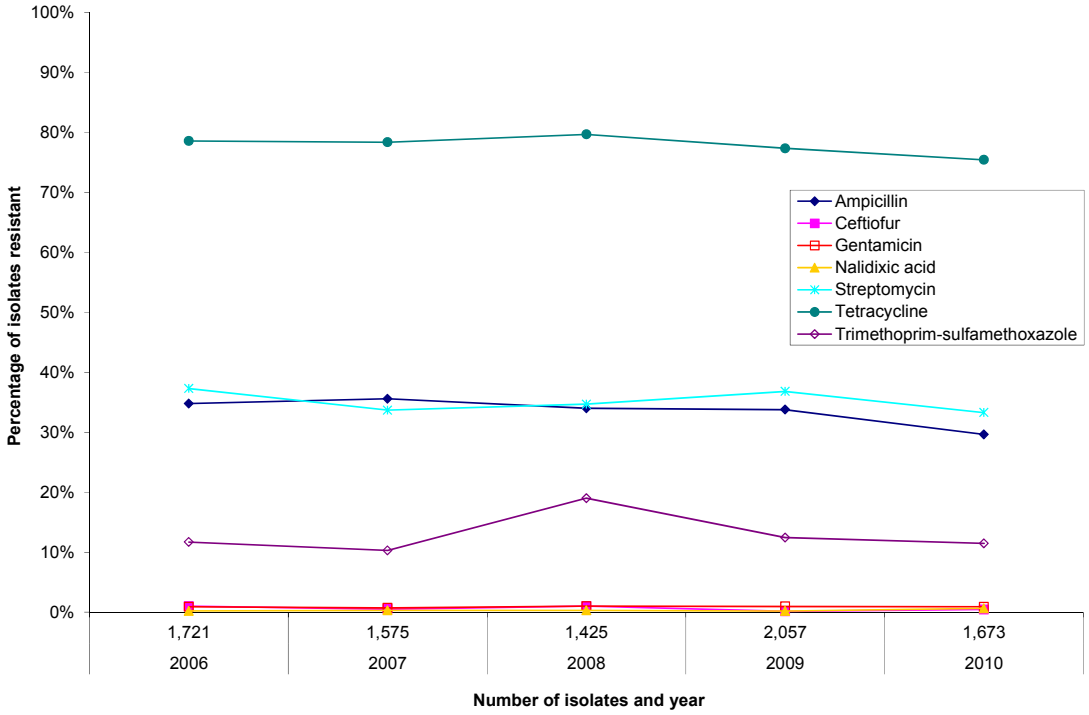


Table 24. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from pigs; *Farm Surveillance*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Pigs	1,673	271	302	801	299			15	187	562	503	10	9	10	8	816	194	339		10	1,270

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

Figure 33. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pigs; *Farm Surveillance*, 2006–2010.



Enterococcus

Farm Surveillance[1]

(n = 1,549)

Recovery: *Enterococcus* isolates were recovered from 96% (545/569) of fecal samples from pigs (Table C.5, Appendix C). Up to 3 isolates per positive sample were kept for analysis.[2] Sixty-nine percent (1,071/1,549) of the isolates were *E. faecalis*, 27% (421/1,549) were other *Enterococcus* spp., and 4% (57/1,549) were *E. faecium*.

Antimicrobial Resistance: Results are presented in Figure 34, Table 25 and Table B.24, Appendix B. Ciprofloxacin resistance was detected in 1% (11/1,071) of *E. faecalis* isolates, 23% (11/57) of *E. faecium* isolates, and in 1% (4/421) of other *Enterococcus* spp. isolates. Resistance to quinupristin-dalfopristin was detected in 11% (7/57) of *E. faecium* isolates and 51% (216/421) of other *Enterococcus* spp. isolates. None of the isolates were resistant to linezolid, tigecycline, or vancomycin. Additionally, none of the isolates were non-susceptible to daptomycin.[3]

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[1] The percentages provided in the text and in the figures and tables were adjusted to account for clustering within herds, whereas proportions represent unadjusted values (see Appendix A).

[2] Up to 3 *Enterococcus* isolates per positive sample were kept for analysis. The expected number of total isolates was 1,635 (545 x 3), but only 1,549 isolates were collected for antimicrobial susceptibility testing leaving a difference of 86 isolates. The difference resulted from 22 samples with only 1 isolate cultured (44 isolates not cultured), 37 samples with only 2 isolates cultured (37 isolates not cultured) and 5 isolates that did not regrow after freezing. 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.

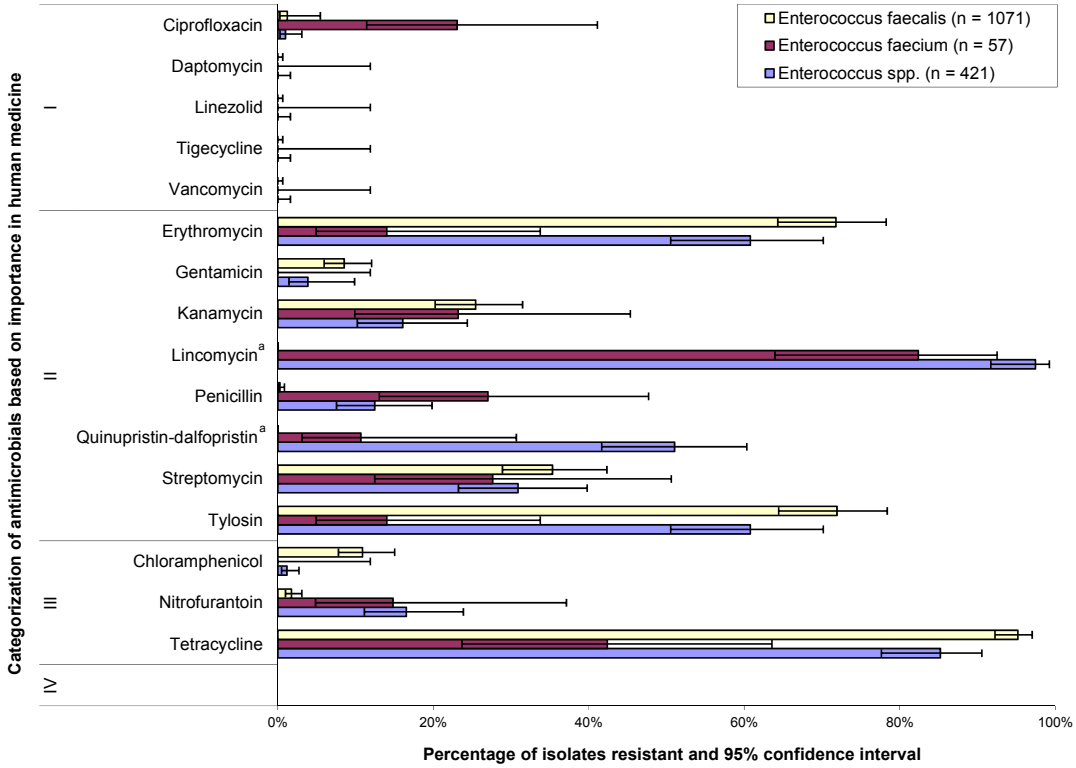
[3] A referenced resistance breakpoint has not been established for this antimicrobial. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression “non-susceptible” was used instead of “resistant” in the text.

Antimicrobial Resistance Patterns: Results are presented in Table 25. Resistance to 1 or more antimicrobial classes was detected in 96% (1,489/1,549) of *Enterococcus* isolates. Resistance to 4 or more antimicrobial classes was detected in 23% (363/1,549) of the isolates. The most common resistance patterns were ERY-TET-TYL (25%, 387/1,549), TET (13%, 209/1,549) and ERY-KAN-STR-TET-TYL (8%, 121/1,549).The patterns involving the greatest number of antimicrobials were ERY-KAN-LIN-NIT-PEN-QDA-STR-TET-TYL (4 *E. faecium* and 9 *Enterococcus* spp. isolates)

Temporal Variations: Results are presented in Figure 35. The percentage of *Enterococcus* isolates with resistance to ERY was significantly lower in 2010 (67%, 1,058/1,549) than in 2009 (73%, 1,385/1,912). The percentage of isolates with resistance to LIN was significantly higher in 2010 (97%, 456/478) than in 2006 (72%, 125/175). The percentage of isolates with resistance to STR was significantly lower in 2010 (33%, 509/1,549) than in 2009 (36%, 702/1,912) or in 2006 (41%, 258/640). The percentage of isolates with resistance to TET was significantly higher in 2010 (91%, 1,403/1,549) than in 2006 (86%, 556/640). The percentage of isolates with resistance to TYL was significantly lower in 2010 (67%, 1,059/1,549) than in 2009 (73%, 1,392/1,912). No other significant temporal variations were detected in the percentages of *Enterococcus* isolates with resistance to the selected antimicrobials between 2010 and 2009 or between 2010 and 2006.

In 2010, none of the *Enterococcus* isolates recovered from on farm pig fecal samples were resistant to linezolid, tigecycline, or vancomycin or were non-susceptible to daptomycin. Ciprofloxacin resistance was detected in 2% (26/1,549) of all *Enterococcus* isolates. The percentage of isolates with erythromycin resistance was significantly lower in 2010 (67%, 1,058/1,549) than in 2009 (73%, 1,385/1,912). The percentage of isolates with lincomycin resistance was significantly higher in 2010 (96%, 456/478) than in 2006 (72%, 125/175). Streptomycin resistance was significantly lower in 2010 (33%, 509/1,549) than in 2009 (36%, 702/1,912) or 2006 (41%, 258/640). Tetracycline resistance was significantly higher in 2010 (91%, 1,403/1,549) than in 2006 (86%, 556/640). Tylosin resistance was significantly lower in 2010 (67%, 1,059/1,549) than in 2009 (73%, 1,392/1,912).

Figure 34. Resistance to antimicrobials in *Enterococcus* isolates from pigs; *Farm Surveillance*, 2010.



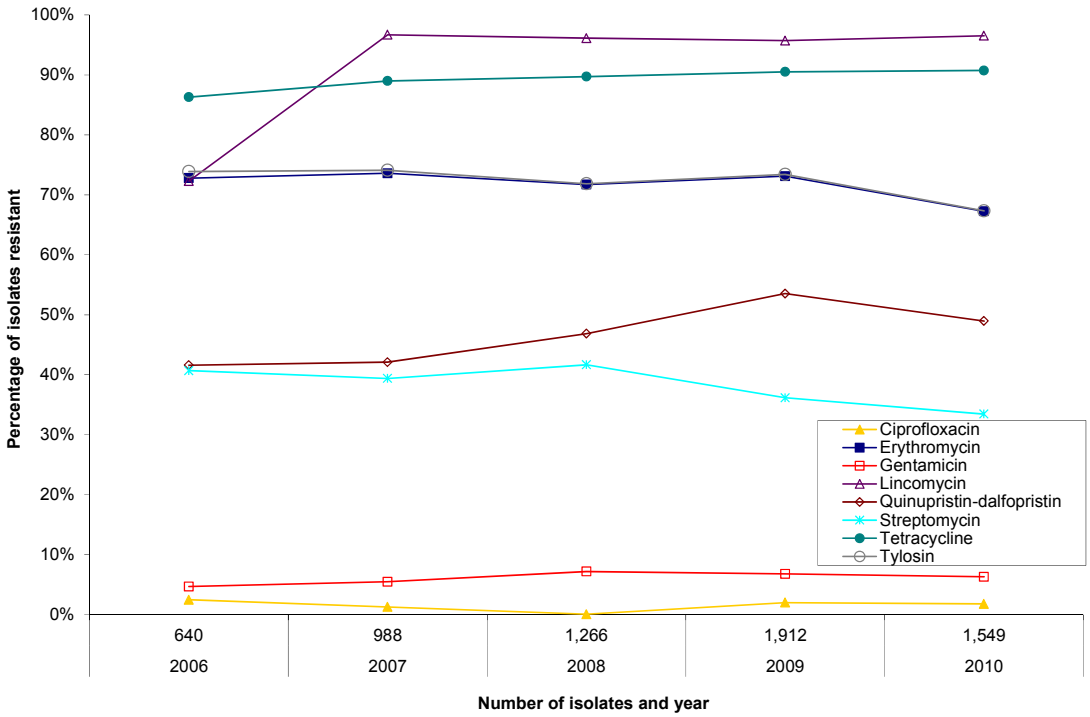
[a] Resistance to quinupristin-dalfopristin and lincomycin is not reported for *E. faecalis* because *E. faecalis* is intrinsically resistant to these antimicrobials.

Table 25. Number of antimicrobial classes in resistance patterns of *Enterococcus* isolates from pigs; *Farm Surveillance*, 2010.

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			Glycopeptides	Glycylcyclines	Lincosamides	Lipopeptides	Macrolides		Nitrofurans	Oxazolidinones	Penicillins	Phenicols	Quinolones	Streptogramins	Tetracyclines
		0	1	2–5	6–9	10–13	GEN	KAN	STR	VAN	TIG	LIN[a]	DAP	ERY	TYL	NIT	LNZ	PEN	CHL	CIP	QDA[a]	TET
Enterococcus faecalis	1,071 (69.1)	45	213	813			85	261	374					788	789	17		3	113	11		1,019
Enterococcus spp.	421 (27.2)	11	46	317	47		13	60	115			408		260	260	62		60	5	4	216	353
Enterococcus faecium	57 (3.7)	4	19	28	6			15	20			48		10	10	8		19		11	7	31
Total	**1,549 (100)**	**60**	**278**	**1,158**	**53**		**98**	**336**	**509**			**456**		**1,058**	**1,059**	**87**		**82**	**118**	**26**	**223**	**1,403**

Antimicrobial abbreviations are defined in Appendix D.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance to human medicine, respectively.
[a] Resistance to quinupristin-dalfopristin and lincomycin is not reported for *E. faecalis* because *E. faecalis* is intrinsically resistant to these antimicrobials.

Figure 35. Temporal variation in resistance to selected antimicrobials in *Enterococcus* isolates from pigs; *Farm Surveillance*, 2006–2010.



Turkeys

Salmonella

Surveillance of Animal Clinical Isolates[1]

(n = 30)

Note: A proportion of the turkey isolates might have been recovered from turkey-related environmental samples.

Serovars: Results are presented in Table 26 and Table C.3, Appendix C. The most common *Salmonella* serovars in turkey clinical isolates were Agona (23%, 7/30), Senftenberg (17%, 5/30), and Heidelberg (13%, 4/30). These 3 serovars accounted for 53% (16/30) of the isolates.

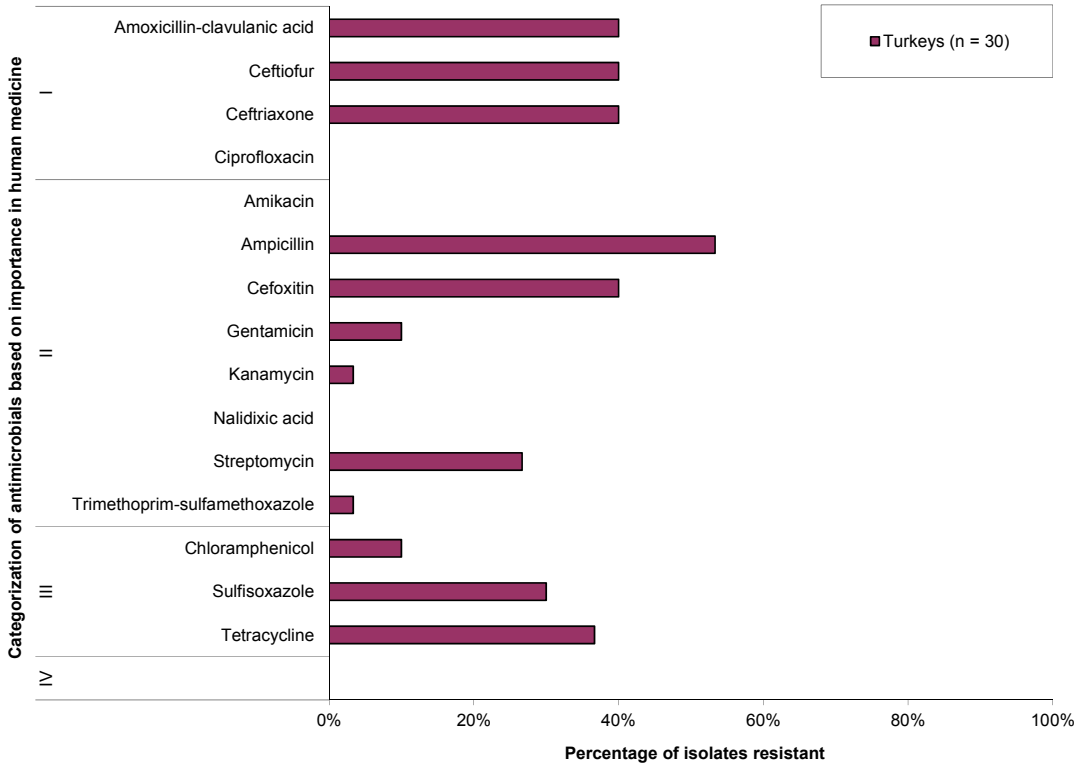
Antimicrobial Resistance: Results are presented in Figure 36, Table 26 and Table B.25, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was each detected in 40% (12/30) of *Salmonella* isolates. None of the isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid. Additionally, none of the isolates had reduced susceptibility to ciprofloxacin.

Antimicrobial Resistance Patterns: Results are presented in Table 26 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 83% (25/30) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 10% (3/30) of the isolates (2 *S*. Agona and 1 *S*. Saintpaul). The most common resistance patterns were A2C-AMP-CRO (27%, 8/30) and TET (10%, 3/30). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (1 *S*. Agona isolate).

In 2010, resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was each detected in 40% (12/30) of turkey *Salmonella* clinical isolates. Resistance to 1 or more antimicrobial classes was detected in 83% (25/30) of *Salmonella* isolates. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (1 *S.* Agona isolate).

[1] The distribution of *Salmonella* isolates across provinces is presented in Table C.6, Appendix C.

Figure 36. Resistance to antimicrobials in *Salmonella* isolates from turkeys; *Surveillance of Animal Clinical Isolates*, 2010.



Confidence intervals are not displayed for animal clinical data because samples were not obtained randomly and may not represent independent observations and true estimates of the prevalence.

Table 26. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from turkeys; *Surveillance of Animal Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Agona	7 (23.3)	1	3	1	2					2	5	5	5	5	5	3	1	2			3
Senftenberg	5 (16.7)		3	2				2		2	4	4	4	4	4	1					
Heidelberg	4 (13.3)	2	2																		2
Hadar	3 (10.0)		1	2						2											3
Saintpaul	2 (6.7)		1		1					1	2	1	1	1	1	1		1			1
Schwarzengrund	2 (6.7)	2																			
Typhimurium	2 (6.7)		2								2	2	2	2	2						
Typhimurium var. 5-	2 (6.7)			2							2					2					
Johannesburg	1 (3.3)			1												1					1
Montevideo	1 (3.3)			1				1	1	1						1					1
Muenster	1 (3.3)		1								1										
Total	**30 (100)**	**5**	**13**	**9**	**3**			**3**	**1**	**8**	**16**	**12**	**12**	**12**	**12**	**9**	**1**	**3**			**11**

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

Horses

Salmonella

Surveillance of Animal Clinical Isolates[1]

(n = 14)

Serovars: Results are presented in Table 27 and Table C.3, Appendix C. The most common *Salmonella* serovars in horse clinical isolates were Heidelberg (36%, 5/14), Typhimurium (21%, 3/14), and Muenster (14%, 2/14). These 3 serovars accounted for 71% (10/14) of the isolates.

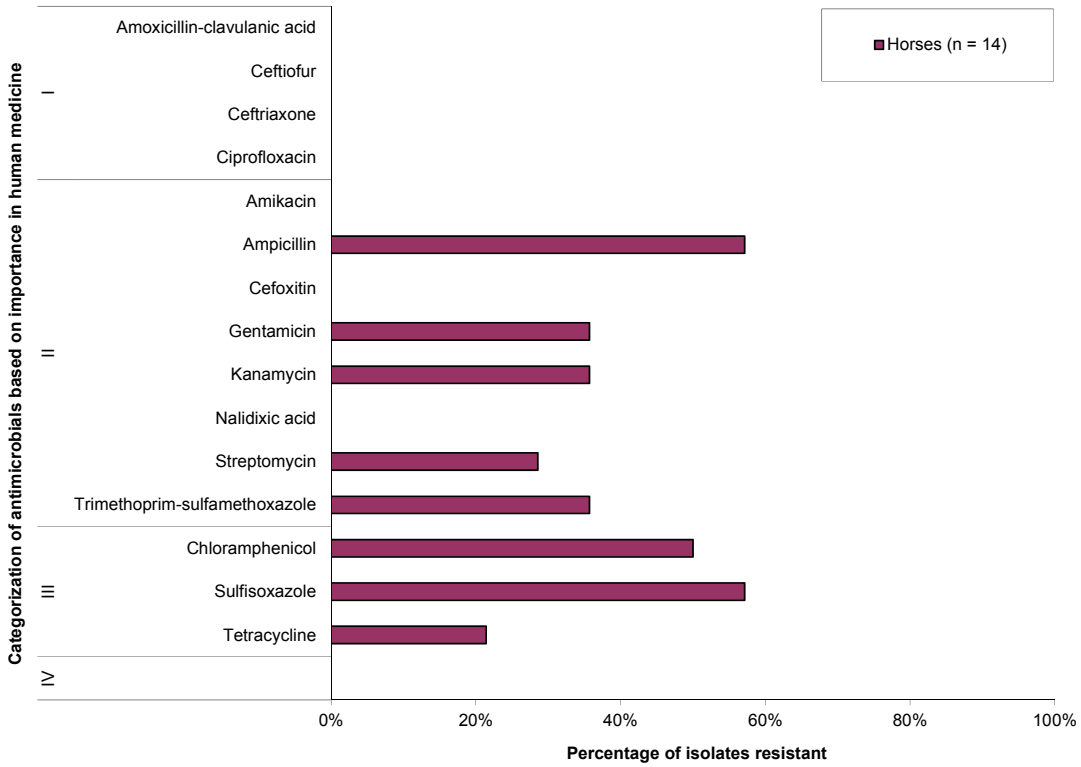
Antimicrobial Resistance: Results are presented in Figure 37, Table 27, and Table B.26, Appendix B. Reduced susceptibility to ciprofloxacin was detected in 21% (3/14) of isolates. None of the isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, or nalidixic acid.

Antimicrobial Resistance Patterns: Results are presented in Table 27 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 57% (8/14) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 50% (7/14) of the isolates (4 *S*. Heidelberg and 3 *S*. Typhimurium). The most common resistance patterns were AMP-CHL-GEN-KAN-SSS-SXT (21%, 3/14) and ACSSuT (21%, 3/14). Twenty-one percent (3/14) of isolates (3 *S.* Heidelberg) had reduced susceptibility to ciprofloxacin but were not resistant to nalidixic acid. The pattern involving the greatest number of antimicrobial were AMP-CHL-GEN-KAN-STR-SSS-SXT (1 *S*. Heidelberg isolate).

In 2010, reduced susceptibility to ciprofloxacin was detected in 21% (3/14) of horse clinical *Salmonella* isolates (*S.* Heidelberg). None of the isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, or nalidixic acid. Resistance to 4 or more antimicrobial classes was detected in 50% (7/14) of the isolates (4 *S*. Heidelberg and 3 *S*. Typhimurium isolates).

[1] The distribution of *Salmonella* isolates across provinces is presented in Table C.6, Appendix C.

Figure 37. Resistance to antimicrobials in *Salmonella* isolates from horses; *Surveillance of Animal Clinical Isolates*, 2010.



Confidence intervals are not displayed for animal clinical data because samples were not obtained randomly and may not represent independent observations and true estimates of the prevalence.

Table 27. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from horses; *Surveillance of Animal Clinical Isolates*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Heidelberg	5 (35.7)			1	4			5	5	1	5					5	5	4			
Typhimurium	3 (21.4)				3					3	3					3		3			3
Muenster	2 (14.3)	2																			
Braenderup	1 (7.1)	1																			
Enteritidis	1 (7.1)	1																			
Oranienburg	1 (7.1)	1																			
Saintpaul	1 (7.1)	1																			
Total	**14 (100)**	**6**		**1**	**7**			**5**	**5**	**4**	**8**					**8**	**5**	**7**			**3**

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

Feed and Feed Ingredients

Salmonella

(n = 31)

Recovery: Data reported here include those obtained from government monitoring programs in 2010. *Salmonella* isolates were recovered from samples of feed destined for consumption by some animal species as follows: 14% (3/31) for swine and 5% (1/31) for poultry. Information about the intended use of the feed was missing for 77% (27/31) of the isolates.

Serovars: Results are presented in Table 28. The most common *Salmonella* serovars were Schwarzengrund (23%, 7/31), Mbandaka (19%, 6/31), and Senftenberg (13%, 4/31). No isolates of Enteritidis, Heidelberg, I 4,[5],12:i:-, Typhimurium, or Typhimurium var. 5- were recovered.

Antimicrobial Resistance: Results are presented in Table B.27, Appendix B. No Category I or nalidixic acid resistance was detected among the *Salmonella* isolates, nor was reduced susceptibility to ciprofloxacin. Additionally, no resistance to amikacin, ampicillin, cefoxitin, gentamicin, kanamycin, or trimethoprim-sulfamethoxazole was detected.

Antimicrobial Resistance Patterns: No table presented. No resistance to 1 or more antimicrobial classes or resistance to 4 or more antimicrobial classes were detected.

In 2010, the most common serovars among *Salmonella* isolates from feed and feed ingredients were Schwarzengrund (23%, 7/31), Mbandaka (19%, 6/31), and Senftenberg (13%, 4/31). No Category I or nalidixic acid resistance was detected among the *Salmonella* isolates, nor was reduced susceptibility to ciprofloxacin.

Table 28. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from feed and feed ingredients; *Feed and Feed Ingredients*, 2010.

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		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Schwarzengrund	7 (22.6)	7																			
Mbandaka	6 (19.4)	6																			
Senftenberg	4 (12.9)	4																			
Alachua	2 (6.5)	2																			
I Rough:z4,z23:-	2 (6.5)	2																			
Johannesburg	2 (6.5)	2																			
Orion var.15+34+	2 (6.5)	2																			
Agona	1 (3.2)	1																			
Cubana	1 (3.2)	1																			
Give	1 (3.2)	1																			
Ohio	1 (3.2)	1																			
Putten	1 (3.2)	1																			
Thompson	1 (3.2)	1																			
Total	**31 (100)**	**31**																			

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

Section Two – Antimicrobial Use

Humans

Analysis of antimicrobial use in humans was carried out in data contained within the Canadian CompuScript (CCS) dataset provided by IMS Health Canada Inc., for 2000 through 2010. This dataset provides information on prescriptions dispensed by Canadian retail pharmacies. Additional information on IMS Health Canada Inc. data collection and CIPARS analytic methods are described in Appendix A.

National Level

In 2010, the antimicrobial prescription dispensing rate (Table 29, Table 30, and Figure 38) remained similar (668.97 prescriptions/1,000 inhabitants) to levels observed in 2009 (670.59 prescriptions/1,000 inhabitants). In 2010, total expenditure appeared similar to what it was in 2000 ($21,007.64/1,000 inhabitants and $20,852.26/1,000 inhabitants, respectively) (Figure 38). However, once inflation was accounted for, the total expenditure was highest in 2000 ($25,372.07/1,000 inhabitants) and has decreased or remained relatively stable each year until it reached its lowest level in 2008 ($20,713.96/1,000 inhabitants) (Table 31 and Figure 38). Since 2008, it has increased to $20,972.45/1,000 inhabitants and $21,007.64/1,000 inhabitants in 2009 and 2010, respectively. Of all antimicrobials dispensed, an increase in levels of expenditures since 2000, after accounting for inflation, was observed among five antimicrobial classes: the glycopeptides ($62.09/1,000 inhabitants in 2000 to $204.14/1,000 inhabitants in 2010), nitrofurantoin derivatives ($354.00/1,000 inhabitants in 2000 to $667.70/1,000 inhabitants in 2010), first-generation cephalosporins ($896.39/1,000 inhabitants in 2000 to $1,290.87/1,000 inhabitants in 2010), lincosamides ($811.33/1,000 inhabitants in 2000 to $875.58/1,000 inhabitants in 2010), and penicillins with extended spectrum ($3,239.69/1,000 inhabitants in 2000 to $3,250.18/1,000 inhabitants in 2010).

The total number of defined daily doses per 1,000 inhabitants per day (DID) increased slightly to 18.29 DID in 2010 from 18.12 DID in 2009 (Table 32, Table 33). However, since the beginning of the surveillance period in 2000, the total DID has decreased by 5% (-1.03 DID). Between 2009 and 2010, increases in consumption were observed in eight antimicrobial groups: the beta-lactamase resistant penicillins (23% increase), third-generation cephalosporins (22%), lincosamides (10%), imidazole (6%), nitrofuran derivatives (7%), penicillins with extended spectrum (5%), tetracyclines (3%), and fluoroquinolones (1%).

Penicillins with extended spectrum represent the largest group of antimicrobial agents consumed (26%), followed by macrolides (21%), tetracyclines (14%), fluoroquinolones (11%), and cephalosporins (10%) (Table 32, Table 33, and Figure 39). Category I antimicrobials continued to represent a high proportion (17%, 3.06/18.29 DID) of the total DID dispensed. This percentage was the same as in 2009 (17%; 3.09/18.12), however it was higher than in 2000 (13%; 2.43/19.32). In 2010, the most frequent Category I antimicrobials dispensed were ciprofloxacin (64.23 prescriptions per 1,000 inhabitants), metronidazole (19.39 prescriptions per 1,000 inhabitants), amoxicillin and enzyme inhibitor (18.75 prescriptions per 1,000 inhabitants), and moxifloxacin (17.28 prescriptions per 1,000 inhabitants) (Figure 40).

Penicillins (J01C)

In 2010, consumption[1] of penicillins increased by 0.13 DID (2%) compared with 2009 (Table 32 and Table 33). The total consumption remained relatively stable due to the increase in use of penicillins with

[1] Defined daily doses were computed from data on dispensed prescriptions for orally administered antimicrobials. However, an unknown proportion of orally administered antimicrobials sold by retail pharmacies are not consumed, therefore the DIDs may slightly overestimate true consumption.

extended spectrum, and beta-lactamase resistant penicillins, and the concurrent decreased consumption of combinations of penicillins, including beta-lactamase inhibitors, and beta-lactamase sensitive penicillins.

Trends observed within the penicillins class was driven by consumption of amoxicillin, as it was the main antimicrobial consumed within this group of antimicrobials (Table 33). In 2010, consumption of amoxicillin increased 0.21 DID (5%) compared to 2009. However, levels of consumption are lower than that observed in 2000 (1%; -0.06 DID). Cloxacillin (J01CF02) also increased in consumption in 2010 compared to 2009 (22%, 0.04 DID), however consumption has decreased since 2000 (41%; -0.16 DID).

Macrolides and Lincosamides (J01FA & J01FF)

Consumption of lincosamides has increased 0.04 DID (10%) since 2009 and 0.18 DID (74%) since 2000 (Table 32, Table 33). This consumption was driven mainly by an increase in consumption of clindamycin (J01FF01) as there has been very limited (less than 0.01 DID in 2000, 2003, and 2004) to no use (2001, 2002, and 2005-2010) of lincomycin across the country. In Canada, lincomycin is covered under provincial drug plans only in the provinces of British Columbia, Manitoba, and Newfoundland and Labrador.[1] In the province of Alberta, coverage for these drugs ended in 2001.[1]

Consumption of macrolides has decreased 0.04 DID (1%) since 2009 (Table 32 and 33), However, consumption continued to be higher than that observed in 2000 (3.68 DID). Clarithromycin (J01FA09) and azithromycin (J01FA10) are the main macrolide drugs prescribed in Canada and have contributed to the increase observed within this class of antimicrobials since 2000 (Table 32, Table 33). Azithromycin consumption remained the same between 2009 and 2010 (0.79 DID), although it contributed to the overall increase in macrolide use observed since 2000 (0.26 DID 49% increase for azithromycin). Clarithromycin decreased 0.03 DID (1%) from 2009, but increased 0.54 DID (25%) since 2000. Consumption of erythromycin continues to decrease, with overall consumption decreasing by 0.72 DID (78%) in 2010 compared to 2000, and by 0.01 DID (6%) compared to 2009.

Tetracyclines (J01A)

Tetracyclines make up 14% of all DID of oral antimicrobials dispensed by retail pharmacies in Canada in 2010 (Table 32, Table 33, and Figure 41). Between 2009 and 2010, the increase observed in consumption of tetracyclines was small (0.06 DID, 3%). However, over the last 10 years, overall consumption has decreased by 9% (-0.25 DID).

Doxycycline (J01AA02) and minocycline (J01AA08) were the most frequent tetracycline drugs prescribed in Canada (Table 32, Table 33). Doxycycline consumption increased 0.19 DID (20%) from 2009 to 2010, and increased 0.40 DID (53%) from 2000 to 2010. Minocycline consumption also increased slightly since both 2009 (0.08 DID, 8%) and 2000 (0.10 DID, 10%). Overall consumption of tetracycline (J01AA07) continues to decrease, with a 46% (-0.21 DID) decrease observed in 2010 compared to 2009, and a 75% (0.74 DID) decrease compared to 2000. This decrease was the largest proportional decrease among all antimicrobial classes observed between 2009 and 2010. In Quarter 1 (January to March), tetracycline use was 0.45 DID (Figure 41). Use then decreased 60% in Quarter 2 (April to June) to 0.18 DID, and an additional 16% in Quarter 3 (July to September) to 0.11 DID. Tetracycline use then increased to 0.26 DID in Quarter 4 (October to December). The observed decrease in tetracycline use during 2010 could have been due to a drug shortage that occurred in multiple countries, including Canada, affecting the supply of both tetracycline and cephalexin, among other drugs.[2]

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[1] © Canadian Institute for Health Information 2011. Data obtained from the National Prescription Drug Utilization Information System (NPDUIS) Database.

[2] Eggertson, L. Continuing drug shortages affect North American patients. Available at: www.cmaj.ca/content/182/18/E811.full. Accessed May 2013.

Fluoroquinolones (J01MA)

Fluoroquinolones account for 11% of the total antimicrobial consumption in 2010 (Table 32, Table 33, and Figure 39). Overall consumption of fluoroquinolones has increased 12% (0.22 DID) since 2000 and by 1% (0.02 DID) compared to 2009.

Over half (59%, 1.20/2.03) of fluoroquinolone consumption was due to the use of ciprofloxacin (J01MA02), for which consumption has increased 0.04 DID (3%) since 2009 (Table 33). The greatest increase in consumption observed among fluoroquinolones during the 10-year surveillance period has been among moxifloxacin (J01MA14) products, which increased from 0.01 DID in 2000 to 0.42 DID in 2010. Ofloxacin (J01MA01), norfloxacin (J01MA06), and levofloxacin (J01MA12) consumption has decreased 75% (-0.10 DID), 54% (-0.15 DID), and 13% (-0.04 DID) since 2000, respectively.

Cephalosporins (J01DB-DD)

Other beta-lactam antimicrobials, such as the cephalosporins, account for 10% of the overall consumption in Canada (Table 32, Table 33, and Figure 39). In 2010, cephalosporin consumption decreased 5% (-0.09 DID) since 2009 and 22% (-0.49 DID) within the 11-year surveillance period.

Fifty-five percent of all cephalosporin consumption was a result of first-generation cephalosporin (J01DB) use, of which 96% (0.92/0.96 DID) was mainly cephalexin (J01DB01) (Table 33 and Figure 42). The use of cephalexin drugs has decreased 2% (-0.02 DID) since 2009 although it has increased 28% (0.20 DID) since 2000.

The second-generation cephalosporins (J01DC) accounted for 40% of all cephalosporin consumption in 2010. Among the second-generation cephalosporins, decreases were observed among cefaclor (J01DC04) and cefuroxime axetil (J01DC02) drugs, consisting of 96% (-0.36 DID) and 55% (-0.44 DID), respectively since 2000 (Table 33, Figure 42). Although there was an overall decrease in the second-generation cephalosporin use, cefprozil use has increased 54% (0.12 DID) since 2000.

Cefixime (J01DD08) was the only oral third-generation cephalosporin monitored under this surveillance program. Consumption of cefixime decreased from 2000 to 2004, remained steady from 2004 to 2007, and has slowly increased from 2007 to 2010. From 2000 to 2010, the overall consumption of cefixime has decreased 20% (0.02 DID) (Table 33 and Figure 42).

Differing temporal trends in consumption exist between the cephalosporin antimicrobials (Figure 42). In 2010, Quarter 1 (January to March) had the highest level of cefprozil (J01DC10) consumption. Quarter 2 (April to June) had the highest cephalexin (J01DB01) consumption, and Quarter 3 (July to September) had the highest cefadroxil (J01DB05) consumption. Quarter 4 (October to December) had the highest cefuroxime axetil (J01DC02), cefprozil (J01DC10), and cefixime (J01DD08) consumption. There was a large decrease (17%) in cephalexin consumption from the 3rd quarter (0.94 DID) to the 4th quarter (0.79 DID). The observed decrease in cephalexin use during 2010 could have been due to a drug shortage that occurred in multiple countries, including Canada, affecting the supply of both tetracycline and cephalexin, among other drugs.[1]

Provincial Level

In 2010, differences in the total number of prescriptions (per 1,000 inhabitants), total consumption of oral antimicrobials (in DDDs/1,000 inhabitant-days or DID) and total cost in dollars (per 1,000 inhabitant-days) were observed across Canada (Table 34, Table 35, Table 36, and Figure 43). Much of the inter-provincial variation in DIDs could be explained by differences in consumption of penicillins with extended-spectrum, fluoroquinolones, tetracyclines, macrolides, first-generation cephalosporins, combinations of sulfonamides and trimethoprim (including derivatives), and nitrofuran derivatives (Figure 43).

[1] Eggertson, L. Continuing drug shortages affect North American patients. Available at: www.cmaj.ca/content/182/18/E811.full. Accessed May 2013.

Among the Category I antimicrobials, consumption of fluoroquinolones, combinations of penicillins, including β-lactamase inhibitors, and imidazole was the highest in Newfoundland and Labrador (4.60 DID, 1.53 DID, and 0.37 DID, respectively) (Table 35). Consumption of the third-generation cephalosporins was the highest in Prince Edward Island (0.28 DID).

Overall, consumption and total cost per 1,000 inhabitant-days were the highest in Newfoundland and Labrador (32.53 DIDs and $93.86 per 1,000 inhabitant-days, respectively); whereas Québec had the lowest overall antimicrobial consumption (14.35 DIDs) and cost ($50.92) (Table 35, Table 36, and Table 37).

Compared to other provinces, Newfoundland and Labrador's consumption was driven primarily by higher consumption of antimicrobials belonging to classes of penicillins with extended spectrum (J01CA; 9.78 DID), macrolides (J01FA; 6.25 DID), and fluoroquinolones (J01MA; 4.60 DID) (Table 35 and Table 36). The higher consumption of penicillins with extended spectrum was attributable to amoxicillin consumption (9.60 DID in Newfoundland and Labrador compared to 3.06 DID in Québec, the province with the lowest amoxicillin use), and ampicillin consumption (0.18 DID in Newfoundland and Labrador compared to less than 0.01 DID in Québec and Manitoba). Ampicillin use in Newfoundland and Labrador however, has decreased 44% (0.14 DID) since 2005[1] and the overall consumption of penicillins with extended spectrum in each province has remained steady since 2000.

Consumption of macrolides (J01FA) in Newfoundland and Labrador continued to increase, with 6.25 DIDs observed in 2010 compared to 5.41 DIDs in 2005.[1] This increase observed in Newfoundland and Labrador was driven by consumption of clarithromycin (J01FA09), whose consumption was much higher than that observed in the province with the lowest consumption, Saskatchewan, 4.97 DID and 1.53 DID, respectively (Table 36, Figure 44, and Figure 45). Clarithromycin use has decreased slightly in Newfoundland and Labrador compared to 2009 (-2%, -0.09 DID), however since 2005 consumption has been higher than any other province. From 2006 to 2008, clarithromycin use in Newfoundland and Labrador has always peaked in the first quarter (January to March) (Figure 45). However, the peak in the 4th quarter (October to December) of 2009 was higher than the peak in Quarter 1 of 2010, which was lower than the Quarter 1 peak in the previous 3 years.

Among the other macrolide drugs, azithromycin (J01FA10) consumption was highest in Manitoba (1.30 DID) and lowest in British Columbia (0.43 DID) (Table 36 and Figure 46). Since 2003, azithromycin consumption in Manitoba has increased 73% (0.55 DID), while consumption in New Brunswick has decreased 46% (-0.76 DID). Generic azithromycin was first sold in Manitoba in January 2006, which may have contributed to the increase in azithromycin consumption in that province. Erythromycin (J01FA01) consumption was highest in Prince Edward Island (0.92 DID) compared to Québec, the province with the lowest consumption (0.05 DID).

The higher consumption of fluoroquinolones in Newfoundland and Labrador was attributable to ciprofloxacin (J01MA02) consumption (3.70 DID versus 1.03 DID in Saskatchewan) (Table 36 and Figure 47). Ciprofloxacin consumption in Newfoundland and Labrador was more than double the ciprofloxacin use in any other province. Ofloxacin (J01MA01) consumption also attributed to the increase in overall fluoroquinolone consumption in Newfoundland and Labrador (0.12 DID in Newfoundland and Labrador versus less than 0.01 in Saskatchewan). Inter-provincial variation was also observed among the other fluoroquinolone drugs. Prince Edward Island was observed to have a higher level of consumption of moxifloxacin (J01MA14; 0.63 DID) versus Manitoba (0.23 DID) (Table 36). New Brunswick had a higher level of consumption of norfloxacin (J01MA06; 0.42 DID) compared to Saskatchewan (0.01 DID). Similarly, Manitoba had higher consumption of levofloxacin (J01MA12) than New Brunswick (the province with the lowest levofloxacin use), 0.41 DID and 0.04 DID, respectively.

Saskatchewan had the second highest total consumption of antimicrobials in 2010, driven by higher consumption of antimicrobials belonging to classes of penicillins with extended spectrum (J01CA; 6.90 DID), tetracyclines (J01AA; 4.56 DID), macrolides (J01FA; 3.17 DID), and first-generation cephalosporins (J01DB; 1.91 DID) (Table 35 and Table 36). In Saskatchewan, the higher consumption of tetracyclines was attributed to the use of doxycycline (J01AA02); Saskatchewan had the highest doxycycline consumption in 2010 (3.93 DID) compared to Québec (0.61 DID), the province with the lowest

[1] Prior to 2005, information for Prince Edward Island and Newfoundland and Labrador was combined.

consumption (Table 36 and Figure 48). Doxycycline use in Saskatchewan was more than double the doxycycline use in all other provinces. From 2009 to 2010, doxycycline consumption increased across all provinces. Since 2005, consumption of doxycycline in Prince Edward Island has been increasing. The increase from 2005 to 2008 was steady: 36% increase (0.25 DID) during the time period. However, from 2008 to 2010 the increase was greater: 70% increase (0.65 DID) in the two-year period. Consumption of tetracycline (J01AA07) was the highest in the province of Prince Edward Island (0.75 DID) compared to Québec, which had the lowest tetracycline consumption (0.11 DID) (Table 36 and Figure 49). The consumption of tetracycline in all provinces decreased from 2009 to 2010, however the largest decrease was observed in Prince Edward Island (41% decrease; -0.52 DID). The drug shortage observed during 2010[1] may explain the reported decline in tetracycline use across Canada, and would likely have a greater effect on provinces with greater use, providing a possible explanation for the largest effect observed in Prince Edward Island. In Saskatchewan, the first-generation cephalosporin use was attributed mainly to the use of cephalexin (J01DB01). Saskatchewan had the highest cephalexin consumption (1.91 DID) versus 0.30 DID in the province of Québec, which had the lowest consumption (Table 36). However, within the remaining first-generation cephalosporin drugs, Québec had the highest level of cefadroxil (J01DB05) consumption with an overall use of 0.14 DID compared to less than or equal to 0.01 DID observed in all of the other provinces (Figure 50). In Québec, the use of cefadroxil has doubled (+0.07 DID) in the ten year surveillance period.

Saskatchewan also had the highest consumption of nitrofuran derivatives (J01XE); 1.05 DID compared to 0.34 DID in Québec, the province with the lowest consumption. Consumption of nitrofurantoin (J01XE01) has increased slightly for all provinces since 2000 with the largest increases observed in British Columbia (96%, 0.39 DID) and Ontario (80%, 0.39 DID). The only decrease in nitrofurantoin consumption observed between 2009 and 2010, was in Prince Edward Island (-9%, -0.07 DID).

Amoxicillin-clavulanic acid (J01CR02) consumption either decreased, or remained steady for all provinces from 2009 to 2010 (Figure 51). The largest decrease was observed in Prince Edward Island, which dropped 30% (-0.44 DID), a finding which may be explained by the drug shortage affecting all Canadian provinces.[1]

Newfoundland and Labrador also had the highest consumption of penicillin v (J01CE02) (Table 36 and Figure 52). Since 2005, consumption in this province has remained relatively steady (from 0.69 to 0.62 DID). Consumption in Alberta however, has decreased 35% (-0.27 DID) since 2005. Similarly, consumption in Prince Edward Island has decreased 32% (-0.25 DID).

Québec had the lowest overall antimicrobial consumption of all Canadian provinces (Table 35 and Table 36). However, the consumption of vancomycin (J01XA01) in this province was the highest (Table 36 and Figure 53). Since 2004, vancomycin use in Québec has been at double that of all other provinces. Vancomycin is recommended for use second to oral metronidazole for treating *Clostridium difficile*. The NAP-1 strain of *C. difficile* has been a recurring problem in Québec and may account for this increase in vancomycin consumption. However, metronidazole consumption was the lowest in Québec and has remained steady around 0.20 DID since 2001.

International Level

The estimate of the total amount of oral antimicrobials dispensed in 2009[2] by Canadian retail pharmacies was compared with the total amount of outpatient antimicrobial use in 32 European countries[3] in the same year (Figure 54). This comparison showed that the level of consumption in Canada was similar to the level of consumption of Finland and the Czech Republic. Canada's oral antimicrobial consumption represented almost twice the level of antimicrobial consumption reported by Romania (country with the lowest level of consumption) and less than half the level estimated in Greece (country with the highest level of total

[1] Eggertson, L. Continuing drug shortages affect North American patients. Available at: www.cmaj.ca/content/182/18/E811.full. Accessed May 2013.
[2] The year 2009 was chosen because data for 2010 were not yet available at the time this report was written.
[3] ESAC Yearbook 2009. ESAC – European Surveillance of Antimicrobial Consumption ESAC Interactive Database. Available at: www.esac.ua.ac.be/main.aspx?c=*ESAC2&n=50036. Accessed May 2013.

consumption). Overall, Canada ranked 15th out of the 33 countries classified by increasing level of total antimicrobial consumption. Canada ranked 30th for its level of consumption of macrolides, lincosamides and streptogramins, 25th for its level of consumption of quinolones (largely consisting of fluoroquinolones), and 22nd for its level of consumption of tetracyclines, sulfonamides and trimethoprim. Canada was 17th for its level of cephalosporin and other beta-lactam consumption and 7th for its penicillin consumption.

In 2010, the antimicrobial prescription dispensing rate remained similar to that observed during 2009 and 2008, but the total oral antimicrobial expenditure continued to increase. Category I antimicrobials continued to represent a high proportion (17%, 3.06/18.30) of the total DDDs/1,000 inhabitant-days dispensed during 2010.

In that same year, oral antimicrobial consumption was highest in Newfoundland and Labrador (32.53 DDDs/1,000 inhabitant-days) and lowest in Québec (14.35 DDDs/1,000 inhabitant-days). Much of the inter-provincial variation in DIDs could be explained by differences in consumption of penicillins with extended-spectrum, fluoroquinolones, tetracyclines, macrolides, first-generation cephalosporins, combinations of sulfonamides and trimethoprim (including derivatives), and nitrofuran derivatives.

In 2010, there was a drug shortage in multiple countries, including Canada, affecting the supply of both tetracycline and cephalexin, among other drugs. This shortage may have been responsible for the 46% (-0.21 DID) decrease in tetracycline (J01AA07) consumption observed in 2010 compared to 2009. Provinces with greater use would likely be affected more providing a possible explanation for the largest decrease observed in Prince Edward Island (-41%; -0.53 DID). The drug shortage may also explain why a large decrease in amoxicillin-clavulanic acid (J01CR02) consumption was also observed in Prince Edward Island (-30%, -0.44 DID).

When the total amount of oral antimicrobials dispensed in 2009 by Canadian retail pharmacies was compared with the total outpatient use in 32 European countries in the same year, Canadian consumption was similar to the level of consumption of Finland and the Czech Republic. Canada ranked 15th out of the 33 countries classified by increasing level of total antimicrobial consumption. Canada ranked 30th for its level of consumption of macrolides, lincosamides and streptogramins. Canada ranked 7th for its penicillin consumption.

Table 29. Number of prescriptions per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	Antimicrobial	ATC Class	Number of prescriptions/1,000 inhabitants										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	18.66	18.41	17.54	17.69	16.98	18.66	19.35	19.67	20.54	21.01	18.75
	Cefixime	Third-generation cephalosporins (J01DD)	5.66	5.28	4.83	4.23	3.68	3.74	3.77	3.98	4.23	4.45	5.26
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	76.23	81.03	85.73	91.74	94.22	95.30	98.66	97.58	97.42	96.35	97.01
	Vancomycin	Glycopeptides (J01XA)	0.14	0.14	0.16	0.19	0.34	0.39	0.37	0.40	0.42	0.48	0.51
	Metronidazole	Imidazole (J01XD)	NPD	16.65	16.71	17.09	17.25	17.41	18.50	17.70	18.06	18.59	19.39
	Linezolid	Linezolid (J01XX)	NPD	< 0.01	0.01	0.02	0.04	0.04	0.04	0.05	0.05	0.06	0.07
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	193.18	183.54	171.05	169.81	156.08	168.34	168.94	158.51	155.79	157.37	162.56
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	45.42	42.10	39.85	39.62	36.59	36.89	37.25	34.87	32.93	32.07	28.34
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	19.78	18.38	16.78	15.61	14.17	12.49	11.87	10.34	9.30	8.35	10.19
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	41.03	41.70	43.07	45.23	45.65	48.36	51.48	49.95	50.17	50.08	48.12
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	55.09	48.95	43.06	41.41	39.37	39.65	37.39	32.64	30.78	29.72	26.68
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	56.52	50.62	44.56	41.05	37.12	35.15	35.45	33.67	33.57	33.10	33.07
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	146.55	149.72	145.48	149.00	138.51	149.25	146.93	134.69	132.75	131.92	127.15
	Clindamycin	Lincosamides (J01FF)	15.92	16.74	17.63	18.48	18.85	19.73	21.86	21.94	22.11	22.33	24.14
	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	0.08	0.06	0.05	0.04	0.05	< 0.01	< 0.01	< 0.01	NPD	< 0.01	NPD
	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	3.50	2.43	1.58	1.05	0.67	0.60	0.52	0.36	0.12	< 0.01	NPD
	Fusidic acid	Steroid antibacterials (J01XC)	0.06	0.06	0.05	0.05	0.05	0.06	0.07	0.05	0.04	0.02	< 0.01

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NPD = No prescriptions dispensed.
Chloramphenicol was removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported during the study period.

Table 29 (continued). Number of prescriptions per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	Antimicrobial	ATC Class	Number of prescriptions/1,000 inhabitants										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	43.47	41.16	39.31	38.41	36.71	36.33	37.07	35.55	35.52	35.61	36.38
	Trimethoprim	Trimethoprim and derivatives (J01EA)	2.22	2.12	2.13	2.16	2.02	1.85	1.95	1.93	1.87	1.91	1.94
	Sulfamethizole, sulfapyridine, sulfisoxazole	Short-acting sulfonamides (J01EB)	0.07	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	NPD
	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	0.02	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	14.61	15.76	16.41	17.48	19.13	20.35	22.67	23.2	24.89	27.04	29.26
	Fosfomycin	Fosfomycin (J01XX)	0.44	0.47	0.29	0.21	0.14	0.11	0.09	0.05	0.01	0.02	0.01
NC	Methenamine	Methenamine (J01XX)	0.27	0.28	0.29	0.28	0.25	0.23	0.23	0.23	0.16	0.24	0.27
		Total (J01)	**737.90**	**733.92**	**702.09**	**705.14**	**668.93**	**694.94**	**710.21**	**676.38**	**670.44**	**670.59**	**668.97**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NC = Not classified. NPD = No prescriptions dispensed.
Chloramphenicol was removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported during the study period.

Table 30. Number of prescriptions per 1,000 inhabitants of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	ATC Class	Antimicrobial	Number of prescriptions/1,000 inhabitants										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
I	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	Amoxicillin and enzyme inhibitor (J01CR02)	18.66	18.41	17.54	17.69	16.98	18.66	19.35	19.67	20.54	21.01	18.75
I	Third-generation cephalosporins (J01DD)	Cefixime (J01DD08)	5.66	5.28	4.83	4.23	3.68	3.74	3.77	3.98	4.23	4.45	5.26
I	Fluoroquinolones (J01MA)	Ofloxacin (J01MA01)	1.78	1.47	1.22	1.09	0.98	0.84	0.85	0.74	0.64	0.55	0.43
I		Ciprofloxacin (J01MA02)	51.25	47.70	48.32	51.35	53.46	55.90	61.06	61.76	62.56	62.50	64.23
I		Norfloxacin (J01MA06)	12.49	12.06	11.43	10.71	10.06	9.30	8.83	7.58	6.96	6.41	5.89
I		Levofloxacin (J01MA12)	10.35	14.32	13.11	13.36	13.10	11.48	10.52	9.68	9.68	9.20	9.18
I		Moxifloxacin (J01MA14)	0.36	4.68	7.89	10.23	11.07	13.35	16.55	17.66	17.48	17.67	17.28
I	Glycopeptides (J01XA)	Vancomycin (J01XA01)	0.14	0.14	0.16	0.19	0.34	0.39	0.37	0.40	0.42	0.48	0.51
I	Imidazole (J01XD)	Metronidazole (J01XD01)	NPD	16.65	16.71	17.09	17.25	17.41	18.50	17.70	18.06	18.59	19.39
I	Linezolid (J01XX)	Linezolid (J01XX08)	NPD	< 0.01	0.01	0.02	0.04	0.04	0.04	0.05	0.05	0.06	0.07
II	Penicillins with extended spectrum (J01CA)	Ampicillin (J01CA01)	3.28	2.77	2.22	1.98	1.68	1.36	1.19	0.98	0.86	0.78	0.73
II		Amoxicillin (J01CA04)	179.87	172.09	162.04	162.10	149.79	163.86	165.55	155.76	154.31	156.58	161.83
II		Pivampicillin (J01CA02)	9.75	8.48	6.64	5.70	4.60	3.12	2.19	1.78	0.63	0.01	< 0.01
II	β-lactamase sensitive penicillins (J01CE)	Penicillin G (J01CE01)	0.13	0.08	0.02	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
II		Penicillin V (J01CE02)	45.29	42.02	39.83	39.62	36.59	36.89	37.25	34.87	32.93	32.07	28.34
II	β-lactamase resistant penicillins (J01CF)	Cloxacillin (J01CF02)	19.78	18.38	16.78	15.61	14.17	12.49	11.87	10.34	9.30	8.35	10.19
II	First-generation cephalosporins (J01DB)	Cephalexin (J01DB01)	39.09	39.63	40.87	42.88	43.28	45.93	48.70	47.15	47.25	47.05	45.48
II		Cefadroxil (J01DB05)	1.94	2.07	2.20	2.36	2.38	2.42	2.77	2.80	2.92	3.02	2.64
II	Second-generation cephalosporins (J01DC)	Cefaclor (J01DC04)	18.62	13.78	9.73	7.19	4.98	4.36	3.23	2.54	2.06	1.65	0.36
II		Cefprozil (J01DC10)	14.59	16.47	18.50	21.20	22.98	23.82	23.44	20.01	18.95	18.52	17.96
II		Cefuroxime axetil (J01DC02)	21.89	18.71	14.83	13.03	11.40	11.47	10.73	10.10	9.76	9.55	8.35
II	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	Sulfamethoxazole and trimethoprim (J01EE01)	56.27	50.43	44.41	40.95	37.07	35.14	35.45	33.67	33.57	33.09	33.07
II		Sulfadiazine and trimethoprim (J01EE02)	0.25	0.20	0.15	0.11	0.05	0.01	< 0.01	NPD	< 0.01	< 0.01	NPD
II	Macrolides (J01FA)	Azithromycin (J01FA10)	42.49	52.86	59.62	66.16	61.02	66.06	65.36	59.71	58.99	58.37	55.28
II		Clarithromycin (J01FA09)	69.20	69.22	64.72	63.47	59.11	65.01	67.07	65.07	65.01	66.61	65.53
II		Erythromycin (J01FA01)	34.14	26.99	20.63	18.69	15.06	12.65	11.14	9.09	8.56	6.81	6.19
II	Lincosamides (J01FF)	Clindamycin (J01FF01)	15.92	16.74	17.63	18.48	18.85	19.73	21.86	21.94	22.11	22.33	24.14
II	Other quinolones, excluding fluoroquinolones (J01MB)	Nalidixic acid (J01MB02)	0.08	0.06	0.05	0.04	0.05	< 0.01	< 0.01	< 0.01	NPD	< 0.01	NPD
II	Sulfonamide combinations, excluding trimethoprim (J01RA)	Erythromycin-sulfisoxazole (J01RA02)	3.50	2.43	1.58	1.05	0.67	0.60	0.52	0.36	0.12	< 0.01	NPD
II	Steroid antimicrobials (J01XC)	Fusidic acid (J01XC01)	0.06	0.06	0.05	0.05	0.05	0.06	0.07	0.05	0.04	0.02	< 0.01

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NPD = No prescriptions dispensed.

Table 30 (continued). Number of prescriptions per 1,000 inhabitants of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	ATC Class	Antimicrobial	Number of prescriptions/1,000 inhabitants										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	Tetracyclines (J01AA)	Doxycycline (J01AA02)	11.79	11.00	10.17	10.07	9.55	10.07	10.92	11.43	12.03	12.57	14.71
		Minocycline (J01AA08)	16.76	16.90	17.01	17.23	17.11	16.97	17.45	16.49	16.34	16.16	17.81
		Tetracycline (J01AA07)	14.91	13.23	12.08	11.07	10.01	9.26	8.66	7.61	7.14	6.88	3.87
	Trimethoprim and derivatives (J01EA)	Trimethoprim (J01EA01)	2.22	2.12	2.13	2.16	2.02	1.85	1.95	1.93	1.87	1.91	1.94
III	Short-acting sulfonamides (J01EB)	Sulfamethizole (J01EB02), sulfapyridine (J01EB04), sulfisoxazole (J01EB05)	0.07	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	NPD
	Intermediate-acting sulfonamides (J01EC)	Sulfadiazine (J01EC02), sulfamethoxazole (J01EC04)	0.02	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Nitrofuran derivatives (J01XE)	Nitrofurantoin (J01XE01)	14.61	15.76	16.41	17.48	19.13	20.35	22.67	23.20	24.89	27.04	29.26
	Fosfomycin (J01XX)	Fosfomycin (J01XX01)	0.44	0.47	0.29	0.21	0.14	0.11	0.09	0.05	0.01	0.02	0.01
NC	Methenamine (J01XX)	Methenamine (J01XX05)	0.27	0.28	0.29	0.28	0.25	0.23	0.23	0.23	0.16	0.24	0.27
	Total (J01)		**737.90**	**733.92**	**702.09**	**705.14**	**668.93**	**694.94**	**710.21**	**676.38**	**670.44**	**670.59**	**668.97**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NC = Not classified. NPD = No prescriptions dispensed.
Chloramphenicol was removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported during the study period.

Figure 38. Number of prescriptions and total cost per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

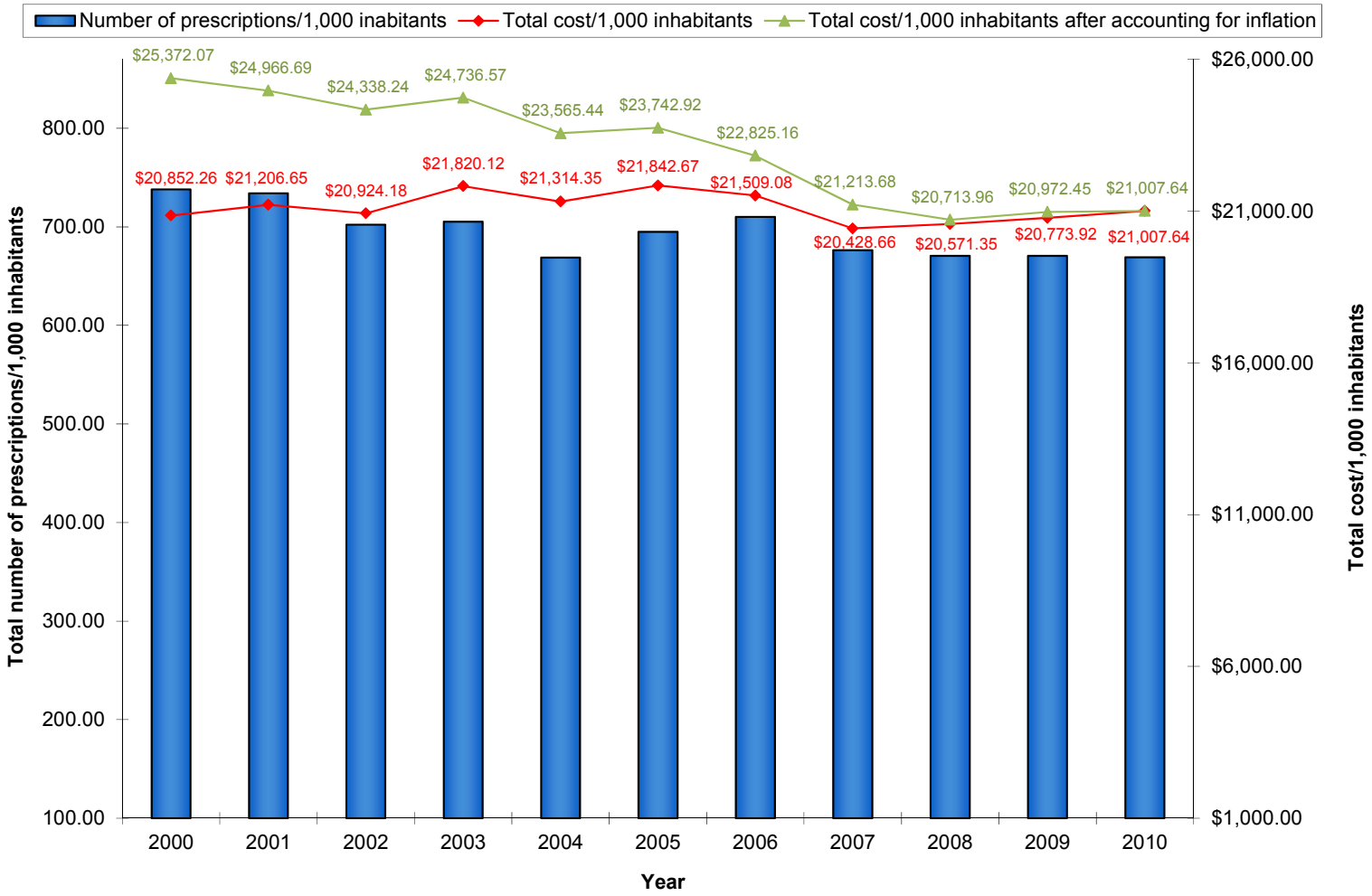


Table 31. Total cost per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	Antimicrobial	ATC Class	Total cost/1,000 inhabitants ($)										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	923.13	873.35	750.05	717.42	646.40	685.99	703.73	696.47	695.31	723.97	664.25
	Cefixime	Third-generation cephalosporins (J01DD)	258.27	231.67	208.87	176.09	147.29	149.45	144.62	153.32	159.97	170.81	206.35
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	5,214.65	5,363.75	5,534.67	5,757.50	5,372.40	4,652.61	4,432.50	4,358.38	4,224.70	4,164.79	4,002.39
	Vancomycin	Glycopeptides (J01XA)	62.09	64.61	72.21	86.59	145.09	161.91	154.43	165.35	161.83	186.21	204.14
	Metronidazole	Imidazole (J01XD)	NPD	234.15	261.19	275.77	288.80	292.12	313.90	292.92	292.80	305.32	376.21
	Linezolid	Linezolid (J01XX)	NPD	7.49	22.72	49.44	79.15	104.16	97.23	102.77	99.77	118.29	119.58
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	3,239.69	3,012.85	2,810.49	2,784.62	2,537.56	2,665.80	2,622.95	2,480.15	2,906.97	3,053.52	3,250.18
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	605.12	550.15	526.61	525.19	481.99	469.70	465.21	437.15	451.92	454.11	423.57
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	350.06	321.03	292.63	274.56	250.02	214.26	200.60	175.48	200.70	188.29	236.44
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	896.39	890.56	929.30	978.59	984.39	1,014.20	1,061.46	1,017.99	1,223.22	1,262.00	1,290.87
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	2,842.20	2,512.79	2,117.08	2,048.94	1,987.63	2,013.05	1,926.40	1,600.16	1,297.58	1,251.66	1,108.27
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	769.12	672.30	594.39	545.41	485.13	443.23	437.29	413.70	400.78	397.51	441.90
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	7,057.51	7,272.73	7,233.99	7,527.10	7,210.60	7,926.75	7,197.47	6,338.06	5,754.52	5,784.36	5,549.92
	Clindamycin	Lincosamides (J01FF)	811.33	712.98	738.66	742.26	746.58	759.59	820.83	811.56	786.52	808.43	875.58
	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	4.40	3.54	2.94	2.57	2.39	0.08	0.02	< 0.01	NPD	< 0.01	NPD
	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	115.76	77.96	50.56	33.31	21.67	19.79	16.78	11.74	3.83	< 0.01	NPD
	Fusidic acid	Steroid antibacterials (J01XC)	7.47	7.94	7.03	7.14	6.90	7.54	7.65	5.79	4.81	2.25	0.11
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	1,771.73	1,709.25	1,728.33	1,728.77	1,672.20	1,648.26	1,662.51	1,587.69	1,465.12	1,456.42	1,546.47
	Chloramphenicol	Amphenicols (J01BA)	0.02	0.06	0.01	NPD	< 0.01	< 0.01	NPD	NPD	NPD	NPD	< 0.01
	Trimethoprim	Trimethoprim and derivatives (J01EA)	58.00	51.42	48.56	44.92	38.73	34.35	34.44	32.69	29.54	33.44	35.77
	Sulfamethizole, sulfapyridine, sulfisoxazole	Short-acting sulfonamides (J01EB)	3.39	0.41	0.03	0.02	0.02	< 0.01	0.01	< 0.01	< 0.01	NPD	NPD
	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	0.55	0.47	0.37	0.54	0.24	0.18	0.17	0.19	0.14	< 0.01	< 0.01
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	354.00	367.71	387.14	413.71	447.20	469.27	515.60	524.07	549.78	604.80	667.70
	Fosfomycin	Fosfomycin (J01XX)	17.90	18.91	12.09	8.62	6.10	4.82	3.81	2.19	0.39	0.91	0.59
NC	Methenamine	Methenamine (J01XX)	9.30	8.56	8.30	7.47	6.98	5.80	5.55	5.80	3.79	5.39	7.34
		Total (J01)	**25,372.07**	**24,966.69**	**24,338.24**	**24,736.57**	**23,565.44**	**23,742.92**	**22,825.16**	**21,213.68**	**20,713.96**	**20,972.45**	**21,007.64**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NC = Not classified. NPD = No prescriptions dispensed.

Table 32. Defined daily doses per 1,000 inhabitant-days of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	Antimicrobial	ATC Class	DDDs/1,000 inhabitant-days										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	0.51	0.52	0.50	0.52	0.52	0.59	0.64	0.67	0.71	0.75	0.67
	Cefixime	Third-generation cephalosporins (J01DD)	0.10	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.07	0.07	0.08
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	1.83	1.93	1.99	2.08	2.09	2.08	2.14	2.09	2.06	2.03	2.05
	Metronidazole	Imidazole (J01XD)	NPD	0.21	0.22	0.22	0.22	0.23	0.24	0.23	0.24	0.24	0.26
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	5.07	4.90	4.63	4.57	4.38	4.52	4.61	4.43	4.43	4.54	4.74
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	0.67	0.63	0.60	0.60	0.55	0.56	0.57	0.54	0.51	0.49	0.44
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	0.37	0.35	0.32	0.31	0.28	0.25	0.24	0.21	0.19	0.18	0.22
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	0.75	0.77	0.80	0.85	0.87	0.92	1.00	0.97	0.98	0.98	0.96
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	1.39	1.22	1.05	1.00	0.94	0.96	0.91	0.83	0.80	0.78	0.70
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	1.39	1.25	1.12	1.04	0.92	0.84	0.84	0.78	0.77	0.76	0.75
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	3.68	3.65	3.44	3.58	3.44	3.78	3.87	3.75	3.73	3.79	3.75
	Clindamycin	Lincosamides (J01FF)	0.24	0.27	0.28	0.31	0.32	0.32	0.36	0.37	0.38	0.39	0.43
	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	0.09	0.06	0.04	0.03	0.02	0.02	0.01	0.01	< 0.01	< 0.01	NPD
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	2.72	2.62	2.54	2.50	2.40	2.42	2.47	2.39	2.39	2.41	2.47
	Trimethoprim	Trimethoprim and derivatives (J01EA)	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.05
	Sulfamethizole, sulfapyridine, sulfisoxazole	Short-acting sulfonamides (J01EB)	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	NPD
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	0.42	0.44	0.45	0.47	0.49	0.52	0.57	0.58	0.61	0.66	0.70
NC	Methenamine	Methenamine (J01XX)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01
		Total (J01)	**19.32**	**19.00**	**18.15**	**18.24**	**17.60**	**18.14**	**18.60**	**17.98**	**17.93**	**18.12**	**18.29**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NC = Not classified. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported during the study period. These are: chloramphenicol, fosfomycin, fusidic acid, linezolid, nalidixic acid, sulfadiazine, sulfamethoxazole, and vancomycin.

Table 33. Defined daily doses per 1,000 inhabitant-days of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	ATC Class	Antimicrobial	DDDs/1,000 inhabitant-days										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
II	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	Amoxicillin and enzyme inhibitor (J01CR02)	0.51	0.52	0.50	0.52	0.52	0.59	0.63	0.67	0.71	0.74	0.67
II	Third-generation cephalosporins (J01DD)	Cefixime (J01DD08)	0.10	0.09	0.08	0.07	0.06	0.06	0.06	0.06	0.07	0.07	0.08
I	Fluoroquinolones (J01MA)	Ofloxacin (J01MA01)	0.13	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.03
I		Ciprofloxacin (J01MA02)	1.14	1.06	1.04	1.07	1.08	1.11	1.20	1.20	1.20	1.20	1.24
I		Norfloxacin (J01MA06)	0.28	0.27	0.26	0.24	0.22	0.21	0.19	0.17	0.15	0.14	0.13
I		Levofloxacin (J01MA12)	0.27	0.36	0.32	0.33	0.32	0.29	0.27	0.25	0.24	0.23	0.23
I		Moxifloxacin (J01MA14)	0.01	0.11	0.19	0.24	0.26	0.32	0.40	0.43	0.42	0.42	0.42
II	Imidazole (J01XD)	Metronidazole (J01XD01)	NPD	0.21	0.22	0.22	0.22	0.23	0.24	0.23	0.24	0.24	0.26
II	Penicillins with extended spectrum (J01CA)	Ampicillin (J01CA01)	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01
II		Amoxicillin (J01CA04)	4.79	4.66	4.43	4.40	4.24	4.42	4.53	4.36	4.39	4.52	4.73
II		Pivampicillin (J01CA02)	0.21	0.19	0.15	0.13	0.11	0.08	0.06	0.05	0.02	< 0.01	< 0.01
II	β-lactamase sensitive penicillins (J01CE)	Penicillin V (J01CE02)	0.67	0.63	0.60	0.60	0.55	0.56	0.57	0.54	0.51	0.49	0.44
II	β-lactamase resistant penicillins (J01CF)	Cloxacillin (J01CF02)	0.37	0.35	0.32	0.31	0.28	0.25	0.24	0.21	0.19	0.18	0.22
II	First-generation cephalosporins (J01DB)	Cephalexin (J01DB01)	0.72	0.74	0.78	0.82	0.84	0.89	0.96	0.94	0.94	0.94	0.92
II		Cefadroxil (J01DB05)	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
II	Second-generation cephalosporins (J01DC)	Cefaclor (J01DC04)	0.37	0.27	0.19	0.15	0.11	0.09	0.07	0.05	0.04	0.04	0.01
II		Cefprozil (J01DC10)	0.22	0.25	0.29	0.34	0.38	0.39	0.39	0.35	0.34	0.33	0.33
II		Cefuroxime axetil (J01DC02)	0.80	0.69	0.56	0.51	0.46	0.47	0.45	0.43	0.42	0.41	0.36
II	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	Sulfamethoxazole and trimethoprim (J01EE01)	1.38	1.25	1.12	1.04	0.92	0.84	0.84	0.78	0.77	0.76	0.75
II		Sulfadiazine and trimethoprim (J01EE02)	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	< 0.01	< 0.01	NPD
II	Macrolides (J01FA)	Azithromycin (J01FA10)	0.53	0.65	0.73	0.82	0.76	0.83	0.83	0.78	0.78	0.79	0.79
II		Clarithromycin (J01FA09)	2.22	2.25	2.11	2.23	2.18	2.48	2.64	2.68	2.70	2.79	2.76
II		Erythromycin (J01FA01)	0.92	0.74	0.59	0.53	0.44	0.37	0.34	0.28	0.25	0.21	0.20
II	Lincosamides (J01FF)	Clindamycin (J01FF01)	0.24	0.27	0.28	0.31	0.32	0.32	0.36	0.37	0.38	0.39	0.43
II	Sulfonamide combinations, excluding trimethoprim (J01RA)	Erythromycin-sulfisoxazole (J01RA02)	0.09	0.06	0.04	0.03	0.02	0.02	0.01	0.01	< 0.01	< 0.01	NPD

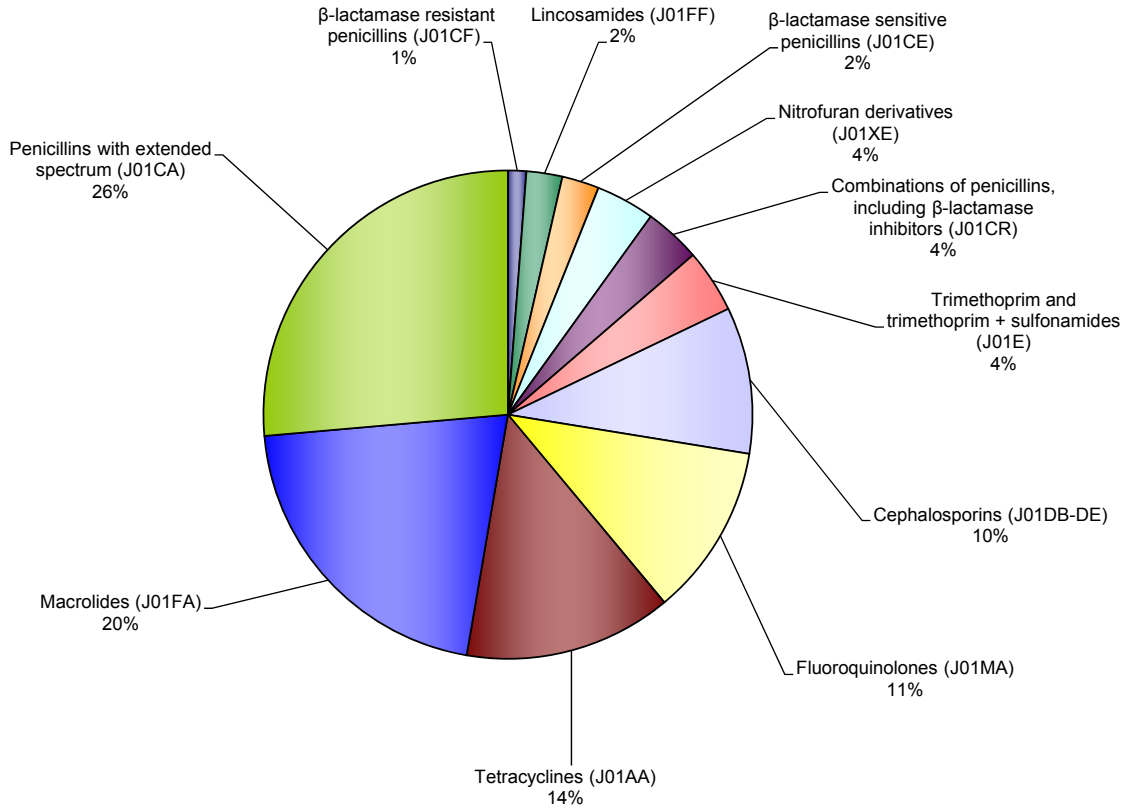
Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported during the study period. These are: chloramphenicol, fosfomycin, fusidic acid, linezolid, nalidixic acid, penicillin G, sulfadiazine, sulfamethoxazole, and vancomycin.

Table 33 (continued). Defined daily doses per 1,000 inhabitant-days of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	ATC Class	Antimicrobial	DDDs/1,000 inhabitant-days										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
III	Tetracyclines (J01AA)	Doxycycline (J01AA02)	0.75	0.73	0.70	0.71	0.70	0.74	0.81	0.85	0.91	0.96	1.15
		Minocycline (J01AA08)	0.97	1.00	1.01	1.04	1.03	1.04	1.07	1.02	1.00	0.99	1.07
		Tetracycline (J01AA07)	0.99	0.89	0.83	0.75	0.67	0.63	0.60	0.52	0.48	0.46	0.25
	Trimethoprim and derivatives (J01EA)	Trimethoprim (J01EA01)	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.05
	Short-acting sulfonamides (J01EB)	Sulfamethizole (J01EB02), sulfapyridine (J01EB04), sulfisoxazole (J01EB05)	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	NPD
	Nitrofuran derivatives (J01XE)	Nitrofurantoin (J01XE01)	0.42	0.44	0.45	0.47	0.49	0.52	0.57	0.58	0.61	0.66	0.70
NC	Methenamine (J01XX)	Methenamine (J01XX05)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	< 0.01	0.01	0.01
	Total (J01)		**19.32**	**19.00**	**18.15**	**18.24**	**17.60**	**18.14**	**18.60**	**17.98**	**17.93**	**18.12**	**18.29**

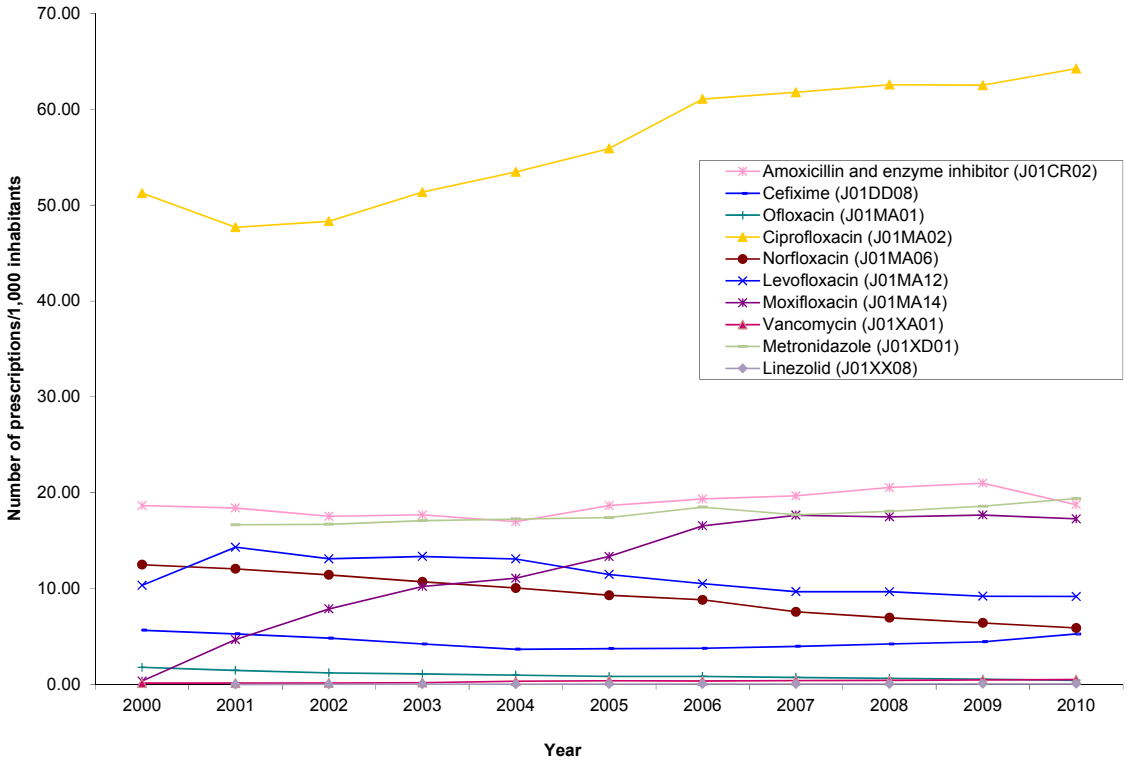
Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NC = Not classified. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported during the study period. These are: chloramphenicol, fosfomycin, fusidic acid, linezolid, nalidixic acid, penicillin G, sulfadiazine, sulfamethoxazole, and vancomycin.

Figure 39. Percentages of defined daily doses per 1,000 inhabitant-days of oral antimicrobials dispensed by Canadian retail pharmacies, 2010.



Alphanumeric codes in parentheses represent Anatomical Therapeutic Chemical classes of antimicrobials.

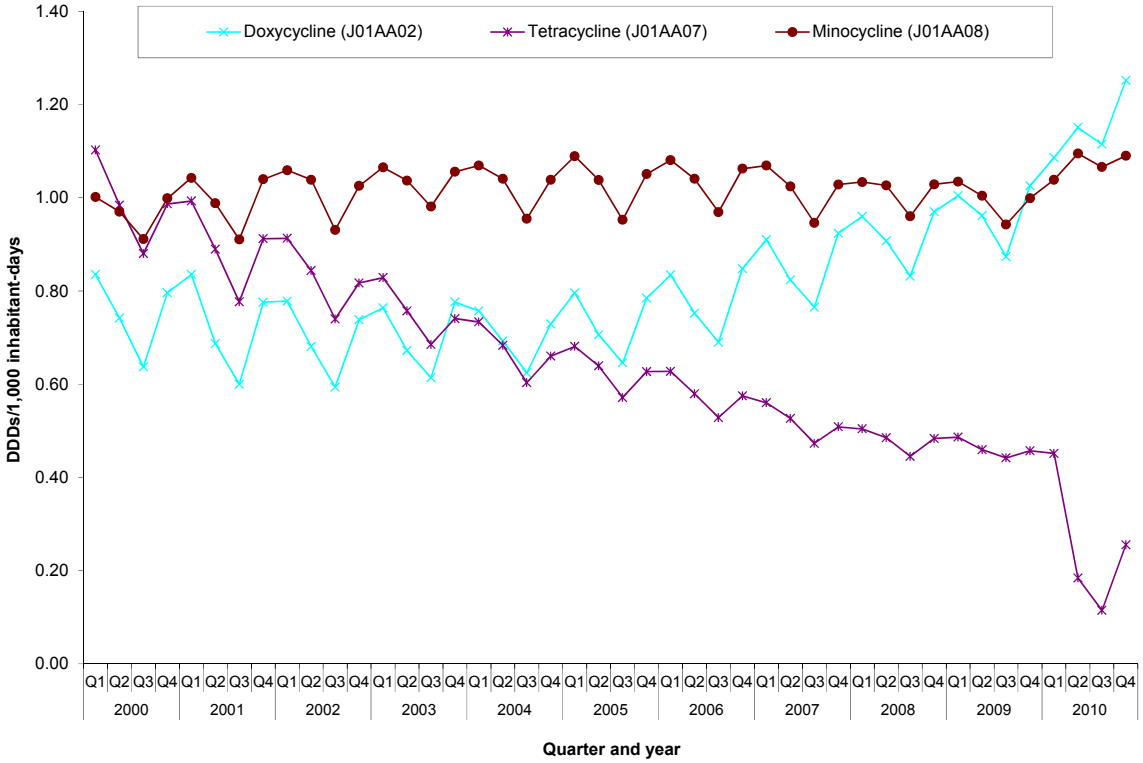
Figure 40. Number of prescriptions per 1,000 of Category I (Very High Importance to Human Medicine)[1] oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.



Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.

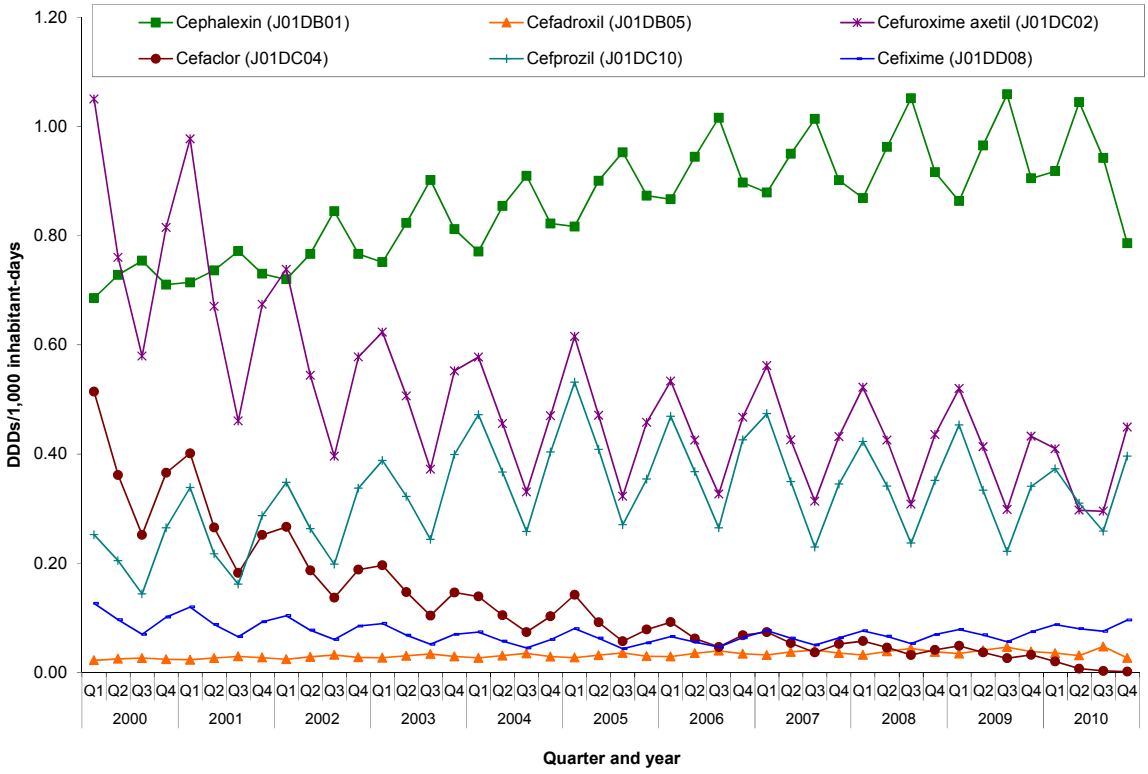
[1] Version April, 2009. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed May 2013.

Figure 41. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral tetracyclines (J01AA) dispensed by Canadian retail pharmacies, 2000–2010.



Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.
DDDs = Defined daily doses.

Figure 42. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral cephalosporins (J01DB-DD) dispensed by Canadian retail pharmacies, 2000–2010.



Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.
DDDs = Defined daily doses.

Table 34. Number of prescriptions per 1,000 inhabitants of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2010.

	Antimicrobial	ATC Class	Number of prescriptions/1,000 inhabitants									
			BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	15.57	18.55	15.30	16.67	14.64	26.36	20.47	20.50	30.70	44.28
	Cefixime	Third-generation cephalosporins (J01DD)	5.55	5.41	1.89	4.11	5.62	4.87	3.61	5.80	13.45	8.17
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	86.24	94.40	67.59	93.12	93.70	112.82	95.47	83.08	108.90	168.13
	Vancomycin	Glycopeptides (J01XA)	0.52	0.24	0.14	0.15	0.21	1.33	0.24	0.26	0.08	0.14
	Metronidazole	Imidazole (J01XD)	19.01	21.67	23.60	20.13	20.34	15.63	19.37	22.56	17.30	28.78
	Linezolid	Linezolid (J01XX)	0.05	0.02	0.09	0.01	0.05	0.14	0.04	0.02	0.04	0.02
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	153.80	171.32	249.45	185.63	188.73	94.13	162.92	180.68	178.24	322.73
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	28.48	30.13	20.70	32.50	23.28	34.99	36.67	30.12	26.68	38.88
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	10.20	9.05	16.95	21.89	10.77	6.62	7.29	11.03	12.97	21.10
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	59.24	58.04	93.98	61.66	47.59	26.22	56.53	56.98	50.71	84.05
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	11.45	23.58	13.17	17.68	32.17	29.42	33.42	36.00	12.16	32.11
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	34.32	36.20	61.95	46.10	32.23	21.43	43.80	51.69	53.67	61.71
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	100.97	128.40	137.24	141.42	142.12	108.33	139.02	134.30	154.85	189.08
	Clindamycin	Lincosamides (J01FF)	24.34	29.81	31.62	19.82	24.13	21.66	25.41	23.99	16.73	20.60
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	42.88	45.65	62.83	35.83	28.85	36.61	31.38	47.32	47.74	41.47
	Trimethoprim	Trimethoprim and derivatives (J01EA)	1.01	1.01	2.87	0.34	1.71	3.55	1.90	0.80	1.53	2.40
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	34.10	24.29	41.80	18.50	36.77	16.19	29.16	39.11	22.80	21.40
	Fosfomycin	Fosfomycin (J01XX)	0.03	0.01	0.03	< 0.01	0.01	0.01	0.01	0.07	NPD	0.02
NC	Methenamine	Methenamine (J01XX)	0.24	0.14	0.14	< 0.01	0.14	0.71	0.16	0.01	NPD	0.01
		Total (J01)	**628.06**	**697.97**	**841.54**	**715.61**	**703.15**	**561.16**	**707.05**	**744.34**	**748.55**	**1,085.11**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NC = Not classified. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported among the provinces. These are: chloramphenicol, erythromycin-sulfisoxazole, fusidic acid, nalidixic acid, sulfadiazine, sulfamethizole, sulfamethoxazole, sulfapyridine, and sulfisoxazole.

Table 35. Consumption (DDDs/1,000 inhabitant-days) of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2010.

	Antimicrobial	ATC Class	DDDs/1,000 inhabitant-days									
			BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL
	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	0.55	0.63	0.51	0.62	0.54	0.95	0.81	0.77	1.04	1.53
	Cefixime	Third-generation cephalosporins (J01DD)	0.11	0.10	0.02	0.07	0.09	0.06	0.07	0.10	0.28	0.17
I	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	1.68	2.01	1.41	2.01	2.16	2.03	2.13	1.96	2.39	4.60
	Vancomycin	Glycopeptides (J01XA)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Metronidazole	Imidazole (J01XD)	0.25	0.28	0.29	0.28	0.28	0.20	0.26	0.30	0.24	0.37
	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	4.37	4.92	6.90	5.50	5.35	3.07	5.18	5.39	5.20	9.78
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	0.47	0.50	0.36	0.47	0.36	0.52	0.59	0.49	0.53	0.65
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	0.21	0.19	0.34	0.47	0.23	0.15	0.16	0.24	0.30	0.46
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	1.15	1.17	1.91	1.21	0.97	0.44	1.24	1.23	1.09	1.81
II	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	0.45	0.60	0.38	0.47	0.77	0.72	1.33	1.08	0.38	1.44
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	0.87	0.96	1.43	1.04	0.72	0.37	1.00	1.14	1.27	1.69
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	3.38	4.03	3.17	3.40	4.07	3.27	4.12	3.87	4.30	6.25
	Clindamycin	Lincosamides (J01FF)	0.42	0.54	0.59	0.38	0.41	0.39	0.50	0.45	0.35	0.38
	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	3.05	3.15	4.56	2.56	2.32	1.77	1.99	3.07	3.48	2.61
III	Trimethoprim	Trimethoprim and derivatives (J01EA)	0.04	0.03	0.11	0.01	0.06	0.05	0.05	0.02	0.03	0.12
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	0.79	0.64	1.05	0.49	0.87	0.34	0.80	1.02	0.69	0.65
NC	Methenamine	Methenamine (J01XX)	0.01	0.01	0.01	< 0.01	< 0.01	0.01	0.01	< 0.01	NPD	< 0.01
		Total (J01)	**17.82**	**19.78**	**23.07**	**19.00**	**19.22**	**14.35**	**20.27**	**21.13**	**21.56**	**32.53**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NC = Not classified. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported among the provinces. These are: chloramphenicol, erythromycin-sulfisoxazole, fosfomycin, fusidic acid, linezolide, nalidixic acid, sulfadiazine, sulfamethizole, sulfamethoxazole, sulfapyridine, and sulfisoxazole.

Table 36. Consumption (DDDs/1,000 inhabitant-days) of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2010.

	ATC Class	Antimicrobial	DDDs/1,000 inhabitant-days									
			BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL
II	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	Amoxicillin and enzyme inhibitor (J01CR02)	0.55	0.63	0.51	0.62	0.54	0.94	0.81	0.77	1.04	1.53
II	Third-generation cephalosporins (J01DD)	Cefixime (J01DD08)	0.11	0.10	0.02	0.07	0.09	0.06	0.07	0.10	0.28	0.17
I	Fluoroquinolones (J01MA)	Ofloxacin (J01MA01)	0.01	0.01	< 0.01	0.02	0.04	0.03	0.03	0.06	0.12	0.12
I		Ciprofloxacin (J01MA02)	1.22	1.27	1.03	1.32	1.17	1.22	1.07	1.22	1.21	3.70
I		Norfloxacin (J01MA06)	0.02	0.11	0.01	0.03	0.23	0.02	0.42	0.10	0.22	0.29
I		Levofloxacin (J01MA12)	0.06	0.33	0.07	0.41	0.31	0.18	0.04	0.25	0.21	0.08
I		Moxifloxacin (J01MA14)	0.37	0.28	0.30	0.23	0.40	0.58	0.57	0.32	0.63	0.41
II	Glycopeptides (J01XA)	Vancomycin (J01XA01)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
II	Imidazole (J01XD)	Metronidazole (J01XD01)	0.25	0.28	0.29	0.28	0.28	0.20	0.26	0.30	0.24	0.37
II	Penicillins with extended spectrum (J01CA)	Ampicillin (J01CA01)	0.01	0.01	0.10	< 0.01	0.01	< 0.01	0.01	0.02	0.05	0.18
II		Amoxicillin (J01CA04)	4.35	4.91	6.80	5.50	5.34	3.06	5.16	5.37	5.15	9.60
II	β-lactamase sensitive penicillins (J01CE)	Penicillin V (J01CE02)	0.47	0.50	0.36	0.47	0.36	0.52	0.59	0.49	0.53	0.65
II	β-lactamase resistant penicillins (J01CF)	Cloxacillin (J01CF02)	0.21	0.19	0.34	0.47	0.23	0.15	0.16	0.24	0.30	0.46
II	First-generation cephalosporins (J01DB)	Cephalexin (J01DB01)	1.15	1.17	1.91	1.21	0.97	0.30	1.23	1.23	1.09	1.81
II		Cefadroxil (J01DB05)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.14	0.01	< 0.01	< 0.01	< 0.01
II	Second-generation cephalosporins (J01DC)	Cefaclor (J01DC04)	0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	0.03	0.01	0.01	0.02
II		Cefprozil (J01DC10)	0.01	0.28	0.06	0.19	0.42	0.49	0.16	0.40	0.11	0.01
II		Cefuroxime axetil (J01DC02)	0.43	0.32	0.31	0.28	0.34	0.23	1.13	0.67	0.27	1.41
II	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	Sulfamethoxazole and trimethoprim (J01EE01)	0.87	0.96	1.43	1.04	0.72	0.37	1.00	1.14	1.27	1.69
II	Macrolides (J01FA)	Azithromycin (J01FA10)	0.43	0.68	0.88	1.30	0.99	0.63	0.88	0.88	0.77	0.93
II		Clarithromycin (J01FA09)	2.66	3.16	1.53	1.78	2.91	2.59	3.03	2.61	2.60	4.97
II		Erythromycin (J01FA01)	0.30	0.20	0.76	0.33	0.17	0.05	0.22	0.38	0.92	0.35
II	Lincosamides (J01FF)	Clindamycin (J01FF01)	0.42	0.54	0.59	0.38	0.41	0.39	0.50	0.45	0.35	0.38

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported among the provinces. These are: chloramphenicol, erythromycin-sulfisoxazole, fosfomycin, fusidic acid, linezolide, nalidixic acid, penicillin G, pivampicillin, sulfadiazine, sulfadiazine and trimethoprim, sulfamethizole, sulfamethoxazole, sulfapyridine, and sulfisoxazole.

Table 36 (continued). Consumption (DDDs/1,000 inhabitant-days) of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2010.

	ATC Class	Antimicrobial	DDDs/1,000 inhabitant-days									
			BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL
III	Tetracyclines (J01AA)	Doxycycline (J01AA02)	1.75	1.33	3.93	1.24	0.99	0.61	0.91	1.46	1.61	1.04
		Minocycline (J01AA08)	1.04	1.62	0.38	1.04	0.99	1.04	0.88	1.32	1.12	1.27
		Tetracycline (J01AA07)	0.26	0.20	0.25	0.28	0.34	0.11	0.19	0.29	0.75	0.30
	Trimethoprim and derivatives (J01EA)	Trimethoprim (J01EA01)	0.04	0.03	0.11	0.01	0.06	0.05	0.05	0.02	0.03	0.12
	Nitrofuran derivatives (J01XE)	Nitrofurantoin (J01XE01)	0.79	0.64	1.05	0.49	0.87	0.34	0.80	1.02	0.69	0.65
NC	Methenamine (J01XX)	Methenamine (J01XX05)	0.01	0.01	0.01	< 0.01	< 0.01	0.01	0.01	< 0.01	NPD	< 0.01
	Total (J01)		**17.82**	**19.78**	**23.07**	**19.00**	**19.22**	**14.35**	**20.27**	**21.13**	**21.56**	**32.53**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NC = Not classified. NPD = No prescriptions dispensed.
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported among the provinces. These are: chloramphenicol, erythromycin-sulfisoxazole, fosfomycin, fusidic acid, linezolide, nalidixic acid, penicillin G, pivampicillin, sulfadiazine, sulfadiazine and trimethoprim, sulfamethizole, sulfamethoxazole, sulfapyridine, and sulfisoxazole.

Table 37. Total cost per 1,000 inhabitant-days of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2010.

	Antimicrobial	ATC Class	Total cost/1,000 inhabitant-days ($)									
			BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	1.51	1.80	1.41	1.77	1.41	2.53	2.12	2.06	2.88	4.45
	Cefixime	Third-generation cephalosporins (J01DD)	0.66	0.63	0.17	0.48	0.62	0.41	0.43	0.66	1.83	1.01
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	9.82	10.96	7.96	10.55	10.80	11.70	12.00	10.45	13.85	22.22
	Vancomycin	Glycopeptides (J01XA)	0.59	0.33	0.18	0.20	0.33	1.23	0.28	0.31	0.09	0.19
	Metronidazole	Imidazole (J01XD)	0.96	1.24	1.09	0.98	1.15	0.75	1.00	1.17	0.83	1.38
	Linezolid	Linezolid (J01XX)	0.37	0.09	0.52	0.17	0.30	0.53	0.10	0.13	0.21	0.11
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	8.19	9.73	11.83	9.73	10.17	5.87	8.86	9.61	8.58	16.21
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	1.17	1.36	0.77	1.34	0.93	1.46	1.34	1.14	0.96	1.35
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	0.65	0.60	1.02	1.39	0.68	0.42	0.45	0.69	0.78	1.27
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	4.25	4.36	6.08	4.52	3.57	1.93	4.30	4.28	3.52	6.05
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	1.39	2.65	1.42	2.07	3.46	3.47	4.48	4.50	1.53	4.46
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	1.34	1.56	2.13	1.78	1.18	0.64	1.60	1.89	1.75	2.24
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	12.45	15.97	13.60	14.68	16.63	13.70	17.14	15.73	16.94	24.28
	Clindamycin	Lincosamides (J01FF)	2.53	3.22	3.39	2.16	2.26	2.06	2.88	2.62	1.92	2.21
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	4.65	5.89	4.74	4.15	4.18	3.23	3.43	5.21	4.97	4.82
	Trimethoprim	Trimethoprim and derivatives (J01EA)	0.07	0.06	0.20	0.02	0.10	0.12	0.10	0.05	0.06	0.18
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	2.17	1.72	2.77	1.16	2.32	0.81	1.92	2.60	1.37	1.42
	Fosfomycin	Fosfomycin (J01XX)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	NPD	< 0.01
NC	Methenamine	Methenamine (J01XX)	0.03	0.02	0.02	< 0.01	0.01	0.04	0.02	< 0.01	NPD	< 0.01
		Total (J01)	**52.79**	**62.18**	**59.31**	**57.14**	**60.12**	**50.92**	**62.45**	**63.10**	**62.08**	**93.86**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
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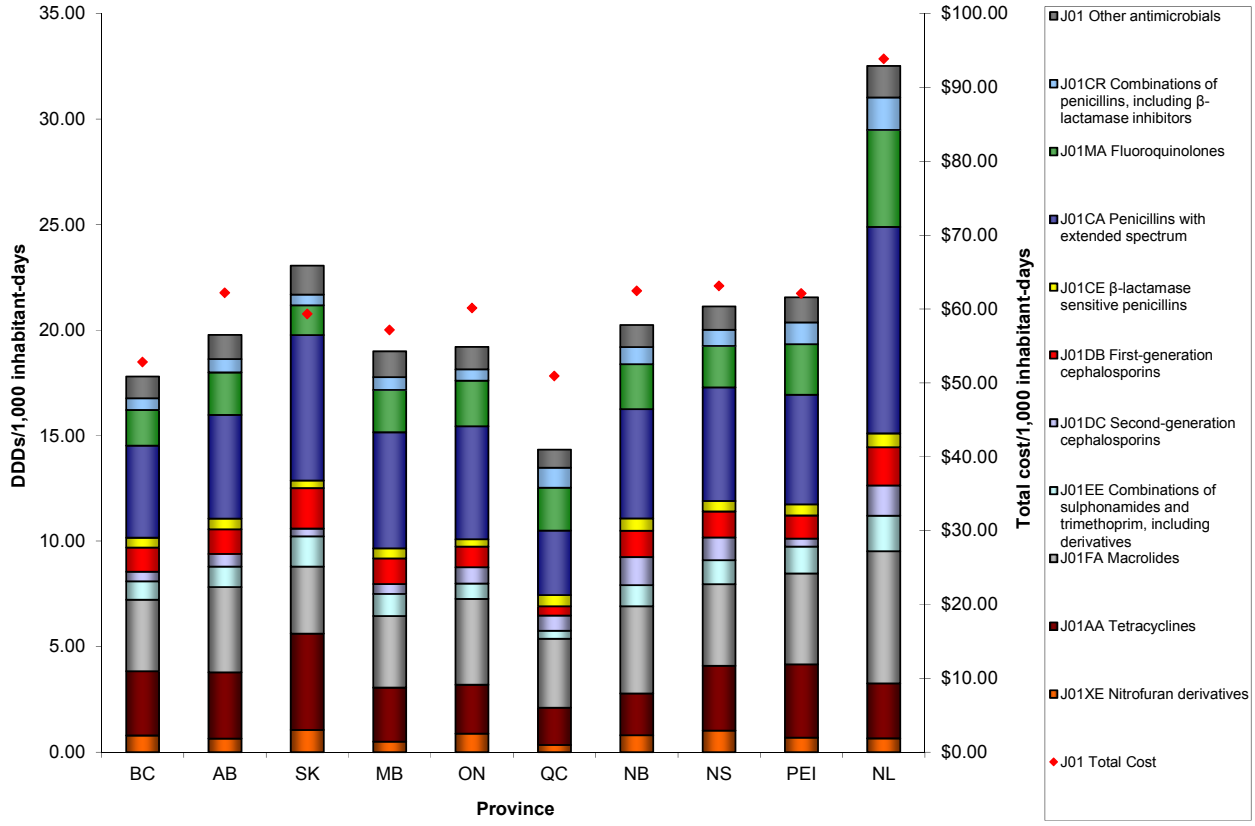
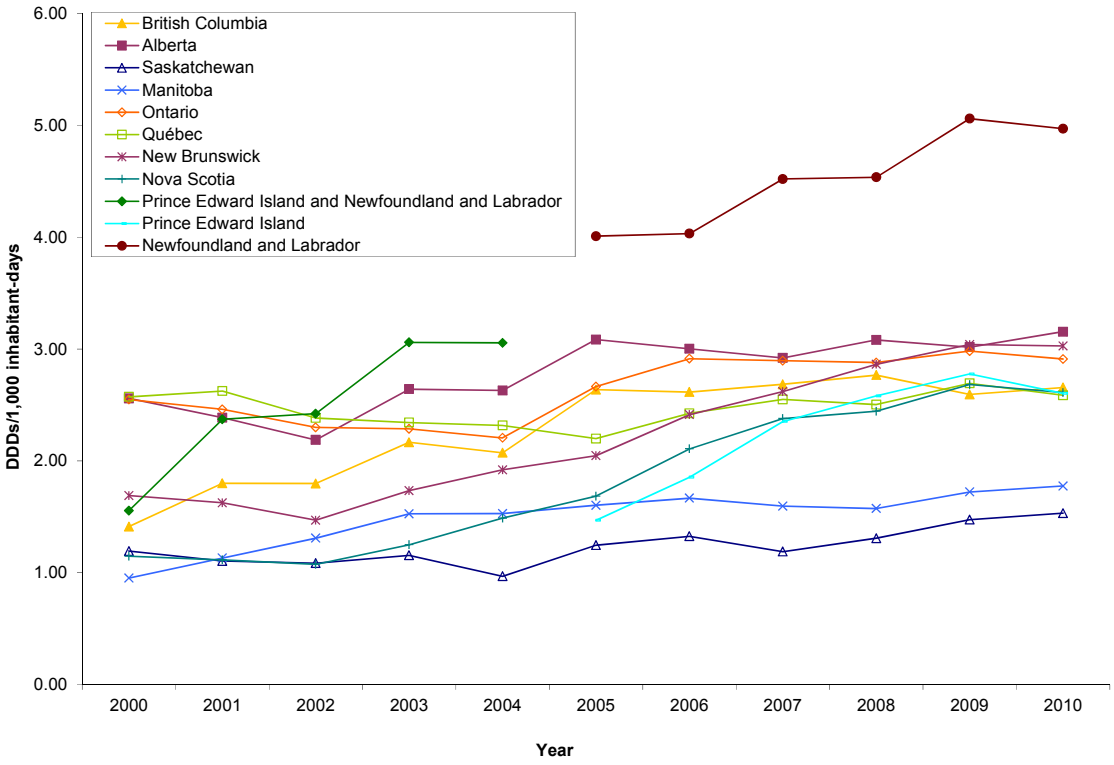
Certain antimicrobials were removed from this table due to low (less than 0.01 prescriptions/1,000 inhabitants) to no sales reported among the provinces. These are: chloramphenicol, erythromycin-sulfisoxazole, fusidic acid, nalidixic acid, sulfadiazine, sulfamethizole, sulfamethoxazole, sulfapyridine, and sulfisoxazole.

Figure 43. Consumption (DDDs/1,000 inhabitant-days) and total cost per 1,000 inhabitant-days of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2010.



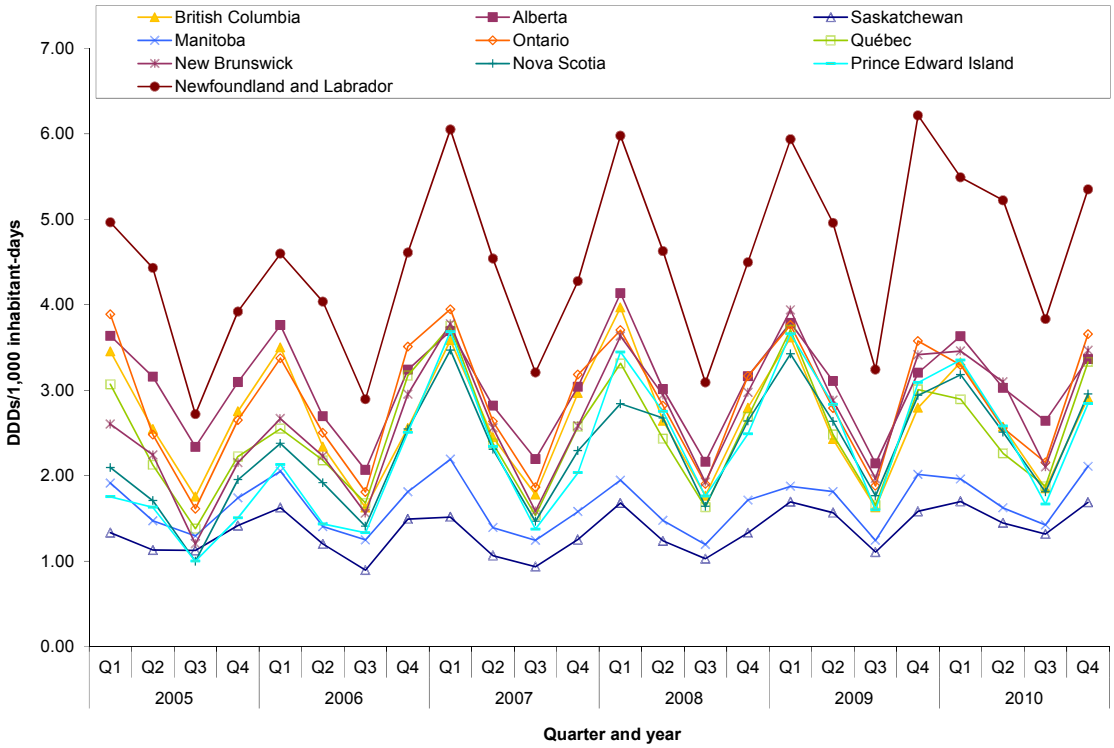
Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.
DDDs = Defined daily doses.

Figure 44. Provincial consumption (DDDs/1,000 inhabitant-days) of oral clarithromycin (J01FA09) dispensed by Canadian retail pharmacies, 2000-2010.



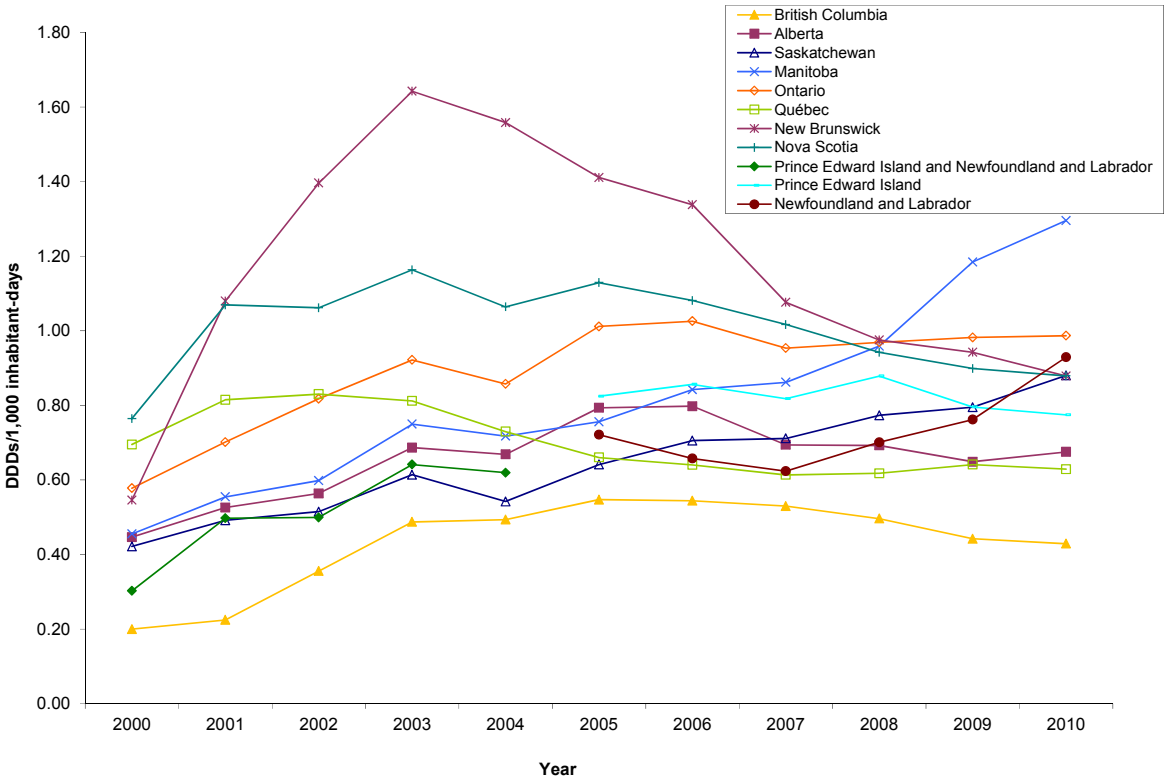
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 45. Provincial consumption (DDDs/1,000 inhabitant-days) by quarter of oral clarithromycin (J01FA09) dispensed by Canadian retail pharmacies, 2000-2010.



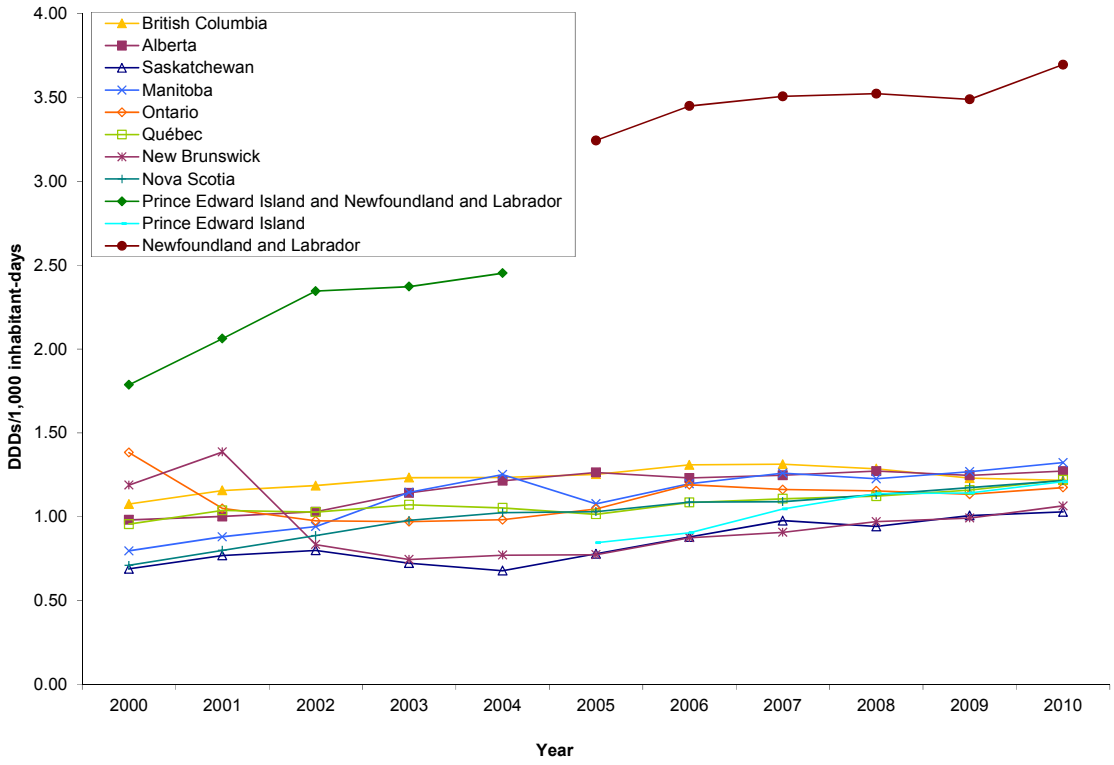
DDDs = Defined daily doses.

Figure 46. Provincial consumption (DDDs/1,000 inhabitant-days) of oral azithromycin (J01FA10) dispensed by Canadian retail pharmacies, 2000-2010.



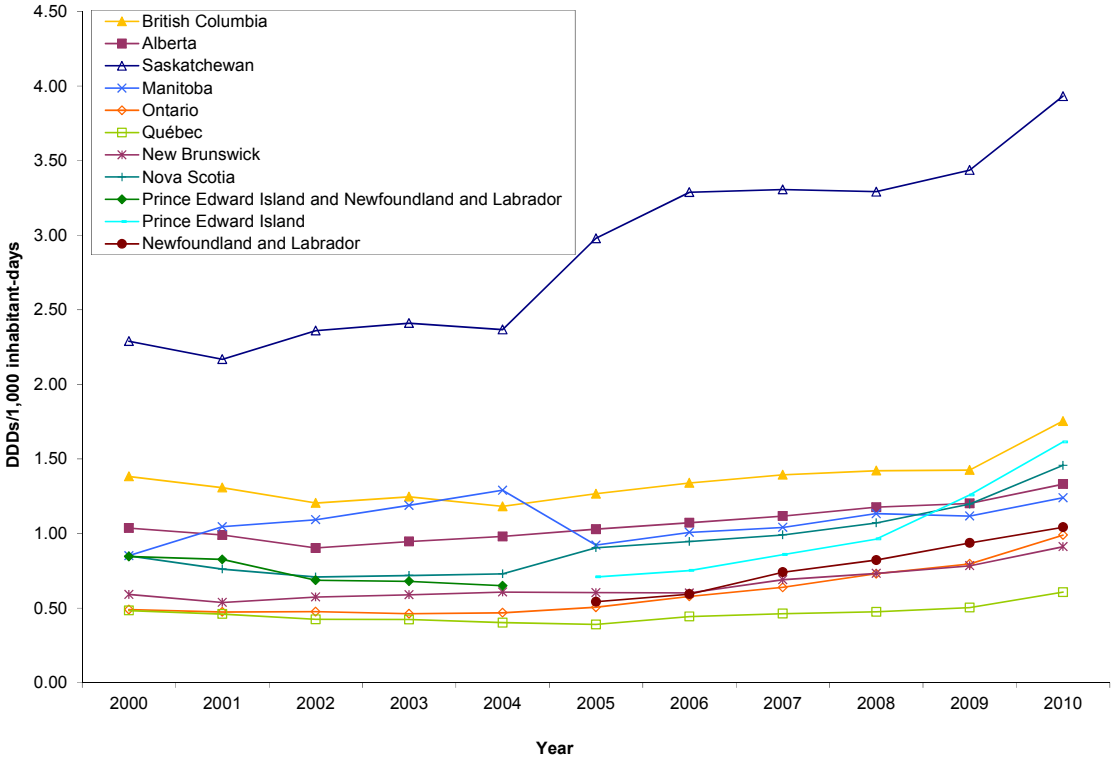
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 47. Provincial consumption (DDDs/1,000 inhabitant-days) of oral ciprofloxacin (J01MA02) dispensed by Canadian retail pharmacies, 2000-2010.



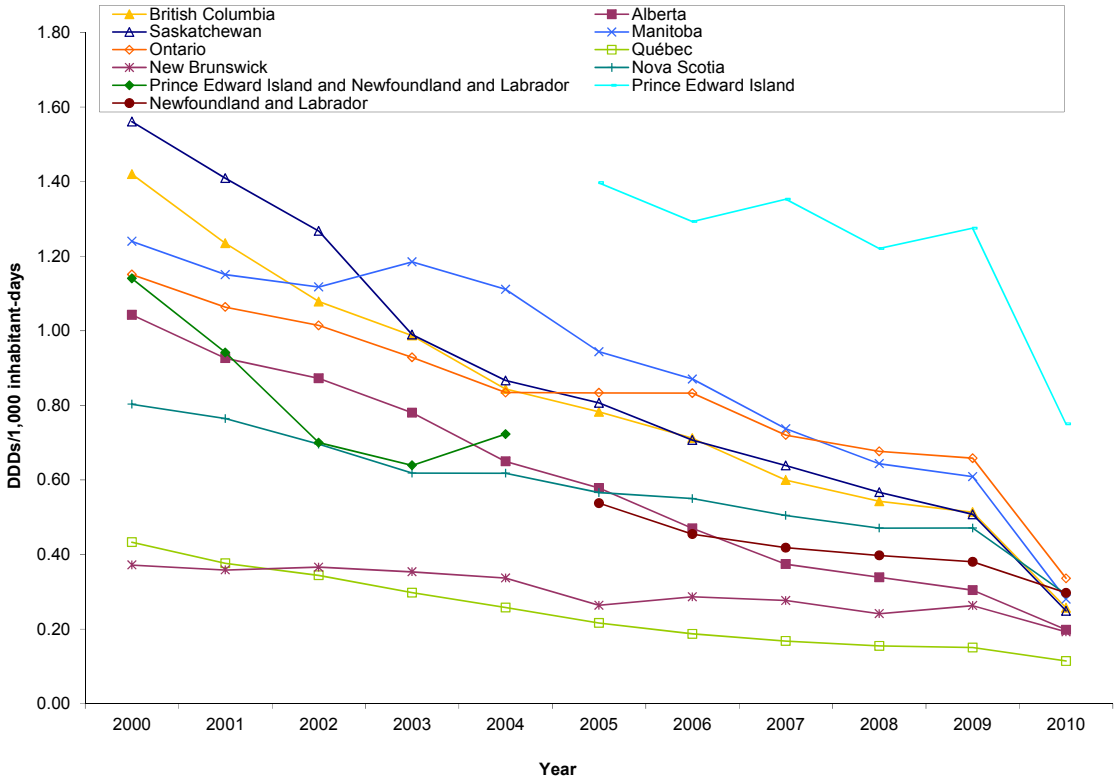
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 48. Provincial consumption (DDDs/1,000 inhabitant-days) of oral doxycycline (J01AA02) dispensed by Canadian retail pharmacies, 2000-2010.



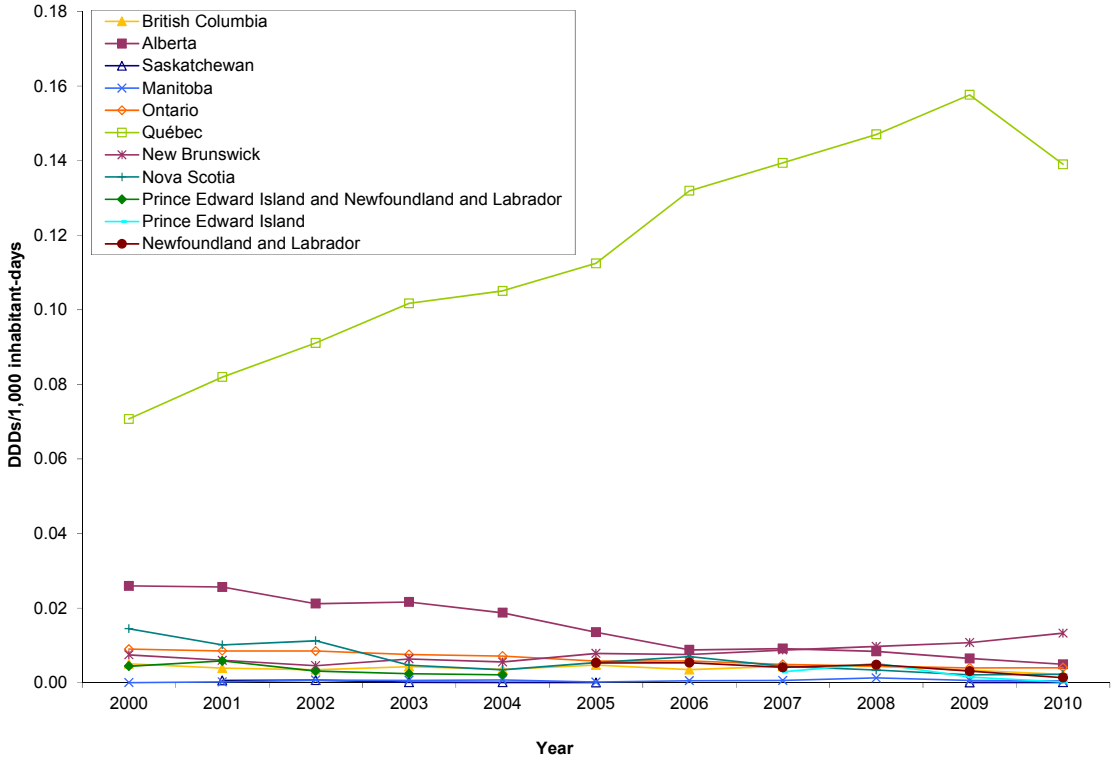
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 49. Provincial consumption (DDDs/1,000 inhabitant-days) of oral tetracycline (J01AA07) dispensed by Canadian retail pharmacies, 2000-2010.



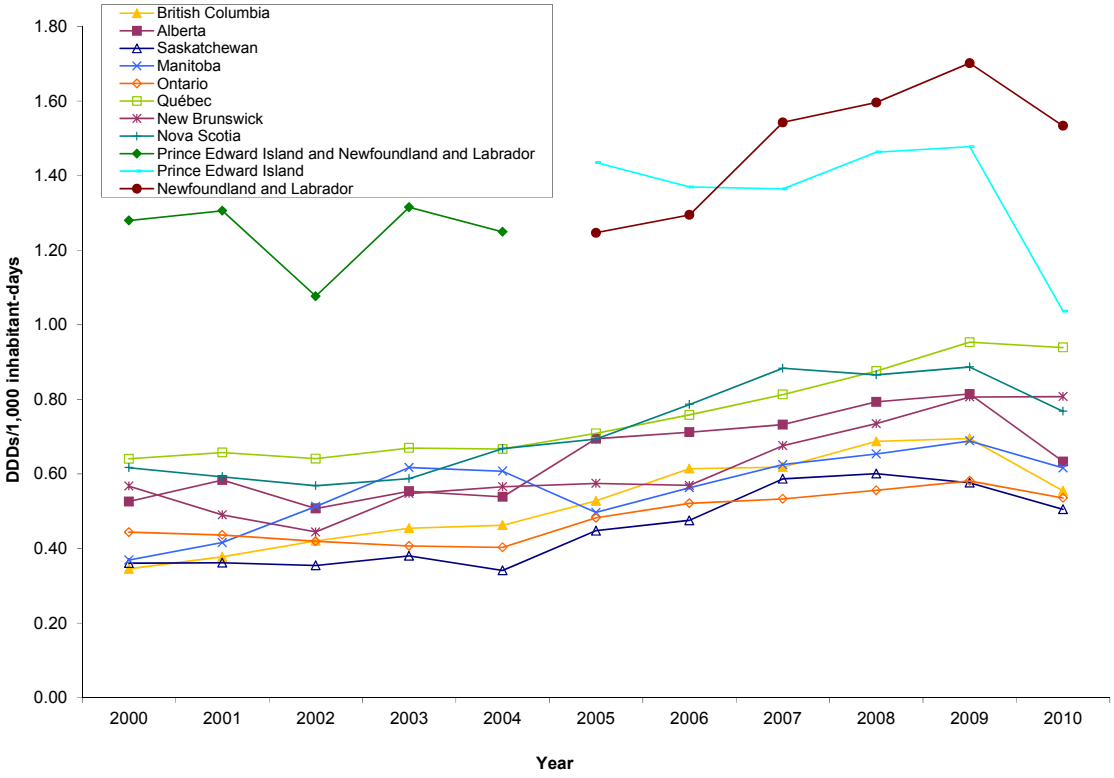
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 50. Provincial consumption (DDDs/1,000 inhabitant-days) of oral cefadroxil (J01DB05) dispensed by Canadian retail pharmacies, 2000-2010.



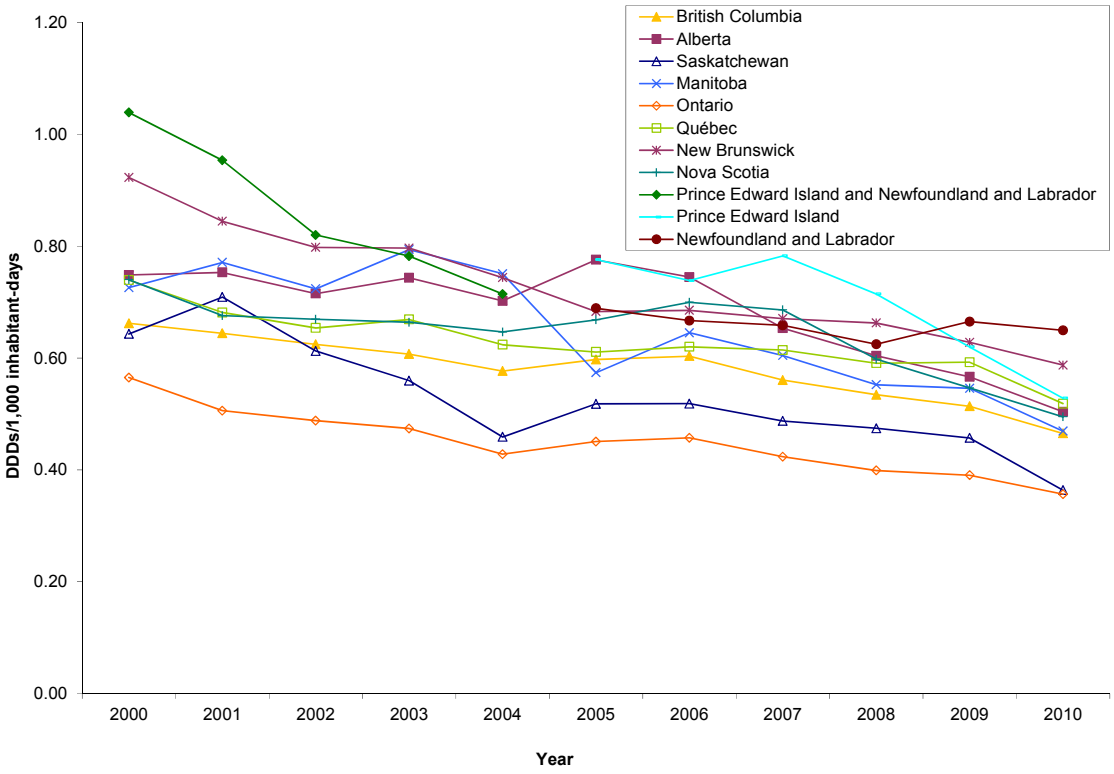
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 51. Provincial consumption (DDDs/1,000 inhabitant-days) of oral amoxicillin-clavulanic acid (J01CR02) dispensed by Canadian retail pharmacies, 2000-2010.



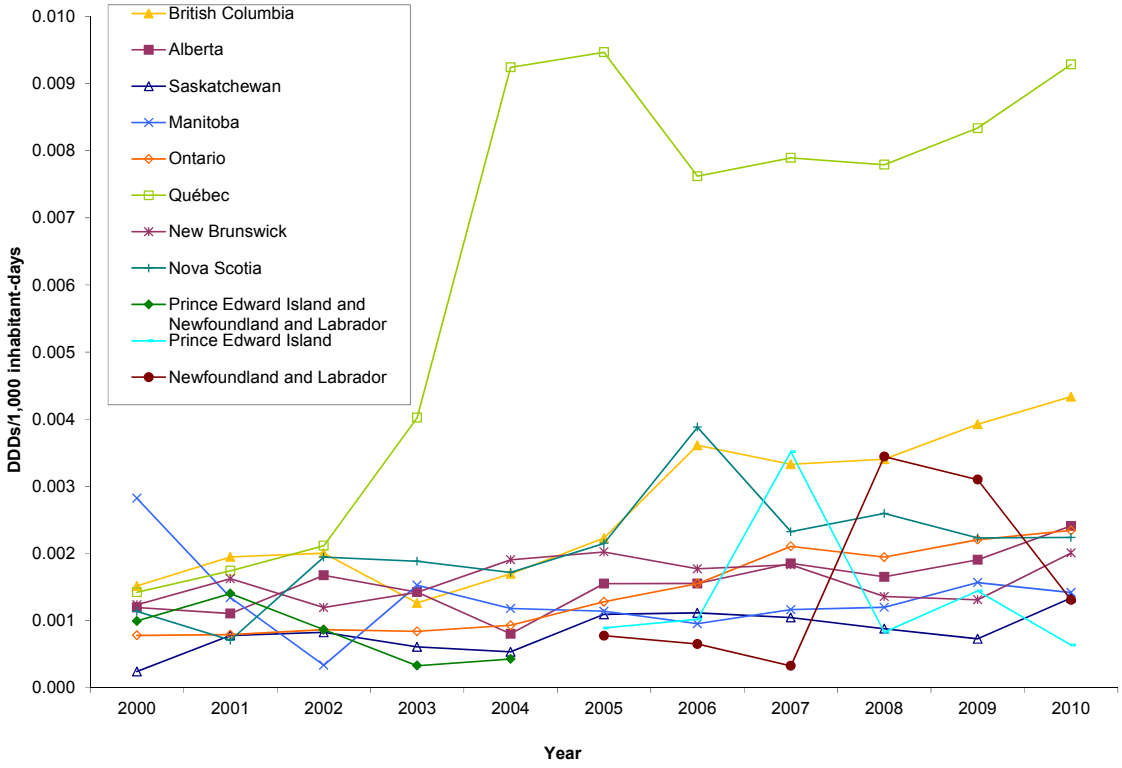
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 52. Provincial consumption (DDDs/1,000 inhabitant-days) of oral penicillin V (J01CE02) dispensed by Canadian retail pharmacies, 2000-2010.



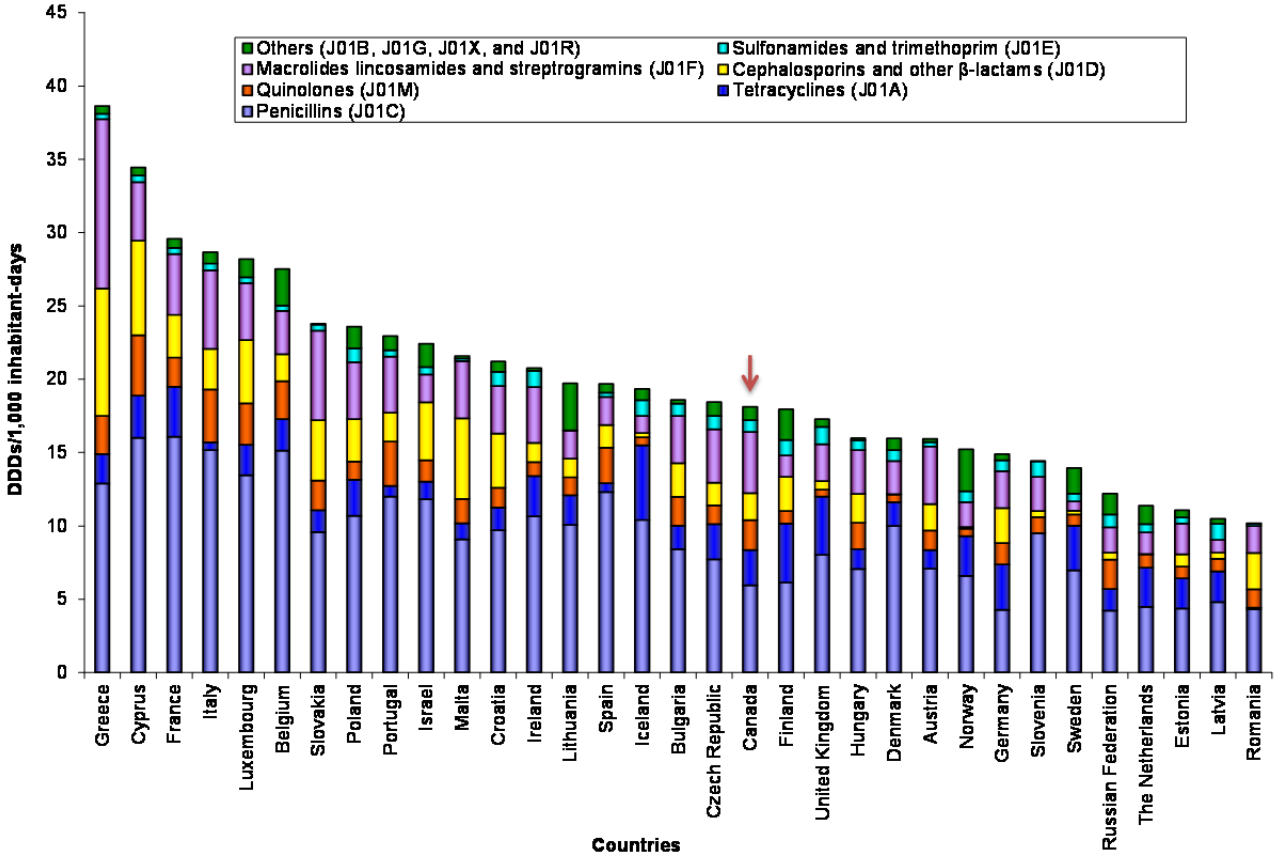
DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 53. Provincial consumption (DDDs/1,000 inhabitant-days) of oral vancomycin (J01XA01) dispensed by Canadian retail pharmacies, 2000-2010.



DDDs = Defined daily doses.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data is available at the individual provincial level.

Figure 54. Antimicrobial consumption (DDDs/1,000 inhabitant-days) in 32 European countries and Canada; *European Surveillance of Antimicrobial Consumption*[1] *and CIPARS*, 2009.



DDDs = Defined daily doses.
Cyprus, Greece, and Lithuania: Total use, including the hospital sector.
Spain: Reimbursement data, does not include over-the-counter sales without prescription.

[1] ESAC Yearbook 2009. ESAC – European Surveillance of Antimicrobial Consumption ESAC Interactive Database. Available at: www.esac.ua.ac.be/main.aspx?c=*ESAC2&n=50036. Accessed May 2013.

Pigs[1]

Twenty-one veterinarians representing 90 sentinel swine herds were enrolled in CIPARS Farm Surveillance in 2010 (Appendix A). The herd veterinarian (or designated practice staff) administered the questionnaire to the producer (or designated farm staff) once per herd per year on the same day that composite pen fecal samples were collected from pigs that were close to market weight. The questionnaire included questions on farm characteristics, management, and antimicrobial use pertaining to the relevant grow-finish period.

Completed questionnaires were submitted for 90 herds, which were distributed among the following provinces: Alberta, 19 (21%); Saskatchewan, 10 (11%); Manitoba, 8 (9%); Ontario, 25 (28%); and Québec, 28 (31%). Veterinarians reported that in 47 (52%) herds, grower-finisher production was managed as a continuous-flow operation. In the remaining 43 (48%) herds, an all-in-all-out management system was used.

National Level

Data regarding antimicrobial use practices were provided for all herds. In 90% (81/90) of the herds, antimicrobials were reportedly used in the grower-finisher phase of production, whereas in 10% (9/90), no antimicrobial use was reported for the same period. Among participating herds, antimicrobial use was more common via feed (76%, 68/90) and injection (60%, 54/90) than by water (28%, 25/90).

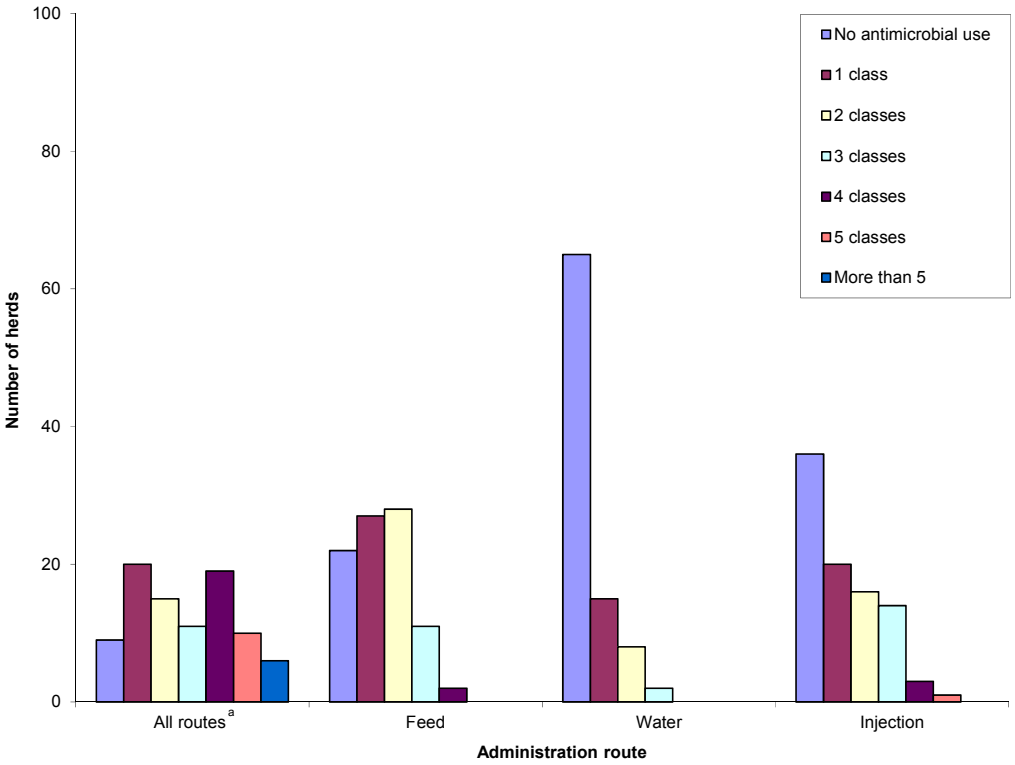
Use of antimicrobials from 3 or more antimicrobial classes (range, 0 to 7) was reported for 51% (46/90) of herds (Figure 55). The most commonly used antimicrobial class was the penicillins (61%, 55/90; Figure 56 and Table 38). Antimicrobials in the macrolide class were the most common antimicrobials administered through feed and were most commonly used to treat enteric disease or promote growth (Figure 57 and Figure 58). Use of macrolides and/or lincosamides via feed often persisted until pigs were close to market weight. Penicillins were the most common antimicrobials administered through water,[2] the primary reason for this use was to prevent disease or treat respiratory disease (Figure 59). Penicillins were also the most common antimicrobials administered by injection (Figure 56),[2] the primary reason for this use was to treat lameness (Figure 60).

Injectable ceftiofur was used in 24% (22/90) of herds. Ceftiofur, which is an extended-spectrum cephalosporin, is the only antimicrobial used on participating farms that is classified by Health Canada's Veterinary Drugs Directorate as a Category I antimicrobial (Table 38). The reported use of ceftiofur in 2010 represents a 3% and 5% increase compared with use in 2008 (21% of herds, 20/95), and 2009 (19% of herds, 18/95) respectively. Ceftiofur was used in the treatment of respiratory diseases, lameness, enteric diseases, and other unspecified conditions (Figure 60).

In 2010, the only Category I antimicrobial used in grower-finisher pig herds was injectable ceftiofur (24% of herds, 22/90). The reported use of ceftiofur in 2010 represented a 3% and 5% increase compared with use in 2008 (21% of herds, 20/95), and 2009 (19% of herds, 18/95) respectively. No antimicrobial use by any route was reported for 10% (9/90) of the herds.

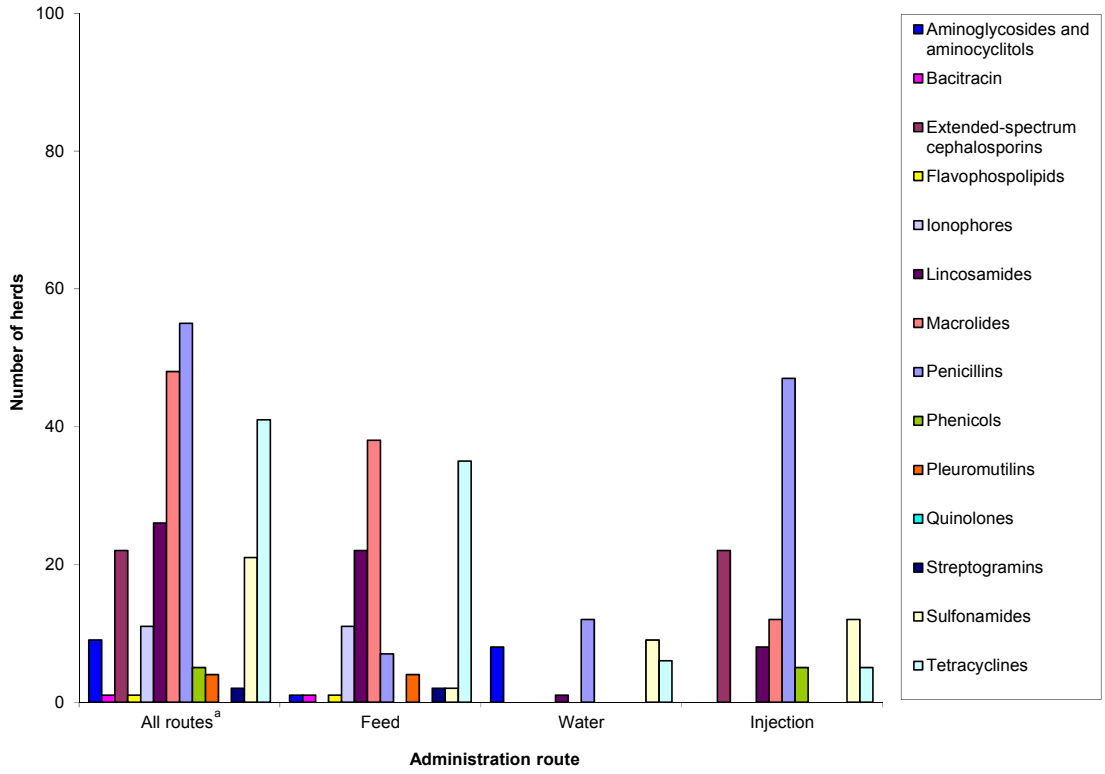
[1] Other animal demographic information is presented in Table C.9 and Table C.10, Appendix C.
[2] Antimicrobial treatment details (dose, duration, and pig age) were not collected for antimicrobials administered through water or injection because those routes were less commonly used than through feed.

Figure 55. Number of pig herds with reported use of no antimicrobials, antimicrobials from a single antimicrobial class, or antimicrobials from multiple antimicrobial classes, by route of administration (n = 90); *Farm Surveillance*, 2010.



[a] Values in this category represent the sum of antimicrobial classes reportedly used in each herd, counting each class no more than once regardless of number of administration routes reported.

Figure 56. Number of pig herds with reported use of antimicrobials from specific antimicrobial classes by route of administration (n = 90); *Farm Surveillance*, 2010.



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

Table 38. Number of pig herds with reported use of specific active antimicrobial ingredients, by route of administration (n = 90); *Farm Surveillance*, 2010.

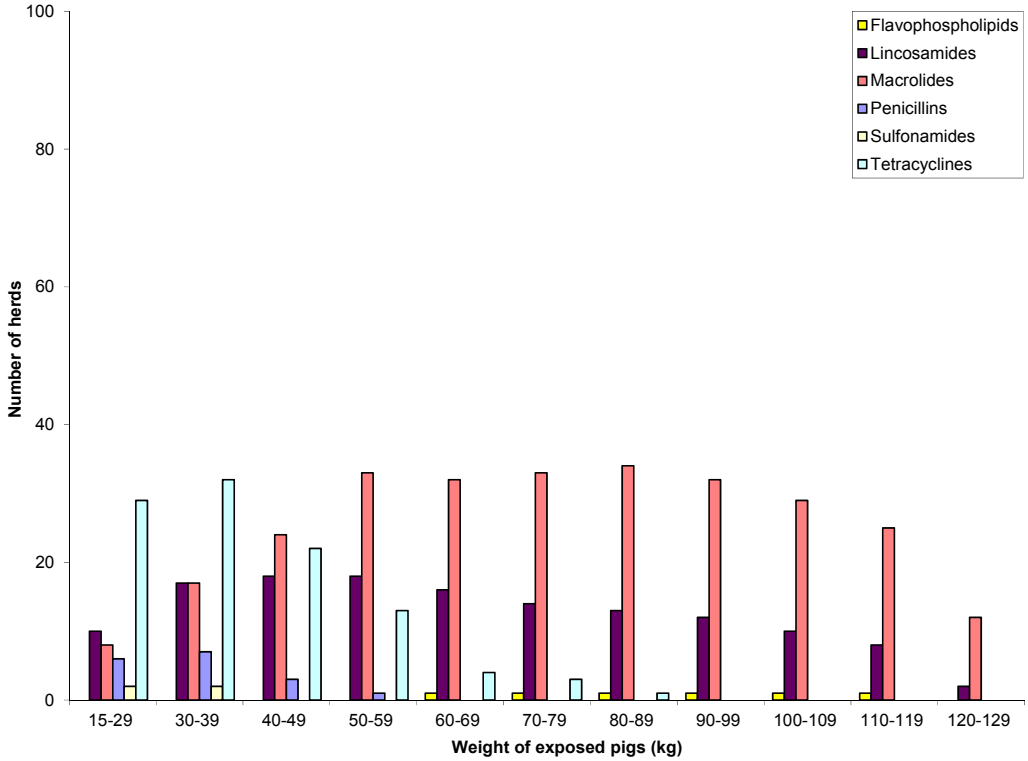
	Antimicrobial class	Antimicrobial	Administration route			
			Any route[a]	Feed	Water	Injection
I	Extended-spectrum cephalosporins	Ceftiofur	22	0	0	22
II	Aminoglycosides	Streptomycin	4	0	4	0
	Lincosamides	Lincomycin	26	22	1	8
	Macrolides	Erythromycin	0	0	0	0
		Tulathromycin	9	0	0	9
		Tilmicosin	3	3	0	0
		Tylosin	40	37	0	4
	Penicillins	Amoxicillin	0	0	0	0
		Ampicillin	4	0	0	4
		Penicillin G	54	7	12	46
		Phenoxymethyl penicillin	0	0	0	0
	Streptogramins	Virginiamycin	2	2	0	0
	Trimethoprim-sulfamethoxazole	Trimethoprim-sulfadoxine	18	0	8	12
III	Aminocyclotols	Spectinomycin	2	1	1	0
	Aminoglycosides	Neomycin	4	0	4	0
	Bacitracins	Bacitracin	1	1	0	0
	Phenicols	Florfenicol	5	0	0	5
	Pleuromutilins[b]	Tiamulin	4	4	0	0
	Sulfonamides	Sulfonamide (unspecified)	3	2	1	0
	Tetracyclines	Chlortetracycline	35	35	0	0
		Oxytetracycline	6	1	0	5
		Tetracycline hydrochloride	6	0	6	0
IV	Flavophospholipids	Bambermycin	1	1	0	0
	Ionophores	Salinomycin	11	11	0	0

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.

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

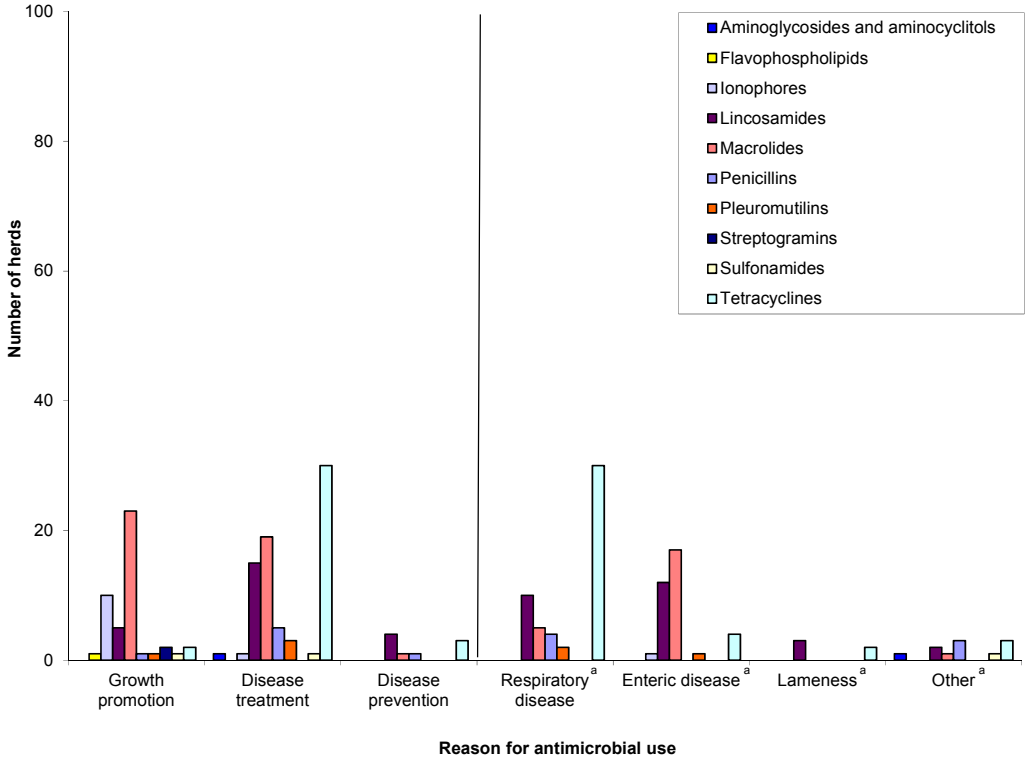
[b] Pleuromutilins are not listed in the current Veterinary Drugs Directorate categorization document; however, they meet the criteria for Category III.

Figure 57. Number of pig herds with reported use of antimicrobials from specific antimicrobial classes in feed, by weight category of pigs (n = 90); *Farm Surveillance*, 2010.



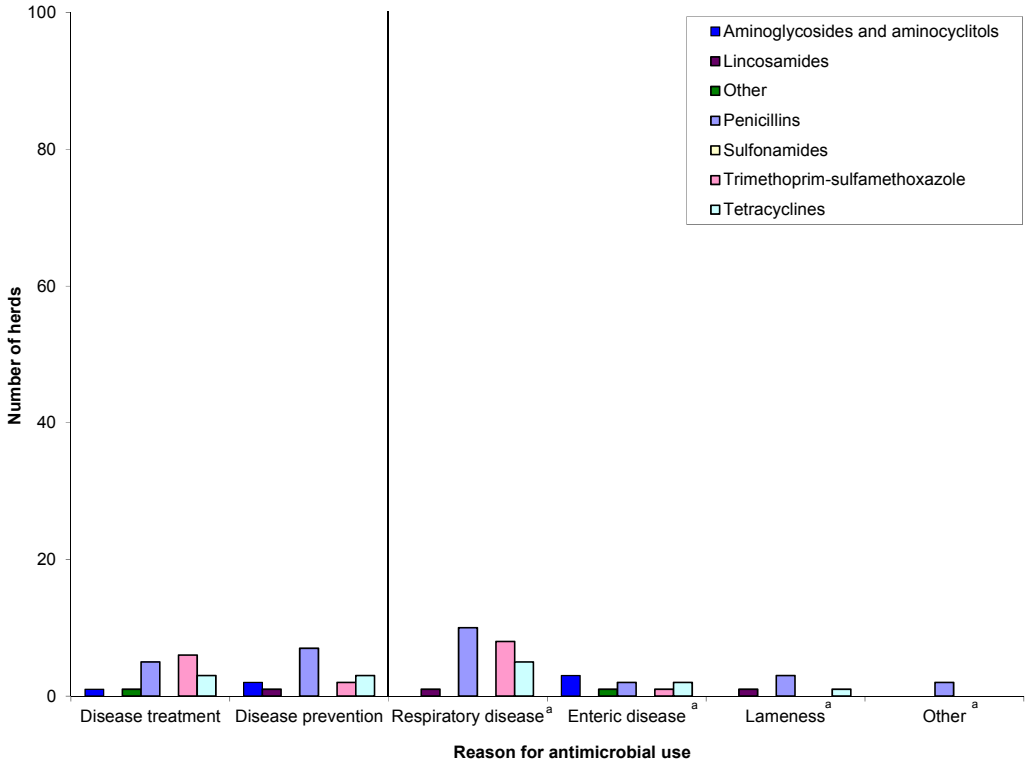
Exposure was defined as any reported use of an antimicrobial within the herd.

Figure 58. Number of pig herds with reported use of specific antimicrobial classes in feed, by reason for use (n = 90); *Farm Surveillance*, 2010.



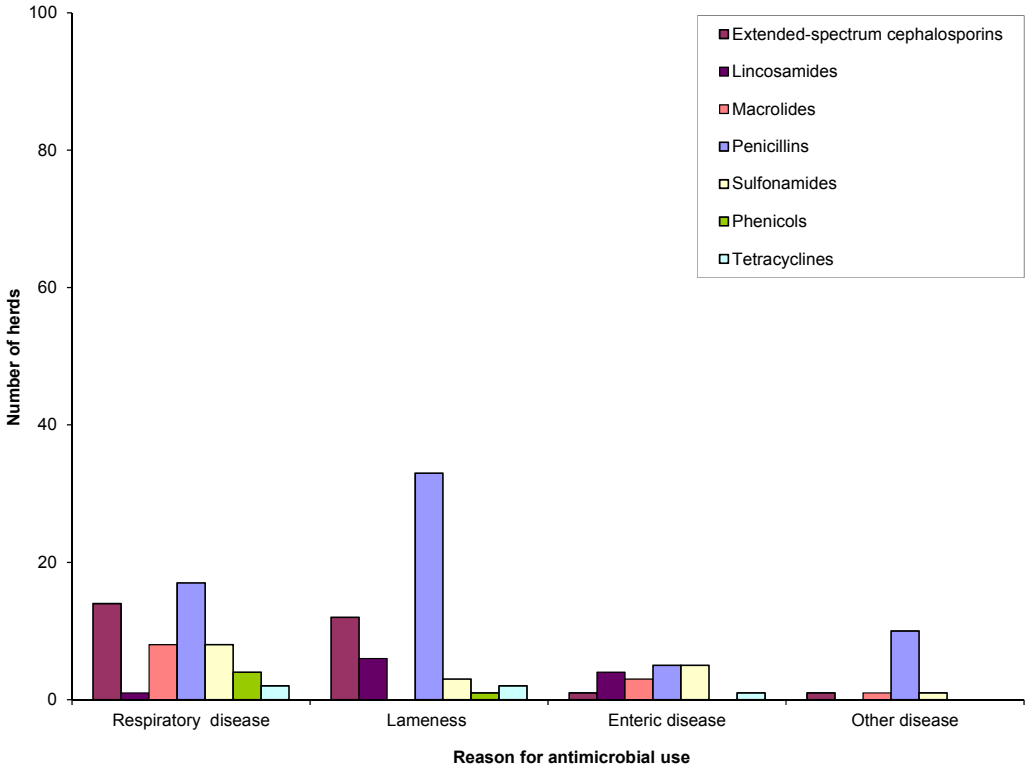
[a] Growth promotion, disease prevention, or disease treatment were the primary reason for antimicrobial use. Secondary antimicrobial use descriptors for disease prevention or treatment included respiratory disease, enteric disease, lameness and other. Secondary antimicrobial use descriptors have been presented jointly for disease prevention and treatment.

Figure 59. Number of pig herds with reported use of specific antimicrobial classes in water, by reason for use (n = 90); *Farm Surveillance*, 2010.



[a] Disease prevention or disease treatment were the primary reason for antimicrobial use. Secondary antimicrobial use descriptors for disease prevention or treatment included respiratory disease, enteric disease, lameness and other. Secondary antimicrobial use descriptors have been presented jointly for disease prevention and treatment.

Figure 60. Number of pig herds with reported use of specific antimicrobial classes via injection, by reason for use (n = 90); *Farm Surveillance*, 2010.



Antimicrobials Distributed for Use in Animals

The Canadian Animal Health Institute (CAHI) is the trade association representing the companies that manufacture and distribute drugs for administration to food (including fish), sporting, and companion animals in Canada. The association estimates that its members' sales represent over 95% of all sales of licensed animal pharmaceutical products in Canada. CAHI coordinates electronic collection of data from its members on the total kilograms of antimicrobials distributed by Canadian companies. Data collection and analysis are performed by a third party, Impact Vet.[1]

As an estimate of antimicrobial use in animals, acquired data on active ingredients were aggregated and provided to the Public Health Agency of Canada by CAHI (Table 39). Data regarding all licensed antimicrobials for use in food (including fish), sporting, and companion animals were included. These data do not represent actual antimicrobial use in a given year; rather, they reflect the volume of antimicrobials distributed by manufacturers. Distribution values should approximate amounts used, particularly when data from more than 1 year are included. However, when data from only 1 year are included, distribution values may vary from amounts actually used because of the time lag between distribution and actual use, as well as stockpiling of antimicrobials at various points in the distribution system.

The data do not include antimicrobials imported for personal use (own use import) under the personal-use provision of the federal *Food and Drugs Act & Regulations*, nor do they include active pharmaceutical ingredients, which are drugs imported in non-dosage form and compounded by a licensed pharmacist or veterinarian and used in veterinary medicine and food-animal production. See the 2006 CIPARS Annual Report for more information.[2]

The CAHI data on the distribution of antimicrobials for use in animals provide a context to interpret other data on antimicrobial use in animals generated through research and farm data collection. They also provide a means to monitor gross temporal changes in antimicrobial use in animals.

CAHI's data collection process, based on accounting rules[3] from 2008-2010 resulted in several changes to the categorization of specific antimicrobials (compared with the categories used in 2006 and 2007). The major changes are outlined below:

- The cephalosporin class was not reported separately by CAHI in 2008 to 2010 as it was in the past. One first-generation cephalosporin was included in "β-lactams." The remainder, a first-generation and a third-generation cephalosporin, were included in "other antimicrobials."
- "Amphenicols" were reported as a separate category (previously included in "other antimicrobials").
- "Bacitracins" were grouped with "macrolides and pleuromutilins" (previously included in "other antimicrobials").
- "Nitroimidazoles" were grouped with "ionophores, chemical anticoccidials, and arsenicals" (previously included in "other antimicrobials").

[1] Division of AgData Ltd.. Available at: www.impactvet.com. Accessed May 2013.
[2] Government of Canada. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2006 Annual Report. Available at: www.phac-aspc.gc.ca/cipars-picra/2006-eng.php. Accessed May 2013.
[3] Antimicrobials could not be separated into specific classes if fewer than three companies produced that antimicrobial (to comply with the EU and US anti-competition regulations) and CAHI added on top in some cases that if any company produced more than 90% of that product (to not infringe on the regulations in the US).

National Level

These changes in aggregation are important to keep in mind when making year-to-year comparisons. Quantities of antimicrobials distributed in Canada from 2006 to 2010 can be found in Table 39 and relative percentages distributed can be found in Figure 61. Overall, the total kilograms of active ingredient distributed for sale by Canadian companies decreased by 14% relative to the 2006 total and decreased by 6% relative to the 2009 total.

In terms of Category I antimicrobials, the quantity of fluoroquinolones distributed for use in animals in 2010 decreased by 36% relative to the 2006 total and increased by 1% relative to the 2009 total. The quantity of the beta-lactams class increased 71% from 2009 to 2010. Reasons for these changes and others noted in Table 39 are unknown but may be related to major livestock production changes in Canada (Tables C.9 and C.10, Appendix C).

Changes in quantities used for other Category I antimicrobials could not be determined because of changes over time to the data aggregation. CIPARS is working on developing an animal biomass denominator to indicate whether changes in the reported volume of antimicrobials distributed could possibly be explained by changes in the population of livestock in Canada.

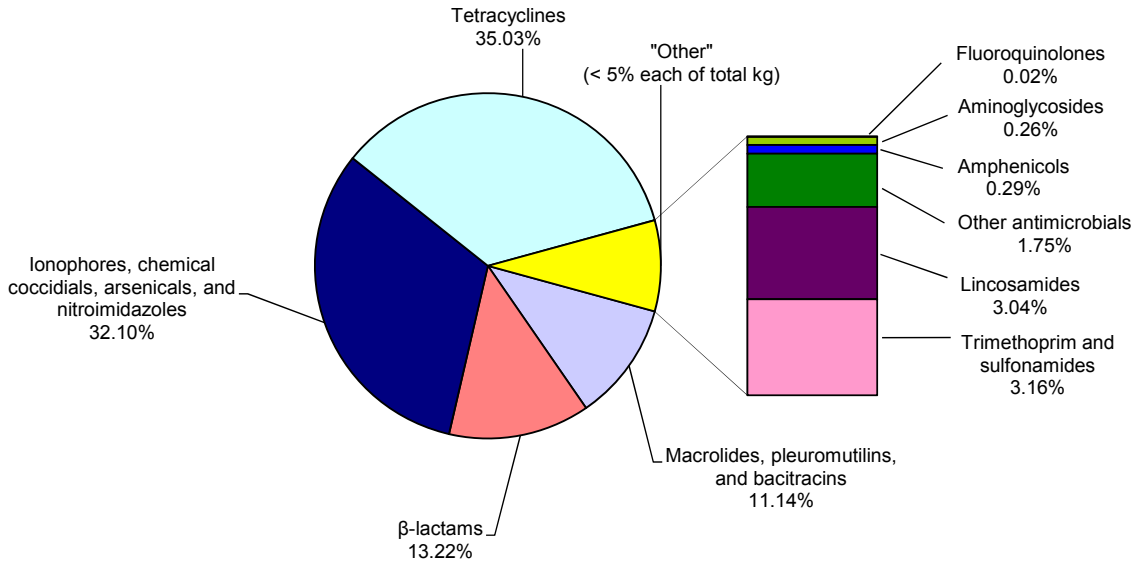
In 2010, the total kilograms of antimicrobials distributed for sale by CAHI member companies decreased by 14% relative to the 2006 total and decreased by 6% relative to the 2009 total. The quantity of fluoroquinolones distributed for use in animals in 2010 decreased by 36% relative to the 2006 total and increased by 1% relative to the 2009 total.

Table 39. Quantity of antimicrobials in dosage form distributed in Canada for use in animals; Canadian Animal Health Institute, 2006–2010.

Antimicrobial class aggregation	Quantity of active ingredients (kg)					Percentage change from 2006 to 2010	Percentage change from 2009 to 2010
	2006	2007	2008	2009	2010		
Aminoglycosides	5,122	4,302	5,817	4,652	3,961	-23%	-15%
Amphenicols	NA	NA	3,242	4,001	4,391	NA	10%
β-lactams (2006 and 2007)	58,538	52,594	NA	NA	NA	NA	NA
β-lactams (2008 to 2010)	NA	NA	109,153	118,109	201,934	NA	71%
Cephalosporins	702	850	NA	NA	NA	NA	NA
Fluoroquinolones	591	443	411	377	381	-36%	1%
Ionophores, chemical anticoccidials, and arsenicals (2006 and 2007)	455,753	445,952	NA	NA	NA	NA	NA
Ionophores, chemical anticoccidials, arsenicals, and nitroimidazoles (2008 to 2010)	NA	NA	472,384	491,152	490,355	NA	< 1%
Lincosamides	67,825	55,872	41,222	44,137	46,373	-32%	5%
Macrolides and pleuromutilins (2006 and 2007)	136,497	118,725	NA	NA	NA	NA	NA
Macrolides, pleuromutilins, and bacitracins (2008 to 2010)	NA	NA	210,869	204,169	170,154	NA	-17%
Other antimicrobials (2006 and 2007)	143,029	146,880	NA	NA	NA	NA	NA
Other antimicrobials (2008 to 2010)	NA	NA	32,706	21,339	26,757	NA	25%
Tetracyclines	847,281	753,168	680,601	686,832	535,142	-37%	-22%
Trimethoprim and sulfonamides	50,789	38,961	59,166	57,596	48,221	-5%	-16%
Total	**1,766,126**	**1,617,748**	**1,615,571**	**1,632,365**	**1,527,669**	**-14%**	**-6%**

Values do not include own use imports or active pharmaceutical ingredients used in compounding.
Grey shading indicates general consistency in class aggregation from 2006 to 2010.
NA = Not available.
In comparison with antimicrobial groupings used in previous years, CAHI's 2008 to 2010 data were provided to CIPARS under different aggregations. The cephalosporin class was not reported separately – one first-generation cephalosporin was included in the "β-lactams" class and the remainder, a first-generation and a third-generation cephalosporin, were included in "Other antimicrobials." "Amphenicols" were reported as a separate category (previously included in "Other antimicrobials"). "Bacitracins" were grouped with the "Macrolides and pleuromutilins" (previously included in "Other antimicrobials"). "Nitroimidazoles" were grouped with the "Ionophores, chemical anticoccidials and arsenicals" (previously included in "Other antimicrobials"). "Other antimicrobials" included: clavulanic acid, bambermycin, ceftiofur, cephapirin, neomycin, nitrofurantoin, nitrofurazone, novobiocin, polymixin, sodium iodide, and virginiamycin.

Figure 61. Percentages of quantities of antimicrobials in dosage form distributed in Canada for use in animals; Canadian Animal Health Institute, 2010.



"Other antimicrobials" (1.75%) included bambermycin, ceftiofur, cephapirin, clavulanic acid,neomycin, nitrofurantoin, nitrofurazone, novobiocin, polymixin, sodium iodide, and virginiamycin.

Section Three – Public Health Agency of Canada Research Collaborations

Box 1. Comparison of *Salmonella* Enteritidis from human and poultry sources using Multi-locus Variable Number of Tandem Repeats Analysis (MLVA).

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In the past years, *Salmonella enterica* serovar Enteritidis has been responsible for a rising proportion of human salmonellosis cases in Ontario, and it has become the most commonly recovered serovar from infected patients in the province. The major sources of these infections are suspected to be chicken meat, eggs, and egg-related products. The egg-production chain and the chicken meat production chain are quite distinct. Thus, using very discriminatory typing methods, one would hope to be able to assess whether most of the human *S*. Enteritidis infections are related to eggs or to chicken meat, or to both. However, *S*. Enteritidis is phenotypically and genetically very homogenous, and typing of *S*. Enteritidis has always been problematic with regards to strain discrimination. For instance, the vast majority of *S*. Enteritidis isolates recovered from humans, and poultry-related sources in Canada belong to only three phage types (8, 13, and 13a). Pulsed-field gel electrophoresis (PFGE) has provided some improvements in our ability to discriminate between *S*. Enteritidis strains. However, this method is very cumbersome and time consuming. MLVA protocols were recently developed for *S*. Enteritidis and it was suggested initially that this new and less tedious method would provide equivalent or better discrimination power than PFGE. Thus, the objectives of this project were 1) to assess the exact value of MLVA, alone and combined with phage typing, for epidemiological investigations of *S*. Enteritidis in Canada, and 2) to use MLVA to assess how *S*. Enteritidis isolates from humans in Ontario compare to isolates from chicken-related sources along the meat and egg production chains.

Using 135 unrelated *S*. Enteritidis isolates from a variety of sources, time periods, and Canadian provinces, we showed that the probability of MLVA differentiating two unrelated isolates is approximately 80%. Attempts to improve this discrimination for isolates of the major phage types 8, 13, and 13a using additional loci in the MLVA protocol as well as the use of DNA sequencing were unsuccessful. However, the combination of MLVA and phage typing significantly improved this discrimination.

Two hundred and sixty-five *S*. Enteritidis isolates from humans (n=100), broiler chicken and related sources (n=121), and layer chicken-related sources (n=44) were subsequently typed using MLVA. In order to avoid biases caused by over-representation by outbreak-related strains, care was taken to use human isolates not known to be related (i.e. isolates that were not known to be linked together by a known common outbreak). Thirty different MLVA types were identified, which could be grouped into two major clusters of genetically related *S*. Enteritidis. One cluster consisted mainly of isolates of phage types 8 and 13a, the other cluster consisted mainly of isolates of phage type 13. However, phage typing and MLVA types did not correlate entirely, thus providing increased discriminatory power when the results of both methods were combined. *Salmonella* recovered from each of the three different sources were found in both clusters.

Box 1 (continued). Comparison of *Salmonella* Enteritidis from human and poultry sources using Multi-locus Variable Number of Tandem Repeats Analysis (MLVA).

Preliminary results suggest that *S*. Enteritidis isolates from humans were more similar to isolates from chicken meat sources than to isolates from layer chicken-related sources. However, more isolates from layer chicken-related sources over a broader time period are needed to further investigate this relationship.

This research project was funded by the Ontario Ministry of Agriculture, Food and Rural Affairs.

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Box 2. The emergence of ciprofloxacin-resistant *Salmonella* enterica serovar Kentucky in Canada.

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[6] Saint John Regional Hospital, Saint John, NB
[7] Provincial Public Health Laboratory Network of Nova Scotia, Halifax, NS
[8] BC Centre for Disease Control, Vancouver, BC
[9] Saskatchewan Disease Control Laboratory, Regina, SK
[10] Alberta Provincial Laboratory for Public Health, Edmonton, AB
[11] Newfoundland Public Health Laboratory, St. John's, NL
[12] Cadham Provincial Laboratory, Winnipeg, MB

Infections caused by *Salmonella* are a global health concern for both humans and animals. The drugs of choice for treating invasive *Salmonella* infections can be fluoroquinolones (in adults) or cephalosporins. Recently, isolates of *Salmonella enterica* serovar Kentucky from Europe and Africa have been described that were ciprofloxacin-resistant (CIP-R) (Le Hello et al., 2011). Interestingly, no *S*. Kentucky isolates submitted to the national surveillance program (NARMS) in the United States of America were CIP-R (Le Hello et al., 2011). Here we describe the emergence of CIP-R *S*. Kentucky from human cases in Canada between 2003-2009.

From 2003 to 2009, provincial public health laboratories submitted human clinical isolates as part of the Canadian Integrated Program on Antimicrobial Resistance Surveillance (CIPARS). MIC values were determined by broth microdilution using the Sensititre™. Pulsed-field gel electrophoresis (PFGE) was performed on all CIP-R isolates and multilocus sequence typing (MLST) was conducted on a subset of isolates. PCR was used to determine the presence of *Salmonella* Genomic Island1 (SGI1) variants.

A total of 76 *S*. Kentucky isolates were identified out of 21,175 non-typhoidal *Salmonella* human isolates submitted for susceptibility testing over the study period. Twenty-three (30%) of these isolates displayed CIP-R (greater than or equal to 4 mg/L). Although *S*. Kentucky is rarely associated with human infections, it comprised 66% (23/35) of all CIP-R isolates identified since 2003. Most CIP-R *S*. Kentucky isolates also displayed resistance to ampicillin, gentamicin, sulfonamide and tetracycline (n=18; 78%).

PFGE analysis revealed that a majority of CIP-R isolates and one multidrug resistant (MDR) ciprofloxacin susceptible (CIP-S) isolate clustered together with a percent similarity of greater than 80% (pattern A), whereas three other MDR CIP-S resistant isolates did not belong to this cluster (patterns B and C). MLST of isolates of PFGE pattern A were ST198. PFGE pattern A were found to contain SGI1-K, SGI1-Q, and SGI1-P. Novel SGI1 variants were also identified.

CIPARS animal and retail meat surveillance has not identified CIP-R *S*. Kentucky. Epidemiological information provided by affected provincial partners showed that travel to the African sub-continent was the most common exposure.

This is the first report of CIP-R *S*. Kentucky in North America. CIP-R ST198 MDR *S*. Kentucky isolates have also been described in Europe and Africa. The data strongly suggest that CIP-R isolates from Canadians are a result of travel to the African sub-continent where resistance is endemic.

This work has been submitted to Epidemiology and Infectious Diseases (EID) and presented at the AMMI-CACMID May 2012 Meeting (Vancouver, British Columbia).

Le Hello, S., et al., 2011. International spread of an epidemic population of *Salmonella enterica* serotype Kentucky ST198 resistant to ciprofloxacin. J Infect Dis. 204(5):675-84.

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Box 3. Prevalence and antimicrobial susceptibility of *Salmonella* and generic *Escherichia coli* isolated from caecal contents of Canadian spent hens.

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Salmonellosis is one of the most common foodborne diseases in Canada, with table eggs and poultry products often identified as vehicles of infection. Treatment of salmonellosis can be further complicated when these bacteria are resistant to antimicrobials. The objective of this pilot study was to estimate the prevalence of antimicrobial resistant *Salmonella enterica* and generic *Escherichia coli* in Canadian spent layer hens at slaughter.

Between February 2009 and July 2011, 279 pooled caecal samples were collected from spent layer hens at slaughter from three provinces. Forty-two percent (117/279) of samples tested positive for *Salmonella*. Table A summarizes the *Salmonella* serovars recovered: *S*. Kentucky, *S*. Heidelberg and *S*. Enteritidis were the top three serovars detected. Generic *E. coli* was isolated from 99.6% (278/279) of caecal samples.

Table A. *Salmonella* serovars recovered from Canadian spent layer hens, 2009-2011.

Salmonella serovar	Number of isolates (%)
Kentucky	54 (46)
Heidelberg	20 (17)
Enteritidis	15 (13)
Infantis	7 (6)
Agona	4 (3)
Mbandaka	4 (3)
Braenderup	3 (3)
Johannesburg	2 (2)
Less common serovars	8 (7)
Total	**117 (100)**

Serovars with only 1 isolate were classified as "Less common serovars."

No resistance was observed among isolates of *S*. Enteritidis; one *S*. Heidelberg isolate was resistant to 5 antimicrobials (amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ampicillin, and cefoxitin). In contrast, 96% (52/54) of *S*. Kentucky isolates showed resistance to greater than 1 antimicrobial. Two *S*. Kentucky isolates demonstrated resistance to 7 antimicrobials (amoxicillin-clavulanic acid, ceftiofur, ampicillin, ceftriaxone, cefoxitin, streptomycin, and tetracycline), and two *S*. Infantis isolates were resistant to 5 antimicrobials (ceftiofur, ampicillin, ceftriaxone, sulfisoxazole, and tetracycline).

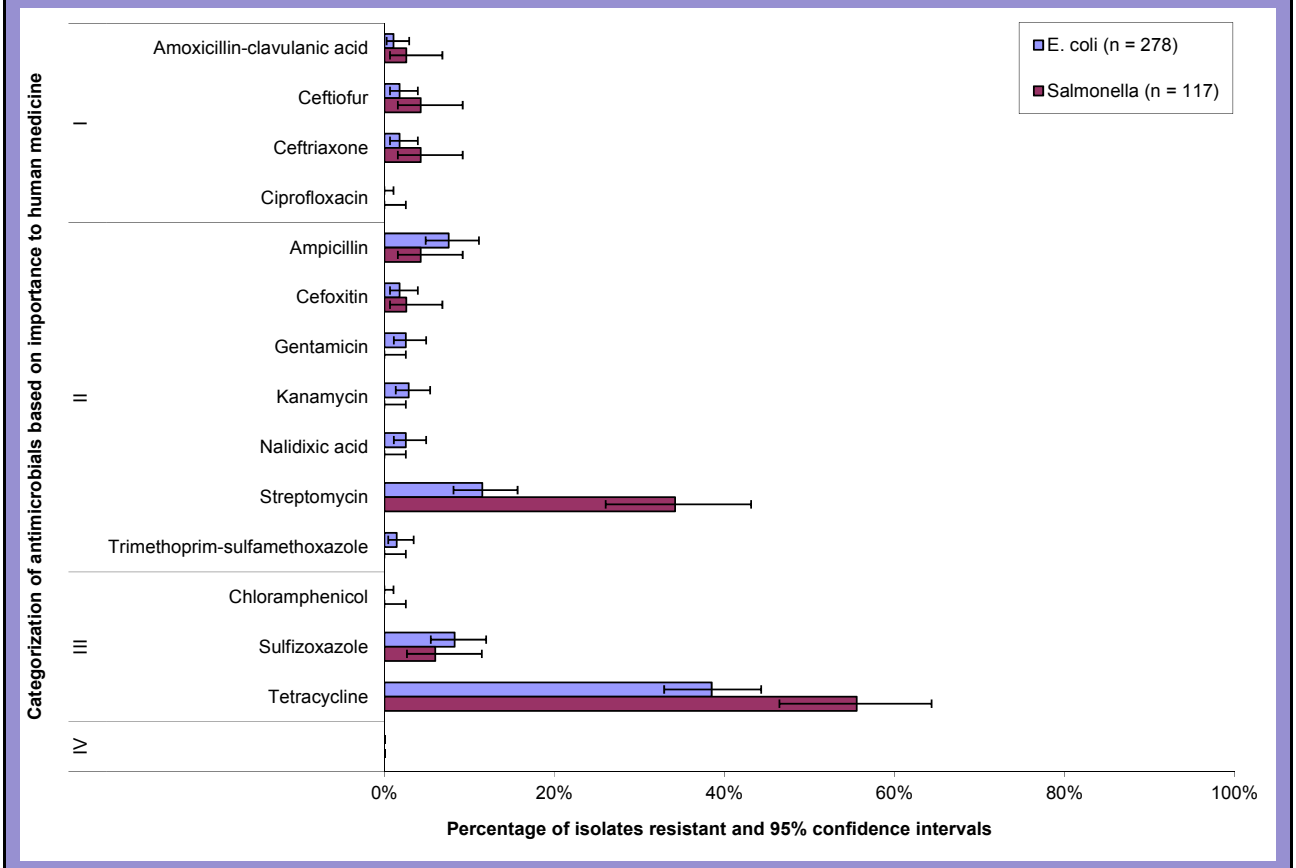
Fifty-seven percent (157/276) of *E. coli* isolates showed no resistance to any of the antimicrobials tested. The most common multi-drug resistance[1] pattern among *E. coli* isolates was streptomycin-tetracycline (n=27). One *E. coli* isolate was resistant to 8 antimicrobials (amoxicillin-clavulanic acid, ampicillin, cefoxitin, ceftiofur, ceftriaxone, streptomycin, tetracycline and trimethoprim-sulfamethoxazole) and one was resistant to 7 antimicrobials (amoxicillin-clavulanic acid, ampicillin, gentamicin, kanamycin, streptomycin, sulfisoxazole, and tetracycline).

[1] Multi-drug resistance was defined as resistance to greater than or equal to 2 antimicrobials.

Box 3 (continued). Prevalence and antimicrobial susceptibility of *Salmonella* and generic *Escherichia coli* isolated from caecal contents of Canadian spent hens.

Figure A illustrates the proportion of *Salmonella* and *E. coli* isolates that showed resistance to individual antimicrobials. Antimicrobials are grouped based on their importance in human medicine (I being the most important), according to the Canadian Veterinary Drugs Directorate (Health Canada).

Figure A. Resistance to individual antimicrobials in *Salmonella* and *Escherichia coli* isolates recovered from spent layer hens, 2009-2011.



Overall, the population of laying hens included in this study were found to be a contributor to the overall reservoir of *Salmonella* serovars that most commonly infect humans. Additionally, resistance to third-generation cephalosporins, such as ceftiofur, in both *E. coli* and *Salmonella* was low. The results of this study provide important baseline data about antimicrobial resistance in the Canadian laying hen population.

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Box 4. Multi-drug resistance in Ontario swine *Streptococcus suis*, *Escherichia coli* K88, and *Pasteurella multocida* isolates (1998–2010).

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As part of a larger project designed to evaluate antimicrobial resistance in Ontario swine pathogens, trends in multi-drug resistance in *Escherichia coli* K88, *Streptococcus suis*, and *Pasteurella multocida* were assessed. Passive surveillance data were obtained from clinical submissions to the Animal Health Laboratory (University of Guelph) between January 1998 and October 2010. Poisson models were used to determine how the proportion of resistance changed over time relative to the number of drugs tested. The dependent variable was the number of antimicrobials to which the isolate was resistant, and the offset was the number of antimicrobial drugs tested for susceptibility.

For all three pathogens, year was a significant variable; however, the trends over time were quite distinct among the three pathogens. Over the study period, the degree of resistance declined for *E. coli* K88, increased for *S. suis*, and was variable for *P. multocida*. Differences in the degree of resistance among the three pathogens may be due to a number of factors. Because the data are clinical submissions rather than random samples, different trends in resistance among these pathogens may result from different trends in drug use at different levels of the industry, differences in the management of specific bacterial infections, and/or the management of viral infections that may be associated with a particular bacterial pathogen. Triangulation with other data sources may be required to confirm the factors driving differing trends in multi-drug resistance from swine pathogens.

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Box 5. A comparison of antimicrobial resistance in generic *Escherichia coli* isolated from wild small mammals and soil collected from different environments in Ontario, Canada.

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A cross-sectional study was conducted to explore the association between antimicrobial resistance in generic *Escherichia coli* isolated from wild small mammals and from soil samples collected from three different environments (swine farms, recreation parks, nature reserves) in Ontario, Canada. We compared the prevalence of resistant bacteria in *E. coli* isolates from these locations.

Escherichia coli was recovered from 62% (221/358) of wild small mammals sampled: 100 from swine farms, 82 from recreation parks and 39 from nature reserves. In total, 13% (29/221) of *E. coli* positive small mammals demonstrated resistance to one or more antimicrobial agents. Twenty-six of these animals were trapped on swine farms, two at the same recreation park and one on a nature reserve. In comparison, *E. coli* was isolated from 62% (226/365) of soil samples; 98 from swine farms, 68 from recreation parks and 60 from nature reserves. Overall, 41 of 226 (18%) *E. coli* positive soil samples were resistant to one or more antimicrobial agents. Thirty-three of the resistant isolates were from soil collected on swine farms, five from recreation parks and three were from nature reserves.

These results indicate that wildlife and soil are both potential reservoirs of resistant bacteria in the environment. In addition, feces from wild small mammals and soil had similar resistance phenotypes. These results suggest that resistant bacteria may be transferred between wildlife and soil or, alternatively, that there is a common source of exposure for both soil and wildlife in the environments we examined.

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Box 6. Occurrence of *Clostridium difficile*, *Clostridium perfringens*, *Salmonella* and *Escherichia coli* in healthy horses in a community setting over one year period.

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Clostridium difficile, *Clostridium perfringe*ns and *Salmonella* are important enteric pathogens in horses, but some healthy animals may also harbour these pathogens (Weese et al., 2001; Keel and Songer, 2006; Ossiprandi et al., 2010). Commensal *Escherichia coli* is an indicator organism used to evaluate enteric bacteria for antimicrobial resistance (AMR). There are limited data about commensal *E. coli* for horses. While point prevalence studies have reported shedding rates of these enteric pathogens in healthy horses, little information is available to indicate whether shedding rates change over time and whether single samples are truly reflective of the status of enteropathogen shedding in horses. The objectives of this study were 1) to longitudinally investigate and molecularly characterize isolates of *C. difficile*, *C. perfringens* and *Salmonella*, and 2) to determine the antimicrobial susceptibility profile for *E. coli.*

Fecal samples were collected monthly from 25 adult horses for one year beginning in December 2009. The horses were from 5 farms in Ontario. All horses were more than one year of age, free of apparent gastrointestinal disease and had no history of medication administration in the two months prior to enrolment in the study. Fecal samples were collected by the horse owners. The owners submitted a completed questionnaire with each sample to determine changes in medical history or medication in-between samplings.

Selective cultures were performed for all above bacteria. *C. difficile* isolates were characterized via polymerase chain reaction (PCR) toxin gene profiling and ribotyping. Up to 3 isolates of commensal *E. coli* were submitted to the Laboratory for Foodborne Zoonoses (Guelph, ON) for antimicrobial susceptibility testing by broth microdilution (Sensititre™). A generalized linear mixed model was used to model binary outcomes to examine differences in *E. coli* prevalence and *E. coli* resistance among months and to account for repeated measures. For comparisons between months, the Tukey-Kramer Test was used.

Toxigenic *C. difficile* was isolated from 15/275 (5.5%) samples and from 10/25 (40%) horses on 3/5 (60%) farms. Ribotypes included 078 (n=6), 001 (n=6) and C (n=3). While *C. difficile* was commonly found, only two horses shed the same strain of toxigenic *C. difficile* for more than one month, indicating that shedding was transient. These data suggest that horses are frequently exposed to different *C. difficile* strains, but colonization is transient and disease is an uncommon consequence of exposure. The high number of isolates with ribotype 078 is consistent with recent emergence of this strain in the local horse population. These findings are notable because ribotype 078 also appears to be of increasing concern in humans, especially in people with community-associated CDI (Mulvey et al., 2010). The low prevalence of AMR in commensal *E. coli* suggests that healthy horses are not likely a major reservoir of resistance for enteric bacteria.

No *C. perfringens* or *Salmonella* isolates were detected from any fecal samples.

Commensal *E. coli* was isolated from 232/300 (77%) fecal samples. It was recovered from each horse at least once, and was isolated from 20 to 100% of samples every month (Table A). The prevalence of *E. coli* in February and December was significantly lower than in January, April, June, July, September or November (all P values were less than 0.02).

Box 6 (continued). Occurrence of *Clostridium difficile*, *Clostridium perfringens*, *Salmonella* and *Escherichia coli* in healthy horses in a community setting over one year period.

Susceptibility testing was performed on 676 isolates. Resistance to greater than or equal to 1 antimicrobials was present in only 31/232 (13.4%) samples and 53/676 isolates (7.8%); resistance to greater than or equal to 3 antimicrobials was present in 6/232 (2.6%) of samples and 7/676 (1%) of isolates. There was no statistical difference in resistance prevalence between months. The most common resistance was to sulfisoxisole (11% of samples; 7% of isolates), trimethoprim/sulfamethoxazole (10% of samples; 7% of isolates), and tetracycline (3% of samples; 2% of isolates). These data indicate that horses on farms such as these tend to harbour a rather susceptible population of enteric *E. coli* and that multidrug resistance is rare.

Table A. Recovery of fecal *Escherichia coli* and of resistant *E. coli* from 25 healthy horses over one year (December 2009–November 2010).

Month	Number of *Escherichia coli* positive fecal samples (%)	Number of resistant *Escherichia coli* positive fecal samples (%)	Number of resistant *Escherichia coli* isolates
December	5 (20)	1 (4)	3
January	19 (76)	7 (28)	17
February	4 (25)	0 (0)	0
March	15 (60)	3 (12)	7
April	22 (88)	3 (12)	5
May	25 (100)	4 (16)	5
June	24 (96)	4 (16)	4
July	24 (96)	2 (8)	4
August	24 (96)	0 (0)	0
September	23 (92)	5 (20)	6
October	25 (100)	0 (0)	0
November	20 (80)	2 (8)	2

Resistant *Escherichia coli* refers to resistance to 1 or more antimicrobials.

Keel, M.K. and Songer, J.G., 2006. The comparative pathology of *Clostridium difficile*-associated disease. Vet. Pathol. 43, 225-240.
Mulvey, M.R., et al., 2010. Hypervirulent *Clostridium difficile* strains in hospitalized patients, Canada. Emerg. Infect. Dis. 16, 678-681.
Ossiprandi, M.C., et al., 2010. Preliminary molecular analysis of *Clostridium difficile* isolates from healthy horses in northern Italy. Comp. Immunol. Microbiol. Infect. Dis. 33, e25-9.
Weese, J.S., et al., 2001. A prospective study of the roles of *Clostridium difficile* and enterotoxigenic *Clostridium perfringens* in equine diarrhoea. Equine Vet. J. 33, 403-409.

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Appendix A – Methods

Categorization of Antimicrobials Based on Importance in Human Medicine

Categories of antimicrobials used in this report were taken from the document Categorization of Antimicrobial Drugs Based on Importance in Human Medicine[1] by Health Canada's Veterinary Drugs Directorate (Table A.1).

Antimicrobials are considered to be of Very High Importance in Human Medicine (Category I) when they are essential for the treatment of serious bacterial infections and there is no or limited availability of alternative antimicrobials for effective treatment. Antimicrobials of High Importance in Human Medicine (Category II) consist of those that can be used to treat a variety of infections, including serious infections, and for which alternatives are generally available. Bacteria resistant to antimicrobials of this category are generally susceptible to Category I antimicrobials, which could be used as alternatives. Antimicrobials of Medium Importance in Human Medicine (Category III) are used in the treatment of bacterial infections for which alternatives are generally available. Infections caused by bacteria resistant to these antimicrobials can, in general, be treated with Category II or I antimicrobials. Antimicrobials of Low Importance in Human Medicine (Category IV) are currently not used in human medicine.

[1] Version April, 2009. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed on May 2013.

Table A.1. Categorization of antimicrobial drugs based on importance in human medicine.

Category of importance in human medicine		Antimicrobial class
I	Very High Importance	Carbapenems
		Cephalosporins – the 3rd and 4th generations
		Fluoroquinolones
		Glycopeptides
		Glycylcyclines
		Ketolides
		Lipopeptides
		Monobactams
		Nitroimidazoles (metronidazole)
		Oxazolidinones
		Penicillin-β-lactamase inhibitor combinations
		Polymyxins (colistin)
		Therapeutic agents for tuberculosis (e.g. ethambutol, isoniazid, pyrazinamide, and rifampin)
II	High Importance	Aminoglycosides (except topical agents)
		Cephalosporins – the first and second generations (including cephamycins)
		Fusidic acid
		Lincosamides
		Macrolides
		Penicillins
		Quinolones (except fluoroquinolones)
		Streptogramins
		Trimethoprim-sulfamethoxazole
III	Medium Importance	Aminocyclitols
		Aminoglycosides (topical agents)
		Bacitracins
		Fosfomycin
		Nitrofurans
		Phenicols
		Sulfonamides
		Tetracyclines
		Trimethoprim
IV	Low Importance	Flavophospholipols
		Ionophores

Antimicrobial Resistance

Sampling Design and Data Collection

Surveillance of Human Clinical Isolates

The objective of the *Surveillance of Human Clinical Isolates* component of CIPARS is to provide a representative and methodologically unified approach to monitor temporal variations in the prevalence of antimicrobial resistance in *Salmonella* isolated from humans.

Hospital-based and private clinical laboratories culture human *Salmonella* isolates in Canada. Although reporting is mandatory through laboratory notification of reportable diseases to the National Notifiable Disease Reporting System, forwarding of *Salmonella* isolates to provincial reference laboratories is voluntary and passive. A high proportion (84% in 2001)[1] of *Salmonella* isolates is forwarded to Provincial Public Health Laboratories (PPHLs), but this proportion may vary among laboratories. The Yukon, Northwest Territories, and Nunavut, which do not have a PPHL counterpart, forward their isolates to one of the PPHLs.

Prior to 2002, PPHLs forwarded *Salmonella* isolates to the Enteric Diseases Program, National Microbiology Laboratory (NML), Public Health Agency of Canada (PHAC), Winnipeg, Manitoba for confirmation and subtype characterization. A letter of agreement by which provinces agreed to forward all or a subset of their *Salmonella* isolates to CIPARS was signed in 2002 by the PPHLs, the NML, the Laboratory for Foodborne Zoonoses (LFZ), and the Centre for Food-borne, Environmental and Zoonotic Infectious Diseases of the PHAC. This agreement officially launched the surveillance program.

To ensure a statistically valid sampling plan, all human *Salmonella* isolates (outbreak-associated and non-outbreak-associated) received passively by PPHLs in Saskatchewan, Manitoba, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador were forwarded to the NML. The PPHLs in more heavily populated provinces (British Columbia, Alberta, Ontario, and Québec) forwarded only the isolates received from the 1st to the 15th of each month. However, all human *S*. Newport and *S*. Typhi isolates were forwarded to the NML because of concerns of multidrug resistance and clinical importance, respectively.

The PPHLs were also asked to provide a defined set of data for each forwarded isolate, including serovar name, date collected, and patient age, sex, and province of residence.

Retail Meat Surveillance

The objectives of CIPARS *Retail Meat Surveillance* are to provide data on the prevalence of antimicrobial resistance and to monitor temporal variations in selected bacteria found in raw meat at the provincial/region level. Retail surveillance provides a measure of human exposure to antimicrobial-resistant bacteria via the consumption of undercooked meat. Retail food represents a logical sampling point for surveillance of antimicrobial resistance because it is the endpoint of food animal production. Through meat sample collection and testing, the retail surveillance provides a measure of human exposure to antimicrobial resistant bacteria through the consumption of meat products available for purchase by Canadian consumers. The scope of the surveillance framework can be modified as necessary (e.g. to evaluate different food commodities, bacteria, or geographic regions) and functions as a research platform for investigation of specific questions regarding antimicrobial resistance in the agri-food sector.

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[1] Report of the 2001 Canadian Laboratory Study, National Studies on Acute Gastrointestinal Illness, Division of Enteric, Foodborne and Waterborne Diseases, 2002.

The unit of concern in *Retail Meat Surveillance* in 2010 was the bacterial isolate cultured from one of the commodities of interest. In this situation, the commodities were raw meat products commonly consumed by Canadians, which originated from the 3 animal species sampled in the *Abattoir Surveillance* component. These raw meat products consisted of poultry (chicken legs or wings [skin on]), pork (chops), and beef (ground beef).

For ground beef, only samples of lean ground beef were collected in the first year of surveillance (2003); however, in 2004, the scope was widened to include systematic selection of extra-lean, lean, medium, and regular ground beef. This change was made to ensure representation of the heterogeneity of ground beef with respect to its origins (e.g. domestic vs. imported beef or raised beef cattle vs. culled dairy cattle). The meat cuts "legs or wings with skin on,"[1] "chops," and "ground beef" were chosen on the basis of suspected high prevalences of the targeted bacterial species within and the low purchase prices of these commodities (Ravel, 2002).

Bacteria of interest in chicken were *Campylobacter*, *Salmonella*, and generic *E. coli*. In pork both *Salmonella* and *E. coli* were cultured, but only isolates of *E. coli* underwent antimicrobial susceptibility testing. *Salmonella* was isolated from pork mainly to provide recovery estimates from this commodity for other PHAC programs. Because the prevalence of *Salmonella* in pork is low, antimicrobial susceptibility results are not presented on an annual basis but are pooled and presented over a multi-year period in the interest of precision. Recovery of *Campylobacter* from pork was not attempted because of the low prevalence observed in the initial stages of *Retail Meat Surveillance*. In beef, only *E. coli* was cultured and then tested for antimicrobial susceptibility given the low prevalence of *Campylobacter* and *Salmonella* in these commodities at the retail level, as determined during the early phase of the program.

The sampling protocol was designed to evaluate antimicrobial resistance in certain bacterial species that contaminate retail meat and to which Canadian consumers may subsequently be exposed. In 2010, it primarily involved continuous weekly submission of samples of retail meat from randomly selected geographic areas (i.e. census divisions defined by Statistics Canada), weighted by population, in each participating province. Retail meat samples were collected in British Columbia, Saskatchewan, Ontario, and Québec, and the Maritimes region (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island). Data from Statistics Canada were used to define strata. This was done by using cumulative population quartiles (or thirdtiles) from a list of census divisions in a province, sorted by population in ascending order. Between 15 and 18 census divisions per province were then chosen by means of stratified random selection and weighted by population within each stratum. The number of sampling days allocated to each stratum was also weighted by population and is summarized as follows:

Ontario and Québec

- Stratum One – 10 divisions selected, with 2 sampling days per division per year
- Stratum Two – 4 divisions selected, with 5 sampling days per division per year
- Stratum Three – 2 divisions selected, with 10 sampling days per division per year
- Stratum Four – 1 division selected, with 20 sampling days per year

Saskatchewan

- Stratum One – 9 divisions selected, with 2 sampling days per division per year
- Stratum Two – 5 divisions selected, with 3 sampling days per division per year
- Stratum Three – 2 divisions selected, with 5 sampling days per division per year
- Stratum Four – 1 division selected, with 7 sampling days per year

[1] When legs with skin on were not available, wings with skin on or other cuts of chicken were purchased instead.

British Columbia

- Stratum One – 10 divisions selected, with 1 sampling day per division per year
- Stratum Two – 4 divisions selected, with 3 sampling days per division per year
- Stratum Three – 1 division selected, with 20 sampling days per year

Maritime Provinces

For the 3 Maritimes provinces, results are aggregated and presented at the Maritimes region level; however, sampling activities for this region were proportional to the population within each province as indicated below. Furthermore, as with the other provinces sampled in the retail component, sampling within each province was proportional to the census division subpopulations and is summarized as follows:

Nova Scotia

- Stratum One – 5 divisions selected, with 1 sampling day per division per year (on average)
- Stratum Two – 4 divisions selected, with 2 sampling days per division per year
- Stratum Three – 1 division selected, with 10 sampling days per division per year

New Brunswick

- Stratum One – 5 divisions selected, with 1 sampling day per division per year (on average)
- Stratum Two – 4 divisions selected, with 2 sampling days per division per year
- Stratum Three – 2 divisions selected, with 4 sampling days per division per year (on average)

Prince Edward Island

- Stratum One – 1 division selected, with 1 sampling day per division per year
- Stratum Two – 1 division selected, with 2 sampling days per division per year

Field workers in Ontario and Québec conducted sampling on a weekly basis, and those in British Columbia, Saskatchewan, and Maritimes region conducted sampling every other week. Sampling was less frequent in British Columbia, Saskatchewan, and the Maritimes region because of funding constraints, limited laboratory capacity, and a desire to avoid over-sampling at particular stores. Samples were collected on Mondays or Tuesdays for submission to the LFZ, Saint-Hyacinthe, Québec (LFZ-Saint-Hyacinthe) by Wednesday. Samples submitted from outside Québec (with the exception of samples from the Maritimes region) were sent to the same laboratory via 24-hour courier. Samples from the whole Maritimes region were collected on Mondays or Tuesdays and submitted to a laboratory in Prince Edward Island within 24 hours.

In each province, 2 census divisions were sampled each sampling week. In each census division, 4 stores were selected prior to the sampling day, based on store type. Generally, 3 chain stores and 1 independent market or butcher shop were selected. An exception to this protocol was made in densely populated urban census divisions (e.g. Toronto or Montréal), where 2 chain stores and 2 independent markets or butcher shops were sampled to reflect the presumed shopping behaviour of that subpopulation. From each store type, 1 sample of each commodity of interest was collected, for a total of 11 meat samples (4 chicken, 4 pork, and 3 beef samples) per division per sampling day.[1] When possible, specific stores were sampled only once per sampling year.

Prevalence estimates were used to determine the numbers of samples to be collected, which were based on an expected yield of 100 isolates per commodity per province per year, plus 20% to account for lost or damaged samples. Because sampling was less frequent in British Columbia, Saskatchewan, and the Maritimes region than in Ontario and Québec, the target of 100 isolates per year may not have always be met in those provinces/region.

[1] At 1 store in each division, the beef sample was not collected to minimize over-sampling of this commodity.

In 2010, personal digital assistants (PDAs) were used to capture the following store and sample data:

- Type of store
- Number of cash registers (surrogate measure of store volume)
- "Sell-by" or packaging date
- "May contain previously frozen meat" label – yes or no
- Final processing in store – yes, no, or unknown
- Air chilled – yes, no, or unknown (applied to chicken samples only)
- Organic – yes, no, or unknown
- Antimicrobial free – yes, no, or unknown
- Price per kilogram

Individual samples were packaged in sealed zipper-type bags and placed in 16-L thermal coolers for transport. The ambient environmental temperature was used to determine the number of ice packs placed in each cooler (i.e. 1 ice pack for temperatures below 20ºC and 2 ice packs for temperatures 20ºC or higher). In 1 or 2 coolers per sampling day, instruments for recording temperature data (Ertco Data Logger™, West Patterson, NJ, USA) were used to monitor temperatures to which samples were exposed.

Abattoir Surveillance

The objectives of the CIPARS *Abattoir Surveillance* component are to provide nationally representative, annual antimicrobial resistance data for bacteria isolated from animals entering the food chain, and to monitor temporal variations in the prevalence of antimicrobial resistance in these bacteria. *Abattoir Surveillance* only includes animals that originated from premises within Canada. Established in September 2002, this component initially targeted generic *Escherichia coli* and *Salmonella* within the meat commodities with the highest per capita consumption: beef cattle, broiler chickens, and pigs. In 2003, the component was refined to discontinue *Salmonella* isolation from beef cattle because of the low prevalence of *Salmonella* in that population. *Campylobacter* surveillance was initiated in beef cattle in late 2005 in order to include a pathogen in beef cattle surveillance and to provide data on fluoroquinolone resistance, following the approval of a fluoroquinolone for use in cattle.

In the *Abattoir Surveillance* component, the unit of concern (i.e. the subject of interest) was the bacterial isolate. The bacteria of interest were isolated from the caecal contents (not carcasses) of slaughtered food animals to avoid misinterpretation related to cross-contamination and to better reflect antimicrobial resistance in bacteria that originated on the farm.

Over 90% of all food-producing animals in Canada are slaughtered in federally inspected abattoirs annually[1]. The program is based on the voluntary participation of federally inspected slaughter plants from across Canada. The sampling method was designed with the goal that, across Canada, 150 isolates of each targeted bacterial species would be recovered from each of the 3 animal species over a 12-month period. The exception was *Campylobacter* in beef cattle, for which it was estimated that 100 isolates would be recovered over the same period. These numbers represented a balance between acceptable statistical precision and affordability (Ravel, 2001). The actual number of samples collected was determined for each food animal species on the basis of the expected caecal prevalence of the bacteria in that animal species. For example, if the expected bacterial prevalence was 10%, then 1,500 samples would need to be collected and submitted for bacterial isolation.

The sampling design was based on a 2-stage sampling plan, with each commodity handled separately. The first stage consisted of random selection of federally inspected slaughterhouses. The probability of an abattoir being selected was proportional to its annual slaughter volume. The second stage involved

[1] Agriculture and Agri-Food Canada. Red meat market information. Available at: www.agr.gc.ca/redmeat-vianderouge/index_eng.htm. Accessed May 2013.

systematic selection of animals on the slaughter line. The annual number of caecal samples collected at each abattoir was proportional to its slaughter volume.

To minimize shipping costs and allow each abattoir to maintain efficiency, the annual total number of samples to be collected in each abattoir was divided by 5, resulting in the number of collection periods. For each collection period, 5 caecal samples were collected within 5 days, at the convenience of the slaughterhouse staff, provided the 5 animals and associated samples originated from different groups. Sampling from different groups of animals was important to maximize diversity and avoid bias attributable to overrepresentation of particular producers. The largest plants were scheduled to sample up to 7 animals from different groups over the 5 day collection period in order to achieve the required number of samples annually. Collection periods were uniformly distributed throughout the year, leading to an abattoir-specific schedule for collection of caecal contents. The uniform distribution of the collection periods helped to avoid any bias that may have resulted from seasonal variation in bacterial prevalence and antimicrobial susceptibility test results.

Forty-two federally inspected slaughter plants (5 beef cattle plants, 24 poultry plants, and 12 swine plants) from across Canada participated in the 2010 CIPARS *Abattoir Surveillance* component. Samples were obtained according to a predetermined protocol, with modifications to accommodate various production-line configurations in the different plants. Protocols were designed to avoid conflict with carcass inspection methods, plant-specific Food Safety Enhancement Programs, and Health and Safety requirements. They were also designed to avoid situations of potential cross-contamination. All samples were collected by industry personnel under the oversight of the Veterinarian-in-Charge of the Canadian Food Inspection Agency (CFIA).

Farm Surveillance

The objectives of the CIPARS *Farm Surveillance* component are to provide data on antimicrobial use (Antimicrobial Use, Appendix A) and resistance, to monitor temporal trends in the prevalence of antimicrobial resistance, to investigate associations between antimicrobial use and resistance on grower-finisher pig farms, and to provide data for human-health risk assessments.

Farm Surveillance is the most recent component of CIPARS and complements existing abattoir and retail sample collection activities. This initiative focuses on a sentinel farm framework that provides data on antimicrobial use and fecal samples obtained from farms for bacterial isolation and antimicrobial susceptibility testing. It is administered and coordinated by the LFZ.

In 2006, the CIPARS *Farm Surveillance* component was initiated in swine herds within the 5 major pork-producing provinces in Canada (Alberta, Saskatchewan, Manitoba, Ontario, and Québec). The swine industry was selected as the pilot commodity for development of the farm surveillance infrastructure because the Canadian Quality Assurance (CQA®) program had been extensively implemented by the industry and because there has not been a recent outbreak of foreign animal disease in pigs.

The *Farm Surveillance* component concentrates on grower-finisher hogs. Pigs in this stage of production were chosen because of their proximity to the consumer.

Nationally, 19 veterinarians and 90 sentinel grower-finisher sites were enrolled. In each of the 5 participating provinces, the number of CIPARS sentinel sites was proportional to the national total of grower-finisher units, except in Alberta, where 10 additional sentinel herds were included. The agri-food laboratory of the Alberta Agriculture and Rural Development (AARD) provided laboratory testing for all samples collected from the CIPARS sentinel herds in Alberta.

To preserve the anonymity of participating producers, herd veterinarians collected the samples and data and submitted coded information to PHAC. In the case of corporate herds, 2 noncorporate supervisory veterinarians ensured confidentiality by holding the key to corporate herd codes. This step was taken because knowing a corporate veterinarian's name could have identified the corporation associated with the herd, thereby breaking anonymity.

Veterinarians were purposively selected from the list of veterinarians practicing swine medicine in each province. Each veterinarian selected a predetermined number of sentinel farm sites by use of specific

inclusion and exclusion criteria. To be included, herds were required to be CQA® validated, produce more than 2,000 market pigs per year, and be representative of the characteristics (i.e. similar production volumes and types of production systems) and geographic distribution of herds in the veterinarian's swine practice. Herds were excluded when they were regarded as organic with respect to animal husbandry, were fed edible residual material, or were raised on pasture. These criteria helped ensure that the herds enrolled were representative of most grower-finisher swine herds in Canada.

Sentinel grower-finisher herds were visited once per year for sample and data collection. Pooled fecal samples were collected from 6 pens of pigs that were close to market weight (i.e. more than 80 kg [175 lb]).

Surveillance of Animal Clinical Isolates

The objective of *Surveillance of Animal Clinical Isolates* is to detect emerging antimicrobial resistance patterns as well as new serovar/resistance pattern combinations in *Salmonella*. This component of CIPARS relies on submissions to veterinary diagnostic laboratories, and samples are typically collected by veterinarians and/or producers. Consequently, sample collection and submission as well as *Salmonella* isolation techniques varied among laboratories in 2010. *Salmonella* isolates were sent by provincial and private animal health laboratories from across the country to the *Salmonella* Typing Laboratory (STL) at the LFZ, Guelph, Ontario (LFZ-Guelph) with the exception of Québec, where isolates from animal health laboratories were sent to the Laboratoire d'épidémiosurveillance animale du Québec, du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec for serotyping. Isolates and serotyping results from Québec were then forwarded to the LFZ to perform phage typing and antimicrobial resistance testing. However, unlike the *Surveillance of Human Clinical Isolates* component, all isolates received by provincial animal health laboratories were not necessarily forwarded to the LFZ, with the exception of isolates received by laboratories in British Columbia, Ontario, and Québec. Therefore, coverage may have varied considerably among provinces.

Samples may also have been collected from animal feed, the animal's environment, or non-diseased animals from the same herd. Reported here are results from chicken, turkey, cattle, pigs, and horses. Cattle isolates could have originated from dairy cattle, milk-fed or grain-fed veal, or beef cattle. Chicken isolates were largely from layer hens or broiler chickens, but could also have been from primary layer breeders or broiler breeder birds. Pig isolates may also have originated from animal feed, the animal's environment, or non-diseased animals from the same herd. A proportion of the turkey isolates might have been recovered from turkey-related environmental samples.

Feed and Feed Ingredients

Data from the *Feed and Feed Ingredients* component of CIPARS were obtained from various sources, including monitoring programs of the CFIA and a few isolates from provincial authorities. Information on specimen collection methods was only available for the CFIA monitoring programs.

The CFIA collects samples of animal feed under 2 different programs: Program 15A (Monitoring Inspection – *Salmonella*) and Program 15E (Directed Inspection – *Salmonella*). Under Program 15A, feeds produced at feed mills, rendering facilities, ingredient manufacturers, and on-farm facilities are sampled and tested for *Salmonella*. Although this program makes use of a random sampling process, extra attention is paid to feeds that are more likely to have a higher degree of *Salmonella* contamination, such as those that contain rendered animal products, oilseed meals, fishmeals, grains, and mashes. Program 15E targets feeds or ingredients from establishments that (i) produce rendered animal products, other feeds containing ingredients in which *Salmonella* could be a concern (e.g. oilseed meal or fishmeal), or a significant volume of poultry feed; (ii) are known to have repeated problems with *Salmonella* contamination; or (iii) have identified a *Salmonella* serovar that is highly pathogenic (e.g. Typhimurium, Enteritidis, or Newport). Program 15E is a targeted program; samples are not randomly selected.

Bacterial Isolation

All samples were cultured by use of standard protocols as described below. All primary isolation of human *Salmonella* isolates was conducted by hospital-based or private clinical laboratories in participating provinces. Most primary isolation of *Escherichia coli, Salmonella*, *Enterococcus*, and *Campylobacter* from agri-food samples was conducted at the LFZ-Saint-Hyacinthe. Primary isolation for *Retail Meat Surveillance in Prince Edward Island* was conducted at the Atlantic Veterinary College, University of Prince Edward Island. Part of the primary isolation for *Farm Surveillance* was conducted at the Agri-Food Laboratory, AARD. Samples from the CIPARS *Animal Clinical Isolates* component were cultured by various participating laboratories. Most primary bacterial isolation from *Feed and Feed Ingredients* samples was conducted by the CFIA – Laboratory Services Division (Calgary or Ottawa).

Salmonella

Surveillance of Human Clinical Isolates

Hospital-based and private clinical laboratories isolated and identified *Salmonella* from human samples according to approved methods (Kauffman, 1966; Ewing, 1986; Le Minor, 2001; Murray et al., 2005).

Farm Surveillance and Abattoir Surveillance

The method used to isolate *Salmonella* was a modification of the MFLP-75 method of the Compendium of Analytical Methods, Health Protection Branch, Methods of Microbiological Analysis of Food, Government of Canada. This method allowed isolation of motile and viable *Salmonella* from fecal samples from pigs and caecal contents from broiler chickens and pigs. It was based on the ability of *Salmonella* to multiply and be motile in modified semi-solid Rappaport Vassiliadis (MSRV) medium at 42°C.

A 10-g portion of each pig sample was mixed with 90 mL of buffered peptone water (BPW), which served as a non-selective pre-enrichment broth. For chickens, caecal contents were weighed and BPW was added at a ratio of 1:10. The pig and chicken samples were incubated at 35 ± 1°C for 24 hours. Afterward, an MSRV plate was inoculated with 0.1 mL of the pre-enrichment broth and incubated at 42 ± 1°C for 24 to 72 hours. Suspect colonies were screened for purity and used to inoculate triple-sugar-iron and urea agar slants. Presumptive *Salmonella* isolates were then assessed with the indole test, and their identities were verified by means of slide agglutination with *Salmonella* Poly A-I and Vi antiserum.

Retail Meat Surveillance

One chicken leg[1] was added to 225 mL of BPW. One hundred and fifty millilitres of the peptone rinse was kept for isolation of *Campylobacter* and *Escherichia coli*. Chicken samples were left in the remaining 75-mL of peptone rinse and were incubated at 35 ± 1°C for 24 hours. Afterward, an MSRV plate was streaked with 0.1 mL of the incubated rinse and incubated at 42 ± 1°C for 24 to 72 hours. Suspect colonies were screened for purity and used to inoculate triple-sugar-iron and urea agar slants. Presumptive *Salmonella* isolates were assessed with the indole test, and their identities were verified by means of slide agglutination with *Salmonella* Poly A-I and Vi antiserum.

Surveillance of Animal Clinical Isolates

Salmonella was isolated according to standard procedures, which varied among laboratories. Most methods for detecting *Salmonella* in animal clinical isolates were similar in principle and involved pre-

[1] When legs with skin on were not available, wings with skin on or other cuts were purchased instead.

enrichment, selective enrichment, differential and selective plating, isolation, and biochemical and serological confirmation of the selected isolates.

Feed and Feed Ingredients

Under both CFIA programs (15A and 15E), all samples were collected aseptically and submitted for bacterial culture and isolation. For *Salmonella* isolation, MSRV medium was used.

Escherichia coli

Farm Surveillance

One drop of the BPW mixture prepared for *Salmonella* isolation was streaked onto MacConkey agar and incubated at 35 ± 1°C for 18 to 24 hours. Suspect lactose-fermenting colonies were screened for purity and transferred onto Luria-Bertani agar. Presumptive generic *E. coli* colonies were assessed with Simmons citrate and indole tests. Isolates with negative indole results were identified with a test kit for identification of enteric bacteria (API®20E system, bioMérieux Clinical Diagnostics, Marcy-l'Étoile, France).

Abattoir Surveillance

Generic *E. coli* was isolated from the caecal contents of broiler chickens, pigs, and beef cattle. Ten grams of each caecal sample was mixed with 90 mL of BPW. One drop of this mixture was streaked onto MacConkey agar and incubated at 35°C for 18 to 24 hours. Suspect lactose-fermenting colonies were screened for purity and transferred onto Luria-Bertani agar. Presumptive *E. coli* colonies were assessed with Simmons citrate and indole tests. Isolates with negative indole results were identified with a test kit for identification of enteric bacteria (API® 20E system).

Retail Meat Surveillance

One chicken leg,[1] 1 pork chop, or 25 g of ground beef was added to 225 mL of BPW. Fifty millilitres of the peptone rinse was mixed with 50 mL of a double-strength broth for selective identification of coliform bacteria and *E. coli* (EC broth) and incubated at 45 ± 1°C for 24 hours. One loopful of the incubated mixture was streaked onto eosin methylene blue agar and incubated at 35 ± 1°C for 24 hours. Suspect colonies were screened for purity and transferred onto trypticase soy agar with 5% sheep blood. Presumptive *E. coli* colonies were assessed with Simmons citrate and indole tests. Isolates with negative indole results were identified with a bacterial identification test kit (API® 20E system).

Campylobacter

Abattoir Surveillance

For isolation of *Campylobacter* from beef cattle caecal samples, 1 mL of the BPW mixture prepared for isolation of *E. coli* was used. This volume was mixed with 9 mL of Hunt's enrichment broth (HEB) and incubated in a microaerophilic atmosphere at 35 ± 1°C for 4 hours. After this first incubation, 36 µL of sterile cefoperazone was added to the HEB. Tubes were then incubated in microaerophilic conditions at 42 ± 1°C for 20 to 24 hours. A loopful of the incubated HEB was then used to inoculate a modified cefoperazone charcoal deoxylate agar (mCCDA) plate. Plates were incubated at 42 ± 1°C in microaerophilic conditions for 72 hours. Suspect colonies were streaked onto another mCCDA plate to obtain pure colonies and on Mueller Hinton agar supplemented with 5% sheep blood. Plates were incubated in a microaerophilic atmosphere at 42 ± 1°C for 48 to 72 hours. Presumptive *Campylobacter* colonies were identified by genus and species (*C. coli*, *C. jejuni*, or other *Campylobacter* spp.) via the

[1] When legs with skin on were not available, wings with skin on or other cuts were purchased instead.

following tests: Gram stain, oxidase, catalase, growth at 25 ± 1°C, cephalothin resistance, and hippurate and indoxyl acetate hydrolysis. A multiplex PCR (mPCR)[1] was then used to speciate colonies that were presumptively positive based on microscopy and the results of oxidase and catalase tests. Specific genomic targets (hippuricase in *C. jejuni* and aspartokinase in *C. coli*) were amplified by mPCR from lysates generated from bacterial colonies. Products were visualized on agarose gel and identified based on their specific molecular size. An internal universal control (16s rRNA) was incorporated into the PCR method. The priming oligonucleotides (primers) used in the PCR were highly specific for *C. jejuni* or *C. coli* and will not amplify DNA present in any other *Campylobacter* spp. or non-*Campylobacter* organisms.

Retail Meat Surveillance

One chicken leg[2] or 2 wings were mixed with 225 mL of BPW. Fifty millilitres of the peptone rinse was mixed with 50 mL of double-strength Bolton broth and incubated in a microaerophilic atmosphere at 42 ± 1°C for 48 hours. A loopful of the incubated broth was then streaked onto a mCCDA plate and incubated in a microaerophilic atmosphere at 42 ± 1°C for 24 hours. Suspect colonies were streaked onto another mCCDA plate and a Mueller Hinton plate. Plates were incubated in a microaerophilic atmosphere at 42 ± 1°C for 48 to 72 hours. Presumptive *Campylobacter* colonies were identified by genus and species (*C. coli*, *C. jejuni*, or other *Campylobacter* spp.) via the following tests: Gram stain, oxidase, catalase, growth at 25 ± 1°C, cephalothin resistance, and hippurate and indoxyl acetate hydrolysis.

Enterococcus

Farm Surveillance

One drop of the BPW mixture prepared for *Salmonella* isolation was streaked onto enterococcal isolation agar (Enterococcosel™ agar, BD, Mississauga, ON) and incubated at 35 ± 1°C for 24 hours. Suspect colonies were screened for purity on Columbia agar with 5% sheep blood. Presumptive *Enterococcus* colonies were transferred onto Slaneth and Bartley agar and used to inoculate 3 tubes of phenol-red base broth containing 0.25% L-arabinose, 1% mannitol, or 1% α-methyl-D-glucoside. The plate and tubes were incubated at 35°C for 24 hours.

Serotyping and Phage Typing of *Salmonella*

Surveillance of Human Clinical Isolates

In general, clinical laboratories forwarded their *Salmonella* isolates to their PPHL for identification and serotyping. The PPHL further forwarded *Salmonella* isolates to NML according to the predefined testing protocol. Isolate identities were confirmed by the NML when isolates received did not have a serovar name (Le Minor and Popoff, 2001) or when inconclusive results arose during phage typing. The O or somatic antigens of the *Salmonella* isolates were serotyped by use of a slide agglutination method (Ewing, 1986). At the NML, *Salmonella* H or flagellar antigens were detected via slide and confirmatory tube agglutination methods. *Salmonella* isolates were maintained at room temperature (25° to 35°C) until typed.

Phage typing was performed at the NML for isolates of the following *Salmonella* serovars: Enteritidis, Heidelberg, Typhimurium, Hadar, Newport, Typhi, Paratyphi A, Paratyphi B, Paratyphi B var. L(+) tartrate+, Infantis, Thompson, Oranienburg, Panama, I 4,[5],12:b:-, and I 4,[5],12:i:-. For phage typing the standard technique described by Anderson and Williams (1956) was followed. Isolates were streaked onto nutrient agar plates and incubated at 37°C for 18 hours. One smooth colony was selected and used to inoculate 4.5 mL of phage broth (Difco™ phage broth, Difco Laboratories, Baltimore, MD; pH, 6.8), which

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[1] The multiplex PCR speciation of *C. jejuni* and *C. coli* was based on the following published method. Persson S, KE Olsen. Multiplex PCR for identification of *Campylobacter coli* and *Campylobacter jejuni* from pure cultures and directly on stool samples. *J Med Microbiol* 2005; 54:1043–1047.

[2] When legs with skin on were not available, wings with skin on or other cuts of chicken were purchased instead.

was then incubated for 1.5 to 2 hours in a shaking water bath at 37°C to attain bacterial growth with a turbidity equivalent to 0.5-McFarland standard. Phage agar plates (Difco™ phage agar, Difco Laboratories) were flooded with approximately 2 mL of culture medium, and the excess liquid was removed with a Pasteur pipette. Flooded plates were allowed to dry for 15 minutes at room temperature. Afterward, approximately 20 μL of each serovar-specific typing phage was used to inoculate the bacterial lawn by means of a multiple inoculating syringe method (Farmer et al., 1975). The plates were incubated at 37°C overnight, and lytic patterns were subsequently interpreted (Anderson and Williams, 1956).

Salmonella Enteritidis strains were phage typed with typing phages obtained from the International Centre for Enteric Phage Typing (ICEPT), Central Public Health Laboratory, Colindale, UK (Ward et al., 1987). The phage-typing protocol and phages for *Salmonella* Typhimurium, developed by Callow (1959) and further extended by Anderson (1964) and Anderson and colleagues (1977) were obtained from the ICEPT. The *S*. Heidelberg phage typing protocol and phages were supplied by the NML (Demczuk et al., 2003). Isolates that reacted with the phages but did not conform to any recognized phage type were designated as atypical. Strains that did not react with any of the typing phages were designated as untypable.

The Identification and Serotyping and the Phage Typing units at the NML have attained International Standards Organization (ISO) 17025 accreditation by the Standards Council of Canada. The Identification and Serotyping, Phage Typing, and Antimicrobial Resistance units at the NML participate in the annual Global Salm-Surv (GSS), External Quality Assurance System of the World Health Organization, the Enter-net (a European network for the surveillance of human gastrointestinal infections) proficiency program for *Salmonella*, and a strain exchange with the LFZ (*Salmonella* and *Escherichia coli*). The NML has been a strategic planning member of the GSS program since 2002.

Surveillance of Agri-Food, Animal Clinical, and Feed Isolates

Animal clinical *Salmonella* isolates from Québec were serotyped at the Laboratoire d'épidémiosurveillance animale du Québec, du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec and were sent to the STL[1] for phage typing.

All *Salmonella* isolates from other provinces were submitted to the STL for serotyping and phage typing. The serotyping method detects O or somatic antigens of the *Salmonella* isolates via slide agglutination (Ewing, 1986). The H or flagellar antigens were identified with a microtitre plate well precipitation method (Shipp and Rowe, 1980). The antigenic formulae of the *Salmonella* serovars as reported by Grimont and Weill (2007) were used to identify and name the serovars.

For phage typing, the standard technique by Anderson and Williams (1956) and described above was followed. The sources of the typing phages for *Salmonella* Enteritidis, Typhimurium and Heidelberg were the same as described above for *Surveillance of Human Clinical Isolates*.

Since 1995, the STL has participated in annual inter-laboratory exchange of serotyping panels with up to 3 other laboratories. The STL began external proficiency testing of the accuracy of phage typing in 2003. Every year, the STL participates successfully in phage typing proficiency panels from the Central Public Health Laboratory, Colindale, England.

Antimicrobial Susceptibility Testing

All *Salmonella* isolates of human origin were tested for antimicrobial susceptibility at the NML, and all isolates of agri-food or feed origin were tested for antimicrobial susceptibility at the LFZ-Guelph. The majority of *Campylobacter* and *Escherichia coli* isolates from all agri-food components were tested at the LFZ-Saint-Hyacinthe. *Escherichia coli* isolates from *Retail Meat Surveillance* in Prince Edward Island were processed at the Atlantic Veterinary College, University of Prince Edward Island. In most instances, only 1 isolate per positive sample was tested for antimicrobial susceptibility.

[1] Office Internationale des Épizooties (OIÉ); All World Organisation for Animal Health, Reference Laboratory for Salmonellosis, Guelph, Ontario.

For *Farm Surveillance*, antimicrobial susceptibility testing was performed on 3 *E. coli* isolates, 3 *Enterococcus* isolates, and 1 *Salmonella* isolate per sample. A portion of the *Enterococcus* and *E. coli* isolates from *Farm Surveillance* in Alberta and Saskatchewan were processed by the Agri-Food Laboratory Branch, AARD. The LFZ-Guelph, LFZ-Saint-Hyacinthe, AARD, and Atlantic Veterinary College participate in external proficiency programs for antimicrobial susceptibility testing for *Salmonella*, *E. coli*, and *Enterococcus*. LFZ-Saint-Hyacinthe and LFZ-Guelph participate in inter-agency proficiency programs for identification and antimicrobial susceptibility testing of *Salmonella*, *E. coli*, *Enterococcus*, and *Campylobacter* with the National Antimicrobial Resistance Monitoring System of the United States. The LFZ-Guelph laboratory for antimicrobial sensitivity testing is ISO/IEC 17025–accredited.

Salmonella, *Escherichia coli*, and *Enterococcus*

All *Salmonella* and *Escherichia coli* isolates were tested for antimicrobial susceptibility with a panel of 15 antimicrobials (Table A.2) and for *Enterococcus* with a panel of 16 antimicrobials (Table A.3). The minimum inhibitory concentration (MIC) values for *Salmonella*, *E. coli*, and *Enterococcus* were determined by means of the broth microdilution method (Clinical and Laboratory Standards Institute [CLSI] M7-A8) by use of an automated system (Sensititre™ Automated Microbiology System, Trek™ Diagnostic Systems Ltd, West Sussex, England). This system involves a commercially available broth dilution technique that involves dehydrated antimicrobials in the wells of microtitre plates. The CMV1AGNF susceptibility plates (Sensititre,™ Trek™ Diagnostic Systems) of the National Antimicrobial Resistance Monitoring System were used for *E. coli* and *Salmonella* isolates, whereas CMV3AGPF plates were used for *Enterococcus* isolates.

Isolates were streaked onto a plate of Mueller Hinton agar (or Columbia blood agar or Mueller Hinton blood agar) and incubated in an inverted position at 36 ± 1°C for 18 to 24 hours to obtain isolated colonies. One colony was chosen from the plate and re-streaked onto agar plates for growth. The agar plates were subsequently incubated at 36 ± 1°C for 18 to 24 hours. A 0.5-McFarland suspension was prepared by transferring bacterial growth from the agar plates into 5.0 mL of sterile, demineralized water and suspending the organisms in the liquid by use of a vortex mixer. Ten microlitres of the water-bacteria suspension was transferred to a tube containing 10 mL of Mueller Hinton broth (MHB) and mixed with a vortex device. The MHB suspension was dispensed into susceptibility testing plates at 50 μL per well. The plates were sealed with adhesive plastic sheets and incubated for 18 hours at 36 ± 1°C. Detection of possible vancomycin-resistant enterococci required 6 more hours of incubation for a total of 24 hours.

After incubation, the CMV1AGNF plates were read and interpreted with an automated reading and incubation system (ARIS®, Trek™ Diagnostic Systems Ltd), whereas the CMV3AGPF plates were read with the manual reader (Sensititre Vizion™, Trek™ Diagnostic Systems). In accordance with standards set by the CLSI (CLSI M100-S20), *Staphylococcus aureus* ATCC 29213, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, and *Enterococcus faecalis* ATCC 29212 were used for quality assurance purposes to ensure validity and integrity of the MIC values yielded by the CMV1AGNF susceptibility panels. *Staphylococcus aureus* ATCC 29213, *Escherichia coli* ATCC 25922, *Enterococcus faecalis* ATCC 29212, and *Enterococcus faecalis* ATCC 51299 were used as quality control organisms for *Enterococcus* antimicrobial susceptibility testing.

Campylobacter

Campylobacter isolates were tested for antimicrobial susceptibility with a panel of 9 antimicrobials (Table A.4).The MIC values for *Campylobacter* isolates were determined by means of the broth microdilution method (CLSI M7-A8). Antimicrobial susceptibility testing was performed with CAMPY susceptibility plates (Sensititre™, Trek™ Diagnostic Systems) from the National Antimicrobial Monitoring System. The colonies were streaked onto Mueller Hinton agar plates with 5% sheep blood and incubated in a microaerophilic atmosphere at 42 ± 1°C for 24 hours. A 0.5-McFarland suspension of bacterial growth was prepared by transferring selected bacterial colonies into a tube containing 5 mL of MHB and mixing the tube contents with a vortex device for at least 10 seconds. Afterward, 10 μL of the MHB mixture was transferred into a tube containing 11 mL of MHB with laked horse blood and mixed for 10 seconds. The MHB mixture was

dispensed into CAMPY plates at 100 μL per well. The plates were sealed with adhesive plastic sheets and incubated in a microaerophilic atmosphere at 42 ± 1°C for 24 hours. *Campylobacter jejuni* ATCC 33560 was used as quality control organism. The MIC values obtained were compared with those of CLSI standards (CLSI M45-A2).

Antimicrobial Susceptibility Breakpoints

Table A.2. Breakpoints in antimicrobial susceptibility of *Salmonella* and *Escherichia coli* isolates; CMV1AGNF plate, 2010.

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Amoxicillin-clavulanic acid	1.0/0.5 – 32/16	≤ 8/4	16/8	≥ 32/16
	Ceftiofur[b]	0.12 – 8	≤ 2	4	≥ 8
	Ceftriaxone	0.25 – 64	≤ 1	2	≥ 4
	Ciprofloxacin	0.015 – 4	≤ 1	2	≥ 4
II	Amikacin	0.5 – 32	≤ 16	32	≥ 64
	Ampicillin	1 – 32	≤ 8	16	≥ 32
	Cefoxitin	0.5 – 32	≤ 8	16	≥ 32
	Gentamicin	0.25 – 16	≤ 4	8	≥ 16
	Kanamycin	8 – 64	≤ 16	32	≥ 64
	Nalidixic acid	0.5 – 32	≤ 16	N/A	≥ 32
	Streptomycin[c]	32 – 64	≤ 32	N/A	≥ 64
	Trimethoprim-sulfamethoxazole	0.12/2.38 – 4/76	≤ 2/38	N/A	≥ 4/76
III	Chloramphenicol	2 – 32	≤ 8	16	≥ 32
	Sulfisoxazole	16 – 512	≤ 256	N/A	≥ 512
	Tetracycline	4 – 32	≤ 4	8	≥ 16
IV					

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate susceptibility. R = Resistant. N/A = Not applicable.
[a] Unless otherwise specified, CLSI M100-S21 was the reference used for all antimicrobials in the panel.
[b] CLSI M31-A3.
[c] No Clinical and Laboratory Standards Institute interpretive criteria for Enterobacteriaceae were available for this antimicrobial. Breakpoints were based on the distribution of minimum inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.

Table A.3. Breakpoints in antimicrobial susceptibility of *Enterococcus* isolates; CMV3AGPF plate, 2010.

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Ciprofloxacin	0.12 – 4	≤ 1	2	≥ 4
	Daptomycin[b]	0.25 – 16	≤ 4	N/A	N/A
	Linezolid	0.5 – 8	≤ 2	4	≥ 8
	Tigecycline[c]	0.015 – 0.5	≤ 0.25	0.5	≥ 1
	Vancomycin	0.25 – 32	≤ 4	8 – 16	≥ 32
II	Erythromycin	0.25 – 8	≤ 0.5	1 – 4	≥ 8
	Gentamicin (high-level)	128 – 1,024	≤ 500	N/A	> 500
	Kanamycin (high-level)[d]	128 – 1,024	≤ 512	N/A	≥ 1,024
	Lincomycin[d]	1 – 8	≤ 2	4	≥ 8
	Penicillin	0.25 – 16	≤ 8	N/A	≥ 16
	Quinupristin-dalfopristin	0.5 – 32	≤ 1	2	≥ 4
	Streptomycin (high-level)[d]	512 – 2,048	≤ 1,000	N/A	> 1,000
	Tylosin[d]	0.25 – 32	≤ 8	16	≥ 32
III	Chloramphenicol	2 – 32	≤ 8	16	≥ 32
	Nitrofurantoin	2 – 64	≤ 32	64	≥ 128
	Tetracycline	1 – 32	≤ 4	8	≥ 16
IV					

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate resistance. R = Resistant. N/A = Not applicable.
[a] CLSI M100-S21 Table 2D. M7-A8-MIC Testing section.
[b] A referenced resistance breakpoint has not been established for this antimicrobial. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression “non-susceptible” was used instead of “resistant” in the text.
[c] Based on the resistance breakpoint from the European Committee on Antimicrobial Susceptibility Testing because no interpretative criteria were available from the CLSI for tigecycline.
[d] No Clinical and Laboratory Standards Institute (CLSI) interpretive criteria for *Enterococcus* were available for this antimicrobial. Breakpoints were based on the distribution of minimum inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.

Table A.4. Breakpoints in antimicrobial susceptibility of *Campylobacter* isolates; CAMPY plate, 2010.

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Ciprofloxacin	0.015 – 64	≤ 1	2	≥ 4
	Telithromycin[b]	0.015 – 8	≤ 4	8	≥ 16
II	Azithromycin[b]	0.015 – 64	≤ 2	4	≥ 8
	Clindamycin[b]	0.03 – 16	≤ 2	4	≥ 8
	Erythromycin	0.03 – 64	≤ 8	16	≥ 32
	Gentamicin[b]	0.12 – 32	≤ 2	4	≥ 8
	Nalidixic acid[b]	4 – 64	≤ 16	32	≥ 64
III	Florfenicol[c]	0.03 – 64	≤ 4	N/A	N/A
	Tetracycline	0.06 – 64	≤ 4	8	≥ 16
IV					

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate susceptibility. R = Resistant. N/A = Not applicable.
[a] CLSI M45-A2.
[b] No Clinical and Laboratory Standards Institute interpretive criteria for *Campylobacter* were available for this antimicrobial. Breakpoints were based on the distribution of minimum inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.
[c] A referenced resistance breakpoint has not been established for this antimicrobial. The susceptibility breakpoint was based on the distribution of minimum inhibitory concentrations and was harmonized with those of the National Antimicrobial Resistance Monitoring System. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression "non-susceptible" was used instead of "resistant" in the text.

Antimicrobial Resistance Data Analysis for Human and Agri-Food Isolates

Data from human and agri-food surveillance were integrated and maintained in 2 computer repositories (Oracle®, Oracle Corp., Redwood Shores, CA, USA) and then transferred to a harmonized database (SAS® 9.1, SAS Institute Inc., Cary, NC, USA). For the *Farm Surveillance* component of CIPARS, the bacterial species, serovar, and MIC data were maintained in a relational database (Microsoft® Access, Microsoft Corp., Redmond, WA, USA).

Data were analyzed with statistical software programs (SAS® 9.1; and Stata® 8, Stata Corp., College Station, TX, USA), and outputs were exported into a spreadsheet application (Microsoft® Excel 2000, Microsoft Corp.). All tables and figures were generated with the spreadsheet application (Microsoft® Excel 2000). For *Farm Surveillance*, statistical analyses were performed to account for clustering of antimicrobial resistance within swine herds through generalized estimating equations (PROC GENMOD, SAS® 9.1). All statistical models for pig farms included a binary outcome, logit-link function, and exchangeable correlation structure. Exact confidence intervals were computed by use of the BINOMIAL statement in PROC FREQ (SAS® 9.1) and an alpha level of 0.05. When the prevalence was 0%, an alpha level of 0.1 was used instead. Null binomial response models were used to estimate the prevalence of resistance to each antimicrobial. From each model, the intercept (β_0) and 95% confidence intervals were used to calculate population-averaged prevalence estimates with the formula $[1 + \exp(-\beta_0)]^{-1}$.

For the *Farm Surveillance*, *Abattoir Surveillance*, and *Retail Meat Surveillance* components, recovery rate was defined as the number of positive culture results divided by the total number of samples submitted for culture.

The percentage of isolates with resistance to antimicrobials was defined as the number of isolates resistant divided by the total number of isolates tested for each antimicrobial, multiplied by 100. The breakpoints used for interpretation of antimicrobial susceptibility results are listed in Table A.2, Table A.3, and Table A.4. Intermediate MIC values were categorized as susceptible for all analyses. A new ceftriaxone breakpoint was officially adopted by the CLSI in January 2010. This new breakpoint was

applied to all data, including historical data, and was used when performing the analysis for the 2010 Annual Report.

The total number of antimicrobials in each resistance pattern was calculated by summing the number of antimicrobials to which each isolate was resistant. The most common resistance pattern may include patterns with only 1 antimicrobial. In this case, like for the most common patterns including 2 or more antimicrobials, the number of isolates reported includes only those resistant to this specific pattern (i.e. without any additional resistance to other antimicrobials).

For the provincial human incidence data, the number of *Salmonella* clinical cases in which a particular serovar was detected per 100,000 inhabitant-years was calculated by dividing the total number of isolates of each serovar received by CIPARS from that province by the provincial population (Statistics Canada post-census population estimates, Jan. 1, 2005) and then multiplying by 100,000.[1] The national estimates for all serovars except *S*. Typhi and *S*. Newport were calculated as follows. In more heavily populated (or larger) provinces, the number of isolates resistant and the number of isolates submitted each month were multiplied by 2 as only isolates received in the first 15 days of the month were forwarded to CIPARS for testing. This provided us with an estimated total number of isolates resistant and estimated number of submissions for the larger provinces. Numbers of isolates resistant (estimated value in larger provinces or actual value in smaller provinces) for all provinces were summed to obtain the total estimated number of isolates resistant. Total numbers of isolates submitted (estimated value in larger provinces or actual value in smaller provinces) for all provinces were summed to obtain the total estimated number of submissions. Finally, the total estimated number of isolates resistant was divided by the total estimated number of submissions for each antimicrobial tested to obtain a national estimate of resistance for each antimicrobial and each serovar.

Temporal analyses were performed for selected antimicrobials. Only 1 antimicrobial per antimicrobial class was selected among those antimicrobials commonly used in the agri-food and/or human sectors. Some antimicrobials were excluded from the temporal analyses for the following reasons:

- Resistance to the antimicrobial was absent or at a very low prevalence, or the breakpoint was debatable and other antimicrobials could be used to provide a surrogate measure of resistance or intermediate susceptibility (e.g. nalidixic acid for ciprofloxacin).
- The isolate was cross-resistant to another selected antimicrobial (e.g. amoxicillin-clavulanic acid and ceftiofur).
- The antimicrobial has been banned for use in the agri-food sector, and resistance to this drug is maintained because of the use of another antimicrobial (e.g. chloramphenicol).

A logistic regression model was developed with year as an independent categorical variable. Data were analyzed with commercial software (Stata 9.1®; or R version 2.2.1, R Foundation for Statistical Computing, Vienna, Austria). Firth's penalized maximum likelihood estimation was performed (R version 2.2.1) when data separation (1 or more zero cells in the contingency table) was encountered. Analyses of *Farm Surveillance* data were adjusted for clustering at the herd level.

In most situations, the year 2003 was selected as the baseline period; therefore, comparisons between 2003 and 2010 were performed. Comparisons between 2004 and 2010 were also performed for resistance to ceftiofur and ampicillin in *Escherichia coli* and *Salmonella* isolated from chicken samples to assess changes in antimicrobial resistance after the early 2005 voluntary withdrawal of ceftiofur by Québec chicken hatcheries. The year 2004 was also used as a reference for temporal comparisons of ceftiofur and ampicillin resistance in human *S*. Heidelberg isolates because *S*. Heidelberg in humans was suspected to be mainly of chicken origin. For analyses of temporal variations in retail data from Saskatchewan, 2005 was used as the comparison year because this was the first year of the *Retail Meat Surveillance* component of CIPARS in that province. At the request of data users, comparisons between the previous year of surveillance (i.e. 2009) and current year (i.e. 2010) are also presented in this report. For temporal analysis of ceftiofur and ampicillin resistance in *Salmonella* and *E. coli* from retail chicken, 2006 was compared with 2010 because of changes in use of those drugs in 2007. For the *Farm Surveillance*

[1] Statistics Canada. Population by year, by province and by territory. Available at: www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo02a-eng.htm. Accessed May 2013.

component, 2006 was used as the comparison year because this was the year surveillance began. Values of $P \leq 0.05$ were considered significant for all analyses.

Antimicrobial Use

Data Collection and Analysis

Humans

Canadian CompuScript (CCS) is a database that records the number of prescriptions and number of units of product dispensed by pharmacists to consumers in Canada. Data fields include product name (including manufacturer), form, and strength as well as province, number of prescriptions, units of product, and dollars spent by month for each year.

The sampling frame (or "universe") for this dataset in 2010 consisted of approximately 7,980 pharmacies, covering nearly all retail pharmacies in Canada and excluding those in the Yukon, Northwest Territories, and Nunavut. The company IMS Health Canada Inc. uses a method of geospatial projection that creates projection factors for application to all non-participating stores on the basis of the number of stores in the area, distance between stores, and store size. In 2010, an average of 5,092 stores was included. The projection factor was used to extrapolate the number of prescriptions dispensed by the pharmacies actually included in the database to that of the "universe" (7,980 pharmacies).

Antimicrobials were classified and defined daily doses (DDDs) were determined according to the Anatomical Therapeutic Chemical (ATC) classification system (Table A.5). Temporary DDDs (not yet approved but posted on the World Health Organization website) were used when available. For pediazole, the DDD for erythromycin ethyl succinate (2 g) was used. For orally administered penicillin G, the DDD for benzylpenicillin by parenteral route (3.6 g) was used. Drugs with no DDDs were excluded, including trisulfaminic (drug discontinued in 2001; a total of 832,384 extended units were dispensed in 2000).

Although no hospital pharmacies participated in the CCS program, CCS data included a small volume of antimicrobials prescribed in non-oral forms such as injectable drugs or inhalants. Inconsistencies related to non-oral drugs, which represent a very small volume of the CCS data, were judged too common to include these drugs in the CIPARS analysis. Consequently, the 2010 report describes orally administered drugs dispensed only by retail pharmacies. Information regarding drugs of the ATC group J01 (antimicrobials for systemic use) was retained in the analysis, as was information on orally administered vancomycin (ATC group A07AA), which was included in the analysis under class J01XA.

The total amount of active ingredient was obtained by multiplying the number of extended units (real or corrected) by the strength of the product in grams. For combination drugs, the DDDs of the active ingredients of all antimicrobial components were summed to obtain the total number of active ingredients. However, the amount of active ingredient used in the calculation of the total number of DDDs for combination drugs included only the compounds for which DDDs were computed. For example, for drugs composed of trimethoprim-sulfamethoxazole, only the total number of grams of sulfamethoxazole was used to compute the number of DDDs.

The total number of DDDs per 1,000 inhabitant-days (abbreviated in this report as DID) for a given year was obtained by summing all DDDs for each ATC class and each year. This number was further divided by the size of the population in thousands during that year, and again divided by the number of days in that year (365 or 366). The total number of prescriptions and total cost per 1,000 inhabitants was obtained by dividing the total number of prescriptions or the total cost by the population size in thousands for each year. Population data were obtained from updated and preliminary post-census estimates based on the results of the 2001 Census (Statistics Canada). Census counts were adjusted for net under-coverage.

In the 2002 and 2003 CIPARS reports, methenamine and linezolid were classified under “other antimicrobials.” As of 2004, they have been reported separately to harmonize with reports from other surveillance programs such as the Danish Integrated Antimicrobial Resistance Monitoring and Research

Program. Data regarding metronidazole (classified under J01XD imidazole) were added in 2005. Because metronidazole data could not be extracted for years between 2000, and 2004, that information is not included in the tables or in any totals for those years.

Data were analyzed with statistical software programs (SAS® 9.1, SAS Institute Inc., Cary, NC, USA; Stata® 8, Stata Corp., College Station, TX, USA), and outputs were exported into a spreadsheet application (Microsoft® Excel 2000, Microsoft Corp., Redmond, WA, USA).

Table A.5 .List of antimicrobials from the CompuScript database for each ATC[1] class.

	Antimicrobial	ATC Class
I	Amoxicillin and enzyme inhibitor (J01CR02)	Combinations of penicillins, including β-lactamase inhibitors (J01CR)
	Cefixime (J01DD08)	Third-generation cephalosporins (J01DD)
	Ofloxacin (J01MA01), ciprofloxacin (J01MA02), norfloxacin (J01MA06), levofloxacin (J01MA12), moxifloxacin (J01MA14)	Fluoroquinolones (J01MA)
	Vancomycin (J01XA01)	Glycopeptides (J01XA)
	Metronidazole (J01XD01)	Imidazole (J01XD)
	Linezolid (J01XX08)	Linezolid (J01XX)
II	Ampicillin (J01CA01), amoxicillin (J01CA04), pivampicillin (J01CA02)	Penicillins with extended spectrum (J01CA)
	Penicillin G (J01CE01), penicillin V (J01CE02)	β-lactamase sensitive penicillins (J01CE)
	Cloxacillin (J01CF02)	β-lactamase resistant penicillins (J01CF)
	Cephalexin (J01DB01), cefadroxil (J01DB05)	First-generation cephalosporins (J01DB)
	Cefaclor (J01DC04), cefprozil (J01DC10), cefuroxime axetil (J01DC02)	Second-generation cephalosporins (J01DC)
	Sulfamethoxazole and trimethoprim (J01EE01), sulfadiazine and trimethoprim (J01EE02)	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)
	Azithromycin (J01FA10), clarithromycin (J01FA09), erythromycin (J01FA01)	Macrolides (J01FA)
	Clindamycin (J01FF01)	Lincosamides (J01FF)
	Nalidixic acid (J01MB02)	Other quinolones, excluding fluoroquinolones (J01MB)
	Erythromycin-sulfisoxazole (J01RA02)	Sulfonamide combinations, excluding trimethoprim (J01RA)
	Fusidic acid (J01XC01)	Steroid antibacterials (J01XC)
III	Doxycycline (J01AA02), minocycline (J01AA08), tetracycline (J01AA07)	Tetracyclines (J01AA)
	Chloramphenicol (J01BA01)	Amphenicols (J01BA)
	Trimethoprim (J01EA01)	Trimethoprim and derivatives (J01EA)
	Sulfamethizole (J01EB02), sulfapyridine (J01EB04), sulfisoxazole (J01EB05)	Short-acting sulfonamides (J01EB)
	Sulfadiazine (J01EC02), sulfamethoxazole (J01EC04)	Intermediate-acting sulfonamides (J01EC)
	Nitrofurantoin (J01XE01)	Nitrofuran derivatives (J01XE)
	Fosfomycin (J01XX01)	Fosfomycin (J01XX)
NC	Methenamine (J01XX05)	Methenamine (J01XX)

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NC = Not classified.

[1] World Health Organization Collaborating Center for Drug Statistics Methodology. Available at: www.whocc.no/atcddd. Accessed May 2013.

Pigs

In the *Farm Surveillance* component of CIPARS, sentinel farm data were collected through questionnaires administered by the herd veterinarian (or designated practice staff) to the producer (or designated farm staff). The questionnaires included questions on antimicrobial use (AMU) within each herd, pig health, and farm characteristics.

Questions pertaining to the number of pigs in the population of interest differed by management system: continuous-flow or all-in-all-out. All-in-all-out management is a production system whereby animals are moved into and out of facilities in distinct groups. By preventing the commingling of groups, the hope is to reduce the spread of diseases. Facilities are normally cleaned and disinfected thoroughly between groups of animals. This type of management is generally by room or by barn. In continuous-flow operations, animals are continually being removed and added and there is no distinct group of animals that stays together within each phase of production.

The AMU questionnaire was designed to collect data for herds of pigs in the grower-finisher production phase. No data on individual pigs were collected. Six pens representative of this population were selected for the collection of fecal specimens for bacterial culture and antimicrobial susceptibility testing. Thus, in herds with all-in-all-out management, the population of interest included all pigs that entered and exited the barn in the same group as the sampled pigs. The population of interest in herds with continuous-flow management was pigs that entered the grower-finisher unit with the sampled pigs.

Herd owners/managers were asked about AMU via feed, water, and injections. Data were collected on each diet fed to each population of interest, including feeds that contained no antimicrobials. Information collected on each type of feed fed during the grow-finish period included the average number of weeks each ration was fed and the associated start and end pig weights. Additional information was collected for diets containing antimicrobials: active antimicrobial ingredient(s) and their concentration(s), primary reason(s) for AMU (growth promotion, disease prevention, or treatment). Secondary antimicrobial use descriptors are captured if the use was for disease prevention or treatment. The secondary descriptors indicate if the use targeted respiratory disease, enteric disease, lameness or other diseases. Data collected on exposure to antimicrobials though water included active ingredient(s) of the drug(s), weight of the pigs at the start and end of exposure, duration of exposure, number of pigs exposed, and reason(s) for AMU. Data collected on AMU through injection included active ingredient(s) of the drug(s), number of pigs exposed, and reason(s) for AMU. No AMU data were collected for any production phase prior to the grower-finisher phase. Any data regarding AMU in pigs weighing less than 15 kg (33 lb) were excluded because this weight is considered below the industry standard for grower-finisher pigs.

Antimicrobial exposures were summarized for each herd. An exposure was defined as any reported use of an active ingredient by a given route of administration in 2010. Data are reported as exposure to an active ingredient by a given route of administration, as well as by exposure to an active ingredient by any administration route. These exposures were summarized by antimicrobial class. It is important to note that, typically, treatment through feed tends to be administered used into a larger groups of pigs and for longer periods than with water treatment through water, whereas injectable drugs are generally administered on an individual basis to a limited number of pigs.[1]

Data were entered into a database, and descriptive statistics were obtained with commercially available software (Microsoft Excel® 2003 and Microsoft Access® 2003, Microsoft Corp., Redmond, WA, USA; SAS® 9.1, SAS Institute Inc., Cary, NC, USA).

Data from the AMU questionnaires were compiled so that any reported exposure mentioned in a single questionnaire was classified as an exposure in that herd in 2010. Quantitative AMU data (dose and duration) were collected for antimicrobials administered through feed but not for antimicrobials administered through water or by injection. However, the results reported here are solely qualitative and do not include exposure rate, duration, or dose of antimicrobial.

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[1] Version April, 2009. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed on May 2013.

Appendix B – Minimum Inhibitory Concentration Tables

The following information is important for the interpretation of tables presenting results on the distribution of minimum inhibitory concentrations (MICs).

- Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate, Health Canada.
- The unshaded fields indicate the range tested for each antimicrobial in the test plate configuration.
- Red numbers indicate the percentage of isolates that were resistant to the antimicrobial according to the predefined resistance breakpoint.
- Numbers to the right of the highest concentration in the tested range (i.e. red numbers in shaded fields) represent the percentage of isolates with growth in all wells of the test plate within the tested range, indicating that the actual MICs were greater than the tested range of concentrations.
- Numbers at the lowest concentration in the tested range (i.e. blue numbers at the far left in unshaded fields) represent the percentage of isolates susceptible to the antimicrobial at the indicated or lower concentrations.
- Solid vertical lines represent resistance breakpoints.
- Dotted vertical lines represent susceptibility breakpoints.
- MIC 50 = MIC at which growth of 50% of isolates was inhibited by a specific antimicrobial.
- MIC 90 = MIC at which growth of 90% of isolates was inhibited by a specific antimicrobial.
- %R = Percentage of isolates that were resistant to a specific antimicrobial.

Humans

Table B.1. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* Enteritidis isolates from humans; *Surveillance of Human Clinical Isolates*, 2010.

	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	995	≤ 1	≤ 1	0.3							95.4	2.1	0.4	1.7	0.1	0.3				
	Ceftiofur	995	1	1	0.4						5.5	92.3	1.7	0.1		0.4					
	Ceftriaxone	995	≤ 0.25	≤ 0.25	0.4					99.6						0.2	0.1		0.1		
	Ciprofloxacin	995	≤ 0.015	0.12	0.0	73.8	15.1	0.5	7.0	3.4		0.2									
II	Amikacin	995	1	1	0.0						15.2	75.5	8.0	1.2	0.1						
	Ampicillin	995	≤ 1	2	2.3							82.1	14.8	0.6	0.2		0.1	2.2			
	Cefoxitin	995	2	2	0.4							7.8	87.7	3.4	0.5	0.1	0.4				
	Gentamicin	995	≤ 0.25	0.50	0.1					79.1	19.9	0.8	0.1				0.1				
	Kanamycin	995	≤ 8	≤ 8	0.1										99.9				0.1		
	Nalidixic acid	995	4	> 32	10.4								10.6	77.7	1.0	0.4	0.1	10.3			
	Streptomycin	995	≤ 32	≤ 32	0.9												99.1		0.9		
	Trimethoprim-sulfamethoxazole	995	≤ 0.12	≤ 0.12	1.1				98.1	0.7		0.1			1.1						
III	Chloramphenicol	995	4	8	0.3									62.3	36.9	0.5		0.3			
	Sulfisoxazole	995	32	64	1.9											2.7	59.6	32.4	3.4		1.9
	Tetracycline	995	≤ 4	≤ 4	2.2									97.6	0.2	0.1	0.1	2.0			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.2. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* Heidelberg isolates from humans; *Surveillance of Human Clinical Isolates*, 2010.

	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	476	≤ 1	32	18.7							67.4	0.8	0.4	8.2	4.4	12.8	5.9			
	Ceftiofur	476	0.50	> 8	18.9				0.2		62.6	17.6	0.4	0.2	0.4	18.5					
	Ceftriaxone	476	≤ 0.25	16	19.1					80.3	0.6			0.4	0.2	14.7	2.3	1.1	0.4		
	Ciprofloxacin	476	≤ 0.015	≤ 0.015	0.0	99.2	0.6				0.2										
II	Amikacin	476	1	2	0.0						3.4	69.1	25.2	2.1	0.2						
	Ampicillin	476	≤ 1	> 32	31.7							67.2	1.1					31.7			
	Cefoxitin	476	1	32	18.7							57.4	20.8	2.1	1.1		14.7	4.0			
	Gentamicin	476	≤ 0.25	0.50	1.5					50.2	44.7	2.5	0.8		0.2	1.3	0.2				
	Kanamycin	476	≤ 8	≤ 8	1.5										98.3		0.2	0.6	0.8		
	Nalidixic acid	476	4	4	0.2								34.9	64.7	0.2			0.2			
	Streptomycin	476	≤ 32	≤ 32	5.7												94.3	1.1	4.6		
	Trimethoprim-sulfamethoxazole	476	≤ 0.12	≤ 0.12	0.4				99.2	0.4					0.4						
III	Chloramphenicol	476	8	8	0.6								0.2	30.9	67.9	0.4		0.6			
	Sulfisoxazole	476	32	32	2.9											13.4	78.2	5.5			2.9
	Tetracycline	476	≤ 4	≤ 4	3.4									96.6				3.4			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.3. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* Paratyphi A and *S.* Paratyphi B isolates isolates from humans; *Surveillance of Human Clinical Isolates*, 2010.

	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	30	≤ 1	2	0.0							83.3	10.0		3.3	3.3					
	Ceftiofur	30	1	1	0.0					3.3	43.3	50.0	3.3								
	Ceftriaxone	30	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	30	0.03	0.50	3.3	46.7	6.7			6.7	36.7				3.3						
II	Amikacin	30	1	2	0.0						36.7	50.0	10.0	3.3							
	Ampicillin	30	2	4	3.3							43.3	46.7	3.3		3.3		3.3			
	Cefoxitin	30	4	8	3.3							33.3	10.0	46.7	3.3	3.3	3.3				
	Gentamicin	30	≤ 0.25	0.50	0.0					80.0	16.7	3.3									
	Kanamycin	30	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	30	8	> 32	43.3								40.0	10.0	6.7			43.3			
	Streptomycin	30	≤ 32	≤ 32	3.3												96.7		3.3		
	Trimethoprim-sulfamethoxazole	30	≤ 0.12	0.25	0.0				86.7	13.3											
III	Chloramphenicol	30	8	16	3.3									43.3	43.3	10.0		3.3			
	Sulfisoxazole	30	64	64	3.3											13.3	33.3	46.7	3.3		3.3
	Tetracycline	30	≤ 4	≤ 4	3.3									96.7		3.3					
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.4. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* Typhi isolates from humans; *Surveillance of Human Clinical Isolates*, 2010.

	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	179	≤ 1	8	0.0							83.8		1.7	14.5						
	Ceftiofur	179	0.50	0.50	0.0				0.6	4.5	89.4	5.6									
	Ceftriaxone	179	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	179	0.25	0.25	3.9	11.7		3.4	16.8	58.7	5.0		0.6	0.6	3.4						
II	Amikacin	179	1	1	0.0						11.7	86.0	2.2								
	Ampicillin	179	≤ 1	> 32	16.2							83.8						16.2			
	Cefoxitin	179	4	4	0.0						2.2	27.4	6.1	54.7	9.5						
	Gentamicin	179	≤ 0.25	≤ 0.25	0.0					99.4	0.6										
	Kanamycin	179	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	179	> 32	> 32	87.2							0.6	11.2	0.6	0.6		2.2	84.9			
	Streptomycin	179	≤ 32	> 64	15.6												84.4		15.6		
	Trimethoprim-sulfamethoxazole	179	≤ 0.12	> 4	17.3				81.6				1.1		17.3						
III	Chloramphenicol	179	4	> 32	16.8								1.7	75.4	6.1			16.8			
	Sulfisoxazole	179	32	> 256	17.3											29.6	32.4	17.9	2.8		17.3
	Tetracycline	179	≤ 4	≤ 4	2.8									97.2				2.8			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.5. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* Typhimurium isolates from humans; *Surveillance of Human Clinical Isolates*, 2010.

	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	453	≤ 1	16	1.8							74.4	1.1	1.5	10.2	11.0	0.7	1.1			
	Ceftiofur	453	1	1	1.3						40.4	57.2	1.1			1.3					
	Ceftriaxone	453	≤ 0.25	≤ 0.25	1.3					98.5		0.2				1.3					
	Ciprofloxacin	453	≤ 0.015	≤ 0.015	0.0	95.1	2.0		0.7	1.5	0.2	0.4									
II	Amikacin	453	1	2	0.0						1.3	69.3	24.5	4.4	0.4						
	Ampicillin	453	≤ 1	> 32	24.3							72.0	3.3	0.2		0.2		24.3			
	Cefoxitin	453	2	2	1.3							30.0	62.9	4.9	0.9		0.9	0.4			
	Gentamicin	453	0.50	0.50	1.3					44.8	49.0	4.2	0.4		0.2	0.7	0.7				
	Kanamycin	453	≤ 8	> 64	11.3										88.7				11.3		
	Nalidixic acid	453	4	4	2.4								38.0	57.6	1.8	0.2		2.4			
	Streptomycin	453	≤ 32	> 64	24.9												75.1	13.7	11.3		
	Trimethoprim-sulfamethoxazole	453	≤ 0.12	≤ 0.12	3.8				94.9	0.9	0.4				3.8						
III	Chloramphenicol	453	8	> 32	17.4								1.1	47.2	34.0	0.2	0.2	17.2			
	Sulfisoxazole	453	32	> 256	27.8											2.6	65.6	3.8	0.2		27.8
	Tetracycline	453	≤ 4	> 32	25.2									74.4	0.4	2.4	9.9	12.8			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.6. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* I 4,[5],12:i:- isolates from humans; *Surveillance of Human Clinical Isolates*, 2010.

	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	163	≤ 1	8	8.0							64.4		8.6	17.2	1.8	3.1	4.9			
	Ceftiofur	163	0.50	1	8.6						52.8	38.0	0.6			8.6					
	Ceftriaxone	163	≤ 0.25	≤ 0.25	8.6					91.4						5.5	1.8	0.6	0.6		
	Ciprofloxacin	163	≤ 0.015	≤ 0.015	0.0	97.5	1.2		0.6		0.6										
II	Amikacin	163	1	2	0.0							74.8	21.5	3.1	0.6						
	Ampicillin	163	≤ 1	> 32	35.0							63.2	1.2			0.6		35.0			
	Cefoxitin	163	2	4	8.0							47.9	39.9	3.1	0.6	0.6	7.4	0.6			
	Gentamicin	163	0.50	0.50	1.2					47.9	49.7	0.6		0.6		0.6	0.6				
	Kanamycin	163	≤ 8	≤ 8	4.3										95.7				4.3		
	Nalidixic acid	163	2	4	0.6								68.7	28.8	1.8			0.6			
	Streptomycin	163	≤ 32	> 64	28.2												71.8	1.8	26.4		
	Trimethoprim-sulfamethoxazole	163	≤ 0.12	≤ 0.12	2.5				96.9	0.6					2.5						
III	Chloramphenicol	163	4	8	5.5									71.2	23.3		0.6	4.9			
	Sulfisoxazole	163	32	> 256	25.2											1.8	64.4	8.6			25.2
	Tetracycline	163	≤ 4	> 32	39.9									60.1			0.6	39.3			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Beef Cattle

Table B.7. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from cattle; *Surveillance of Animal Clinical Isolates*, 2010.

	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	143	8	> 32	18.2							48.3	0.7		15.4	17.5		18.2			
	Ceftiofur	143	1	> 8	18.2					0.7	10.5	67.1	3.5			18.2					
	Ceftriaxone	143	≤ 0.25	16	18.2					81.8					0.7	7.7	9.1	0.7			
	Ciprofloxacin	143	≤ 0.015	≤ 0.015	0.0	95.8	2.8		1.4												
II	Amikacin	143	1	2	0.0						6.3	73.4	16.8	3.5							
	Ampicillin	143	> 32	> 32	51.0							46.2	2.8					51.0			
	Cefoxitin	143	2	> 32	18.2						0.7	21.7	42.0	14.7	2.8		6.3	11.9			
	Gentamicin	143	≤ 0.25	0.50	6.3					55.2	35.0	3.5					6.3				
	Kanamycin	143	≤ 8	> 64	44.8										55.2			2.1	42.7		
	Nalidixic acid	143	2	4	1.4							0.7	62.2	35.0	0.7			1.4			
	Streptomycin	143	≤ 32	> 64	33.6												66.4	7.7	25.9		
	Trimethoprim-sulfamethoxazole	143	≤ 0.12	0.25	8.4				79.0	11.9	0.7				8.4						
III	Chloramphenicol	143	8	> 32	28.7								1.4	11.9	58.0		0.7	28.0			
	Sulfisoxazole	143	> 256	> 256	55.9											0.7	26.6	16.8			55.9
	Tetracycline	143	32	> 32	54.5									45.5			5.6	49.0			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.8. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2010.

	Antimicrobial	Province / region	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	64	4	4	0.0							3.1	31.3	60.9	4.7						
		Saskatchewan	107	4	4	0.0							5.6	26.2	61.7	6.5						
		Ontario	123	4	4	0.0							4.9	35.8	56.1	3.3						
		Québec	101	4	4	1.0							4.0	39.6	51.5	4.0		1.0				
		Maritimes	126	4	4	0.8							6.3	31.7	57.9	3.2		0.8				
	Ceftiofur	British Columbia	64	0.25	0.50	0.0				4.7	56.3	34.4	3.1	1.6								
		Saskatchewan	107	0.25	0.50	0.0				7.5	58.9	33.6										
		Ontario	123	0.25	0.50	0.0				6.5	62.6	30.1	0.8									
		Québec	101	0.25	0.50	1.0				5.0	66.3	26.7	1.0			1.0						
I		Maritimes	126	0.25	0.50	0.8				7.1	62.7	28.6			0.8	0.8						
	Ceftriaxone	British Columbia	64	≤ 0.25	≤ 0.25	0.0					96.9		1.6	1.6								
		Saskatchewan	107	≤ 0.25	≤ 0.25	0.0					100.0											
		Ontario	123	≤ 0.25	≤ 0.25	0.0					100.0											
		Québec	101	≤ 0.25	≤ 0.25	1.0					99.0						1.0					
		Maritimes	126	≤ 0.25	≤ 0.25	0.8					99.2					0.8						
	Ciprofloxacin	British Columbia	64	≤ 0.015	≤ 0.015	0.0	98.4				1.6											
		Saskatchewan	107	≤ 0.015	≤ 0.015	0.0	100.0															
		Ontario	123	≤ 0.015	≤ 0.015	1.6	95.9	0.8		0.8	0.8					1.6						
		Québec	101	≤ 0.015	≤ 0.015	1.0	97.0	1.0	1.0							1.0						
		Maritimes	126	≤ 0.015	≤ 0.015	0.0	100.0															
	Amikacin	British Columbia	64	2	4	0.0							26.6	60.9	12.5							
		Saskatchewan	107	2	2	0.0							38.3	52.3	8.4	0.9						
		Ontario	123	2	2	0.0							23.6	69.1	6.5	0.8						
		Québec	101	2	4	0.0						1.0	24.8	55.4	15.8	3.0						
		Maritimes	126	2	2	0.0							31.0	65.1	3.2	0.8						
	Ampicillin	British Columbia	64	2	4	6.3							9.4	64.1	20.3			1.6	4.7			
		Saskatchewan	107	2	4	3.7							16.8	55.1	23.4	0.9			3.7			
		Ontario	123	2	4	4.1							8.1	72.4	15.4				4.1			
		Québec	101	2	4	3.0							14.9	65.3	16.8				3.0			
		Maritimes	126	2	4	2.4							13.5	65.9	18.3				2.4			
	Cefoxitin	British Columbia	64	4	4	0.0								29.7	62.5	7.8						
		Saskatchewan	107	4	4	0.0							1.9	36.4	53.3	8.4						
		Ontario	123	4	8	0.0								44.7	43.9	11.4						
		Québec	101	4	4	1.0							1.0	33.7	56.4	6.9	1.0		1.0			
		Maritimes	126	4	4	0.8							0.8	42.9	50.0	5.6		0.8				
	Gentamicin	British Columbia	64	0.50	1	0.0					12.5	59.4	25.0	1.6		1.6						
		Saskatchewan	107	0.50	1	0.0					12.1	73.8	12.1	1.9								
		Ontario	123	0.50	1	1.6					15.4	71.5	11.4					1.6				
		Québec	101	0.50	1	1.0					12.9	70.3	13.9	2.0			1.0					
		Maritimes	126	0.50	1	0.0					11.1	77.0	10.3	1.6								
II	Kanamycin	British Columbia	64	≤ 8	≤ 8	0.0										100.0						
		Saskatchewan	107	≤ 8	≤ 8	0.0										100.0						
		Ontario	123	≤ 8	≤ 8	5.7										94.3				5.7		
		Québec	101	≤ 8	≤ 8	1.0										99.0				1.0		
		Maritimes	126	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	British Columbia	64	2	4	1.6							6.3	79.7	12.5				1.6			
		Saskatchewan	107	2	4	0.0						1.9	8.4	78.5	11.2							
		Ontario	123	2	4	3.3							9.8	74.0	12.2		0.8		3.3			
		Québec	101	2	4	1.0						1.0	17.8	65.3	13.9	1.0			1.0			
		Maritimes	126	2	4	0.0							10.3	74.6	14.3	0.8						
	Streptomycin	British Columbia	64	≤ 32	≤ 32	7.8												92.2	6.3	1.6		
		Saskatchewan	107	≤ 32	≤ 32	5.6												94.4	4.7	0.9		
		Ontario	123	≤ 32	64	10.6												89.4	2.4	8.1		
		Québec	101	≤ 32	≤ 32	7.9												92.1	5.9	2.0		
		Maritimes	126	≤ 32	≤ 32	2.4												97.6	1.6	0.8		
	Trimethoprim-sulfamethoxazole	British Columbia	64	≤ 0.12	≤ 0.12	0.0				96.9	3.1											
		Saskatchewan	107	≤ 0.12	≤ 0.12	0.0				100.0												
		Ontario	123	≤ 0.12	≤ 0.12	5.7				93.5	0.8					5.7						
		Québec	101	≤ 0.12	≤ 0.12	1.0				97.0	1.0	1.0				1.0						
		Maritimes	126	≤ 0.12	≤ 0.12	1.6				96.8	1.6					1.6						
	Chloramphenicol	British Columbia	64	8	8	1.6									29.7	68.8			1.6			
		Saskatchewan	107	8	8	1.9								8.4	29.0	59.8	0.9		1.9			
		Ontario	123	8	8	3.3								4.1	37.4	54.5	0.8		3.3			
		Québec	101	4	8	2.0								6.9	44.6	46.5		1.0	1.0			
		Maritimes	126	8	8	0.0								1.6	44.4	54.0						
	Sulfisoxazole	British Columbia	64	≤ 16	> 256	12.5											68.8	18.8				12.5
		Saskatchewan	107	≤ 16	32	2.8											82.2	14.0	0.9			2.8
III		Ontario	123	≤ 16	> 256	11.4											77.2	10.6	0.8			11.4
		Québec	101	≤ 16	32	6.9											79.2	11.9	2.0			6.9
		Maritimes	126	≤ 16	32	4.8											64.3	30.2	0.8			4.8
	Tetracycline	British Columbia	64	≤ 4	32	15.6									84.4			6.3	9.4			
		Saskatchewan	107	≤ 4	> 32	14.0									84.1	1.9	2.8	0.9	10.3			
		Ontario	123	≤ 4	> 32	17.9									80.5	1.6		2.4	15.4			
		Québec	101	≤ 4	> 32	14.9									80.2	5.0		1.0	13.9			
		Maritimes	126	≤ 4	32	11.9									87.3	0.8	0.8	1.6	9.5			
IV																						

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table B.9. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from beef cattle; *Abattoir Surveillance*, 2010.

	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	77	4	4	0.0							6.5	29.9	55.8	5.2	2.6					
	Ceftiofur	77	0.25	0.50	0.0				5.2	58.4	36.4										
	Ceftriaxone	77	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	77	≤ 0.015	≤ 0.015	0.0	96.1	2.6	1.3													
II	Amikacin	77	2	2	0.0						2.6	40.3	50.6	6.5							
	Ampicillin	77	2	4	1.3							13.0	62.3	20.8	1.3	1.3		1.3			
	Cefoxitin	77	4	8	0.0								31.2	55.8	11.7	1.3					
	Gentamicin	77	0.50	1	0.0					22.1	67.5	9.1			1.3						
	Kanamycin	77	≤ 8	≤ 8	0.0										98.7	1.3					
	Nalidixic acid	77	2	4	0.0						2.6	6.5	72.7	18.2							
	Streptomycin	77	≤ 32	≤ 32	5.2												94.8	3.9	1.3		
	Trimethoprim-sulfamethoxazole	77	≤ 0.12	≤ 0.12	0.0				93.5	6.5											
III	Chloramphenicol	77	8	8	1.3								6.5	35.1	54.5	2.6		1.3			
	Sulfisoxazole	77	≤ 16	> 256	11.7											75.3	13.0				11.7
	Tetracycline	77	≤ 4	> 32	14.3									85.7		1.3	1.3	11.7			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.10. Distribution of minimum inhibitory concentrations for antimicrobials in *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2010.

	Antimicrobial	Species	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)												
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
I	Ciprofloxacin	*Campylobacter coli*	9	0.125	0.25	0.0				66.7	33.3									
	Ciprofloxacin	*Campylobacter jejuni*	27	0.125	0.125	3.7			22.2	70.4	3.7						3.7			
	Ciprofloxacin	*Campylobacter* spp.	1	0.064	0.064	0.0			100.0											
	Telithromycin	*Campylobacter coli*	9	2	4	0.0								66.7	33.3					
	Telithromycin	*Campylobacter jejuni*	27	1	2	0.0						14.8	70.4	14.8						
	Telithromycin	*Campylobacter* spp.	1	0.25	0.25	0.0					100.0									
II	Azithromycin	*Campylobacter coli*	9	0.125	0.25	0.0				55.6	44.4									
	Azithromycin	*Campylobacter jejuni*	27	0.064	0.064	0.0	3.7	14.8	77.8	3.7										
	Azithromycin	*Campylobacter* spp.	1	0.032	0.032	0.0		100.0												
	Clindamycin	*Campylobacter coli*	9	1	1	0.0						44.4	55.6							
	Clindamycin	*Campylobacter jejuni*	27	0.125	0.25	0.0			7.4	48.1	40.7	3.7								
	Clindamycin	*Campylobacter* spp.	1	≤ 0.03	≤ 0.03	0.0		100.0												
	Erythromycin	*Campylobacter coli*	9	2	4	0.0								22.2	66.7	11.1				
	Erythromycin	*Campylobacter jejuni*	27	0.5	0.5	0.0					29.6	63.0	7.4							
	Erythromycin	*Campylobacter* spp.	1	0.25	0.25	0.0					100.0									
	Gentamicin	*Campylobacter coli*	9	1	2	0.0							88.9	11.1						
	Gentamicin	*Campylobacter jejuni*	27	1	1	0.0						11.1	81.5	7.4						
	Gentamicin	*Campylobacter* spp.	1	≤ 0.12	≤ 0.12	0.0				100.0										
	Nalidixic acid	*Campylobacter coli*	9	8	16	0.0											55.6	44.4		
	Nalidixic acid	*Campylobacter jejuni*	27	≤ 4	8	3.7										85.2	11.1			3.7
	Nalidixic acid	*Campylobacter* spp.	1	8	8	0.0											100.0			
III	Florfenicol	*Campylobacter coli*	9	2	2	0.0								22.2	77.8					
	Florfenicol	*Campylobacter jejuni*	27	1	1	0.0						7.4	85.2	7.4						
	Florfenicol	*Campylobacter* spp.	1	0.064	0.064	0.0			100.0											
	Tetracycline	*Campylobacter coli*	9	> 64	> 64	66.7								33.3				11.1		55.6
	Tetracycline	*Campylobacter jejuni*	27	0.5	> 64	48.1				11.1	22.2	18.5							18.5	29.6
	Tetracycline	*Campylobacter* spp.	1	0.125	0.125	0.0				100.0										
IV																				

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Chickens

Table B.11. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2010.

	Antimicrobial	Province / region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)													
				MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	56	≤ 1	> 32	23.2							67.9	7.1			1.8	7.1	16.1			
		Saskatchew an	42	≤ 1	8	7.1							81.0		2.4	7.1	2.4	2.4	4.8			
		Ontario	90	≤ 1	> 32	24.4							71.1			4.4		10.0	14.4			
		Québec	116	≤ 1	> 32	25.0							65.5	0.9		5.2	3.4	12.9	12.1			
		Maritimes	77	≤ 1	> 32	20.8							76.6			2.6		9.1	11.7			
	Ceftiofur	British Columbia	56	1	> 8	25.0					1.8	12.5	53.6	7.1		3.6	21.4					
		Saskatchew an	42	1	1	7.1						19.0	73.8				7.1					
		Ontario	90	1	> 8	24.4					2.2	34.4	37.8	1.1		2.2	22.2					
		Québec	116	1	> 8	25.0						37.9	37.1			3.4	21.6					
I		Maritimes	77	1	> 8	20.8						48.1	31.2			1.3	19.5					
	Ceftriaxone	British Columbia	56	≤ 0.25	16	25.0					75.0					10.7	12.5	1.8				
		Saskatchew an	42	≤ 0.25	≤ 0.25	7.1					92.9						7.1					
		Ontario	90	≤ 0.25	16	24.4					75.6				1.1	11.1	10.0	2.2				
		Québec	116	≤ 0.25	16	25.0					74.1	0.9				7.8	14.7	2.6				
		Maritimes	77	≤ 0.25	16	20.8					79.2					3.9	14.3	2.6				
	Ciprofloxacin	British Columbia	56	≤ 0.015	0.03	0.0	82.1	16.1	1.8													
		Saskatchew an	42	≤ 0.015	0.03	0.0	85.7	14.3														
		Ontario	90	≤ 0.015	≤ 0.015	0.0	92.2	7.8														
		Québec	116	≤ 0.015	0.03	0.0	89.7	9.5	0.9													
		Maritimes	77	≤ 0.015	≤ 0.015	0.0	96.1	3.9														
	Amikacin	British Columbia	56	1	2	0.0						23.2	62.5	14.3								
		Saskatchew an	42	1	2	0.0						9.5	73.8	14.3	2.4							
		Ontario	90	1	2	0.0						23.3	58.9	14.4	3.3							
		Québec	116	1	2	0.0						19.8	64.7	14.7	0.9							
		Maritimes	77	1	2	0.0						13.0	74.0	11.7	1.3							
	Ampicillin	British Columbia	56	≤ 1	> 32	25.0							58.9	12.5	3.6			1.8	23.2			
		Saskatchew an	42	≤ 1	> 32	19.0							78.6	2.4					19.0			
		Ontario	90	≤ 1	> 32	28.9							63.3	7.8					28.9			
		Québec	116	≤ 1	> 32	33.6							61.2	5.2					33.6			
		Maritimes	77	≤ 1	> 32	23.4							75.3	1.3					23.4			
II	Cefoxitin	British Columbia	56	2	32	16.1							21.4	42.9	8.9	3.6	7.1	14.3	1.8			
		Saskatchew an	42	2	4	7.1							47.6	33.3	11.9			4.8	2.4			
		Ontario	90	2	32	20.0							44.4	27.8	2.2	1.1	4.4	15.6	4.4			
		Québec	116	2	32	20.7							35.3	33.6	6.0	0.9	3.4	14.7	6.0			
		Maritimes	77	2	32	19.5						1.3	48.1	24.7	5.2		1.3	14.3	5.2			
	Gentamicin	British Columbia	56	≤ 0.25	0.50	0.0					78.6	19.6	1.8									
		Saskatchew an	42	≤ 0.25	0.50	0.0					73.8	26.2										
		Ontario	90	≤ 0.25	0.50	0.0					75.6	22.2	2.2									
		Québec	116	≤ 0.25	0.50	0.0					76.7	21.6	1.7									
		Maritimes	77	≤ 0.25	0.50	0.0					76.6	20.8	1.3		1.3							

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 11 (continued). Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2010.

	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
	Kanamycin	British Columbia	56	≤ 8	≤ 8	0.0										100.0						
		Saskatchew an	42	≤ 8	≤ 8	0.0										100.0						
		Ontario	90	≤ 8	≤ 8	0.0										100.0						
		Québec	116	≤ 8	≤ 8	0.0										100.0						
		Maritimes	77	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	British Columbia	56	4	4	0.0						1.8	1.8	32.1	57.1	7.1						
		Saskatchew an	42	4	4	0.0								28.6	66.7	4.8						
		Ontario	90	4	4	0.0							1.1	43.3	51.1	4.4						
		Québec	116	4	4	0.0							2.6	40.5	53.4	3.4						
		Maritimes	77	2	4	0.0							3.9	49.4	45.5	1.3						
II	Streptomycin	British Columbia	56	≤ 32	> 64	26.8												73.2	14.3	12.5		
		Saskatchew an	42	≤ 32	> 64	23.8												76.2	7.1	16.7		
		Ontario	90	≤ 32	> 64	28.9												71.1	14.4	14.4		
		Québec	116	≤ 32	> 64	25.0												75.0	14.7	10.3		
		Maritimes	77	≤ 32	64	24.7												75.3	19.5	5.2		
	Trimethoprim-sulfamethoxazole	British Columbia	56	≤ 0.12	≤ 0.12	0.0				100.0												
		Saskatchew an	42	≤ 0.12	≤ 0.12	0.0				97.6	2.4											
		Ontario	90	≤ 0.12	≤ 0.12	0.0				100.0												
		Québec	116	≤ 0.12	≤ 0.12	0.0				98.3	1.7											
		Maritimes	77	≤ 0.12	≤ 0.12	2.6				96.1	1.3					2.6						
	Chloramphenicol	British Columbia	56	4	8	0.0								5.4	51.8	39.3	3.6					
		Saskatchew an	42	8	8	0.0									40.5	59.5						
		Ontario	90	4	8	1.1								2.2	58.9	36.7	1.1		1.1			
		Québec	116	8	8	0.0								2.6	40.5	56.0	0.9					
		Maritimes	77	8	8	0.0								1.3	46.8	50.6	1.3					
	Sulfisoxazole	British Columbia	56	64	64	0.0											8.9	33.9	53.6	3.6		
		Saskatchew an	42	32	64	2.4											4.8	57.1	31.0	4.8		2.4
III		Ontario	90	32	64	2.2											14.4	57.8	25.6			2.2
		Québec	116	32	64	0.9											14.7	53.4	27.6	3.4		0.9
		Maritimes	77	32	64	7.8											11.7	53.2	27.3			7.8
	Tetracycline	British Columbia	56	≤ 4	> 32	28.6									71.4				28.6			
		Saskatchew an	42	≤ 4	> 32	16.7									83.3				16.7			
		Ontario	90	≤ 4	> 32	33.3									66.7			3.3	30.0			
		Québec	116	≤ 4	> 32	24.1									75.9			1.7	22.4			
		Maritimes	77	≤ 4	> 32	26.0									74.0				26.0			
IV																						

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table B.12. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2010.

	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	142	≤ 1	> 32	32.4							59.9	3.5		3.5	0.7	6.3	26.1			
	Ceftiofur	142	1	> 8	32.4						28.2	35.9	3.5		0.7	31.7					
	Ceftriaxone	142	≤ 0.25	16	32.4					66.9	0.7			0.7	7.0	19.7	4.2	0.7			
	Ciprofloxacin	142	≤ 0.015	≤ 0.015	0.0	90.1	8.5	0.7		0.7											
II	Amikacin	142	1	1	0.0						22.5	71.1	6.3								
	Ampicillin	142	≤ 1	> 32	36.6							57.7	4.2	1.4				36.6			
	Cefoxitin	142	2	32	25.4							35.9	25.4	4.2	2.1	7.0	19.7	5.6			
	Gentamicin	142	≤ 0.25	0.50	0.7					86.6	12.7					0.7					
	Kanamycin	142	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	142	4	4	0.7							0.7	40.1	55.6	2.8			0.7			
	Streptomycin	142	≤ 32	> 64	29.6												70.4	15.5	14.1		
	Trimethoprim-sulfamethoxazole	142	≤ 0.12	≤ 0.12	0.7				97.9	1.4					0.7						
III	Chloramphenicol	142	4	8	1.4								2.1	52.8	40.8	2.8		1.4			
	Sulfisoxazole	142	32	64	2.8											10.6	44.4	41.5	0.7		2.8
	Tetracycline	142	≤ 4	> 32	31.0									68.3	0.7			31.0			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.13. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from chickens; *Surveillance of Animal Clinical Isolates*, 2010.

	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	342	≤ 1	> 32	13.7							78.1	1.5		2.9	3.8	1.8	12.0			
	Ceftiofur	342	1	> 8	13.7					0.6	19.9	64.9	0.9			13.7					
	Ceftriaxone	342	≤ 0.25	16	13.7					86.0	0.3				0.6	11.1	2.0				
	Ciprofloxacin	342	≤ 0.015	0.03	0.0	88.0	11.7				0.3										
II	Amikacin	342	1	1	0.0						8.5	81.6	8.2	1.8							
	Ampicillin	342	≤ 1	> 32	20.5							67.3	11.4	0.9				20.5			
	Cefoxitin	342	2	32	13.7							25.7	52.3	6.7	0.3	1.2	12.0	1.8			
	Gentamicin	342	≤ 0.25	0.50	0.9					78.1	19.6	0.9	0.3		0.3	0.3	0.6				
	Kanamycin	342	≤ 8	≤ 8	1.5										98.5				1.5		
	Nalidixic acid	342	4	4	0.3							2.6	34.5	62.0	0.6			0.3			
	Streptomycin	342	≤ 32	64	18.7												81.3	11.4	7.3		
	Trimethoprim-sulfamethoxazole	342	≤ 0.12	≤ 0.12	0.9				98.8	0.3					0.9						
III	Chloramphenicol	342	8	8	2.0								0.3	29.5	67.3	0.9		2.0			
	Sulfisoxazole	342	64	64	7.3											1.2	43.6	46.8	1.2		7.3
	Tetracycline	342	≤ 4	> 32	20.8									78.9	0.3		0.9	19.9			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.14. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2010.

	Antimicrobial	Province / region	n	Percentiles MIC 50	MIC 90	%R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	75	8	32	48.0								21.3	21.3	8.0	1.3	41.3	6.7			
		Saskatchewan	71	4	32	22.5							4.2	21.1	39.4	12.7		16.9	5.6			
		Ontario	100	4	32	24.0							2.0	24.0	42.0	7.0	1.0	21.0	3.0			
		Québec	138	8	32	30.4							1.4	21.7	26.1	18.8	1.4	23.9	6.5			
		Maritimes	175	4	32	21.1							7.4	26.3	29.1	13.7	2.3	16.6	4.6			
	Ceftiofur	British Columbia	75	1	8	44.0				1.3	17.3	24.0	8.0	1.3	4.0	37.3	6.7					
		Saskatchewan	71	0.50	8	19.7				2.8	32.4	40.8	1.4		2.8	14.1	5.6					
		Ontario	100	0.50	8	21.0				3.0	41.0	31.0	1.0		3.0	15.0	6.0					
		Québec	138	0.50	8	26.8				1.4	34.1	31.9	0.7	1.4	3.6	20.3	6.5					
I		Maritimes	175	0.25	8	17.7				3.4	47.4	26.9	0.6	0.6	3.4	13.1	4.6					
	Ceftriaxone	British Columbia	75	1	16	48.0					44.0	1.3	6.7		1.3	13.3	30.7	2.7				
		Saskatchewan	71	≤ 0.25	8	22.5					76.1		1.4		2.8	9.9	9.9					
		Ontario	100	≤ 0.25	8	24.0					75.0	1.0				15.0	8.0	1.0				
		Québec	138	≤ 0.25	16	31.2					68.1	0.7			1.4	13.0	14.5	2.2				
		Maritimes	175	≤ 0.25	16	21.1					78.3		0.6		0.6	7.4	12.6	0.6				
	Ciprofloxacin	British Columbia	75	≤ 0.015	≤ 0.015	0.0	92.0	1.3		1.3	4.0	1.3										
		Saskatchewan	71	≤ 0.015	≤ 0.015	0.0	90.1			2.8	7.0											
		Ontario	100	≤ 0.015	≤ 0.015	0.0	95.0	3.0			2.0											
		Québec	138	≤ 0.015	≤ 0.015	0.0	97.8	1.4				0.7										
		Maritimes	175	≤ 0.015	≤ 0.015	0.0	96.0	0.6		0.6	2.3	0.6										
	Amikacin	British Columbia	75	2	2	0.0							22.7	69.3	8.0							
		Saskatchewan	71	2	2	0.0							21.1	69.0	8.5	1.4						
		Ontario	100	2	4	0.0						1.0	17.0	68.0	13.0	1.0						
		Québec	138	2	4	0.0						0.7	18.1	66.7	14.5							
		Maritimes	175	2	2	0.0							29.7	61.7	8.6							
	Ampicillin	British Columbia	75	> 32	> 32	62.7							5.3	24.0	6.7	1.3			62.7			
		Saskatchewan	71	4	> 32	35.2							9.9	29.6	23.9	1.4			35.2			
		Ontario	100	4	> 32	39.0							8.0	42.0	10.0	1.0			39.0			
		Québec	138	> 32	> 32	54.3							8.7	24.6	12.3			1.4	52.9			
		Maritimes	175	4	> 32	40.0							13.7	36.0	10.3				40.0			
	Cefoxitin	British Columbia	75	32	> 32	50.7								8.0	29.3	12.0		14.7	36.0			
		Saskatchewan	71	4	> 32	19.7								9.9	46.5	21.1	2.8		19.7			
		Ontario	100	4	> 32	24.0							1.0	13.0	54.0	7.0	1.0	8.0	16.0			
		Québec	138	4	> 32	30.4								14.5	42.0	11.6	1.4	9.4	21.0			
		Maritimes	175	4	> 32	21.7							2.3	29.7	37.1	8.6	0.6	8.0	13.7			
	Gentamicin	British Columbia	75	0.50	1	2.7					8.0	65.3	18.7	4.0	1.3			2.7				
		Saskatchewan	71	0.50	1	5.6					9.9	62.0	18.3	1.4	1.4	1.4		5.6				
		Ontario	100	0.50	> 16	18.0					11.0	55.0	14.0	2.0			5.0	13.0				
		Québec	138	0.50	> 16	18.1					8.0	50.7	21.7	0.7		0.7	4.3	13.8				
		Maritimes	175	0.50	16	13.7					9.7	62.9	10.3	1.7		1.7	5.1	8.6				
II	Kanamycin	British Columbia	75	≤ 8	≤ 8	4.0										96.0				4.0		
		Saskatchewan	71	≤ 8	64	11.3										87.3	1.4		1.4	9.9		
		Ontario	100	≤ 8	32	8.0										87.0	3.0	2.0	1.0	7.0		
		Québec	138	≤ 8	> 64	13.8										85.5	0.7			13.8		
		Maritimes	175	≤ 8	16	8.6										89.7	0.6	1.1	1.1	7.4		
	Nalidixic acid	British Columbia	75	2	4	6.7						1.3	12.0	64.0	16.0			1.3	5.3			
		Saskatchewan	71	2	4	9.9							14.1	63.4	12.7			2.8	7.0			
		Ontario	100	2	4	2.0							11.0	79.0	8.0				2.0			
		Québec	138	2	2	0.7						1.4	13.0	76.1	8.7				0.7			
		Maritimes	175	2	4	3.4						2.3	12.0	72.6	9.7			1.1	2.3			
	Streptomycin	British Columbia	75	≤ 32	> 64	21.3												78.7	9.3	12.0		
		Saskatchewan	71	≤ 32	> 64	26.8												73.2	11.3	15.5		
		Ontario	100	≤ 32	> 64	36.0												64.0	9.0	27.0		
		Québec	138	≤ 32	> 64	43.5												56.5	15.9	27.5		
		Maritimes	175	≤ 32	> 64	36.6												63.4	14.9	21.7		
	Trimethoprim-sulfamethoxazole	British Columbia	75	≤ 0.12	0.25	4.0				89.3	4.0	2.7				4.0						
		Saskatchewan	71	≤ 0.12	≤ 0.12	1.4				94.4	4.2					1.4						
		Ontario	100	≤ 0.12	> 4	10.0				87.0	3.0					10.0						
		Québec	138	≤ 0.12	> 4	18.1				73.2	5.8	1.4	0.7	0.7		18.1						
		Maritimes	175	≤ 0.12	> 4	20.0				63.4	8.0	6.3	1.1	1.1		20.0						
	Chloramphenicol	British Columbia	75	8	8	2.7								5.3	44.0	44.0	4.0		2.7			
		Saskatchewan	71	8	8	0.0									36.6	62.0	1.4					
		Ontario	100	8	8	4.0								2.0	48.0	44.0	2.0		4.0			
		Québec	138	8	8	6.5								2.9	44.2	45.7	0.7		6.5			
		Maritimes	175	4	8	6.9								5.7	47.4	39.4	0.6	2.9	4.0			
	Sulfisoxazole	British Columbia	75	≤ 16	> 256	21.3											56.0	20.0	2.7			21.3
		Saskatchewan	71	≤ 16	> 256	23.9											56.3	16.9	2.8			23.9
III		Ontario	100	≤ 16	> 256	34.0											52.0	13.0	1.0			34.0
		Québec	138	32	> 256	46.4											42.0	11.6				46.4
		Maritimes	175	32	> 256	47.4											31.4	20.0	0.6	0.6		47.4
	Tetracycline	British Columbia	75	≤ 4	> 32	45.3									54.7			2.7	42.7			
		Saskatchewan	71	≤ 4	> 32	40.8									57.7	1.4		4.2	36.6			
		Ontario	100	≤ 4	> 32	41.0									59.0		1.0	3.0	37.0			
		Québec	138	32	> 32	57.2									42.0	0.7	0.7	8.0	48.6			
		Maritimes	175	32	> 32	52.0									46.9	1.1	0.6	5.1	46.3			
IV																						

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table B.15. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2010.

	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	119	8	32	38.7							5.0	16.0	26.1	12.6	1.7	32.8	5.9			
	Ceftiofur	119	0.50	> 8	34.5				3.4	32.8	21.8	4.2		3.4	23.5	10.9					
	Ceftriaxone	119	≤ 0.25	16	37.8					60.5	0.8	0.8		3.4	11.8	21.0	1.7				
	Ciprofloxacin	119	≤ 0.015	≤ 0.015	0.0	92.4	3.4		0.8	3.4											
II	Amikacin	119	2	4	0.0							13.4	71.4	14.3	0.8						
	Ampicillin	119	> 32	> 32	52.9							9.2	23.5	12.6	0.8	0.8		52.9			
	Cefoxitin	119	8	> 32	39.5							1.7	15.1	29.4	11.8	2.5	11.8	27.7			
	Gentamicin	119	0.50	16	10.1					7.6	63.0	12.6	2.5	0.8	3.4	4.2	5.9				
	Kanamycin	119	≤ 8	> 64	15.1										83.2	1.7			15.1		
	Nalidixic acid	119	2	4	4.2							13.4	64.7	16.8	0.8			4.2			
	Streptomycin	119	≤ 32	> 64	49.6												50.4	21.0	28.6		
	Trimethoprim-sulfamethoxazole	119	≤ 0.12	4	10.1				83.2	4.2	2.5			0.8	9.2						
III	Chloramphenicol	119	8	16	8.4								3.4	32.8	50.4	5.0	1.7	6.7			
	Sulfisoxazole	119	32	> 256	39.5											42.0	17.6	0.8			39.5
	Tetracycline	119	> 32	> 32	52.1									47.9			0.8	51.3			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.16. Distribution of minimum inhibitory concentrations for antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2010.

Antimicrobial	Species	Province / region	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)												
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
Ciprofloxacin	*Campylobacter coli*	British Columbia	4	0.25	8	25.0				50.0	25.0					25.0				
Ciprofloxacin	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
Ciprofloxacin	*Campylobacter coli*	Ontario	6	0.25	16	16.7			16.7	16.7	50.0						16.7			
Ciprofloxacin	*Campylobacter coli*	Québec	4	0.25	0.25	0.0			25.0	25.0	50.0									
Ciprofloxacin	*Campylobacter coli*	Maritimes	4	0.25	16	25.0			25.0	25.0	25.0						25.0			
Ciprofloxacin	*Campylobacter jejuni*	British Columbia	62	0.125	16	14.5			12.9	69.4	3.2					1.6	8.1	3.2	1.6	
Ciprofloxacin	*Campylobacter jejuni*	Saskatchewan	34	0.125	0.25	8.8			20.6	61.8	8.8						8.8			
Ciprofloxacin	*Campylobacter jejuni*	Ontario	58	0.125	0.25	3.4			24.1	62.1	8.6	1.7				1.7	1.7			
Ciprofloxacin	*Campylobacter jejuni*	Québec	58	0.125	0.25	0.0			22.4	63.8	13.8									
Ciprofloxacin	*Campylobacter jejuni*	Maritimes	63	0.125	0.25	1.6			20.6	65.1	12.7					1.6				
Ciprofloxacin	*Campylobacter* spp.	British Columbia	4	4	16	50.0				50.0					25.0		25.0			
Ciprofloxacin	*Campylobacter* spp.	Saskatchewan	2	4	4	50.0				50.0					50.0					
Ciprofloxacin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Québec	1	8	8	100.0										100.0				
I Ciprofloxacin	*Campylobacter* spp.	Maritimes	1	4	4	100.0									100.0					
Telithromycin	*Campylobacter coli*	British Columbia	4	0.5	2	0.0					50.0	25.0		25.0						
Telithromycin	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
Telithromycin	*Campylobacter coli*	Ontario	6	2	4	0.0					16.7		33.3	16.7	33.3					
Telithromycin	*Campylobacter coli*	Québec	4	2	16	25.0					25.0	25.0		25.0			25.0			
Telithromycin	*Campylobacter coli*	Maritimes	4	4	4	0.0					25.0		25.0		50.0					
Telithromycin	*Campylobacter jejuni*	British Columbia	62	1	2	0.0					1.6	40.3	43.5	11.3		3.2				
Telithromycin	*Campylobacter jejuni*	Saskatchewan	34	1	1	0.0					8.8	38.2	44.1	5.9	2.9					
Telithromycin	*Campylobacter jejuni*	Ontario	58	1	4	6.9			1.7		5.2	31.0	39.7	8.6	5.2	1.7	6.9			
Telithromycin	*Campylobacter jejuni*	Québec	58	0.5	2	3.4					10.3	48.3	29.3	6.9		1.7	3.4			
Telithromycin	*Campylobacter jejuni*	Maritimes	63	0.5	2	0.0					11.1	46.0	30.2	11.1		1.6				
Telithromycin	*Campylobacter* spp.	British Columbia	4	0.5	1	0.0					25.0	50.0	25.0							
Telithromycin	*Campylobacter* spp.	Saskatchewan	2	1	1	0.0						50.0	50.0							
Telithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Québec	1	4	4	0.0									100.0					
Telithromycin	*Campylobacter* spp.	Maritimes	1	2	2	0.0								100.0						
Azithromycin	*Campylobacter coli*	British Columbia	4	0.064	0.125	0.0			75.0	25.0										
Azithromycin	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
Azithromycin	*Campylobacter coli*	Ontario	6	0.064	0.5	0.0		16.7	50.0		16.7	16.7								
Azithromycin	*Campylobacter coli*	Québec	4	0.125	> 64	25.0			50.0	25.0										25.0
Azithromycin	*Campylobacter coli*	Maritimes	4	0.125	0.25	0.0			50.0	25.0	25.0									
Azithromycin	*Campylobacter jejuni*	British Columbia	62	0.064	0.125	3.2		14.5	67.7	14.5										3.2
Azithromycin	*Campylobacter jejuni*	Saskatchewan	34	0.064	0.125	2.9	2.9	23.5	58.8	11.8										2.9
Azithromycin	*Campylobacter jejuni*	Ontario	58	0.064	> 64	10.3	3.4	19.0	50.0	13.8	3.4									10.3
Azithromycin	*Campylobacter jejuni*	Québec	58	0.064	0.125	1.7		27.6	55.2	12.1	1.7	1.7								1.7
Azithromycin	*Campylobacter jejuni*	Maritimes	63	0.064	0.125	0.0		19.0	65.1	14.3		1.6								
Azithromycin	*Campylobacter* spp.	British Columbia	4	0.064	0.064	0.0			100.0											
Azithromycin	*Campylobacter* spp.	Saskatchewan	2	0.125	0.125	0.0			50.0	50.0										
Azithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Québec	1	0.25	0.25	0.0					100.0									
Azithromycin	*Campylobacter* spp.	Maritimes	1	0.125	0.125	0.0				100.0										
Clindamycin	*Campylobacter coli*	British Columbia	4	0.25	0.5	0.0					75.0	25.0								
Clindamycin	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
Clindamycin	*Campylobacter coli*	Ontario	6	0.5	1	0.0					50.0	33.3	16.7							
Clindamycin	*Campylobacter coli*	Québec	4	0.25	16	25.0				50.0	25.0						25.0			
Clindamycin	*Campylobacter coli*	Maritimes	4	1	1	0.0					50.0		50.0							
Clindamycin	*Campylobacter jejuni*	British Columbia	62	0.125	0.25	1.6			4.8	58.1	33.9				1.6	1.6				
II Clindamycin	*Campylobacter jejuni*	Saskatchewan	34	0.125	0.25	0.0			14.7	52.9	29.4			2.9						
Clindamycin	*Campylobacter jejuni*	Ontario	58	0.25	4	6.9		1.7	5.2	41.4	37.9	3.4			3.4	3.4	3.4			
Clindamycin	*Campylobacter jejuni*	Québec	58	0.125	0.25	1.7			12.1	50.0	31.0	5.2				1.7				
Clindamycin	*Campylobacter jejuni*	Maritimes	63	0.25	0.25	0.0			7.9	34.9	52.4	4.8								
Clindamycin	*Campylobacter* spp.	British Columbia	4	0.25	0.25	0.0				50.0	50.0									
Clindamycin	*Campylobacter* spp.	Saskatchewan	2	0.25	0.25	0.0				50.0	50.0									
Clindamycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Québec	1	0.25	0.25	0.0					100.0									
Clindamycin	*Campylobacter* spp.	Maritimes	1	0.25	0.25	0.0					100.0									
Erythromycin	*Campylobacter coli*	British Columbia	4	0.25	2	0.0					75.0			25.0						
Erythromycin	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
Erythromycin	*Campylobacter coli*	Ontario	6	1	2	0.0						33.3	33.3	33.3						
Erythromycin	*Campylobacter coli*	Québec	4	1	> 64	25.0					50.0		25.0							25.0
Erythromycin	*Campylobacter coli*	Maritimes	4	2	2	0.0					25.0	25.0		50.0						
Erythromycin	*Campylobacter jejuni*	British Columbia	62	0.5	1	3.2					33.9	48.4	12.9	1.6						3.2
Erythromycin	*Campylobacter jejuni*	Saskatchewan	34	0.25	0.5	2.9				2.9	50.0	38.2	5.9						2.9	
Erythromycin	*Campylobacter jejuni*	Ontario	58	0.5	64	10.3			1.7	1.7	34.5	32.8	13.8	5.2					1.7	8.6
Erythromycin	*Campylobacter jejuni*	Québec	58	0.5	1	1.7					37.9	46.6	10.3		3.4					1.7
Erythromycin	*Campylobacter jejuni*	Maritimes	63	0.5	1	0.0				1.6	42.9	42.9	11.1		1.6					
Erythromycin	*Campylobacter* spp.	British Columbia	4	0.25	0.5	0.0					75.0	25.0								
Erythromycin	*Campylobacter* spp.	Saskatchewan	2	0.5	0.5	0.0					50.0	50.0								
Erythromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Québec	1	2	2	0.0								100.0						
Erythromycin	*Campylobacter* spp.	Maritimes	1	1	1	0.0							100.0							

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table B.16. (continued). Distribution of minimum inhibitory concentrations for antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance,* 2010.

	Antimicrobial	Species	Province / region	n	Percentiles		%R	Distribution (%) of MICs (µg/mL)											
					MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
	Gentamicin	*Campylobacter coli*	British Columbia	4	1	1	0.0						25.0	75.0							
	Gentamicin	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
	Gentamicin	*Campylobacter coli*	Ontario	6	1	2	0.0						16.7	66.7	16.7						
	Gentamicin	*Campylobacter coli*	Québec	4	1	2	0.0						25.0	50.0	25.0						
	Gentamicin	*Campylobacter coli*	Maritimes	4	1	1	0.0							100.0							
	Gentamicin	*Campylobacter jejuni*	British Columbia	62	1	1	0.0						17.7	82.3							
	Gentamicin	*Campylobacter jejuni*	Saskatchewan	34	1	1	0.0					2.9	17.6	76.5	2.9						
	Gentamicin	*Campylobacter jejuni*	Ontario	58	1	1	0.0				1.7		20.7	72.4	5.2						
	Gentamicin	*Campylobacter jejuni*	Québec	58	1	1	0.0						32.8	67.2							
	Gentamicin	*Campylobacter jejuni*	Maritimes	63	1	1	0.0						36.5	63.5							
	Gentamicin	*Campylobacter* spp.	British Columbia	4	1	1	0.0							100.0							
	Gentamicin	*Campylobacter* spp.	Saskatchewan	2	2	2	0.0						50.0		50.0						
	Gentamicin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Québec	1	1	1	0.0							100.0							
II	Gentamicin	*Campylobacter* spp.	Maritimes	1	2	2	0.0								100.0						
	Nalidixic acid	*Campylobacter coli*	British Columbia	4	8	> 64	25.0									25.0	50.0				**25.0**
	Nalidixic acid	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
	Nalidixic acid	*Campylobacter coli*	Ontario	6	≤ 4	> 64	16.7									66.7	16.7				**16.7**
	Nalidixic acid	*Campylobacter coli*	Québec	4	8	8	0.0									25.0	75.0				
	Nalidixic acid	*Campylobacter coli*	Maritimes	4	8	> 64	25.0									50.0	25.0				**25.0**
	Nalidixic acid	*Campylobacter jejuni*	British Columbia	62	≤ 4	> 64	16.1									66.1	17.7				**16.1**
	Nalidixic acid	*Campylobacter jejuni*	Saskatchewan	34	≤ 4	8	8.8									79.4	11.8				**8.8**
	Nalidixic acid	*Campylobacter jejuni*	Ontario	58	≤ 4	8	5.2									79.3	15.5				**5.2**
	Nalidixic acid	*Campylobacter jejuni*	Québec	58	≤ 4	8	0.0									82.8	15.5	1.7			
	Nalidixic acid	*Campylobacter jejuni*	Maritimes	63	≤ 4	8	1.6									74.6	22.2	1.6			**1.6**
	Nalidixic acid	*Campylobacter* spp.	British Columbia	4	> 64	> 64	50.0									25.0	25.0				**50.0**
	Nalidixic acid	*Campylobacter* spp.	Saskatchewan	2	> 64	> 64	50.0									50.0					**50.0**
	Nalidixic acid	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Québec	1	> 64	> 64	100.0														**100.0**
	Nalidixic acid	*Campylobacter* spp.	Maritimes	1	> 64	> 64	100.0														**100.0**
	Florfenicol	*Campylobacter coli*	British Columbia	4	2	2	0.0							50.0	50.0						
	Florfenicol	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
	Florfenicol	*Campylobacter coli*	Ontario	6	1	2	0.0							66.7	33.3						
	Florfenicol	*Campylobacter coli*	Québec	4	1	2	0.0							75.0	25.0						
	Florfenicol	*Campylobacter coli*	Maritimes	4	1	2	0.0							75.0	25.0						
	Florfenicol	*Campylobacter jejuni*	British Columbia	62	1	1	0.0						3.2	88.7	8.1						
	Florfenicol	*Campylobacter jejuni*	Saskatchewan	34	1	1	0.0						8.8	82.4	8.8						
	Florfenicol	*Campylobacter jejuni*	Ontario	58	1	2	0.0						13.8	70.7	15.5						
	Florfenicol	*Campylobacter jejuni*	Québec	58	1	1	0.0						10.3	81.0	6.9	1.7					
	Florfenicol	*Campylobacter jejuni*	Maritimes	63	1	2	0.0						1.6	84.1	12.7	1.6					
	Florfenicol	*Campylobacter* spp.	British Columbia	4	1	2	0.0						25.0	50.0	25.0						
	Florfenicol	*Campylobacter* spp.	Saskatchewan	2	1	1	0.0							100.0							
	Florfenicol	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Québec	1	1	1	0.0							100.0							
III	Florfenicol	*Campylobacter* spp.	Maritimes	1	1	1	0.0							100.0							
	Tetracycline	*Campylobacter coli*	British Columbia	4	> 64	> 64	50.0						50.0								**50.0**
	Tetracycline	*Campylobacter coli*	Saskatchewan	0	0	0	0.0														
	Tetracycline	*Campylobacter coli*	Ontario	6	> 64	> 64	50.0						16.7	16.7	16.7						**50.0**
	Tetracycline	*Campylobacter coli*	Québec	4	1	> 64	25.0					25.0		50.0							**25.0**
	Tetracycline	*Campylobacter coli*	Maritimes	4	> 64	> 64	50.0					25.0			25.0						**50.0**
	Tetracycline	*Campylobacter jejuni*	British Columbia	62	0.5	> 64	41.9				8.1	35.5	9.7	3.2	1.6				4.8	17.7	**19.4**
	Tetracycline	*Campylobacter jejuni*	Saskatchewan	34	64	> 64	61.8				11.8	17.6	8.8						5.9	35.3	**20.6**
	Tetracycline	*Campylobacter jejuni*	Ontario	58	32	> 64	53.4				8.6	29.3	3.4	3.4	1.7			1.7	3.4	17.2	**31.0**
	Tetracycline	*Campylobacter jejuni*	Québec	58	64	> 64	53.4				10.3	27.6	5.2	3.4					3.4	15.5	**34.5**
	Tetracycline	*Campylobacter jejuni*	Maritimes	63	0.25	> 64	42.9				23.8	27.0	6.3						1.6	7.9	**33.3**
	Tetracycline	*Campylobacter* spp.	British Columbia	4	64	64	50.0				25.0		25.0							50.0	
	Tetracycline	*Campylobacter* spp.	Saskatchewan	2	64	64	50.0					50.0								50.0	
	Tetracycline	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Québec	1	0.5	0.5	0.0						100.0								
	Tetracycline	*Campylobacter* spp.	Maritimes	1	0.25	0.25	0.0					100.0									
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
Campylobacter spp. includes unidentified species, some of which may be intrinsically resistant to nalidixic acid.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table B.17. Distribution of minimum inhibitory concentrations for antimicrobials in *Campylobacter* isolates from chickens; *Abattoir Surveillance*, 2010.

	Antimicrobial	Species	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)												
				MIC 50	MIC 90		≤ 0.016	0.032	0.064	0.125	0.25	0.5	1	2	4	8	16	32	64	> 64
I	Ciprofloxacin	*Campylobacter coli*	12	0.25	0.25	8.3			8.3	25.0	58.3					8.3				
	Ciprofloxacin	*Campylobacter jejuni*	99	0.125	0.25	3.0			21.2	62.6	13.1						3.0			
	Ciprofloxacin	*Campylobacter* spp.	0	0	0	0.0														
	Telithromycin	*Campylobacter coli*	12	2	4	8.3				8.3	25.0	8.3	8.3	25.0	16.7		8.3			
	Telithromycin	*Campylobacter jejuni*	99	1	2	3.0					12.1	22.2	53.5	6.1	2.0	1.0	3.0			
	Telithromycin	*Campylobacter* spp.	0	0	0	0.0														
II	Azithromycin	*Campylobacter coli*	12	0.125	0.125	8.3		8.3	41.7	41.7										8.3
	Azithromycin	*Campylobacter jejuni*	99	0.064	0.125	6.1		22.2	56.6	15.2										6.1
	Azithromycin	*Campylobacter* spp.	0	0	0	0.0														
	Clindamycin	*Campylobacter coli*	12	0.5	0.5	8.3				8.3	41.7	41.7					8.3			
	Clindamycin	*Campylobacter jejuni*	99	0.125	0.25	3.0			7.1	55.6	28.3	3.0		1.0	2.0			3.0		
	Clindamycin	*Campylobacter* spp.	0	0	0	0.0														
	Erythromycin	*Campylobacter coli*	12	1	1	8.3					33.3	16.7	41.7							8.3
	Erythromycin	*Campylobacter jejuni*	99	0.5	1	6.1				1.0	39.4	41.4	12.1							6.1
	Erythromycin	*Campylobacter* spp.	0	0	0	0.0														
	Gentamicin	*Campylobacter coli*	12	1	2	0.0							83.3	16.7						
	Gentamicin	*Campylobacter jejuni*	99	1	1	0.0					1.0	19.2	79.8							
	Gentamicin	*Campylobacter* spp.	0	0	0	0.0														
	Nalidixic acid	*Campylobacter coli*	12	8	8	8.3									50.0	41.7				8.3
	Nalidixic acid	*Campylobacter jejuni*	99	≤ 4	8	3.0									78.8	18.2				3.0
	Nalidixic acid	*Campylobacter* spp.	0	0	0	0.0														
III	Florfenicol	*Campylobacter coli*	12	1	2	0.0						8.3	50.0	41.7						
	Florfenicol	*Campylobacter jejuni*	99	1	1	0.0						8.1	87.9	4.0						
	Florfenicol	*Campylobacter* spp.	0	0	0	0.0														
	Tetracycline	*Campylobacter coli*	12	32	> 64	50.0					16.7	25.0	8.3					8.3		41.7
	Tetracycline	*Campylobacter jejuni*	99	0.5	> 64	46.5				20.2	24.2	7.1	2.0				1.0	7.1	8.1	30.3
	Tetracycline	*Campylobacter* spp.	0	0	0	0.0														
IV																				

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Pigs

Table B.18. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2010.

	Antimicrobien	n	Percentiles		% R	Distribution (%) des CMI (µg/mL)														
			CMI 50	CMI 90		≤ 0,015	0,03	0,06	0,12	0,25	0,5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicilline-acide clavulanique	182	≤ 1	16	3,3							75,3	1,6	3,8	5,5	10,4	2,7	0,5			
	Ceftiofur	182	1	1	3,3						18,7	74,7	3,3		0,5	2,7					
	Ceftriaxone	182	≤ 0,25	≤ 0,25	3,3					95,6	1,1				0,5	1,1	1,6				
	Ciprofloxacine	182	≤ 0,015	≤ 0,015	0,0	93,4	6,6														
II	Amikacine	182	1	2	0,0						7,1	70,9	19,2	2,7							
	Ampicilline	182	≤ 1	>32	23,6							68,7	7,1			0,5	0,5	23,1			
	Céfoxitine	182	2	4	2,7							9,9	46,7	36,3	3,8	0,5	0,5	2,2			
	Gentamicine	182	≤ 0,25	0,50	2,2					59,3	37,4	0,5			0,5	0,5	1,6				
	Kanamycine	182	≤ 8	≤ 8	8,2										91,8			1,1	7,1		
	Acide nalidixique	182	4	4	0,0								46,7	52,2	1,1						
	Streptomycine	182	≤ 32	> 64	36,8												63,2	12,6	24,2		
	Triméthoprime-sulfaméthoxazole	182	≤ 0,12	0,50	6,0				73,6	13,7	4,9	1,6			6,0						
III	Chloramphénicol	182	8	> 32	13,7								0,5	13,7	70,9	1,1	0,5	13,2			
	Sulfisoxazole	182	64	> 256	37,9											3,8	27,5	29,7	1,1		37,9
	Tétracycline	182	≤ 4	> 32	48,4									51,6			8,2	40,1			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.19. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from pigs; *Farm Surveillance*, 2010.

	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	101	≤ 1	16	2.0							61.4	8.9	2.0	5.0	20.8		2.0			
	Ceftiofur	101	1	1	2.0						13.9	83.2	1.0			2.0					
	Ceftriaxone	101	≤ 0.25	≤ 0.25	2.0					98.0					1.0		1.0				
	Ciprofloxacin	101	≤ 0.015	≤ 0.015	0.0	88.1	10.9	1.0													
II	Amikacin	101	1	2	0.0						4.0	64.4	30.7			1.0					
	Ampicillin	101	≤ 1	> 32	31.7							54.5	12.9	1.0			2.0	29.7			
	Cefoxitin	101	2	4	2.0							8.9	55.4	26.7	6.9		1.0	1.0			
	Gentamicin	101	≤ 0.25	0.5	0.0					50.5	43.6	5.0			1.0						
	Kanamycin	101	≤ 8	> 64	18.8										81.2				18.8		
	Nalidixic acid	101	4	4	0.0								46.5	51.5	2.0						
	Streptomycin	101	≤ 32	> 64	44.6												55.4	15.8	28.7		
	Trimethoprim-sulfamethoxazole	101	≤ 0.12	0.50	3.0				74.3	14.9	5.9		2.0		3.0						
III	Chloramphenicol	101	8	> 32	25.7									4.0	69.3	1.0		25.7			
	Sulfisoxazole	101	128	> 256	48.5											1.0	19.8	28.7	2.0		48.5
	Tetracycline	101	32	> 32	54.5									45.5			10.9	43.6			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.20. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from pigs; *Surveillance of Animal Clinical Isolates*, 2010.

	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	235	2	16	6.8							46.4	9.8	3.8	11.5	21.7	2.6	4.3			
	Ceftiofur	235	1	2	6.0					0.4	8.5	79.6	5.1	0.4	0.9	5.1					
	Ceftriaxone	235	≤ 0.25	≤ 0.25	6.0					94.0					1.3	2.6	1.7	0.4			
	Ciprofloxacin	235	≤ 0.015	0.03	0.0	89.8	9.4	0.4	0.4												
II	Amikacin	235	1	2	0.0						5.5	71.9	20.0	2.1	0.4						
	Ampicillin	235	2	> 32	44.7							41.7	9.8	2.1	0.4	1.3	2.1	42.6			
	Cefoxitin	235	2	8	6.8							10.2	45.1	29.4	7.2	1.3	4.7	2.1			
	Gentamicin	235	0.50	1	3.8					46.0	42.1	5.1		0.4	2.6	1.3	2.6				
	Kanamycin	235	≤ 8	> 64	18.3										81.3		0.4	0.4	17.9		
	Nalidixic acid	235	2	4	0.0							0.4	51.9	44.3	3.4						
	Streptomycin	235	64	> 64	51.1												48.9	23.4	27.7		
	Trimethoprim-sulfamethoxazole	235	≤ 0.12	> 4	13.6				71.5	13.2	0.9	0.9			13.6						
III	Chloramphenicol	235	8	> 32	26.0								0.9	11.1	56.6	5.5	0.4	25.5			
	Sulfisoxazole	235	> 256	> 256	55.3											2.6	17.4	23.4	1.3		55.3
	Tetracycline	235	> 32	> 32	66.0									33.6	0.4		7.2	58.7			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.21. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2010.

	Antimicrobial	Province / region	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	British Columbia	31	4	32	12.9								29.0	51.6	6.5		9.7	3.2			
		Saskatchewan	17	4	4	0.0							5.9	23.5	64.7	5.9						
		Ontario	84	4	4	2.4							8.3	32.1	51.2	6.0		1.2	1.2			
		Québec	47	4	8	6.4							6.4	36.2	31.9	19.1		4.3	2.1			
		Maritimes	71	4	8	4.2							4.2	36.6	39.4	12.7	2.8	4.2				
	Ceftiofur	British Columbia	31	0.25	8	12.9				9.7	51.6	22.6	3.2			9.7	3.2					
		Saskatchewan	17	0.25	0.50	0.0					64.7	35.3										
		Ontario	84	0.25	0.50	2.4				16.7	60.7	20.2				1.2	1.2					
		Québec	47	0.25	1	4.3				10.6	55.3	23.4	2.1	2.1	2.1		4.3					
I		Maritimes	71	0.25	0.50	2.8				7.0	59.2	28.2		2.8		2.8						
	Ceftriaxone	British Columbia	31	≤ 0.25	8	12.9					83.9		3.2			6.5	3.2	3.2				
		Saskatchewan	17	≤ 0.25	≤ 0.25	0.0					100.0											
		Ontario	84	≤ 0.25	≤ 0.25	2.4					97.6						2.4					
		Québec	47	≤ 0.25	≤ 0.25	6.4					93.6				2.1	2.1	2.1					
		Maritimes	71	≤ 0.25	≤ 0.25	2.8					95.8			1.4		2.8						
	Ciprofloxacin	British Columbia	31	≤ 0.015	≤ 0.015	0.0	90.3	6.5			3.2											
		Saskatchewan	17	≤ 0.015	≤ 0.015	0.0	100.0															
		Ontario	84	≤ 0.015	≤ 0.015	0.0	98.8				1.2											
		Québec	47	≤ 0.015	≤ 0.015	0.0	93.6	2.1	4.3													
		Maritimes	71	≤ 0.015	≤ 0.015	0.0	97.2	1.4	1.4													
	Amikacin	British Columbia	31	2	4	0.0							9.7	67.7	16.1	6.5						
		Saskatchewan	17	2	4	0.0							35.3	29.4	29.4	5.9						
		Ontario	84	2	4	0.0							20.2	65.5	10.7	3.6						
		Québec	47	2	4	0.0							25.5	55.3	14.9	4.3						
		Maritimes	71	2	2	0.0						1.4	36.6	52.1	9.9							
	Ampicillin	British Columbia	31	4	> 32	22.6							12.9	35.5	29.0				22.6			
		Saskatchewan	17	2	> 32	17.6								64.7	17.6				17.6			
		Ontario	84	2	> 32	10.7							20.2	51.2	16.7	1.2			10.7			
		Québec	47	2	> 32	21.3							23.4	36.2	14.9	2.1	2.1		21.3			
		Maritimes	71	2	> 32	22.5							14.1	43.7	12.7	2.8	4.2	1.4	21.1			
	Cefoxitin	British Columbia	31	4	> 32	12.9								22.6	64.5				12.9			
		Saskatchewan	17	4	8	0.0								35.3	52.9	11.8						
		Ontario	84	4	4	2.4							3.6	36.9	50.0	7.1		1.2	1.2			
		Québec	47	4	16	6.4							2.1	42.6	36.2	8.5	4.3	4.3	2.1			
		Maritimes	71	2	4	2.8							5.6	45.1	40.8	4.2	1.4	2.8				
	Gentamicin	British Columbia	31	0.50	1	0.0					16.1	58.1	25.8									
		Saskatchewan	17	0.50	2	0.0						76.5	11.8	11.8								
		Ontario	84	0.50	1	1.2					11.9	65.5	17.9	3.6				1.2				
		Québec	47	0.50	1	0.0					8.5	66.0	25.5									
		Maritimes	71	0.50	1	2.8					16.9	64.8	14.1	1.4			1.4	1.4				
II	Kanamycin	British Columbia	31	≤ 8	≤ 8	0.0										100.0						
		Saskatchewan	17	≤ 8	≤ 8	5.9										94.1				5.9		
		Ontario	84	≤ 8	≤ 8	7.1										91.7		1.2		7.1		
		Québec	47	≤ 8	≤ 8	6.4										93.6			2.1	4.3		
		Maritimes	71	≤ 8	≤ 8	5.6										93.0		1.4		5.6		
	Nalidixic acid	British Columbia	31	2	4	3.2							16.1	71.0	9.7				3.2			
		Saskatchewan	17	2	4	0.0							23.5	64.7	11.8							
		Ontario	84	2	4	1.2							17.9	65.5	15.5				1.2			
		Québec	47	2	4	0.0							23.4	66.0	6.4	4.3						
		Maritimes	71	2	4	1.4						1.4	12.7	71.8	12.7				1.4			
	Streptomycin	British Columbia	31	≤ 32	≤ 32	6.5												93.5	6.5			
		Saskatchewan	17	≤ 32	64	17.6												82.4	11.8	5.9		
		Ontario	84	≤ 32	64	16.7												83.3	7.1	9.5		
		Québec	47	≤ 32	> 64	23.4												76.6	10.6	12.8		
		Maritimes	71	≤ 32	64	15.5												84.5	7.0	8.5		
	Trimethoprim-sulfamethoxazole	British Columbia	31	≤ 0.12	≤ 0.12	0.0				96.8	3.2											
		Saskatchewan	17	≤ 0.12	≤ 0.12	0.0				100.0												
		Ontario	84	≤ 0.12	≤ 0.12	4.8				92.9		2.4			1.2	3.6						
		Québec	47	≤ 0.12	> 4	10.6				87.2	2.1					10.6						
		Maritimes	71	≤ 0.12	> 4	12.7				73.2	11.3	1.4		1.4		12.7						
	Chloramphenicol	British Columbia	31	4	8	6.5								9.7	45.2	38.7		6.5				
		Saskatchewan	17	8	8	0.0								11.8	17.6	70.6						
		Ontario	84	4	8	2.4								6.0	53.6	35.7	2.4	1.2	1.2			
		Québec	47	4	32	17.0								4.3	46.8	27.7	4.3	12.8	4.3			
		Maritimes	71	4	8	8.5								5.6	45.1	39.4	1.4	5.6	2.8			
	Sulfisoxazole	British Columbia	31	≤ 16	64	9.7											67.7	16.1	6.5			9.7
		Saskatchewan	17	≤ 16	> 256	23.5											70.6	5.9				23.5
III		Ontario	84	≤ 16	> 256	13.1											70.2	15.5	1.2			13.1
		Québec	47	≤ 16	> 256	25.5											61.7	8.5	4.3			25.5
		Maritimes	71	32	> 256	26.8											49.3	19.7	4.2			26.8
	Tetracycline	British Columbia	31	≤ 4	> 32	32.3									67.7			6.5	25.8			
		Saskatchewan	17	≤ 4	> 32	35.3									64.7				35.3			
		Ontario	84	≤ 4	> 32	33.3									65.5	1.2		4.8	28.6			
		Québec	47	≤ 4	> 32	34.0									66.0			12.8	21.3			
		Maritimes	71	32	> 32	59.2									40.8		1.4	8.5	49.3			
IV																						

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table B.22. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2010.

	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	199	4	8	2.0							3.0	28.6	37.7	27.6	1.0	**1.0**	**1.0**			
	Ceftiofur	199	0.25	0.50	2.0				3.5	59.8	34.2	0.5			**1.0**	**1.0**					
	Ceftriaxone	199	≤ 0.25	≤ 0.25	2.0					98.0					**0.5**	**1.5**					
	Ciprofloxacin	199	≤ 0.015	≤ 0.015	0.0	99.0	1.0														
II	Amikacin	199	2	4	0.0							25.6	62.3	11.6	0.5						
	Ampicillin	199	4	> 32	36.7							7.5	40.2	14.6	0.5	0.5		**36.7**			
	Cefoxitin	199	4	8	2.0								29.1	57.8	10.1	1.0		**2.0**			
	Gentamicin	199	0.50	1	0.0					9.0	68.8	21.1	1.0								
	Kanamycin	199	≤ 8	> 64	15.1										84.9			**0.5**	**14.6**		
	Nalidixic acid	199	2	4	0.0							12.1	72.4	14.6	1.0						
	Streptomycin	199	≤ 32	> 64	35.7												64.3	**16.6**	**19.1**		
	Trimethoprim-sulfamethoxazole	199	≤ 0.12	> 4	14.1				73.9	10.1	1.5	0.5			**14.1**						
III	Chloramphenicol	199	8	32	18.1								3.5	32.7	42.2	3.5	**12.1**	**6.0**			
	Sulfisoxazole	199	32	> 256	46.2											46.2	7.0	0.5			**46.2**
	Tetracycline	199	> 32	> 32	71.9									27.6	0.5		**4.5**	**67.3**			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.23. Distribution of minimum inhibitory concentrations for antimicrobials in *Escherichia coli* isolates from pigs; *Farm Surveillance*, 2010.

	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	1,673	4	8	0.6							5.4	29.5	43.0	20.3	1.1	**0.5**	**0.1**			
	Ceftiofur	1,673	0.25	0.5	0.5				6.4	61.0	31.7	0.3		0.1	**0.3**	**0.2**					
	Ceftriaxone	1,673	≤ 0.25	≤ 0.25	0.5					99.4		0.1			**0.1**	**0.4**	**0.1**	**0.1**			
	Ciprofloxacin	1,673	≤ 0.015	≤ 0.015	0.0	98.6	0.5	0.4	0.2	0.2											
II	Amikacin	1,673	2	2	0.0						2.2	36.8	53.1	7.1	0.8						
	Ampicillin	1,673	4	> 32	30.1							11.5	41.0	14.9	1.5	1.0	**0.3**	**29.8**			
	Cefoxitin	1,673	4	4	0.6						0.1	1.5	37.8	51.6	7.7	0.7	**0.2**	**0.4**			
	Gentamicin	1,673	0.5	1	0.9					19.9	66.5	11.2	0.5	0.3	0.8	**0.7**	**0.2**				
	Kanamycin	1,673	≤ 8	64	11.2										88.5	0.1	0.2	**1.9**	**9.3**		
	Nalidixic acid	1,673	2	4	0.6						1.1	14.9	73.7	9.5	0.2		**0.2**	**0.4**			
	Streptomycin	1,673	≤ 32	> 64	33.6												66.4	**16.2**	**17.4**		
	Trimethoprim-sulfamethoxazole	1,673	≤ 0.12	>4	11.6				75.7	10.3	2.0	0.4		**0.1**	**11.5**						
III	Chloramphenicol	1,673	8	32	20.3								3.3	35.9	35.9	4.5	**14.3**	**6.0**			
	Sulfisoxazole	1,673	32	> 256	48.8											44.9	5.6	0.5		0.1	**48.8**
	Tetracycline	1,673	> 32	> 32	75.9									23.6	0.5	**0.4**	**5.6**	**70.0**			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Table B.24. Distribution of minimum inhibitory concentrations for antimicrobials in *Enterococcus* isolates from pigs; *Farm Surveillance*, 2010.

	Antimicrobial	Species	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	512	1024	2048	> 2048
	Ciprofloxacin	*Enterococcus faecalis*	1,071	1	2	1.0					0.2	4.1	67.6	27.1	0.1	0.9									
	Ciprofloxacin	*Enterococcus faecium*	57	1	4	19.3						26.3	26.3	28.1	17.5	1.8									
	Ciprofloxacin	*Enterococcus* spp.	421	0.5	1	1.0					13.1	62.9	17.3	5.7	1.0										
	Daptomycin	*Enterococcus faecalis*	1,071	1	2	0.0						5.1	78.0	16.3	0.3	0.3									
	Daptomycin	*Enterococcus faecium*	57	2	4	0.0						21.1	15.8	22.8	40.4										
	Daptomycin	*Enterococcus* spp.	421	2	4	0.0						13.5	13.8	39.4	29.2	4.0									
	Linezolid	*Enterococcus faecalis*	1,071	1	2	0.0						1.1	70.4	28.5											
I	Linezolid	*Enterococcus faecium*	57	2	2	0.0							36.8	63.2											
	Linezolid	*Enterococcus* spp.	421	1	2	0.0						8.1	58.2	33.7											
	Tigecycline	*Enterococcus faecalis*	1,071	0.12	0.25	0.0	0.2	0.7	6.2	65.0	27.9	0.1													
	Tigecycline	*Enterococcus faecium*	57	0.12	0.250	0.0	1.8	7.0	35.1	43.9	12.3														
	Tigecycline	*Enterococcus* spp.	421	0.12	0.12	0.0	1.4	8.1	28.7	52.7	9.0														
	Vancomycin	*Enterococcus faecalis*	1,071	1	2	0.0						2.2	79.9	16.9	0.9										
	Vancomycin	*Enterococcus faecium*	57	0.5	2	0.0						80.7	12.3	7.0											
	Vancomycin	*Enterococcus* spp.	421	0.5	1	0.0						54.4	37.5	3.3	1.7	3.1									
	Erythromycin	*Enterococcus faecalis*	1,071	> 8	> 8	73.6						7.9	15.0	3.4	0.1		73.6								
	Erythromycin	*Enterococcus faecium*	57	2	> 8	17.5						14.0	28.1	29.8	10.5		17.5								
	Erythromycin	*Enterococcus* spp.	421	> 8	> 8	61.8						35.4	1.7	1.0	0.2		61.8								
	Gentamicin	*Enterococcus faecalis*	1,071	≤ 128	≤ 128	7.9														92.0	0.1	0.2	2.0	5.8	
	Gentamicin	*Enterococcus faecium*	57	≤ 128	≤ 128	0.0														100.0					
	Gentamicin	*Enterococcus* spp.	421	≤ 128	≤ 128	3.1														96.9			1.7	1.4	
	Kanamycin	*Enterococcus faecalis*	1,071	≤ 128	> 1024	24.4														75.2	0.1	0.4	0.1	24.3	
	Kanamycin	*Enterococcus faecium*	57	256	> 1024	26.3														49.1	21.1	3.5	1.8	24.6	
	Kanamycin	*Enterococcus* spp.	421	≤ 128	> 1024	14.3														84.1	1.0	0.7		14.3	
	Lincomycin[a]	*Enterococcus faecium*	57	> 8	> 8	84.2							14.0		1.8		84.2								
	Lincomycin	*Enterococcus* spp.	421	> 8	> 8	96.9							0.7		2.4	1.2	95.7								
II	Penicillin	*Enterococcus faecalis*	1,071	4	4	0.3						1.4	0.3	28.7	69.2	0.2	0.3								
	Penicillin	*Enterococcus faecium*	57	4	16	33.3						1.8	5.3	19.3	29.8	10.5	31.6	1.8							
	Penicillin	*Enterococcus* spp.	421	1	16	14.3						20.2	34.2	13.8	8.8	8.8	7.6	6.7							
	Quinupristin-dalfopristin[a]	*Enterococcus faecium*	57	2	4	12.3							19.3	68.4	12.3										
	Quinupristin-dalfopristin	*Enterococcus* spp.	421	0.5	1	51.3							13.5	35.2	34.7	15.0	1.7								
	Streptomycin	*Enterococcus faecalis*	1,071	≤ 512	> 2048	34.9																65.1	0.2	1.8	33.0
	Streptomycin	*Enterococcus faecium*	57	≤ 512	> 2048	35.1																64.9	8.8	3.5	22.8
	Streptomycin	*Enterococcus* spp.	421	≤ 512	> 2048	27.3																72.7	1.7	9.5	16.2
	Tylosin	*Enterococcus faecalis*	1,071	> 32	> 32	73.7					0.1	0.2	1.2	23.4	1.1	0.3		0.1	73.6						
	Tylosin	*Enterococcus faecium*	57	4	> 32	17.5							10.5	19.3	31.6	19.3	1.8		17.5						
	Tylosin	*Enterococcus* spp.	421	> 32	> 32	61.8						1.4	3.3	27.6	4.5	0.7	0.7		61.8						
	Chloramphenicol	*Enterococcus faecalis*	1,071	8	32	10.6								0.2	2.6	79.3	7.4	2.4	8.1						
	Chloramphenicol	*Enterococcus faecium*	57	4	8	0.0									61.4	33.3	5.3								
	Chloramphenicol	*Enterococcus* spp.	421	8	8	1.2								1.7	40.9	55.8	0.5	0.5	0.7						
	Nitrofurantoin	*Enterococcus faecalis*	1,071	8	16	1.6									0.1	72.5	23.7	0.7	1.4	1.6					
III	Nitrofurantoin	*Enterococcus faecium*	57	64	> 64	14.0											1.8	1.8	82.5	14.0					
	Nitrofurantoin	*Enterococcus* spp.	421	32	> 64	14.7									1.0	9.5	9.3	44.7	20.9	14.7					
	Tetracycline	*Enterococcus faecalis*	1,071	> 32	> 32	95.1									4.8	0.1	0.7	1.2	93.2						
	Tetracycline	*Enterococcus faecium*	57	> 32	> 32	54.4									45.6			1.8	52.6						
	Tetracycline	*Enterococcus* spp.	421	> 32	> 32	83.8									15.9	0.2	1.7	5.2	77.0						
IV																									

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

[a] Resistance to quinupristin-dalfopristin and lincomycin is not reported for *E. faecalis* because *E. faecalis* is intrinsically resistant to these antimicrobials.

Turkeys

Table B.25. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from turkeys; *Surveillance of Animal Clinical Isolates*, 2010.

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
	Amoxicillin-clavulanic acid	30	16	> 32	40.0							46.7			3.3	10.0		40.0			
I	Ceftiofur	30	1	> 8	40.0						10.0	50.0				40.0					
	Ceftriaxone	30	≤ 0.25	32	40.0					60.0						13.3	20.0	6.7			
	Ciprofloxacin	30	≤ 0.015	≤ 0.015	0.0	93.3	3.3	3.3													
	Amikacin	30	1	2	0.0						6.7	76.7	16.7								
	Ampicillin	30	> 32	> 32	53.3							36.7	10.0					53.3			
	Cefoxitin	30	4	> 32	40.0							20.0	26.7	13.3			6.7	33.3			
II	Gentamicin	30	≤ 0.25	> 16	10.0					56.7	33.3						10.0				
	Kanamycin	30	≤ 8	≤ 8	3.3										93.3		3.3	3.3			
	Nalidixic acid	30	4	4	0.0								26.7	70.0	3.3						
	Streptomycin	30	≤ 32	> 64	26.7												73.3	13.3	13.3		
	Trimethoprim-sulfamethoxazole	30	≤ 0.12	≤ 0.12	3.3				96.7						3.3						
	Chloramphenicol	30	8	> 32	10.0									16.7	73.3			10.0			
III	Sulfisoxazole	30	64	> 256	30.0											6.7	43.3	20.0			30.0
	Tetracycline	30	≤ 4	> 32	36.7									63.3		3.3		33.3			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Horses

Table B.26. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from horses; *Surveillance of Animal Clinical Isolates*, 2010.

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	14	8	16	0.0							42.9			14.3	42.9					
	Ceftiofur	14	1	1	0.0						14.3	85.7									
	Ceftriaxone	14	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	14	≤ 0.015	0.25	0.0	71.4	7.1			21.4											
II	Amikacin	14	1	16	0.0							57.1	7.1	7.1	7.1	14.3	7.1				
	Ampicillin	14	> 32	> 32	57.1							42.9						57.1			
	Cefoxitin	14	4	4	0.0							28.6	14.3	57.1							
	Gentamicin	14	0.50	> 16	35.7					28.6	28.6	7.1					35.7				
	Kanamycin	14	≤ 8	> 64	35.7										64.3				35.7		
	Nalidixic acid	14	4	16	0.0								35.7	42.9	7.1	14.3					
	Streptomycin	14	≤ 32	> 64	28.6												71.4		28.6		
	Trimethoprim-sulfamethoxazole	14	0.25	> 4	35.7				50.0	14.3					35.7						
III	Chloramphenicol	14	> 32	> 32	50.0									7.1	42.9			50.0			
	Sulfisoxazole	14	> 256	> 256	57.1												14.3	28.6			57.1
	Tetracycline	14	≤ 4	> 32	21.4									78.6				21.4			
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Feed and Feed Ingredients

Table B.27. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from animal feed; *Feed and Feed Ingredients*, 2010.

	Antimicrobial	n	Percentiles MIC 50	MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	31	≤ 1	≤ 1	0.0							100.0									
	Ceftiofur	31	1	1	0.0						41.9	58.1									
	Ceftriaxone	31	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	31	≤ 0.015	≤ 0.015	0.0	100.0															
II	Amikacin	31	1	1	0.0						12.9	77.4	9.7								
	Ampicillin	31	≤ 1	≤ 1	0.0							93.5	6.5								
	Cefoxitin	31	2	4	0.0							29.0	32.3	35.5	3.2						
	Gentamicin	31	≤ 0.25	0.50	0.0					74.2	25.8										
	Kanamycin	31	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	31	2	4	0.0								67.7	32.3							
	Streptomycin	31	≤ 32	≤ 32	0.0												100.0				
	Trimethoprim-sulfamethoxazole	31	≤ 0.12	≤ 0.12	0.0				100.0												
III	Chloramphenicol	31	8	8	0.0									35.5	64.5						
	Sulfisoxazole	31	64	64	0.0											3.2	38.7	48.4	9.7		
	Tetracycline	31	≤ 4	≤ 4	0.0									100.0							
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.

Appendix C – Additional Tables

Antimicrobial Resistance

Table C.1. Distribution of *Salmonella* isolates from humans, by patient age and province; *Surveillance of Human Clinical Isolates*, 2010.

Age (year)	Number (%) of isolates	Province	Number (%) of isolates
Less than 5	193 (8)	British Columbia	252 (11)
5 to 12	199 (9)	Alberta	289 (13)
13 to 17	96 (4)	Saskatchewan	143 (6)
18 to 29	330 (14)	Manitoba	173 (8)
30 to 49	356 (16)	Ontario	777 (34)
50 to 69	285 (12)	Québec	371 (16)
70 and more	122 (5)	New Brunswick	121 (5)
Not specified	715 (31)	Nova Scotia	111 (5)
		Prince Edward Island	27 (1)
		Newfoundland and Labrador	32 (1)
Total	**2,296 (100)**		**2,296 (100)**

Table C.2. Distribution of isolates of primary human *Salmonella* serovars from humans, by source; *Surveillance of Human Clinical Isolates*, 2010.

Specimen source	Number (%) of isolates						
	Enteritidis	Heidelberg	Paratyphi A and B	Typhi	Typhimurium	I 4,[5],12:i:-	Total
Stool	828 (83)	348 (73)	14 (47)	42 (24)	405 (89)	143 (88)	1,780 (78)
Blood	21 (2)	56 (12)	15 (50)	131 (73)	10 (2)	6 (4)	239 (10)
Urine	16 (2)	19 (4)		2 (1)	11 (2)	5 (3)	53 (2)
Anatomy part					1 (< 1)		1 (< 1)
Other body fluid	11 (1)	13 (3)			7 (2)	3 (2)	34 (1)
Unknown	119 (12)	40 (8)	1 (3)	4 (2)	19 (4)	6 (4)	189 (8)
Total	**995 (100)**	**476 (100)**	**30 (100)**	**160 (100)**	**453 (100)**	**163 (100)**	**2,296 (100)**

Table C.3. Summary of antimicrobial susceptibility in the most common *Salmonella* serovars from humans and the agri-food sector; CIPARS, 2010.

Species	Most common serovars					
	Total (n)	Susceptible to antimicrobials	1 antimicrobial class in resistance pattern	2-3 antimicrobial classes in resistance pattern	4-5 antimicrobial classes in resistance pattern	6 antimicrobial classes in resistance pattern
Surveillance of Human Clinical Isolates						
	n = 2,296	**n = 1,593**	**n = 326**	**n = 76**	**n = 220**	**n = 81**
	Enteritidis (995)	Enteritidis (863)	Typhi (118)	Typhimurium (29)	Heidelberg (83)	Typhimurium (31)
	Heidelberg (476)	Heidelberg (310)	Enteritidis (106)	Heidelberg (19)	Typhimurium (77)	Typhi (28)
Humans	Typhimurium (453)	Typhimurium (307)	Heidelberg (52)	I 4,[5],12:i:- (10)	I 4,[5],12:i:- (40)	Heidelberg (12)
	Typhi (179)	I 4,[5],12:i:- (74)	I 4,[5],12:i:- (30)	Enteritidis (8)	Enteritidis (17)	I 4,[5],12:i:- (9)
	I 4,[5],12:i:- (163)	Typhi (23)	Paratyphi A and B (11)	Typhi (8)	Typhi (2)	Enteritidis (1)
	Paratyphi A and B (30)	Paratyphi A and B (16)	Typhimurium (9)	Paratyphi A and B (2)	Paratyphi A and B (1)	
Retail Meat Surveillance						
	n = 381	**n = 209**	**n = 70**	**n = 101**	**n = 1**	**n = 0**
	Heidelberg (106)	Enteritidis (60)	Heidelberg (40)	Kentucky (68)	Indiana (1)	
	Kentucky (100)	Heidelberg (59)	Kentucky (8)	Hadar (19)		
	Enteritidis (60)	Kentucky (24)	Albany (7)	Heidelberg (7)		
Chicken	Hadar (23)	Typhimurium (14)	I 4,[5],12:i:- (3)			
	Typhimurium (15)	Schwarzengrund (7)	Thompson (3)			
	Schwarzengrund (10)	Braenderup (5)	Hadar (2)			
	Albany (9)	Thompson (5)				
	Thompson (9)					
Abattoir Surveillance						
	n = 142	**n = 71**	**n = 29**	**n = 39**	**n = 3**	**n = 0**
	Kentucky (59)	Enteritidis (25)	Heidelberg (17)	Kentucky (35)	Indiana (1)	
	Heidelberg (30)	Kentucky (14)	Kentucky (9)	Hadar (2)	Infantis (1)	
Chickens	Enteritidis (25)	Heidelberg (13)	Braenderup (1)	I 6,8:-:e,n,x (1)	Kentucky (1)	
	Typhimurium (6)	Typhimurium (6)	I 4,[5],12:i:- (1)	Mbandaka (1)		
	Litchfield (4)	Litchfield (4)	Muenchen (1)			
	Hadar (3)					
	n = 182	**n = 83**	**n = 20**	**n = 49**	**n = 30**	**n = 0**
	Typhimurium (37)	Infantis (16)	Derby (6)	Derby (23)	Typhimurium (23)	
	Derby (36)	Brandenburg (11)	Worthington (6)	Typhimurium (9)	Infantis (2)	
	Infantis (22)	Derby (7)	Infantis (4)	Brandenburg (3)	Bovismorbificans (1)	
	Brandenburg (15)	Schwarzengrund (7)	Typhimurium (2)	Mbandaka (3)	Give (1)	
	Worthington (13)	Worthington (7)	Brandenburg (1)	Schwarzengrund (3)	I 4,[5],12:i:- (1)	
	Schwarzengrund (11)	Agona (4)	London (1)	Havana (2)	Mbandaka (1)	
	Mbandaka (6)	Give (3)		Heidelberg (2)	Schwarzengrund (1)	
Pigs	Agona (5)	Ohio (3)		Agona (1)		
	Give (4)	Typhimurium (3)		Hadar (1)		
	Ohio (4)	Anatum (2)		Johannesburg (1)		
		Bovismorbificans (2)		Ohio (1)		
		I 4,[5],12:i:- (2)				
		Mbandaka (2)				
		Muenster (2)				
		Soerenga (2)				
Farm Surveillance						
	n =101	**n = 32**	**n = 15**	**n = 25**	**n =26**	**n = 0**
	Typhimurium (35)	Infantis (11)	Brandenburg (5)	Derby (15)	Typhimurium (26)	
	Derby (19)	Brandenburg (6)	Derby (3)	Typhimurium (6)	Ohio (2)	
	Infantis (14)	Bovismorbificans (2)	Infantis (3)	Agona (1)	I 4,[5],12:i:- (1)	
	Brandenburg (11)	Manhattan (2)	I 4,[5],12:i:- (3)	I 4,[5],12:i:- (1)		
	I 4,[5],12:i:- (6)	Typhimurium (2)	Typhimurium (1)	Johannesburg (1)		
	Bovismorbificans (2)	Albany (1)		Mbandaka (1)		
Pigs	Manhattan (2)	California (1)				
	Mbandaka (2)	Derby (1)				
	Ohio (2)	Enteritidis (1)				
		Give (1)				
		I Rough:z:l,w (1)				
		I 4,[5],12:i:- (1)				
		Mbandaka (1)				
		Roodepoort (1)				

Most common serovars were those representing 2% or more of the isolates within each surveillance component and species. For the purpose of this table, *S*. Typhimurium var. 5- results were combined with *S.* Typhimurium results to harmonize serovar classification with that of the National Microbiology Laboratory.

Table C.3 (continued). Summary of antimicrobial susceptibility in the most common *Salmonella* serovars from humans and the agri-food sector; CIPARS, 2010.

Species	Most common serovars					
	Total (n)	Susceptible to antimicrobials	1 antimicrobial class in resistance pattern	2-3 antimicrobial classes in resistance pattern	4-5 antimicrobial classes in resistance pattern	6 antimicrobial classes in resistance pattern
Surveillance of Animal Clinical Isolates						
Cattle	**n = 143** Typhimurium (87) Enteritidis (11) Dublin (6) Heidelberg (5) I 4,[5],12:i:- (5) Infantis (4) Mbandaka (4) Muenster (3)	**n = 62** Typhimurium (22) Enteritidis (10) Heidelberg (5) Infantis (4) Muenster (3) Cerro (2) I 4,[5],12:i:- (2) I 6,14,18:-:- (2) Kentucky (2) Mbandaka (2) Ohio var. 14+ (2) Schw arzengrund (2)	**n = 2** Agona (1) Braenderup (1)	**n = 5** Typhimurium (3) Mbandaka (2)	**n = 74** Typhimurium (62) Dublin (6) I 4,[5],12:i:- (3) Brandenburg (2) Enteritidis (1)	**n = 0**
Chickens	**n = 342** Enteritidis (114) Heidelberg (95) Kentucky (68) Typhimurium (15) Mbandaka (9) I 4,[5],12:i:- (8)	**n = 228** Enteritidis (110) Heidelberg (63) Kentucky (16) Typhimurium (10) I 4,[5],12:i:- (6)	**n = 40** Heidelberg (24) Kentucky (10) Enteritidis (2) Braenderup (1) I 4,[5],12:i:- (1) Rissen (1) Typhimurium (1)	**n = 67** Kentucky (42) Heidelberg (8) Mbandaka (7)	**n = 7** Typhimurium (3) Agona (2) Enteritidis (1) Indiana (1)	**n = 0**
Pigs	**n = 235** Typhimurium (103) Derby (38) I 4,[5],12:i:- (15) Infantis (15) Brandenburg (8) Mbandaka (8) Agona (6)	**n = 62** Derby (12) Infantis (10) Typhimurium (9) Brandenburg (5) I 4,[5],12:i:- (3) Mbandaka (3) Agona (2) Bovismorbificans (2)	**n = 27** Typhimurium (12) Derby (4) Anatum (3) Infantis (2) Agona (1) Heidelberg (1) I 6,7:-:l,w (1) Illa Rough:-:- (1) Johannesburg (1) Rissen (1)	**n = 64** Typhimurium (25) Derby (20) Mbandaka (4) Infantis (3) Agona (2) Brandenburg (2) Schw arzengrund (2)	**n = 82** Typhimurium (57) I 4,[5],12:i:- (12) I 6,8:r:- (3) Derby (2) Agona (1) Brandenburg (1) I 6,7:-:l,w (1) Johannesburg (1) Krefeld (1) Mbandaka (1) New port (1) Schw arzengrund (1)	**n = 0**
Turkeys	**n = 30** Agona (7) Senftenberg (5) Heidelberg (4) Typhimurium (4) Hadar (3) Saintpaul (2) Schw arzengrund (2) Johannesburg (1) Montevideo (1) Muenster (1)	**n = 5** Heidelberg (2) Schw arzengrund (2) Agona (1)	**n = 13** Agona (3) Senftenberg (3) Heidelberg (2) Typhimurium (2) Hadar (1) Muenster (1) Saintpaul (1)	**n = 9** Hadar (2) Senftenberg (2) Typhimurium (2) Agona (1) Johannesburg (1) Montevideo (1)	**n = 3** Agona (2) Saintpaul (1)	**n = 0**
Horses	**n = 14** Heidelberg (5) Typhimurium (3) Muenster (2) Braenderup (1) Enteritidis (1) Oranienburg (1) Saintpaul (1)	**n = 6** Muenster (2) Braenderup (1) Enteritidis (1) Oranienburg (1) Saintpaul (1)	**n = 0**	**n = 1** Heidelberg (1)	**n = 7** Heidelberg (4) Typhimurium (3)	**n = 0**

Most common serovars were those representing 2% or more of the isolates within each surveillance component and species. For the purpose of this table, *S*. Typhimurium var. 5- results were combined with *S.* Typhimurium results to harmonize serovar classification with that of the National Microbiology Laboratory.

Table C.4. Summary of selected resistance patterns involving multiple antimicrobials in bacterial isolates from humans and the agri-food sector; CIPARS, 2010.

Species	Bacterial species	Number (%) of isolates / serovar total Number (%) of isolates / *Salmonella* total							
		Susceptible to all antimicrobials	Resistant to A2C-AMP	ACSSuT	AKSSuT	ACKSSuT	A2C-ACSSuT	A2C-AKSSuT	A2C-ACKSSuT
Surveillance of Human Clinical Isolates									
Humans	*Salmonella* Enteritidis (n = 995)	863/995 (87%) 863/2,296 (38%)	2/995 (< 1%) 2/2,296 (< 1%)						
	Salmonella Heidelberg (n = 476)	310/476 (65%) 310/2,296 (14%)	88/476 (18%) 88/2,296 (4%)				1/476 (< 1%) 1/2,296 (< 1%)		
	Salmonella Paratyphi A and B (n = 30)	16/30 (53%) 16/2,296 (< 1%)		1/30 (3%) 1/2,296 (< 1%)					
	Salmonella Typhi (n = 179)	23/179 (13%) 23/2,296 (1%)		4/179 (2%) 4/2,296 (< 1%)					
	Salmonella Typhimurium (n = 453)	307/453 (68%) 307/2,296 (13%)	3/452 (< 1%) 3/2,296 (< 1%)	44/453 (10%) 44/2,296 (2%)	9/453 (2%) 9/2,296 (< 1%)	21/453 (5%) 21/2,296 (< 1%)	3/453 (< 1%) 3/2,296 (< 1%)		
	Salmonella I 4,[5],12:i:- (n = 163)	74/163 (45%) 74/2,296 (3%)	12/163 (7%) 12/2,296 (< 1%)	1/163 (< 1%) 1/2,296 (< 1%)		5/163 (3%) 5/2,296 (< 1%)	1/163 (< 1%) 1/2,296 (< 1%)		
Retail Meat Surveillance									
Beef	*Escherichia coli* (n = 521)	440/521 (84%)	2/521 (< 1%)	3/521 (< 1%)	1/521 (< 1%)	2/521 (< 1%)			
Chicken	*Salmonella* Enteritidis (n = 60)	60/60 (100%) 60/381 (16%)							
	Salmonella Heidelberg (n = 106)	59/106 (56%) 59/381 (15%)	22/106 (21%) 22/381 (6%)						
	Salmonella Typhimurium (n = 15)	14/15 (93%) 14/381 (4%)							
	Salmonella I 4,[5],12:i:- (n = 4)	1/4 (25%) 1/381 (< 1%)	2/4 (50%) 2/381 (< 1%)						
	Other serovars (n = 196)	75/196 (38%) 75/381 (20%)	44/196 (22%) 44/381 (12%)				1/196 (< 1%) 1/381 (< 1%)		
	Escherichia coli (n = 559)	137/559 (25%)	109/559 (19%)	3/559 (< 1%)	7/559 (1%)	1/559 (< 1%)	15/559 (3%)	8/559 (1%)	2/559 (< 1%)
Pork	*Escherichia coli* (n = 250)	132/250 (53%)	8/250 (3%)	3/250 (1%)	1/250 (< 1%)	2/250 (< 1%)	1/250 (< 1%)		
Abattoir Surveillance									
Beef cattle	*Escherichia coli* (n = 77)	65/77 (84%)							
Chickens	*Salmonella* Enteritidis (n = 25)	25/25 (100%) 25/142 (18%)							
	Salmonella Heidelberg (n = 30)	13/30 (43%) 13/142 (9%)	10/30 (33%) 10/142 (7%)						
	Salmonella Typhimurium (n = 6)	6/6 (100%) 6/142 (4%)							
	Salmonella I 4,[5],12:i:- (n = 1)		1/1 (100%) 1/142 (< 1%)						
	Other serovars (n = 80)	27/80 (34%) 27/142 (19%)	23/80 (29%) 23/142 (16%)				2/80 (3%) 2/142 (1%)		
	Escherichia coli (n = 119)	24/119 (20%)	30/119 (25%)		2/119 (2%)		5/119 (4%)	5/119 (4%)	1/119 (< 1%)
Pigs	*Salmonella* Enteritidis (n = 1)	1/1 (100%) 1/182 (< 1%)							
	Salmonella Heidelberg (n = 3)	1/3 (33%) 1/182 (< 1%)							
	Salmonella Typhimurium (n = 37)	3/37 (8%) 3/182 (2%)	1/37 (3%) 1/182 (< 1%)	16/37 (43%) 16/182 (9%)		4/37 (11%) 4/182 (2%)			
	Salmonella I 4,[5],12:i:- (n = 3)	2/3 (67%) 2/182 (1%)				1/3 (33%) 1/182 (< 1%)			
	Other serovars (n = 138)	76/138 (55%) 76/182 (42%)	3/138 (2%) 3/182 (2%)				1/138 (< 1%) 1/182 (< 1%)		
	Escherichia coli (n = 199)	34/199 (17%)	3/199 (2%)	9/199 (5%)	1/199 (< 1%)			1/199 (< 1%)	

For *Salmonella* isolates, results are given both as a percentage of isolates of a given serovar (upper row) and as a percentage of all *Salmonella* isolates (lower row).
Results for each of the above specific patterns exclude isolates resistant to one of the other patterns presented in this table but may include isolates resistant to other antimicrobials. Blank cells represent values equal to 0 (0%). For the purpose of this table, *S.* Typhimurium var. 5- results were combined with *S.* Typhimurium results to harmonized serovar classification with that of the National Microbiology Laboratory.

Table C.4 (continued). Summary of selected resistance patterns involving multiple antimicrobials in bacterial isolates from humans and the agri-food sector; CIPARS, 2010.

Species	Bacterial species	Number (%) of isolates / serovar total Number (%) of isolates / *Salmonella* total							
		Susceptible to all antimicrobials	Resistant to A2C-AMP	ACSSuT	AKSSuT	ACKSSuT	A2C-ACSSuT	A2C-AKSSuT	A2C-ACKSSuT
Farm Surveillance									
Pigs	*Salmonella* Enteritidis (n = 1)	1/1 (100%) 1/101 (< 1%)							
	Salmonella Typhimurium (n = 35)	2/35 (6%) 2/101 (2%)	1/35 (3%) 1/101 (< 1%)	12/35 (34%) 12/101 (12%)		11/35 (31%)			
	Other serovars (n = 65)	29/65 (45%) 29/101 (29%)							1/65 (< 1%) 1/101 (< 1%)
	Escherichia coli (n = 1,673)	271/1,673 (16%)	5/1,673 (< 1%)	40/1,673 (2%)	34/1,673 (2%)	4/1,673 (< 1%)	3/1,673 (< 1%)		
Surveillance of Animal Clinical Isolates									
Cattle	*Salmonella* Enteritidis (n = 11)	10/11 (91%) 10/143 (7%)							1/11 (9%) 1/143 (< 1%)
	Salmonella Heidelberg (n = 5)	5/5 (100%) 5/143 (3%)							
	Salmonella Typhimurium (n = 87)	22/87 (25%) 22/143 (15%)	15/87 (17%) 15/143 (10%)	9/87 (10%) 9/143 (6%)	6/87 (7%) 6/143 (4%)	19/87 (22%) 19/143 (13%)			2/87 (2%) 2/143 (1%)
	Salmonella I 4,[5],12:i:- (n = 5)	2/5 (40%) 2/143 (1%)				2/5 (40%) 2/143 (1%)	1/5 (20%) 1/143 (< 1%)		
	Other serovars (n = 35)	23/35 (66%) 23/143 (16%)	6/35 (17%) 6/143 (4%)						1/35 (3%) 1/143 (< 1%)
Chickens	*Salmonella* Enteritidis (n = 114)	110/114 (96%) 110/342 (32%)					1/114 (< 1%) 1/342 (< 1%)		
	Salmonella Heidelberg (n = 95)	63/95 (66%) 63/342 (18%)	13/95 (14%) 13/342 (4%)						
	Salmonella Typhimurium (n = 15)	10/15 (67%) 10/342 (3%)		2/15 (13%) 2/342 (< 1%)		1/15 (7%) 1/342 (< 1%)			
	Salmonella I 4,[5],12:i:- (n = 8)	6/8 (75%) 6/342 (2%)	1/8 (13%) 1/342 (< 1%)						
	Other serovars (n = 110)	39/110 (35%) 39/342 (11%)	29/110 (26%) 29/342 (8%)				3/110 (3%) 3/342 (< 1%)		
Pigs	*Salmonella* Heidelberg (n = 1)								
	Salmonella Typhimurium (n = 103)	9/103 (9%) 9/235 (4%)	2/103 (2%) 2/235 (< 1%)	31/103 (30%) 31/235 (13%)	4/103 (4%) 4/235 (2%)	14/103 (14%) 14/235 (6%)		1/103 (< 1%) 1/235 (< 1%)	1/103 (< 1%) 1/235 (< 1%)
	Salmonella I 4,[5],12:i:- (n = 15)	3/15 (20%) 3/235 (1%)				5/15 (33%) 5/235 (2%)			
	Other serovars (n = 116)	50/116 (43%) 50/235 (21%)	7/116 (6%) 7/235 (3%)			3/116 (3%) 3/235 (1%)	1/116 (< 1%) 1/235 (< 1%)		1/116 (< 1%) 1/235 (< 1%)
Turkeys	*Salmonella* Heidelberg (n = 4)	2/4 (50%) 2/30 (7%)							
	Salmonella Typhimurium (n = 4)		2/4 (50%) 2/30 (7%)						
	Other serovars (n = 22)	3/22 (14%) 3/30 (10%)	8/22 (36%) 8/30 (27%)				2/22 (9%) 2/30 (7%)		
Horses	*Salmonella* Enteritidis (n = 1)	1/1 (100%) 1/14 (7%)							
	Salmonella Heidelberg (n = 5)								
	Salmonella Typhimurium (n = 3)			3/3 (100%) 3/14 (21%)					
	Other serovars (n = 5)	5/5 (100%) 5/14 (36%)							

For *Salmonella* isolates, results are given both as a percentage of isolates of a given serovar (upper row) and as a percentage of all *Salmonella* isolates (lower row).
Results for each of the above specific patterns exclude isolates resistant to one of the other patterns presented in this table but may include isolates resistant to other antimicrobials. Blank cells represent values equal to 0 (0%). For the purpose of this table, *S.* Typhimurium var. 5- results were combined with *S.* Typhimurium results to harmonized serovar classification with that of the National Microbiology Laboratory.

Table C.5. Bacterial recovery rates for samples collected through the CIPARS agri-food components, 2002–2010.

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted					
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Retail Meat Surveillance										
Beef	British Columbia	2005	**93%**	27/29						
		2007	**79%**	49/62						
		2008	**77%**	88/115						
		2009	**71%**	79/112						
		2010	**51%**	64/125						
	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						
	Ontario	2003	**66%**	101/154	**2%**	2/84	**3%**	2/76	**91%**	69/76
		2004	**80%**	190/237						
		2005	**81%**	184/227						
		2006	**81%**	189/235						
		2007	**71%**	184/227						
		2008	**78%**	185/236						
		2009	**79%**	195/248						
		2010	**69%**	123/177						
	Québec	2003	**57%**	84/147	**0%**	0/33	**0%**	0/33	**80%**	28/35
		2004	**56%**	137/245						
		2005	**56%**	126/225						
		2006	**50%**	109/215						
		2007	**68%**	147/216						
		2008	**59%**	126/214						
		2009	**54%**	108/201						
		2010	**45%**	101/223						
	Maritimes	2004	**67%**	16/24						
		2007	**52%**	16/31						
		2008	**70%**	39/56						
		2009	**69%**	137/200						
		2010	**69%**	126/183						

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities
Human and animal clinical *Salmonella* data were not presented as the information on the number of samples cultured and isolates recovered was unavailable to CIPARS.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table C.5 (continued). Bacterial recovery rates of samples collected through the CIPARS agri-food components, 2002–2010.

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Retail Meat Surveillance										
Chicken	British Columbia	2005	**95%**	19/20	**13%**	5/39	**69%**	27/39	**100%**	20/20
		2007	**98%**	42/43	**22%**[a]	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%**	56/165	**42%**	70/165		
	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%**[a]	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		
	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%**[a]	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		
	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%**[a]	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		
	Maritimes	2004	**100%**	13/13	**4%**	1/25	**40%**	10/25	**100%**	13/13
		2007[b]	**91%**	29/32	**22%**[a]	7/32				
		2008[b]	**68%**	38/56	**22%**	12/56				
		2009[b]	**94%**	187/199	**49%**	97/199	**29%**	57/199		
		2010	**93%**	176/190	**41%**	77/190	**37%**	70/190		

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities

Human and animal clinical *Salmonella* data were not presented as the information on the number of samples cultured and isolates recovered was unavailable to CIPARS.

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

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

[b] 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.

Table C.5 (continued). Bacterial recovery rates of samples collected through the CIPARS agri-food components, 2002–2010.

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Retail Meat Surveillance										
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				
	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				
	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				
	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				
	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				

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities
Human and animal clinical *Salmonella* data were not presented as the information on the number of samples cultured and isolates recovered was unavailable to CIPARS.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table C.5 (continued). Bacterial recovery rates of samples collected through the CIPARS agri-food components, 2002–2010.

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered / number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Abattoir Surveillance										
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%**[c]	129/182		
		2009	**94%**	119/126			**68%**	86/126		
		2010	**97%**[d]	77/79			**53%**[d]	37/70		
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		
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				
Farm Surveillance										
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

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities

Human and animal clinical *Salmonella* data were not presented as the information on the number of samples cultured and isolates recovered was unavailable to CIPARS.

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

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

[d] In 2010, the number of samples received from abattoir beef cattle was much lower than anticipated due to a 55% drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.

Table C.6. Distribution of *Salmonella* isolates across provinces; *Surveillance of Animal Clinical Isolates*, 2010.

Species (n)	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Québec	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Unknown
	Number (%) of isolates									
Cattle (143)	11 (8)	53 (37)	2 (1)	3 (2)	43 (30)	22 (15)	1 (1)		8 (6)	
Chickens (342)	95 (28)	44 (13)		78 (23)	102 (30)	19 (6)		1 (< 1)		3 (1)
Pigs (235)	6 (3)	3 (1)	2 (1)	40 (17)	59 (25)	114 (49)		11 (5)		
Turkeys (30)	3 (10)			2 (7)	17 (57)	8 (27)				
Horses (14)					7 (50)	2 (14)		3 (21)		2 (14)

No *Salmonella* isolates from animal clinical submissions were received from the New Brunswick.

Antimicrobial Use

Humans

Table C.7. Quantity of active ingredients of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	Antimicrobial	ATC Class	Total active ingredients (kg)										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	6,943.80	7,111.36	6,953.47	7,328.95	7,354.77	8,276.17	8,829.72	9,653.61	10,434.61	11,042.43	9,972.34
I	Cefixime	Third-generation cephalosporins (J01DD)	441.47	412.56	372.50	321.45	275.37	282.37	274.85	303.43	322.03	341.52	421.21
I	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	17,387.35	17,569.37	17,718.15	18,469.28	18,738.69	18,781.31	19,348.63	19,806.00	19,946.58	19,875.99	20,342.44
I	Vancomycin	Glycopeptides (J01XA)	25.90	28.25	32.23	40.56	70.36	79.17	75.77	83.99	83.73	92.41	102.57
I	Metronidazole	Imidazole (J01XD)	NPD	4,808.34	4,927.11	5,126.54	5,237.51	5,311.07	5,563.92	5,587.82	5,791.00	6,027.77	6,459.99
I	Linezolid	Linezolid (J01XX)	NPD	1.55	4.91	10.82	17.29	23.26	22.44	25.34	26.11	31.23	31.65
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	57,566.37	56,004.37	53,404.23	53,132.75	51,471.46	53,138.73	53,534.54	53,445.95	54,514.40	56,299.19	59,225.50
II	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	15,079.86	14,253.92	13,722.26	13,802.13	12,916.80	13,174.53	13,139.44	12,881.10	12,395.39	12,214.39	11,000.10
II	Cloxacillin	β-lactamase resistant penicillins (J01CF)	8,351.00	8,004.27	7,376.34	7,135.18	6,596.38	5,861.06	5,604.72	5,159.05	4,777.41	4,355.43	5,396.23
II	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	16,693.30	17,295.99	18,358.43	19,683.24	20,312.94	21,585.02	22,980.75	23,353.79	24,059.39	24,295.70	23,803.98
II	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	11,099.40	9,857.59	8,712.26	8,570.41	8,277.23	8,410.81	7,937.34	7,424.93	7,216.85	7,126.74	6,506.07
II	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	29,783.84	27,065.80	24,548.61	23,018.83	20,511.55	18,858.59	18,519.88	18,102.01	18,165.26	18,066.09	18,016.39
II	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	25,163.98	23,844.04	21,665.44	22,138.28	21,168.11	22,746.49	22,646.72	22,517.45	22,785.16	22,901.64	22,746.17
II	Clindamycin	Lincosamides (J01FF)	3,289.35	3,590.12	3,896.00	4,272.26	4,441.95	4,499.59	4,976.64	5,303.74	5,553.15	5,744.36	6,357.64
II	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	76.31	62.19	52.12	45.35	41.87	1.05	0.26	0.01	NPD	0.01	NPD
II	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	2,745.17	1,910.05	1,251.28	843.14	548.87	494.05	418.86	305.33	102.70	0.07	NPD
II	Fusidic acid	Steroid antibacterials (J01XC)	34.79	39.06	35.54	37.27	36.64	41.91	42.73	34.22	30.08	14.26	0.66

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NPD = No prescriptions dispensed.

Table C.7 (continued). Quantity of active ingredients of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2010.

	Antimicrobial	ATC Class	Total active ingredients (kg)										
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	14,112.37	13,169.24	12,595.12	11,902.77	11,050.90	10,709.61	10,280.96	9,678.89	9,419.51	9,300.87	7,211.78
	Chloramphenicol	Amphenicols (J01BA)	0.78	0.99	0.20	NPD	0.06	0.01	NPD	NPD	NPD	NPD	< 0.01
	Trimethoprim	Trimethoprim and derivatives (J01EA)	315.71	297.29	310.34	307.34	288.32	265.98	265.88	261.01	242.58	247.47	246.86
III	Sulfamethizole, sulfapyridine, sulfisoxazole	Short-acting sulfonamides (J01EB)	105.38	13.45	0.88	1.04	1.02	0.26	0.13	0.03	0.03	NPD	NPD
	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	28.08	4.48	4.77	5.55	4.51	2.93	2.27	2.36	1.33	0.04	0.10
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	935.24	981.97	1,019.51	1,073.19	1,152.40	1,210.89	1,323.74	1,390.41	1,503.67	1,621.76	1,741.72
	Fosfomycin	Fosfomycin (J01XX)	64.76	74.26	48.00	35.71	26.28	20.78	17.78	11.00	1.98	5.04	3.43
NC	Methenamine	Methenamine (J01XX)	389.51	356.69	350.35	296.88	282.20	253.34	249.14	261.99	163.43	210.81	238.88
		Total (J01)	**210,633.72**	**206,757.23**	**197,360.06**	**197,598.93**	**190,823.45**	**194,028.99**	**196,057.09**	**195,593.50**	**197,536.37**	**199,815.22**	**199,825.69**

Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. NC = Not classified. NPD = No prescriptions dispensed.

Demographics and Health

Humans

Table C.8. Population demographics in Canada, 2009 and 2010.

Province / territory	Post-census population estimates 2009[a]	Post-census population estimates 2010[a]	Percentage change in 2010[c]	Population density/km^2 (2010)[b]
British Columbia	4,459,900	4,529,500	1.56	4.90
Alberta	3,672,700	3,723,800	1.39	5.80
Saskatchewan	1,029,500	1,044,400	1.45	1.77
Manitoba	1,219,900	1,235,700	1.30	2.23
Ontario	13,068,800	13,223,800	1.19	14.41
Québec	7,825,800	7,905,100	1.01	5.79
New Brunswick	749,900	752,900	0.40	10.54
Nova Scotia	940,600	945,200	0.49	17.72
Prince Edward Island	141,100	143,100	1.42	25.28
Newfoundland and Labrador	509,100	511,900	0.55	1.37
Yukon	33,700	34,600	2.67	0.07
Northwest Territories	43,600	43,900	0.69	0.04
Nunavut	32,200	32,800	1.86	0.02
Canada	**33,726,900**	**34,126,500**	**1.18**	**3.75**

Some statistics from the 2009 CIPARS report are slightly different than those reported here. These changes were made to reflect updates in the estimates for population by year, by province and territory.

[a] Statistics Canada. Population by year, by province and territory. Available at: www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo02a-eng.htm. Accessed December 2012.

[b] Population density per square kilometre in 2010 was calculated on the basis of the population in 2010 and the land area in square kilometres reported by Statistics Canada at www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/phys01-eng.htm. Accessed December 2012.

[c] Percentage change was calculated as ([2010 value - 2009 value] / 2009 value) X 100.

Table C.9. Characteristics, production, and per-capita consumption of Canadian livestock.

Farmed animal species	Number of farms in 2006	Number of animals Jan. 1, 2009	Number of animals Jan. 1, 2010	Percentage change in 2010[a]	Product produced in 2010[b] (metric tonnes) Jan 1, 2010	Per-capita consumption in 2010[c,d,e]
Cattle	**109,901[f]**	**13,195,000[g]**	**12,905,000[g]**	**-2.20**	**1,236,090[g]**	**Beef = 27.72 kg**
Beef cows	83,000	4,649,500	4,391,000	-5.56	Calves = 36,170	Veal = 1.09 kg
Dairy cows	17,515	978,500	981,000	0.26		Fluid milk = 77.98 L
Heifers (≥ 1 year old)	72,929					Cream = 8.21 L
Heifers for beef replacement	45,407	537,000	516,400	-3.84		Cheese = 12.41 kg
Heifers for dairy replacement	16,585	450,600	450,700	0.02		
Heifers for slaughter or feeding	23,998	834,500	899,800	7.83		
Steers (≥ 1 year old)	36,695	1,067,600	1,141,700	6.94		
Calves (< 1 year old)	98,107	4,433,400	4,292,300	-3.18		
Bulls (≥ 1 year old)	71,958	243,900	232,100	-4.84		
Swine	**11,497[h]**	**12,180,000[i]**	**11,835,000[i]**	**-2.83**	**1,925,120[j]**	**Pork = 21.66 kg**
Sows and bred gilts	5,831	1,371,200	1,310,400	-4.43		
Boars	5,133	23,800	21,600	-9.24		
Nursing and weaner pigs	5,560					
Grower and finishing pigs	8,937					
Pigs < 20 kg		3,688,600	3,598,500	-2.44		
Pigs 20–60 kg		3,618,800	3,604,600	-0.39		
Pigs > 60 kg		3,477,600	3,299,900	-5.11		

Statistics from the 2006 CIPARS report are slightly different than those reported here. These changes were made to reflect updates in the 2007 Census of Agriculture report.

[a] Percentage change was calculated as ([2010 value – 2009 value] / 2009 value) X 100.

[b] Total cold dressed weight, not including edible offal.

[c] Statistics Canada. Table 002-0011-Food available in Canada, annual (kilograms per person, per year unless otherwise noted), CANSIM (database). Available at: www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0020011&pattern=&csid=. Accessed December 2012.

[d] Food available for consumption (eviscerated).

[e] Statistics Canada. Table 002-0019-Food available by major groups in Canada, annual (kilograms per person, per year unless otherwise noted), CANSIM (database). Available at: www5.statcan.gc.ca/cansim/a05?lang=eng&id=0020019&pattern=0020019&searchTypeByValue=1&p2=35. Accessed on December 2012.

[f] Statistics Canada. Agriculture overview, Canada and the provinces-cattle and calves on Census Day, 2006 and 2001. Available at: www.statcan.gc.ca/pub/95-629-x/2007000/4123855-eng.htm#cattle. Accessed December 2012.

[g] Statistics Canada. Cattle Statistics 2011. Cat. No.23-012-X, Vol. 10, No. 2. Available at: www.statcan.gc.ca/pub/23-012-x/23-012-x2011001-eng.pdf. Accessed December 2012.

[h] Statistics Canada. Agriculture overview, Canada and the provinces - pigs on Census Day, 2006 and 2001. Available at: www.statcan.gc.ca/pub/95-629-x/2007000/4123855-eng.htm#pigs. Accessed December 2012.

[i] Statistics Canada. Hog Statistics – First quarter 2011. Cat. No. 23-010-X, Vol. 10, No. 2. Available at: www.statcan.gc.ca/pub/23-010-x/23-010-x2011002-eng.pdf. Accessed December 2012.

[j] Statistics Canada. Table 002-0010-Supply and disposition of food in Canada, annual (tonnes unless otherwise noted), CANSIM (database). Available at: www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0020010&pattern=0020010&csid=. Accessed on December 2012.

Table C.9 (continued). Characteristics, production, and per-capita consumption of Canadian livestock.

Farmed animal species	Number of farms in 2006	Number of animals Jan. 1, 2009	Number of animals Jan. 1, 2010	Percentage change in 2010[a]	Product produced in 2010[b] (metric tonnes) Jan 1, 2010	Per-capita consumption in 2010[c,d,e]
Poultry		**658,683,000[k]**	**662,047,000[k]**	**0.51**	**1,207,457[k]**	**Poultry = 37.82 kg** **Eggs = 11.16 kg**
Hens and chickens Broilers, roasters, and cornish hens	22,712[l] 8,831	637,035,000	641,506,000	0.70	Chicken = 1,048,459	Chicken = 31.27 kg Stewing hens = 2.14 kg
Turkeys	3,174	21,648,000	20,541,000	-5.11	Turkey = 158,998	Turkey = 4.40 kg
Sheep	**11,031[m]**	**808,200[n]**	**805,500[n]**	**-0.33**	**16,000j**	**Lamb and mutton = 1.08 kg**
Ewes	10,309	522,100	515,700	-1.23		
Rams	8,175	23,800	22,900	-3.78		
Lambs	9,117					
Replacement lambs		77,900	74,000	-5.01		
Market lambs		184,400	192,900	4.61		
Fish					**160,925[o]**	**Fish = 7.69 kg[p]**
Finfishes					Salmon = 101,385	Fresh and frozen sea fish = 3.58 kg
					Trout = 6,883	Fresh water fish = 0.33 kg
					Other finfish = 993	Processed sea fish = 2.20 kg
Shellfishes					Clams = 1,938	Shellfish = 1.58 kg
					Oysters = 10,862	
					Mussels = 24,484	
					Scallops = 702	
					Other shellfish = 777	

Statistics from the 2006 CIPARS report are slightly different than those reported here. These changes were made to reflect updates in the 2007 Census of Agriculture report.

[a] Percentage change was calculated as ([2010 value – 2009 value] / 2009 value) X 100.

[b] Total cold dressed weight, not including edible offal.

[c] Statistics Canada. Table 002-0011-Food available in Canada, annual (kilograms per person, per year unless otherwise noted), CANSIM (database). Available at: www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0020011&pattern=&csid=. Accessed December 2012.

[d] Food available for consumption (eviscerated).

[e] Statistics Canada. Table 002-0019-Food available by major groups in Canada, annual (kilograms per person, per year unless otherwise noted), CANSIM (database). Available at: www5.statcan.gc.ca/cansim/a05?lang=eng&id=0020019&pattern=0020019&searchTypeByValue=1&p2=35. Accessed on December 2012.

[k] Statistics Canada. Poultry and Egg Statistics January to March 2011. Cat. No. 23-015-XIE, Vol. 8, No. 1. Available at: www.statcan.gc.ca/pub/23-015-x/23-015-x2011001-eng.pdf. Accessed December 2012.

[l] Statistics Canada. Agriculture overview, Canada and the provinces - poultry inventory on Census Day, 2006 and 2001. Available at: www.statcan.gc.ca/pub/95-629-x/2007000/4123855-eng.htm#poulinv. Accessed December 2012.

[m] Statistics Canada. Agriculture overview, Canada and the provinces - sheep and lambs on Census Day, 2006 and 2001. Available at: www.statcan.gc.ca/pub/95-629-x/2007000/4123855-eng.htm#sheep. Accessed December 2012.

[n] Statistics Canada. Sheep Statistics 2011. Cat. No. 23-011-X, Vol. 10, No. 1. Available at: www.statcan.gc.ca/pub/23-011-x/23-011-x2010002-eng.pdf. Accessed December 2012.

[o] Statistics Canada. Aquaculture Statistics 2010. Cat. No. 23-222-X. Available at: www.statcan.gc.ca/pub/23-222-x/23-222-x2010000-eng.pdf. Accessed December 2012. Aquaculture product produced in 2010 was calculated by using Total finfish and Total shellfish values.

[p] In 2010, per capita consumption of fish was reported using unadjusted data. Previous reports used adjusted data which accounted for retail, household, cooking and plate loss.

Table C.10. Number of births, slaughters, international imports and exports, and farm deaths for Canadian cattle, pigs, and sheep.

Supply and disposition	Cattle[a]	Swine[b]	Sheep[c]
Births	4,835,300	30,866,500	810,800
Slaughters[d]	3,745,600	21,296,400	713,900
Percentage change in slaughters in 2010[e]	1.09	-2.34	-3.61
International imports	55,800	3,000	33,500
Percentage change in imports in 2010[e]	2.95	-9.09	-0.30
International exports	1,064,500	5,760,100	1,400
Percentage change in exports in 2010[e]	-0.20	-9.66	1300.00[f]
Deaths and condemnations	529,000	1,395,700	122,000
Percentage change in deaths and condemnations in 2010[e]	-0.26	-4.63	-1.93

[a] Statistics Canada. Cattle Statistics 2012. Cat. No.23-012-X, Vol. 11, No. 1. Available at: www.statcan.gc.ca/pub/23-012-x/23-012-x2011002-eng.pdf. Accessed December 2012.
[b] Statistics Canada. Hog Statistics – First quarter 2012. Cat. No. 23-010-X, Vol. 11, No. 2. Available at: www.statcan.gc.ca/pub/23-010-x/23-010-x2012002-eng.pdf. Accessed December 2012.
[c] Statistics Canada. Sheep Statistics 2012. Cat. No. 23-011-X, Vol. 11, No. 1. Available at: www.statcan.gc.ca/pub/23-011-x/23-011-x2011002-eng.pdf. Accessed December 2012.
[d] For swine data: represents slaughter but may include pigs destined for export (varies by province).
[e] Percentage change was calculated as ([2010 value - 2009 value] / 2009 value) X 100.
[f] For international sheep exports only, the percentage change was calculated as ([2010 value - 2007 value] / 2007 value) X 100. The reference year 2007 was used as no international sheep exports were reported for 2008 and 2009.

Appendix D – Additional Information

Abbreviations

General Abbreviations

A2C-AMP Resistance to amoxicillin-clavulanic acid, cefoxitin, ceftiofur, and ampicillin

AARD Alberta Agriculture and Rural Development

ACSSuT Resistance to ampicillin, chloramphenicol, streptomycin, sulfisoxazole, and tetracycline

ACKSSuT Resistance to ampicillin, chloramphenicol, kanamycin, streptomycin, sulfisoxazole, and tetracycline

AKSSuT Resistance to ampicillin, kanamycin, streptomycin, sulfisoxazole, and tetracycline

AMU Antimicrobial use

AMR Antimicrobial resistance

ATC Anatomical Therapeutic Chemical

ATCC American Type Culture Collection

BPW Buffered peptone water

CAHI Canadian Animal Health Institute

CCS Canadian CompuScript

CFIA Canadian Food Inspection Agency

CLSI Clinical and Laboratory Standards Institute

CQA® Canadian Quality Assurance

DANMAP Danish Integrated Antimicrobial Resistance Monitoring and Research Program

DDDs Defined daily doses

DID Total number of DDDs per 1,000 inhabitants per day

GSS Global *Salmonella* Surveillance

IEC International Electrotechnical Commission

ISO International Standards Organization

LFZ Laboratory for Foodborne Zoonoses

mCCDA Modified cefoperazone charcoal deoxycholate agar

MHB Mueller Hinton broth

MIC Minimum inhibitory concentration

MSRV Modified semi-solid Rappaport Vassiliadis

NA Not available

N/A Not applicable

NC Not classified

NML National Microbiology Laboratory

NPD No prescriptions dispensed

OIÉ Office Internationale des Épizooties (World Organisation for Animal Health)

PHAC Public Health Agency of Canada

PPHL Provincial Public Health Laboratory

PT Phage type

STL *Salmonella* Typing Laboratory

USA United States of America

VDD Veterinary Drugs Directorate

Antimicrobials

AMC	Amoxicillin-clavulanic acid
AMK	Amikacin
AMP	Ampicillin
AZM	Azithromycin
CHL	Chloramphenicol
CIP	Ciprofloxacin
CLI	Clindamycin
CRO	Ceftriaxone
DAP	Daptomycin
ERY	Erythromycin
FLR	Florfenicol
FOX	Cefoxitin
GEN	Gentamicin
KAN	Kanamycin
LIN	Lincomycin
LNZ	Linezolid
NAL	Nalidixic acid
NIT	Nitrofurantoin
PEN	Penicillin
QDA	Quinupristin-dalfopristin
SSS	Sulfisoxazole
STR	Streptomycin
SXT	Trimethoprim-sulfamethoxazole
TEL	Telithromycin
TET	Tetracycline
TIG	Tigecycline
TIO	Ceftiofur
TYL	Tylosin
VAN	Vancomycin

Canadian Provinces/Region and Territories

AB	Alberta
BC	British Columbia
MB	Manitoba
NB	New Brunswick
NL	Newfoundland and Labrador
NS	Nova Scotia
NT	Northwest Territories
NU	Nunavut
ON	Ontario
PEI	Prince Edward Island
QC	Québec
SK	Saskatchewan
YT	Yukon Territory

Maritimes region:

New Brunswick, Nova Scotia, and Prince Edward Island

Glossary

Antimicrobial: Substance (including natural and synthetic products) that kills or inhibits the growth of organisms such as bacteria, fungi, viruses, or parasites. Throughout this report, the term “antimicrobial” is used to refer only to drugs effective against bacteria.

Antimicrobial resistance: Observed when the minimum inhibitory concentration of an antimicrobial is equal to or greater than the defined resistance breakpoint. Resistant bacteria are able to withstand the effects of an antimicrobial principally through 1 of these 4 mechanisms: 1) drug inactivation or modification by enzyme production, 2) adaptation of bacterial metabolism, 3) structural modification of antimicrobial targets, and 4) mechanisms to decrease drug permeability or increase drug elimination. Moreover, some bacteria have natural (or intrinsic) resistance to certain antimicrobials.

Co-resistance: Coexistence of 2 or more genes or mutations in the same bacterial strain, each of which confers resistance to a different class of drug. Also designated “associated resistance" (Aarestrup, 2006).

Cross-resistance: Situation in which resistance to 1 drug is associated with resistance to another drug, and that resistance is attributable to a single biochemical mechanism (Aarestrup, 2006). For more details, see Appendix C.3 in the 2005 CIPARS Annual Report.

Defined daily doses (DDDs): Statistical measure of drug consumption developed by the World Health Organization to standardize comparisons of drug usage at international and other levels, independently of cost or drug formulation.

Minimum inhibitory concentration (MIC): Lowest antimicrobial concentration required to inhibit bacterial growth after an overnight in vitro incubation. The MIC is used to confirm or monitor antimicrobial resistance in bacteria. Resistance is said to exist when the MIC is higher than the defined breakpoint of resistance for a given bacterial isolate.

Multidrug resistance: Used in this report to describe resistance to more than 1 structurally-unrelated class of antimicrobials in a given bacteria isolate, regardless of the resistance mechanisms involved. Multidrug resistance (also referred to as multiple drug resistance or multiresistance) can result from bacterial mechanisms of cross-resistance and/or co-resistance. For more details, see the 2005 CIPARS Annual Report, Appendix C.3.

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