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Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)

Annual Report

2009

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

Canada

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National Library of Canada Cataloguing in Publication:

Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) – 2009 Annual Report

Également disponible en français sous le titre:

Programme intégré canadien de surveillance de la résistance aux antimicrobiens (PICRA) – Rapport Annuel 2009

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Printed ISSN: 1910-4286

Online ISSN: 1925-9859

Government of Canada. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2009 Annual Report. Guelph, Ontario: Public Health Agency of Canada, 2013.

To the memory of our dear friend and colleague,
Dr. Lucie Dutil

"We are who we are today because of Lucie; an instrumental founding member of CIPARS. She is deeply missed and will never be forgotten."

Contributors to CIPARS 2009

These acknowledgements are intended to identify and thank the numerous individuals and organizations that have contributed to the success of CIPARS 2009.

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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 (J.T. McClure, Matthew Saab, Cynthia Mitchell, and Anne Muckle)
- Carol McClure, Prince Edward Island
- Prince Edward Island Food Technology Centre
- Centre for Coastal Health, British Columbia

We also thank the following health unit managers, public health inspectors, and environmental health officers: Ken Ast, Lucy Beck, Bob Bell, Christopher Beveridge, Ingo Frankfurt, Jim Green, Paul Harl, Iqbal Kalsi, Robyn Land, Sharlene Lively, Carla Plotnikoff, Colin Poirer, Chasch Ray, Shawna Scafe, Matthew Shumaker, Russell Seltenrich, and Pearly Yip.

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 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 the 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 United States National Antimicrobial Resistance Monitoring System for sharing information and facilitating harmonization with CIPARS.

We would also like to thank the following individuals and organizations for their contribution to CIPARS 2009.

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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. CIPARS highlights antimicrobials considered to be of very high importance in human medicine (Category I of the antimicrobial classification system of the Veterinary Drugs Directorate, Health Canada), such as ciprofloxacin and ceftriaxone.

With respect to human antimicrobial use, overall consumption in 2009 remained similar to trends observed in 2008, as measured by prescription dispensing rates and defined daily doses (DDDs)/1,000 inhabitant-days. However, the total oral antimicrobial expenditure continued to increase compared with that in previous years. Category I antimicrobials continued to represent a high percentage (17%) of the total DDDs dispensed. There were provincial differences with respect to oral antimicrobial consumption, with higher consumption in Newfoundland and Labrador and lower consumption in Québec. Differences in antimicrobial consumption were observed for fluoroquinolones, penicillins with extended spectrum, first-generation cephalosporins, and macrolides, among others. When the total amount of oral antimicrobials dispensed in Canada in 2008 was compared with the total outpatient antimicrobial use in 30 European countries in the same year, Canada ranked 14th out of the 31 countries classified by increasing level of total antimicrobial consumption.

For antimicrobial use in animals, surveillance of sentinel swine herds (grower-finisher pigs) in 2009 revealed that antimicrobials had been used in 89% of the herds. The most commonly used antimicrobials overall were penicillins, which were administered primarily via drinking water or injection. Macrolides were the most common antimicrobials administered through feed. The only Category I antimicrobial used was ceftiofur, which was administered via injection to individual animals in 19% of the herds. At the herd level, ceftiofur use in 2009 represented a 10% and 2% decrease compared with use in 2007 and 2008, respectively. Antimicrobial use in 2009 was more common via feed (76%) and injection (52%) than through water (26%). Data from the Canadian Animal Health Institute regarding total kilograms of veterinary antimicrobials distributed for sale for all animal species indicated a total of 1,633,337 kg was distributed in 2009. This represents a decrease of 8% from the total in 2006 and an increase of 1% over the total in 2008. The quantity of fluoroquinolones distributed for use in animals in 2009 decreased by 33% relative to the 2006 total and decreased by 4% relative to the 2008 total.

Among the 3,394 human clinical isolates submitted for susceptibility testing in 2009, the 3 most commonly detected *Salmonella* serovars were Enteritidis, Typhimurium, and Heidelberg. The prevalence of resistance to the Category I antimicrobial ceftriaxone (and generally with cross-resistance to ceftiofur and amoxicillin-clavulanic acid) among *S*. Heidelberg isolates continued to remain higher (14%) than in other serovars. The percentage of isolates with reduced susceptibility or resistance to ciprofloxacin ranged from 0% to 5%, with the exception of serovars Paratyphi A (87%), Typhi (76%), and Enteritidis (11%).

Beginning in 2008 in Saskatchewan and in 2009 in both British Columbia and Saskatchewan, an emerging trend (i.e. greater than 10% prevalence) was evident in ciprofloxacin-resistant *Campylobacter* isolated from retail chicken. This was is in contrast to findings of other Canadian studies of comparable scope and to CIPARS data from previous years and other provinces, in which the prevalence was less than 6%.[1] The increase in the prevalence of fluoroquinolone resistance is suggestive of extra-label use of fluoroquinolones in the broiler or broiler-breeder chicken sectors. To notify stakeholders of this concern, CIPARS issued a surveillance bulletin highlighting the issue in mid 2011.[2]

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[1] Deckert A, Valdivieso-Garcia A, Reid-Smith R et al. Prevalence and antimicrobial resistance in *Campylobacter* spp. isolated from retail chicken in two health units in Ontario. J Food Prot 2010;73:1317-24.

[2] Available at: www.phac-aspc.gc.ca/cipars-picra/bulletin-eng.php. Accessed April 2012.

At the time of writing, beef cattle are the only food animal commodity for which fluoroquinolones are labelled for use in Canada (subsequent to this date fluoroquinolones have been approved for use in pigs). To monitor resistance related to this labelled use in beef cattle, CIPARS conducts surveillance of *Campylobacter* isolated from beef cattle at abattoirs. In 2009, ciprofloxacin resistance was detected in 1 *Campylobacter* isolate.

Additional temporal variations of note in 2009 were primarily detected among bacterial isolates from retail chicken. In Québec, the prevalence of ceftiofur resistance continued to rise in *E. coli* from retail chicken and was significantly higher in 2009 than in 2006 (the last year of ceftiofur voluntary withdrawal). This significant increase likely resulted from the resumption of extra-label ceftiofur use by broiler chicken hatcheries in early 2007. Resistance to ampicillin in *E. coli*, from retail chicken from Québec, was also more prevalent in 2009 than in 2006, and resistance to streptomycin and tetracycline were each more prevalent in 2009 than in 2008.

In *Salmonella* from retail chicken from Québec, ampicillin resistance was more prevalent in 2009 than in 2006 and the prevalence of ceftiofur resistance was lower to that in 2004. In Ontario, ceftiofur and ampicillin resistance was less prevalent in 2009 than in 2004 and streptomycin resistance was more prevalent in 2009 than in 2003. In *E. coli* from retail chicken from Ontario, the prevalence of resistance to trimethoprim-sulfamethoxazole was higher in 2009 than in 2003. In Saskatchewan, ampicillin resistance in *Salmonella* was more prevalent in 2009 than in 2008 and ceftiofur resistance was more prevalent in *E. coli* in 2009 than in 2005. Also in Saskatchewan in 2009, the prevalence of resistance to erythromycin and tylosin were each significantly higher in *Enterococcus* isolated from retail chicken than in 2005. In British Columbia in 2009, resistance to nalidixic acid and tetracycline in *Campylobacter* from retail chicken were both more prevalent than in 2008 and resistance to nalidixic acid was more prevalent than in 2007. *Salmonella* isolates obtained from chickens at abattoirs in 2009 had a significant increase in the prevalence of ceftiofur and ampicillin resistance, compared with the prevalence in 2006.

For pigs, significant temporal variations included a higher prevalence in 2009 of streptomycin resistance in *E. coli* isolated from retail pork from Ontario, compared with the prevalence in 2008. Across all participating provinces, streptomycin resistance was significantly more prevalent in *E. coli* isolated from pigs at abattoirs in 2009 than in 2008. Among *Enterococcus* isolated from pigs, lincomycin and tetracycline resistance were each more prevalent in 2009 than in 2006. There were no significant temporal increases in the prevalence of antimicrobial resistance in *Campylobacter* and *E. coli* isolated from beef cattle. Also important to note, vancomycin resistance was not detected in any of the *Enterococcus* isolates obtained from retail chicken or pigs on farms.

For veterinary clinical isolates, which reflect antimicrobial resistance from an animal health perspective (sick animals) and potentially emerging resistance patterns, reduced susceptibility to ciprofloxacin was detected in *Salmonella* from chickens and horses. Similar to 2008 findings, 35% of isolates from horses had a reduced susceptibility to ciprofloxacin; however, none of these isolates were resistant to nalidixic acid.

Of particular concern in 2009, isolates with joint reduced susceptibility to ciprofloxacin and resistance to ceftriaxone were detected in retail chicken (in both *Salmonella* and *E. coli* isolates, with a prevalence as high as 8% for *E. coli*), in retail beef (1 *E. coli* isolate), and in a clinical horse isolate (1 *Salmonella* isolate).

CIPARS is continually evolving to provide a better understanding of the ecology of antimicrobial resistance in Canada. The program currently has a pilot project in the broiler chicken sector to capture antimicrobial use information and isolates for antimicrobial susceptibility testing as a potential model for a future national farm surveillance program for broiler chicken. CIPARS, as a research platform, has involvement in projects studying aspects of antimicrobial use and resistance not covered by routine core surveillance. Examples include evaluation of risk factors for macrolide and fluoroquinolone use in people and studies of wild animals as sentinels of antimicrobial resistance.

Summary of antimicrobial resistance surveillance findings for bacterial isolates from humans and the agri-food sector, 2009.

Species	Bacterial species	Number (%) of isolates resistant				
		Resistance to 1 or more antimicrobials	Resistance to 5 or more antimicrobials[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*	862/3,394 (25%)	249/3,394 (7%)	AMC: 91/3,394 (3%) TIO: 99/3,394 (3%) CRO: 99/3,394 (3%) CIP: 10/3,394 (< 1%)	NAL: 339/3,394 (10%) RSCIP: 360/3,394 (11%)	104/862
Retail Meat Surveillance						
Beef	*Escherichia coli*	124/652 (19%)	16/652 (2%)	AMC: 8/652 (1%) TIO: 5/652 (1%) CRO: 6/652 (1%)	NAL: 1/652 (< 1%) RSCIP: 2/652 (< 1%)	37/124
Chicken	*Salmonella*	242/473 (51%)	102/473 (22%)	AMC: 101/473 (21%) TIO: 104/473 (22%) CRO: 104/473 (22%)		27/242
	Escherichia coli	464/626 (74%)	201/626 (32%)	AMC: 173/626 (28%) TIO: 156/626 (25%) CRO: 166/626 (27%)	NAL: 25/626 (4%) RSCIP: 26/626 (4%)	101/464
	Campylobacter	183/325 (56%)	32/325 (10%)	CIP: 32/325 (10%) TEL: 10/325 (3%)	N/A	11/183
	Enterococcus	416/459 (91%)	81/459 (18%)	CIP: 12/459 (3%)	N/A	48/459
Pork	*Escherichia coli*	139/325 (43%)	21/325 (6%)	AMC: 2/325 (1%) TIO: 1/325 (< 1%) CRO: 1/325 (< 1%)	NAL: 1/325 (< 1%) RSCIP: 1/325 (< 1%)	43/139
Abattoir Surveillance						
Beef cattle	*Escherichia coli*	43/119 (36%)				13/43
	Campylobacter	49/86 (57%)		CIP: 1/86 (1%)	N/A	4/86
Chickens	*Salmonella*	124/230 (54%)	53/230 (23%)	AMC: 53/230 (23%) TIO: 53/230 (23%) CRO: 53/230 (23%)	NAL: 1/230 (< 1%) RSCIP: 1/230 (< 1%)	19/124
	Escherichia coli	124/171 (73%)	60/171 (35%)	AMC: 54/171 (32%) TIO: 49/171 (29%) CRO: 53/171 (31%)	NAL: 8/171 (5%) RSCIP: 7/171 (4%)	62/124
Pork	*Salmonella*	75/147 (51%)	22/147 (15%)			22/75
	Escherichia coli	138/160 (86%)	18/160 (11%)	AMC: 2/160 (1%) TIO: 2/160 (1%) CRO: 2/160 (1%)		42/138
Farm Surveillance						
Pigs	*Salmonella*	88/124 (71%)	23/124 (19%)			19/88
	Escherichia coli	1,721/2,057 (84%)	211/2,057 (10%)	AMC: 24/2,057 (1%) TIO: 3/2,057 (< 1%) CRO: 3/2,057 (< 1%) CIP: 1/2,057 (< 1%)	NAL: 4/2,057 (< 1%) RSCIP: 2/2,057 (< 1%)	118/1,721
	Enterococcus	1,849/1,912 (97%)	156/1,912 (8%)	CIP: 39/1,912 (2%)	N/A	98/1,849
Surveillance of Animal Clinical Isolates						
Cattle	*Salmonella*	82/131 (63%)	57/131 (44%)	AMC: 10/131 (8%) TIO: 10/131 (8%) CRO: 10/131 (8%)		18/82
Pigs	*Salmonella*	170/226 (75%)	84/226 (37%)	AMC: 8/226 (4%) TIO: 9/226 (4%) CRO: 9/226 (4%)		38/170
Chickens	*Salmonella*	62/280 (22%)	27/280 (10%)	AMC: 24/280 (9%) TIO: 25/280 (9%) CRO: 25/280 (9%)	NAL: 3/280 (1%) RSCIP: 4/280 (1%)	16/62
Turkeys	*Salmonella*	29/60 (48%)	16/60 (27%)	AMC: 16/60 (27%) TIO: 16/60 (27%) CRO: 16/60 (27%)		14/29
Horses	*Salmonella*	17/23 (74%)	10/23 (43%)	AMC: 1/23 (4%) TIO: 1/23 (4%) CRO: 2/23 (9%)	RSCIP: 8/23 (35%)	9/17

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 of 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 8th 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 2009 Activities

In 2009, 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 were forwarded to the National Microbiology Laboratory.
- *Retail Meat Surveillance* involved active sample collection and antimicrobial susceptibility testing of generic *Escherichia coli*,[1] *Salmonella*, *Campylobacter,* and *Enterococcus* in retail chicken,[2] and of *E. coli* in retail beef and pork from British Columbia, Saskatchewan, Ontario, Québec, and the

[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.
[2] *Enterococcus* isolates recovered from retail chicken from the Maritimes region underwent antimicrobial susceptibility testing, but results are not presented in this report because of concerns surrounding harmonization of laboratory methods for 2009.

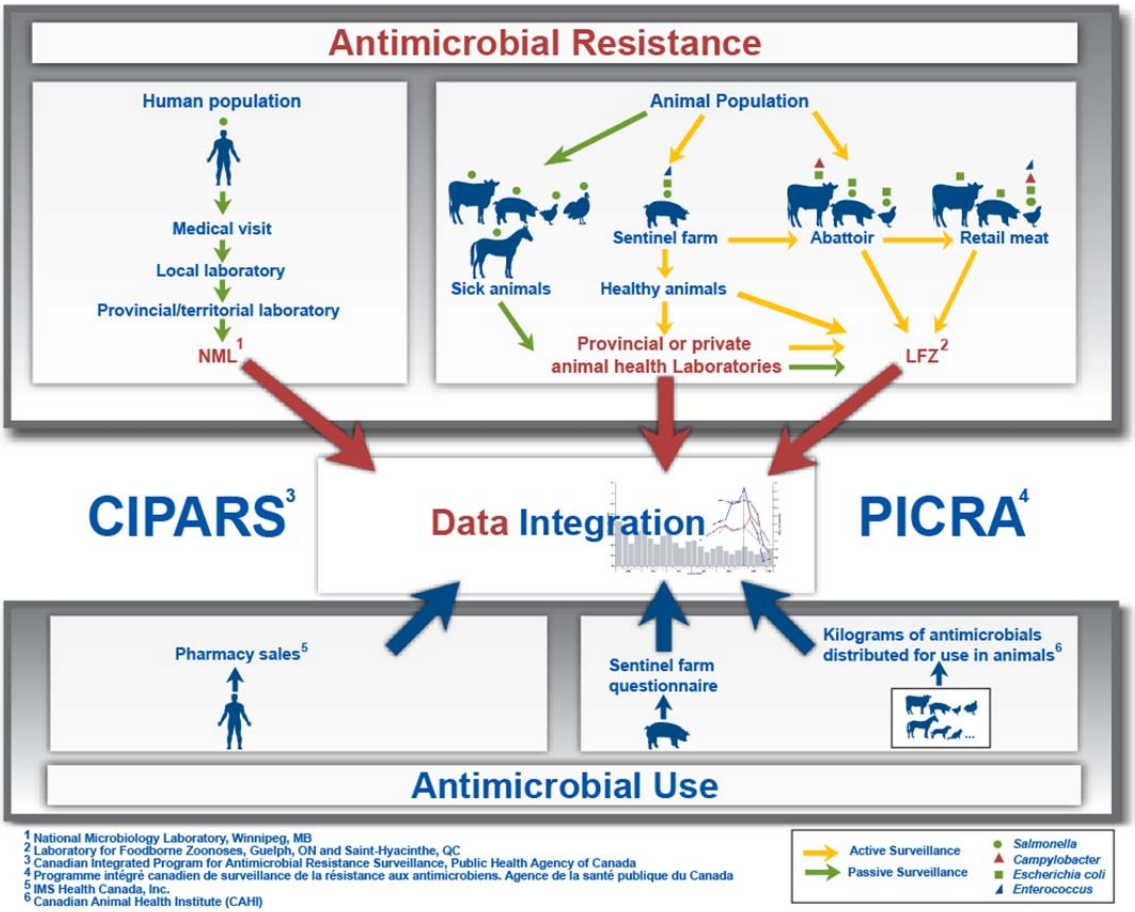
Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island).

- *Abattoir Surveillance* involved active collection of caecal contents from healthy chickens, pigs, and cattle from across Canada as they entered the food supply. Antimicrobial susceptibility testing was carried out on isolates of *Salmonella* (chickens and pigs), *Campylobacter* (cattle), and generic *E. coli* (chickens, pigs, and cattle).
- *Farm Surveillance* involved swine herds in the 5 major pork-producing provinces of Canada (Alberta, Saskatchewan, Manitoba, Ontario, and Québec). A sentinel farm framework was used to organize the active collection of pooled fecal samples from grower-finisher 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 local or provincial laboratories and 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. 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.
- *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 dataset provided by IMS Health Canada, Inc. for the years 2000 through 2009. This dataset contains information on prescriptions for oral antimicrobials dispensed by Canadian retail pharmacies.
- Antimicrobial use surveillance in pigs included herd demographic and antimicrobial use data obtained through questionnaires 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 (CAHI) and analysed by Impact Vet for 2006 through 2009. 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 activities in 2009.



What's New in the 2009 Report

Changes to CIPARS Surveillance Components

- Unlike in previous years, antimicrobial resistance among human *Salmonella* Newport isolates is not highlighted in this year's report because most of the *S.* Newport isolates obtained in 2009 were susceptible to all antimicrobials tested. Results for this serovar are included in the "Other Serovars" category in Section One.

Methodological Changes

- The *Enterococcus* CMV2AGPF plate used for antimicrobial susceptibility testing was replaced with the CMV3AGPF plate. This new plate does not include flavomycin (Category IV antimicrobial) and the range of dilutions tested was increased for daptomycin, vancomycin, erythromycin, penicillin, quinupristin-dalfopristin, and tetracycline.

Important Notes

Antimicrobial Groupings

- 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 Veterinary Drugs Directorate (VDD), Health Canada (categories revised in April 2009; Appendix A).
    - All Category I antimicrobials (Very High Importance in Human Medicine) used in susceptibility testing are highlighted throughout the report. These antimicrobials include amoxicillin-clavulanic acid, ceftiofur,[1] ceftriaxone, ciprofloxacin, daptomycin, linezolid, telithromycin, and vancomycin.
    - Antimicrobials are generally listed first according to this classification and then alphabetically.
- ATC class: For human antimicrobial use data, antimicrobials have been classified by the international standard Anatomic Therapeutic Chemical (ATC) class system[2] in addition to the category of importance in human medicine.
- CAHI aggregate class: Data on the distribution of antimicrobials for use in animals were provided to CIPARS by CAHI in aggregate 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, specific antimicrobials were selected 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.

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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 Collaborating Center for Drug Statistics Methodology. Available at: www.whocc.no/atc_ddd_index/. Accessed April 2012.

[3] The current CLSI resistance breakpoint for this antimicrobial and the one adopted in this report is ≥ 4 µg/mL. However, the Danish Integrated Antimicrobial Resistance Monitoring and Research Program (DANMAP) has used a resistance breakpoint of ≥ 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 with 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] The MIC is the lowest concentration of an antimicrobial that inhibits visible bacterial growth after incubation.

- 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.[1] 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* and *E. coli*.

Additional Notes

- Temporal variations: In general, temporal variations in the percentage of isolates resistant to the selected antimicrobials were identified by comparing results for 2009 with those for 2003 (the year most surveillance components of CIPARS began) and with those for the previous year (2008).
    - 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[2] 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: In the report, the definition of "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).
- Detailed tables and figures are provided in the human antimicrobial use section for antimicrobial classes in which consumption consisted of more than 10% of the total number of defined daily doses (DDDs) per 1,000 inhabitant-days of oral antimicrobials dispensed by retail pharmacies in Canada.

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[1] "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)

[2] 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 April 2012.

- Provincial level comparisons are presented for antimicrobials used in the treatment of respiratory illness and urinary tract infections in humans.
- *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.

Section One – Antimicrobial Resistance

Humans

Salmonella

Throughout 2009, the Provincial Public Health Laboratories forwarded a total of 3,413 *Salmonella* isolates (171 serovars) to the National Microbiology Laboratory, Public Health Agency of Canada, Winnipeg, Manitoba for phage typing and susceptibility testing (see Appendix A). No *Salmonella* isolates were submitted to CIPARS by the territories (Yukon, Northwest Territories, and Nunavut) in 2009, whether directly or through Public Health Laboratories. Because duplicate submissions or records were received for 19 isolates, the final analysis was conducted on 3,394 isolates.

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 typically 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]

Human patients aged 30 to 49 years represented the most common age group for which *Salmonella* isolates were submitted (11%, 378/3,394; Table C.1 and Appendix C). Ontario was the province from which the largest proportion of isolates was received (36%, 1,225/3,394).

Salmonella Enteritidis

(n = 1,092)

The provincial incidence rates of *Salmonella* Enteritidis detection in humans varied from 1.28 to 7.53 (median = 4.25) cases per 100,000 inhabitant-years (see Appendix A for formula). The most common phage types (PTs) recovered from samples were PT 8 (37%, 403/1,092), PT 13a (14%, 155/1,092), PT 13 (12%, 128/1,092), PT 1 (7%, 79/1,092), and PT 5b (7%, 71/1,092). Three percent (37/1,092) of isolates were recovered from blood, and 2% (21/1,092) were recovered from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in

Table 1 and Table B.1, Appendix B. Resistance to ceftiofur, ceftriaxone, and ciprofloxacin were each detected in less than 1% (1/1,092) of *S.* Enteritidis isolates. Reduced susceptibility to ciprofloxacin was detected in 11% (115/1,092) of isolates. Resistance to nalidixic acid was detected in 10% (112/1,092). No isolates were resistant to amoxicillin-clavulanic acid, amikacin, or cefoxitin.

Antimicrobial Resistance Patterns: Results are presented in Table 7, Table C.3, and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 13% (144/1,092) of *S*. Enteritidis isolates. Resistance to 4 or more antimicrobial classes was detected in less than 1% (8/1,092) of isolates. The most common resistance pattern was NAL (8%, 92/1,092). This resistance pattern was mainly detected among PT 1 isolates (67%, 62/92) and PT 4 isolates (9%, 8/92). The combination of reduced susceptibility to ciprofloxacin, or resistance to nalidixic acid, and resistance to ceftriaxone were both detected in 1 isolate (PT 6a). Less than 1% (5/1,092) of isolates (2 PT 5b, 2 untypable isolates and 1 PT 23) with reduced susceptibility to ciprofloxacin were not resistant to nalidixic acid. The pattern involving the greatest number of antimicrobials was AMP-CHL-CIP-GEN-NAL-SSS-TET (1 PT 51).

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[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 severe, typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate+ is commonly associated with gastrointestinal illness and because animals can be a source of this serovar, it is included under "Other Serovars."

[2] Public Health Agency of Canada, Material Safety Data Sheet – Infectious Substances. Available at www.phac-aspc.gc.ca/msds-ftss/msds133e.html. Accessed April 2012.

Fourteen percent (5/37) of blood isolates and 5% (1/21) of urine isolates were resistant to 1 or more antimicrobial classes. In these isolates, NAL was the most common resistance pattern, detected in 4 blood isolates and the 1 urine isolate.

Temporal Variations: Results are presented in Figure 2. The percentage of *S*. Enteritidis isolates with nalidixic acid resistance was significantly lower in 2009 (10%, 112/1,092) than in 2003 (19%, 66/352). The percentage of isolates with trimethoprim-sulfamethoxazole resistance was significantly lower in 2009 (less than 1%, 2/1,092) than in 2003 (1%, 5/352). The percentage of isolates with streptomycin resistance was significantly higher in 2009 (2%, 27/1,092) than in 2008 (less than 1%, 11/1,258). No other significant temporal variations between 2009 and 2003 or between 2009 and 2008 were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, resistance to ceftiofur, ceftriaxone, and ciprofloxacin were each detected in less than 1% (1/1,092) of human *Salmonella* Enteritidis isolates. The percentage of *S*. Enteritidis isolates with nalidixic acid resistance was significantly lower in 2009 (10%, 112/1,092) than in 2003 (19%, 66/352). The percentage of isolates with trimethoprim-sulfamethoxazole resistance was also significantly lower in 2009 (less than 1%, 2/1,092) than in 2003 (1%, 5/352).

Table 1. Resistance to antimicrobials in *Salmonella* Enteritidis isolates; *Surveillance of Human Clinical Isolates*, 2009.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 208	n = 94	n = 72	n = 92	n = 369	n = 167	n = 39	n = 36	n = 5	n = 10	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ceftiofur	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ceftriaxone	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ampicillin	5 (2)	2 (2)	0 (0)	2 (2)	9 (2)	5 (3)	0 (0)	1 (3)	0 (0)	0 (0)	2
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Gentamicin	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Kanamycin	1 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Nalidixic acid	25 (12)	12 (13)	4 (6)	10 (11)	39 (11)	12 (7)	3 (8)	6 (17)	1 (20)	0 (0)	10
	Streptomycin	6 (3)	5 (5)	5 (7)	3 (3)	5 (1)	2 (1)	0 (0)	1 (3)	0 (0)	0 (0)	2
	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)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Sulfisoxazole	3 (1)	1 (1)	0 (0)	2 (2)	5 (1)	5 (3)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Tetracycline	4 (2)	1 (1)	0 (0)	1 (1)	6 (2)	4 (2)	0 (0)	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.
Provincial abbreviations are defined in Appendix D
[a] Estimated percentage for Canada corrected for non-proportional submission protocols among provinces, whereas percentage in the text represent crude estimates (See Appendix A).

Salmonella Heidelberg

(n = 381)

Provincial incidence rates of *Salmonella* Heidelberg detection in humans varied from 0.38 to 3.93 (median = 1.37) cases per 100,000 inhabitant-years. The most common phage types were PT 19 (46%, 177/381), PT 2 (9%, 33/381), and PT 29 (8%, 32/381). Twelve percent (44/381) of isolates were cultured from blood, and 5% (20/381) 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 ceftiofur and ceftriaxone were each detected in 14% (53/381) of *S*. Heidelberg isolates. Resistance to amoxicillin-clavulanic acid was detected in 12% (46/381) of isolates. Reduced susceptibility to ciprofloxacin was detected in 1% (2/381), as was resistance to nalidixic acid (2/381). No isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Tables C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 37% (141/381) of *S*. Heidelberg isolates. Resistance to 4 or more antimicrobial classes was detected in 1% (3/381) of isolates. The most common resistance pattern was AMP (13%, 49/381), which was most prevalent among PT 19 isolates from Ontario (44%, 14/32). Reduced susceptibility to ciprofloxacin and resistance to ceftriaxone or nalidixic acid were detected in 1% (2/381; PT 29). The patterns involving the greatest number of antimicrobials were AMP-CHL-KAN-STR-SSS (1 PT 10), AMP-GEN-KAN-STR-SSS (1 PT 32), and AKSSuT-GEN (1 PT 2).

Fifty percent (22/44) of blood isolates and 30% (6/20) urine isolates were resistant to 1 or more antimicrobial classes. The most common resistance pattern, AMP, was detected in 30% (13/44) of blood isolates (8 PT 19, 2 PT 2, 2 PT 51, and 1 PT 18) and in 10% (2//20) of urine isolates (PT 19 and PT 2).

Temporal Variations: Results are presented in Figure 2. Percentages of *S*. Heidelberg isolates with resistance to streptomycin and tetracycline were significantly lower in 2009 (7%, [27/381] and 5% [20/381], respectively) than in 2003 (12% [72/608] and 15% [93/608], respectively). No other significant temporal variations were detected between 2009 and 2003. In other comparisons, the percentage of isolates with resistance to ceftiofur was significantly lower in 2009 (14%, 53/381) than in 2004 (33%, 181/556).[1] Similarly, the percentage of isolates with resistance to ampicillin was significantly lower in 2009 (33%, 125/381) than in 2004 (45%, 250/556). Between 2009 and 2008, no significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, resistance to ceftiofur in human *Salmonella* Heidelberg isolates was significantly lower in 2009 (14%, 53/381) than in 2004 (33%, 181/556). Resistance to ceftriaxone was detected in 14% (53/381) of isolates. Percentages of isolates with resistance to streptomycin and tetracycline were significantly lower in 2009 (7%, [27/381] and 5% [20/381], respectively) than in 2003 (12% [72/608] and 15% [93/608], respectively). Similarly, the percentage of isolates with resistance to ampicillin was significantly lower in 2009 (33%, 125/381) than in 2004 (45%, 250/556).

[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 2. Resistance to antimicrobials in *Salmonella* Heidelberg isolates; *Surveillance of Human Clinical Isolates*, 2009.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 17	n = 38	n = 15	n = 48	n = 112	n = 100	n = 24	n = 18	n = 3	n = 6	%
I	Amoxicillin-clavulanic acid	0 (0)	4 (11)	3 (20)	5 (10)	13 (12)	10 (10)	4 (17)	7 (39)	0 (0)	0 (0)	11
	Ceftiofur	0 (0)	7 (18)	4 (27)	8 (17)	13 (12)	10 (10)	4 (17)	7 (39)	0 (0)	0 (0)	13
	Ceftriaxone	0 (0)	7 (18)	4 (27)	8 (17)	13 (12)	10 (10)	4 (17)	7 (39)	0 (0)	0 (0)	13
	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	2 (12)	20 (53)	6 (40)	9 (19)	39 (35)	33 (33)	5 (21)	11 (61)	0 (0)	0 (0)	34
	Cefoxitin	0 (0)	4 (11)	3 (20)	5 (10)	13 (12)	10 (10)	4 (17)	7 (39)	0 (0)	0 (0)	11
	Gentamicin	0 (0)	1 (3)	0 (0)	0 (0)	8 (7)	6 (6)	0 (0)	0 (0)	0 (0)	0 (0)	5
	Kanamycin	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	1 (6)	0 (0)	0 (0)	< 1
	Nalidixic acid	0 (0)	0 (0)	1 (7)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
	Streptomycin	1 (6)	4 (11)	0 (0)	2 (4)	9 (8)	8 (8)	1 (4)	1 (6)	0 (0)	1 (17)	8
	Trimethoprim-sulfamethoxazole	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	1 (17)	< 1
III	Chloramphenicol	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (6)	0 (0)	0 (0)	< 1
	Sulfisoxazole	1 (6)	3 (8)	0 (0)	0 (0)	9 (8)	8 (8)	0 (0)	1 (6)	0 (0)	1 (17)	7
	Tetracycline	2 (12)	5 (13)	2 (13)	3 (6)	3 (3)	4 (4)	0 (0)	0 (0)	0 (0)	1 (17)	5
IV												

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

Salmonella Paratyphi A and Paratyphi B

(n = 54)

The combined provincial incidence rates of *Salmonella* Paratyphi A and *S*. Paratyphi B[1] detection in humans varied from 0 to 0.40 (median = 0.12) cases per 100,000 inhabitant-years. No isolates of either serovar were submitted from Manitoba, Newfoundland and Labrador, or Prince Edward Island. Phage typing is not applicable to Paratyphi A isolates.

Among all 8 isolates of *S*. Paratyphi B, phage types included atypical (4/8), Battersea (1/8), Dundee (1/8), Dundee var. 2 (1/8), and untypable (1/8). Eighty percent (37/46) of *S*. Paratyphi A isolates were cultured from blood, and none were cultured from urine. Two *S*. Paratyphi B isolates were cultured from blood, and none were cultured from urine (Table C.2, Appendix C).

Antimicrobial Resistance: Results are presented in Table 3 and Table B.3, Appendix B. Reduced susceptibility to ciprofloxacin was detected in 87% (40/46) of *S*. Paratyphi A isolates. Reduced susceptibility to ciprofloxacin was not detected in any *S*. Paratyphi B isolate. Resistance to nalidixic acid was detected in 87% (40/46) of *S*. Paratyphi A isolates. No *S*. Paratyphi A and *S*. Paratyphi B isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, gentamicin, kanamycin, or trimethoprim-sulfamethoxazole.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Tables C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 87% (40/46) of *S*. Paratyphi A isolates and in 2 of 8 *S*. Paratyphi B isolates. Resistance to 4 or more antimicrobial classes was not detected in any of the *S*. Paratyphi A isolates but was observed in 1 *S*. Paratyphi B isolate. The most common resistance pattern among *S*. Paratyphi A isolates was NAL. The pattern involving the greatest number of antimicrobials for both serovars was ACSSuT (1 Paratyphi B, PT atypical).

[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 negative and associated with severe, typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate+ is commonly associated with gastroenteritidis and is included in the "Other serovars" category.

Among blood isolates of both serovars, the most common resistance pattern was NAL, which was detected in 82% (32/39) of isolates.

Temporal Variations: Results are presented in Figure 3. Between 2009 and 2003 and between 2009 and 2008, no significant temporal variations were detected in the percentages of *S*. Paratyphi A and B isolates with resistance to the selected antimicrobials.

In 2009, reduced susceptibility to ciprofloxacin was detected in 87% (40/46) of human *Salmonella* Paratyphi A isolates but not in any (0/8) *S*. Paratyphi B isolate. Resistance to nalidixic acid was detected in 87% (40/46) of *S*. Paratyphi A isolates.

Table 3. Resistance to antimicrobials in *Salmonella* Paratyphi A and *S*. Paratyphi B isolates; *Surveillance of Human Clinical Isolates*, 2009.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 18	n = 5	n = 2	n = 0	n = 19	n = 8	n = 1	n = 1	n = 0	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	0 (0)			0
	Ceftiofur	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
	Ciprofloxacin	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
	Ampicillin	0 (0)	0 (0)	0 (0)		0 (0)	2 (25)	0 (0)	0 (0)			4
	Cefoxitin	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
	Kanamycin	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	0 (0)			0
	Nalidixic acid	16 (89)	3 (60)	1 (50)		17 (89)	3 (38)	0 (0)	0 (0)			76
	Streptomycin	0 (0)	0 (0)	0 (0)		0 (0)	1 (13)	0 (0)	0 (0)			2
	Trimethoprim-sulfamethoxazole	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	0 (0)			0
III	Chloramphenicol	0 (0)	0 (0)	0 (0)		0 (0)	1 (13)	0 (0)	0 (0)			2
	Sulfisoxazole	0 (0)	0 (0)	0 (0)		0 (0)	1 (13)	0 (0)	0 (0)			2
	Tetracycline	0 (0)	0 (0)	0 (0)		0 (0)	1 (13)	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.
Provincial 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 and is included in the "Other serovars" category.
No *S*. Paratyphi A or *S*. Paratyphi B isolates were received from Manitoba, Prince Edward Island, or Newfoundland and Labrador.
[a] Estimated percentage for Canada corrected for non-proportional submission protocols among provinces, whereas percentage in the text represent crude estimates (See Appendix A).

Salmonella Typhi

(n = 160)

The provincial incidence rate of *Salmonella* Typhi detection in humans varied from 0 to 0.83 cases (median = 0.14) per 100,000 inhabitant-years. No isolates were received from New Brunswick, Nova Scotia, Newfoundland and Labrador, or Prince Edward Island. The most common phage types recovered were PT E1 (29%, 46/160), PT UVS (13%, 20/160), and PT E9 var. (9%, 14/160). The phage type could not be identified for 15% (24/160) of isolates. Seventy-one percent (113/160) of isolates were cultured from blood, and 3 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 2% (3/160) of *S*. Typhi isolates. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 1% (1/160) of isolates. Reduced susceptibility to ciprofloxacin was detected in 76% (121/160). Resistance to nalidixic acid was detected in 78% (124/160). No isolates were resistant to amikacin, gentamicin, or kanamycin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Tables C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 79% (126/160) of *S*. Typhi isolates. Resistance to 4 or more antimicrobial classes was detected in 17% (27/160) of isolates. The most common resistance pattern was NAL (58%, 93/160). This resistance pattern was mainly detected among PT E1 (38%, 35/93) and PT UVS (12%, 11/93). The pattern involving the greatest number of antimicrobials was ACSSuT-NAL-SXT (1 PT E1 and 7 untypable).

For blood isolates, the most common resistance pattern was NAL, which was detected in 61% (69/113) of isolates. For urine isolates, the most common resistance pattern was CIP-NAL, which was detected in 2 isolates.

Temporal Variations: Results are presented in Figure 3. The percentage of *S*. Typhi isolates that were resistant to nalidixic acid was significantly higher in 2009 (78%, 124/160) than in 2003 (44%, 56/127). Between 2009 and 2003 and between 2009 and 2008, no other significant temporal variations were detected.

In 2009, reduced susceptibility to ciprofloxacin was detected in 78% (124/160) of human *Salmonella* Typhi isolates. Resistance to nalidixic acid was detected in 78% (124/160) of isolates. Resistance to 1 or more antimicrobial classes was detected in 79% (126/160). The percentage of *S*. Typhi isolates with resistance to nalidixic acid was significantly higher in 2009 (78%, 124/160) than in 2003 (44%, 56/127).

Table 4. Resistance to antimicrobials in *Salmonella* Typhi isolates; *Surveillance of Human Clinical Isolates*, 2009.

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 37	n = 13	n = 1	n = 9	n = 86	n = 14	n = 0	n = 0	n = 0	n = 0	%
I	Amoxicillin-clavulanic acid	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)					< 1
	Ceftiofur	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)					< 1
	Ceftriaxone	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)					< 1
	Ciprofloxacin	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (14)					2
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)					0
	Ampicillin	2 (5)	9 (69)	0 (0)	1 (11)	14 (16)	3 (21)					18
	Cefoxitin	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)					< 1
	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	31 (84)	12 (92)	1 (100)	8 (89)	64 (74)	8 (57)					77
	Streptomycin	1 (3)	7 (54)	0 (0)	1 (11)	13 (15)	3 (21)					16
	Trimethoprim-sulfamethoxazole	1 (3)	7 (54)	0 (0)	1 (11)	14 (16)	3 (21)					16
III	Chloramphenicol	1 (3)	7 (54)	0 (0)	1 (11)	14 (16)	3 (21)					16
	Sulfisoxazole	1 (3)	9 (69)	0 (0)	1 (11)	15 (17)	3 (21)					18
	Tetracycline	0 (0)	4 (31)	0 (0)	1 (11)	4 (5)	1 (7)					6
IV												

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

Salmonella Typhimurium

(n = 417)

The provincial incidence rates of *Salmonella* Typhimurium detection in humans varied from 0.54 to 3.55 (median = 1.44) cases per 100,000 inhabitant-years. The most common phage types recovered were PT 108 (17%, 71/417), PT 104 (13%, 55/417), PT atypical (13%, 53/417), and PT 2 (6%, 23/417). One percent (5/417) of isolates were cultured from blood, and 2% (8/417) 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, ceftriaxone, and ceftiofur were each detected in 2% (7/417) of *S*. Typhimurium isolates. Reduced susceptibility to ciprofloxacin was detected in 5% (19/417) of isolates. Resistance to nalidixic acid was detected in 3% (11/417). No isolates were resistant to ciprofloxacin or amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Tables C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 33% (139/417) of *S*. Typhimurium isolates. Resistance to 4 or more antimicrobial classes was detected in 24% (98/417) of isolates. The most common resistance pattern was ACSSuT (16%, 66/417), and most isolates with this pattern were PT 104 (71%, 47/66). Resistance to ceftriaxone with reduced susceptibility to ciprofloxacin was detected in less than 1% (2/417) of isolates (1 PT 194 and 1 untypable). Reduced susceptibility to ciprofloxacin without resistance to nalidixic acid was observed in 2% (8/417; 2 PT 120, 2 atypical, 1 PT 104b, 1 PT 194, 1 PT 94, and 1 PT untypable). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-GEN-SXT (1 PT untypable).

For blood isolates, the most common resistance pattern was STR-SSS-TET, which was detected in 1 of 5 isolates (PT atypical). The most common resistance pattern for urine isolates was ACSSuT, which was detected in 1 of 8 isolates (PT U302).

Temporal Variations: Results are presented in Figure 3. Percentages of isolates with resistance to streptomycin and tetracycline were significantly lower in 2009 (26% [109/417] and 28% [118/417], respectively) than in 2003 (39% [234/605)] and 47% [282/605], respectively). The percentage of *S*. Typhimurium isolates with resistance to trimethoprim-sulfamethoxazole was also significantly lower in 2009 (2%, 8/417) than in 2003 (6%, 38/605) and 2008 (5%, 24/474).

In 2009, resistance to 1 or more antimicrobial classes was detected in 33% (139/417) of human *Salmonella* Typhimurium isolates. Resistance to 4 or more antimicrobial classes was detected in 24% (98/417). The most common resistance pattern was ACSSuT (16%, 66/417), and most isolates with this pattern were PT 104 (71%, 47/66). Percentages of isolates with resistance to streptomycin and tetracycline were significantly lower in 2009 (26% [109/417] and 28% [118/417], respectively) than in 2003 (39% [234/605] and 47% [282/605], respectively). The percentage of *S*. Typhimurium isolates with resistance to trimethoprim-sulfamethoxazole was significantly lower in 2009 (2%, 8/417) than in 2003 (6%, 38/605) and 2008 (5%, 24/474).

Table 5. Resistance to antimicrobials in *Salmonella* Typhimurium isolates; *Surveillance of Human Clinical Isolates*, 2009.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 24	n = 45	n = 28	n = 22	n = 194	n = 68	n = 10	n = 13	n = 5	n = 8	%
I	Amoxicillin-clavulanic acid	3 (13)	1 (2)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Ceftiofur	3 (13)	1 (2)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Ceftriaxone	3 (13)	1 (2)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	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 (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	9 (38)	9 (20)	4 (14)	7 (32)	57 (29)	13 (19)	0 (0)	3 (23)	0 (0)	0 (0)	25
	Cefoxitin	3 (13)	1 (2)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2
	Gentamicin	1 (4)	2 (4)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1
	Kanamycin	2 (8)	5 (11)	1 (4)	4 (18)	9 (5)	4 (6)	0 (0)	0 (0)	0 (0)	0 (0)	6
	Nalidixic acid	3 (13)	2 (4)	0 (0)	1 (5)	5 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Streptomycin	8 (33)	15 (33)	3 (11)	6 (27)	57 (29)	14 (21)	3 (30)	3 (23)	0 (0)	0 (0)	27
	Trimethoprim-sulfamethoxazole	3 (13)	0 (0)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)	2
III	Chloramphenicol	7 (29)	9 (20)	2 (7)	3 (14)	50 (26)	13 (19)	0 (0)	2 (15)	0 (0)	0 (0)	22
	Sulfisoxazole	8 (33)	15 (33)	4 (14)	6 (27)	61 (31)	16 (24)	3 (30)	3 (23)	0 (0)	0 (0)	29
	Tetracycline	8 (33)	10 (22)	4 (14)	7 (32)	64 (33)	19 (28)	3 (30)	3 (23)	0 (0)	0 (0)	29
IV												

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

Salmonella "Other Serovars"

(n = 1,290)

The *Salmonella* "Other Serovars" represented 38% (1,290/3,392) of all human *Salmonella* isolates and included 165 different serovars. Five percent (60/1,290) of the isolates were cultured from blood, and 6% (75/1,290) 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 3% (37/1,290) of *Salmonella* "Other Serovars" isolates (19. I 4,[5],12:i:-, 3 Infantis, 2 Agona, 2 Muenchen, 2 Newport, 1 Braenderup, 1 Corvallis, 1 I 6,7:z4,z23:-, 1 I Rough-O:-:-, 1 I Rough-O:r:1,2, 1 Orion, 1 Reading, 1 Stanley, and 1 Worthington). Resistance to ceftiofur and ceftriaxone were each detected in 3% (37/1,290) of the isolates (19 I 4,[5],12:i:-, 3 Infantis, 2 Muenchen, 2 Newport, 1 Agona, 1 Braenderup, 1 Corvallis, 1 I 6,7:z4,z23:-, 1 I Rough-O:-:-, 1 I Rough-O:r:1,2, 1 Mbandaka, 1 Orion, 1 Reading, 1 Stanley, and 1 Worthington). Resistance to ceftriaxone were each detected in 3% (37/1,290) of isolates (19 I 4,[5],12:i:-, 3 Infantis, 2 Muenchen, 2 Newport, 1 Agona, 1 Braenderup, 1 Corvallis, 1 I 6,7:z4,z23:-, 1 I Rough-O:-:-, 1 I Rough-O:r:1,2, 1 Mbandaka, 1 Orion, 1 Reading, 1 Stanley, and 1 Worthington).

Resistance to ciprofloxacin was detected in less than 1% (6/1,290) of isolates (*S*. Kentucky), and reduced susceptibility to ciprofloxacin was detected in 5% (63/1,290), the serovars of which were primarily Kentucky, Stanley, Infantis, Muenchen, Virchow, Blockley, Agona, Corvallis, I 4,[5],12:i:-, I 6,7:-:1,5, I 6,7:c:-, I 6,7:r:-, Nessziona, Paratyphi B var. L(+) tartrate+, Saintpaul, Schwarzengrund, Adelaide, Albany, Braenderup, Bredeney, Cerro, Choleraesuis, Cubana, Derby, Emek, Hadar, Haifa, I 9,12:-:-, I Rough-O:-:-, I Rough-O:d:-, I Vi:d:-, IV 42:z36:-, Indiana, Litchfield, Mbandaka, Senftenberg, and Tennessee. Resistance to nalidixic acid was detected in 4% (50/1,290) of isolates (6 Kentucky, 4 Infantis, 4 Virchow, 3 Blockley, 2 I 4,[5],12:i:-, 2 I 6,7:-:1,5, 2 I 6,7:c:, 2 I 6,7:r:-, 2 Paratyphi B var. L(+) tartrate+, 2 Saintpaul, 2 Senftenberg, 2 Stanley, 1 Adelaide, 1 Agona, 1 Albany, 1 Bredeney, 1 Cerro, 1 Choleraesuis, 1 Cubana, 1 Emek, 1 Hadar, 1 Haifa, 1 I Rough-O:-:-, 1 I Rough-O:d:-, 1 I Vi:d:-, 1 IV 42:z36:-, 1 India, 1 Nessziona, and 1 Schwarzengrund). No isolates were resistant to amikacin.

Antimicrobial Resistance Patterns: Results are presented in Table 7 and Tables C.3 and C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 21% (270/1,290) of *Salmonella* "Other

Serovars" isolates. Resistance to 4 or more antimicrobial classes was detected in 4% (58/1,290) of isolates. The most common resistance pattern was TET (5%, 60/1,290), which was detected in *Salmonella* I 4,[5],12:i:- (70%, 42/60), Hadar (12%, 7/60), Agona (5%, 3/60), Anatum (3%, 2/60), Saintpaul (3%, 2/60), Derby (2%, 1/60), I 4,[5],12:r:- (2%, 1/60), Infantis (2%, 1/60), and Meleagridis (2%, 1/60) isolates. Resistance to ceftriaxone with reduced susceptibility to ciprofloxacin was detected in 1 isolate (Corvallis). Two percent (20/1,290) of isolates (Muenchen, Stanley, Corvallis, Agona, Braenderup, Corvallis, Derby, I 9,12:-:-, Kentucky, Litchfield, Mbandaka, Nessziona, Schwarzengrund, and Tennessee) with reduced susceptibility to ciprofloxacin were not resistant to nalidixic acid. The patterns involving the greatest number of antimicrobials were ACKSSuT-A2C-CRO (1 Infantis) and ACSSuT-A2C-CRO-STX (1 Worthington).

Twenty-five percent (15/60) of blood isolates and 16% (12/75) of urine isolates were resistant to 1 or more antimicrobials. The most common resistance patterns among blood isolates were NAL (5%, 3/60) and A2C-AMP-CRO (3%, 2/60) and among urine isolates were SSS-TET (3%, 2/75), STR-TET (3%, 2/75), and TET (3%, 2/75).

Temporal Variations: Results are presented in Figure 2. Between 2009 and 2003 and between 2009 and 2008, no significant temporal variations were detected in the percentages of *Salmonella* "Other Serovars" with resistance to the selected antimicrobials.

In 2009, resistance to 1 or more antimicrobial classes was detected in 21% (270/1,290) of human *Salmonella* "Other Serovars" isolates. Two percent (20/1,290) of isolates (Muenchen, Stanley, Corvallis, Agona, Braenderup, Corvallis, Derby, I 9,12:-:-, Kentucky, Litchfield, Mbandaka, Nessziona, Schwarzengrund, and Tennessee) with reduced susceptibility to ciprofloxacin were not resistant to nalidixic acid.

Table 6. Resistance to antimicrobials in *Salmonella* "Other Serovars" isolates; *Surveillance of Human Clinical Isolates*, 2009.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 162	n = 191	n = 86	n = 121	n = 445	n = 205	n = 37	n = 29	n = 3	n = 11	%
I	Amoxicillin-clavulanic acid	7 (4)	7 (4)	4 (5)	8 (7)	9 (2)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Ceftiofur	7 (4)	7 (4)	4 (5)	8 (7)	9 (2)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Ceftriaxone	7 (4)	7 (4)	4 (5)	8 (7)	9 (2)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Ciprofloxacin	0 (0)	1 (1)	1 (1)	0 (0)	4 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
	Ampicillin	19 (12)	13 (7)	8 (9)	14 (12)	25 (6)	13 (6)	3 (8)	2 (7)	0 (0)	2 (18)	7
	Cefoxitin	7 (4)	7 (4)	4 (5)	8 (7)	8 (2)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	3
	Gentamicin	4 (2)	2 (1)	1 (1)	3 (2)	7 (2)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1
	Kanamycin	2 (1)	4 (2)	0 (0)	1 (1)	5 (1)	0 (0)	2 (5)	0 (0)	0 (0)	0 (0)	1
	Nalidixic acid	6 (4)	16 (8)	2 (2)	2 (2)	18 (4)	4 (2)	1 (3)	1 (3)	0 (0)	0 (0)	4
	Streptomycin	16 (10)	13 (7)	10 (12)	10 (8)	43 (10)	23 (11)	4 (11)	5 (17)	0 (0)	0 (0)	10
	Trimethoprim-sulfamethoxazole	9 (6)	9 (5)	1 (1)	1 (1)	11 (2)	7 (3)	2 (5)	0 (0)	0 (0)	1 (9)	3
III	Chloramphenicol	12 (7)	5 (3)	0 (0)	0 (0)	11 (2)	3 (1)	1 (3)	0 (0)	0 (0)	0 (0)	3
	Sulfisoxazole	17 (10)	16 (8)	12 (14)	8 (7)	27 (6)	19 (9)	3 (8)	2 (7)	0 (0)	1 (9)	8
	Tetracycline	24 (15)	42 (22)	23 (27)	15 (12)	62 (14)	25 (12)	6 (16)	6 (21)	0 (0)	2 (18)	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.
Provincial abbreviations are defined in Appendix D.
[a] Estimated percentage for Canada corrected for non-proportional submission protocols among provinces, whereas percentage in the text represent crude estimates (See Appendix A).

Table 7. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from humans; *Surveillance of Human Clinical Isolates*, 2009.

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	208 (44.6)	175	25	8					1	6	5					3				25	4	
Typhi	37 (7.9)	5	31		1					1	2	1	1	1	1	1	1	1	1	31		
Typhimurium	24 (5.2)	10	5	2	7		1		2	8	9	3	3	3	3	8	3	7		3	8	
Paratyphi A	18 (3.9)	2	16																	16		
Heidelberg	17 (3.6)	14	1	2					1	1	2					1					2	
Newport	16 (3.4)	14			2					2	2	2	2	2	2	2		2			2	
I 4,[5],12:i:-	15 (3.2)	6	5	2	1	1	1			2	5	3	3	3	3	4	1	2		1	6	
Stanley	10 (2.1)	6			4		1		2	4	4	1	1	1	1	4	3	3			4	
Less common serovars	121 (26.0)	105	5	6	2	3	2			8	8	1	1	1	1	7	5	5		5	12	
Total	**466 (100)**	**337**	**88**	**20**	**17**	**4**	**5**	**6**	**32**		**37**	**11**	**11**	**11**	**11**	**30**	**13**	**20**	**1**	**81**	**38**	
Alberta																						
Enteritidis	94 (24.4)	78	14	1	1		1	1	5		2		1		1	1				12	1	
Typhimurium	45 (11.7)	25	4	7	9		2	5	15		9	1	1	1	1	15		9		2	10	
Heidelberg	38 (9.8)	17	11	10			1		4		20	4	7	4	7	3					5	
I 4,[5],12:i:-	25 (6.5)	6	19								2	2	2	2	2						17	
Saintpaul	17 (4.4)	14	2		1					1	1					1				1	3	
Infantis	13 (3.4)	9	1	2		1	1	1			2	1	1	1	1	3	1	1		3	3	
Typhi	13 (3.4)	1	3		7	2				7	9					9	7	7		12	4	
Newport	11 (2.8)	11																				
Less common serovars	130 (33.7)	99	14	11	6		1	3	12		8	4	4	4	4	12	8	4	1	15	19	
Total	**386 (100)**	**260**	**68**	**31**	**24**	**3**	**6**	**10**	**44**		**53**	**12**	**16**	**12**	**16**	**44**	**16**	**21**	**1**	**45**	**62**	
Saskatchewan																						
Enteritidis	72 (35.3)	63	9							5										4		
I 4,[5],12:i:-	29 (14.2)	11	15	1	2					3	7	4	4	4	4	3				1	13	
Typhimurium	28 (13.7)	23	1	1	3			1	3		4					4		2			4	
Heidelberg	15 (7.4)	8	5	2							6	3	4	3	4					1	2	
Agona	8 (3.9)	3	1	4						2						4					5	
Infantis	8 (3.9)	8																				
Newport	5 (2.5)	5																				
Less common serovars	39 (19.1)	31	2	5	1		1			5	1					5	1		1	3	5	
Total	**204 (100)**	**152**	**33**	**13**	**6**		**1**	**1**	**18**		**18**	**7**	**8**	**7**	**8**	**16**	**1**	**2**	**1**	**9**	**29**	
Manitoba																						
Enteritidis	92 (31.5)	80	10		1	1	1			3	2					2		1	1	10	1	
I 4,[5],12:i:-	56 (19.2)	39	15	2			1			2	10	7	7	7	7	1					7	
Heidelberg	48 (16.4)	38	6	4						2	9	5	8	5	8						3	
Typhimurium	22 (7.5)	15			7				4	6	7					6		3		1	7	
Newport	14 (4.8)	14																				
Typhi	9 (3.1)		8		1					1	1					1	1	1		8	1	
Less common serovars	51 (17.5)	42	1	6	2		2		1	8	4	1	1	1	1	7	1			2	8	
Total	**292 (100)**	**228**	**40**	**12**	**11**	**1**	**4**	**5**	**22**		**33**	**13**	**16**	**13**	**16**	**17**	**2**	**5**	**1**	**21**	**27**	
Ontario																						
Enteritidis	369 (30.1)	322	37	7	3					5	9					5	2			39	6	
Typhimurium	193 (15.8)	126	6	4	56	1	1		9	57	57	3	3	3	3	61	3	50		5	64	
Heidelberg	112 (9.2)	68	34	9	1		8			9	39	13	13	13	13	9				1	3	
Typhi	86 (7.0)	22	49	2	9	4				13	14					15	14	14		64	4	
Newport	63 (5.1)	59	1	3						2	1					1	1				3	
I 4,[5],12:i:-	38 (3.1)	29	5	3	1		1			3	5	2	2	2	2	2					5	
Hadar	28 (2.3)	2	6	20					1	19						1	1				26	
Saintpaul	28 (2.3)	27		1			1			1						1						
Less common serovars	307 (25.1)	252	26	13	13	3	5		4	18	19	7	7	6	7	22	9	11	4	35	28	
Total	**1,224 (100)**	**907**	**164**	**62**	**83**	**8**	**16**	**14**	**127**		**144**	**25**	**25**	**24**	**25**	**117**	**30**	**75**	**4**	**144**	**139**	

Serovars represented by less than 2% of isolates were classified as “Less common serovars.”
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Table 7 (continued). Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from humans; *Surveillance of Human Clinical Isolates*, 2009.

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																					
Enteritidis	167 (29.7)	151	10	4	2			1		2	5					5				12	4
Heidelberg	100 (17.8)	61	30	8	1			6	1	8	33	10	10	10	10	8	2				4
Typhimurium	68 (12.1)	49	3	3	13				4	14	13					16	2	13			19
Javiana	28 (5.0)	28																			
Newport	22 (3.9)	22																			
Thompson	20 (3.6)	20																			
I 4,[5],12:i:-	16 (2.8)	5	1	1	9			1		10	9	1	1	1	1	10	1	1			9
I 4,[5],12:b:-	15 (2.7)	15																			
Typhi	14 (2.5)	6	5		2	1				3	3					3	3	3	2	8	1
Less common serovars	112 (19.9)	84	12	12	4					14	6	1	1	1	1	10	6	3		7	17
Total	**562 (100)**	**441**	**61**	**28**	**31**	**1**		**8**	**5**	**51**	**69**	**12**	**12**	**12**	**12**	**52**	**14**	**20**	**2**	**27**	**54**
New Brunswick																					
Enteritidis	39 (35.1)	36	3																	3	
Heidelberg	24 (21.6)	19	4	1						1	5	4	4	4	4						
Typhimurium	10 (9.0)	7		3						3						3					3
Carrau	4 (3.6)	3	1								1										
I 4,[5],12:i:-	4 (3.6)	2		1	1				2	1	1					1		1			2
Javiana	3 (2.7)	3																			
Poona	3 (2.7)	3																			
Less common serovars	24 (21.6)	20		3	1					3	1					2	2			1	4
Total	**111 (100)**	**93**	**8**	**8**	**2**				**2**	**8**	**8**	**4**	**4**	**4**	**4**	**6**	**2**	**1**		**4**	**9**
Nova Scotia																					
Enteritidis	36 (37.1)	29	6	1						1	1									6	
Heidelberg	18 (18.6)	7	10		1				1	1	11	7	7	7	7	1		1			
Typhimurium	13 (13.4)	9	1	1	2					3	3					3		2			3
Hadar	3 (3.1)		1	2						2											3
I 4,[5],12:i:-	3 (3.1)	1	1		1					1	1					1					2
Carrau	2 (2.1)	2																			
Mbandaka	2 (2.1)	2																			
Newport	2 (2.1)	2																			
Saintpaul	2 (2.1)	1	1													1					
Less common serovars	16 (16.5)	13	2	1						2	1									1	1
Total	**97 (100)**	**66**	**22**	**5**	**4**				**1**	**10**	**17**	**7**	**7**	**7**	**7**	**6**		**3**		**7**	**9**
Prince Edward Island																					
Enteritidis	5 (31.3)	4	1																	1	
Typhimurium	5 (31.3)	5																			
Heidelberg	3 (18.8)	3																			
Carrau	1 (6.3)	1																			
Muenchen	1 (6.3)	1																			
Thompson	1 (6.3)	1																			
Total	**16 (100)**	**15**	**1**																	**1**	
Newfoundland and Labrador																					
Enteritidis	10 (28.6)	10																			
Typhimurium	8 (22.9)	8																			
Heidelberg	6 (17.1)	5		1						1						1	1				1
Braenderup	1 (2.9)	1																			
Brancaster	1 (2.9)	1																			
Fillmore	1 (2.9)			1							1										1
Kentucky	1 (2.9)			1							1					1	1				1
Mbandaka	1 (2.9)	1																			
Nessziona	1 (2.9)	1																			
Newport	1 (2.9)	1																			
Oslo	1 (2.9)	1																			
Paratyphi B var. L(+) tartrate+	1 (2.9)	1																			
Poona	1 (2.9)	1																			
Rissen	1 (2.9)	1																			
Total	**35 (100)**	**32**		**3**						**1**	**2**					**2**	**2**				**3**

Serovars represented by less than 2% of isolates were classified as “Less common serovars.”
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Figure 2. Temporal variation in resistance to selected antimicrobials in human isolates of *Salmonella* serovars Enteritidis, Heidelberg, and "Other Serovars"; *Surveillance of Human Clinical Isolates*, 2003–2009.

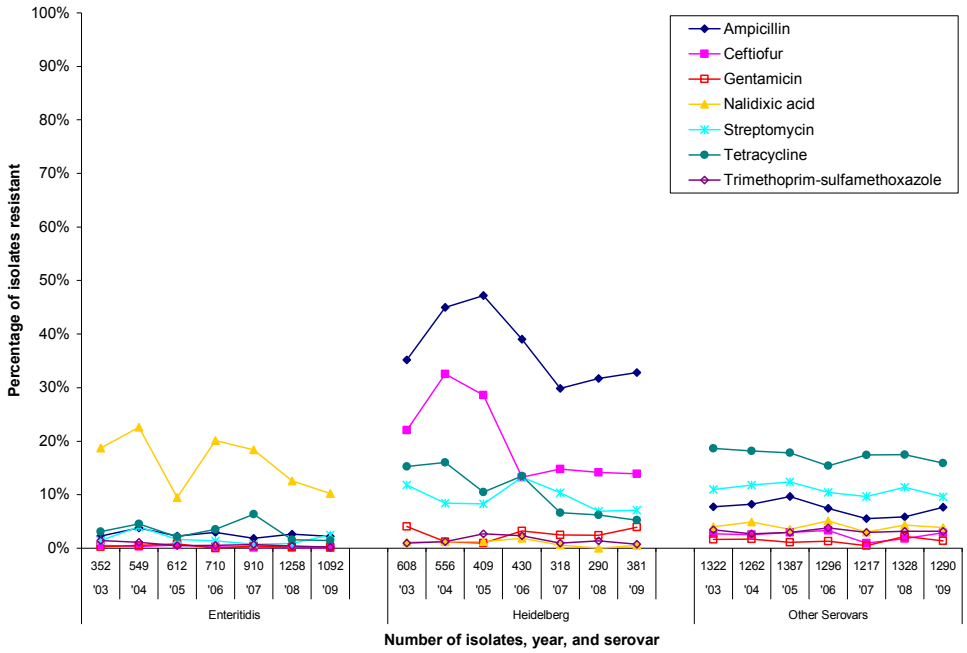
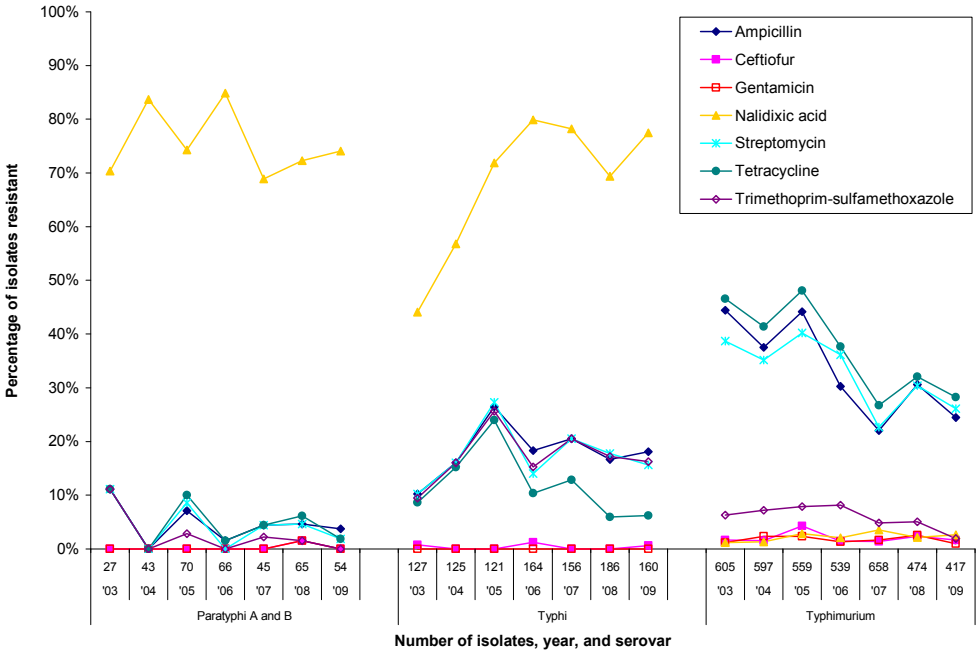


Figure 3. Temporal variation in resistance to selected antimicrobials in human isolates of *Salmonella* serovars Paratyphi A and B, Typhi, and Typhimurium; *Surveillance of Human Clinical Isolates*, 2003–2009.



Does not include *Salmonella* 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 gastrointestinal illness and is included in the "Other serovars" category..

Beef Cattle

Salmonella

Surveillance of Animal Clinical Isolates[1]

(n = 131)

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 var. 5- (38%, 50/131), Typhimurium (26%, 34/131), and Heidelberg (5%, 7/131). These 3 serovars accounted for 69% (91/131) of the isolates.

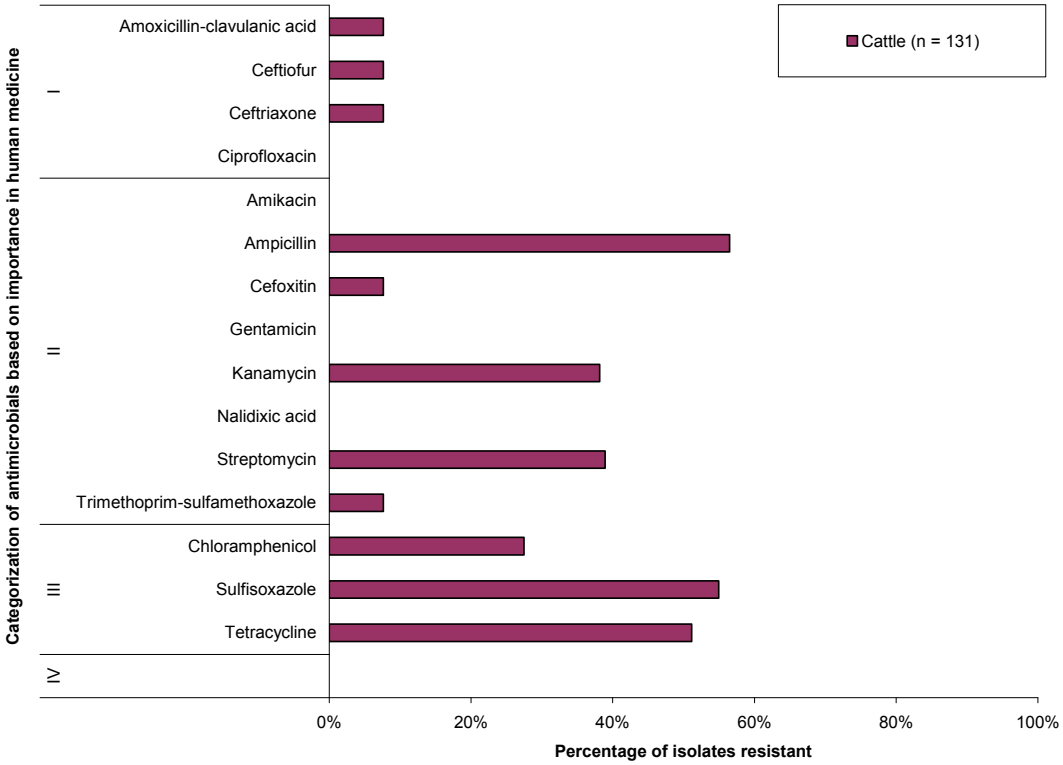
Antimicrobial Resistance: Results are presented in Figure 4, Table 8, and Table B.7, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 8% (10/131) of *Salmonella* isolates. No resistance to ciprofloxacin, amikacin, gentamicin, or nalidixic acid was detected, nor was reduced susceptibility to ciprofloxacin observed.

Antimicrobial Resistance Patterns: Results are presented in Table 8 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 63% (82/131) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 47% (62/131) of isolates (41 *S.* Typhimurium var. 5-, 20 *S.* Typhimurium, and 1 *S.* Newport). The most common resistance patterns were AMP-KAN-SSS-TET (10%, 13/131; 12 *S.* Typhimurium var. 5- and 1 *S.* Typhimurium), ACKSSuT (10%, 13/131; 7 *S.* Typhimurium var. 5- and 6 *S.* Typhimurium), AKSSuT (10%, 13/131; 13 *S.* Typhimurium var. 5-), and ACSSuT (9%, 12/131; 8 *S.* Typhimurium var. 5- and 4 *S.* Typhimurium). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO (1 *S.* Newport).

In 2009, the most common resistance patterns in cattle clinical isolates of *Salmonella* were AMP-KAN-SSS-TET (10%, 13/131; 12 *S.* Typhimurium var. 5- and 1 *S.* Typhimurium), ACKSSuT (10%, 13/131; 7 *S.* Typhimurium var. 5- and 6 *S.* Typhimurium), AKSSuT (10%, 13/131; 13 *S.* Typhimurium var. 5-), and ACSSuT (9%, 12/131; 8 *S.* Typhimurium var. 5- and 4 *S.* Typhimurium). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO (1 *S.* Newport).

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

Figure 4. Resistance to antimicrobials in *Salmonella* isolates from cattle; *Surveillance of Animal Clinical Isolates*, 2009.



Confidence intervals are not displayed for animal clinical isolate 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*, 2009.

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-	50 (38.2)	1	7	1	41				32	30	48	7	7	7	7	42	1	16			41
Typhimurium	34 (26.0)	11	1	2	20				16	19	21	1	1	1	1	22	7	19			22
Heidelberg	7 (5.3)	4	1	2							3					2	2				
I 6,14,18:-:-	5 (3.8)	5																			
Kentucky	4 (3.1)	4																			
Cerro	3 (2.3)	3																			
Dublin	3 (2.3)	1	2													2					
Oranienburg	3 (2.3)	3																			
Less common serovars	22 (16.8)	17	1	3	1				2	2	2	2	2	2	2	4		1			4
Total	**131 (100)**	**49**	**12**	**8**	**62**				**50**	**51**	**74**	**10**	**10**	**10**	**10**	**72**	**10**	**36**			**67**

Serovars represented by less than 2% of isolates were classified as “Less common serovars.”
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Escherichia coli

Retail Meat Surveillance

(n = 652)

(British Columbia [n = 79], Saskatchewan [n = 135], Ontario [n = 195], Québec [n = 108],

Maritimes [n = 135])

Recovery: *Escherichia coli* isolates were recovered from 71% (654/924)[1] of retail beef samples. Province/region-specific percentages of beef samples from which *E. coli* isolates were recovered were as follows: British Columbia, 71% (79/112); Saskatchewan, 83% (135/163); Ontario, 79% (195/248); Québec, 54% (108/201); and Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 68% (137/200; Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 5, Table 9, and Table B.8, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 1% (1/79) of *E. coli* isolates from British Columbia, 1% (2/195) of isolates from Ontario, 1% (1/108) of isolates from Québec, and 3% (4/135) of isolates from the Maritimes. Resistance to ceftiofur was detected in 1% (2/195) of *E. coli* isolates from Ontario, 1% (1/108) of isolates from Québec, and 1% (2/135) of isolates from the Maritimes. Resistance to ceftriaxone was detected in 1% (2/195) of isolates from Ontario, 1% (1/108) of isolates from Québec, and 2% (3/135) of isolates from the Maritimes. Reduced susceptibility to ciprofloxacin was detected in 1% (1/108) of isolates from Québec and 1% (1/135) of isolates from the Maritimes. Resistance to nalidixic acid was detected in 1% (1/108) of isolates from Québec.

Significant differences were detected between Saskatchewan and Ontario in percentages of isolates with resistance to streptomycin (3% [4/135] and 13% [25/195], respectively) and sulfisoxazole (2% [3/135] and 13% [25/195], respectively). There were no significant differences among the provinces/region in percentages of resistant isolates for any of the other antimicrobials tested. No isolates from any province/region were resistant to ciprofloxacin or amikacin.

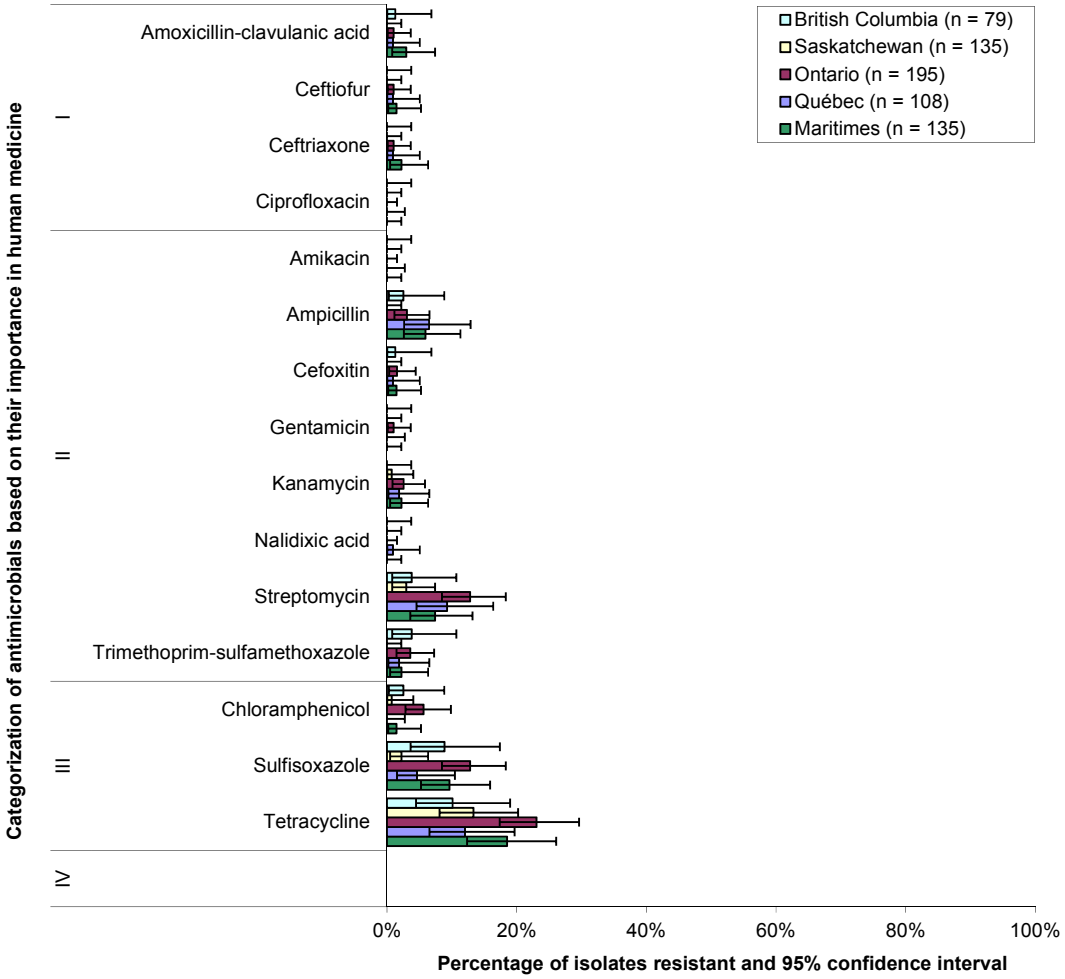
Antimicrobial Resistance Patterns: Results are presented in Table 9 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 14% (11/79) of *E. coli* isolates from British Columbia, 13% (18/135) of isolates from Saskatchewan, 25% (48/195) of isolates from Ontario, 13% (14/108) of isolates from Québec, and 24% (33/135) of isolates from the Maritimes. Resistance to 4 or more antimicrobials classes was detected in 1% (1/79) of isolates from British Columbia, 1% (1/135) of isolates from Saskatchewan, 6% (11/195) of isolates from Ontario, 4% (3/108) of isolates from Québec, and 4% (5/135) of isolates from the Maritimes. Among the isolates from all 5 provinces/region, the most common resistance patterns were TET (7%, 47/652) and STR-SSS-TET (2%, 11/652). Reduced susceptibility to ciprofloxacin with resistance to ceftriaxone was detected in less than 1% (1/652) of isolates. Reduced susceptibility to ciprofloxacin without resistance to nalidixic acid was also detected in less than 1% (1/652) of isolates. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (1 isolate).

Temporal Variations: Results are presented in Figure 6. The percentage of *E. coli* isolates from British Columbia with resistance to tetracycline was significantly lower in 2009 (10% 8/79) than in 2008 (23% 20/88). No other significant temporal variations were detected in the percentages of isolates resistant to the selected antimicrobials.

[1] Two isolates could not be tested after freezing, leaving 652 isolates available for antimicrobial susceptibility testing.

In 2009, reduced susceptibility to ciprofloxacin was detected in 1% (1/108) of retail beef *Escherichia coli* isolates from Québec and 1% (1/108) of isolates from the Maritimes. The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (1 isolate). There were significant differences between Saskatchewan and Ontario in percentages of isolates with resistance to streptomycin (3% [4/135] and 13% [25/195], respectively) and sulfisoxazole (2% [3/135] and 13% [25/195], respectively. The percentage of isolates from British Columbia with resistance to tetracycline was significantly lower in 2009 (10%, 8/79) than in 2008 (23%, 20/88).

Figure 5. Resistance to antimicrobials in *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2009.



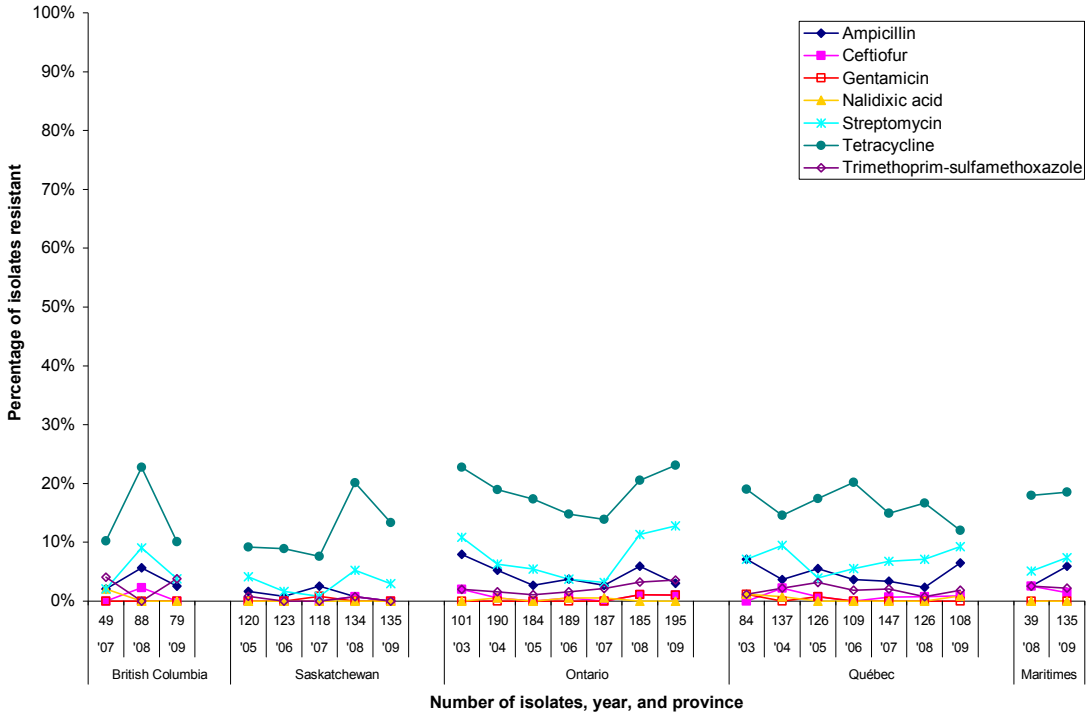
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 9. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2009.

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	79 (12.1)	68	5	5	1					3	2	1		1			7	3	2			8
Saskatchewan	135 (20.7)	117	13	4	1				1	4							3		1			18
Ontario	195 (29.9)	147	17	20	11		2		5	25	6	2	2	3	2		25	7	11			45
Québec	108 (16.6)	94	4	7	3				2	10	7	1	1	1	1		5	2			1	13
Maritimes	135 (20.7)	102	20	8	5				3	10	8	4	3	2	2		13	3	2			25

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

Figure 6. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from beef; *Retail Meat Surveillance*, 2003–2009.



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 94% (119/126) of beef cattle caecal samples (Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 7, Table 10, and Table B.9, Appendix B. No *E. coli* isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate.

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 36% (43/119) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 4% (5/119) of isolates. The most common resistance patterns were TET (11%, 13/119) and STR-SSS-TET (8%, 9/119). The patterns involving the greatest number of antimicrobials were CHL-STR-SSS-TET (5 isolates), CHL-SSS-TET-SXT (1 isolate), GEN-KAN-STR-SSS (1 isolate), and KAN-STR-SSS-TET (1 isolate).

Temporal Variations: Results are presented in Figure 8. Between 2009 and 2008 and between 2009 and 2003, there were no significant temporal variations in percentages of *E. coli* isolates resistant to the selected antimicrobials.

In 2009, resistance to 1 or more antimicrobial classes was detected in 36% (43/119) of *Escherichia coli* isolates from abattoir beef cattle. No isolates were resistant to the Category I antimicrobials tested. The most common resistance patterns were TET (11%, 13/119) and STR-SSS-TET (8%, 9/119). Resistance to 4 or more antimicrobial classes was detected in 4% (5/119) of isolates.

Figure 7. Resistance to antimicrobials in *Escherichia coli* isolates from beef cattle; *Abattoir Surveillance*, 2009.

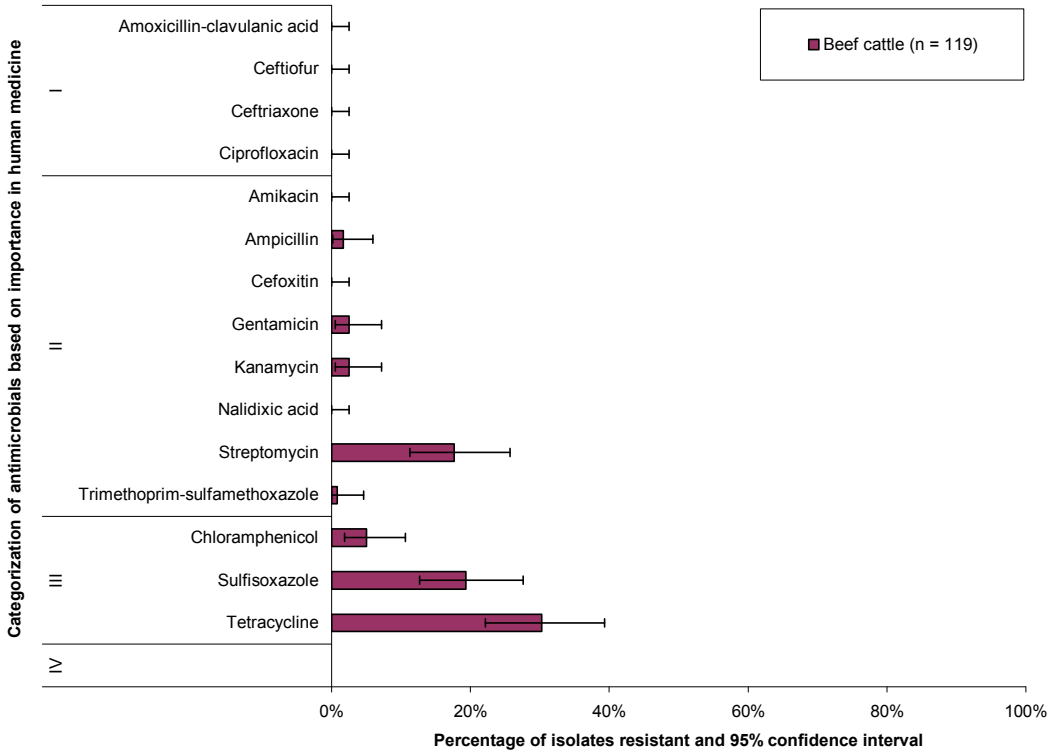
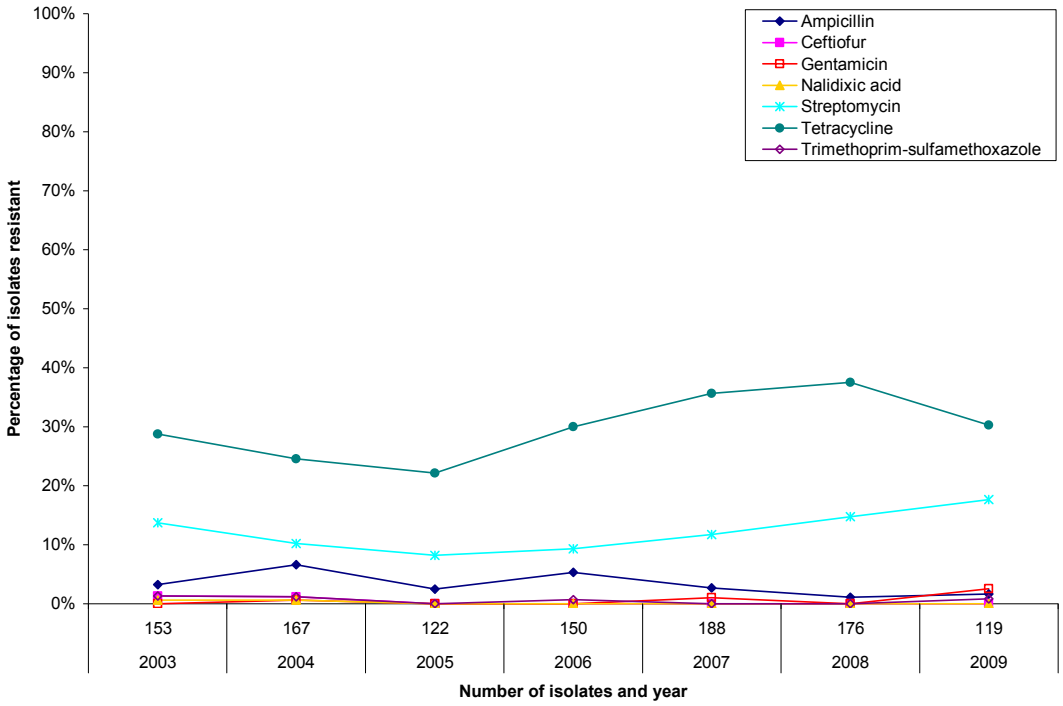


Table 10. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from beef cattle, chickens, and pigs; *Abattoir Surveillance*, 2009.

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	119	76	16	22	5			3	3	21	2					23	1	6			36
Chickens	171	47	36	60	26	2		20	25	77	74	54	53	54	49	61	16	14		8	75
Pigs	160	22	21	85	32			3	18	75	53	2	2	2	2	81	19	36			123

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

Figure 8. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from beef cattle; *Abattoir Surveillance*, 2003–2009.



Campylobacter

Abattoir Surveillance

(n = 86)

Recovery: *Campylobacter* isolates were recovered from 68% (86/126) of beef cattle caecal samples (Table C.5, Appendix C). Seventy-four percent (64/86) of the isolates were *C. jejuni*, 19% (16/86) were *C. coli*, and 7% (6/86) were other *Campylobacter* spp.

Antimicrobial Resistance: Results are presented in Figure 9, Table 11, and Table B.10, Appendix B. Resistance to ciprofloxacin was detected in 1 of the 16 *C. coli* isolates. No isolates were resistant to telithromycin, azithromycin, clindamycin, erythromycin, or gentamicin. Additionally, no isolates were non-susceptible to florfenicol.[1]

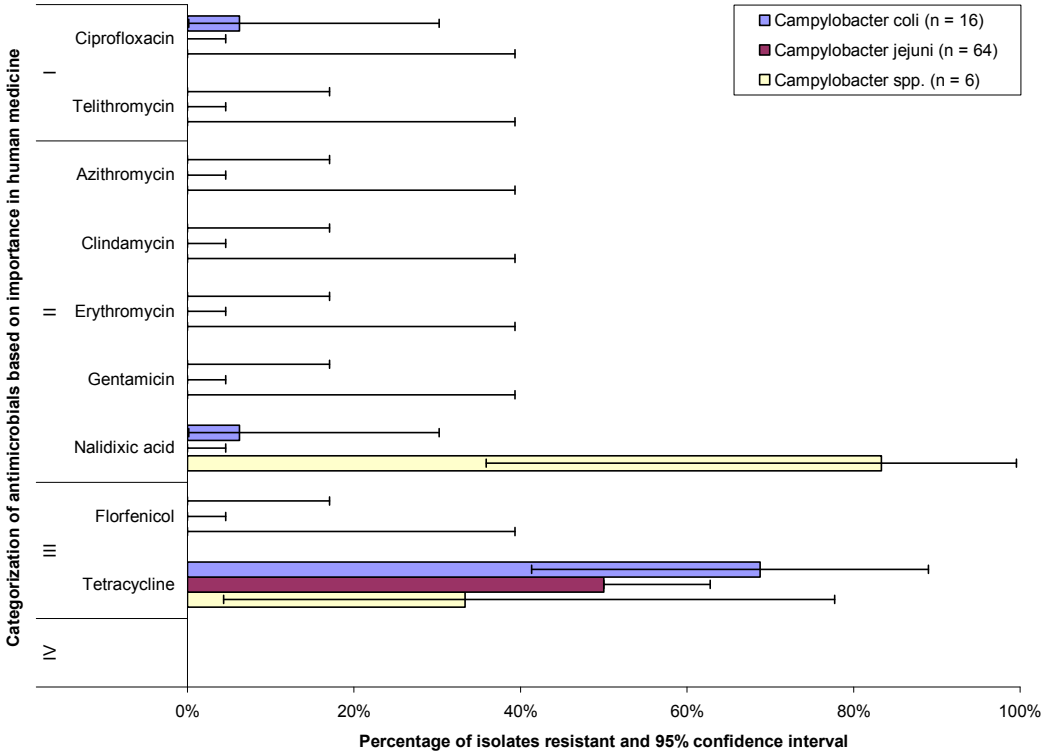
Antimicrobial Resistance Patterns: Results are presented in Table 11. Resistance to 1 or more antimicrobial classes was detected in 57% (49/86) of *Campylobacter* isolates. No isolates were resistant to 4 or more antimicrobial classes. The most common resistance pattern was TET (50%, 43/86). The pattern involving the greatest number of antimicrobials was NAL-TET (2 *Campylobacter* spp.) and CIP-NAL (1 *Campylobacter* spp.).

Temporal Variations: Results are presented in Figure 10. The percentage of *Campylobacter* isolates with tetracycline resistance was significantly lower in 2009 (52%, 45/86) than in 2008 (66%, 85/128). No other significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, resistance to 1 or more antimicrobial classes was detected in 57% (49/86) of *Campylobacter* isolates recovered from abattoir beef cattle. Resistance to ciprofloxacin was detected in 1 of the 16 *C. coli* isolates. No isolates were resistant to 4 or more antimicrobial classes. The percentage of *Campylobacter* isolates with tetracycline resistance was significantly lower in 2009 (51%, 58/113) than in 2008 (66%, 85/128).

[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.

Figure 9. Resistance to antimicrobials in *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2009.



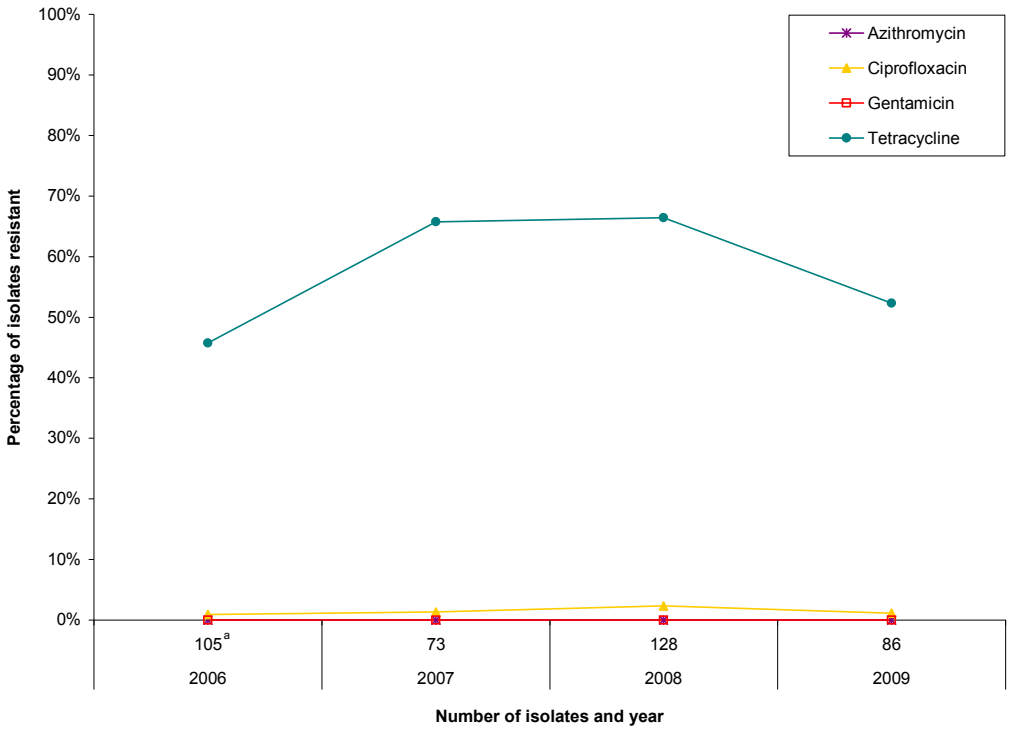
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table 11. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2009.

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	64 (74.4)	32	32												32
Campylobacter coli	16 (18.6)	4	12										1	1	11
Campylobacter spp.	6 (7.0)	1	3	2										5	2
Total	**86 (100)**	**37**	**47**	**2**									**1**	**6**	**45**

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

Figure 10. Temporal variation in resistance to selected antimicrobials in *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2009.



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

Chickens

Salmonella

Retail Meat Surveillance

(n = 473)

(British Columbia [n = 59], Saskatchewan [n = 71], Ontario [n = 142], Québec [n = 105],

Maritimes [n = 96])

Recovery: *Salmonella* isolates were recovered from 43% (474/1,090) of retail chicken samples.[1] Province/region-specific percentages of chicken samples from which isolates were recovered were as follows: British Columbia, 40% (59/146); Saskatchewan, 47% (71/150); Ontario, 43% (142/328); Québec, 39% (105/267), and the Maritimes (a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island), 49% (97/199; Table C.5, Appendix C).

Serovars: Results are presented in Table 12 and Table C.3, Appendix C. Across all provinces/region, the most common *Salmonella* serovars recovered from retail chicken were Heidelberg (32%, 153/473), Kentucky (26%, 123/473), Enteritidis (20%, 94/473), and Hadar (6%, 27/473). These 4 serovars accounted for 84% (397/473) of the isolates. In British Columbia and Saskatchewan, the most common *Salmonella* serovar was Enteritidis (51% [30/59] and 32% [23/71], respectively). In Ontario, the most common *Salmonella* serovars were Kentucky (36%, 51/142) and Heidelberg (31%, 44/142). In Québec and the Maritimes, the most common *Salmonella* serovars were Heidelberg (47% [49/105] and 42% [40/96], respectively) and Kentucky (23% [24/105] and 29% [28/96], respectively).

Antimicrobial Resistance: Results are presented in Figure 11, Table 12, and Table B.11, Appendix B. Resistance to amoxicillin-clavulanic was detected in 25% (15/59) of *Salmonella* isolates from British Columbia, 14% (10/71) of isolates from Saskatchewan, and 19% (20/105) of isolates from Québec. Resistance to ceftiofur and ceftriaxone were each detected in 27% (16/59) of isolates from British Columbia, 15% (11/71) of isolates from Saskatchewan, and 20% (21/105) of isolates from Québec. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 24% (34/142) of isolates from Ontario and 23% (22/96) of isolates from the Maritimes. The percentage of isolates from British Columbia with resistance to streptomycin (14%, 8/59) was significantly lower than in Ontario (35%, 50/142). There were no significant differences among the provinces/region in percentages of resistant isolates for any of the other antimicrobials tested. No isolates from the 5 provinces/region were resistant to ciprofloxacin, amikacin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate.

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 34% (20/59) of *Salmonella* isolates from British Columbia, 39% (28/71) of isolates from Saskatchewan, 56% (80/142) of isolates from Ontario, 59% (62/105) of isolates from Québec, and 54% (52/96) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 1% (1/142) of isolates (1 *S*. Typhimurium) from Ontario, 1% (1/105) of isolates (1 *S*. Heidelberg) from Québec, and 1% (1/96) of isolates (1 *S*. Heidelberg) from the Maritimes. Among isolates from all 5 provinces/region, the most common resistance patterns were STR-TET (15%, 72/473), A2C-AMP-CRO (12%, 59/473), and AMP (7%, 32/473). The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-GEN-STR-SSS (1 *S*. Kiambu).

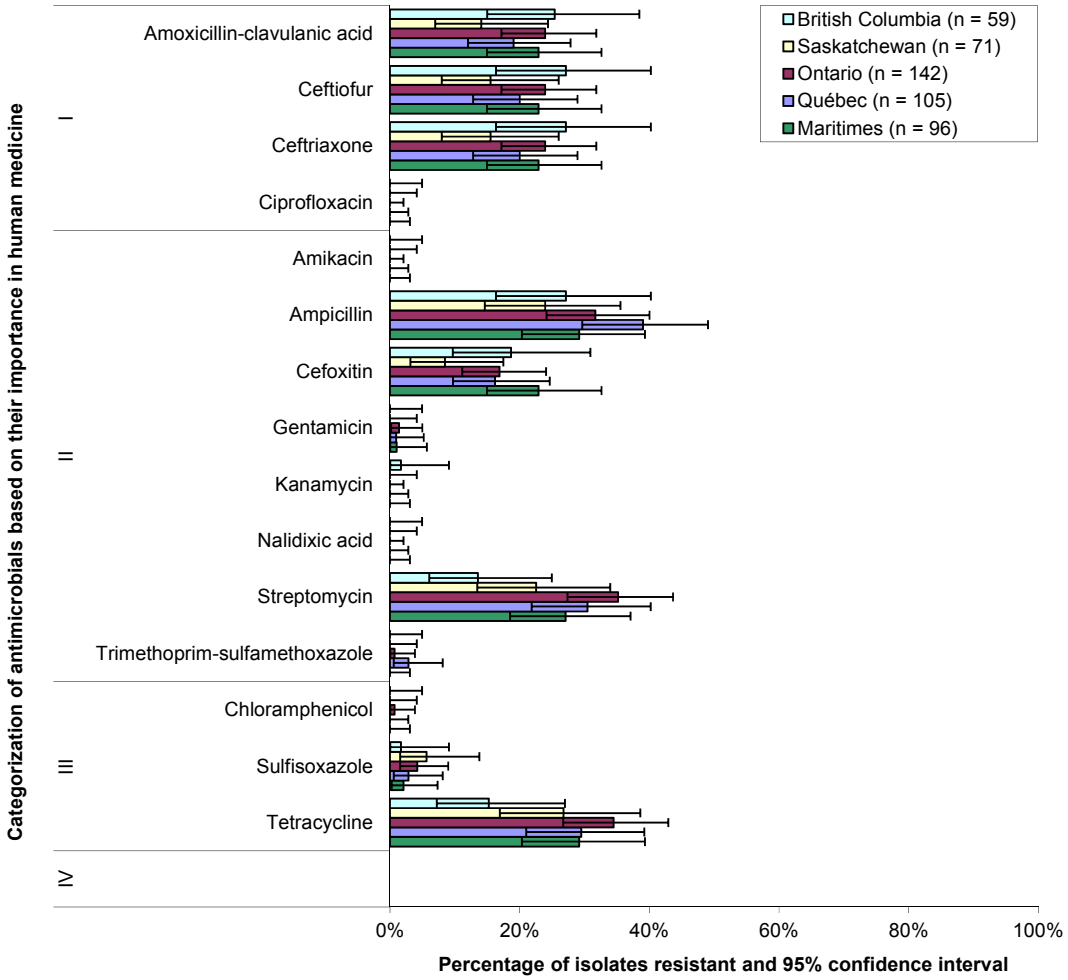
[1] One isolate from the Maritimes could not be tested after freezing, leaving 473 isolates available for antimicrobial susceptibility testing.

Temporal Variations: Results are presented in Figure 12. In British Columbia, the percentage of *Salmonella* isolates resistant to streptomycin was significantly lower in 2009 (14%, 8/59) than in 2008 (30%, 14/47). In Saskatchewan, the percentage of isolates resistant to ampicillin was significantly higher in 2009 (24%, 17/71) than in 2008 (9%, 6/64). On the other hand, the percentage of isolates resistant to tetracycline was significantly lower in 2009 (27%, 19/71) than in 2005 (52%, 11/21). In Ontario, the percentages of *Salmonella* isolates resistant to ceftiofur and ampicillin were significantly lower in 2009 (24% [34/142] and 32% [45/142], respectively) than in 2004 (46% [25/54] and 52% [28/54], respectively). In addition, the percentage of isolates resistant to streptomycin was significantly higher in 2009 (35%, 50/142) than in 2003 (4%, 1/26). In Québec, the percentage of isolates resistant to ampicillin was significantly higher in 2009 (39%, 41/105) than in 2006 (15%, 5/33). The percentage of isolates from Québec with resistance to ceftiofur was significantly lower in 2009 (20%, 21/105) than in 2004 (40%, 21/53).[1] No other significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, the percentage of retail chicken *Salmonella* isolates from British Columbia that were resistant to streptomycin was significantly lower than the percentage from Ontario. Resistance to ceftiofur and ceftriaxone were each detected in 27% (16/59) of isolates from British Columbia, 15% (11/71) of isolates from Saskatchewan, and 20% (21/105) of isolates from Québec. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 24% (34/142) of isolates from Ontario and 23% (22/96) of isolates from the Maritimes. The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-GEN-STR-SSS. In Saskatchewan, the percentage of isolates resistant to ampicillin was significantly higher in 2009 (24%, 17/71) than in 2008 (9%, 6/64). In Ontario, the percentages of *Salmonella* isolates resistant to ceftiofur and ampicillin were significantly higher in 2009 (34% [34/142] and 32% [45/142], respectively) than in 2004 (46% [25/54] and 52% [28/54], respectively). In addition, the percentage of isolates resistant to streptomycin was significantly higher in 2009 (35%, 50/142) than in 2003 (4%, 1/26). In Québec, the percentage of isolates resistant to ampicillin was significantly higher in 2009 (39%, 41/105) than in 2006 (15%, 5/33).

[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 11. Resistance to antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2009.



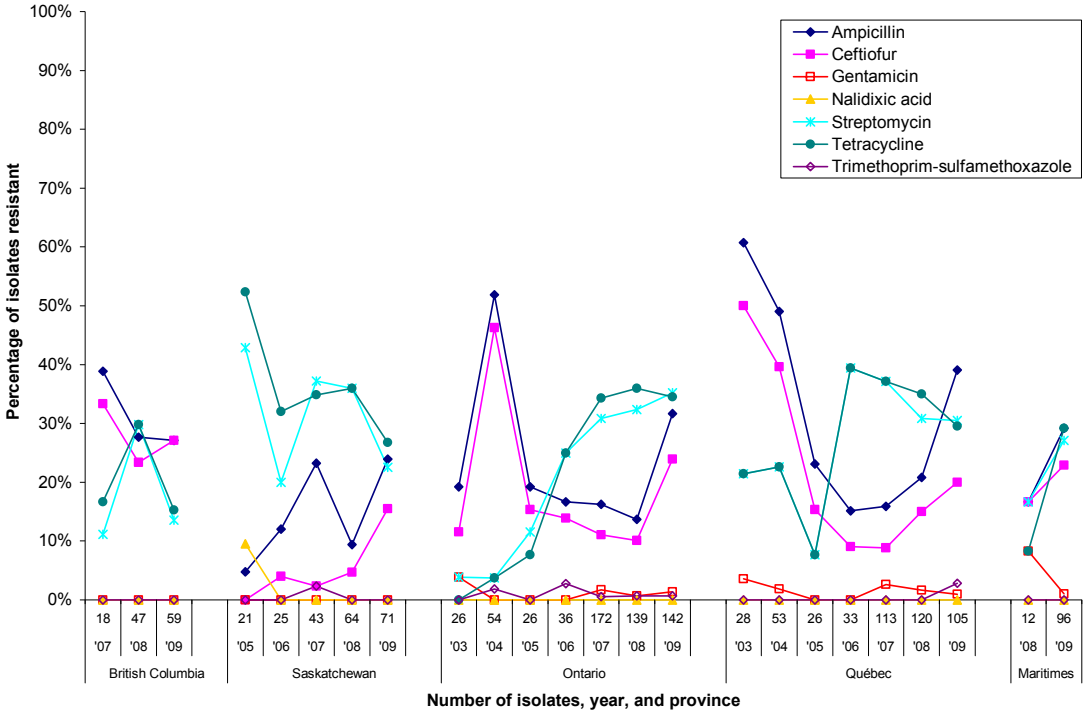
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 12. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2009.

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	30 (50.8)	30																			
Kentucky	10 (16.9)		4	6						6	8	7	8	3	8						7
Hadar	8 (13.6)	6	1	1						1	1	1	1	1	1						1
Heidelberg	6 (10.2)		6								6	6	6	6	6						
Worthington	2 (3.4)	1		1					1	1						1					1
Less common serovars	3 (5.1)	2	1								1	1	1	1	1						
Total	**59 (100)**	**39**	**12**	**8**					**1**	**8**	**16**	**15**	**16**	**11**	**16**	**1**					**9**
Saskatchewan																					
Enteritidis	23 (32.4)	23																			
Heidelberg	14 (19.7)	5	7	2							9	2	3	2	3						2
Kentucky	10 (14.1)			10						10	6	6	6	2	6						10
Schwarzengrund	4 (5.6)	1		3						3						3					3
Typhimurium	4 (5.6)	4																			
I 4,[5],12:i:-	3 (4.2)	3																			
Infantis	3 (4.2)	2	1								1	1	1	1	1						
Agona	2 (2.8)	1	1																		1
Montevideo	2 (2.8)	2																			
Less common serovars	6 (8.5)	2	1	3						3	1	1	1	1	1	1					3
Total	**71 (100)**	**43**	**10**	**18**						**16**	**17**	**10**	**11**	**6**	**11**	**4**					**19**
Ontario																					
Kentucky	51 (35.9)	11	4	36						37	14	14	14	5	14						37
Heidelberg	44 (31.0)	21	20	3						2	22	13	13	13	13	1	1				1
Enteritidis	19 (13.4)	19																			
Hadar	8 (5.6)	2		6				1		6	1	1	1	1	1	1					6
Schwarzengrund	5 (3.5)	3	2								2	2	2	2	2						
Typhimurium	4 (2.8)	2		1	1			1		2	1					2		1			1
Thompson	3 (2.1)	2		1						1	1					1					
Less common serovars	8 (5.6)	2	3	3						2	4	4	4	3	4	1					4
Total	**142 (100)**	**62**	**29**	**50**	**1**			**2**		**50**	**45**	**34**	**34**	**24**	**34**	**6**	**1**	**1**			**49**
Québec																					
Heidelberg	49 (46.7)	19	25	4	1					4	29	9	10	10	10	2	3				2
Kentucky	24 (22.9)	2		22						22	8	8	8	4	8						22
Enteritidis	14 (13.3)	14																			
I 8,20:i:-	3 (2.9)		1	2						2	1	1	1	1	1						3
Infantis	3 (2.9)	1	2								2	2	2	2	2						
Thompson	3 (2.9)	3																			
Less common serovars	9 (8.6)	4	1	4				1		4	1					1					4
Total	**105 (100)**	**43**	**29**	**32**	**1**			**1**		**32**	**41**	**20**	**21**	**17**	**21**	**3**	**3**				**31**
Maritimes																					
Heidelberg	40 (41.7)	23	15	1	1					2	17	11	11	11	11	1					1
Kentucky	28 (29.2)	6	5	17						18	6	6	6	6	6						19
Enteritidis	8 (8.3)	8																			
Hadar	8 (8.3)	1	2	5						5											7
Kiambu	3 (3.1)	1	1	1				1		1	2	2	2	2	2	1					
Albany	2 (2.1)		2								2	2	2	2	2						
Infantis	2 (2.1)	2																			
Less common serovars	5 (5.2)	3	2								1	1	1	1	1						1
Total	**96 (100)**	**44**	**27**	**24**	**1**			**1**		**26**	**28**	**22**	**22**	**22**	**22**	**2**					**28**

Serovars represented by less than 2% of isolates were classified as "Less common serovars."
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Figure 12. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance*, 2003–2009.



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

Abattoir Surveillance

(n = 230)

Recovery: *Salmonella* isolates were recovered from 27% (230/851) 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 (41%, 95/230), Heidelberg (22%, 50/230), and Enteritidis (19%, 44/230). These 3 serovars accounted for 82% (189/230) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 13, Table 13 and Table B.12, Appendix B. The percentage of *Salmonella* isolates resistant to each of amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone was 23% (53/230). Reduced susceptibility to ciprofloxacin and resistance to nalidixic acid were each detected in less than 1% (1/230) of isolates. No isolates were resistant to ciprofloxacin, amikacin, or trimethoprim-sulfamethoxazole.

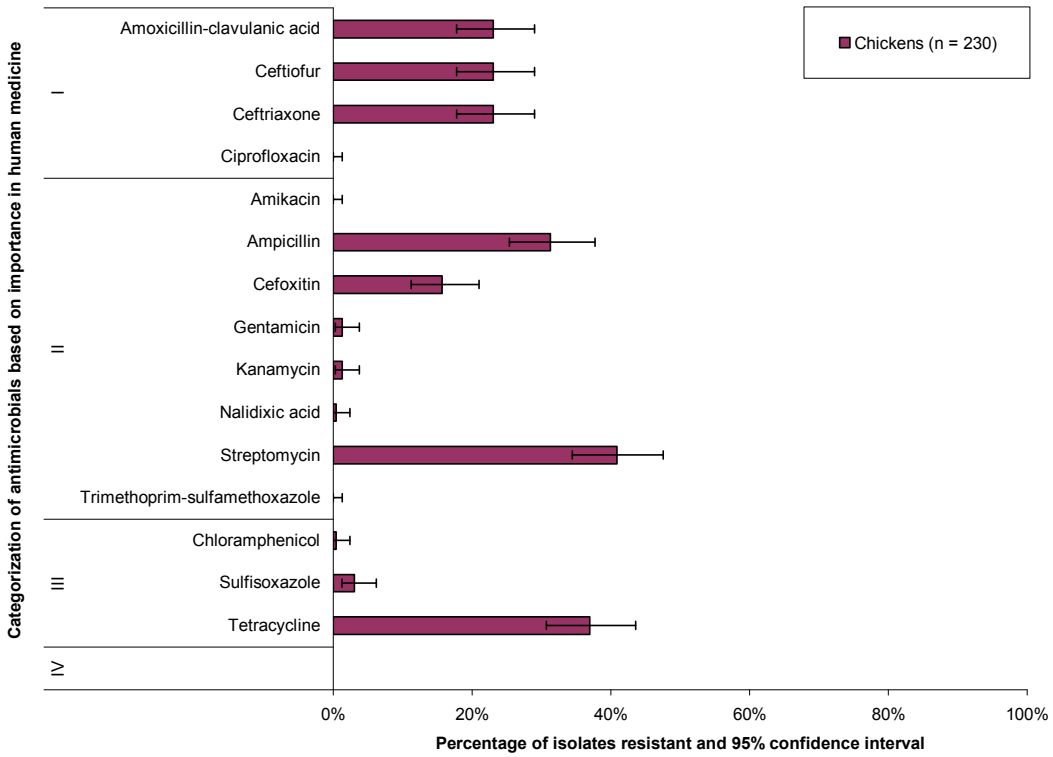
Antimicrobial Resistance Patterns: Results are presented in Table 13 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 54% (124/230) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 1% (2/230) of isolates (1 *S*. Kentucky and 1 *S*. Typhimurium var. 5-). The most common resistance patterns were STR-TET (20%, 46/230), A2C-AMP-CRO-STR-TET (8%, 18/230), and A2C-AMP-CRO (7%, 17/230). Resistance to ceftriaxone and nalidixic acid and reduced susceptibility to ciprofloxacin were detected in less than 1% of isolates (1/230). The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-KAN-STR-SSS (1 *S*. Typhimurium var. 5-).

Temporal Variations: Results are presented in Figure 14. Percentages of *Salmonella* isolates with resistance to ampicillin and ceftiofur were significantly higher in 2009 (31% [72/230] and 23% [53/230],

respectively) than in 2006 (16% [29/187] and 10% [18/187], respectively).[1] No other significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, 54% (124/230) of *Salmonella* isolates recovered from abattoir chickens were resistant to 1 or more classes of antimicrobials. The A2C-AMP resistance pattern was detected in 16% (36/230) of isolates. Resistance to ceftriaxone and nalidixic acid as well as reduced susceptibility to ciprofloxacin were detected in less than 1% of isolates (1/230). The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-KAN-STR-SSS (1 *S.* Typhimurium var. 5- isolate). Percentages of *Salmonella* isolates with resistance to ampicillin and ceftiofur were significantly higher in 2009 (31% [72/230] and 23% [53/230], respectively) than in 2006 (16% [29/187] and 10% [18/187], respectively).

Figure 13. Resistance to antimicrobials in *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2009.



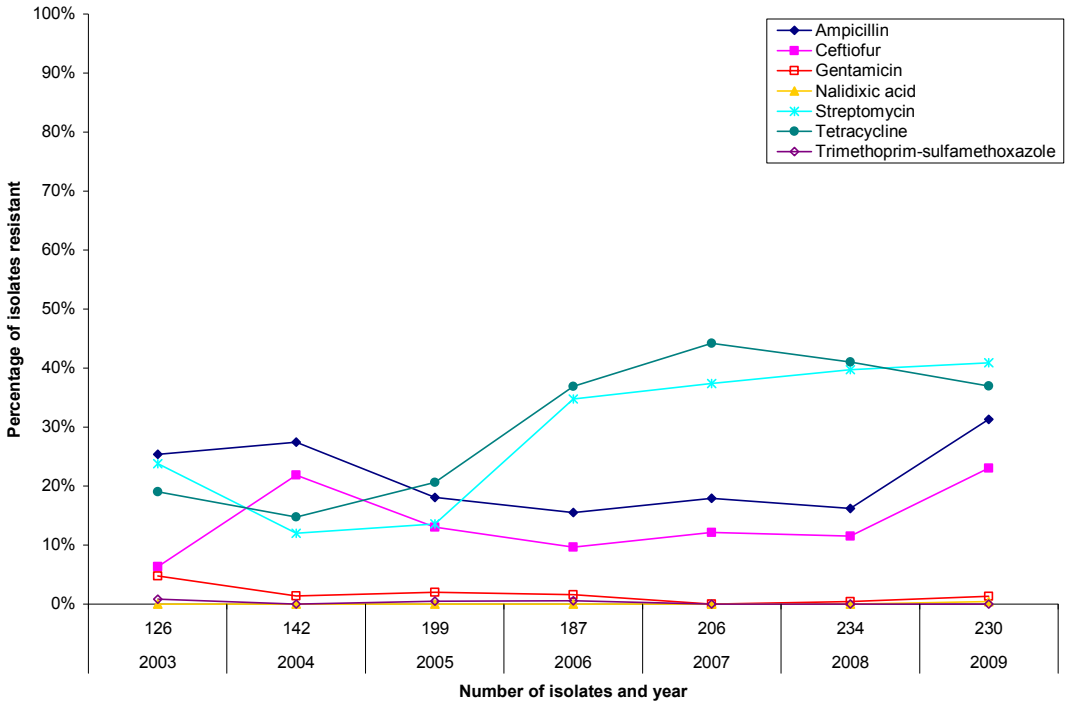
[1] 2004 and 2006 were selected as years of comparison for ceftiofur and ampicillin resistance because of a change in ceftiofur use practices by Québec chicken hatcheries in early 2005 and in 2006 (start and end of the voluntary period of withdrawal).

Table 13. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2009.

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	95 (41.3)	16	9	69	1					70	41	40	40	24	40						1	71
Heidelberg	50 (21.7)	23	18	9				2		8	27	10	10	9	10		2					
Enteritidis	44 (19.1)	43	1							1												
Hadar	9 (3.9)	2	1	6						7												6
Typhimurium	6 (2.6)	5			1					1	1						1		1			1
Less common serovars	26 (11.3)	17	1	8				1	3	7	3	3	3	3	3		4					7
Total	**230 (100)**	**106**	**30**	**92**	**2**			**3**	**3**	**94**	**72**	**53**	**53**	**36**	**53**		**7**		**1**		**1**	**85**

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

Figure 14. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2003–2009.



Surveillance of Animal Clinical Isolates[1]

(n = 280)

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 (49%, 137/280), Heidelberg (15%, 41/280), and Kentucky (15%, 40/280). These 3 serovars accounted for 78% (218/280) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 15, Table 14, and Table B.13. Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 9% (24/280) of *Salmonella* isolates. Resistance to ceftiofur and ceftriaxone were each detected in 9% (25/280) of isolates. Reduced susceptibility to ciprofloxacin was detected in 1% (4/280) of isolates. One percent (3/280) of isolates were resistant to nalidixic acid. No isolates were resistant to ciprofloxacin, amikacin, kanamycin, or trimethoprim-sulfamethoxazole.

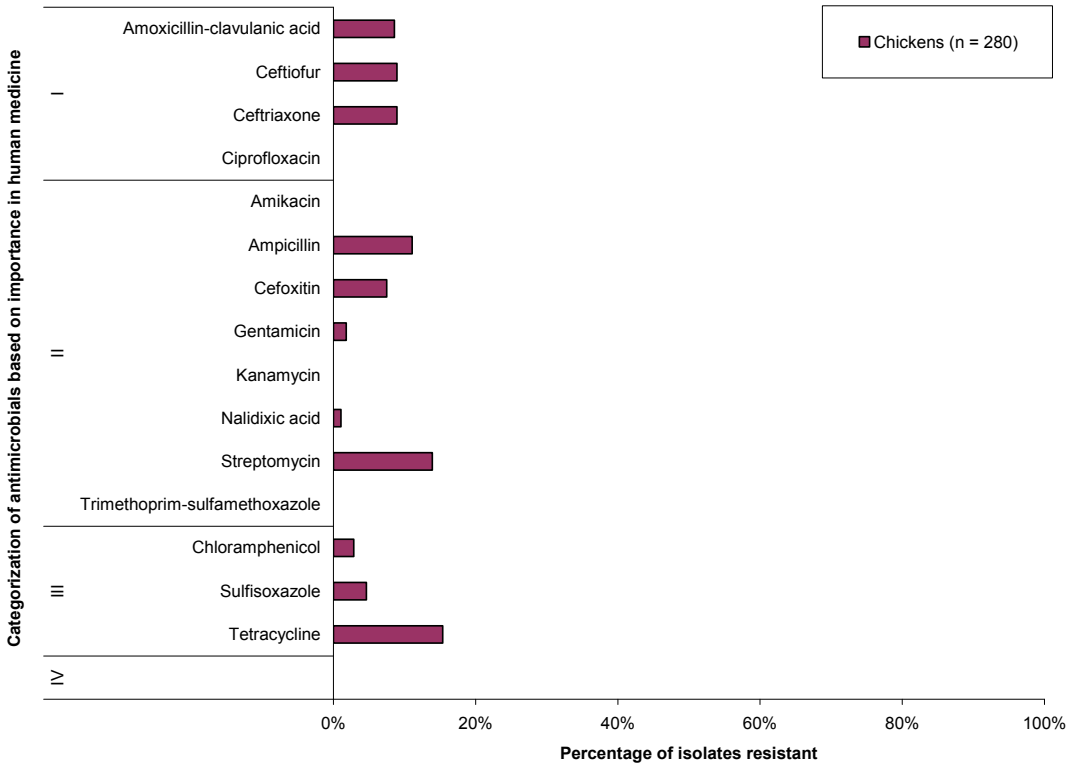
Antimicrobial Resistance Patterns: Results are presented in Table 14 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected in 22% (62/280) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 3% (9/280) of isolates (3 *S*. Typhimurium, 2 *S*. Indiana, 2 *S*. Kentucky, 1 *S*. Enteritidis, and 1 *S*. Heidelberg).

The most common resistance patterns were STR-TET (8%, 23/280) and A2C-AMP-CRO (4%, 11/280). Reduced susceptibility to ciprofloxacin with resistance to nalidixic acid and ceftriaxone was detected in 1% (3/280). Reduced susceptibility to ciprofloxacin without resistance to nalidixic acid was detected in less than 1% (1/280). The patterns involving the greatest number of antimicrobials were ACSSuT-A2C-CRO (2 *S*. Indiana) and ACSSuT-AMC-TIO-CRO-GEN (1 *S*. Enteritidis and 1 *S*. Heidelberg).

In 2009, resistance to 1 or more antimicrobials was detected in 23% (62/280) of chicken clinical isolates of *Salmonella*. Reduced susceptibility to ciprofloxacin with resistance to nalidixic acid and ceftriaxone was detected in 1% (3/280) of isolates. Reduced susceptibility to ciprofloxacin without resistance to nalidixic acid was detected in less than 1% (1/280). The patterns involving the greatest number of antimicrobials were ACSSuT-A2C-CRO (2 *S*. Indiana) and ACSSuT-AMC-TIO-CRO-GEN (1 *S*. Enteritidis and 1 *S*. Heidelberg).

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

Figure 15. Resistance to antimicrobials in *Salmonella* isolates from chicken; *Surveillance of Animal Clinical Isolates*, 2009.



Confidence intervals are not displayed for animal clinical isolate 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*, 2009.

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	144 (51.4)	143			1			1		1	1	1	1		1	1		1			1
Heidelberg	41 (14.6)	34	5	1	1			1		1	7	4	5	3	5	1		1			2
Kentucky	40 (14.3)	7	2	29	2			2		28	9	8	8	8	8	2				3	28
Typhimurium	14 (5.0)	10	1		3					3	4	1	1	1	1	3		3			3
I Rough:g,m:-	7 (2.5)	7																			
I 4,[5],12:i:-	6 (2.1)	3	3								1	1	1	1	1						2
Less common serovars	28 (10.0)	15	7	4	2			1		5	8	8	8	8	8	5		2			6
Total	**280 (100)**	**219**	**18**	**34**	**9**			**5**		**38**	**30**	**23**	**24**	**21**	**24**	**12**		**7**		**3**	**42**

Serovars represented by less than 2% of isolates were classified as “Less common serovars.”
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Escherichia coli

Retail Meat Surveillance

(n = 626)

(British Columbia [n = 70], Saskatchewan [n = 90], Ontario [n = 155], Québec [n = 126],

Maritimes region [n = 185])

Recovery: *Escherichia coli* isolates were recovered from 95% (628/663)[1] of retail chicken samples. Province/region-specific percentages of chicken samples from which isolates were recovered were as follows: British Columbia, 95% (70/74); Saskatchewan, 98% (90/92); Ontario, 95% (155/164); Québec, 94% (126/134); and Maritimes region (New Brunswick, Nova Scotia, and Prince Edward Island), 94% (187/199; Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 16, Table 15, and Table B.14, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 49% (34/70) of *E. coli* isolates from British Columbia, 26% (23/90) of isolates from Saskatchewan, 23% (36/155) of isolates from Ontario, 23% (29/126) of isolates from Québec, and 28% (51/185) of isolates from the Maritimes. Resistance to ceftiofur was detected in 41% (29/70) of isolates from British Columbia, 22% (20/90) of isolates from Saskatchewan, 21% (33/155) of isolates from Ontario, 19% (24/126) of isolates from Québec, and 27% (50/185) of isolates from the Maritimes. Resistance to ceftriaxone was detected in 47% (33/70) of isolates from British Columbia, 23% (21/90) of isolates from Saskatchewan, 23% (35/155) of isolates from Ontario, 21% (27/126) of isolates from Québec, and 27% (50/185) of isolates from the Maritimes. Reduced susceptibility to ciprofloxacin was detected in 7% (5/70) of isolates from British Columbia, 4% (4/90) of isolates from Saskatchewan, 3% (5/155) of isolates from Ontario, 3% (4/126) of isolates from Québec, and 4% (8/185) of isolates from the Maritimes. Resistance to nalidixic acid was detected in 7% (5/70) of isolates from British Columbia, 4% (4/90) of isolates from Saskatchewan, 3% (5/155) of isolates from Ontario, 3% (4/126) of isolates from Québec, and 4% (7/185) of isolates from the Maritimes.

Percentages of isolates resistant to amoxicillin-clavulanic acid, ceftriaxone, and cefoxitin were each significantly higher in British Columbia than in the other provinces/regions. The percentage of isolates resistant to ceftiofur was significantly higher in British Columbia than in Ontario and Québec. The percentage of isolates resistant to ampicillin was significantly higher in British Columbia than in Saskatchewan and Ontario. Percentages of isolates resistant to gentamicin and trimethoprim-sulfamethoxazole were each significantly lower in British Columbia than in Québec and the Maritimes. The percentage of isolates resistant to gentamicin was significantly lower in Saskatchewan and Ontario than in Québec. The percentage of isolates resistant to kanamycin was significantly lower in British Columbia than in Saskatchewan. Percentages of isolates resistant to streptomycin and tetracycline were each significantly higher in Québec than in the Maritimes. The percentage of isolates resistant to sulfisoxazole was significantly lower in Saskatchewan and Ontario than in Québec. There were no significant differences among provinces/region in percentages of resistant isolates for any other antimicrobials tested. No isolates from any province/region 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% (54/70) of *E. coli* isolates from British Columbia, 73% (66/90) of isolates from Saskatchewan, 72% (111/155) of isolates from Ontario, 83% (104/126) of isolates from Québec, and 70% (129/185) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 19% (13/70) of isolates from British Columbia, 9% (8/90) of isolates from Saskatchewan, 11% (17/155) of isolates from Ontario, 15% (19/126) of isolates from Québec, and 14% (25/185) of isolates from the Maritimes.

[1] Two isolates from the Maritimes could not be tested after freezing, leaving 626 isolates available for antimicrobial susceptibility testing.

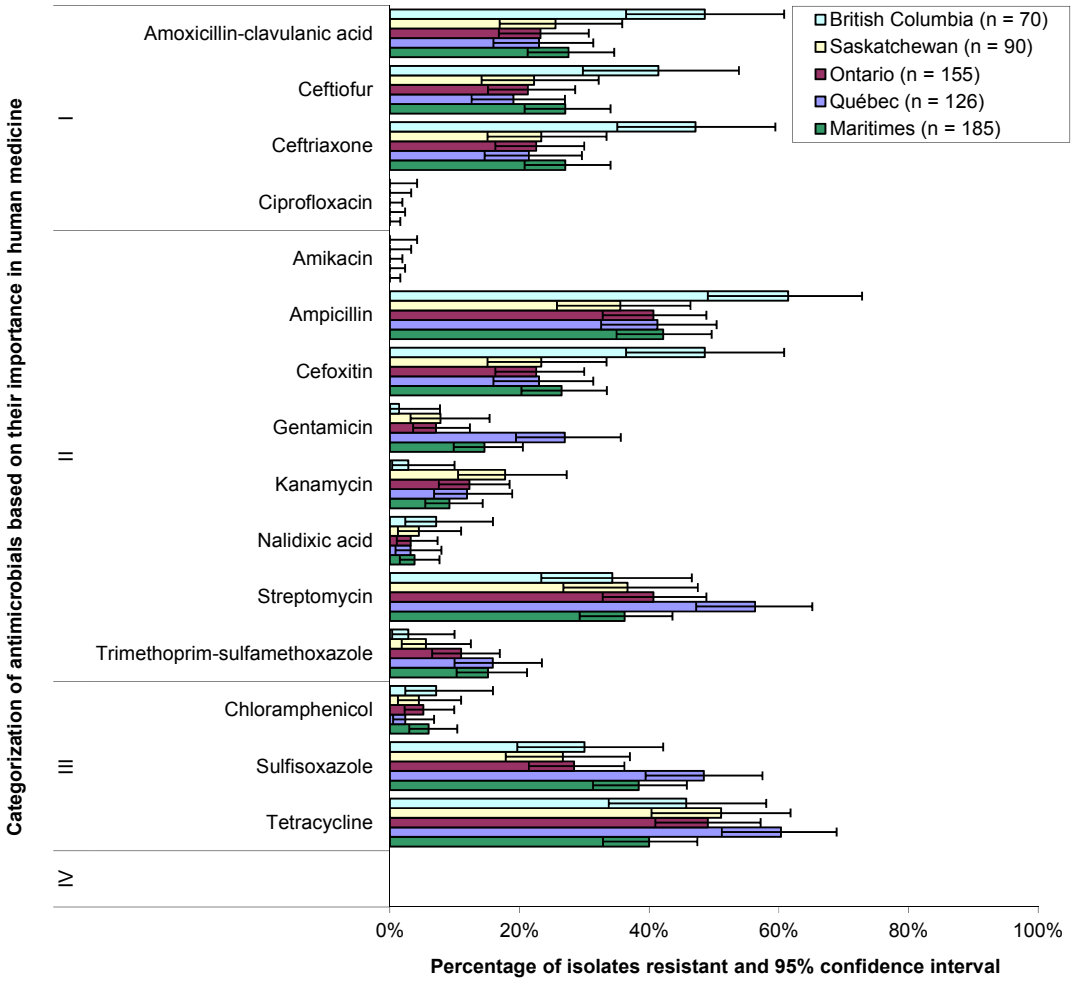
Among all isolates, the most common resistance patterns were A2C-AMP-CRO (9%, 54/626), TET (8%, 48/626), and STR-TET (4%, 22/626). Reduced susceptibility to ciprofloxacin with resistance to ceftriaxone was detected in 2% (13/626) of isolates. Resistance to nalidixic acid and ceftriaxone was detected in 2% (12/626). Reduced susceptibility to ciprofloxacin without resistance to nalidixic acid was detected in less than 1% (1/626). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO-GEN-NAL (1 isolate).

Temporal Variations: Results are presented in Figure 17. Percentages of *E. coli* isolates from Québec with resistance to streptomycin and tetracycline were significantly higher in 2009 (56% [71/126] and 60% [76/126], respectively) than in 2008 (39% [51/131] and 45% [59/131], respectively). Similarly, the percentage of isolates from Québec with resistance to ceftiofur was significantly higher in 2009 (19%, 24/126) than in 2006 (6%, 8/135). The percentage of isolates from Québec with resistance to ampicillin was significantly higher in 2009 (41%, 52/126) than in 2006 (35%, 47/135).[1] On the other hand, the percentages of isolates with resistance to ampicillin and ceftiofur were significantly lower in 2009 (41% [52/126] and 19% [24/126], respectively) than in 2004 (52% [82/158] and 34% [54/158], respectively).[1] The percentage of isolates from Saskatchewan with resistance to ceftiofur was significantly higher in 2009 (22%, 20/90) than in 2005 (4%, 3/81). The percentage of isolates from Ontario with resistance to trimethoprim-sulfamethoxazole was significantly higher in 2009 (11%, 17/155) than in 2003 (3%, 5/145). The percentage of isolates from British Columbia with resistance to trimethoprim-sulfamethoxazole was significantly lower in 2009 (3%, 2/70) than in 2007 (17%, 7/42). No other significant temporal variations were detected.

In 2009, 47% (33/70) of *Escherichia coli* isolates from British Columbia retail chicken were resistant to ceftriaxone. Percentages of isolates resistant to amoxicillin-clavulanic acid, ceftriaxone, and cefoxitin were each significantly higher in British Columbia than in the other provinces/region. The percentage of isolates resistant to ceftiofur was significantly higher in British Columbia than in Ontario and Québec. Among all isolates, the most common resistance patterns were A2C-AMP-CRO (9%, 54/626), TET (8%, 48/626), and STR-TET (4%, 22/626). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO-GEN-NAL (1 isolate). Percentages of isolates from Québec with resistance to streptomycin and tetracycline were significantly higher in 2009 (56% [71/126] and 60% [76/126], respectively) than in 2008 (39% [51/131] and 45% [59/131], respectively). Similarly, the percentage of isolates from Québec with resistance to ceftiofur was significantly higher in 2009 (19%, 24/126) than in 2006 (6%, 8/135). The percentage of isolates from Québec with resistance to ampicillin was significantly higher in 2009 (41%, 52/126) than in 2006 (35%, 47/135). The percentage of isolates from Saskatchewan with resistance to ceftiofur was significantly higher in 2009 (22%, 20/90) than in 2005 (4%, 3/81). The percentage of isolates from Ontario with resistance to trimethoprim-sulfamethoxazole was significantly higher in 2009 (11%, 17/155) than in 2003 (3%, 5/145).

[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 16. Resistance to antimicrobials in *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2009.



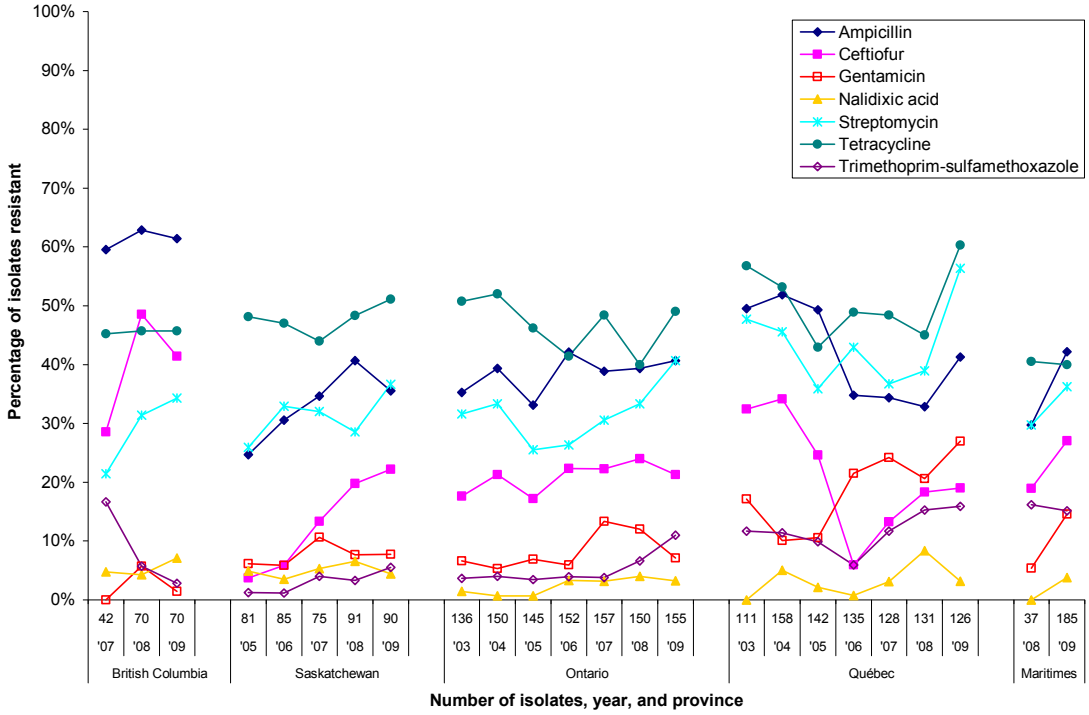
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island

Table 15. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2009.

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	70 (11.2)	16	20	21	12	1	1		2	24	43	34	33	34	29	21	2	5		5	32
Saskatchewan	90 (14.4)	24	23	35	8		7		16	33	32	23	21	21	20	24	5	4		4	46
Ontario	155 (24.8)	44	32	62	16	1	11		19	63	63	36	35	35	33	44	17	8		5	76
Québec	126 (20.1)	22	17	68	19		34		15	71	52	29	27	29	24	61	20	3		4	76
Maritimes	185 (29.6)	56	36	68	24	1	27		17	67	78	51	50	49	50	71	28	11		7	74

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

Figure 17. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from chicken; *Retail Meat Surveillance*, 2003–2009.



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

Abattoir Surveillance

(n = 171)

Recovery: *Escherichia coli* isolates were recovered from 100% (171/171) of abattoir chicken caecal samples (Table C.5, Appendix C).

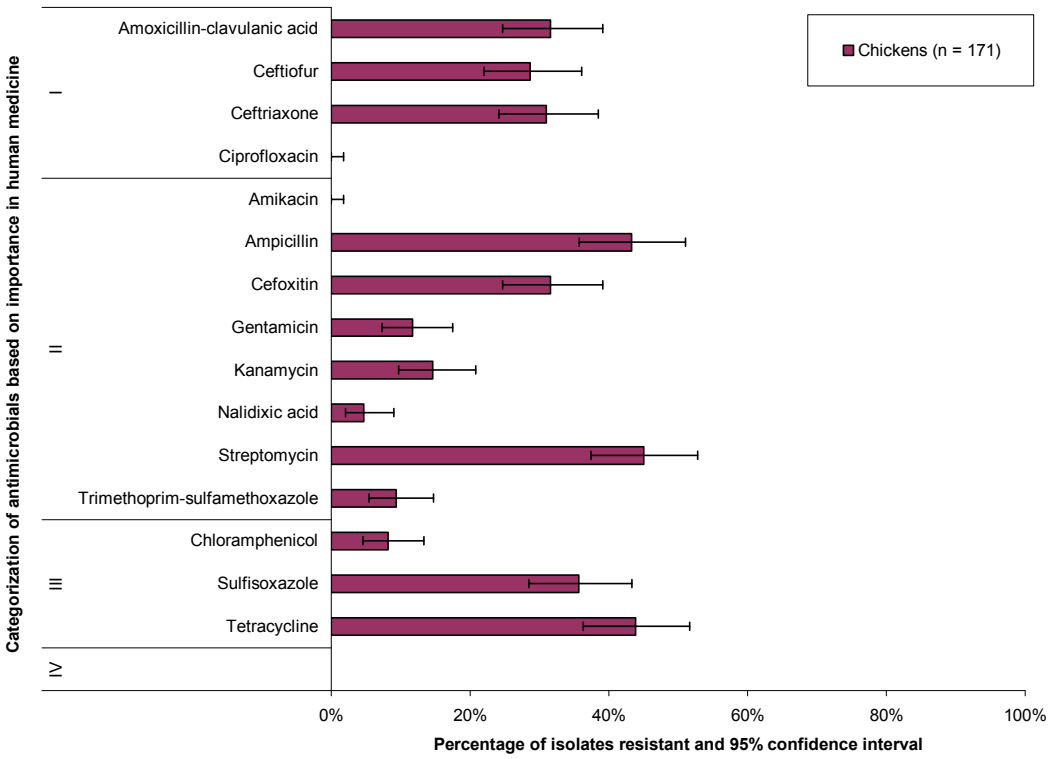
Antimicrobial Resistance: Results are presented in Figure 18, Table 10, and Table B.15, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 32% (54/171), 29% (49/171), and 31% (53/171) of *E. coli* isolates, respectively. Reduced susceptibility to ciprofloxacin was detected in 4% (7/171) of isolates. Resistance to nalidixic acid was detected in 5% (8/171). No isolates were resistant to ciprofloxacin or amikacin.

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 73% (124/171) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 16% (28/171) of isolates. The most common resistance patterns were A2C-AMP-CRO (8%, 14/171), TET (5%, 8/171), KAN-STR-SSS-TET (4%, 6/171), and STR (4%, 6/171). All isolates with reduced susceptibility to ciprofloxacin were also resistant to nalidixic acid. In addition, 2 of these isolates were also resistant to ceftriaxone (1%, 2/171). The patterns involving the greatest number of antimicrobials were ACKSSuT-A2C-CRO-GEN, ACSSuT-A2C-CRO-GEN-SXT, and ACSSuT-A2C-CRO-NAL-SXT (1 isolate each).

Temporal Variations: Results are presented in Figure 19. There were no significant temporal variations in the percentages of *E. coli* isolates resistant to the selected antimicrobials.

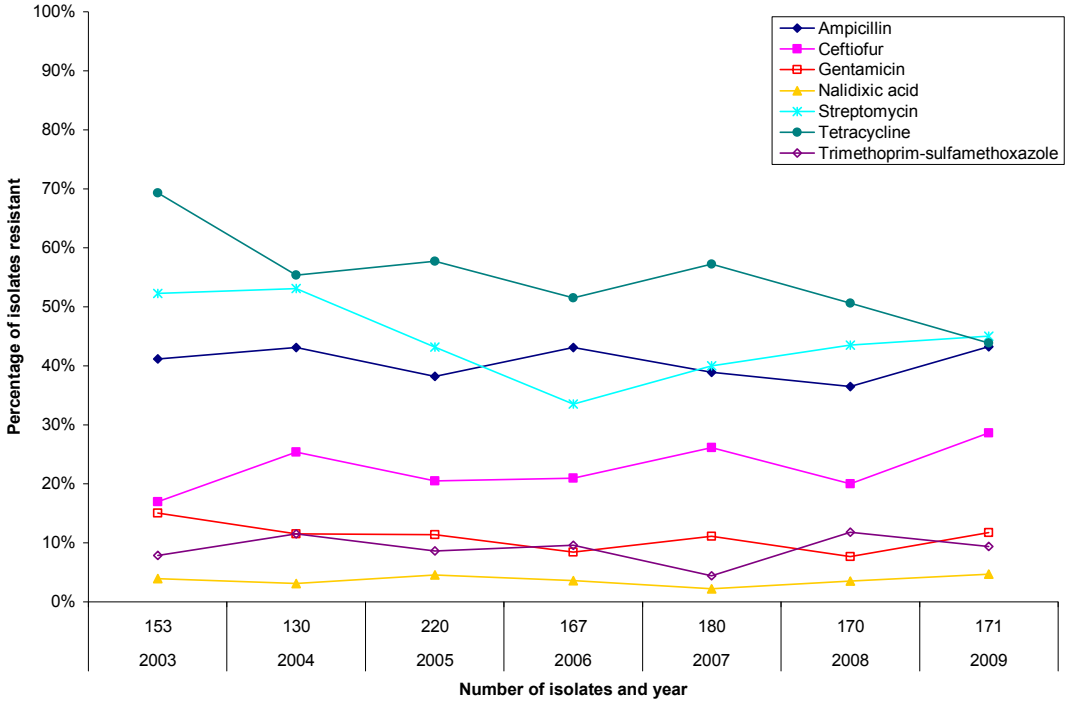
In 2009, reduced susceptibility to ciprofloxacin was detected in 4% (7/171) of *Escherichia coli* isolates recovered from abattoir chicken. All isolates with a reduced susceptibility to ciprofloxacin were also resistant to nalidixic acid. In addition, 2 of these isolates were also resistant to ceftriaxone (1%, 2/171). The patterns involving the greatest number of antimicrobials were ACKSSuT-A2C-CRO-GEN, ACSSuT-A2C-CRO-GEN-SXT, and ACSSuT-A2C-CRO-NAL-SXT (1 isolate each). There were no significant temporal variations in percentages of *E. coli* isolates resistant to the selected antimicrobials.

Figure 18. Resistance to antimicrobials in *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2009.



Results regarding the number of antimicrobial classes in resistance patterns of *E. coli* isolates from abattoir chickens can be found in Table 10.

Figure 19. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2003–2009.



Campylobacter

Retail Meat Surveillance

(n = 325)

(British Columbia [n = 77], Saskatchewan [n = 48], Ontario [n = 101], Québec [n = 52],

Maritimes region [n = 47])

Recovery: *Campylobacter* isolates were recovered from 31% (336/1,089) of retail chicken samples.[1] Province/region-specific percentages of chicken samples from which isolates were recovered were as follows: British Columbia, 53% (78/146); Saskatchewan, 32% (48/150); Ontario, 31% (101/328); Québec, 20% (52/266); and Maritimes region (New Brunswick, Nova Scotia, and Prince Edward Island), 29% (57/199; Table C.5, Appendix C). Eighty-nine percent (290/325) of isolates were *C. jejuni*, 10% (34/325) were *C. coli*, and less than 1% (1/325) were other *Campylobacter* spp.

Antimicrobial Resistance: Results are presented in Figure 20, Figure 21, Table 16, and Table B.16, Appendix B. Resistance to ciprofloxacin was detected in 29% (22/77) of *Campylobacter* isolates from British Columbia, 15% (7/48) of isolates from Saskatchewan, 1% (1/101) of isolates from Ontario, and 4% (2/47) of isolates from the Maritimes. Resistance to ciprofloxacin was detected in 18% (6/34) of *C. coli* isolates, 9% (25/290) of *C. jejuni* isolates, and less than 1% (1/325) of *Campylobacter* spp. isolates.

[1] One isolate (1 *Campylobacter* spp.) from British Columbia and 10 isolates (2 *C. coli* and 8 *C. jejuni)* from the Maritimes region could not be cultured after freezing, leaving 325 isolates available for antimicrobial susceptibility testing.

Resistance to telithromycin was detected in 4% (4/101) of *Campylobacter* isolates from Ontario, 6% (3/52) of isolates from Québec, and 6% (3/47) of isolates from the Maritimes. Resistance to telithromycin was detected in 3% (1/34) of *C. coli* isolates and in 3% (9/290) of *C. jejuni* isolates but not in other *Campylobacter* spp. isolates.

Percentages of isolates with resistance to ciprofloxacin and nalidixic acid were both significantly higher in British Columbia than in Ontario, Québec, and the Maritimes. Percentages of isolates with resistance to ciprofloxacin and nalidixic acid were both significantly higher in Saskatchewan than in Ontario and Québec. There were no significant differences among the provinces/region in percentages of resistant isolates for any of the other antimicrobials tested. No isolates were resistant to gentamicin or were non-susceptible to florfenicol.[1] Additionally, no isolates from British Columbia or Saskatchewan were resistant to azithromycin, clindamycin, or erythromycin.

Antimicrobial Resistance Patterns: Results are presented in Table 16. Resistance to 1 or more antimicrobial classes was detected in 65% (50/77) of *Campylobacter* isolates from British Columbia, 65% (31/48) of isolates from Saskatchewan, 44% (44/101) of isolates from Ontario, 63% (33/52) of isolates from Québec, and 53% (25/47) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 2% (1/47) of isolates (1 *C. jejuni*) from the Maritimes. Among all isolates, the most common resistance patterns were TET (42%, 138/325), CIP-NAL-TET (6%, 21/325), and CIP-NAL (3%, 11/325). The pattern involving the greatest number of antimicrobials was AZM-CLI-ERY-TEL-TET (1 *C. jejuni*).

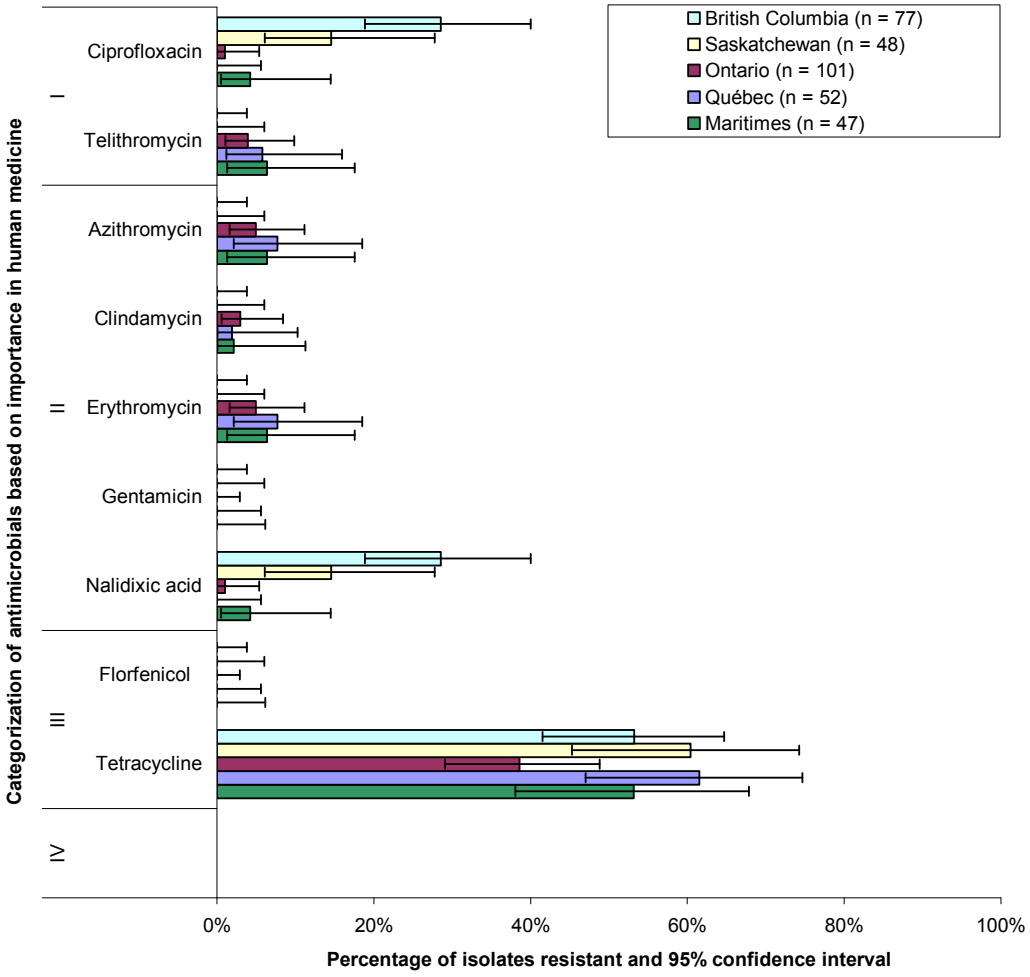
Temporal Variations: Results are presented in Figure 22.[2] Percentages of *Campylobacter* isolates from Ontario with resistance to nalidixic acid and tetracycline were significantly lower in 2009 (1% [1/101] and 39% [39/101], respectively) than in 2003 (10% [8/78] and 58% [45/78], respectively). Similarly, the percentage of isolates from Québec with resistance to azithromycin was significantly lower in 2009 (8%, 4/52) than in 2003 (22%, 21/94). Percentages of isolates from British Columbia with resistance to nalidixic acid and tetracycline were significantly higher in 2009 (29% [22/77] and 53% [41/77], respectively) than in 2008 (8% [4/50] and 32% [16/50], respectively). Similarly, the percentage of isolates from British Columbia resistant to nalidixic acid was significantly higher in 2009 (29%, 22/77) than in 2007 (4%, 1/28). No other significant temporal variations were detected.

In 2009, the percentage of *Campylobacter* isolates from retail chicken with resistance to ciprofloxacin was 29% (22/77) for British Columbia, 15% (7/48) for Saskatchewan, 1% (1/101) for Ontario, and 4% (2/47) for the Maritimes region. Among all isolates, the most common resistance patterns were TET (42%, 138/325), CIP-NAL-TET (6%, 21/325), and CIP-NAL (3%, 11/325). The pattern involving the greatest number of antimicrobials was AZM-CLI-ERY-TEL-TET (1 isolate). Percentages of *Campylobacter* isolates from British Columbia with resistance to nalidixic acid and tetracycline were significantly higher in 2009 (29% [22/77] and 53% [41/77], respectively) than in 2008 (8% [4/50] and 32% [16/50], respectively). Similarly, the percentage of isolates from British Columbia with resistance to nalidixic acid was significantly higher in 2009 (29%, 22/77) than in 2007 (4%, 1/28).

[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.

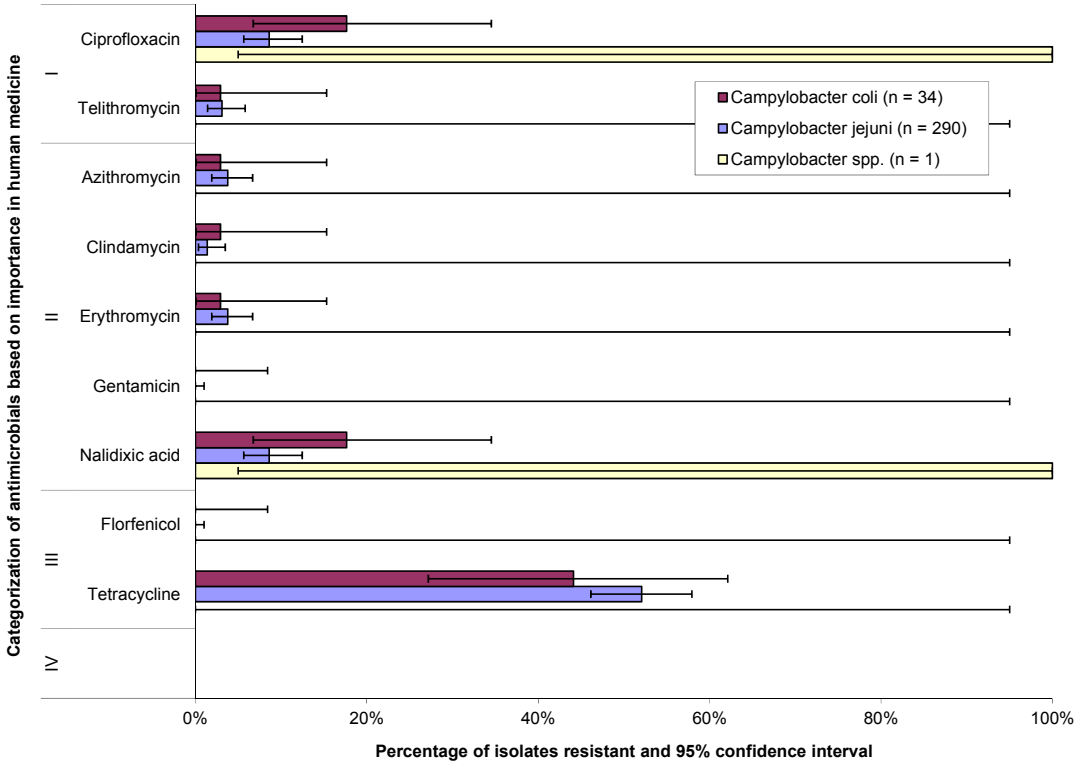
[2] Although routine retail surveillance began in the Maritimes region in 2008, no results are displayed for that year due to concerns regarding harmonization of laboratory methods.

Figure 20. Resistance to antimicrobials in *Campylobacter* isolates from chicken, by province/region; *Retail Meat Surveillance*, 2009.



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

Figure 21. Resistance to antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2009.



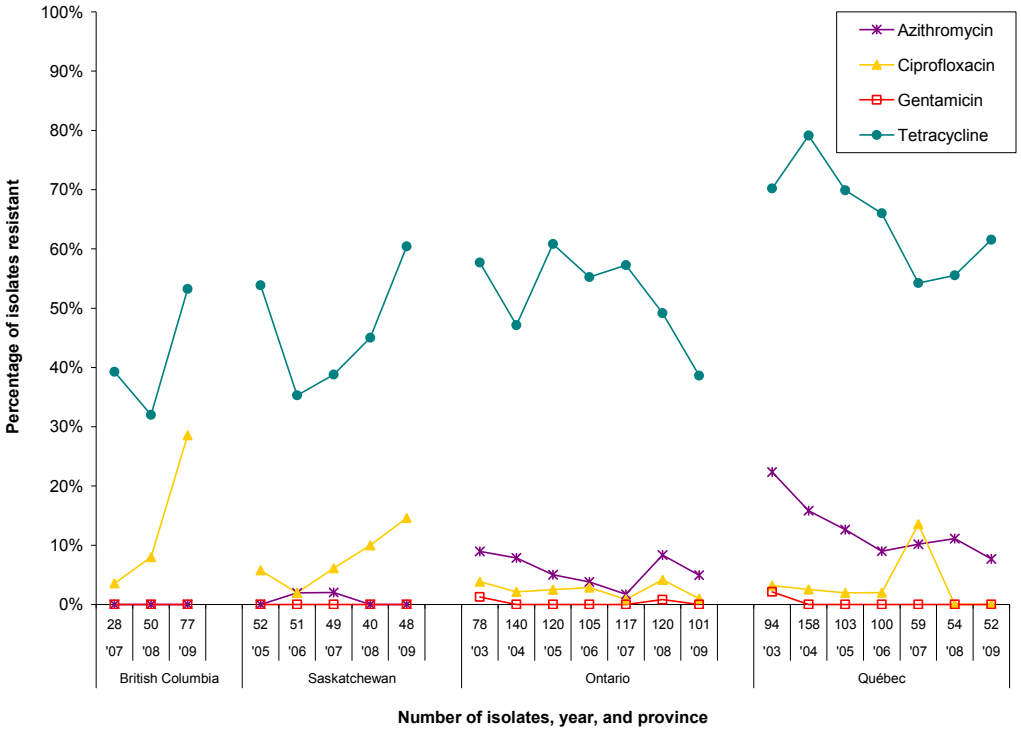
Campylobacter spp. includes unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table 16. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2009.

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	65 (84.4)	21	31	13									18	18	39
Campylobacter coli	11 (14.3)	6	5										3	3	2
Campylobacter spp.	1 (1.3)		1										1	1	
Total	**77 (100)**	**27**	**37**	**13**									**22**	**22**	**41**
Saskatchewan															
Campylobacter jejuni	41 (85.4)	16	20	5									6	6	24
Campylobacter coli	7 (14.6)	1	6										1	1	5
Total	**48 (100)**	**17**	**26**	**5**									**7**	**7**	**29**
Ontario															
Campylobacter jejuni	94 (93.1)	54	36	4				3	2	4	4		1	1	36
Campylobacter coli	7 (6.9)	3	3	1				1	1	1	1				3
Total	**101 (100)**	**57**	**39**	**5**				**4**	**3**	**5**	**5**		**1**	**1**	**39**
Québec															
Campylobacter jejuni	48 (92.3)	17	27	4				3	1	4	4				30
Campylobacter coli	4 (7.7)	2	2												2
Total	**52 (100)**	**19**	**29**	**4**				**3**	**1**	**4**	**4**				**32**
Maritimes															
Campylobacter jejuni	42 (89.4)	20	19	2	1			3	1	3	3				22
Campylobacter coli	5 (10.6)	2	1	2									2	2	3
Total	**47 (100)**	**22**	**20**	**4**	**1**			**3**	**1**	**3**	**3**		**2**	**2**	**25**

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

Figure 22. Temporal variation in resistance to selected antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2003–2009.



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

Enterococcus

Retail Meat Surveillance

(n = 459)

(British Columbia [n = 72], Saskatchewan [n = 92], Ontario [n = 164], Québec [n = 131])[1]

Recovery: *Enterococcus* isolates were recovered from 99% (460/464) of retail chicken samples.[2] Province-specific percentages of chicken samples from which *Enterococcus* was recovered were as follows: British Columbia, 97% (72/74); Saskatchewan, 100% (92/92); Ontario, 100% (164/164); and Québec, 99% (132/134; Table C.5, Appendix C). Ninety-three percent (426/459) of the isolates were *E. faecalis*, 5% (25/459) were other *Enterococcus* spp., and 2% (8/459) were *E. faecium*.

Antimicrobial Resistance: Results are presented in Figure 23, Figure 24, Table 17, and Table B.17, Appendix B. Resistance to ciprofloxacin was detected in 6% (4/72) of *Enterococcus* isolates from British Columbia, 3% (5/164) of isolates from Ontario, and 2% (3/131) of isolates from Québec. Ciprofloxacin resistance was detected in 5 of 8 *E. faecium* isolates, in 1% (5/426) of *E. faecalis* isolates, and in 8%

[1] Ninety-three isolates recovered from retail chicken from the Maritimes region underwent antimicrobial susceptibility testing but results are not presented in this report because of concerns surrounding harmonization of laboratory methods for 2009.
[2] One isolate (*Enterococcus* spp.) from Québec could not be cultured after freezing, leaving 459 isolates available for antimicrobial susceptibility testing.

(2/25) of other *Enterococcus* spp. isolates. No isolates from any province/region were resistant to linezolid, tigecycline, or vancomycin. Additionally, no isolates were non-susceptible to daptomycin.[1]

The percentage of isolates with resistance to gentamicin was significantly lower in British Columbia (0%) than in Ontario and Québec. There were no significant differences among the provinces/region in percentages of resistant isolates for any of the other antimicrobials tested.

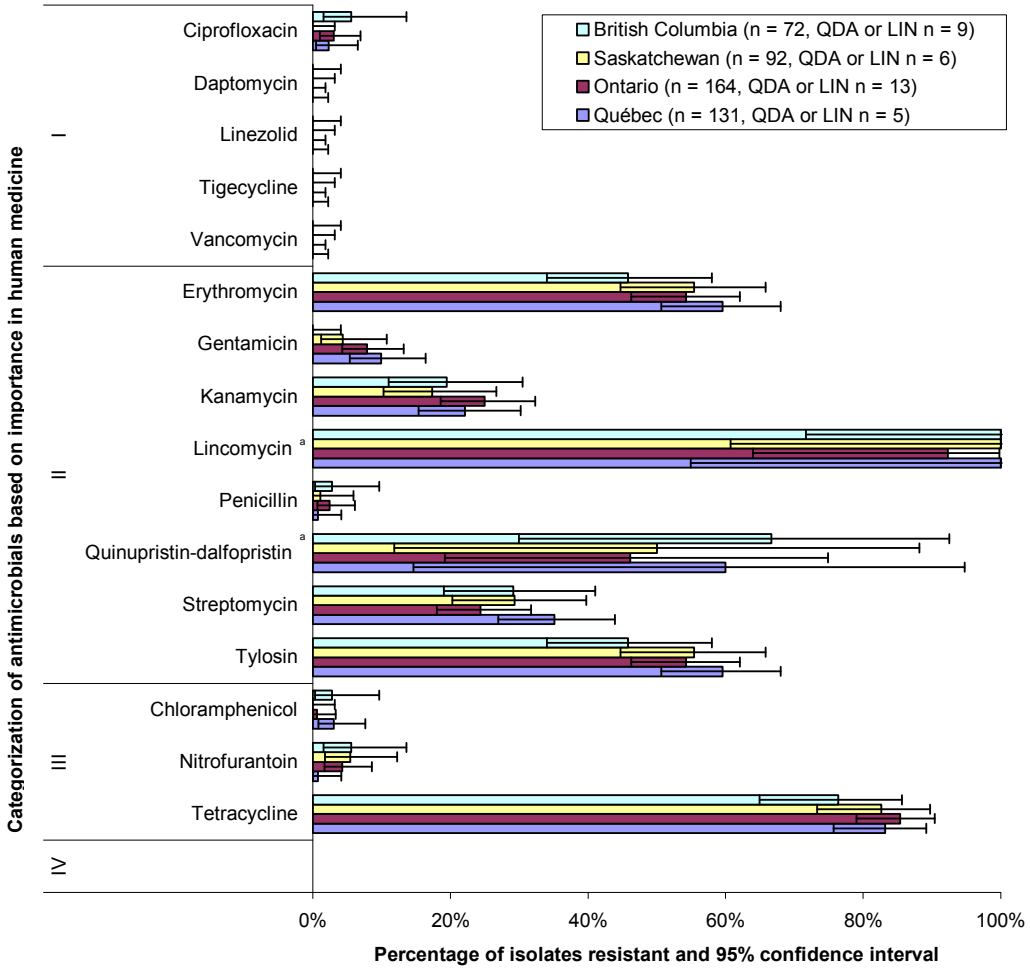
Antimicrobial Resistance Patterns: Results are presented in Table 17. Resistance to 1 or more antimicrobial classes was detected in 86% (62/72) of *Enterococcus* isolates from British Columbia, 91% (84/92) of isolates from Saskatchewan, 91% (149/164) of isolates from Ontario, and 92% (121/131) of isolates from Québec. Resistance to 6 or more antimicrobial classes was detected in 6% (4/72) of isolates (2 *E. faecium*) from British Columbia and 3% (5/164) of isolates (3 *E. faecium* and 2 *Enterococcus* spp.) from Ontario. Among all isolates, the most common resistance patterns were TET (27%, 123/459) and ERY-TET-TYL (21%, 95/459). The pattern involving the greatest number of antimicrobials was CIP-ERY-KAN-LIN-NIT-PEN-STR-QDA-TET-TYL (2 *E. faecium*).

Temporal Variations: Results are presented in Figure 25. Percentages of *Enterococcus* isolates from Saskatchewan with resistance to erythromycin and tylosin were significantly higher in 2009 (55% [51/92] and 55% [51/92], respectively) than in 2005 (39% [31/80] and 40% [32/80], respectively). No other significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, resistance to ciprofloxacin was detected in 6% (4/72) of retail chicken isolates of *Enterococcus* from British Columbia, 3% (5/164) of isolates from Ontario, and 2% (3/131) of isolates from Québec. Ciprofloxacin resistance was detected in 5 of 8 *E. faecium* isolates, in 1% (5/426) of *E. faecalis* isolates, and in 8% (2/25) of other *Enterococcus* spp. isolates. The pattern involving the greatest number of antimicrobials was CIP-ERY-KAN-LIN-NIT-PEN-STR-QDA-TET-TYL (2 *E. faecium* isolates). Percentages of *Enterococcus* isolates from Saskatchewan with resistance to erythromycin and tylosin were significantly higher in 2009 (55% [51/92] and 55% [51/92], respectively) than in 2005 (39% [31/80] and 40% [32/80], respectively).

[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.

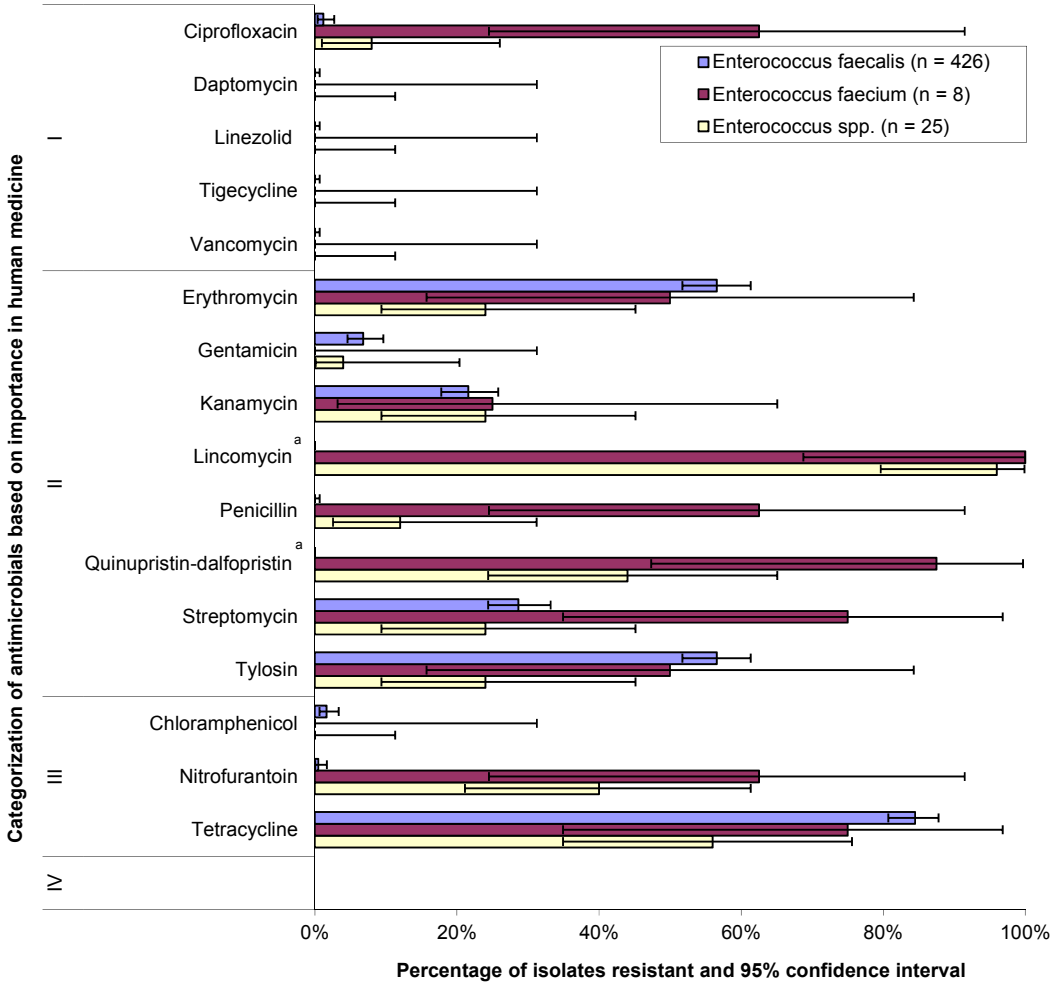
Figure 23. Resistance to antimicrobials in *Enterococcus* isolates from chicken, by province; *Retail Meat Surveillance*, 2009.



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

Ninety-three isolates recovered from retail chicken from the Maritimes region underwent antimicrobial susceptibility testing but results are not presented in this report because of concerns surrounding harmonization of laboratory methods for 2009.

Figure 24. Resistance to antimicrobials in *Enterococcus* isolates from chicken by species; *Retail Meat Surveillance*, 2009.



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

Table 17. Number of antimicrobial classes in resistance patterns of *Enterococcus* isolates from chicken; *Retail Meat Surveillance*, 2009.

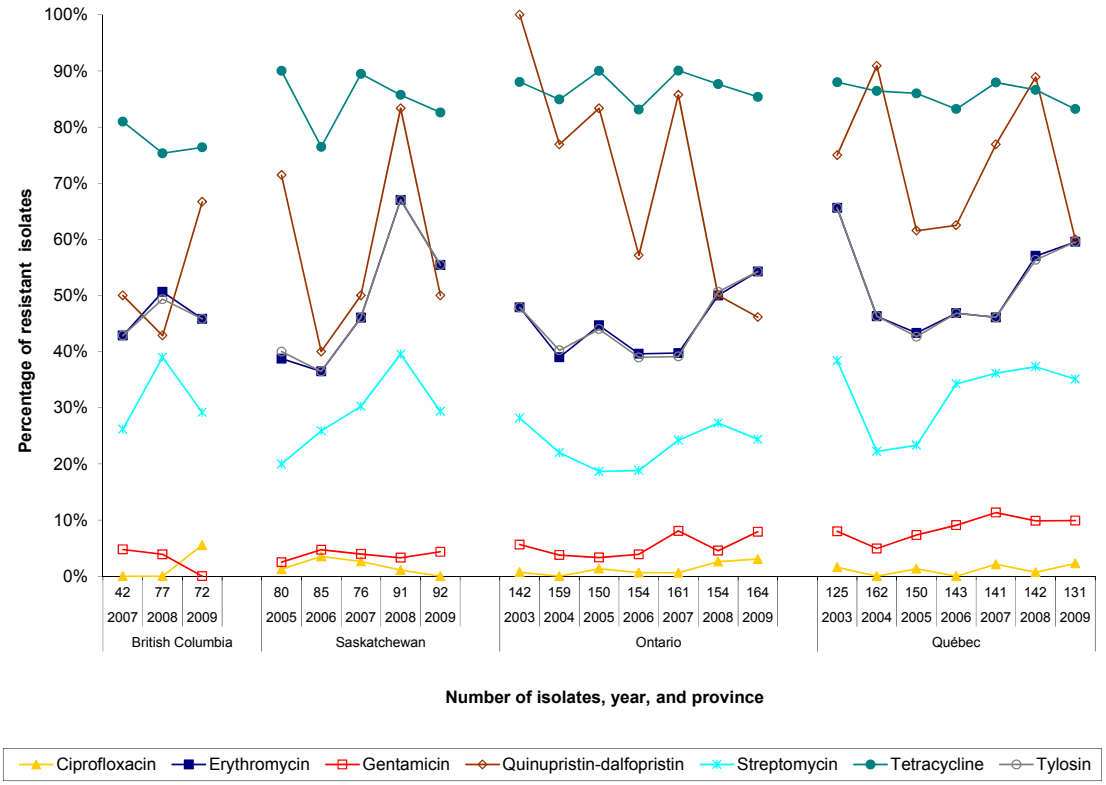
Province or region / species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial															
							Aminoglycosides			Glycopeptides	Glycylcyclines	Lincosamides	Lipopeptides	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
British Columbia																						
Enterococcus faecalis	63 (87.5)	10	21	32				12	17					31	31				2	2		50
Enterococcus spp.	7 (9.7)			7				1	2			7		1	1	3					4	3
Enterococcus faecium	2 (2.8)				2			1	2			2		1	1	1		2		2	2	2
Total	**72 (100)**	**10**	**21**	**39**	**2**			**14**	**21**			**9**		**33**	**33**	**4**		**2**	**2**	**4**	**6**	**55**
Saskatchewan																						
Enterococcus faecalis	86 (93.5)	8	30	48			4	16	27					51	51							72
Enterococcus spp.	5 (5.4)			5								5				4		1			2	3
Enterococcus faecium	1 (1.1)			1								1				1					1	1
Total	**92 (100)**	**8**	**30**	**54**			**4**	**16**	**27**			**6**		**51**	**51**	**5**		**1**			**3**	**76**
Ontario																						
Enterococcus faecalis	151 (92.1)	15	50	86			12	36	34					82	82	2			1	1		131
Enterococcus spp.	9 (5.5)		2	5	2		1	4	3			8		4	4	2		1		2	3	6
Enterococcus faecium	4 (2.4)		1		3			1	3			4		3	3	3		3		2	3	3
Total	**164 (100)**	**15**	**53**	**91**	**5**		**13**	**41**	**40**			**12**		**89**	**89**	**7**		**4**	**1**	**5**	**6**	**140**
Québec																						
Enterococcus faecalis	126 (96.2)	10	38	78			13	28	44					77	77				4	2		107
Enterococcus spp.	4 (3.1)		1	3				1	1			4		1	1	1		1			2	2
Enterococcus faecium	1 (0.8)			1					1			1								1	1	
Total	**131 (100)**	**10**	**39**	**82**			**13**	**29**	**46**			**5**		**78**	**78**	**1**		**1**	**4**	**3**	**3**	**109**

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

Ninety-three isolates recovered from retail chicken from the Maritimes region underwent antimicrobial susceptibility testing, but results are not presented in this report because of concerns surrounding harmonization of laboratory methods for 2009.

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

Figure 25. Temporal variation in resistance to selected antimicrobials in *Enterococcus* isolates from chicken; *Retail Meat Surveillance*, 2003–2009.



The annual number of isolates tested for resistance to quinupristin-dalfopristin was smaller than indicated because no isolates of *E. faecalis* were included in the analysis for this antimicrobial.
Ninety-three isolates recovered from retail chicken from the Maritimes region underwent antimicrobial susceptibility testing, but results are not presented in this report because of concerns surrounding harmonization of laboratory methods for 2009.

Pigs

Salmonella

Abattoir Surveillance

(n = 147)

Recovery: *Salmonella* isolates were recovered from 45% (147/327) of pig caecal samples (Table C.5, Appendix C).

Serovars: Results are presented in Table 18 and Table C.3, Appendix C. The most common *Salmonella* serovars were Derby (18%, 26/147), Typhimurium var. 5- (14%, 20/147), and Brandenburg (9%, 13/147). These 3 serovars accounted for 40% (59/147) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 26, Table 18, and Table B.18, Appendix B. No *Salmonella* isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate.

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% (75/147) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 16% (24/147) of isolates (12 *S*. Typhimurium var. 5-, 6 *S*. Typhimurium, 3 *S*. Krefeld, 1 *S*. Agona, 1 *S*. Anatum, and 1 *S*. Ohio). The most common resistance patterns were STR-SSS-TET (14%, 21/147), TET (8%, 12/147), and ACKSSuT (7%, 11/147). The pattern involving the greatest number of antimicrobials was ACKSSuT-GEN-SXT (1 *S*. Ohio isolate).

Temporal Variations: Results are presented in Figure 27. The percentage of *Salmonella* isolates with resistance to tetracycline was significantly lower in 2009 (46%, 68/147) than in 2008 (57%, 87/151). No other significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, no *Salmonella* isolates recovered from abattoir pigs were resistant to the Category I antimicrobials tested. There were no isolates with reduced susceptibility to ciprofloxacin. Resistance to 4 or more antimicrobial classes was detected in 16% (24/147) of the isolates. The percentage of isolates with resistance to tetracycline was significantly lower in 2009 (46%, 68/147) than in 2008 (57%, 87/151).

Figure 26. Resistance to antimicrobials in *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2009.

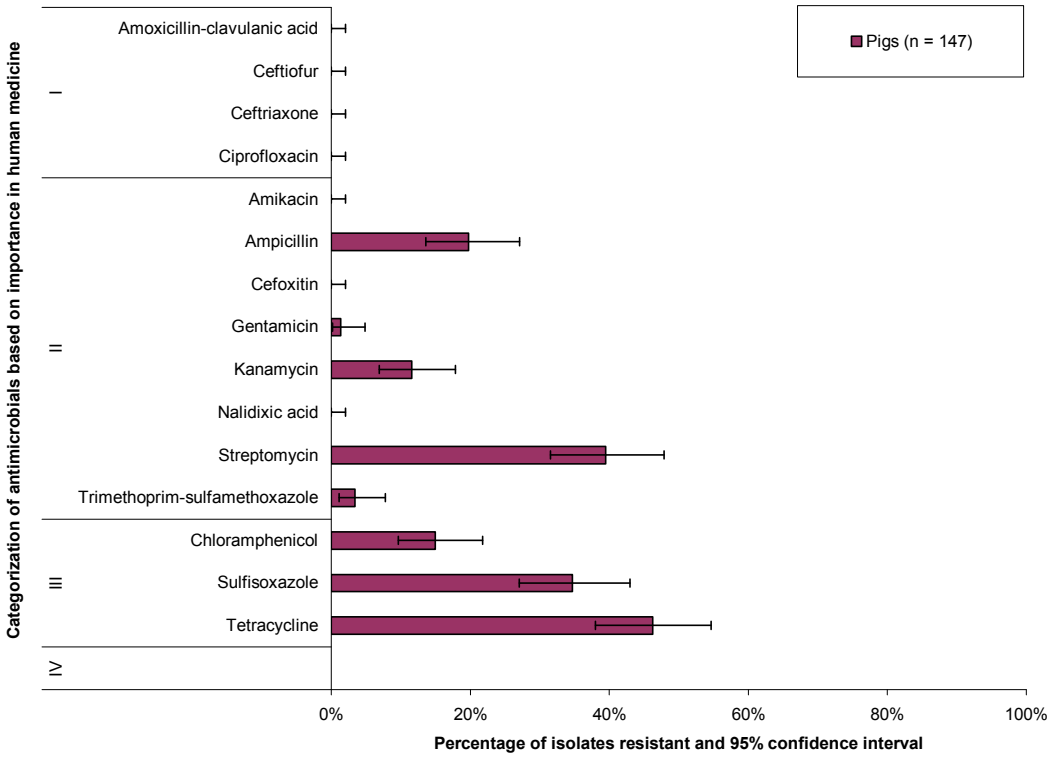
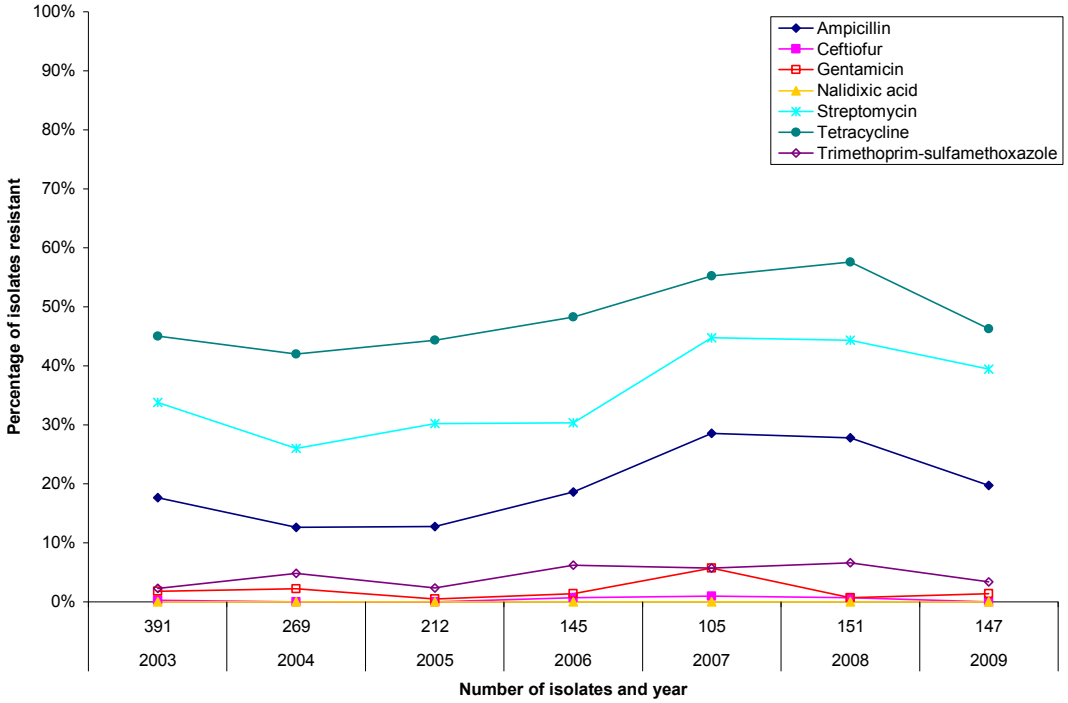


Table 18. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2009.

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	26 (17.7)	6	2	18						17						18	1	1			17
Typhimurium var. 5-	20 (13.6)	6	2		12				6	12	12					12		11			14
Brandenburg	13 (8.8)	8	3	2					1	2	1										4
Infantis	11 (7.5)	11																			
Typhimurium	11 (7.5)			5	6				4	9	10					7	2	5			10
Worthington	8 (5.4)	3	5																		5
Schwarzengrund	5 (3.4)	4		1						1						1		1			
Anatum	4 (2.7)	2	1		1				1		1					1	1				2
Enteritidis	4 (2.7)	4																			
Give	4 (2.7)	3		1						1	1										
Hadar	3 (2.0)			3						3											3
Havana	3 (2.0)	3																			
Krefeld	3 (2.0)				3				3	3	3					3		2			3
Mbandaka	3 (2.0)			3				1	1	3						3					3
Less common serovars	29 (19.7)	22		5	2			1	1	7	1					6	1	2			7
Total	**147 (100)**	**72**	**13**	**38**	**24**			**2**	**17**	**58**	**29**					**51**	**5**	**22**			**68**

Serovars represented by less than 2% of isolates were classified as “Less common serovars.”
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Figure 27. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2003–2009.



Farm Surveillance[1]

(n = 124)

Recovery: *Salmonella* isolates were recovered from 18% (124/698) of pig fecal 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 Typhimurium var. 5- (23%, 28/124) and Derby (20%, 25/124). These 2 serovars accounted for 43% (53/124) of the isolates.

Antimicrobial Resistance: Results are presented in Figure 28, Table 19, and Table B.19, Appendix B. No *Salmonella* isolates were resistant to amoxicillin-clavulanic acid, ceftiofur, ceftriaxone, ciprofloxacin, amikacin, cefoxitin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate.

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 71% (88/124) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 22% (27/124) of isolates (11 *S.* Typhimurium var 5-, 9 *S.* Typhimurium, 3 *S.* I 4,12:i:-, 1 *S.* Derby, 1 *S.* California, 1 *S.* Mbandaka, 1 *S.* Ohio). The most common resistance patterns were STR-SSS-TET (19%, 23/124), TET (11%, 14/124), and KAN-TET (7%, 9/124). The patterns involving the greatest number of antimicrobials were ACKSSuT-SXT (3 *S.* Typhimurium) and AKSSuT-GEN-SXT (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 29. No significant temporal variations were detected in the percentages of Salmonella isolates with resistance to the selected antimicrobials between 2009 and 2006 or between 2009 and 2008.

In 2009, no *Salmonella* isolates recovered from pigs on farms were resistant to the Category I antimicrobials tested or had reduced susceptibility to ciprofloxacin. Resistance to 4 or more antimicrobial classes was detected in 22% (27/124) of the isolates. The patterns involving the greatest number of antimicrobials were ACKSSuT-SXT and AKSSuT-GEN-SXT. No significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials between 2009 and 2006 or between 2009 and 2008.

Figure 28. Resistance to antimicrobials in *Salmonella* isolates from pigs; *Farm Surveillance*, 2009.

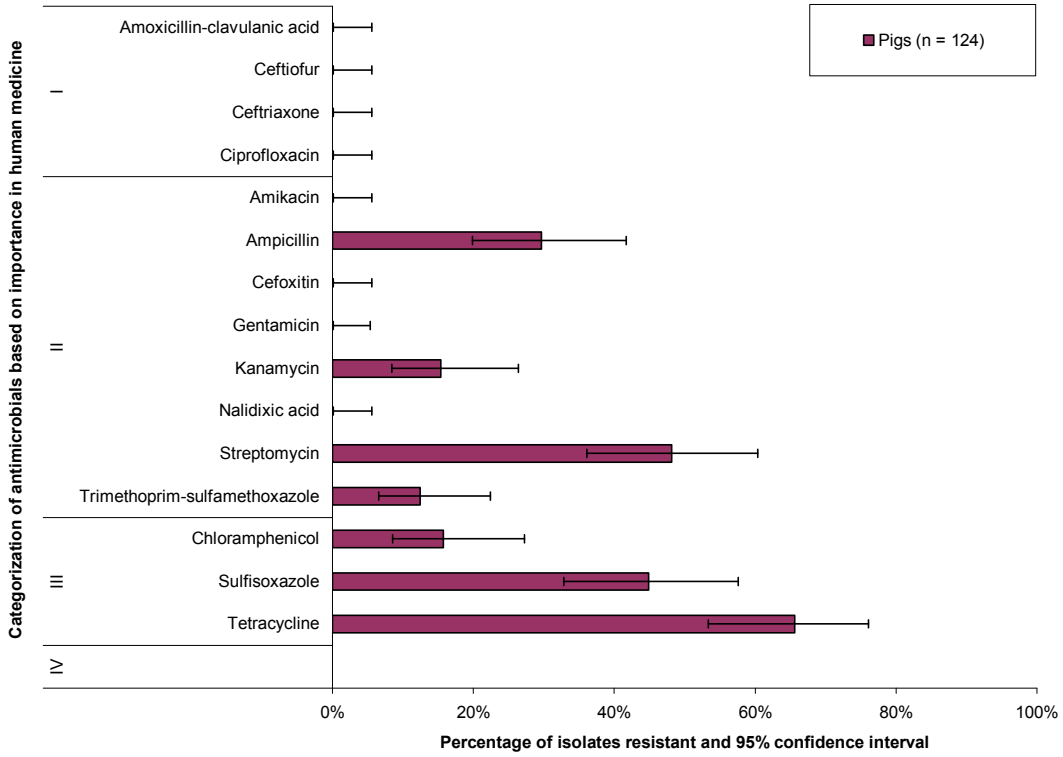
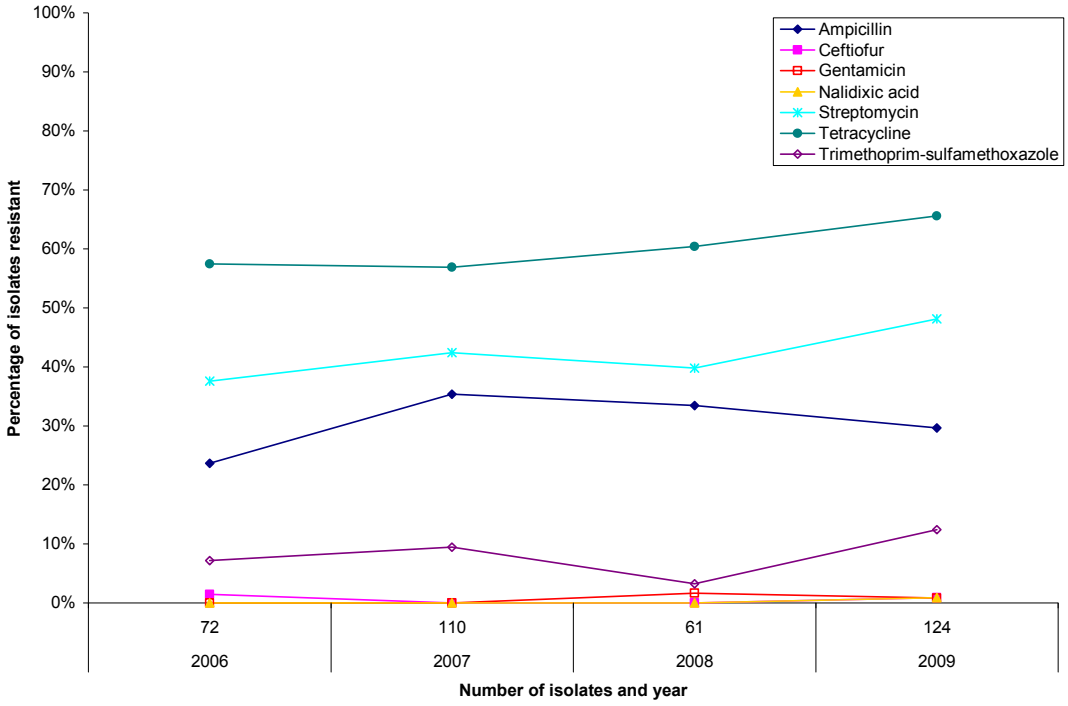


Table 19. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Farm Surveillance*, 2009.

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-	28 (22.6)		2	15	11				11	13	15					12	4	7			28
Derby	25 (20.2)	6	1	17	1					18	1					18	1				19
Typhimurium	13 (10.5)	1		3	9				12	12	9					12	6	7			11
Brandenburg	12 (9.7)	2	8	2							2										10
Infantis	7 (5.6)	7																			
Senftenberg	5 (4.0)	5																			
I 4,12:i:-	4 (3.2)			1	3					3	4					3	1				4
Schwarzengrund	4 (3.2)	1		3						3						3					3
Bovismorbificans	3 (2.4)	1	2								2										
I 4,12:-:e,n,z15	3 (2.4)	3																			
Cerro	2 (1.6)	2																			
London	2 (1.6)	2																			
Rissen	2 (1.6)	1		1						1						1					1
Less common serovars	14(11.3)	5	4	2	3			1	3	5	3					4	3	1			8
Total	**124 (100)**	**36**	**17**	**44**	**27**			**1**	**26**	**55**	**36**					**53**	**15**	**15**			**84**

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

Figure 29. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from pigs; *Farm Surveillance*, 2006-2009.



Surveillance of Animal Clinical Isolates[1]

(n = 226)

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 20 and Table C.3, Appendix C. The most common *Salmonella* serovars among pig clinical isolates were Typhimurium (31%, 71/226), Derby (12%, 27/226), and Typhimurium var. 5- (12%, 27/226). These 3 serovars accounted for 55% (125/226) of the isolates.

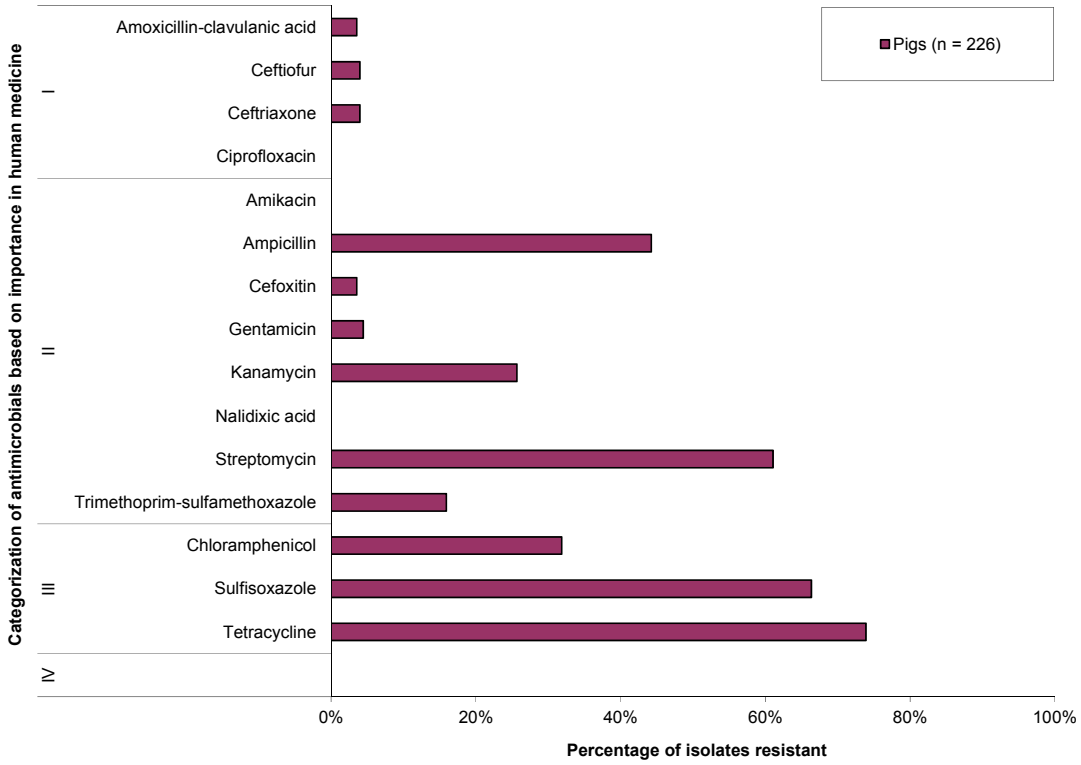
Antimicrobial Resistance: Results are presented in Figure 30, Table 20, and Table B.20, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 4% (8/226) of *Salmonella* isolates. Resistance to ceftiofur and ceftriaxone were each detected in 4% (9/226) of isolates. No isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate.

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 75% (170/226) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 42% (95/226) of isolates (50 *S*. Typhimurium, 20 *S*. Typhimurium var. 5-, 6 *S.* I 4,[5],12:i:-, 4 *S*. Bovismorbificans, 3 *S*. Ohio, 2 *S.* I 6,8:r:-, 2 *S*. Krefeld, 1 *S*. Brandenburg, 1 *S*. Derby, 1 *S.* I 39:-:-, 1 *S.* I 4,[5],12:-:-, 1 *S*. Mbandaka, 1 *S*. Ohio var. 14+, 1 *S*. Putten, and 1 *S*. Schwarzengrund). The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO-GEN-SXT (2 *S*. Ohio).

In 2009, resistance to ceftiofur and ceftriaxone were each detected in 4% (9/226) of pig clinical isolates of *Salmonella*. The pattern involving the greatest number of antimicrobials was ACKSSuT-A2C-CRO-GEN-SXT (2 *S*. Ohio).

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

Figure 30. Resistance to antimicrobials in *Salmonella* isolates from pigs; *Surveillance of Animal Clinical Isolates*, 2009.



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

Table 20. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Surveillance of Animal Clinical Isolates*, 2009.

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	71 (31.4)	7	1	13	50			3	26	53	54	3	3	3	3	61	22	41			64
Derby	27 (11.9)	4	2	20	1					21						21		1			23
Typhimurium var. 5-	27 (11.9)	2	1	4	20			3	15	22	21					24	4	13			24
Infantis	12 (5.3)	11	1																		1
Brandenburg	8 (3.5)	4	2	1	1			1	1	2	1		1		1	1	1	1			4
Schwarzengrund	8 (3.5)	3		4	1				1	5	1					5					5
I 4,[5],12:i:-	7 (3.1)	1			6				4	6	6					6	3	5			6
Mbandaka	7 (3.1)	3		3	1			1	1	3	1					3	1				4
Worthington	6 (2.7)	3		3						3						3					3
Bovismorbificans	5 (2.2)		1		4				2	4	5	2	2	2	2	4		2			4
Less common serovars	48 (21.2)	18	5	14	11			2	8	19	11	3	3	3	3	22	5	9			29
Total	**226 (100)**	**56**	**13**	**62**	**95**			**10**	**58**	**138**	**100**	**8**	**9**	**8**	**9**	**150**	**36**	**72**			**167**

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

Escherichia coli

Retail Meat Surveillance

(n = 325)

(British Columbia [n = 38], Saskatchewan [n = 29], Ontario [n = 136], Québec [n = 41],

Maritimes region [n = 81])

Recovery: *Escherichia coli* isolates were recovered from 30% (326/1,105) of retail pork samples.[1] Province/region-specific percentages of pork samples from which isolates were recovered were as follows: British Columbia, 26% (38/145); Saskatchewan, 18% (29/164); Ontario, 41% (136/328); Québec, 15% (41/268); and Maritimes region (New Brunswick, Nova Scotia, and Prince Edward Island), 41% (82/200; Table C.5, Appendix C).

Antimicrobial Resistance: Results are presented in Figure 31, Table 21, and Table B.21, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 3% (1/29) of *E. coli* isolates from Saskatchewan and 1% (1/81) of isolates from the Maritimes. Resistance to ceftiofur and ceftriaxone were each detected in 3% (1/29) of isolates from Saskatchewan. Reduced susceptibility to ciprofloxacin was detected in 1% (1/81) of isolates from the Maritimes, as was resistance to nalidixic acid. No isolates from any province/region were resistant to ciprofloxacin and amikacin. No significant differences were detected among the provinces/region in percentages of isolates with resistance to any of the antimicrobials tested.

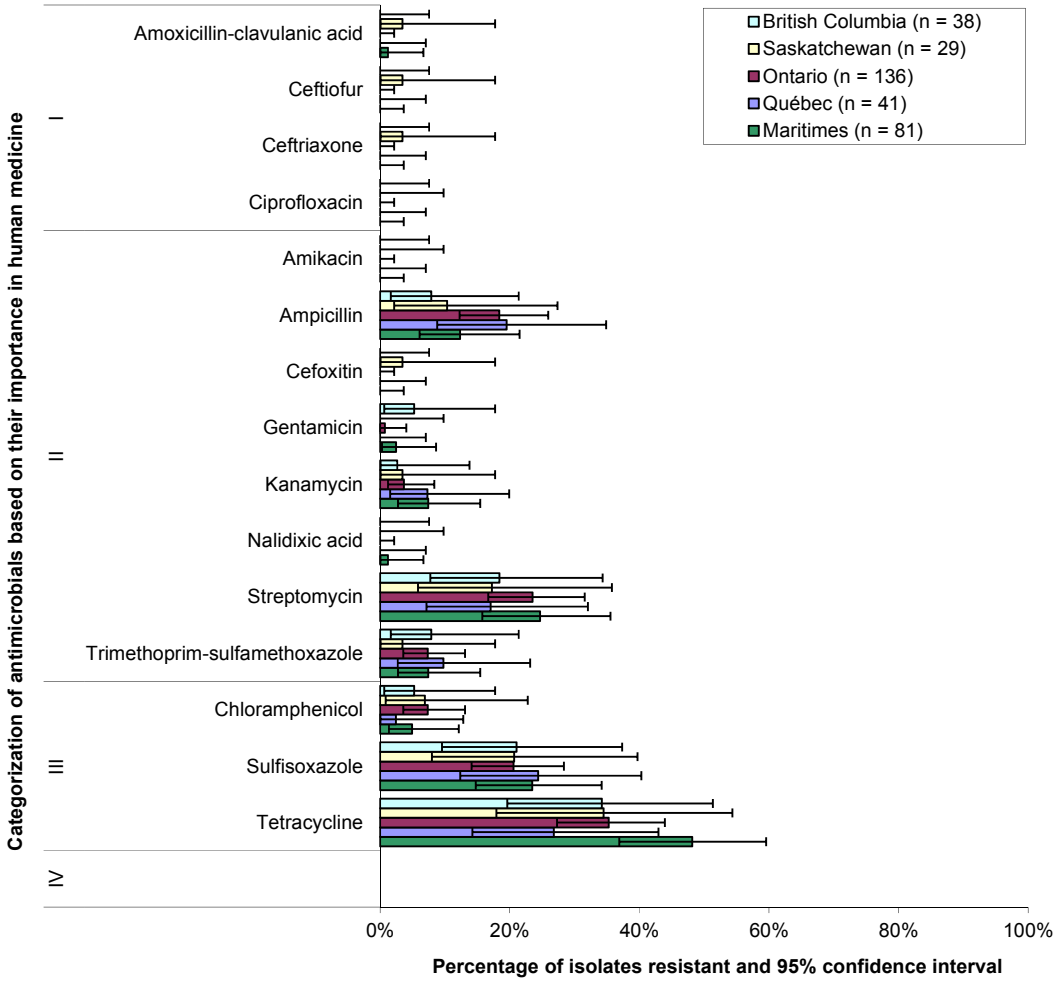
Antimicrobial Resistance Patterns: Results are presented in Table 21 and Table C.4, Appendix C. Resistance to 1 or more antimicrobial classes was detected 37% (14/38) of *E. coli* isolates from British Columbia, 41% (12/29) of isolates from Saskatchewan, 40% (54/136) of isolates from Ontario, 39% (16/41) of isolates from Québec, and 53% (43/81) of isolates from the Maritimes. Resistance to 4 or more antimicrobial classes was detected in 10% (3/29) of isolates from Saskatchewan, 10% (14/136) of isolates from Ontario, 5% (2/41) of isolates from Québec, and 10% (8/81) of isolates from the Maritimes. Among all isolates, the most common resistance patterns were TET (10%, 31/325), STR-TET (4%, 13/325), and AMP-STR-TET (3%, 10/325). The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-CHL-KAN-SSS-TET (1 isolate).

Temporal Variations: Results are presented in Figure 32. The percentage of *E. coli* isolates from Ontario with resistance to streptomycin was significantly higher in 2009 (24%, 32/136) than in 2008 (14%, 22/155). The percentage of isolates from Ontario with resistance to tetracycline was significantly lower in 2009 (35%, 48/136) than in 2003 (54%, 49/90). Similarly, the percentage of isolates from Québec with resistance to tetracycline was significantly lower in 2009 (27%, 11/41) than in 2008 (48%, 29/61). No other significant temporal variations were detected.

In 2009, resistance to ceftiofur and ceftriaxone were each detected in 3% (1/29) of *Escherichia coli* isolates from retail pork samples from Saskatchewan. Reduced susceptibility to ciprofloxacin was detected in 1% (1/81) of isolates from the Maritimes. The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-CHL-KAN-SSS-TET (1 isolate). The percentage of *E. coli* isolates from Ontario with resistance to streptomycin was significantly higher in 2009 (24%, 32/136) than in 2008 (14%, 22/155). The percentage of isolates from Ontario with resistance to tetracycline was significantly lower in 2009 (35%, 48/136) than in 2003 (54%, 49/90). Similarly, the percentage of isolates from Québec with resistance to tetracycline was significantly lower in 2009 (27%, 11/41) than in 2008 (48%, 29/61).

[1] One isolate from the Maritimes could not be cultured after freezing, leaving 325 isolates available for antimicrobial susceptibility testing.

Figure 31. Resistance to antimicrobials in *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2009.



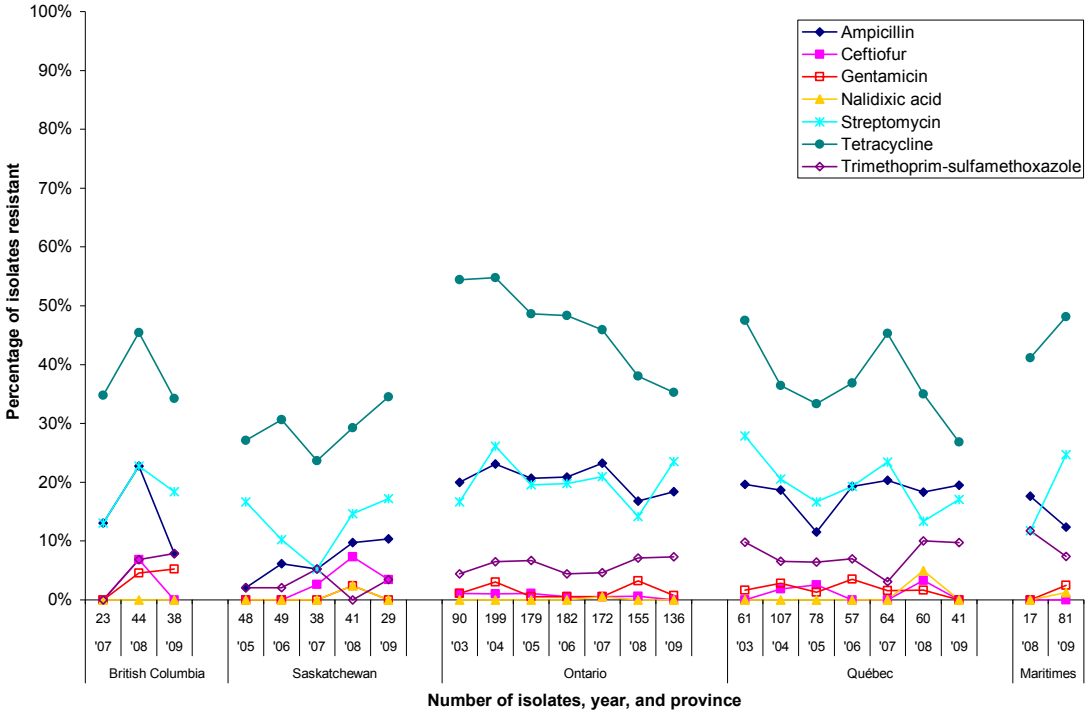
The Maritimes is a region including the provinces of New Brunswick, Nova Scotia, and Prince Edward Island.

Table 21. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2009.

Province / region	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial												
							Aminoglycosides				β-lactams					Folate pathway inhibitors		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	38 (11.7)	24	2	12				2	1	7	3					8	3	2			13
Saskatchewan	29 (8.9)	17	6	3	3				1	5	3	1	1	1	1	6	1	2			10
Ontario	136 (41.8)	82	14	26	14			1	5	32	25					28	10	10			48
Québec	41 (12.6)	25	5	9	2				3	7	8					10	4	1			11
Maritimes	81 (24.9)	38	14	21	8			2	6	20	10	1				19	6	4		1	39

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

Figure 32. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2003–2009.



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

Abattoir Surveillance

(n = 160)

Recovery: *Escherichia coli* isolates were recovered from 98% (160/163) of pig caecal samples (Table C.5, Appendix C).

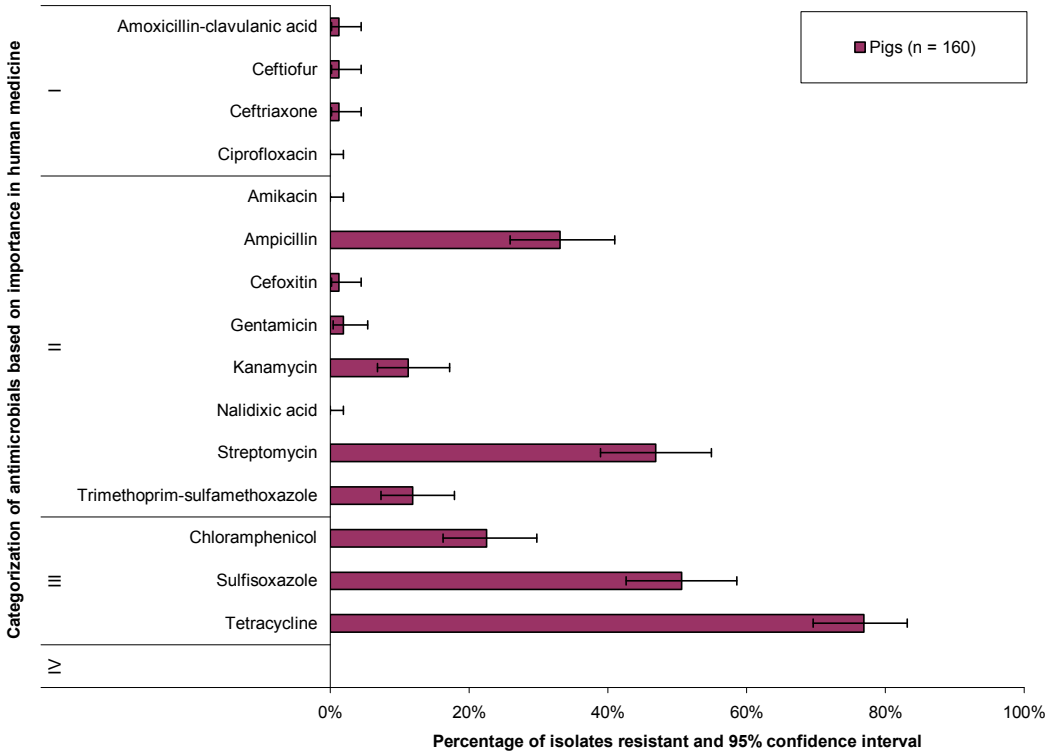
Antimicrobial Resistance: Results are presented in Figure 33, Table 10, and Table B.22, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 1% (2/160) of *E. coli* isolates. No isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate.

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 86% (138/160) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 20% (32/160) of isolates. The most common resistance patterns were TET (10%, 16/160), STR-TET (8%, 12/160), AMP-STR-TET (6%, 10/160), and SSS-TET (6%, 10/160). The pattern involving the greatest number of antimicrobials was ACSSuT-A2C-CRO-SXT (2 isolates).

Temporal Variations: Results are presented in Figure 28. The percentage of *E. coli* isolates with resistance to streptomycin was significantly higher in 2009 (47%, 75/160) than in 2008 (35%, 53/150). Between 2009 and 2003, no significant temporal variations were detected in the percentages of *E. coli* isolates with resistance to selected antimicrobials.

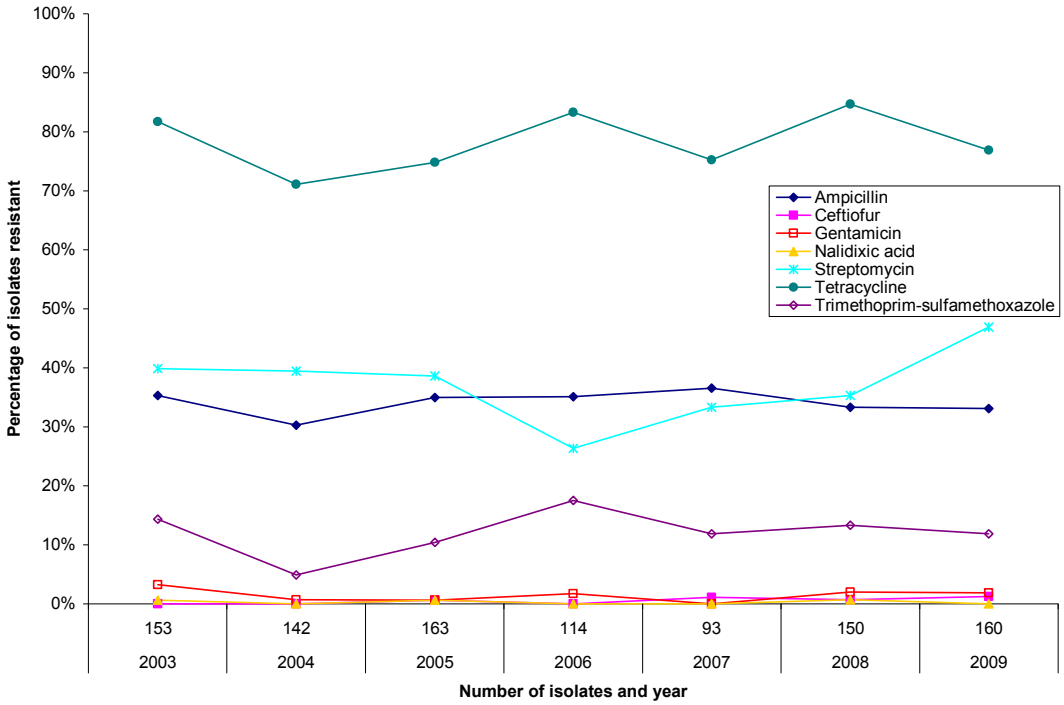
In 2009, resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 1% (2/160) of *Escherichia coli* isolates from pigs at abattoirs. Resistance to 1 or more antimicrobial classes was detected in 86% (138/160) of isolates. Resistance to 4 or more antimicrobial classes was detected in 20% (32/160). The percentage of isolates resistant to streptomycin was significantly higher in 2009 (47%, 75/160) than in 2008 (35%, 53/150).

Figure 33. Resistance to antimicrobials in *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2009.



Results regarding the number of antimicrobial classes in resistance patterns of *E. coli* isolates from abattoir pigs can be found in Table 10.

Figure 34. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2003–2009.



Farm Surveillance[1]

(n = 2,057)

Recovery: *Escherichia coli* isolates were recovered from 99% (695/698) 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 35 and Table B.23, Appendix B. Resistance to amoxicillin-clavulanic acid was detected in 1% (24/2,057) of *E. coli* isolates. Resistance to ceftiofur and ceftriaxone were each detected in less than 1% (3/2,057) of isolates. Ciprofloxacin resistance was detected in less than 1% (1/2,057), as was reduced susceptibility to ciprofloxacin (2/2,057). Resistance to nalidixic acid was also detected in less than 1% (4/2,057). No isolates were resistant to amikacin.

Antimicrobial Resistance Patterns: Resistance to 1 or more antimicrobial classes was detected in 84% (1,721/2,057) of *E. coli* isolates. Resistance to 4 or more antimicrobial classes was detected in 19% (384/2,057) of isolates. The most common resistance patterns were TET (15%, 316/2,057), AMP-TET (5%, 104/2,057), and AMP-STR-TET (5%, 95/2,057). Resistance or reduced susceptibility to ciprofloxacin with resistance to nalidixic acid was detected in less than 1% (1/2,057 for each pattern). The pattern involving the greatest number of antimicrobials was ACKSSuT-GEN-SXT (1 isolate).

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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] The total expected number of isolates was 1,836 (695 X 3), but 28 isolates could not be cultured after freezing, leaving 2,057 available for antimicrobial susceptibility testing. 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 was to ensure adequate statistical power to investigate the association between antimicrobial resistance and antimicrobial use.

Temporal Variations: Results are presented in Figure 36. The percentage of *E. coli* isolates with ceftiofur resistance was significantly lower in 2009 (less than 1%, 3/2,057) than in 2006 (1%, 17/1,721) and 2008 (1%, 15/1,425). The percentage of *E. coli* isolates with tetracycline resistance was significantly lower in 2009 (77%, 1,572/2,057) than in 2008 (80%, 1,131/1,425). No other significant temporal variations were detected.

In 2009, resistance to ceftiofur and ceftriaxone were each detected in less than 1% (3/2,057) of *Escherichia coli* isolates from pigs on farms. Ciprofloxacin resistance was detected in less than 1% (1/2,057) of isolates, as was reduced susceptibility to ciprofloxacin (2/2,057). Nineteen percent (389/2,057) of isolates were resistant to 4 or more antimicrobial classes. The percentage of isolates with ceftiofur resistance was significantly lower in 2009 (less than 1%, 3/2,057) than in 2006 (1%, 17/1,721) and 2008 (1%, 15/1,425). The percentage of isolates with tetracycline resistance was significantly lower in 2009 (77%, 1,572/2,057) than in 2008 (80%, 1,131/1,425).

Figure 35. Resistance to antimicrobials in *Escherichia coli* isolates from pigs; *Farm Surveillance*, 2009.

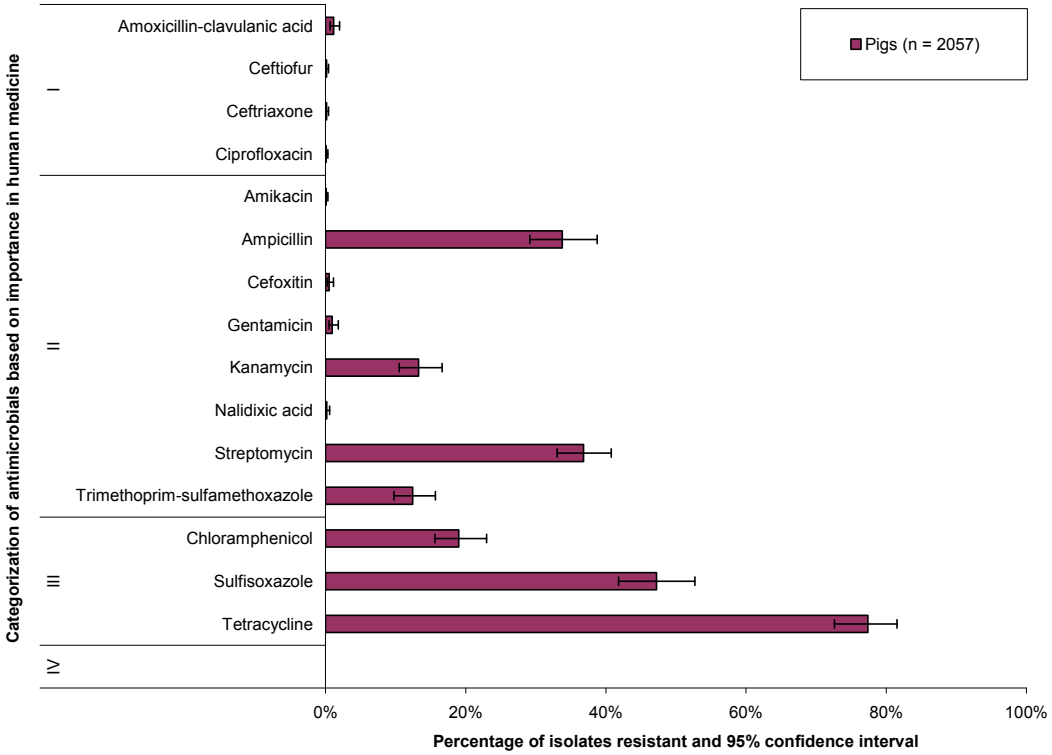
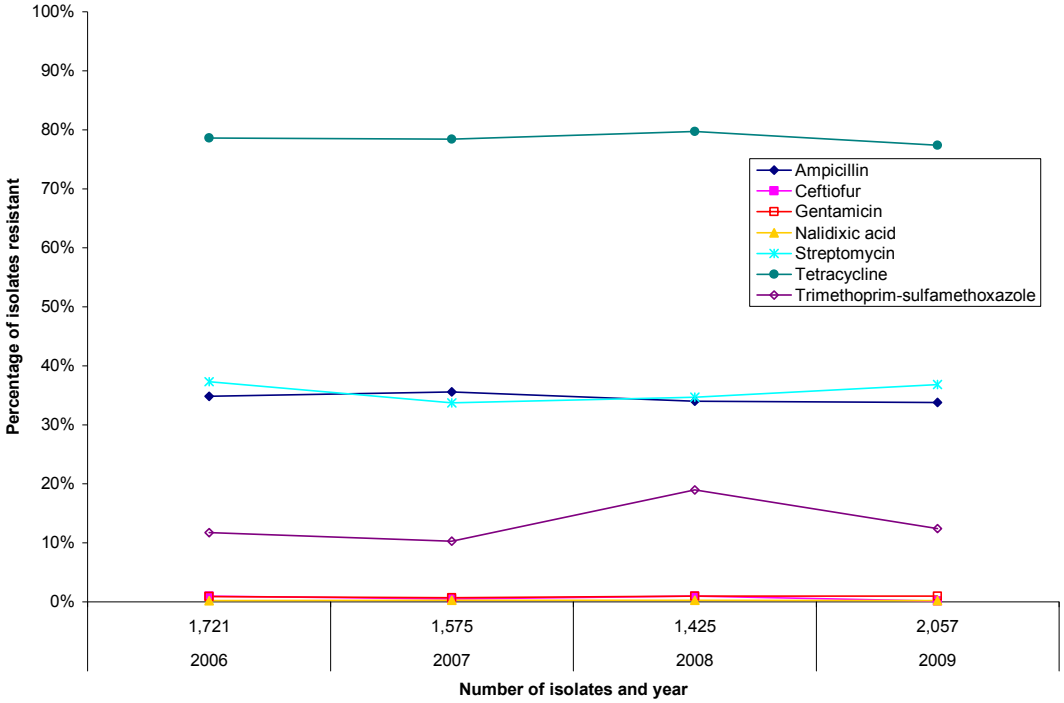


Figure 36. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pigs; *Farm Surveillance*, 2006-2009.



Enterococcus

Farm Surveillance[1]

(n = 1,912)

Recovery: *Enterococcus* isolates were recovered from 97% (680/698) of fecal samples from pigs (Table C.5, Appendix C). As many as 3 isolates per positive sample were kept for analysis.[2] Seventy-three percent (1,397/1,912) of isolates were *E. faecalis*, 24% (467/1,912) were other *Enterococcus* spp., and 3% (48/1,912) were *E. faecium*.

Antimicrobial Resistance: Results are presented in Figure 37, Table 22, and Table B.24, Appendix B. Ciprofloxacin resistance was detected in 2% (30/1,397) of *E. faecalis* isolates, 17% (8/48) of *E. faecium* isolates, and less than 1% (1/467) of other *Enterococcus* spp. isolates. No isolates were resistant to linezolid, tigecycline, or vancomycin. Additionally, no 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] The total expected number of total was 2,040 (680 X 3), but 128 isolates could not be cultured after freezing, leaving 1,912 available for antimicrobial susceptibility testing. 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 was to ensure adequate statistical power to investigate the association between antimicrobial resistance and antimicrobial use.

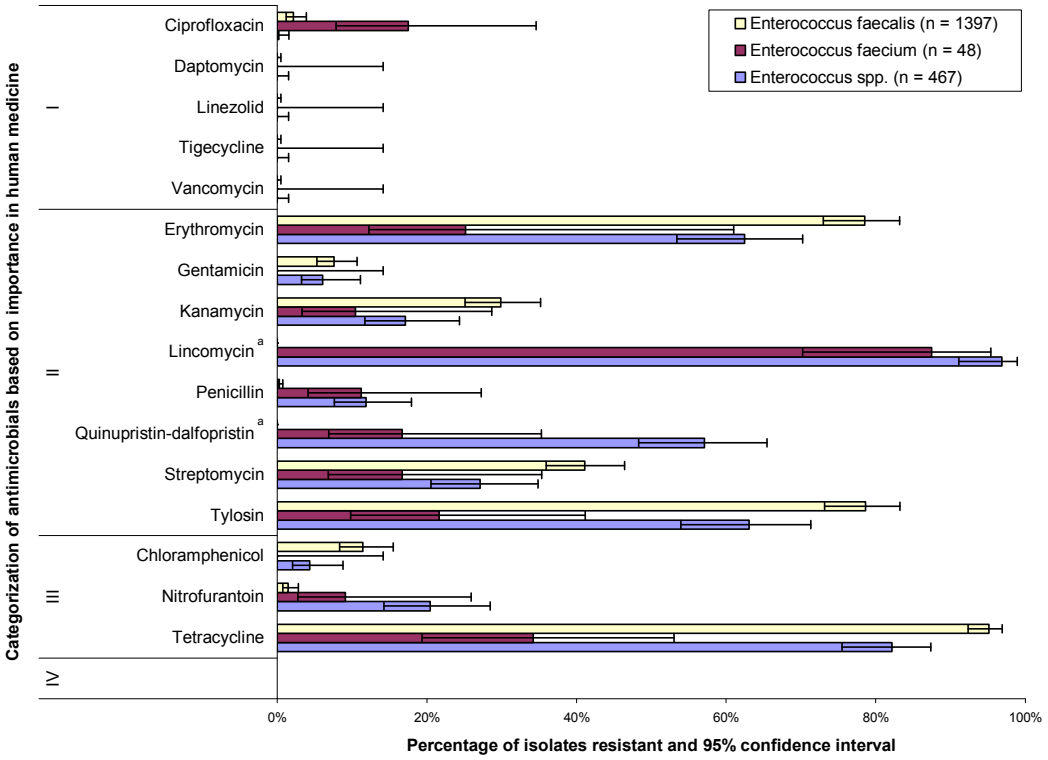
[3] A referenced resistance breakpoint has not been established for this antimicrobial. Therefore, results were determined on a susceptibility/non-susceptibility basis and the expression “non-susceptible” was used instead of “resistant” in the text.

Antimicrobial Resistance Patterns: Results are presented in Table 22. Resistance to 1 or more antimicrobial classes was detected in 97% (1,849/1,912) of *Enterococcus* isolates. Resistance to 6 or more antimicrobial classes was detected in 4% (82/1,912) of isolates (77 *Enterococcus* spp. and 5 *E. faecium*). The most common resistance patterns were ERY-TET-TYL (26%, 498/1,912), ERY-KAN-STR-TET-TYL (12%, 238/1,912), and TET (10%, 189/1,912). The pattern involving the greatest number of antimicrobials was ERY-KAN-LIN-NIT-PEN-QDA-STR-TET-TYL-CHL (1 *Enterococcus* spp.).

Temporal Variations: Results are presented in Figure 38. The percentage of *Enterococcus* isolates with lincomycin resistance was significantly higher in 2009 (96%, 497/515) than in 2006 (72%, 125/175).[1] The percentage with streptomycin resistance was significantly lower in 2009 (36%, 702/1,912) than in 2006 (41%, 258/640) and 2008 (42%, 521/1,266). The percentage of isolates with tetracycline resistance was significantly higher in 2009 (90%, 1,737/1,912) than in 2006 (86%, 556/640). No other significant temporal variations were detected in the percentages of isolates with resistance to the selected antimicrobials.

In 2009, no *Enterococcus* isolates recovered from pigs on farms were resistant to linezolid, tigecycline, or vancomycin or were non-susceptible to daptomycin. Percentages of isolates with lincomycin and tetracycline resistance were significantly higher in 2009 (96% [497/515] and 90% [1,737/1,912], respectively) than in 2006 (72% [125/175] and 86% [556/640], respectively). On the other hand, the percentage of isolates with streptomycin resistance was significantly lower in 2009 (36%, 702/1,912) than in 2006 (41%, 258/640) and 2008 (42% 521/1,266).

Figure 37. Resistance to antimicrobials in *Enterococcus* isolates from pigs; *Farm Surveillance*, 2009.



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

[1] These results include only those from *E. faecium* and *Enterococcus* spp. because *E. faecalis* is intrinsically resistant to lincomycin.

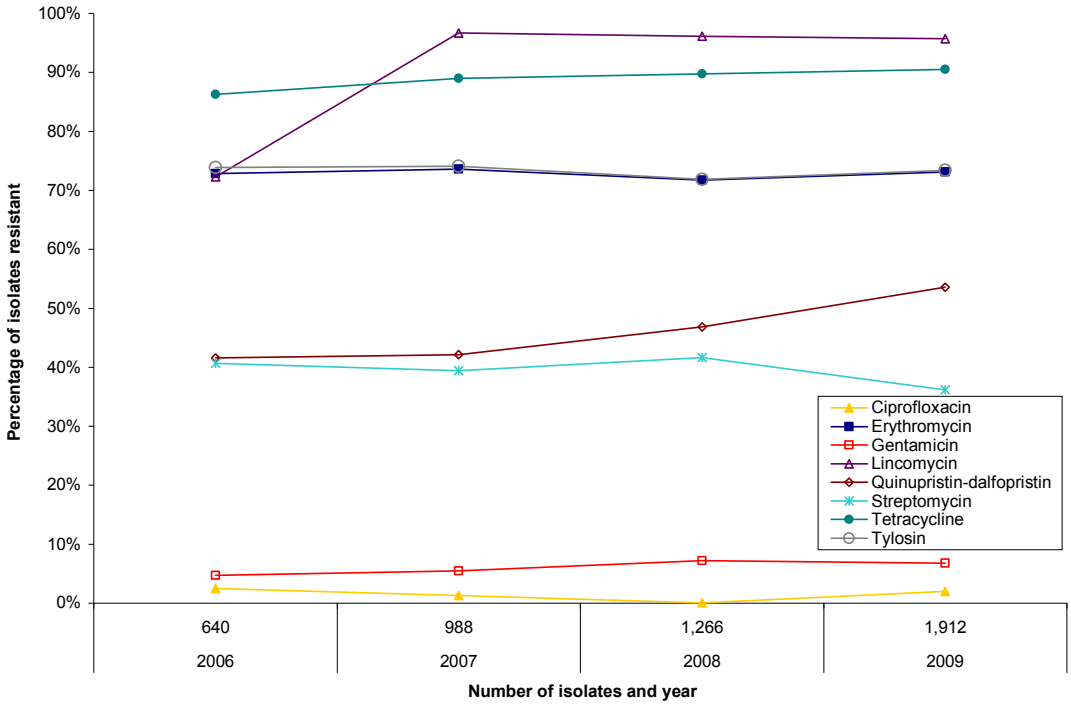
Table 22. Number of antimicrobial classes in resistance patterns of *Enterococcus* isolates from pigs; *Farm Surveillance*, 2009.

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	1,397 (73.1)	53	203	1,141			104	410	573					1,085	1,087	18		4	156	30		1,330
Enterococcus spp.	467 (24.3)	9	38	343	77		23	73	120			454		289	295	104		63	18	1	270	391
Enterococcus faecium	48 (2.5)	1	29	13	5			6	9			43		11	10	4		5		8	7	16
Total	**1,912 (100)**	**63**	**270**	**1,497**	**82**		**127**	**489**	**702**			**497**		**1,385**	**1,392**	**126**		**72**	**174**	**39**	**277**	**1,737**

Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in 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 38. Temporal variation in resistance to selected antimicrobials in *Enterococcus* isolates from pigs; *Farm Surveillance*, 2006-2009.



Turkeys

Salmonella

Surveillance of Animal Clinical Isolates[1]

(n = 60)

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

Serovars: Results are presented in Table 23 and Table C.3, Appendix C. The most common *Salmonella* serovars among turkey clinical isolates were Schwarzengrund (50%, 30/60), Heidelberg (7%, 4/60), and Senftenberg (7%, 4/60). These 3 serovars accounted for 63% (38/60) of the isolates.

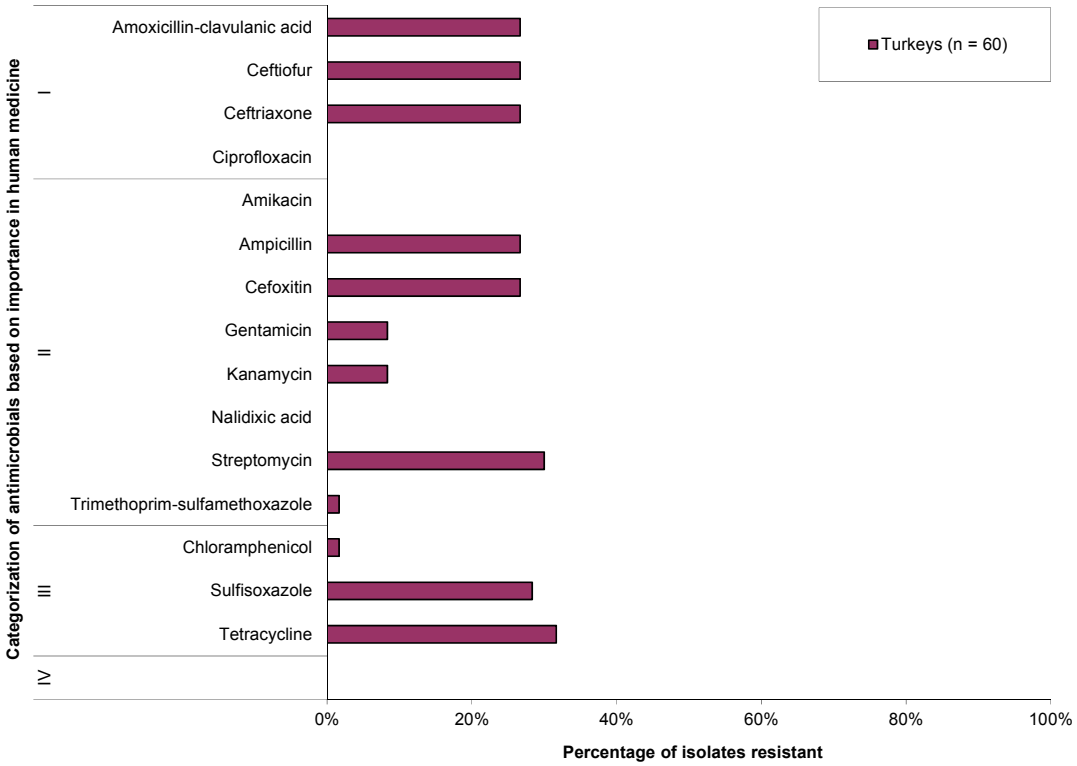
Antimicrobial Resistance: Results are presented in Figure 39, Table 23, and Table B.25, Appendix B. Resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 27% (16/60) of *Salmonella* isolates. No isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid. Additionally, reduced susceptibility to ciprofloxacin was not detected in any isolate**.**

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 48% (29/60) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 8% (5/60) of isolates (2 *S*. Hadar, 1 *S*. Agona, 1 *S*. Heidelberg, and 1 *S*. Schwarzengrund). The most common resistance patterns were A2C-AMP-CRO (13%, 8/60), STR-SSS-TET (12%, 7/60), and A2C-AMP-CRO-STR-SSS-TET (5%, 3/60). The patterns involving the greatest number of antimicrobials were ACSSuT-A2C-CRO-SXT (1 *S*. Agona) and AKSSuT-A2C-CRO-GEN (1 *S*. Heidelberg).

In 2009, resistance to amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone were each detected in 27% (16/60) of turkey clinical isolates of *Salmonella*. Resistance to 4 or more antimicrobial classes was detected in 8% (5/60) of isolates. The patterns involving the greatest number of antimicrobials were ACSSuT-A2C-CRO-SXT (1 *S*. Agona) and AKSSuT-A2C-CRO-GEN (1 *S*. Heidelberg).

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

Figure 39. Resistance to antimicrobials in *Salmonella* isolates from turkeys; *Surveillance of Animal Clinical Isolates*, 2009.



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

Table 23. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from turkeys; *Surveillance of Animal Clinical Isolates*, 2009.

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	30 (50.0)	26		3	1					4	1	1	1	1	1	4					4
Heidelberg	4 (6.7)		3		1			1	1	1	4	4	4	4	4	1					1
Senftenberg	4 (6.7)	1	2	1				1		1	2	2	2	2	2	1					1
Hadar	3 (5.0)			1	2				1	3	2	2	2	2	2	2					3
Worthington	3 (5.0)			3					1	3						3					3
Agona	2 (3.3)		1		1					1	2	2	2	2	2	1	1	1			1
Give	2 (3.3)	2																			
I 4,[5],12:-:-	2 (3.3)		1	1							2	2	2	2	2	1					1
Ouakam	2 (3.3)		2					1	1	1											1
Less common serovars	8 (13.3)	2	1	5				2	1	4	3	3	3	3	3	4					4
Total	**60 (100)**	**31**	**10**	**14**	**5**			**5**	**5**	**18**	**16**	**16**	**16**	**16**	**16**	**17**	**1**	**1**			**19**

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

Horses

Salmonella

Surveillance of Animal Clinical Isolates[1]

(n = 23)

Serovars: Results are presented in Table 24 and Table C.3, Appendix C. The most common *Salmonella* serovars among horse clinical isolates were Heidelberg (39%, 9/23), Hadar (22%, 5/23), Typhimurium (9%, 2/23), and Thompson (9%, 2/23). These 4 serovars accounted for 78% (18/23) of the isolates.

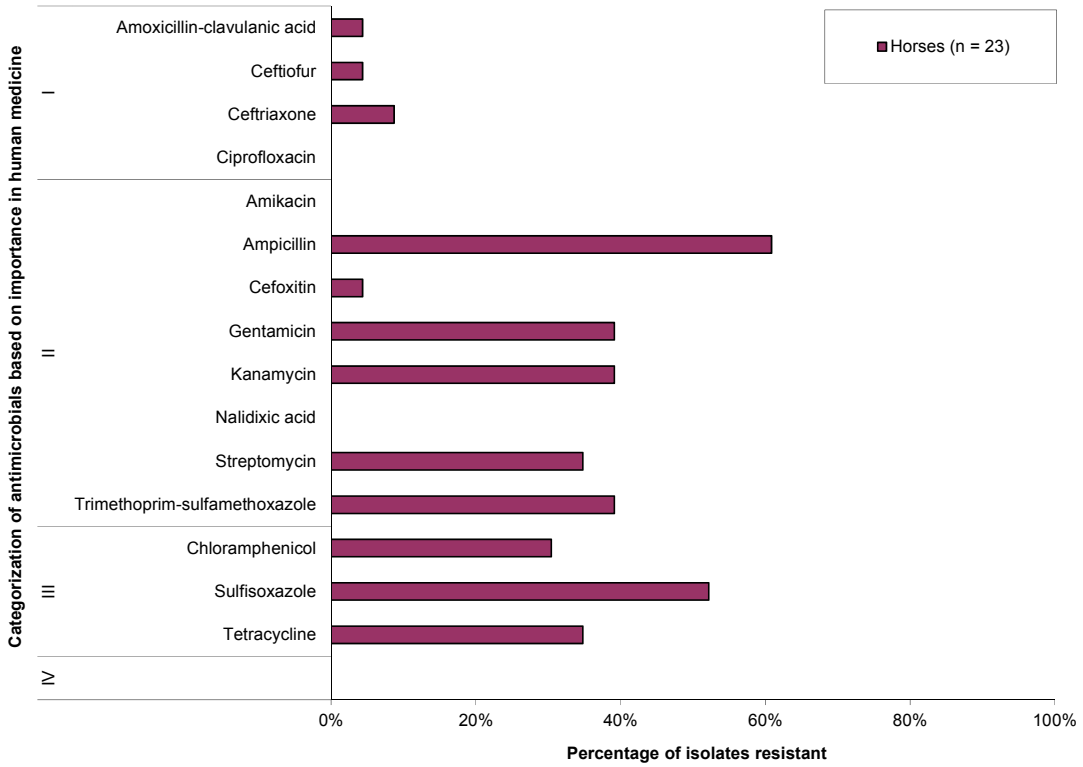
Antimicrobial Resistance: Results are presented in Figure 40, Table 24, and Table B.26, Appendix B. Resistance to amoxicillin-clavulanic acid and ceftiofur were each detected in 4% (1/23) of *Salmonella* isolates. Resistance to ceftriaxone was detected in 9% (2/23) of isolates. Reduced susceptibility to ciprofloxacin was detected in 35% (8/23). No isolates were resistant to ciprofloxacin, amikacin, or nalidixic acid.

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 74% (17/23) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 30% (7/23) of isolates (6 *S*. Heidelberg and 1 *S*. Typhimurium). The most common resistance patterns were AMP-CHL-GEN-KAN-SSS-SXT (13%, 3/23), AMP-GEN-KAN-SSS-SXT (13%, 3/23), and AMP-STR-TET (13%, 3/23). Reduced susceptibility to ciprofloxacin with resistance to ceftriaxone was detected in 4% (1/23) of isolates. Thirty-five percent (8/23) of isolates with reduced susceptibility to ciprofloxacin were not resistant to nalidixic acid. The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-CHL-GEN-KAN-SSS-SXT (1 *S*. Heidelberg).

In 2009, reduced susceptibility to ciprofloxacin was detected in 35% (8/23) of horse clinical isolates of *Salmonella*. Resistance to 4 or more antimicrobial classes was detected in 30% (7/23) of isolates (6 *S*. Heidelberg and 1 *S*. Typhimurium). The pattern involving the greatest number of antimicrobials was A2C-AMP-CRO-CHL-GEN-KAN-SSS-SXT, which was detected in 1 *S*. Heidelberg isolate.

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

Figure 40. Resistance to antimicrobials in *Salmonella* isolates from horses; *Surveillance of Animal Clinical Isolates*, 2009.



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

Table 24. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from horses; *Surveillance of Animal Clinical Isolates*, 2009.

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	9 (39.1)			3	6			9	9	2	9	1	1	1	1	9	9	6			
Hadar	5 (21.7)		1	4						3	4		1								5
Thompson	2 (8.7)	2																			
Typhimurium	2 (8.7)	1			1					1	1					1		1			1
Daytona	1 (4.3)	1																			
Mbandaka	1 (4.3)			1						1						1					1
Newport	1 (4.3)	1																			
Oranienburg	1 (4.3)	1																			
Orion var.15+	1 (4.3)			1						1						1					1
Total	**23 (100)**	**6**	**1**	**9**	**7**			**9**	**9**	**8**	**14**	**1**	**2**	**1**	**1**	**12**	**9**	**7**			**8**

Serovars represented by less than 2% of isolates were classified as “Less common serovars.”
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Feed and Feed Ingredients

Salmonella

(n = 31)

Recovery: Data reported here include those obtained from government monitoring programs in 2009. *Salmonella* isolates were recovered from samples of feed destined for consumption by various animal species as follows: 6% (2/31) each for swine and poultry and 3% (1/31) each for chickens, turkeys, and dairy cattle. Information about the intended use of the feed was missing for 77% (24/31) of the isolates.

Serovars: No table presented. The most common *Salmonella* serovars were Senftenberg (52%, 16/31) and Schwarzengrund (10%, 3/31). No isolates of Enteritidis, Heidelberg, Newport, Typhimurium, or Typhimurium var. 5- were recovered.

Antimicrobial Resistance: No figure presented. 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. Resistance to 1 or more antimicrobial classes was detected in 3% (1/31) of *Salmonella* isolates. Resistance to 4 or more antimicrobial classes was detected in 3% (1/31) of isolates (*S*. Worthington). The only resistance pattern was CHL-STR-SSS-TET (3%, 1/31).

In 2009, the most common serovars among *Salmonella* isolates from feed and feed ingredients were Senftenberg (52%, 16/31) and Schwarzengrund (10%, 3/31). Resistance to 4 or more antimicrobial classes was detected in 3% (1/31) of isolates (*S*. Worthington), in which the only resistance pattern among the isolates (CHL-STR-SSS-TET) was identified.

Section Two – Antimicrobial Use

Humans

Antimicrobial use in humans was determined by use of data from the Canadian CompuScript (CCS) dataset provided by IMS Health Canada Inc. for 2000 through 2009. This dataset provides information on prescriptions dispensed by Canadian retail pharmacies. Additional information on data collection by IMS Health Canada Inc. and data analysis for CIPARS is provided in Appendix A.

National Level

In 2009, the antimicrobial prescription dispensing rate remained similar (671.10 prescriptions/1,000 inhabitants) to levels observed in 2008 (670.79 prescriptions/1,000 inhabitants), during which the lowest rate during the 10-year surveillance period was observed (Table 25, Table 26, and Figure 41). In 2009, total expenditures continued to increase ($21,047.50/1,000 inhabitants) compared with expenditures in 2007, during which the lowest expenditures ($20,619.77/1,000 inhabitants) were observed (Table 27 and Figure 41). Of all antimicrobials dispensed, the highest increase in expenditures since 2000 was observed among the glycopeptides (+243%), nitrofuran derivatives (+85%), and lincosamides (+40%; Table 27).

The total number of defined daily doses (DDDs) per 1,000 inhabitants per day (DID) remained stable in 2009, compared with that of previous years, at 18.20 DID (Table 28 and Table 29). However, the total DID in 2009 was 5% (-1.03 DID) lower than in 2000, which was the year the surveillance period began. Between 2008 and 2009, increases in consumption were observed in 6 antimicrobial groups: nitrofuran derivatives (+8%); combinations of penicillins, including β-lactamase inhibitors (+6%), lincosamides (+3%); penicillins with extended spectrum (+2%); macrolides (+2%); and tetracyclines (less than 1% increase). Small decreases in 2009 relative to 2008 were observed among the β-lactamase-resistant penicillins (-5%), β-lactamase-sensitive penicillins (-3%), second generation cephalosporins (-3%), fluoroquinolones (-1%), and combinations of sulfonamides and trimethoprim, including derivatives (-1%).

Penicillins with extended spectrum were the largest group of antimicrobials consumed in 2009 (25% of all antimicrobials), followed by macrolides and lincosamides (23%), tetracyclines (13%), fluoroquinolones (11%), and cephalosporins (10%; Table 28, Table 29, and Figure 42). Category I antimicrobials continued to represent a high proportion (17%, 3.11/18.20 DID) of the total DID consumed in 2009 (Table 28 and Table 29).

Penicillins (J01C)

In 2009, consumption[1] of penicillins increased by 0.11 DID (+2%) compared with consumption in 2008 (Table 28 and Table 29). The total consumption remained stable because of the increased use of combinations of penicillins, including β-lactamase inhibitors and penicillins with extended spectrum, and the concurrent decreased consumption of β-lactamase-sensitive and resistant penicillins.

[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.

Trends observed within the penicillins class were driven by consumption of amoxicillin, which was the main antimicrobial consumed within this group of antimicrobials (Table 26, Table 29, and Figure 43). In 2009, consumption of amoxicillin increased by 0.13 DID (+3%) compared with consumption in 2008. However, consumption was lower in 2009 than in 2000 (-6%, -0.27 DID).

Consumption of amoxicillin and enzyme inhibitors (J01CR02) increased in 2009, compared with consumption in 2008 (+6%) and 2000 (+47%). The highest levels of consumption each year were observed during the first quarter (January to March; Figure 43). Similarly, consumption of penicillin V and amoxicillin appeared to peak during these months. Consumption of cloxacillin peaked during the third quarter of each year (July to September), whereas consumption of ampicillin remained consistent throughout each year.

Macrolides and Lincosamides (J01FA & J01FF)

Consumption of both macrolides and lincosamides increased in 2009, compared with consumption in 2008 (Table 27, Table 28, Table 29, and Figure 44). However, consumption of lincosamides was 0.15 DID (+63%) higher in 2009 than in 2000. This increase was driven mainly by consumption of clindamycin (J01FF01), as there was very limited use (less than 0.01 DID in 2000, 2003, and 2004) or no use (2001, 2002, and 2005–2009) of lincomycin across the country. In Canada, lincomycin is covered under provincial drug plans only in British Columbia, Manitoba, and Newfoundland and Labrador.[1] In Alberta, drug plan coverage for these antimicrobials ended in 2001.[1]

Within the macrolide class, clarithromycin (J01FA09) and azithromycin (J01FA10) have been the main macrolide drugs prescribed in Canada and have contributed toward the 4% increase (+0.15 DID) observed within this class from 2000 through 2009 (Table 28, Table 29, and Figure 44). Consumption of erythromycin continued to decrease in 2009, with overall consumption decreasing by 0.67 DID (-76%), compared with in 2000, and by 0.04 DID (-16%), compared with in 2008. As observed for antimicrobials within the penicillin class, macrolide consumption was highest during the first quarter of each year under surveillance (January to March; Figure 44).

Tetracyclines (J01A)

Tetracyclines comprised 13% of the total DID for oral antimicrobials dispensed by retail pharmacies in Canada in 2009 (Table 28, Table 29, and Figure 42). The increase observed in tetracycline consumption in 2009, compared with consumption in 2008, was very small (less than 1%, +0.02 DID). However, overall consumption decreased in 2009 by 11% (-0.31 DID), compared with consumption in 2000.

Minocycline (J01AA08) consumption remained stable over the 10-year surveillance period (Table 29 and Figure 45). Overall consumption of tetracycline (J01AA07) continued to decrease in 2009, with 4% (-0.02 DID) lower consumption than in 2008 and 54% (-0.53 DID) lower consumption than in 2000. Conversely, doxycycline consumption was 28% (+0.21 DID) higher in 2009 than in 2000 and 5% (+0.05 DID) higher in 2009 than in 2008. The highest level of consumption during each year for all tetracyclines occurred in the first (January to March) and fourth (October to December) quarters.

Fluoroquinolones (J01MA)

Fluoroquinolones accounted for 11% of the total antimicrobial consumption in 2009 (Table 28, Table 29, and Figure 42). Overall consumption of fluoroquinolones increased by 11% (+0.20 DID) in 2009,

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

compared with consumption in 2000. However, consumption in 2009 was slightly lower (-1%, -0.03 DID) than in 2008.

Over half (59%, 1.20/2.03 DID) of fluoroquinolone consumption was due to the use of ciprofloxacin (J01MA02), for which consumption has levelled off since 2006 (Table 29 and Figure 46). The greatest increase in consumption among fluoroquinolones during the 10-year surveillance period was for moxifloxacin (J01MA14) products, the consumption of which increased 4,100% (+0.41 DID) since 2000. Ofloxacin (J01MA01) and norfloxacin (J01MA06) consumption decreased by 69% (-0.09 DID) and 50% (-0.14 DID), respectively, in 2009, compared with consumption in 2000.

The highest levels of consumption in each year were observed during the first (January to March) and fourth (October to December) quarters. Since 2005, this trend has generally remained the same for consumption of ciprofloxacin, moxifloxacin, and levofloxacin (J01MA12). Consumption of norfloxacin and ofloxacin was evenly distributed across the year (Figure 46).

Cephalosporins (J01DB-DD)

Other β-lactam antimicrobials, such as the cephalosporins, accounted for 10% of overall consumption in Canada in 2009 (Table 28, Table 29, and Figure 42). Between 2007 and 2009, cephalosporin consumption remained stable, with 1.83 DID observed in 2009. An overall decrease of 18% (-0.41 DID) in consumption was observed within the 10-year surveillance period.

Fifty-three percent of all cephalosporin consumption was a result of first-generation cephalosporin (J01DB) use, of which 96% (0.94/0.98 DID) was primarily cephalexin (J01DB01; Table 29 and Figure 47). Consumption of cephalexin steadily increased by 31% (+0.22 DID) between 2000 and 2009.

Among the second-generation cephalosporins (J01DC), decreases were observed in 2009 in the consumption of cefaclor (J01DC04; -89% [-0.33 DID]) and cefuroxime axetil (J01DC02; -49% [-0.39 DID]) relative to values in 2000 (Figure 47). Although there was an overall decrease in the use of second-generation cephalosporins since 2000, use of cefprozil increased by 50% (+0.11 DID).

Cefixime (J01DD08) was the only oral third-generation cephalosporin monitored under CIPARS. Consumption of cefixime decreased from 2000 to 2004, and remained steady from 2005 to 2009. Since 2000, the overall consumption of cefixime has decreased by 30% (0.03 DID; Table 29 and Figure 47).

Different temporal trends in consumption were evident among the cephalosporin classes (Figure 47). The highest levels of overall cephalosporin consumption occurred in the first quarter (January to March) of each year, influenced by consumption of cefprozil (J01DC10), cefixime (J01DD08), cefaclor (J01DC04), and cefuroxime axetil (J01DC02). Conversely, consumption of cephalexin was highest during the third quarter (July to September) of every year.

Provincial Level

In 2009, differences in the total number of prescriptions (per 1,000 inhabitants), total consumption of oral antimicrobials (in DID), and total cost in dollars (per 1,000 inhabitant-days) were observed across Canada (Table 30, Table 31, Table 32, and Figure 48). Much of the inter-provincial variation in DID values 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 48). Consumption and total cost per 1,000 inhabitant-days were highest in Newfoundland and Labrador (31.44 DID and $90.56 per 1,000 inhabitant-days, respectively), whereas Québec had the lowest overall antimicrobial consumption (14.30 DID) and British Columbia had the lowest overall cost ($50.88 per 1,000 inhabitant-days).

Compared with consumption in other provinces, antimicrobial consumption in Newfoundland and Labrador was driven primarily by higher consumption of antimicrobials classified as penicillins with extended spectrum (9.09 DID), macrolides (6.22 DID), and fluoroquinolones (4.44 DID; Table 31). The higher consumption of fluoroquinolones was attributable to ciprofloxacin consumption (3.49 DID in Newfoundland and Labrador vs. 0.99 DID in New Brunswick; Table 33). Inter-provincial variation was also observed among the other fluoroquinolones. Prince Edward Island had the highest consumption of ofloxacin (0.14 DID) and moxifloxacin (0.69 DID; Table 34 and Table 35). New Brunswick had higher consumption of norfloxacin (0.44 DID) than Saskatchewan (the province with the lowest norfloxacin use; 0.01 DID; Table 34). Similarly, Manitoba had higher consumption of levofloxacin (0.39 DID) than New Brunswick (the province with the lowest levofloxacin use; 0.04 DID).

Consumption of macrolides (J01FA) in Newfoundland and Labrador continued to increase, to a height of 6.22 DID in 2009 (Table 31), compared with 5.38 DID in 2005.[1] This increase was driven by consumption in Newfoundland and Labrador of clarithromycin (5.07 DID), the consumption of which was much higher than that observed in the province with the lowest consumption, Saskatchewan (1.48 DID; Table 35). Among the other macrolide drugs, azithromycin (J01FA10) consumption was highest in Manitoba (1.19 DID) and lowest in British Columbia (0.44 DID; Table 35), whereas erythromycin consumption was highest in Prince Edward Island (1.08 DID) and lowest in Québec (0.06 DID; Table 34).

Saskatchewan had the second highest total consumption of antimicrobials in 2009, driven by higher consumption of antimicrobials classified as penicillins with extended spectrum (6.94 DID), tetracyclines (4.28 DID), macrolides (3.09 DID), and first-generation cephalosporins (J01DB; 1.92 DID; Table 31). In Saskatchewan, the higher consumption of first-generation cephalosporins was attributed mainly to the use of cephalexin (J01DB01). Saskatchewan had the highest cephalexin consumption (1.92 DID), whereas Québec had the lowest consumption (0.26 DID; Table 34). However, for the remaining first-generation cephalosporins, Québec had the highest consumption of cefadroxil (J01DB05), with an overall consumption of 0.16 DID, compared with less than or equal to 0.01 DID in all other provinces. In Québec, consumption of cefadroxil increased by 129% (+0.09 DID) during the 10 year surveillance period.

Consumption of doxycycline continued to increase across all provinces at a steady rate (Table 36 and Figure 49). Saskatchewan had the highest consumption of doxycycline in 2009, which contributed to a high overall consumption of tetracyclines as observed in previous years (Table 36). Total doxycycline consumption in Saskatchewan in 2009 was 3.44 DID, compared with 0.50 DID in Québec (the province with the lowest doxycycline use).

Consumption of tetracycline was highest in Prince Edward Island (1.28 DID), whereas Québec had the lowest consumption (0.15 DID). Consumption of tetracycline in Prince Edward Island decreased by 9% (0.12 DID) in 2009, compared with consumption in 2005.[1] However, there was a higher proportional decrease in consumption among the remaining provinces, ranging from a decrease of 18% (-0.10 DID) in Nova Scotia to 47% (-0.27 DID) in Alberta. The only exception was New Brunswick, which remained the same since 2005 at 0.26 DID. For minocycline, the highest consumption was observed in Alberta (1.51 DID), which had 4 times the consumption observed in Saskatchewan (0.34 DID).

Antimicrobials Generally Prescribed for the Treatment of Urinary Tract Infections

Oral formulations of sulfamethoxazole-trimethoprim (J01EE01), ciprofloxacin, and nitrofurantoin (J01XE01) are generally prescribed for treatment of urinary tract infections.[2] In 2009, these 3 antimicrobials comprised 14% (2.62 DID) of all consumed oral antimicrobials dispensed by retail pharmacies in Canada (Table 29). Among these 3 antimicrobials, the highest consumption was

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

[2] Repchinsky C, ed. Compendium of Pharmaceuticals and Specialties. Ottawa, ON: Canadian Pharmacists Association; 2008.

observed for ciprofloxacin (1.20 DID), followed by sulfamethoxazole-trimethoprim (0.76 DID), and nitrofurantoin (0.66 DID).

At the provincial level, higher ciprofloxacin consumption in 2009 than in 2000 was observed in Nova Scotia (+66%, +0.47 DID), Manitoba (+60%, +0.47 DID), Saskatchewan (+46%, + 0.32 DID), Alberta (+28%, +0.27 DID), Québec (+21%, +0.20 DID), and British Columbia (14%; 0.15 DID; Table 33). Between 2005 and 2009, an increase in ciprofloxacin consumption was observed in Prince Edward Island (+34%, +0.29 DID) and Newfoundland and Labrador (+8%, +0.25 DID)[1]. In 2009, Newfoundland and Labrador had the highest ciprofloxacin consumption (3.49 DID), and New Brunswick had the lowest (0.99 DID).

Consumption of sulfamethoxazole-trimethoprim was lower in 2009 than in 2000 for all provinces, with the greatest proportional decrease in consumption observed in Québec (-60%, -0.58 DID), Saskatchewan (-58%, -0.82 DID), and New Brunswick (-53%, -1.17 DID). In 2009, Saskatchewan had the highest sulfamethoxazole-trimethoprim consumption (16.05 DID), whereas Québec had the lowest (5.53 DID).

The consumption of nitrofurantoin was higher in 2009 than in previous years for all provinces. The highest proportional increase in consumption was observed in Ontario (73% increase from 2000 to 2009, +0.35 DID), British Columbia (70% increase from 2000 to 2009, +0.28 DID), and Prince Edward Island (70% increase from 2005 to 2009[1], +0.22 DID). In 2009, Saskatchewan had the highest nitrofurantoin consumption (1.04 DID) and Québec had the lowest (0.32 DID).

Antimicrobials Generally Prescribed for the Treatment of Respiratory Disease

The macrolides azithromycin and clarithromycin, as well as the fluoroquinolones levofloxacin and moxifloxacin, are generally prescribed for treatment of respiratory disease.[2] In 2009, these antimicrobials comprised 23% (4.23 DID) of all consumed oral antimicrobials dispensed by retail pharmacies in Canada (Table 29). Among these 4 antimicrobials, the highest consumption was observed for clarithromycin (2.79 DID), followed by azithromycin (0.79 DID), moxifloxacin (0.42 DID), and levofloxacin (0.23 DID). At the provincial level, an increase in clarithromycin has been observed in all provinces since the beginning of surveillance (Table 35). The highest relative increases in clarithromycin consumption were in Nova Scotia (+133%, +1.53 DID), Prince Edward Island (89% increase from 2005,[1] +1.31 DID), Manitoba (+81%, +0.77 DID), and New Brunswick (+80%, +1.35). In 2009, Newfoundland and Labrador had the highest clarithromycin consumption (3.49 DID) and Saskatchewan had the lowest (0.99 DID).

Since 2000, there has been an increase in azithromycin consumption in Manitoba (+164%, +0.74 DID), British Columbia (+120%, +0.24 DID), Saskatchewan (+90%, +0.38 DID), New Brunswick (+71%, +0.39 DID), Ontario (+69%, +0.40 DID), Alberta (+44%, +0.20 DID), and Nova Scotia (+18%, +0.14 DID). In 2009, Manitoba had the highest azithromycin consumption (1.19 DID), whereas British Columbia had the lowest (0.44 DID).

In 2000, moxifloxacin consumption in all provinces was equal to or less than 0.01 DID. In 2009, it was higher in all provinces, with the highest consumption observed in Prince Edward Island (0.69 DID), Québec (0.61 DID), and New Brunswick (0.52 DID). Moxifloxacin consumption was higher in 2009 than in 2000 in Manitoba (+63%, +0.15 DID), Alberta (+26%, +0.07 DID), Nova Scotia (+14%, +0.03 DID), and Ontario (+11%, +0.03 DID). In 2009, Manitoba had the highest moxifloxacin consumption (0.39 DID), whereas New Brunswick had the lowest (0.04 DID).

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

[2] Repchinsky C, editor. Compendium of Pharmaceuticals and Specialties. Ottawa, ON: Canadian Pharmacists Association; 2008.

International Level

The estimate of the total amount of oral antimicrobials dispensed in 2008[1] by Canadian retail pharmacies was compared with the total amount of outpatient antimicrobial use in 30 European countries[2] in the same year (Figure 50). This comparison showed that the level of consumption in Canada was similar to that in Finland and the Czech Republic. Canada's oral antimicrobial consumption represented almost twice the level of antimicrobial consumption reported by the Russian Federation (country with the lowest level of consumption) and less than half the level estimated in Greece (country with the highest level of consumption).

Overall, Canada ranked 14th out of the 31 countries classified by increasing level of total antimicrobial consumption. It ranked 28th in consumption of macrolides, lincosamides, and streptogramins and 22nd in consumption of quinolones (largely consisting of fluoroquinolones). Canada ranked 18th in tetracycline consumption and 6th in penicillin consumption.

In 2009, the antimicrobial prescription dispensing rate remained similar to that observed during 2008, but the total oral antimicrobial expenditures continued to increase. Category I antimicrobials continued to represent a high proportion (17%, 3.11/18.20) of the total DDDs dispensed during 2009.

In that same year, oral antimicrobial consumption was highest in Newfoundland and Labrador (31.44 DID) and lowest in Quebec (14.30 DID). Much of the inter-provincial variation in consumption 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.

When the total amount of oral antimicrobials dispensed in 2008 by Canadian retail pharmacies was compared with the total outpatient use in 30 European countries in the same year, Canadian consumption was similar to that of Finland and the Czech Republic. Canada ranked 14th out of the 31 countries classified by increasing level of total antimicrobial consumption.

[1] The year 2008 was chosen because data for 2009 were not yet available at the time this report was written.
[2] ESAC, 2010. ESAC – European Surveillance of Antimicrobial Consumption ESAC Interactive Database. Available at: http://app.esac.ua.ac.be/esac_idb/main.htm. Accessed April 2012.

Table 25. Number of prescriptions per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	Antimicrobial	ATC Class	Number of prescriptions/1,000 inhabitants									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	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	21.02
	Cefixime	Third-generation cephalosporins (J01DD)	5.66	5.28	4.83	4.23	3.68	3.74	3.77	3.98	4.23	4.46
I	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	96.40
	Vancomycin	Glycopeptides (J01XA)	0.14	0.14	0.16	0.19	0.34	0.39	0.37	0.40	0.42	0.48
	Metronidazole	Imidazole (J01XD)	NPD	16.65	16.71	17.09	17.25	17.41	18.50	17.70	18.06	18.60
	Linezolid	Linezolid (J01XX)	NPD	< 0.01	0.01	0.02	0.04	0.04	0.04	0.05	0.05	0.07
	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	193.18	183.54	171.05	169.81	156.08	168.34	168.93	158.51	155.79	157.44
	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	32.09
	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
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	41.03	41.70	43.07	45.23	45.65	48.36	51.48	49.95	50.17	50.09
	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	29.74
	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	33.11
II	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	146.55	149.72	145.48	149.00	138.51	149.25	146.93	134.69	132.75	131.97
	Clindamycin	Lincosamides (J01FF)	15.92	16.74	17.63	18.48	18.85	19.73	21.86	21.94	22.11	22.33
	Tobramycin	Aminoglycosides (J01GB)	0.06	< 0.01	< 0.01	< 0.01	< 0.01	NPD	0.05	0.06	0.06	0.08
	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
	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
	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

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 25 (continued). Number of prescriptions per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	Antimicrobial	ATC Class	Number of prescriptions/1,000 inhabitants									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	43.47	41.16	39.31	38.41	36.71	36.33	37.07	35.55	35.52	35.63
	Chloramphenicol	Amphenicols (J01BA)	< 0.01	< 0.01	< 0.01	NPD	< 0.01	< 0.01	NPD	NPD	NPD	NPD
	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
III	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
	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
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	14.61	15.76	16.41	17.48	19.13	20.35	22.67	23.20	24.89	27.05
	Fosfomycin	Fosfomycin (J01XX)	0.44	0.47	0.29	0.21	0.14	0.11	0.09	0.05	0.01	0.02
NC	Methenamine	Methenamine (J01XX)	0.27	0.28	0.29	0.28	0.25	0.23	0.23	0.23	0.16	0.24
		Total (J01)	**738.98**	**735.62**	**706.57**	**710.89**	**677.86**	**704.95**	**714.52**	**677.44**	**670.79**	**671.10**

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 26. Number of prescriptions per 1,000 inhabitants of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	ATC Class	Antimicrobial	Number of prescriptions/1,000 inhabitants									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
II	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	21.02
II	Third-generation cephalosporins (J01DD)	Cefixime (J01DD08)	5.66	5.28	4.83	4.23	3.68	3.74	3.77	3.98	4.23	4.46
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
I		Ciprofloxacin (J01MA02)	51.25	47.70	48.32	51.35	53.46	55.90	61.06	61.76	62.56	62.54
I		Norfloxacin (J01MA06)	12.49	12.06	11.43	10.71	10.06	9.30	8.83	7.58	6.96	6.42
I		Levofloxacin (J01MA12)	10.35	14.32	13.11	13.36	13.10	11.48	10.51	9.68	9.68	9.21
I		Moxifloxacin (J01MA14)	0.36	4.68	7.89	10.23	11.07	13.35	16.55	17.66	17.48	17.68
II	Glycopeptides (J01XA)	Vancomycin (J01XA01)	0.14	0.14	0.16	0.19	0.34	0.39	0.37	0.40	0.42	0.48
II	Imidazole (J01XD)	Metronidazole (J01XD01)	NPD	16.65	16.71	17.09	17.25	17.41	18.50	17.70	18.06	18.60
II	Linezolid (J01XX)	Linezolid (J01XX08)	NPD	< 0.01	0.01	0.02	0.04	0.04	0.04	0.05	0.05	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
II		Amoxicillin (J01CA04)	179.87	172.09	162.04	162.10	149.79	163.86	165.55	155.76	154.31	156.66
II		Pivampicillin (J01CA02)	9.75	8.48	6.64	5.70	4.60	3.12	2.19	1.78	0.63	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
II		Penicillin V (J01CE02)	45.29	42.02	39.83	39.62	36.59	36.89	37.25	34.87	32.93	32.09
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
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	47.07
II		Cefadroxil (J01DB05)	1.94	2.07	2.20	2.36	2.38	2.42	2.77	2.80	2.92	3.02
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
II		Cefprozil (J01DC10)	14.59	16.47	18.50	21.20	22.98	23.82	23.44	20.01	18.95	18.53
II		Cefuroxime axetil (J01DC02)	21.89	18.71	14.83	13.03	11.40	11.47	10.73	10.10	9.76	9.55
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	33.11
II		Sulfadiazine and trimethoprim (J01EE02)	0.25	0.20	0.15	0.11	0.05	0.01	< 0.01	NPD	< 0.01	< 0.01
II	Macrolides (J01FA)	Azithromycin (J01FA10)	42.49	52.86	59.62	66.16	61.02	66.06	65.36	59.71	58.99	58.39
II		Clarithromycin (J01FA09)	69.20	69.22	64.72	63.47	59.11	65.01	67.07	65.07	65.01	66.64
II		Erythromycin (J01FA01)	34.14	26.99	20.63	18.69	15.06	12.65	11.14	9.09	8.56	6.82
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
II	Aminoglycosides (J01GB)	Tobramycin (J01GB01)	NPD	NPD	NPD	NPD	NPD	NPD	0.05	0.06	0.06	0.08
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
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
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

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 26 (continued). Number of prescriptions per 1,000 inhabitants of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	ATC Class	Antimicrobial	Number of prescriptions/1,000 inhabitants									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
III	Tetracyclines (J01AA)	Doxycycline (J01AA02)	11.79	11.00	10.17	10.07	9.55	10.07	10.92	11.43	12.03	12.58
		Minocycline (J01AA08)	16.76	16.90	17.01	17.23	17.11	16.97	17.45	16.49	16.34	16.17
		Tetracycline (J01AA07)	14.91	13.23	12.08	11.07	10.01	9.26	8.66	7.61	7.14	6.88
	Amphenicols (J01BA)	Chloramphenicol (J01BA01)	< 0.01	< 0.01	< 0.01	NPD	< 0.01	< 0.01	NPD	NPD	NPD	NPD
	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
	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
	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
	Nitrofuran derivatives (J01XE)	Nitrofurantoin (J01XE01)	14.61	15.76	16.41	17.48	19.13	20.35	22.67	23.20	24.89	27.05
	Fosfomycin (J01XX)	Fosfomycin (J01XX01)	0.44	0.47	0.29	0.21	0.14	0.11	0.09	0.05	0.01	0.02
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
	Total (J01)		**738.98**	**735.62**	**706.57**	**710.89**	**677.86**	**704.95**	**714.52**	**677.44**	**670.79**	**671.10**

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.

Figure 41. Number of prescriptions and total cost per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

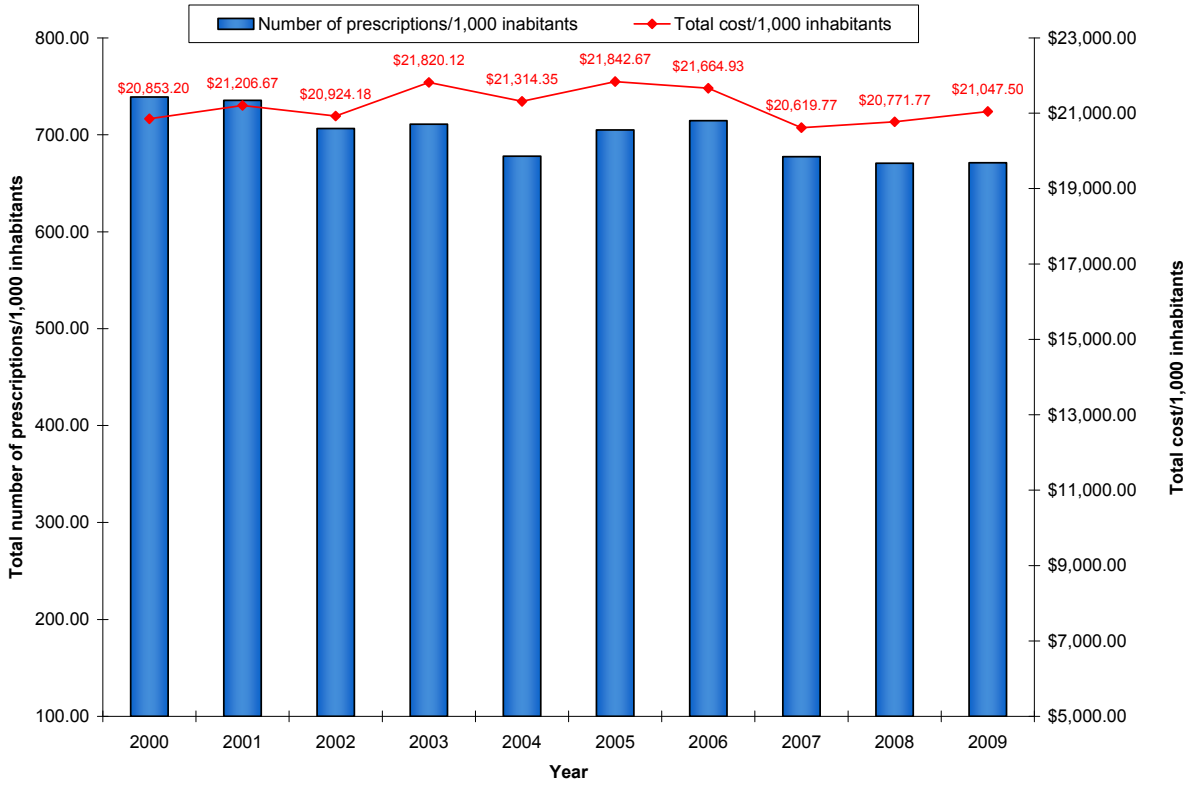


Table 27. Total cost per 1,000 inhabitants of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	Antimicrobial	ATC Class	Total cost/1,000 inhabitants ($)									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors (J01CR)	758.68	741.82	644.84	632.84	584.65	631.09	663.15	670.70	690.52	717.44
I	Cefixime	Third-generation cephalosporins (J01DD)	212.26	196.78	179.57	155.33	133.22	137.49	136.28	147.65	158.87	169.24
I	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	4,285.71	4,555.96	4,758.29	5,078.69	4,859.20	4,280.24	4,176.93	4,197.10	4,195.61	4,127.83
I	Vancomycin	Glycopeptides (J01XA)	51.03	54.88	62.08	76.38	131.23	148.95	145.53	159.23	160.72	184.91
I	Metronidazole	Imidazole (J01XD)	NPD	198.89	224.55	243.26	261.21	268.74	295.80	282.08	290.78	302.53
I	Linezolid	Linezolid (J01XX)	NPD	6.36	19.53	43.61	71.59	95.82	91.62	98.97	99.08	117.86
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	2,662.57	2,559.11	2,416.25	2,456.31	2,295.16	2,452.44	2,471.71	2,388.37	2,886.96	3,025.90
II	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	497.32	467.30	452.74	463.27	435.95	432.11	438.39	420.97	448.81	449.93
II	Cloxacillin	β-lactamase resistant penicillins (J01CF)	287.70	272.68	251.58	242.19	226.14	197.11	189.03	168.99	199.32	186.62
II	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	736.71	756.44	798.94	863.21	890.36	933.03	1,000.26	980.32	1,214.80	1,250.52
II	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	2,335.89	2,134.36	1,820.11	1,807.37	1,797.76	1,851.94	1,815.33	1,540.95	1,288.65	1,240.21
II	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	632.11	571.05	511.01	481.11	438.79	407.76	412.08	398.39	398.02	393.95
II	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	5,800.28	6,177.44	6,219.24	6,639.65	6,521.81	7,292.34	6,782.47	6,103.52	5,714.90	5,731.94
II	Clindamycin	Lincosamides (J01FF)	666.80	605.60	635.04	654.75	675.26	698.80	773.50	781.53	781.11	801.07
II	Tobramycin	Aminoglycosides (J01GB)	0.93	0.02	< 0.01	< 0.01	< 0.01	NPD	155.86	191.11	200.41	262.94
II	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	3.62	3.01	2.53	2.27	2.16	0.07	0.02	< 0.01	NPD	< 0.01
II	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	95.14	66.22	43.47	29.38	19.60	18.21	15.81	11.31	3.80	0.00
II	Fusidic acid	Steroid antibacterials (J01XC)	6.14	6.74	6.04	6.30	6.24	6.94	7.21	5.58	4.78	2.23
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	1,456.11	1,451.83	1,485.89	1,524.95	1,512.46	1,516.34	1,566.65	1,528.94	1,455.03	1,443.62
III	Chloramphenicol	Amphenicols (J01BA)	0.02	0.05	0.01	NPD	< 0.01	< 0.01	NPD	NPD	NPD	NPD
III	Trimethoprim	Trimethoprim and derivatives (J01EA)	47.67	43.68	41.75	39.62	35.03	31.60	32.45	31.48	29.34	33.13
III	Sulfamethizole, sulfapyridine, sulfisoxazole	Short-acting sulfonamides (J01EB)	2.79	0.35	0.03	0.02	0.02	< 0.01	0.01	< 0.01	< 0.01	NPD
III	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	0.45	0.40	0.32	0.48	0.22	0.17	0.16	0.18	0.14	< 0.01
III	Nitrofurantoin	Nitrofuran derivatives (J01XE)	290.94	312.33	332.83	364.93	404.48	431.71	485.87	504.68	545.99	599.38
III	Fosfomycin	Fosfomycin (J01XX)	14.71	16.06	10.39	7.60	5.52	4.43	3.59	2.11	0.39	0.90
NC	Methenamine	Methenamine (J01XX)	7.64	7.27	7.14	6.59	6.31	5.34	5.23	5.59	3.76	5.34
		Total (J01)	**20,853.20**	**21,206.67**	**20,924.18**	**21,820.12**	**21,314.35**	**21,842.67**	**21,664.93**	**20,619.77**	**20,771.77**	**21,047.50**

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 28. Defined daily doses per 1,000 inhabitant-days of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	Antimicrobial	ATC Class	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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
	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
	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
	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)	NPD	0.21	0.22	0.22	0.22	0.23	0.24	0.23	0.24	0.24
	Linezolid	Linezolid (J01XX)	NPD	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
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
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	0.67	0.63	0.60	0.60	0.55	0.56	0.62	0.58	0.58	0.56
	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
	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
	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
	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
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	3.64	3.62	3.42	3.57	3.43	3.77	3.86	3.75	3.73	3.79
	Clindamycin	Lincosamides (J01FF)	0.24	0.27	0.28	0.31	0.32	0.32	0.36	0.37	0.38	0.39
	Tobramycin	Aminoglycosides (J01GB)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	< 0.01	0.01	0.01	0.01
	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	< 0.01
	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	0.03	0.02	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Fusidic acid	Steroid antibacterials (J01XC)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
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
	Chloramphenicol	Amphenicols (J01BA)	< 0.01	< 0.01	< 0.01	NPD	< 0.01	< 0.01	NPD	NPD	NPD	NPD
	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
	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
	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	0.42	0.44	0.45	0.47	0.49	0.52	0.57	0.58	0.61	0.66
	Fosfomycin	Fosfomycin (J01XX)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NC	Methenamine	Methenamine (J01XX)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	< 0.01	0.01
		Total (J01)	**19.23**	**18.93**	**18.11**	**18.21**	**17.58**	**18.13**	**18.64**	**18.03**	**18.00**	**18.20**

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.

Table 29. Defined daily doses per 1,000 inhabitant-days of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	ATC Class	Antimicrobial	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	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	0.64	0.67	0.71	0.75
	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
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
		Ciprofloxacin (J01MA02)	1.14	1.06	1.04	1.07	1.08	1.11	1.20	1.20	1.20	1.20
		Norfloxacin (J01MA06)	0.28	0.27	0.26	0.24	0.22	0.21	0.19	0.17	0.15	0.14
		Levofloxacin (J01MA12)	0.27	0.36	0.32	0.33	0.32	0.29	0.27	0.25	0.24	0.23
		Moxifloxacin (J01MA14)	0.01	0.11	0.19	0.24	0.26	0.32	0.40	0.43	0.42	0.42
	Glycopeptides (J01XA)	Vancomycin (J01XA01)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Imidazole (J01XD)	Metronidazole (J01XD01)	NPD	0.21	0.22	0.22	0.22	0.23	0.24	0.23	0.24	0.24
	Linezolid (J01XX)	Linezolid (J01XX08)	NPD	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	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
		Amoxicillin (J01CA04)	4.79	4.66	4.43	4.40	4.24	4.42	4.53	4.36	4.39	4.52
		Pivampicillin (J01CA02)	0.21	0.19	0.15	0.13	0.11	0.08	0.06	0.05	0.02	< 0.01
	β-lactamase sensitive penicillins (J01CE)	Penicillin G (J01CE01)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
		Penicillin V (J01CE02)	0.67	0.63	0.60	0.60	0.55	0.56	0.62	0.58	0.58	0.56
	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
	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
		Cefadroxil (J01DB05)	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
	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
		Cefprozil (J01DC10)	0.22	0.25	0.29	0.34	0.38	0.39	0.39	0.35	0.34	0.33
		Cefuroxime axetil (J01DC02)	0.80	0.69	0.56	0.51	0.46	0.47	0.45	0.43	0.42	0.41
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
		Sulfadiazine and trimethoprim (J01EE02)	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	< 0.01	< 0.01
	Macrolides (J01FA)	Azithromycin (J01FA10)	0.53	0.65	0.73	0.82	0.76	0.83	0.83	0.78	0.78	0.79
		Clarithromycin (J01FA09)	2.22	2.25	2.11	2.23	2.18	2.48	2.64	2.68	2.70	2.79
		Erythromycin (J01FA01)	0.88	0.72	0.57	0.52	0.43	0.36	0.33	0.28	0.25	0.21
	Lincosamides (J01FF)	Clindamycin (J01FF01)	0.24	0.27	0.28	0.31	0.32	0.32	0.36	0.37	0.38	0.39
	Aminoglycosides (J01GB)	Tobramycin (J01GB01)	NPD	NPD	NPD	NPD	NPD	NPD	< 0.01	0.01	0.01	0.01
	Other quinolones, excluding fluoroquinolones (J01MB)	Nalidixic acid (J01MB02)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	< 0.01
	Sulfonamide combinations, excluding trimethoprim (J01RA)	Erythromycin-sulfisoxazole (J01RA02)	0.03	0.02	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Steroid antimicrobials (j01XC)	Fusidic acid (J01XC01)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

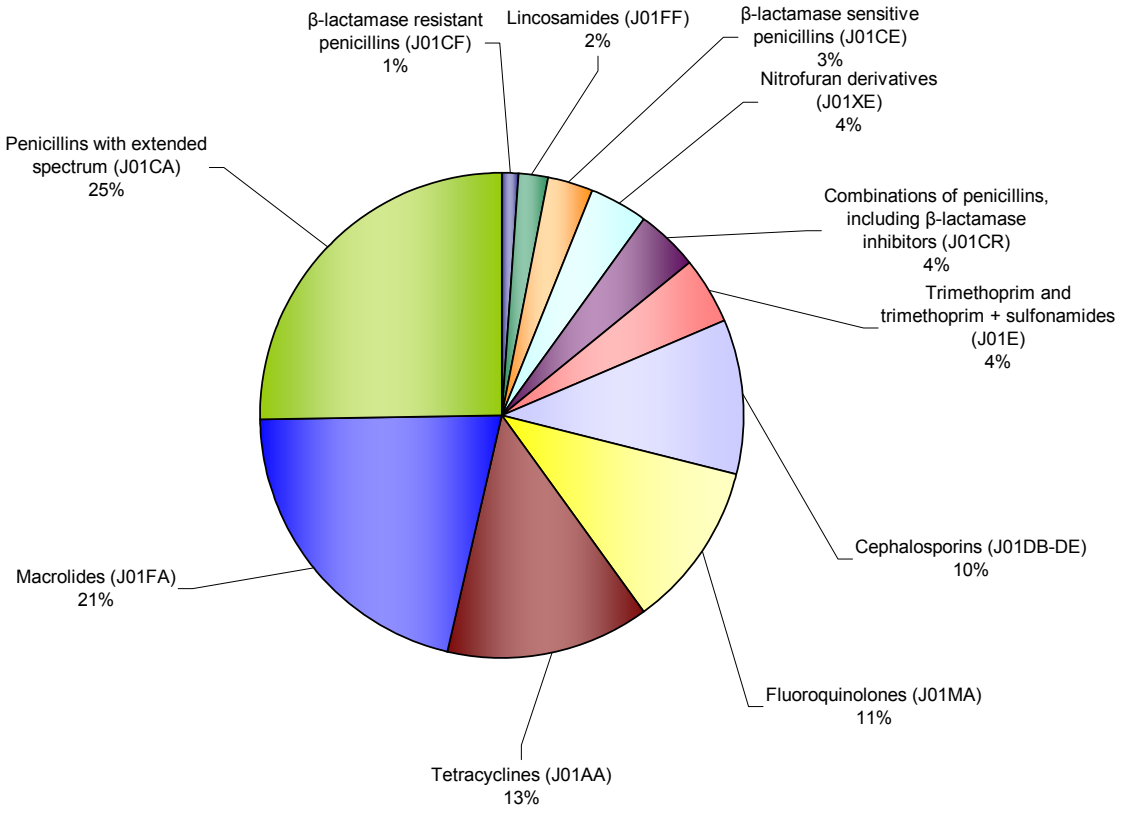
Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NPD = No prescriptions dispensed.

Table 29 (continued). Defined daily doses per 1,000 inhabitant-days of individual oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	ATC Class	Antimicrobial	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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
		Minocycline (J01AA08)	0.97	1.00	1.01	1.04	1.03	1.04	1.07	1.02	1.00	0.99
		Tetracycline (J01AA07)	0.99	0.89	0.83	0.75	0.67	0.63	0.60	0.52	0.48	0.46
	Amphenicols (J01BA)	Chloramphenicol (J01BA01)	< 0.01	< 0.01	< 0.01	NPD	< 0.01	< 0.01	NPD	NPD	NPD	NPD
	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
	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
	Intermediate-acting sulfonamides (J01EC)	Sulfadiazine (J01EC02), sulfamethoxazole (J01EC04)	< 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)	0.42	0.44	0.45	0.47	0.49	0.52	0.57	0.58	0.61	0.66
	Fosfomycin (J01XX)	Fosfomycin (J01XX01)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
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
	Total (J01)		**19.23**	**18.93**	**18.11**	**18.21**	**17.58**	**18.13**	**18.64**	**18.03**	**18.00**	**18.20**

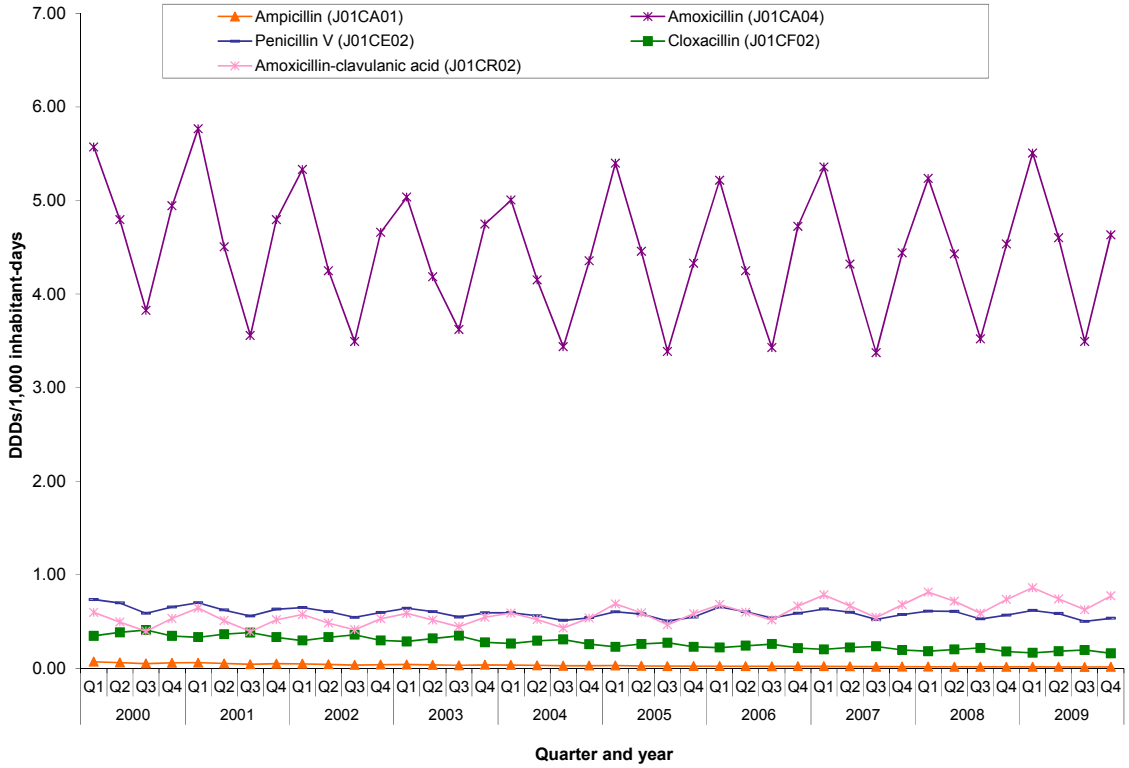
Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NC = Not classified. NPD = No prescriptions dispensed.

Figure 42. Percentages of defined daily doses per 1,000 inhabitant-days of oral antimicrobials dispensed by Canadian retail pharmacies, 2009.



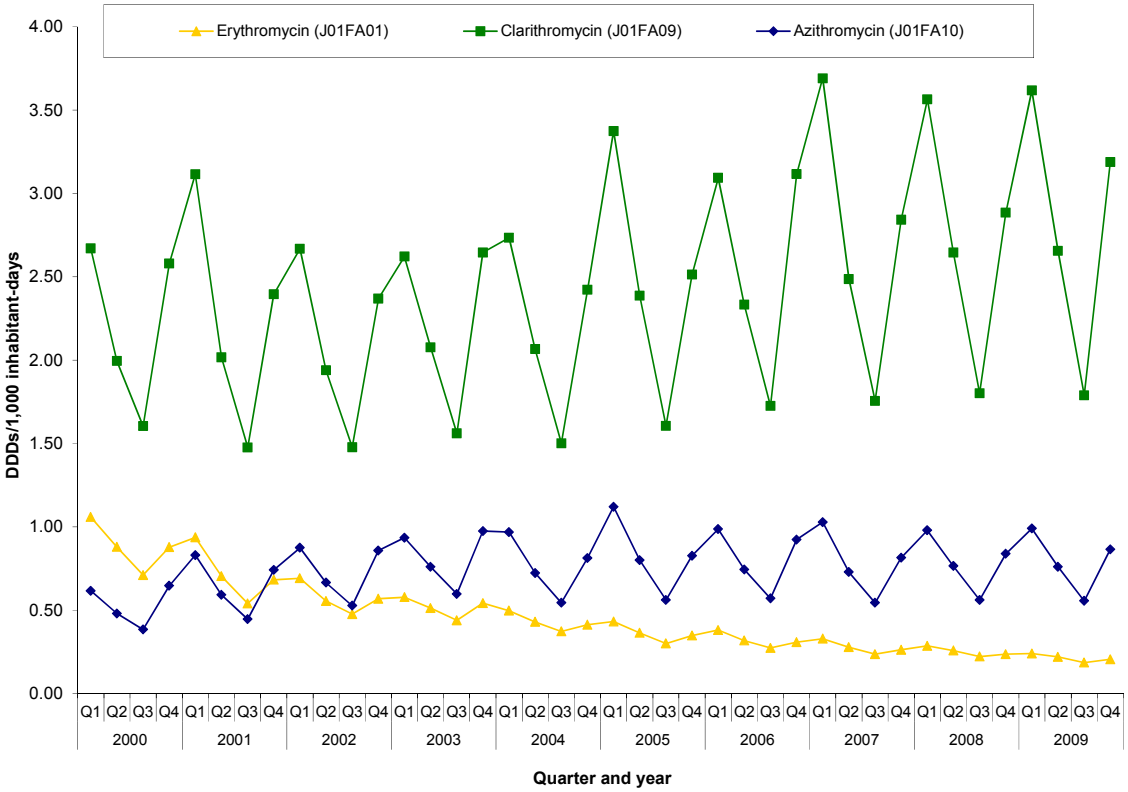
Alphanumeric codes in parentheses represent Anatomical Therapeutic Chemical classes of antimicrobials.

Figure 43. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral penicillins (J01C) dispensed by Canadian retail pharmacies, 2000–2009.



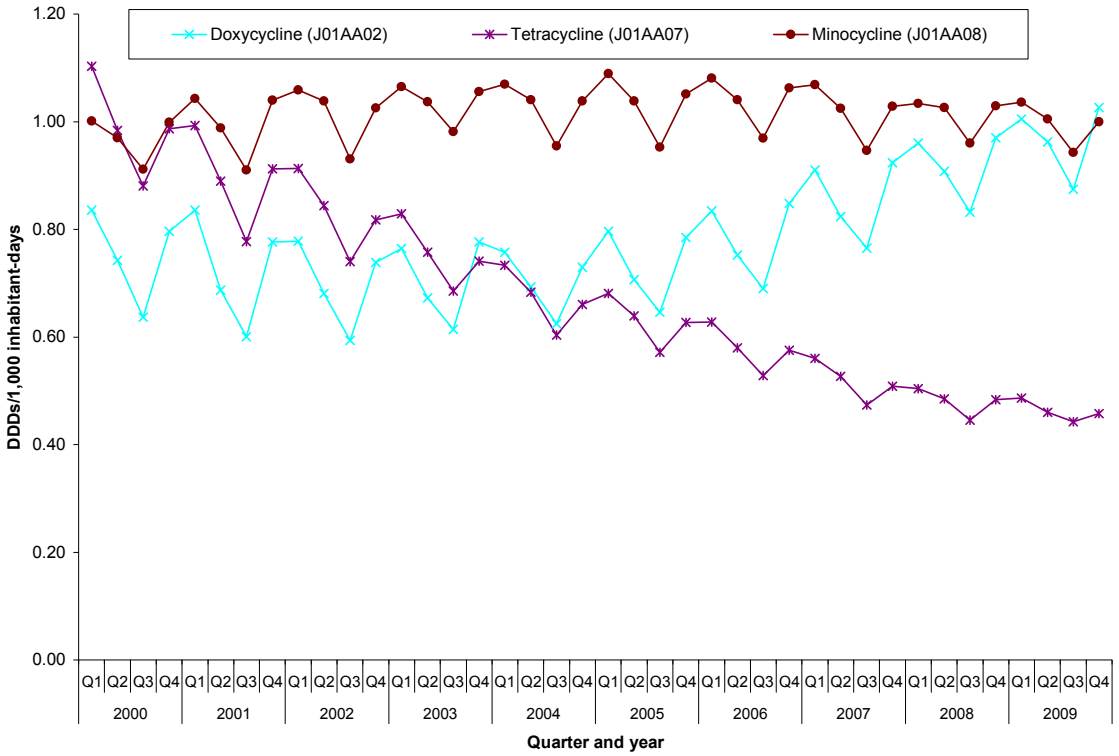
Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.
DDDs = Defined daily doses.

Figure 44. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral macrolides (J01FA) dispensed by Canadian retail pharmacies, 2000–2009.



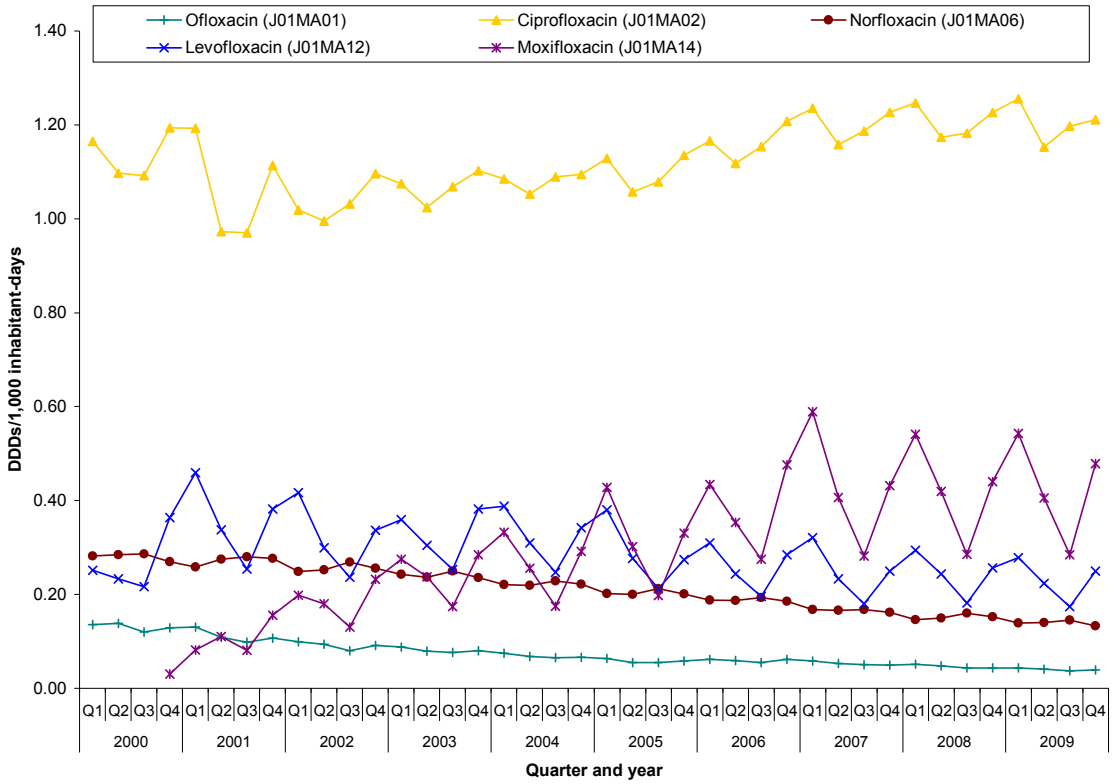
Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.
DDDs = Defined daily doses.

Figure 45. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral tetracyclines (J01AA) dispensed by Canadian retail pharmacies, 2000–2009.



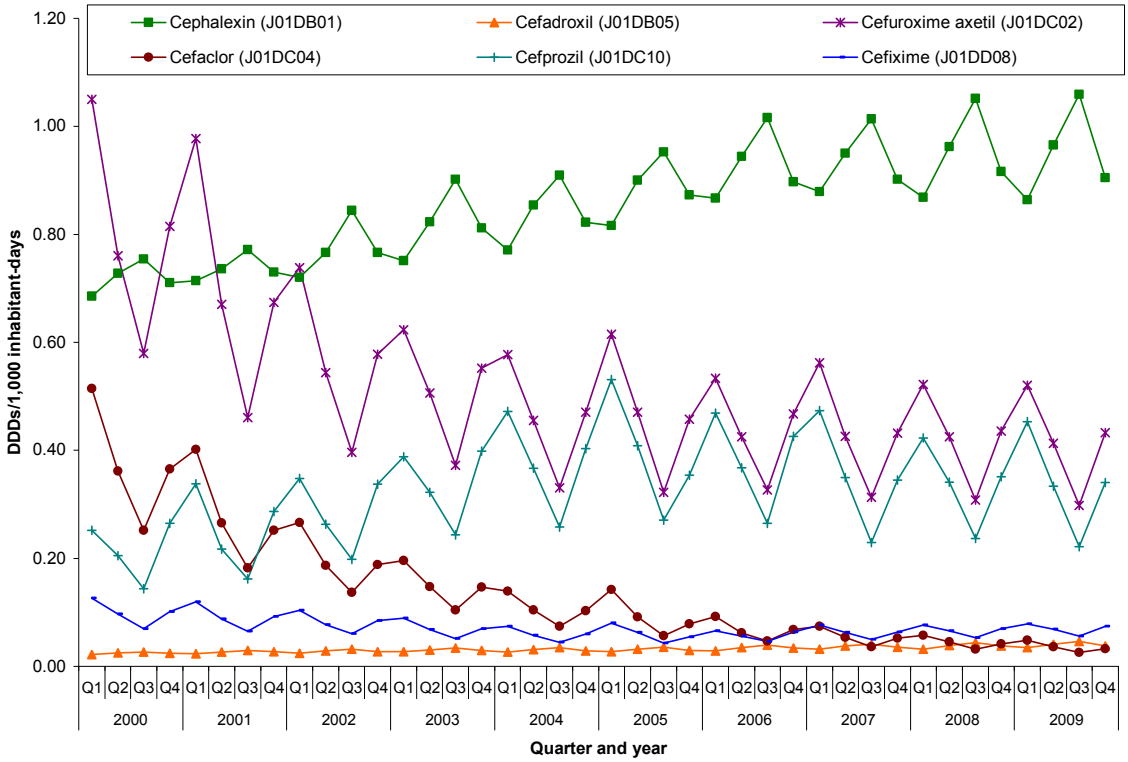
Alphanumeric codes represent Anatomical Therapeutic Chemical classes of antimicrobials.
DDDs = Defined daily doses.

Figure 46. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral fluoroquinolones (J01MA) dispensed by Canadian retail pharmacies, 2000–2009.



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

Figure 47. Consumption (DDDs/1,000 inhabitant-days) by quarter of oral cephalosporins (J01DB-DD) dispensed by Canadian retail pharmacies, 2000–2009.



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

Table 30. Number of prescriptions per 1,000 inhabitants of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2009.

	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)	19.97	23.69	18.21	19.05	16.49	26.01	20.82	24.75	46.14	51.87
	Cefixime	Third-generation cephalosporins (J01DD)	4.02	4.05	1.75	2.92	4.94	4.46	2.80	4.92	14.01	7.67
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	87.10	93.47	68.38	90.15	93.48	111.37	92.44	83.23	110.04	162.80
	Vancomycin	Glycopeptides (J01XA)	0.44	0.22	0.07	0.13	0.22	1.25	0.15	0.25	0.16	0.21
	Metronidazole	Imidazole (J01XD)	18.68	20.83	24.01	20.48	19.17	15.13	18.10	20.80	17.49	25.95
	Linezolid	Linezolid (J01XX)	0.07	0.04	0.05	0.01	0.04	0.14	0.01	0.04	0.01	0.08
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	142.36	165.03	250.45	187.22	186.19	88.76	160.59	165.37	176.87	302.22
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	32.13	34.57	26.07	37.50	25.91	40.20	39.46	33.40	33.90	39.83
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	8.37	7.59	17.36	20.94	7.70	6.17	6.72	9.39	9.36	17.74
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	62.86	60.86	94.53	61.77	50.83	25.95	56.19	57.84	57.51	79.98
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	14.86	24.08	13.06	18.01	36.59	31.98	41.56	36.85	13.64	32.94
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	35.46	35.64	59.76	45.63	32.20	21.51	44.45	52.93	57.61	59.10
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	103.09	127.78	130.78	140.60	150.77	113.35	146.50	139.12	174.18	183.38
	Clindamycin	Lincosamides (J01FF)	22.80	27.15	30.41	16.61	22.78	19.70	21.85	21.57	15.95	18.50
	Tobramycin	Aminoglycosides (J01GB)	0.06	0.06	0.16	0.08	0.07	0.12	0.20	< 0.01	NPD	< 0.01
	Fusidic acid	Steroid antibacterials (J01XC)	0.02	0.01	< 0.01	0.01	0.01	0.04	0.01	0.01	0.04	NPD
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	38.80	43.65	60.53	35.28	29.98	35.72	30.53	44.47	47.77	39.27
	Trimethoprim	Trimethoprim and derivatives (J01EA)	0.97	1.11	2.83	0.43	1.74	3.42	1.75	0.83	0.46	2.13
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	28.39	22.70	40.92	17.52	34.59	15.19	26.69	36.56	25.16	19.76
	Fosfomycin	Fosfomycin (J01XX)	0.05	0.03	0.03	< 0.01	0.01	0.01	0.02	0.08	NPD	0.01
NC	Methenamine	Methenamine (J01XX)	0.23	0.14	0.10	< 0.01	0.11	0.59	0.15	0.05	NPD	0.02
		Total (J01)	**620.73**	**692.70**	**839.47**	**714.34**	**713.82**	**561.08**	**711.02**	**732.46**	**800.31**	**1,043.47**

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 (< 0.01 prescriptions/1,000 inhabitants) to no sales reported among the provinces. These are: nalidixic acid, sulfonamides, combinations with other antimicrobials excluding trimethoprim, sulfadiazine, sulfamethoxazole, chloramphenicol, sulfamethizole, sulfapyridine, and sulfisoxazole.

Table 31. Consumption (DDDs/1,000 inhabitant-days) of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2009.

	Antimicrobial	ATC Class	DDDs/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)	0.70	0.82	0.58	0.69	0.58	0.96	0.81	0.89	1.48	1.70
I	Cefixime	Third-generation cephalosporins (J01DD)	0.08	0.06	0.02	0.04	0.08	0.05	0.05	0.08	0.30	0.17
I	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	1.68	1.98	1.40	1.93	2.16	2.02	2.03	1.95	2.40	4.44
I	Vancomycin	Glycopeptides (J01XA)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
I	Metronidazole	Imidazole (J01XD)	0.24	0.27	0.29	0.28	0.26	0.20	0.24	0.27	0.23	0.33
I	Linezolid	Linezolid (J01XX)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	4.01	4.69	6.94	5.59	5.21	2.85	5.06	4.87	4.94	9.09
II	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	0.55	0.60	0.47	0.60	0.45	0.70	0.67	0.58	0.68	0.71
II	Cloxacillin	β-lactamase resistant penicillins (J01CF)	0.17	0.16	0.35	0.45	0.16	0.13	0.15	0.20	0.19	0.38
II	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	1.21	1.21	1.92	1.22	1.03	0.42	1.24	1.22	1.20	1.71
II	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	0.56	0.62	0.38	0.49	0.87	0.78	1.68	1.15	0.43	1.43
II	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	0.91	0.96	1.41	1.05	0.73	0.38	1.03	1.17	1.34	1.71
II	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	3.35	3.90	3.09	3.32	4.13	3.40	4.20	3.95	4.66	6.22
II	Clindamycin	Lincosamides (J01FF)	0.40	0.49	0.57	0.32	0.38	0.35	0.42	0.40	0.32	0.32
II	Tobramycin	Aminoglycosides (J01GB)	0.01	0.01	0.01	0.01	0.01	< 0.01	0.03	< 0.01	NPD	< 0.01
II	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	NPD	NPD	NPD	NPD	< 0.01	NPD	NPD	NPD	NPD	NPD
II	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	NPD	NPD	NPD	NPD	NPD	< 0.01	NPD	NPD	NPD	NPD
II	Fusidic acid	Steroid antibacterials (J01XC)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	NPD
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	2.87	3.02	4.28	2.59	2.36	1.68	1.86	2.84	3.33	2.50
III	Trimethoprim	Trimethoprim and derivatives (J01EA)	0.04	0.03	0.11	0.01	0.06	0.05	0.05	0.02	0.01	0.11
III	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	NPD	< 0.01	NPD	NPD	< 0.01	NPD	NPD	NPD	NPD	NPD
III	Nitrofurantoin	Nitrofuran derivatives (J01XE)	0.68	0.61	1.04	0.47	0.83	0.32	0.74	0.97	0.75	0.60
III	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)	0.01	0.01	0.01	< 0.01	< 0.01	0.01	0.01	< 0.01	NPD	< 0.01
		Total (J01)	**17.46**	**19.42**	**22.86**	**19.06**	**19.30**	**14.30**	**20.28**	**20.56**	**22.27**	**31.44**

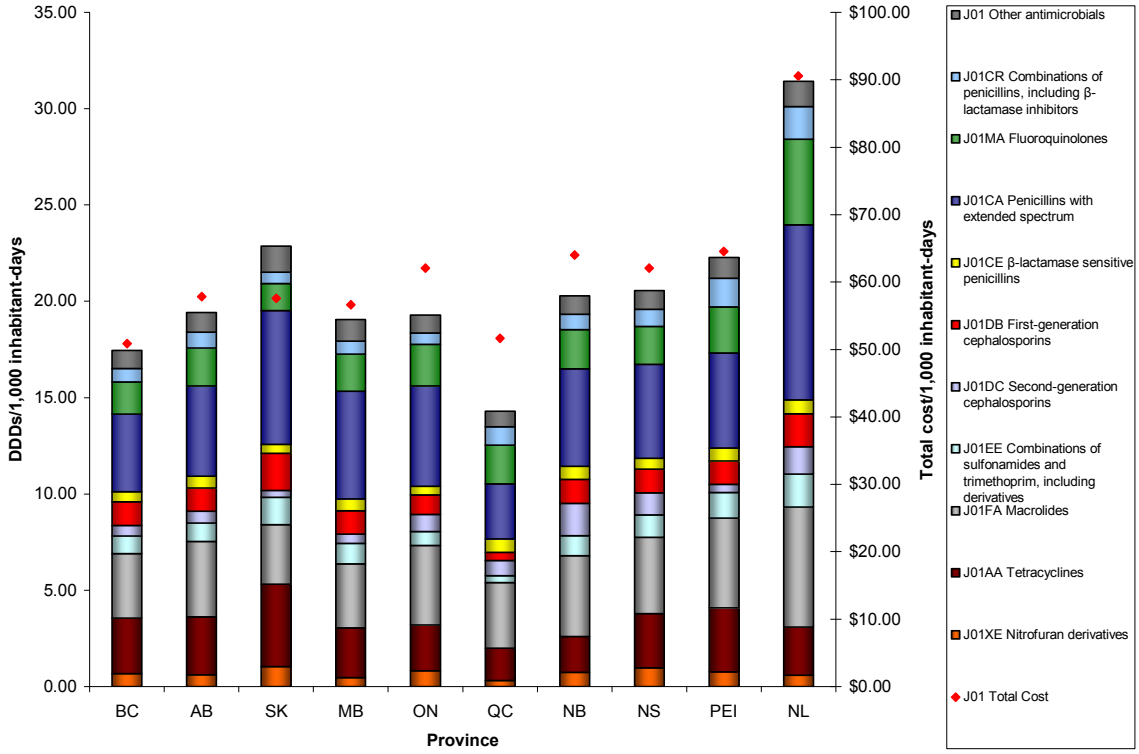
Roman numerals I to III indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
ATC = Anatomical Therapeutic Chemical. DDDs= Defined daily doses. NC = Not classified. NPD = No prescriptions dispensed.

Table 32. Total cost per 1,000 inhabitant-days of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2009.

	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)	1.88	2.14	1.63	1.99	1.56	2.36	2.14	2.42	4.26	4.98
	Cefixime	Third-generation cephalosporins (J01DD)	0.46	0.43	0.14	0.31	0.53	0.38	0.34	0.56	1.98	0.97
	Ofloxacin, ciprofloxacin, norfloxacin, levofloxacin, moxifloxacin	Fluoroquinolones (J01MA)	9.64	10.78	7.98	10.73	11.75	11.78	11.53	10.83	14.34	21.63
	Vancomycin	Glycopeptides (J01XA)	0.52	0.27	0.10	0.21	0.32	1.10	0.18	0.30	0.19	0.41
	Metronidazole	Imidazole (J01XD)	0.68	0.82	0.74	0.81	1.01	0.61	0.83	0.93	0.69	1.18
	Linezolid	Linezolid (J01XX)	0.41	0.20	0.21	0.04	0.24	0.55	0.05	0.31	0.05	0.53
II	Ampicillin, amoxicillin, pivampicillin	Penicillins with extended spectrum (J01CA)	7.15	8.33	11.58	9.98	9.79	5.31	8.68	8.72	8.29	15.07
	Penicillin G, penicillin V	β-lactamase sensitive penicillins (J01CE)	1.20	1.31	0.93	1.50	0.99	1.60	1.41	1.24	1.14	1.36
	Cloxacillin	β-lactamase resistant penicillins (J01CF)	0.50	0.45	1.02	1.32	0.47	0.38	0.42	0.59	0.53	1.06
	Cephalexin, cefadroxil	First-generation cephalosporins (J01DB)	4.16	3.99	5.83	4.25	3.56	1.84	4.07	4.12	3.75	5.52
	Cefaclor, cefprozil, cefuroxime axetil	Second-generation cephalosporins (J01DC)	1.73	2.60	1.36	2.08	4.03	3.82	5.55	4.48	1.67	4.42
	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	1.21	1.23	1.81	1.63	1.05	0.63	1.43	1.77	1.69	1.86
	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	12.39	15.23	12.72	14.25	17.76	14.43	17.75	16.12	18.37	23.58
	Clindamycin	Lincosamides (J01FF)	2.29	2.74	3.21	1.78	2.19	1.84	2.47	2.34	1.83	1.92
	Tobramycin	Aminoglycosides (J01GB)	0.58	0.52	1.17	0.90	0.62	1.00	1.98	0.03	NPD	0.04
	Nalidixic acid	Other quinolones, excluding fluoroquinolones (J01MB)	NPD	NPD	NPD	NPD	< 0.01	NPD	NPD	NPD	NPD	NPD
	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	NPD	NPD	NPD	NPD	NPD	< 0.01	NPD	NPD	NPD	NPD
	Fusidic acid	Steroid antibacterials (J01XC)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.10	NPD
III	Doxycycline, minocycline, tetracycline	Tetracyclines (J01AA)	4.21	5.28	4.29	3.75	3.96	3.14	3.32	4.81	4.17	4.58
	Trimethoprim	Trimethoprim and derivatives (J01EA)	0.06	0.06	0.18	0.02	0.10	0.11	0.09	0.05	0.02	0.15
	Sulfadiazine, sulfamethoxazole	Intermediate-acting sulfonamides (J01EC)	NPD	< 0.01	NPD	NPD	< 0.01	NPD	NPD	NPD	NPD	NPD
	Nitrofurantoin	Nitrofuran derivatives (J01XE)	1.75	1.46	2.64	1.07	2.14	0.74	1.75	2.42	1.51	1.29
	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)	0.02	0.01	0.01	< 0.01	0.01	0.03	0.02	< 0.01	NPD	0.01
		Total (J01)	**50.88**	**57.85**	**57.57**	**56.62**	**62.08**	**51.66**	**64.01**	**62.04**	**64.57**	**90.56**

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.

Figure 48. Consumption (DDDs/1,000 inhabitant-days) and total cost per 1,000 inhabitant-days of oral antimicrobials dispensed by retail pharmacies across Canadian provinces, 2009.



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

Table 33. Consumption (DDDs/1,000 inhabitant-days) of oral sulfamethoxazole-trimethoprim, ciprofloxacin, and nitrofurantoin, generally prescribed for treatment of urinary tract infections, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	Sulfamethoxazole-trimethoprim (J01EE01)	British Columbia	1.61	1.47	1.31	1.23	1.06	0.97	0.97	0.96	0.95	0.91
		Alberta	1.68	1.44	1.30	1.29	1.15	1.11	1.08	0.98	0.98	0.96
		Saskatchewan	2.23	1.91	1.74	1.63	1.37	1.41	1.52	1.44	1.38	1.41
		Manitoba	1.65	1.60	1.56	1.64	1.45	1.06	1.14	1.07	1.05	1.05
		Ontario	1.21	1.16	1.07	0.97	0.86	0.82	0.82	0.75	0.73	0.73
		Québec	0.96	0.82	0.67	0.59	0.50	0.42	0.41	0.39	0.39	0.38
		New Brunswick	2.20	1.78	1.64	1.45	1.26	1.13	1.16	1.09	1.05	1.03
		Nova Scotia	1.76	1.52	1.34	1.27	1.23	1.19	1.21	1.16	1.16	1.17
		Prince Edward Island and Newfoundland and Labrador	3.11	2.70	2.26	2.37	2.15	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	1.61	1.52	1.45	1.29	1.34
		Newfoundland and Labrador	NA	NA	NA	NA	NA	1.88	1.77	1.69	1.66	1.71
Fluoroquinolones (J01MA)	Ciprofloxacin (J01MA02)	British Columbia	1.08	1.16	1.19	1.23	1.23	1.25	1.31	1.31	1.29	1.23
		Alberta	0.98	1.00	1.03	1.14	1.21	1.26	1.23	1.25	1.27	1.25
		Saskatchewan	0.69	0.77	0.80	0.72	0.68	0.78	0.88	0.98	0.94	1.01
		Manitoba	0.80	0.88	0.94	1.15	1.25	1.08	1.20	1.26	1.23	1.27
		Ontario	1.38	1.05	0.98	0.97	0.98	1.05	1.19	1.16	1.15	1.13
		Québec	0.96	1.04	1.03	1.07	1.05	1.01	1.09	1.11	1.12	1.16
		New Brunswick	1.19	1.39	0.84	0.75	0.77	0.77	0.88	0.91	0.97	0.99
		Nova Scotia	0.71	0.80	0.89	0.98	1.02	1.03	1.09	1.09	1.13	1.18
		Prince Edward Island and Newfoundland and Labrador	1.79	2.06	2.35	2.37	2.45	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.85	0.91	1.05	1.14	1.14
		Newfoundland and Labrador	NA	NA	NA	NA	NA	3.24	3.45	3.51	3.52	3.49

The numbers presented above represent all antimicrobial treatments, not solely those dispensed for the treatment of urinary tract infections.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
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 are available at the individual provincial level.

Table 33 (continued). Consumption (DDDs/1,000 inhabitant-days) of oral sulfamethoxazole-trimethoprim, ciprofloxacin, and nitrofurantoin, generally prescribed for treatment of urinary tract infections, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Nitrofuran derivatives (J01XE)	Nitrofurantoin (J01XE01)	British Columbia	0.40	0.39	0.40	0.44	0.49	0.51	0.56	0.58	0.63	0.68
		Alberta	0.41	0.42	0.42	0.44	0.48	0.50	0.56	0.55	0.59	0.61
		Saskatchewan	0.91	0.95	0.87	0.87	0.88	0.90	0.97	0.98	0.99	1.04
		Manitoba	0.35	0.37	0.36	0.43	0.46	0.34	0.39	0.41	0.44	0.47
		Ontario	0.48	0.52	0.55	0.57	0.59	0.66	0.73	0.72	0.77	0.83
		Québec	0.22	0.24	0.24	0.25	0.26	0.25	0.27	0.28	0.29	0.32
		New Brunswick	0.47	0.47	0.55	0.58	0.61	0.59	0.68	0.69	0.73	0.74
		Nova Scotia	0.74	0.70	0.67	0.68	0.69	0.76	0.89	0.92	0.95	0.97
		Prince Edward Island and Newfoundland and Labrador	0.42	0.38	0.38	0.39	0.39	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.44	0.53	0.64	0.74	0.75
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.38	0.45	0.52	0.59	0.60

The numbers presented above represent all antimicrobial treatments, not solely those dispensed for the treatment of urinary tract infections.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
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 are available at the individual provincial level.

Table 34. Consumption (DDDs/1,000 inhabitant-days) of oral ofloxacin, norfloxacin, erythromycin, cephalexin, and cefadroxil, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
First-generation cephalosporins (J01DB)	Cephalexin (J01DB01)	British Columbia	0.94	0.97	1.04	1.10	1.15	1.27	1.31	1.26	1.24	1.21
		Alberta	1.16	1.16	1.17	1.30	1.27	1.34	1.36	1.25	1.25	1.20
		Saskatchewan	2.12	2.03	1.92	1.84	1.77	2.06	2.09	1.97	2.00	1.92
		Manitoba	0.78	0.80	0.96	1.16	1.18	1.00	1.17	1.24	1.23	1.22
		Ontario	0.65	0.69	0.74	0.78	0.81	0.90	1.01	0.99	1.00	1.02
		Quebec	0.26	0.27	0.26	0.27	0.27	0.24	0.26	0.26	0.26	0.26
		New Brunswick	0.84	0.89	1.03	1.10	1.11	1.01	1.11	1.09	1.18	1.23
		Nova Scotia	0.75	0.75	0.74	0.85	0.92	1.00	1.15	1.19	1.22	1.22
		Prince Edward Island and Newfoundland and Labrador	1.33	1.34	1.36	1.41	1.51	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.94	1.01	1.10	1.22	1.19
		Newfoundland and Labrador	NA	NA	NA	NA	NA	1.56	1.68	1.68	1.67	1.71
	Cefadroxil (J01DB05)	British Columbia	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
		Alberta	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
		Saskatchewan	NPD	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	NPD	NPD	NPD	< 0.01
		Manitoba	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
		Ontario	0.01	0.01	0.01	0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01
		Quebec	0.07	0.08	0.09	0.10	0.11	0.11	0.13	0.14	0.15	0.16
		New Brunswick	0.01	0.01	< 0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
		Nova Scotia	0.01	0.01	0.01	< 0.01	< 0.01	0.01	0.01	< 0.01	< 0.01	< 0.01
		Prince Edward Island and Newfoundland and Labrador	< 0.01	0.01	< 0.01	< 0.01	< 0.01	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	NPD	NPD	< 0.01	0.01	< 0.01
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.01	0.01	< 0.01	< 0.01	< 0.01

ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available. NPD = No prescriptions dispensed.
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 are available at the individual provincial level.
Data for the rest of the fluoroquinolones can be found in Tables 33 and 35; data for the rest of the macrolides can be found in Table 35.

Table 34 (continued). Consumption (DDDs/1,000 inhabitant-days) of oral ofloxacin, norfloxacin. erythromycin, cephalexin, and cefadroxil, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Macrolides (J01FA)	Erythromycin (J01FA01)	British Columbia	1.48	1.18	0.92	0.81	0.66	0.56	0.49	0.42	0.37	0.31
		Alberta	1.05	0.85	0.71	0.68	0.59	0.47	0.40	0.31	0.26	0.23
		Saskatchewan	2.00	1.69	1.46	1.48	1.16	1.26	1.15	0.99	0.85	0.81
		Manitoba	1.49	1.43	1.33	1.35	1.10	0.74	0.71	0.61	0.51	0.41
		Ontario	0.76	0.60	0.48	0.41	0.33	0.29	0.28	0.22	0.22	0.17
		Quebec	0.28	0.22	0.16	0.14	0.11	0.09	0.08	0.07	0.06	0.06
		New Brunswick	1.13	0.81	0.58	0.52	0.47	0.35	0.32	0.24	0.23	0.22
		Nova Scotia	1.12	0.95	0.77	0.71	0.67	0.57	0.53	0.46	0.40	0.37
		Prince Edward Island and Newfoundland and Labrador	1.92	1.68	1.14	1.17	0.90	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	1.24	1.20	1.03	1.03	1.08
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.64	0.57	0.51	0.43	0.39

ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
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 are available at the individual provincial level.
Data for the rest of the fluoroquinolones can be found in Tables 33 and 35; data for the rest of the macrolides can be found in Table 35.

Table 34 (continued). Consumption (DDDs/1,000 inhabitant-days) of oral ofloxacin, norfloxacin. erythromycin, cephalexin, and cefadroxil, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fluoroquinolones (J01MA)	Ofloxacin (J01MA01)	British Columbia	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
		Alberta	0.10	0.08	0.05	0.05	0.05	0.03	0.03	0.03	0.02	0.02
		Saskatchewan	0.03	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	< 0.01
		Manitoba	0.04	0.03	0.04	0.04	0.03	0.02	0.03	0.03	0.02	0.02
		Ontario	0.15	0.12	0.10	0.08	0.07	0.07	0.07	0.06	0.06	0.05
		Quebec	0.14	0.12	0.11	0.10	0.09	0.06	0.07	0.06	0.05	0.04
		New Brunswick	0.13	0.10	0.10	0.08	0.07	0.05	0.07	0.04	0.04	0.04
		Nova Scotia	0.19	0.17	0.15	0.16	0.12	0.10	0.10	0.09	0.09	0.07
		Prince Edward Island and Newfoundland and Labrador	0.33	0.32	0.23	0.21	0.15	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.17	0.21	0.22	0.20	0.14
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.15	0.18	0.17	0.16	0.13
	Norfloxacin (J01MA06)	British Columbia	0.16	0.15	0.12	0.11	0.09	0.08	0.07	0.05	0.04	0.03
		Alberta	0.31	0.25	0.21	0.19	0.16	0.14	0.15	0.13	0.13	0.12
		Saskatchewan	0.10	0.06	0.05	0.04	0.02	0.02	0.02	0.02	0.02	0.01
		Manitoba	0.17	0.14	0.13	0.11	0.09	0.05	0.05	0.04	0.03	0.03
		Ontario	0.38	0.41	0.42	0.40	0.38	0.37	0.35	0.30	0.27	0.25
		Quebec	0.14	0.12	0.09	0.07	0.05	0.04	0.04	0.03	0.02	0.02
		New Brunswick	0.55	0.46	0.53	0.55	0.57	0.47	0.49	0.44	0.41	0.44
		Nova Scotia	0.39	0.31	0.25	0.22	0.20	0.17	0.16	0.14	0.13	0.12
		Prince Edward Island and Newfoundland and Labrador	0.67	0.63	0.53	0.51	0.45	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.40	0.39	0.36	0.27	0.21
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.42	0.42	0.37	0.35	0.32

ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
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 are available at the individual provincial level.
Data for the rest of the fluoroquinolones can be found in Tables 33 and 35; data for the rest of the macrolides can be found in Table 35.

Table 35. Consumption (DDDs/1,000 inhabitant-days) of oral macrolides and fluoroquinolones, generally prescribed for treatment of respiratory diseases, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Macrolide (J01FA)	Azithromycin (J01FA10)	British Columbia	0.20	0.22	0.36	0.49	0.49	0.55	0.54	0.53	0.50	0.44
		Alberta	0.45	0.53	0.56	0.69	0.67	0.79	0.80	0.69	0.69	0.65
		Saskatchewan	0.42	0.49	0.51	0.61	0.54	0.64	0.71	0.71	0.77	0.80
		Manitoba	0.45	0.55	0.60	0.75	0.72	0.76	0.84	0.86	0.96	1.19
		Ontario	0.58	0.70	0.82	0.92	0.86	1.01	1.03	0.95	0.97	0.98
		Québec	0.69	0.81	0.83	0.81	0.73	0.66	0.64	0.61	0.62	0.64
		New Brunswick	0.55	1.08	1.40	1.64	1.56	1.41	1.34	1.08	0.98	0.94
		Nova Scotia	0.76	1.07	1.06	1.16	1.06	1.13	1.08	1.02	0.94	0.90
		Prince Edward Island and Newfoundland and Labrador	0.30	0.50	0.50	0.64	0.62	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.82	0.86	0.82	0.88	0.80
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.72	0.66	0.62	0.70	0.76
	Clarithromycin (J01FA09)	British Columbia	1.41	1.80	1.80	2.17	2.07	2.64	2.62	2.68	2.77	2.59
		Alberta	2.56	2.39	2.19	2.64	2.63	3.08	3.00	2.92	3.08	3.03
		Saskatchewan	1.19	1.10	1.09	1.16	0.97	1.25	1.33	1.19	1.31	1.48
		Manitoba	0.95	1.13	1.31	1.53	1.53	1.60	1.67	1.60	1.57	1.72
		Ontario	2.55	2.46	2.30	2.29	2.21	2.66	2.91	2.90	2.88	2.98
		Québec	2.57	2.62	2.38	2.34	2.32	2.20	2.43	2.55	2.50	2.69
		New Brunswick	1.69	1.63	1.47	1.73	1.92	2.05	2.41	2.62	2.86	3.04
		Nova Scotia	1.15	1.11	1.08	1.25	1.49	1.68	2.11	2.38	2.44	2.68
		Prince Edward Island and Newfoundland and Labrador	1.56	2.37	2.42	3.06	3.05	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	1.47	1.85	2.35	2.58	2.78
		Newfoundland and Labrador	NA	NA	NA	NA	NA	4.01	4.03	4.52	4.54	5.07

The numbers presented above represent all antimicrobial treatments, not solely those dispensed for the treatment of respiratory diseases.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
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 are available at the individual provincial level.

Table 35 (continued). Consumption (DDDs/1,000 inhabitant-days) of oral macrolides and fluoroquinolones, generally prescribed for treatment of respiratory diseases, dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fluoroquinolones (J01MA)	Levofloxacin (J01MA12)	British Columbia	0.09	0.12	0.11	0.12	0.11	0.10	0.09	0.08	0.07	0.06
		Alberta	0.27	0.48	0.53	0.60	0.71	0.64	0.43	0.39	0.38	0.34
		Saskatchewan	0.15	0.17	0.19	0.20	0.18	0.15	0.12	0.10	0.10	0.07
		Manitoba	0.24	0.33	0.39	0.38	0.31	0.27	0.34	0.37	0.39	0.39
		Ontario	0.27	0.35	0.32	0.35	0.35	0.32	0.34	0.31	0.31	0.30
		Québec	0.40	0.52	0.39	0.33	0.29	0.24	0.21	0.19	0.18	0.18
		New Brunswick	0.18	0.24	0.22	0.20	0.16	0.10	0.08	0.07	0.05	0.04
		Nova Scotia	0.21	0.24	0.20	0.19	0.19	0.21	0.20	0.20	0.24	0.24
		Prince Edward Island and Newfoundland and Labrador	0.15	0.24	0.20	0.23	0.23	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.42	0.33	0.26	0.25	0.20
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.15	0.11	0.10	0.10	0.08
	Moxifloxacin (J01MA14)	British Columbia	0.01	0.06	0.09	0.13	0.16	0.23	0.26	0.27	0.29	0.34
		Alberta	0.01	0.05	0.08	0.10	0.12	0.14	0.22	0.27	0.28	0.25
		Saskatchewan	< 0.01	0.06	0.14	0.16	0.18	0.27	0.30	0.32	0.34	0.30
		Manitoba	0.01	0.07	0.10	0.12	0.13	0.16	0.22	0.24	0.24	0.22
		Ontario	0.01	0.09	0.18	0.24	0.25	0.31	0.42	0.44	0.43	0.42
		Québec	0.01	0.20	0.32	0.41	0.45	0.47	0.56	0.61	0.58	0.61
		New Brunswick	< 0.01	0.13	0.17	0.21	0.33	0.46	0.51	0.54	0.54	0.52
		Nova Scotia	< 0.01	0.07	0.13	0.17	0.23	0.25	0.31	0.32	0.34	0.35
		Prince Edward Island and Newfoundland and Labrador	< 0.01	0.09	0.13	0.19	0.19	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.31	0.43	0.55	0.66	0.69
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.28	0.31	0.38	0.42	0.42

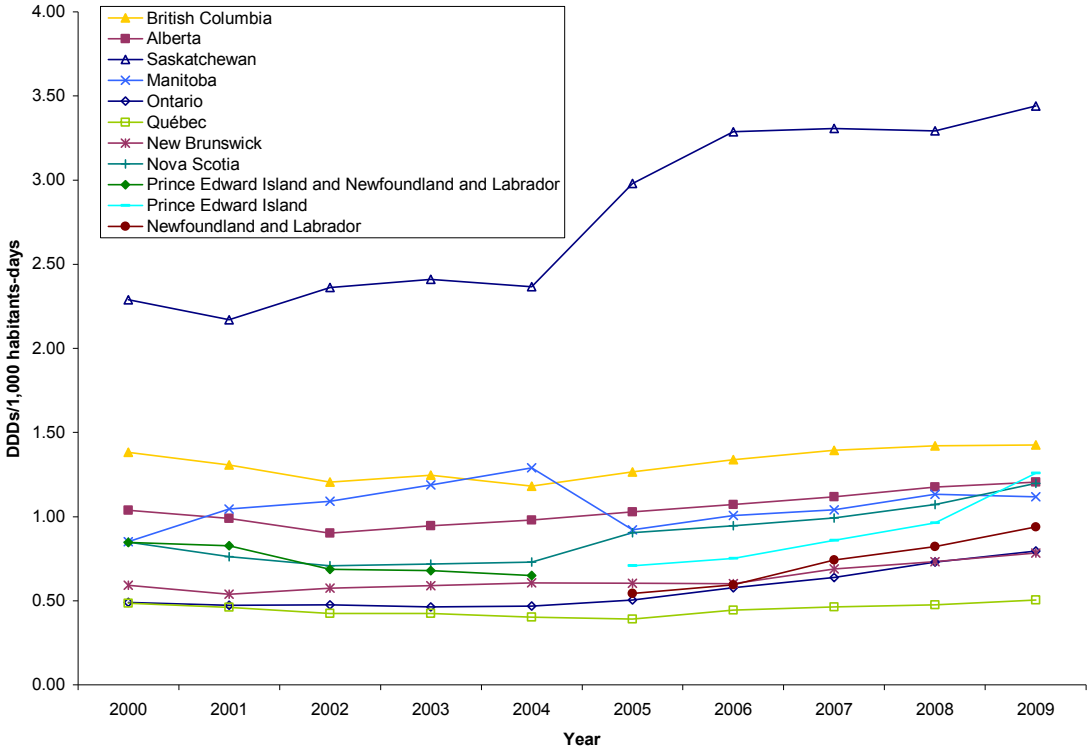
The numbers presented above represent all antimicrobial treatments, not solely those dispensed for the treatment of respiratory diseases.
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data are available at the individual provincial level.

Table 36. Defined daily doses per 1,000 inhabitant-days of oral tetracyclines dispensed by retail pharmacies across Canadian provinces, 2000–2009.

ATC Class	Antimicrobial	Province	DDDs/1,000 inhabitant-days									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tetracyclines (J01AA)	Doxycycline (J01AA02)	British Columbia	1.38	1.31	1.20	1.25	1.18	1.27	1.34	1.39	1.42	1.43
		Alberta	1.04	0.99	0.90	0.95	0.98	1.03	1.07	1.12	1.18	1.21
		Saskatchewan	2.29	2.17	2.36	2.41	2.37	2.98	3.29	3.31	3.29	3.44
		Manitoba	0.85	1.05	1.09	1.19	1.29	0.92	1.01	1.04	1.13	1.12
		Ontario	0.49	0.47	0.48	0.46	0.47	0.51	0.58	0.64	0.73	0.80
		Québec	0.48	0.46	0.42	0.42	0.40	0.39	0.44	0.46	0.47	0.50
		New Brunswick	0.59	0.54	0.57	0.59	0.61	0.60	0.60	0.69	0.73	0.78
		Nova Scotia	0.85	0.76	0.71	0.72	0.73	0.90	0.95	0.99	1.07	1.20
		Prince Edward Island and Newfoundland and Labrador	0.85	0.83	0.69	0.68	0.65	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.71	0.75	0.86	0.96	1.26
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.54	0.59	0.74	0.82	0.94
	Tetracycline (J01AA07)	British Columbia	1.42	1.23	1.08	0.99	0.84	0.78	0.71	0.60	0.54	0.51
		Alberta	1.04	0.93	0.87	0.78	0.65	0.58	0.47	0.37	0.34	0.31
		Saskatchewan	1.56	1.41	1.27	0.99	0.87	0.81	0.71	0.64	0.57	0.51
		Manitoba	1.24	1.15	1.12	1.18	1.11	0.94	0.87	0.74	0.64	0.61
		Ontario	1.15	1.06	1.01	0.93	0.83	0.83	0.83	0.72	0.68	0.66
		Québec	0.43	0.38	0.34	0.30	0.26	0.22	0.19	0.17	0.15	0.15
		New Brunswick	0.37	0.36	0.37	0.35	0.34	0.26	0.29	0.28	0.24	0.26
		Nova Scotia	0.80	0.76	0.70	0.62	0.62	0.57	0.55	0.50	0.47	0.47
		Prince Edward Island and Newfoundland and Labrador	1.14	0.94	0.70	0.64	0.72	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	1.40	1.29	1.35	1.22	1.28
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.54	0.45	0.42	0.40	0.38
	Minocycline (J01AA08)	British Columbia	0.81	0.81	0.87	0.90	0.90	0.92	0.95	0.91	0.92	0.93
		Alberta	1.49	1.57	1.64	1.76	1.82	1.83	1.73	1.61	1.57	1.51
		Saskatchewan	0.42	0.43	0.38	0.32	0.34	0.40	0.42	0.37	0.37	0.34
		Manitoba	0.80	0.85	0.88	0.96	1.02	0.90	0.94	0.92	0.87	0.86
		Ontario	1.02	1.01	1.00	0.98	0.94	1.00	1.04	0.96	0.94	0.91
		Québec	0.88	0.95	0.98	1.00	0.97	0.93	0.99	0.98	1.00	1.03
		New Brunswick	0.73	0.77	0.86	0.88	0.90	0.87	0.89	0.84	0.80	0.82
		Nova Scotia	1.03	1.10	1.12	1.25	1.33	1.35	1.41	1.35	1.36	1.17
		Prince Edward Island and Newfoundland and Labrador	1.10	1.06	0.93	0.96	0.98	NA	NA	NA	NA	NA
		Prince Edward Island	NA	NA	NA	NA	NA	0.62	0.74	0.61	0.73	0.79
		Newfoundland and Labrador	NA	NA	NA	NA	NA	0.99	1.16	1.11	1.11	1.18

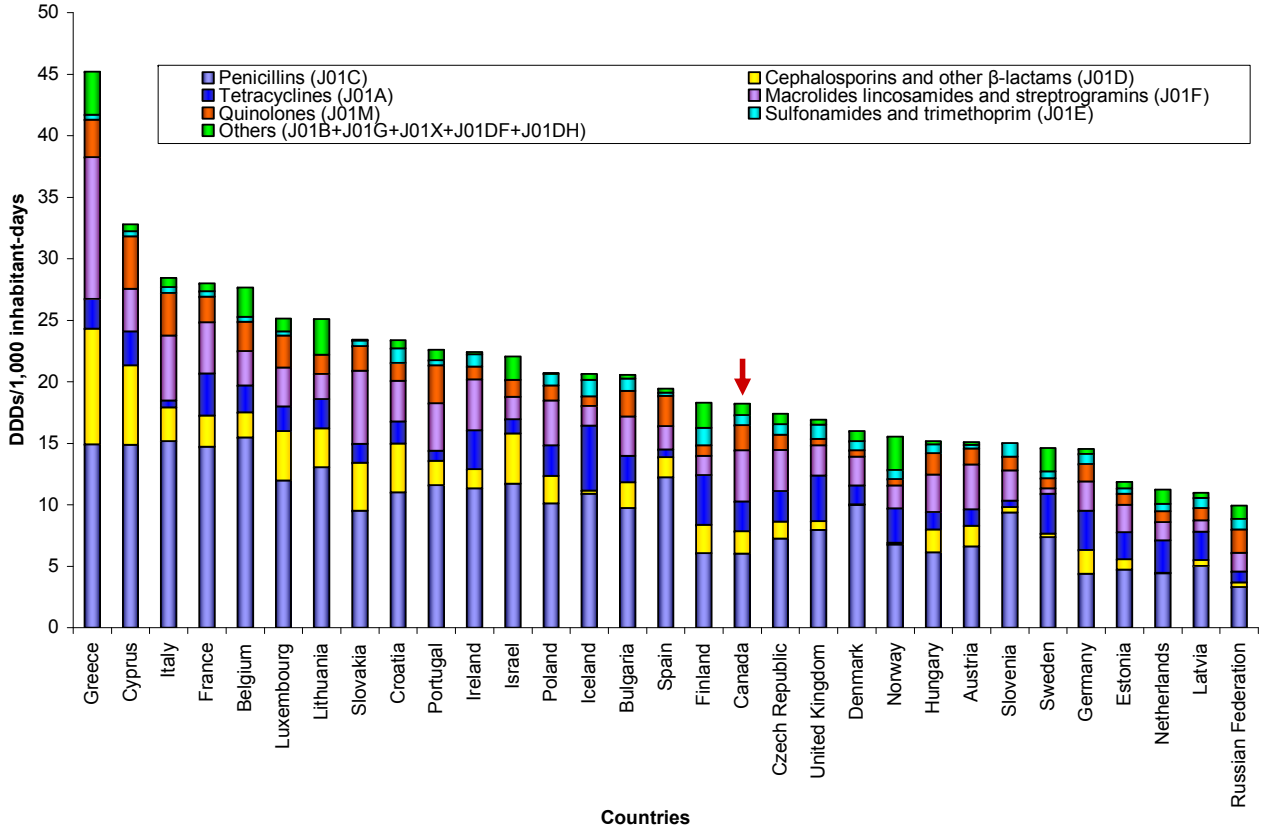
ATC = Anatomical Therapeutic Chemical. DDDs = Defined daily doses. NA = Not available.
Prior to 2005, data for the provinces of Prince Edward Island and Newfoundland and Labrador were provided in a combined format. As of 2005, data are available at the individual provincial level.

Figure 49. Consumption (DDDs/1,000 inhabitant-days) of oral doxycycline (J01AA02) dispensed by retail pharmacies across Canadian provinces, 2000–2009.



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

Figure 50. Antimicrobial consumption (DDDs/1,000 inhabitant-days) in 30 European countries and Canada[1]; European Surveillance of Antimicrobial Consumption and CIPARS, 2008.



DDDs = Defined daily doses.

[1] ESAC, 2010. ESAC – European Surveillance of Antimicrobial Consumption ESAC Interactive Database. Available at: http://app.esac.ua.ac.be/esac_idb/main.htm. Accessed April 2012.

Pigs[1]

Twenty-three veterinarians representing 97 sentinel swine herds were enrolled in CIPARS *Farm Surveillance* in 2009 (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 95 herds, which were distributed among the following provinces: Alberta, 22 (23%); Saskatchewan, 12 (13%); Manitoba, 9 (9%); Ontario, 26 (27%); and Québec, 26 (27%). Veterinarians reported that in 52 (55%) herds, grower-finisher production was managed as a continuous-flow operation. In the remaining 43 (45%) herds, an all-in-all-out management system was used.

National Level

Data regarding antimicrobial use practices were provided for all herds. In 89% (85/95) of the herds, antimicrobials were reportedly used in the grower-finisher phase of production, whereas in 11% (10/95), no antimicrobial use was reported for the same period. Among participating herds, antimicrobial use was more common via feed (76%, 72/95) and injection (52%, 49/95) than by water (26%, 25/95).

Use of antimicrobials from 3 or more antimicrobial classes (range, 0 to 6) was reported for 44% (42/95) of herds (Figure 51). The most commonly used antimicrobial class was the penicillins (55%, 52/95; Figure 52 and Table 37). 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 53 and Figure 54). 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 55). Penicillins were also the most common antimicrobials administered by injection (Figure 52),[2] the primary reason for this use was to treat respiratory disease and lameness (Figure 56).

Injectable ceftiofur was used in 19% (18/95) 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 37). The reported use of ceftiofur in 2009 represents a 10% and 2% decrease compared with use in 2007 (29% of herds, 29/100) and 2008 (21% of herds, 20/95), respectively. Ceftiofur was used in the treatment of respiratory diseases, lamenesses, enteric diseases, and other unspecified conditions (Figure 56).

In 2009, the only Category I antimicrobial used in grower-finisher pig herds was injectable ceftiofur (19% of herds, 18/95). The reported use of ceftiofur in 2009 represented a 10% and 2% decrease in use compared with use in 2007 (29% of herds, 29/100) and 2008 (21% of herds, 20/95), respectively. No antimicrobial use by any route was reported for 11% (10/95) of the herds.

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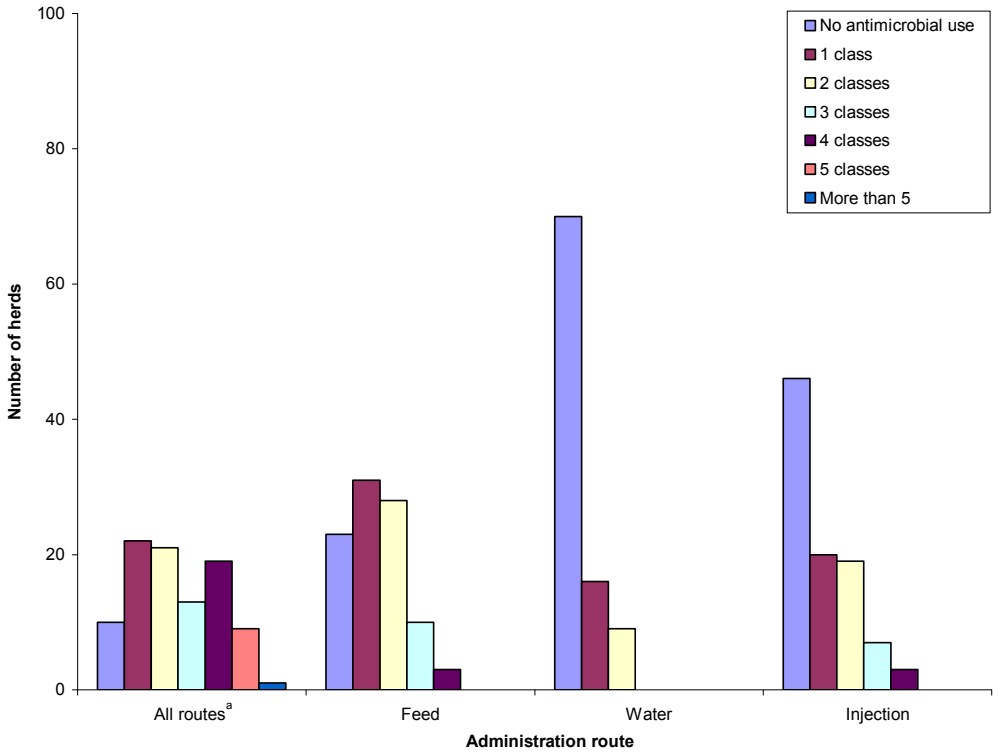
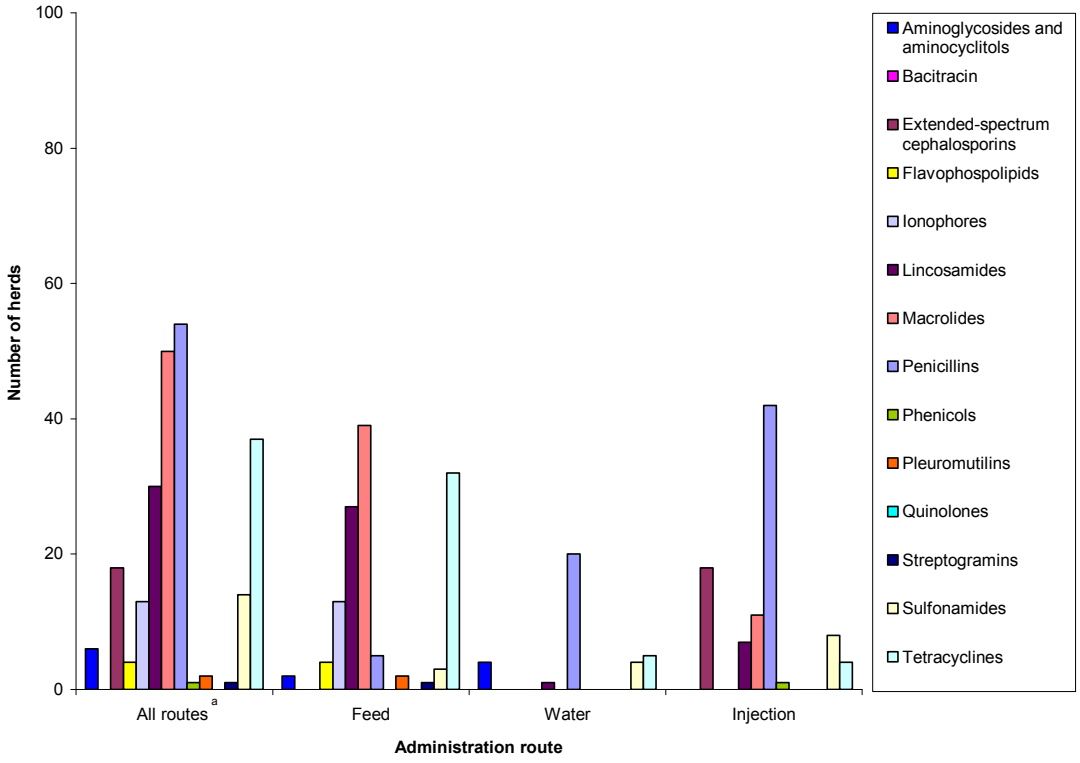
[1] Other animal demographic information is presented in Table C.9 and Table C.10, Appendix C.
[2] Antimicrobial treatment details (dose, duration, and pig age) were not collected for antimicrobials administered through water or injection because those routes were less commonly used than through feed.

Figure 51. 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 = 95); *Farm Surveillance*, 2009.



[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 52. Number of pig herds with reported use of antimicrobials from specific antimicrobial classes, by route of administration (n = 95); *Farm Surveillance*, 2009.



[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 37. Number of pig herds with reported use of specific active antimicrobial ingredients, by route of administration (n = 95); *Farm Surveillance*, 2009.

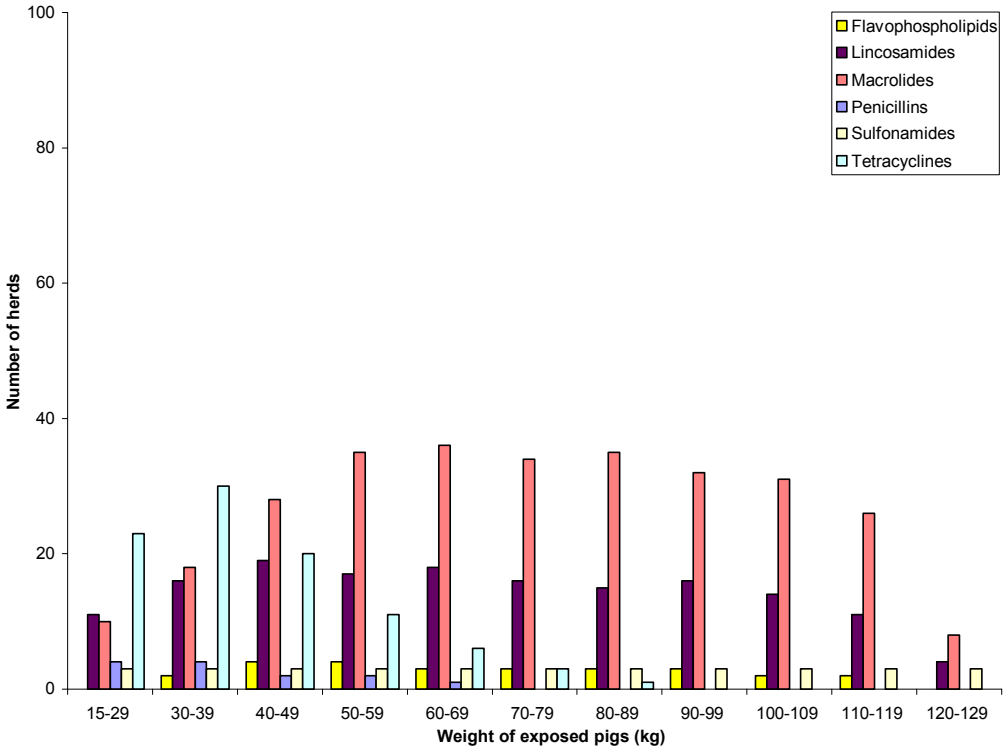
	Antimicrobial class	Antimicrobial	Administration route			
			Any route[a]	Feed	Water	Injection
I	Extended-spectrum cephalosporins	Ceftiofur	18	0	0	18
II	Aminoglycosides	Streptomycin	2	0	2	0
	Lincosamides	Lincomycin	30	27	1	7
	Macrolides	Erythromycin	0	0	0	0
		Tulathromycin	7	0	0	7
		Tilmicosin	1	1	0	0
		Tylosin	44	39	0	5
	Penicillins	Amoxicillin	0	0	0	0
		Ampicillin	4	0	0	4
		Penicillin G	52	5	20	40
		Phenoxymethyl penicillin	0	0	0	0
	Streptogramins	Virginiamycin	1	1	0	0
	Trimethoprim-sulfamethoxazole	Trimethoprim-sulfadoxine	9	0	2	8
III	Aminocyclotols	Spectinomycin	2	2	0	0
	Aminoglycosides	Neomycin	2	0	2	0
	Bacitracins	Bacitracin	0	0	0	0
	Phenicols	Florfenicol	1	0	0	1
	Pleuromutilins[b]	Tiamulin	2	2	0	0
	Sulfonamides	Sulfonamide (unspecified)	5	3	2	0
	Tetracyclines	Chlortetracycline	28	28	0	0
		Oxytetracycline	8	4	0	4
		Tetracycline hydrochloride	5	0	5	0
IV	Flavophospholipids	Bambermycin	4	4	0	0
	Ionophores	Salinomycin	13	13	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.

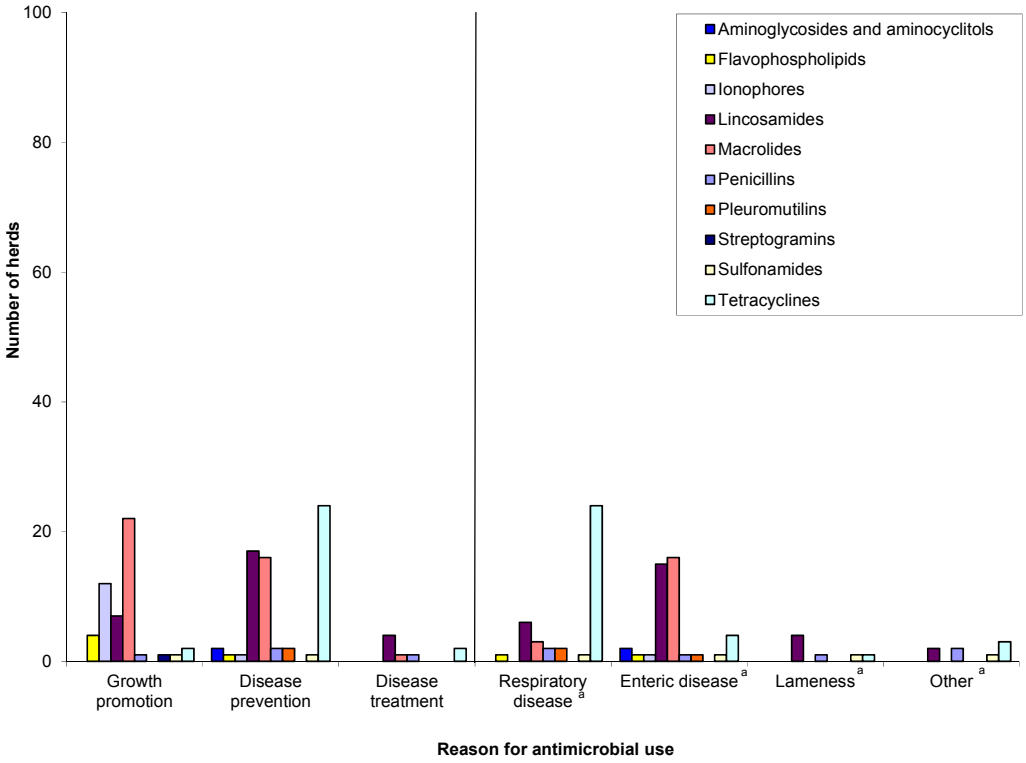
[b] Pleuromutilins are not listed in the current Veterinary Drugs Directorate categorization document; however, they meet the criteria for Category III.

Figure 53. Number of pig herds with reported use of antimicrobials from specific antimicrobial classes in feed, by weight category of pigs (n = 95); *Farm Surveillance*, 2009.



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

Figure 54. Number of pig herds with reported use of specific antimicrobial classes in feed, by reason for use (n = 95); *Farm Surveillance*, 2009.



[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.

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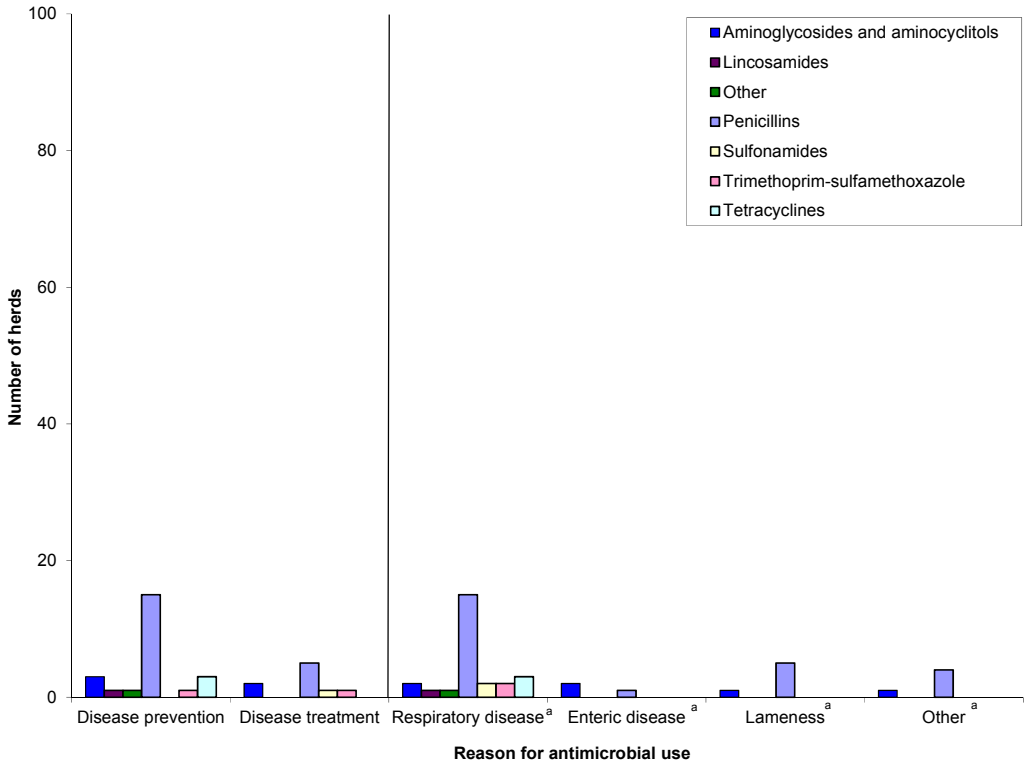
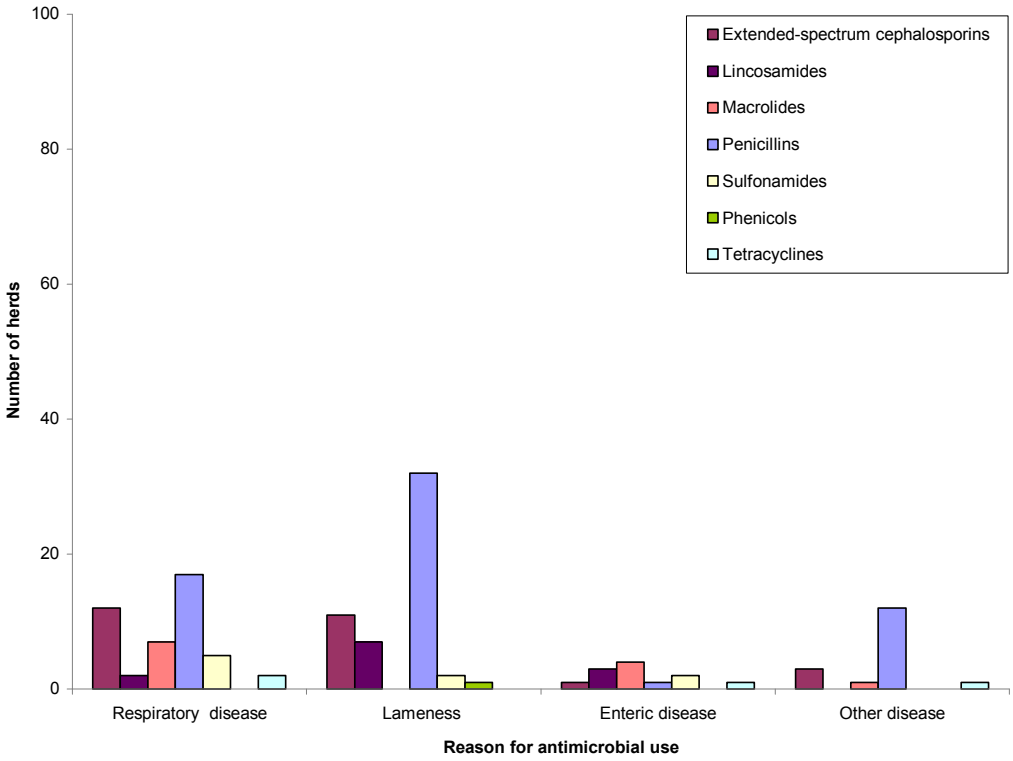
Figure 55. Number of pig herds with reported use of specific antimicrobial classes in water, by reason for use (n = 95); *Farm Surveillance*, 2009.



[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 56. Number of pig herds with reported use of specific antimicrobial classes via injection, by reason for use (n = 95); *Farm Surveillance*, 2009.



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 and 1 non-member 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 38). 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 through which 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 in 2008 and 2009 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 in 2008 and 2009 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 coccidiostats, and arsenicals" (previously included in "other antimicrobials").

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 2009 can be found in Table 38 and relative percentages distributed can be found in Figure 57. Overall, the total kilograms of active ingredient

[1] Division of AgLine/TI Communications Ltd. Available at: www.impactvet.com. Accessed April 2012.
[2] Available at: www.phac-aspc.gc.ca/cipars-picra/2006-eng.php. Accessed April 2012.

distributed for sale by Canadian companies decreased by 8% relative to the 2006 total and increased by 1% relative to the 2008 total.

In terms of Category I antimicrobials, the quantity of fluoroquinolones distributed for use in animals in 2009 decreased by 36% relative to the 2006 total and decreased by 8% relative to the 2008 total. Reasons for these decreases 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 the data were aggregated.

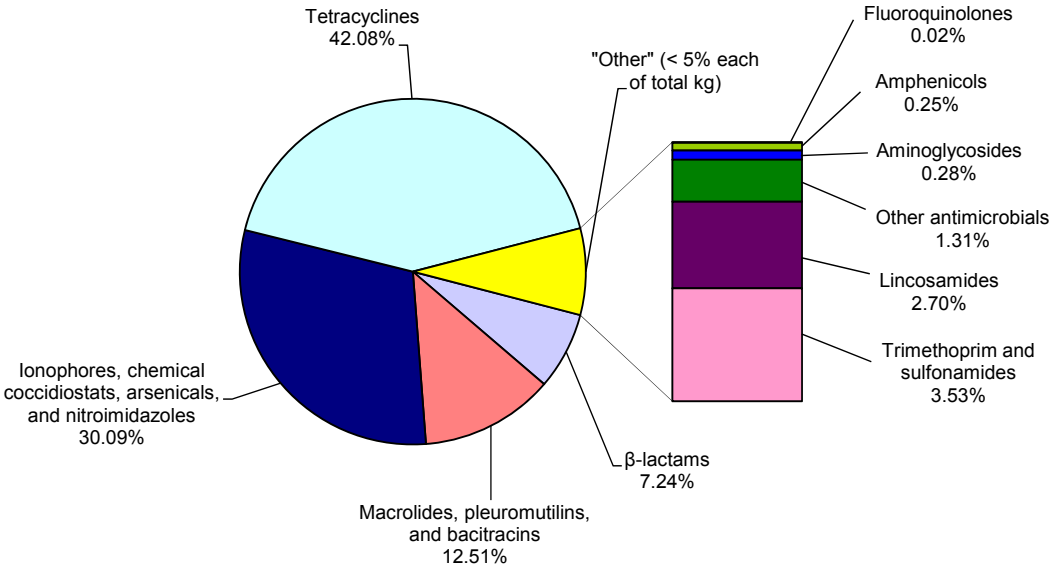
In 2009, the total kilograms of antimicrobials distributed for sale by CAHI member companies decreased by 8% relative to the 2006 total and increased by 1% relative to the 2008 total. The quantity of fluoroquinolones distributed for use in animals in 2009 decreased by 36% relative to the 2006 total and decreased by 8% to the 2008 total.

Table 38. Quantity of antimicrobials in dosage form distributed in Canada for use in animals; Canadian Animal Health Institute, 2006–2009.

Antimicrobial class aggregation	Quantity of active ingredients (kg)				Percentage change from 2006 to 2009	Percentage change from 2008 to 2009
	2006	2007	2008	2009		
Aminoglycosides	5,121.60	4,302.20	5,816.88	4,651.82	-9.17	-20.03
Amphenicols	NA	NA	3,242.03	4,001.47	NA	23.42
β-lactams (2006 and 2007)	58,538.00	52,594.00	NA	NA	NA	NA
β-lactams (2008 and 2009)	NA	NA	109,152.97	118,109.06	NA	8.21
Cephalosporins	702.00	850.00	NA	NA	NA	NA
Fluoroquinolones	591.00	443.10	411.44	377.21	-36.17	-8.32
Ionophores, chemical coccidiostats, and arsenicals (2006 and 2007)	455,753.00	445,952.00	NA	NA	NA	NA
Ionophores, chemical coccidiostats, arsenicals, and nitroimidazoles (2008 and 2009)	NA	NA	472,384.36	491,151.78	NA	3.97
Lincosamides	67,825.30	55,872.30	41,222.12	44,136.76	-34.93	7.07
Macrolides and pleuromutilins (2006 and 2007)	136,496.50	118,724.80	NA	NA	NA	NA
Macrolides, pleuromutilins, and bacitracins (2008 and 2009)	NA	NA	210,868.75	204,169.33	NA	-3.18
Other antimicrobials (2006 and 2007)	143,029.00	146,879.80	NA	NA	NA	NA
Other antimicrobials (2008 and 2009)	NA	NA	32,706.00	21,338.85	NA	-34.76
Tetracyclines	847,280.60	753,168.40	680,601.15	686,832.30	-18.94	0.92
Trimethoprim and sulfonamides	50,789.00	38,961.00	59,165.54	57,596.10	13.40	-2.65
Total	**1,766,126.00**	**1,617,747.60**	**1,615,571.23**	**1,632,364.68**	**-7.57**	**1.04**

Values do not include own use imports or active pharmaceutical ingredients used in compounding.
Grey shading indicates consistency in class aggregation from 2006 to 2009.
NA = Not available.
In comparison with previous years, CAHI provided 2008 and 2009 data to CIPARS in different aggregations. The cephalosporin class was not reported separately for 2008 and 2009 as it was in the past—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 coccidiostats, and arsenicals" (previously included in "other antimicrobials"). For 2008 and 2009, "other antimicrobials" included bambermycin, ceftiofur, cephapirin, clavulanic acid, neomycin, nitrofurantoin, nitrofurazone, novobiocin, polymixin, sodium iodide, and virginiamycin.

Figure 57. Percentages of quantities of antimicrobials in dosage form distributed in Canada for use in animals; Canadian Animal Health Institute, 2009.



"Other antimicrobials" (1.31%) includes bambermycin, ceftiofur, cephapirin, clavulanic acid, nitrofurantoin, nitrofurazone, novobiocin, polymixin, sodium iodide, and virginiamycin.

Section Three – Public Health Agency of Canada Research Collaborations

Box 1. *Salmonella*, *Escherichia coli*, and antimicrobial resistance in salmon and shrimp purchased in Canada.

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National antimicrobial resistance surveillance systems, including CIPARS, have focused on the major meat commodities (i.e. beef, chicken, and pork) with little attention paid to domestic and imported fish and seafood. Because antimicrobials are used in aquaculture, the potential for antimicrobial resistant strains as well as transferrable resistance genes to emerge and persist in aquatic zoonotic and indicator/reservoir bacteria poses a concern to public health. There is a limited amount of information about the prevalence of zoonotic pathogens, indicator organisms, and antimicrobial resistant bacteria in seafood products sold in Canada.

The retail sampling infrastructure of CIPARS was used to collect fresh and frozen raw salmon and shrimp from across the country in 2008 and 2009. Samples of both domestic and imported salmon and shrimp were collected. *Salmonella* spp. and *Escherichia coli* were recovered at the Canadian Research Institute for Food Safety, University of Guelph, through the use of standard protocols. Serotyping and phage typing of *Salmonella* isolates and susceptibility testing of all isolates with the broth microdilution method were performed at the Laboratory for Foodborne Zoonoses in Guelph, Ontario. At most, 3 *E. coli* isolates and 1 *Salmonella* isolate were selected and tested per sample.

Salmonella was recovered from 5% (8/159) of shrimp samples (Table A). No *Salmonella* was recovered from salmon samples (0/179). *Escherichia coli* was recovered from 31% (49/159) of shrimp and 24% (43/179) of salmon samples. Antimicrobial resistance was detected in *E. coli* isolates, including resistance to Category I antimicrobials (Very High Importance in Human Medicine) such as ciprofloxacin, ceftiofur, and amoxicillin-clavulanic acid (Figure A). Among *Salmonella* isolates, only resistance to sulfisoxazole was detected (1 isolate; Table A).

Table A. Antimicrobial resistance in Salmonella serovars recovered from retail shrimp, 2008–2009.

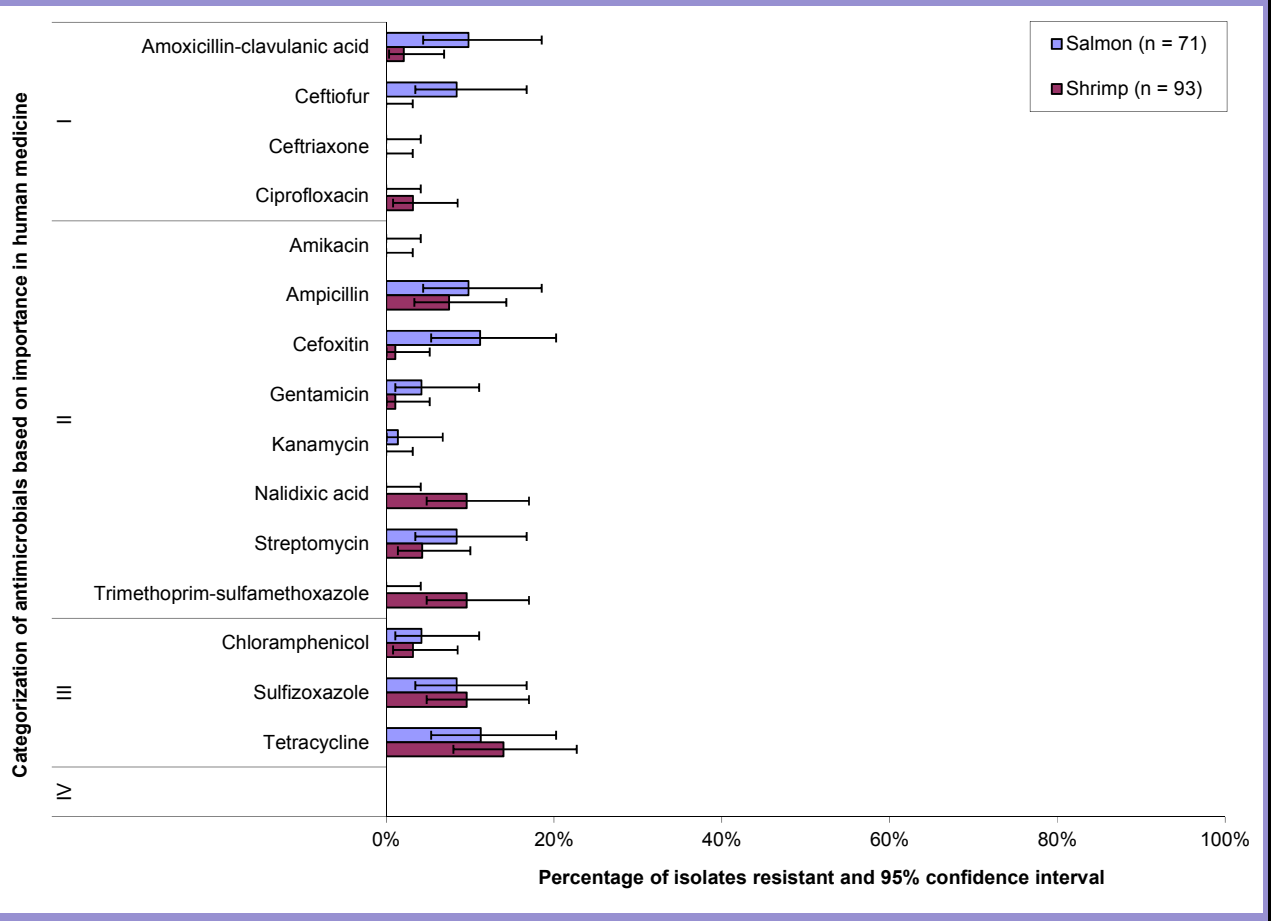
Sample Type (n)	Number of samples	Serovar	Resistance pattern
Shrimp (159)	2	Weltevreden	None
	1	IV 43:z4,z23:-	SSS
	1	Virchow	None
	1	Saintpaul	None
	1	Wandw orth	None
	1	Paratyphi B var. L(+) tartrate+	None
	1	Bootle	None

SSS = Sulfisoxazole
The biotype *Salmonella* Paratyphi B var. L (+) tartrate+ was formerly called *S*. Paratyphi var. Java.

Box 1 (continued). *Salmonella*, *Escherichia coli*, and antimicrobial resistance in salmon and shrimp purchased in Canada.

Escherichia coli isolates from salmon were more commonly resistant to cephalosporins (cefoxitin and ceftiofur), ampicillin, and amoxicillin-clavulanic acid than were shrimp isolates. The source of this resistance is unknown; to our knowledge, cephalosporins are not used in salmon production in Canada. Fresh and frozen raw salmon and shrimp are potential sources of bacteria harbouring antimicrobial resistance, and some of these bacteria may have resistance to Category I antimicrobials.

Figure A. Resistance among *Escherichia coli* isolates recovered from retail shrimp and salmon, 2008–2009.



Because each sample from which *Escherichia coli* was isolated could have yielded a maximum of 3 isolates for testing, the numbers of isolates shown in the figure key do not match the number of associated samples (49 shrimp and 43 salmon samples).

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Box 2. Enteric pathogens and antimicrobial resistance in food animals in the Canadian Eastern Arctic.

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Little is known about the presence and distribution of enteric pathogens and antimicrobial resistance (among both pathogenic and commensal bacteria) in food animals in the Canadian Arctic. The Arctic enteric pathogens and antimicrobial resistance (AMR) project is a complement to other research programs either planned or currently running in Nunavik with an overall objective of understanding food safety concerns in retail and indigenous foods. Information gathered through this project will add to our overall understanding of the distribution of bacteria and any associated AMR that may be of public health concern in Northern communities.

Samples of intestinal contents and meat were collected from arctic hare, Canada geese, snow geese, polar cod, rock ptarmigan, willow ptarmigan, musk ox, walrus, and arctic char that were frozen at –20°C without preservatives. Samples were submitted from 10 communities in the Eastern Canadian Arctic and were brought to the Nunavik Research Centre (Kuujjuaq, Québec) between 2008 and 2009. In 2010, the samples were submitted to the Canadian Research Institute for Food Safety (CRIFS), University of Guelph for bacterial isolation and antimicrobial susceptibility testing. After arrival at the CRIFS laboratory, whenever possible, each sample was aseptically divided in half. One half of the sample was tested at the CRIFS laboratory for the presence of *Escherichia coli*, *Salmonella* spp., *Vibrio* spp., and *Aeromonas* spp. by means of standard culture and identification techniques. The remaining portion of each sample (of sufficient quantity) was submitted to Health Canada - Bureau of Microbial Hazards (Ottawa, Ontario) for additional enteric pathogen and virus testing (results not shown). Overall, 128 meat and fish samples were collected, as well as 31 intestinal samples from geese (Table A).

Table A. Number of samples originating from each participating community.

Community of origin	Number of intestinal content samples	Number of meat samples
Akulivuk	0	1
Inukjuak	19	41
Ivujivik	0	8
Kangiqsualuujjuaq	0	1
Kangiqsujuaq	0	1
Kangirsuk	0	3
Kuujjuaq	2	34
Quaqtaq	0	3
Salluit	0	23
Tasiujaq	1	11
Umiujaq	9	0
Unknown	0	2

Box 2 (continued). Enteric pathogens and antimicrobial resistance in food animals in the Canadian Eastern Arctic.

Of the intestinal content samples, 24 were from Canada geese and 7 were from snow geese. *Escherichia coli* was isolated from 13% (3/24) of Canada geese and from 2 of the 7 snow geese. No *Salmonella* spp. *Vibrio* spp., or *Aeromonas* spp. were detected. Fifteen *E. coli* isolates (3 from each positive sample) were tested for antimicrobial susceptibility; all were non-resistant to all antimicrobials in the testing panel.

Overall, *E. coli* was recovered from 19% (24/128) of meat and fish samples. The isolates originated from 82% (18/22) of musk ox samples, 25% (3/12) walrus samples, 5% (1/19) ptarmigan samples, and 4% (1/28) of arctic char samples. The sole arctic hare sample also yielded *E. coli*. Table B describes the origin of samples and sample types that contained *E. coli*. No *Salmonella* spp. *Vibrio* spp., or *Aeromonas* spp. were detected in any of the meat/fish samples tested. For each sample found to contain *E. coli*, 3 isolates were tested for antimicrobial susceptibility. Testing revealed that none of the 70 isolates were resistant to the antimicrobials evaluated.

Table B. Prevalence of *Escherichia coli* in meat and fish samples collected in various Eastern Canadian Arctic regions.

Sample type (n)	Community of origin (n)	Number of samples positive for *Escherichia coli*
Arctic char (28)	Kangirsuk (3)	0
	Kangiqsualuujjuaq (1)	0
	Kuujjuaq (1)	1
	Salluit (23)	0
Arctic hare (1)	Kuujjuaq (1)	1
Brook trout (1)	Kangiqsuajuaq (1)	0
Canada goose (28)	Inukjjuak (26)	0
	Kuujjuaq (2)	0
Longhorn sculpin (3)	Inukjjuak (3)	0
Musk ox (22)	Kuujjuaq (11)	10
	Tasuijaq (11)	8
Polar cod (12)	Inukjjuak (12)	0
Ptarmigan (19)	Kuujjuaq (18)	1
	Unknow n (1)	0
Snow shoe hare (1)	Kuujjuaq (1)	0
Walrus (12)	Akulivik (1)	0
	Ivujivik (8)	3
	Quaqtaq (3)	0
Unknow n (1)	Unknow n (1)	0

Recovery rates for *E. coli* varied among the various animal species; the highest proportion of positive samples was observed among musk ox samples. No resistance was detected in any isolates recovered from intestinal contents or meat of any species. Although the number of samples tested was fairly small, the lack of resistance among *E. coli*, which are used as indicator bacteria, suggests that antimicrobial selection pressure may not be strong in food animals in the Eastern Canadian Arctic. Because of low sample numbers, as well as the pilot nature of this project, we plan to continue the work on enteric pathogens and AMR in food animals in the Canadian Arctic and expand the project to include examination of retail meats purchased in selected Arctic communities.

We would like to acknowledge personnel at the Nunavik Research Center for coordination and processing of the samples; the Hunter's, Fisher's and Trapper's Association for coordination of the samples in the villages; and the Nunavik hunters for collection of the samples. This project is partly funded by the International Polar Year program (sampling and coordination, hunter payments, administration, and equipment) and Makivik Corporation (personnel salary).

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Box 3. Bacterial recovery and antimicrobial resistance in *Salmonella* spp. and *Escherichia coli* isolated from various non-core CIPARS meat commodities in Canada.

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In Canada, CIPARS has been monitoring both the prevalence and antimicrobial resistance profiles of *Salmonella* and *Escherichia coli* in beef, chicken, and pork products at retail since 2003. Targeted studies of other meats have also been conducted. In a 2006 study of grain-fed (i.e. red) veal and lamb, recovery of bacteria was rare and resistance was infrequent, whereas in milk-fed (i.e. white) veal and turkey, bacterial recovery rates were higher and multidrug resistance and resistance to Category I antimicrobials (Very High Importance in Human Health) were found (Cook, 2006). In particular, ciprofloxacin resistance was identified in *E. coli* isolated from milk-fed veal. Other niche market meat commodities have not been evaluated.

From March to October 2009, targeted sampling of milk-fed and grain-fed veal, turkey, and lamb was re-started; other niche market meats were also included. Samples were obtained from stores in 11 census divisions in Southwestern Ontario following the CIPARS retail meat sampling and laboratory protocols for *Salmonella* and *E. coli*. Molecular testing was carried out on selected *E. coli* isolates for the following genes: *qnr* (*E. coli* only) for isolates with a minimum inhibitory concentration (MIC) greater than 0.125 µg/mL for ciprofloxacin, and bla_{CMY}, bla_{TEM}, bla_{SHV}, bla_{CTX-M}, and bla_{OXA} (*E. coli* and *Salmonella*) for isolates with an MIC greater than 32 µg/mL for ampicillin.

Twenty-three *E. coli* isolates were tested for *qnr* genes. Three *Salmonella* and 142 *E. coli* isolates were tested for the *bla* genes.

Salmonella was recovered from 40% (8/20) of quail, 28% (21/76) of turkey, 1 of 9 duck, 15% (3/20) of goat, 7% (2/27) of grain-fed veal, and 2 of 6 rabbit samples (Table A). The most commonly isolated serotypes were *S*. Saintpaul (16%, 6/37), *S*. Enteritidis (11%, 4/37), *S*. Typhimurium var. 5- (11%, 4/37), and *S*. Senftenberg (8%, 3/37). Antimicrobial resistance was uncommon.

Three isolates were submitted for molecular testing. One *S*. Agona isolate from a turkey sample contained the bla_{CMY-2} gene, and 1 *S*. Senftenberg isolate from a turkey sample contained the bla_{TEM} gene. No *bla* genes were detected in the sole *S*. Schwarzengrund isolate.

Escherichia coli was recovered from 90% (268/299) of purchased meat products (Table B). Resistance in *E. coli* isolates varied by meat type, but resistance to 1 or more antimicrobials was observed in most of the meat types tested, with the highest prevalence of multidrug resistance observed in milk-fed and grain-fed veal. Turkey and both veal commodities yielded isolates with resistance to 9 or more antimicrobials. Fluoroquinolone resistance was detected in 6% (4/69) and 4% (3/70) of milk-fed and grain-fed veal samples, respectively (Figure A) and in 1% (2/215) of turkey samples (Figure B). Ceftiofur resistance was detected in 2% (5/247) of lamb (Figure B) and 3% (7/215) of turkey samples (Figure B).

One hundred and forty-two *E. coli* isolates were submitted for molecular testing. One lamb and 3 turkey isolates contained the bla_{CMY-2} gene, and 1 *E. coli* isolate from a goat sample contained the bla_{CTX-M} gene. The bla_{TEM} gene was detected in *E. coli* isolates from all commodities tested. No *qnr* genes were found.

Although dissimilar resistance patterns were detected in isolates from grain-fed and milk-fed veal products in the past, resistance to Category I antimicrobials was observed in grain-fed veal in Ontario in 2009. Non-core CIPARS meat commodities, including niche market meat types, may act as a source of foodborne pathogens and antimicrobial resistance genes.

Box 3 (continued). Bacterial recovery and antimicrobial resistance in *Salmonella* spp. and *Escherichia coli* isolated from various non-core CIPARS meat commodities in Canada.

Table A. Summary of meat types, prevalence and serotypes of *Salmonella*, and antimicrobial resistance patterns in non-core CIPARS meats from retail meat from Ontario; March–October 2009.

Species	Meat type (number of positive samples / number of samples)	Meat cut (number of samples)	Serovar	Resistance pattern	Number of antimicrobials in resistance pattern			
					0	1-4	5-8	9-15
					Number of isolates			
Poultry	Turkey (21/76)	Ground (4)	Enteritidis	None	4	0	0	0
		Ground (1); drumstick (1)	Heidelberg	TET; none	1	1	0	0
		Ground (1)	I 4,5,12:i:-	None	1	0	0	0
		Ground (1)	Muenster	None	1	0	0	0
		Thigh (1); ground (1)	Agona	AMC-AMP-FOX-TIO-SSS-TET; none	1	0	1	0
		Thigh (2); ground (2); fillet (2)	Saintpaul	None	6	0	0	0
		Ground (1)	Oranienburg	None	1	0	0	0
		Wing (1); ground (2)	Senftenberg	AMP-GEN; none	2	1	0	0
		Ground (1)	Schwarzengrund	AMP-STR	0	1	0	0
	Quail (8/20)	Whole (1)	Kiambu	STR	0	1	0	0
		Whole (3)	Typhimurium var. 5-	None	3	0	0	0
		Whole (1)	Schwarzengrund	SSS-TET	0	1	0	0
		Whole (1)	Agona	None	1	0	0	0
		Whole (2)	Hadar	STR-TET	0	2	0	0
	Duck (1/9)	Skin-on breast (1)	Kottbus	None	1	0	0	0
Large ruminant	Grain-fed veal (2/27)	Scallopini (1)	Uganda	None	1	0	0	0
		Scallopini (1)	I ROUGH-O:l,z13:1,5	None	1	0	0	0
Small ruminant	Goat (3/20)	Stew pieces (1)	Welikade	None	1	0	0	0
		Stew pieces (1)	Kentucky	None	1	0	0	0
		Stew pieces (1)	Typhimurium	None	1	0	0	0
Other	Rabbit (2/6)	Whole (1)	IIIb 61:k:1,5	None	1	0	0	0
		Whole (1)	Typhimurium var. 5-	None	1	0	0	0

None = No resistance patterns detected.

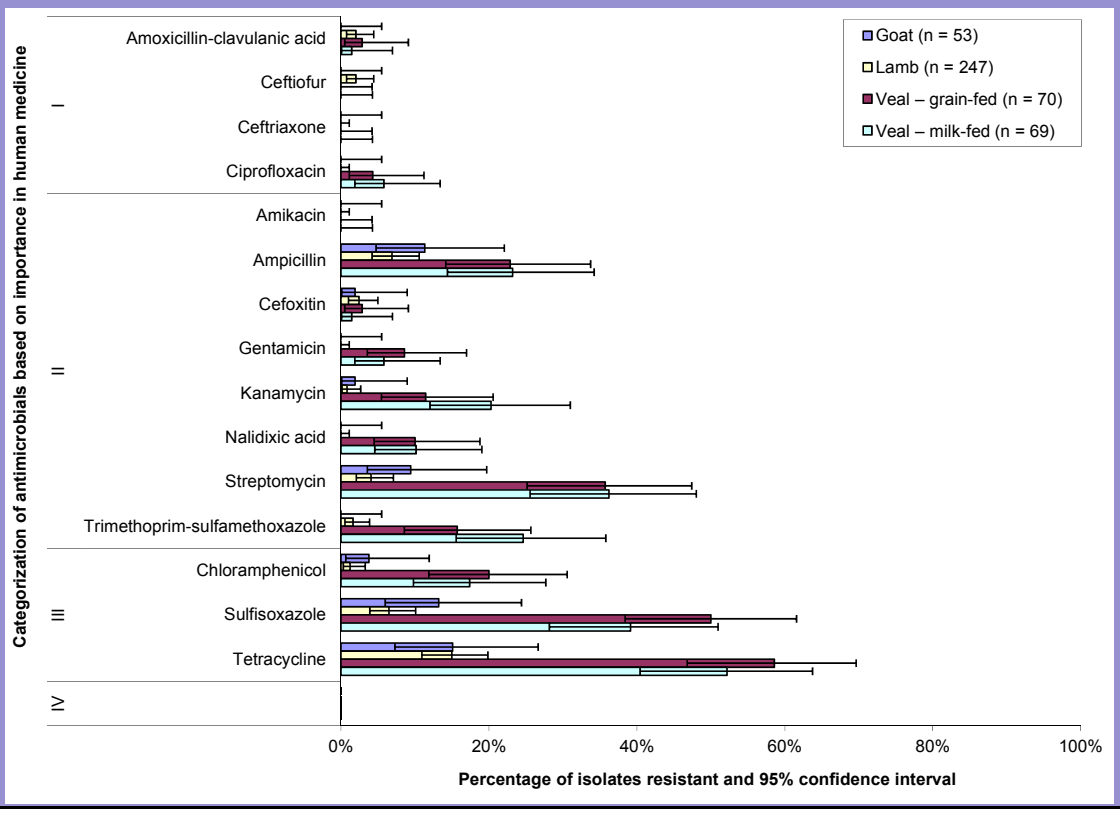
Table B. Prevalence of *Escherichia coli* contamination in non-core CIPARS meat commodities (n=299).

Species	Sample Type	Number of *Escherichia coli* positive samples / total number of samples (%)	Number of isolates	Number of antimicrobials in resistance pattern			
				0	1-4	5-8	9-15
				Percentage of isolates			
Poultry	Turkey	73/76 (96)	215	30	59	10	1
	Quail	16/20 (80)	48	38	51	12	0
	Duck	8/9 (89)	24	21	79	0	0
	Ostrich	1/1 (100)	3	100	0	0	0
Large ruminant	Grain-fed veal	25/27 (93)	70	37	43	19	1
	Milk-fed veal	25/32 (78)	69	42	32	25	2
	Bison	0/2 (0)	0	N/A	N/A	N/A	N/A
	Elk	1/1 (100)	3	100	0	0	0
	Venison	0/1 (0)	0	N/A	N/A	N/A	N/A
	Camel	1/1 (100)	3	33	67	0	0
Small ruminant	Goat	18/20 (90)	53	76	23	2	0
	Lamb	84/102 (82)	247	83	15	2	0
Other	Kangaroo	1/1 (100)	3	100	0	0	0
	Rabbit	5/6 (83)	15	60	40	0	0

N/A = Not applicable.

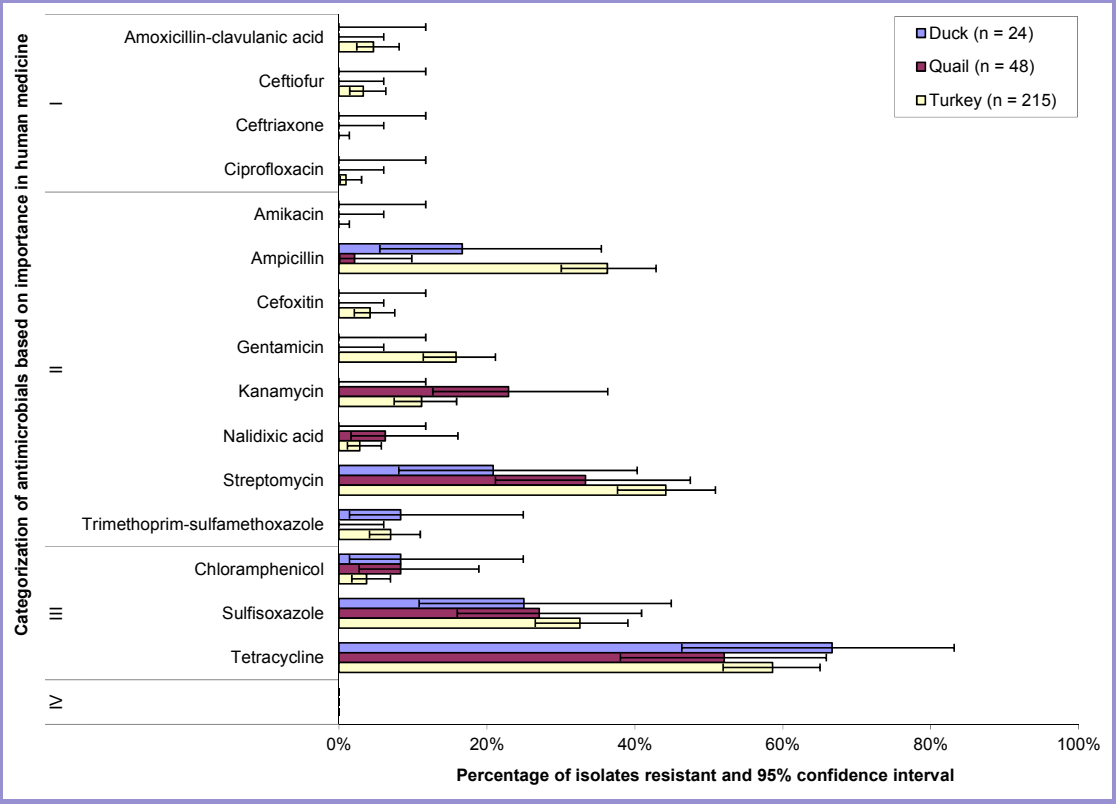
Box 3 (continued). Bacterial recovery and antimicrobial resistance in *Salmonella* spp. and *Escherichia coli* isolated from various non-core CIPARS meat commodities in Canada.

Figure A. Resistance to antimicrobials in *Escherichia coli* isolates from milk-fed veal, grain-fed veal, lamb, and goat; 2009.



Box 3 (continued). Bacterial recovery and antimicrobial resistance in *Salmonella* spp. and *Escherichia coli* isolated from various non-core CIPARS meat commodities in Canada.

Figure B. Resistance to antimicrobials in *Escherichia coli* isolates from turkey, quail, and duck; minor retail meats research, 2009.



Cook, A. Antimicrobial resistance in enteric bacteria isolated from retail turkey and veal meat. MSc thesis-University of Guelph, 2006.

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Box 4. Antimicrobial resistance in *Escherichia coli* isolated from wild small mammals living in swine farm, residential, landfill, and natural environments in Southern Ontario.

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To assess the impact of different types of human activity on the development of resistant bacteria in the gut of wild small mammals, we compared the prevalence and patterns of antimicrobial resistance (AMR) and resistance genes in *Escherichia coli* and *Salmonella enterica* isolated from fecal samples collected from wild small mammals living in 4 environments: swine farms (9 sites), residential areas (10 sites), landfills (8 sites), and natural habitats (9 sites). Samples were collected from May to October, 2008, and all sampling sites were within a 100 km radius of Guelph, Ontario.

Escherichia coli was recovered from 7 wild small mammal species (Table A). Resistance to antimicrobials was detected in *E. coli* from animals trapped in all environments: 48% (25/52) of animals on swine farms, 9% (6/69) of animals in residential areas, 15% (3/20) of animals at landfills, and 5% (1/22) of animals in natural habitats. Logistic regression models using generalized estimating equations were built to investigate associations among AMR detection, trapping area, and host species; exact logistic regression models were built to explore the association between trapping area, resistance phenotype, and resistance genes.

Animals trapped on swine farms were significantly more likely to carry *E. coli* with resistance to tetracycline, ampicillin, sulfisoxazole, and streptomycin than animals trapped in residential areas. The resistance genes *sul2*, *aadA*, and *tet(A)* were significantly more likely to be detected in *E. coli* from animals trapped on swine farms than in isolates from animals trapped in residential areas.

Table A. Number of wild small mammals from which *Escherichia coli* was isolated.

Environment	Number of animals from which *Escherichia coli* was isolated / number of animals trapped						
	Peromyscus spp. (Deer and white-footed mice)	House mice	Short-tailed shrew	Meadow vole	Eastern chipmunk	Norway rat	Total
Swine farm	7/13	43/52	0/1	0/1	1/1	1/1	52/69
Natural	15/31	0/0	1/8	0/2	6/7	0/0	22/48
Landfill	10/18	6/6	2/6	1/2	1/1	0/0	20/33
Residential	42/109	4/7	9/17	0/1	14/18	0/0	69/152
Total	**74/171**	**53/65**	**12/32**	**1/6**	**22/27**	**1/1**	**163/302**

Three *Salmonella* serovars (Give, Typhimurium, and Newport) were recovered from the feces of wild small mammals 4/302 (1%): 2 *S.* Give from 2 house mice trapped on a landfill site, 2 *S.* Newport from 1 *Peromyscus* spp. trapped at a natural site, and 1 *S.* Typhimurium from an Eastern chipmunk trapped on a swine farm. All *Salmonella* isolates were non-resistant to the antimicrobials tested.

Swine farm origin was significantly associated with the presence of AMR bacteria and AMR genes in the feces of wild small mammals in Southern Ontario. However, resistant fecal bacteria were isolated from small mammals in all environments studied, indicating that animal exposure to resistant bacteria, antimicrobial residues, resistant bacteria, or resistance genes is widespread in the environment.

Published in *Applied and Environmental Microbiology* 2011;77:882-888.

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Box 5. Prevalence of antimicrobial resistance among *Escherichia coli* and *Salmonella* isolated from wild bighorn sheep in British Columbia.

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Bighorn sheep are an important game species in British Columbia (BC). Under the provincial wild sheep management policy, animals from high density herds are captured and translocated to augment other sheep herds. High sheep density may negatively impact winter range quality and herd health; therefore, translocation of animals allows wildlife managers to quickly reduce herd density. Sheep are baited under a remotely released drop net and restrained. Blood and fecal samples are collected from the animals prior to transport. The handling and movement of wild sheep in BC is overseen by the provincial wildlife veterinarian with help from other Ministry of Natural Resources Operations staff members, local students, and volunteers.

Fecal samples from 77 wild bighorn sheep were collected from the Tranquille herd, northwest of Kamloops, BC; 8 samples were collected in April 2007 and 69 samples were collected in January–February 2009. All samples were frozen at –20°C prior to laboratory submission. Bacterial culture was performed on thawed samples for detection of *Escherichia coli* and *Salmonella*. Up to 3 *E. coli* isolates and 1 *Salmonella* isolate per sample were examined for evidence of antimicrobial resistance.

Escherichia coli was recovered from 82% (63/77) of samples: 6 of 8 of samples collected in 2007 and 83% (57/69) of those collected in 2009. In total, 184 *E. coli* isolates were submitted for antimicrobial susceptibility testing: 3 isolates from each of 60 samples, 2 isolates from 1 sample, and 1 isolate from each of 2 samples. One percent (2/184) of isolates were resistant to ampicillin, amoxicillin-clavulanic acid, and cefoxitin. These isolates were recovered from different fecal samples. Three isolates (3/184, 2%) recovered from 1 fecal sample were resistant to tetracycline.

Salmonella Typhimurium was recovered from 1 sample collected in 2009; it was susceptible to all antimicrobials tested.

Overall, antimicrobial resistance among *E. coli* isolates recovered from wild bighorn sheep in BC was low. The detection of resistance to Category I (amoxicillin-clavulanic acid) and Category II (ampicillin and cefoxitin) antimicrobials in 2 isolates from different fecal samples was unexpected. Given its location, the Tranquille herd may share range with cattle ranches. However, the frequency and extent of bighorn sheep exposure to domestic livestock is unknown.

We would like to acknowledge the students from Thompson Rivers University Animal Health Technology program, local volunteers, and Ministry of Natural Resources biologists and staff who helped in the collection of the samples reported here.

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Box 6. Risk factors for the use of macrolide and fluoroquinolone antimicrobials by human populations in Canada, 2000–2006.

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Decisions to use and prescribe antimicrobials are shaped by biological and socioeconomic characteristics of the individual being treated.[1] However, the impact of antimicrobial use extends to the wider population. With each antimicrobial treatment, there is potential for the development and spread of antimicrobial resistance among bacteria within the community at large. Moreover, regulation of antimicrobial use is reportedly most effective when community-level policy changes are put in place.[2-4] In order to determine appropriate community-level changes in Canada to reduce macrolide and fluoroquinolone use, associations among socioeconomic and other factors with antimicrobial use were assessed.

Multivariate linear and negative binomial models were produced to assess whether certain socioeconomic variables and the rate of influenza in Canada were associated with the use of macrolide and fluoroquinolone antimicrobials by Canadians. Antimicrobial use data were obtained from CIPARS (IMS Health Canada Inc. CompuScript dataset), and influenza rates were obtained from FluWatch (www.phac-aspc.gc.ca/fluwatch/).

Results varied both among and between drugs within the macrolide and fluoroquinolone classes; however, a pattern of accessibility to care was apparent. Cheaper antimicrobials were used most often in the most disadvantaged populations, and more expensive antimicrobials were used most frequently in advantaged populations. Significant interactions were detected between influenza and socioeconomic variables relating to unemployment, education, and degree of poverty in a population. Findings suggested that antimicrobials are being prescribed and consumed at inappropriate rates in both disadvantaged and affluent populations in Canada.

Because no specific population was considered to be at high risk for consumption of all macrolide and fluoroquinolone drugs, we suggest that responsible antimicrobial stewardship be practiced and promoted by all physicians in community and hospital settings. Furthermore, we strongly suggest that particular attention to antimicrobial stewardship be exercised by all physicians during the influenza season. We also recommend that educational materials be supplied or social campaigns initiated on the inappropriateness of antimicrobial use for viral versus bacterial infections and that these educational approaches be adapted for a range of populations across Canada.

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Published in *Journal of Antimicrobial Chemotherapy* 2010;65:2019–2027.

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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 the CIPARS *Retail Meat Surveillance* component are to provide data on the prevalence of antimicrobial resistance and to monitor temporal variations in selected bacteria found in raw meat at the provincial/region level. 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 surveillance method provides a measure of human exposure to antimicrobial resistant bacteria through the consumption of meat products available for purchase by Canadian consumers. The scope of the surveillance framework can be modified as necessary (e.g. to evaluate different food commodities, bacteria, or geographic regions) and functions as a research platform for investigation of specific questions regarding antimicrobial resistance in the agri-food sector.

The unit of concern in *Retail Meat Surveillance* in 2009 was the bacterial isolate cultured from one of the commodities of interest. In this situation, the commodities were raw meat products commonly consumed

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

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 *Escherichia coli*.[2] 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 for 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. Lastly, the presence of *Enterococcus* in beef and pork was not determined because of resource and budgetary constraints.

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 2009, 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, Québec, and the Maritimes (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.
[2] *Enterococcus* isolated from retail chicken from the Maritimes region underwent antimicrobial susceptibility testing, but results are not presented in this report because of concerns surrounding harmonization of laboratory methods for 2009.

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 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 the Maritimes conducted sampling every other week. Sampling was less frequent in British Columbia, Saskatchewan, and the Maritimes 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) were sent to the same laboratory via 24-hour courier. Samples from the whole Maritimes 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 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 2009, 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

[1] Agriculture and Agri-Food Canada. Red meat market information. Available at: www.agr.gc.ca/redmeat-vianderouge/index_eng.htm. Accessed April 2012.

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

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 (6 beef cattle plants, 24 poultry plants, and 12 swine plants) from across Canada participated in the 2009 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 variations 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, 23 veterinarians and 97 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 2009. *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 Réseau des laboratoires de l'Institut national de santé animale, Saint-Hyacinthe 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, for a few isolates, 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*, *Escherichia coli*, and *Enterococcus*. 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 following tests: Gram stain, oxidase, catalase, growth at 25 ± 1°C, cephalothin resistance, and hippurate and indoxyl acetate hydrolysis.

Retail Meat Surveillance

One chicken leg[1] 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.

Retail Meat Surveillance

One chicken leg[1] or 2 wings were added to 225 mL of BPW. Fifty millilitres of the peptone rinse was mixed with 50 mL of double-strength selective broth (Enterococcosel™ broth, BD) and incubated at 35 ± 1°C for 24 hours. One loopful of incubated broth was then streaked onto selective agar (Enterococcosel™ agar) 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 ± 1°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

[1] 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, England (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, Saint-Hyacinthe, 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 *Enterococcus*, *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, 2009.

	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	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[b]	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] CLSI M100-S20.
[b] 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, 2009.

	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-S20 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, 2009.

	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 prevalence 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 2009 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

[1] Statistics Canada. Population by year, by province and by territory. Available at: www40.statcan.ca/l01/cst01/demo02a-eng.htm. Accessed February 2010.

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 2009 were performed. Comparisons between 2004 and 2009 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. 2008) and current year (i.e. 2009) 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 2009 because of changes in use of those drugs in 2007. For the *Farm Surveillance* 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 2009 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 2009, 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 2009 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)
	Tobramycin (J01GB01)	Aminoglycosides (J01GB)
	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 February 2012.

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 2009. 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 2009. 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; *Surveillance of Human Clinical Isolates*, 2009.

	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	1,092	≤ 1	≤ 1	0.0							94.0	3.7	0.2	1.7	0.4					
	Ceftiofur	1,092	1	1	0.1				0.2	0.3	4.8	92.5	2.2			0.1					
	Ceftriaxone	1,092	≤ 0.25	≤ 0.25	0.1					99.3	0.5	0.1	0.1						0.1		
	Ciprofloxacin	1,092	≤ 0.015	0.12	0.1	71.7	16.8	0.9	6.4	3.6	0.3	0.2	0.1		0.1						
II	Amikacin	1,092	1	2	0.0						9.2	72.6	16.9	0.9	0.4						
	Ampicillin	1,092	≤ 1	2	2.2							82.3	14.7	0.5	0.2			2.2			
	Cefoxitin	1,092	2	2	0.0							12.5	81.8	4.9	0.6	0.2					
	Gentamicin	1,092	≤ 0.25	0.50	0.3					64.9	33.4	1.4				0.2	0.1				
	Kanamycin	1,092	≤ 8	≤ 8	0.2										99.7	0.1			0.2		
	Nalidixic acid	1,092	4	> 32	10.3							0.1	12.0	75.0	2.1	0.5	0.1	10.2			
	Streptomycin	1,092	≤ 32	≤ 32	2.5												97.5		2.5		
	Trimethoprim-sulfamethoxazole	1,092	≤ 0.12	≤ 0.12	0.2				96.3	3.5					0.2						
III	Chloramphenicol	1,092	4	8	0.1								0.1	63.5	36.0	0.4		0.1			
	Sulfisoxazole	1,092	32	128	1.5											8.3	50.5	24.8	14.6	0.3	1.5
	Tetracycline	1,092	≤ 4	≤ 4	1.5									98.1	0.5	0.1	0.1	1.3			
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; *Surveillance of Human Clinical Isolates*, 2009.

	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	381	≤ 1	32	12.1							66.1	1.0	2.4	8.4	10.0	5.5	6.6			
	Ceftiofur	381	1	> 8	13.9				0.3	0.3	40.9	43.3	0.3	1.0	1.8	12.1					
	Ceftriaxone	381	≤ 0.25	8	13.9					85.0			1.0	1.3	3.4	8.7	0.3	0.3			
	Ciprofloxacin	381	≤ 0.015	≤ 0.015	0.0	98.4	1.0			0.3		0.3									
II	Amikacin	381	2	2	0.0						0.5	33.1	65.4	1.0							
	Ampicillin	381	≤ 1	> 32	32.8							65.4	1.8					32.8			
	Cefoxitin	381	1	32	12.1						0.3	68.0	17.6	1.8	0.3		11.3	0.8			
	Gentamicin	381	0.50	0.50	3.9					13.1	77.2	5.5			0.3		3.9				
	Kanamycin	381	≤ 8	≤ 8	0.8										99.0	0.3			0.8		
	Nalidixic acid	381	4	4	0.5							0.3	31.2	67.7		0.3		0.5			
	Streptomycin	381	≤ 32	≤ 32	7.1												92.9	2.6	4.5		
	Trimethoprim-sulfamethoxazole	381	≤ 0.12	≤ 0.12	0.8				96.6	2.6					0.8						
III	Chloramphenicol	381	8	8	0.3									31.8	67.7	0.3		0.3			
	Sulfisoxazole	381	32	64	6.0											36.2	52.5	5.2			6.0
	Tetracycline	381	≤ 4	≤ 4	5.2									94.8			0.3	5.0			
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; *Surveillance of Human Clinical Isolates,* 2009.

	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	54	2	2	0.0							37.0	59.3			3.7					
	Ceftiofur	54	1	1	0.0						1.9	98.1									
	Ceftriaxone	54	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	54	0.50	0.50	0.0	22.2	3.7				70.4	3.7									
II	Amikacin	54	0.50	2	0.0						64.8	18.5	14.8	1.9							
	Ampicillin	54	2	2	3.7							11.1	83.3	1.9				3.7			
	Cefoxitin	54	4	4	0.0							5.6	13.0	72.2	9.3						
	Gentamicin	54	≤ 0.25	0.50	0.0					75.9	18.5	5.6									
	Kanamycin	54	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	54	> 32	> 32	74.1								3.7	20.4		1.9		74.1			
	Streptomycin	54	≤ 32	≤ 32	1.9												98.1	1.9			
	Trimethoprim-sulfamethoxazole	54	≤ 0.12	0.25	0.0				88.9	11.1											
III	Chloramphenicol	54	8	8	1.9									7.4	88.9	1.9		1.9			
	Sulfisoxazole	54	32	128	1.9											33.3	42.6	13.0	7.4	1.9	1.9
	Tetracycline	54	≤ 4	≤ 4	1.9									98.1			1.9				
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; *Surveillance of Human Clinical Isolates*, 2009.

	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	160	≤ 1	8	0.6							81.9		1.3	15.6	0.6		0.6			
	Ceftiofur	160	0.50	1	0.6					3.1	74.4	21.9				0.6					
	Ceftriaxone	160	≤ 0.25	≤ 0.25	0.6					99.4						0.6					
	Ciprofloxacin	160	0.25	0.50	1.9	21.3		1.3	14.4	51.3	8.1		1.9		1.9						
II	Amikacin	160	1	2	0.0						1.9	76.3	20.6	1.3							
	Ampicillin	160	≤ 1	> 32	18.1							81.3	0.6					18.1			
	Cefoxitin	160	4	8	0.6						1.9	29.4	6.9	47.5	13.1	0.6	0.6				
	Gentamicin	160	≤ 0.25	0.50	0.0					76.9	21.9	1.3									
	Kanamycin	160	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	160	> 32	> 32	77.5								19.4	3.1				77.5			
	Streptomycin	160	≤ 32	> 64	15.6												84.4		15.6		
	Trimethoprim-sulfamethoxazole	160	≤ 0.12	> 4	16.3				80.0	3.1	0.6				16.3						
III	Chloramphenicol	160	4	> 32	16.3								1.3	68.1	14.4			16.3			
	Sulfisoxazole	160	32	> 256	18.1											38.8	19.4	11.9	10.0	1.9	18.1
	Tetracycline	160	≤ 4	≤ 4	6.3									93.8				6.3			
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; *Surveillance of Human Clinical Isolates*, 2009.

	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	417	≤ 1	16	1.7							72.2	3.1	0.7	5.8	16.5	0.2	1.4			
	Ceftiofur	417	1	1	1.7						18.5	78.4	1.2	0.2		1.7					
	Ceftriaxone	417	≤ 0.25	≤ 0.25	1.7					98.3					0.5	1.0		0.2			
	Ciprofloxacin	417	≤ 0.015	≤ 0.015	0.0	92.8	2.2	0.5	0.5	1.9	2.2										
II	Amikacin	417	2	2	0.0							33.6	60.0	6.0	0.5						
	Ampicillin	417	≤ 1	> 32	24.5							70.3	4.1	0.7	0.2	0.2		24.5			
	Cefoxitin	417	2	4	1.7							30.7	59.2	7.0	1.0	0.5	0.5	1.2			
	Gentamicin	417	0.50	1	1.0					15.1	73.1	9.4	1.4			0.2	0.7				
	Kanamycin	417	≤ 8	≤ 8	6.0										93.5	0.2	0.2		6.0		
	Nalidixic acid	417	4	4	2.6							0.2	34.5	59.5	1.9	1.2	0.2	2.4			
	Streptomycin	417	≤ 32	> 64	26.1												73.9	14.1	12.0		
	Trimethoprim-sulfamethoxazole	417	≤ 0.12	0.25	1.9				86.1	11.0	0.7		0.2		1.9						
III	Chloramphenicol	417	8	> 32	20.6								0.7	45.1	33.1	0.5		20.6			
	Sulfisoxazole	417	64	> 256	27.8											9.1	38.1	20.6	4.3		27.8
	Tetracycline	417	≤ 4	> 32	28.3									71.2	0.5	1.0	14.6	12.7			
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* "Other Serovars" isolates; *Surveillance of Human Clinical Isolates*, 2009.

	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	1,290	≤ 1	2	2.9							89.2	3.0	0.9	2.9	1.2	1.0	1.9			
	Ceftiofur	1,290	1	1	2.9					0.5	30.8	64.3	1.6		0.1	2.8					
	Ceftriaxone	1,290	≤ 0.25	≤ 0.25	2.9					96.9	0.2		0.1		0.4	1.8	0.4	0.2	0.2		
	Ciprofloxacin	1,290	≤ 0.015	≤ 0.015	0.5	91.2	2.9	0.5	1.0	2.6	1.2	0.1	0.1		0.5						
II	Amikacin	1,290	2	2	0.0						0.2	35.9	59.4	4.2	0.3	0.1					
	Ampicillin	1,290	≤ 1	2	7.7							88.7	3.3	0.3				7.7			
	Cefoxitin	1,290	2	4	2.8						0.2	30.9	44.5	20.2	1.3	0.2	1.7	1.1			
	Gentamicin	1,290	0.50	0.50	1.4					16.4	74.6	7.1	0.4	0.2		0.6	0.8				
	Kanamycin	1,290	≤ 8	≤ 8	1.1										98.7	0.2	0.1	0.2	0.9		
	Nalidixic acid	1,290	4	4	3.9							0.2	49.1	44.7	1.1	1.0		3.9			
	Streptomycin	1,290	≤ 32	≤ 32	9.6												90.4	4.7	4.9		
	Trimethoprim-sulfamethoxazole	1,290	≤ 0.12	≤ 0.12	3.2				91.3	5.3	0.1	0.1		0.1	3.1						
III	Chloramphenicol	1,290	4	8	2.5								0.7	52.7	43.6	0.5	0.1	2.4			
	Sulfisoxazole	1,290	32	128	8.1											10.9	48.2	27.2	5.0	0.5	8.1
	Tetracycline	1,290	≤ 4	> 32	15.9									83.8	0.3		1.2	14.7			
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*, 2009.

	Antimicrobial	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	131	8	16	7.6							43.5			26.7	22.1	1.5	6.1			
	Ceftiofur	131	1	2	7.6						17.6	71.8	3.1			7.6					
	Ceftriaxone	131	≤ 0.25	≤ 0.25	7.6					92.4					0.8	5.3	1.5				
	Ciprofloxacin	131	≤ 0.015	≤ 0.015	0.0	96.2	3.8														
II	Amikacin	131	1	2	0.0						3.8	52.7	39.7	3.8							
	Ampicillin	131	> 32	> 32	56.5							40.5	3.1					56.5			
	Cefoxitin	131	2	4	7.6							32.8	37.4	21.4	0.8		6.9	0.8			
	Gentamicin	131	0.50	1	0.0					32.8	56.5	9.9	0.8								
	Kanamycin	131	≤ 8	> 64	38.2										61.1	0.8			38.2		
	Nalidixic acid	131	2	4	0.0								51.1	48.9							
	Streptomycin	131	≤ 32	> 64	38.9												61.1	13.7	25.2		
	Trimethoprim-sulfamethoxazole	131	≤ 0.12	0.25	7.6				87.0	5.3				0.8	6.9						
III	Chloramphenicol	131	8	> 32	27.5								1.5	26.7	44.3			27.5			
	Sulfisoxazole	131	> 256	> 256	55.0											7.6	26.0	11.5			55.0
	Tetracycline	131	32	> 32	51.1									48.9			6.9	44.3			
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*, 2009.

	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	79	4	4	1.3							8.9	27.8	60.8	1.3		1.3				
		Saskatchewan	135	4	4	0.0							8.1	28.1	60.7	3.0						
		Ontario	195	4	4	1.0							4.6	29.2	58.5	6.7		1.0				
		Québec	108	4	4	0.9							7.4	34.3	50.0	7.4			0.9			
		Maritimes	135	4	8	3.0							5.2	19.3	63.0	9.6		2.2	0.7			
	Ceftiofur	British Columbia	79	0.50	0.50	0.0				5.1	43.0	49.4	1.3	1.3								
		Saskatchewan	135	0.50	0.50	0.0				5.2	40.0	54.1	0.7									
		Ontario	195	0.50	0.50	1.0				4.1	36.4	57.4	1.0			0.5	0.5					
		Québec	108	0.50	0.50	0.9				5.6	42.6	48.1	2.8				0.9					
I		Maritimes	135	0.50	0.50	1.5				6.7	28.9	60.0	2.2		0.7	0.7	0.7					
	Ceftriaxone	British Columbia	79	≤ 0.25	≤ 0.25	0.0					97.5	1.3	1.3									
		Saskatchewan	135	≤ 0.25	≤ 0.25	0.0					100.0											
		Ontario	195	≤ 0.25	≤ 0.25	1.0					99.0					0.5	0.5					
		Québec	108	≤ 0.25	≤ 0.25	0.9					99.1						0.9					
		Maritimes	135	≤ 0.25	≤ 0.25	2.2					97.8					1.5	0.7					
	Ciprofloxacin	British Columbia	79	≤ 0.015	≤ 0.015	0.0	100.0															
		Saskatchewan	135	≤ 0.015	≤ 0.015	0.0	98.5	0.7	0.7													
		Ontario	195	≤ 0.015	≤ 0.015	0.0	97.9	1.5	0.5													
		Québec	108	≤ 0.015	≤ 0.015	0.0	99.1				0.9											
		Maritimes	135	≤ 0.015	≤ 0.015	0.0	97.8		1.5	0.7												
	Amikacin	British Columbia	79	2	4	0.0							3.8	67.1	26.6	2.5						
		Saskatchewan	135	2	4	0.0							0.7	78.5	19.3	1.5						
		Ontario	195	2	4	0.0							1.0	71.8	25.6	1.5						
		Québec	108	2	4	0.0							0.9	68.5	27.8	2.8						
		Maritimes	135	2	4	0.0						2.2	5.2	69.6	20.0	3.0						
	Ampicillin	British Columbia	79	2	4	2.5							22.8	43.0	30.4	1.3			2.5			
		Saskatchewan	135	2	4	0.0							15.6	50.4	33.3	0.7						
		Ontario	195	2	4	3.1							9.2	52.3	34.9	0.5			3.1			
		Québec	108	2	4	6.5							14.8	53.7	24.1	0.9			6.5			
		Maritimes	135	2	4	5.9							8.9	54.1	27.4	3.0	0.7		5.9			
	Cefoxitin	British Columbia	79	4	4	1.3							1.3	36.7	55.7	3.8	1.3		1.3			
		Saskatchewan	135	4	4	0.0							3.0	28.9	61.5	5.2	1.5					
		Ontario	195	4	4	1.5							1.0	37.4	53.8	6.2		1.0	0.5			
		Québec	108	4	4	0.9							5.6	29.6	55.6	7.4	0.9		0.9			
		Maritimes	135	4	8	1.5							2.2	37.0	50.4	8.1	0.7	0.7	0.7			
	Gentamicin	British Columbia	79	1	1	0.0						49.4	46.8	3.8								
		Saskatchewan	135	0.50	1	0.0						53.3	45.2	1.5								
		Ontario	195	1	1	1.0						43.6	53.3	2.1			0.5	0.5				
		Québec	108	0.50	1	0.0						50.9	47.2	1.9								
		Maritimes	135	0.50	1	0.0					3.0	60.0	34.8	2.2								
II	Kanamycin	British Columbia	79	≤ 8	≤ 8	0.0										100.0						
		Saskatchewan	135	≤ 8	≤ 8	0.7										99.3				0.7		
		Ontario	195	≤ 8	≤ 8	2.6										96.9	0.5			2.6		
		Québec	108	≤ 8	≤ 8	1.9										97.2	0.9			1.9		
		Maritimes	135	≤ 8	≤ 8	2.2										97.8				2.2		
	Nalidixic acid	British Columbia	79	2	4	0.0							13.9	75.9	10.1							
		Saskatchewan	135	2	4	0.0						3.0	11.1	75.6	9.6	0.7						
		Ontario	195	2	4	0.0						1.0	8.2	80.5	9.7	0.5						
		Québec	108	2	2	0.9							13.9	77.8	7.4				0.9			
		Maritimes	135	2	4	0.0							9.6	76.3	14.1							
	Streptomycin	British Columbia	79	≤ 32	≤ 32	3.8												96.2	1.3	2.5		
		Saskatchewan	135	≤ 32	≤ 32	3.0												97.0	0.7	2.2		
		Ontario	195	≤ 32	64	12.8												87.2	4.1	8.7		
		Québec	108	≤ 32	≤ 32	9.3												90.7	1.9	7.4		
		Maritimes	135	≤ 32	≤ 32	7.4												92.6	2.2	5.2		
	Trimethoprim-sulfamethoxazole	British Columbia	79	≤ 0.12	≤ 0.12	3.8				94.9	1.3					3.8						
		Saskatchewan	135	≤ 0.12	≤ 0.12	0.0				97.8	0.7	1.5										
		Ontario	195	≤ 0.12	≤ 0.12	3.6				90.3	4.1	2.1				3.6						
		Québec	108	≤ 0.12	≤ 0.12	1.9				96.3		1.9				1.9						
		Maritimes	135	≤ 0.12	0.25	2.2				88.1	5.9	3.7				2.2						
	Chloramphenicol	British Columbia	79	4	8	2.5								10.1	50.6	34.2	2.5		2.5			
		Saskatchewan	135	4	8	0.7								10.4	53.3	34.1	1.5		0.7			
		Ontario	195	4	8	5.6								5.1	53.8	34.9	0.5	2.1	3.6			
		Québec	108	4	8	0.0								6.5	55.6	37.0	0.9					
		Maritimes	135	4	8	1.5								4.4	48.1	45.2	0.7	0.7	0.7			
	Sulfisoxazole	British Columbia	79	≤ 16	32	8.9											83.5	7.6				8.9
		Saskatchewan	135	≤ 16	32	2.2											88.9	8.1	0.7			2.2
III		Ontario	195	≤ 16	> 256	12.8											77.4	9.7				12.8
		Québec	108	≤ 16	32	4.6											85.2	8.3	1.9			4.6
		Maritimes	135	≤ 16	128	9.6											77.0	8.9	3.0	1.5		9.6
	Tetracycline	British Columbia	79	≤ 4	16	10.1									84.8	5.1	2.5	2.5	5.1			
		Saskatchewan	135	≤ 4	> 32	13.3									81.5	5.2	2.2	0.7	10.4			
		Ontario	195	≤ 4	> 32	23.1									73.8	3.1	1.0	1.0	21.0			
		Québec	108	≤ 4	> 32	12.0									86.1	1.9	0.9		11.1			
		Maritimes	135	≤ 4	> 32	18.5									80.0	1.5	4.4	2.2	11.9			
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*, 2009.

	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	4	4	0.0							10.9	31.1	52.1	5.9						
	Ceftiofur	119	0.50	0.50	0.0				8.4	33.6	57.1	0.8									
	Ceftriaxone	119	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	119	≤ 0.015	≤ 0.015	0.0	99.2	0.8														
II	Amikacin	119	2	4	0.0							7.6	71.4	21.0							
	Ampicillin	119	2	4	1.7							18.5	54.6	25.2				1.7			
	Cefoxitin	119	4	4	0.0						0.8	3.4	31.1	58.8	5.9						
	Gentamicin	119	0.50	1	2.5					3.4	61.3	28.6	2.5	0.8	0.8	2.5					
	Kanamycin	119	≤ 8	≤ 8	2.5										95.0	1.7	0.8	1.7	0.8		
	Nalidixic acid	119	2	2	0.0							10.9	82.4	5.9	0.8						
	Streptomycin	119	≤ 32	> 64	17.6												82.4	6.7	10.9		
	Trimethoprim-sulfamethoxazole	119	≤ 0.12	≤ 0.12	0.8				91.6	5.9	1.7				0.8						
III	Chloramphenicol	119	4	8	5.0								5.0	52.1	37.0	0.8	0.8	4.2			
	Sulfisoxazole	119	≤ 16	> 256	19.3											79.0	1.7				19.3
	Tetracycline	119	≤ 4	> 32	30.3									67.2	2.5	5.0	2.5	22.7			
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*, 2009.

	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*	16	0.125	0.25	6.3				81.3	12.5						6.3			
	Ciprofloxacin	*Campylobacter jejuni*	64	0.125	0.125	0.0		1.6	32.8	62.5	3.1									
	Ciprofloxacin	*Campylobacter* spp.	6	0.125	0.25	0.0				66.7	33.3									
	Telithromycin	*Campylobacter coli*	16	4	4	0.0								25.0	75.0					
	Telithromycin	*Campylobacter jejuni*	64	1	2	0.0					9.4	18.8	50.0	21.9						
	Telithromycin	*Campylobacter* spp.	6	1	1	0.0					16.7	16.7	66.7							
II	Azithromycin	*Campylobacter coli*	16	0.25	0.25	0.0				31.3	62.5	6.3								
	Azithromycin	*Campylobacter jejuni*	64	0.064	0.064	0.0	1.6	35.9	56.3	4.7	1.6									
	Azithromycin	*Campylobacter* spp.	6	0.125	0.125	0.0		16.7		83.3										
	Clindamycin	*Campylobacter coli*	16	1	1	0.0					6.3	43.8	50.0							
	Clindamycin	*Campylobacter jejuni*	64	0.125	0.25	0.0		3.1	7.8	53.1	34.4	1.6								
	Clindamycin	*Campylobacter* spp.	6	0.125	0.25	0.0			16.7	50.0	33.3									
	Erythromycin	*Campylobacter coli*	16	2	2	0.0								100.0						
	Erythromycin	*Campylobacter jejuni*	64	0.5	1	0.0				3.1	28.1	57.8	9.4	1.6						
	Erythromycin	*Campylobacter* spp.	6	0.5	1	0.0				16.7		66.7	16.7							
	Gentamicin	*Campylobacter coli*	16	1	1	0.0						50.0	50.0							
	Gentamicin	*Campylobacter jejuni*	64	1	1	0.0						48.4	50.0	1.6						
	Gentamicin	*Campylobacter* spp.	6	0.25	0.25	0.0				50.0	50.0									
	Nalidixic acid	*Campylobacter coli*	16	16	16	6.3											37.5	56.3		6.3
	Nalidixic acid	*Campylobacter jejuni*	64	≤ 4	8	0.0									73.4	26.6				
	Nalidixic acid	*Campylobacter* spp.	6	64	> 64	83.3												16.7	50.0	33.3
III	Florfenicol	*Campylobacter coli*	16	2	2	0.0								100.0						
	Florfenicol	*Campylobacter jejuni*	64	1	1	0.0			1.6			15.6	79.7	3.1						
	Florfenicol	*Campylobacter* spp.	6	0.5	0.5	0.0					16.7	83.3								
	Tetracycline	*Campylobacter coli*	16	> 64	> 64	68.8						6.3	25.0							68.8
	Tetracycline	*Campylobacter jejuni*	64	16	> 64	50.0			1.6	18.8	23.4	6.3						1.6	1.6	14.1	32.8
	Tetracycline	*Campylobacter* spp.	6	8	64	33.3						16.7					50.0		16.7	16.7	
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Chickens

Table B.11. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from chicken; *Retail Meat Surveillance,* 2009.

	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	59	≤ 1	> 32	25.4							67.8	5.1			1.7	8.5	16.9			
		Saskatchewan	71	≤ 1	32	14.1							71.8	5.6	1.4	2.8	4.2	5.6	8.5			
		Ontario	142	≤ 1	> 32	23.9							67.6	0.7		6.3	1.4	5.6	18.3			
		Québec	105	≤ 1	32	19.0							58.1	2.9		15.2	4.8	10.5	8.6			
		Maritimes	96	≤ 1	> 32	22.9							70.8			3.1	3.1	7.3	15.6			
	Ceftiofur	British Columbia	59	1	> 8	27.1						16.9	50.8	5.1		3.4	23.7					
		Saskatchewan	71	1	> 8	15.5						21.1	59.2	2.8	1.4	4.2	11.3					
		Ontario	142	1	> 8	23.9						35.9	40.1			2.1	21.8					
		Québec	105	1	> 8	20.0						36.2	41.9	1.9		1.0	19.0					
I		Maritimes	96	1	> 8	22.9				1.0		43.8	32.3				22.9					
	Ceftriaxone	British Columbia	59	≤ 0.25	16	27.1					72.9				5.1	6.8	13.6	1.7				
		Saskatchewan	71	≤ 0.25	8	15.5					83.1			1.4	4.2	2.8	5.6	2.8				
		Ontario	142	≤ 0.25	16	23.9					76.1				2.1	9.2	11.3	1.4				
		Québec	105	≤ 0.25	16	20.0					80.0				1.0	8.6	8.6	1.9				
		Maritimes	96	≤ 0.25	16	22.9					76.0	1.0				5.2	15.6	2.1				
	Ciprofloxacin	British Columbia	59	≤ 0.015	0.03	0.0	79.7	18.6	1.7													
		Saskatchewan	71	≤ 0.015	0.03	0.0	85.9	14.1														
		Ontario	142	≤ 0.015	≤ 0.015	0.0	90.8	9.2														
		Québec	105	≤ 0.015	0.03	0.0	83.8	16.2														
		Maritimes	96	≤ 0.015	≤ 0.015	0.0	96.9	3.1														
	Amikacin	British Columbia	59	1	2	0.0						22.0	55.9	20.3	1.7							
		Saskatchewan	71	1	2	0.0						9.9	60.6	28.2	1.4							
		Ontario	142	1	2	0.0						13.4	57.0	28.2	1.4							
		Québec	105	1	2	0.0						9.5	70.5	19.0	1.0							
		Maritimes	96	1	2	0.0						9.4	72.9	17.7								
	Ampicillin	British Columbia	59	≤ 1	> 32	27.1							67.8	3.4	1.7				27.1			
		Saskatchewan	71	≤ 1	> 32	23.9							71.8	4.2					23.9			
		Ontario	142	≤ 1	> 32	31.7							66.9	1.4					31.7			
		Québec	105	≤ 1	> 32	39.0							55.2	5.7				1.0	38.1			
		Maritimes	96	≤ 1	> 32	29.2							69.8	1.0					29.2			
	Cefoxitin	British Columbia	59	2	32	18.6							30.5	35.6	5.1		10.2	15.3	3.4			
		Saskatchewan	71	2	16	8.5							32.4	43.7	9.9		5.6	2.8	5.6			
		Ontario	142	2	32	16.9							41.5	25.4	7.7	1.4	7.0	14.8	2.1			
		Québec	105	2	32	16.2						1.0	43.8	32.4	1.0	1.9	3.8	10.5	5.7			
		Maritimes	96	2	32	22.9							44.8	26.0	6.3			15.6	7.3			
	Gentamicin	British Columbia	59	≤ 0.25	0.50	0.0					66.1	32.2	1.7									
		Saskatchewan	71	≤ 0.25	0.50	0.0					57.7	36.6	5.6									
		Ontario	142	≤ 0.25	0.50	1.4					61.3	33.1	3.5	0.7				1.4				
		Québec	105	≤ 0.25	0.50	1.0					57.1	41.0	1.0				1.0					
		Maritimes	96	≤ 0.25	0.50	1.0					71.9	27.1						1.0				
II	Kanamycin	British Columbia	59	≤ 8	≤ 8	1.7										98.3				1.7		
		Saskatchewan	71	≤ 8	≤ 8	0.0										100.0						
		Ontario	142	≤ 8	≤ 8	0.0										99.3	0.7					
		Québec	105	≤ 8	≤ 8	0.0										100.0						
		Maritimes	96	≤ 8	≤ 8	0.0										100.0						
	Nalidixic acid	British Columbia	59	4	4	0.0								18.6	76.3	5.1						
		Saskatchewan	71	4	4	0.0							1.4	18.3	77.5	2.8						
		Ontario	142	4	4	0.0							2.8	31.7	63.4	2.1						
		Québec	105	4	4	0.0							2.9	30.5	60.0	6.7						
		Maritimes	96	4	4	0.0							4.2	32.3	60.4	3.1						
	Streptomycin	British Columbia	59	≤ 32	64	13.6												86.4	8.5	5.1		
		Saskatchewan	71	≤ 32	> 64	22.5												77.5	9.9	12.7		
		Ontario	142	≤ 32	> 64	35.2												64.8	16.9	18.3		
		Québec	105	≤ 32	> 64	30.5												69.5	14.3	16.2		
		Maritimes	96	≤ 32	64	27.1												72.9	18.8	8.3		
	Trimethoprim-sulfamethoxazole	British Columbia	59	≤ 0.12	≤ 0.12	0.0				100.0												
		Saskatchewan	71	≤ 0.12	≤ 0.12	0.0				97.2	2.8											
		Ontario	142	≤ 0.12	≤ 0.12	0.7				97.9	1.4					0.7						
		Québec	105	≤ 0.12	≤ 0.12	2.9				96.2	1.0				1.0	1.9						
		Maritimes	96	≤ 0.12	≤ 0.12	0.0				99.0	1.0											
	Chloramphenicol	British Columbia	59	4	8	0.0								1.7	64.4	32.2	1.7					
		Saskatchewan	71	8	8	0.0								4.2	42.3	53.5						
		Ontario	142	4	8	0.7								4.2	52.8	42.3			0.7			
		Québec	105	8	8	0.0								5.7	41.0	51.4	1.9					
		Maritimes	96	8	8	0.0								1.0	46.9	50.0	2.1					
	Sulfisoxazole	British Columbia	59	32	64	1.7											22.0	42.4	28.8	5.1		1.7
		Saskatchewan	71	32	64	5.6											18.3	47.9	26.8	1.4		5.6
III		Ontario	142	32	64	4.2											13.4	59.9	18.3	4.2		4.2
		Québec	105	32	64	2.9											18.1	53.3	23.8	1.9		2.9
		Maritimes	96	32	64	2.1											13.5	59.4	25.0			2.1
	Tetracycline	British Columbia	59	≤ 4	> 32	15.3									84.7				15.3			
		Saskatchewan	71	≤ 4	> 32	26.8									73.2			1.4	25.4			
		Ontario	142	≤ 4	> 32	34.5									65.5			1.4	33.1			
		Québec	105	≤ 4	> 32	29.5									70.5				29.5			
		Maritimes	96	≤ 4	> 32	29.2									70.8				29.2			
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*, 2009.

	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	230	≤ 1	> 32	23.0							67.8	0.9		3.9	4.3	9.1	13.9			
	Ceftiofur	230	1	> 8	23.0					1.3	29.6	45.7	0.4		1.7	21.3					
	Ceftriaxone	230	≤ 0.25	8	23.0					77.0				2.2	11.3	6.5	2.6		0.4		
	Ciprofloxacin	230	≤ 0.015	0.03	0.0	85.2	14.3			0.4											
II	Amikacin	230	1	2	0.0						9.6	63.9	23.9	1.7	0.9						
	Ampicillin	230	≤ 1	> 32	31.3							66.5	2.2					31.3			
	Cefoxitin	230	2	32	15.7							44.3	27.8	3.9	1.3	7.0	13.5	2.2			
	Gentamicin	230	0.50	0.50	1.3					50.0	46.1	0.9	1.3		0.4	0.4	0.9				
	Kanamycin	230	≤ 8	≤ 8	1.3										97.8	0.9			1.3		
	Nalidixic acid	230	4	4	0.4							3.0	30.9	63.9	1.3	0.4		0.4			
	Streptomycin	230	≤ 32	> 64	40.9												59.1	21.7	19.1		
	Trimethoprim-sulfamethoxazole	230	≤ 0.12	≤ 0.12	0.0				99.1	0.9											
III	Chloramphenicol	230	4	8	0.4								7.4	52.6	38.7	0.9		0.4			
	Sulfisoxazole	230	32	64	3.0											18.3	50.4	27.0	1.3		3.0
	Tetracycline	230	≤ 4	> 32	37.0									62.6	0.4		0.9	36.1			
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*, 2009.

	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	280	≤ 1	16	8.6							86.4	2.1	0.4	1.1	1.4	2.5	6.1			
	Ceftiofur	280	1	2	8.9				1.4		18.2	70.4	0.7	0.4	0.4	8.6					
	Ceftriaxone	280	≤ 0.25	≤ 0.25	8.9					90.7	0.4			0.4	4.3	3.6	0.7				
	Ciprofloxacin	280	≤ 0.015	0.03	0.0	80.0	18.2	0.4	0.4	1.1											
II	Amikacin	280	1	2	0.0						8.9	65.0	23.6	2.5							
	Ampicillin	280	≤ 1	> 32	11.1							79.3	8.6	0.7	0.4			11.1			
	Cefoxitin	280	2	8	7.5							27.1	56.8	6.1	0.7	1.8	5.4	2.1			
	Gentamicin	280	≤ 0.25	0.50	1.8					52.5	42.9	2.5	0.4			0.7	1.1				
	Kanamycin	280	≤ 8	≤ 8	0.0										99.6	0.4					
	Nalidixic acid	280	4	4	1.1							1.1	24.3	71.1	1.1	1.4		1.1			
	Streptomycin	280	≤ 32	64	13.9												86.1	11.4	2.5		
	Trimethoprim-sulfamethoxazole	280	≤ 0.12	≤ 0.12	0.0				98.6	1.4											
III	Chloramphenicol	280	8	8	2.9								3.2	38.2	55.0	0.7		2.9			
	Sulfisoxazole	280	32	64	4.6											6.4	53.9	31.4	3.6		4.6
	Tetracycline	280	≤ 4	> 32	15.4									84.6				15.4			
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*, 2009.

	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	70	8	> 32	48.6							1.4	12.9	22.9	14.3		31.4	17.1			
		Saskatchewan	90	4	> 32	25.6							6.7	22.2	34.4	11.1		14.4	11.1			
		Ontario	155	4	32	23.2							1.9	23.9	27.7	20.0	3.2	17.4	5.8			
		Québec	126	4	32	23.0							1.6	23.8	31.7	19.0	0.8	15.9	7.1			
		Maritimes	185	4	32	27.6							2.2	18.4	34.6	16.8	0.5	18.4	9.2			
	Ceftiofur	British Columbia	70	2	> 8	41.4					14.3	30.0	5.7	2.9	5.7	17.1	24.3					
		Saskatchewan	90	0.50	> 8	22.2				2.2	20.0	50.0	2.2		3.3	12.2	10.0					
		Ontario	155	0.50	8	21.3				0.6	28.4	47.7			1.9	11.6	9.7					
		Québec	126	0.50	8	19.0					27.0	46.8	3.2	1.6	2.4	10.3	8.7					
I		Maritimes	185	0.50	> 8	27.0				1.1	15.1	54.1	1.6	0.5	0.5	12.4	14.6					
	Ceftriaxone	British Columbia	70	1	16	47.1					44.3	4.3	4.3		4.3	21.4	20.0	1.4				
		Saskatchewan	90	≤ 0.25	16	23.3					73.3		1.1	2.2	2.2	11.1	8.9	1.1				
		Ontario	155	≤ 0.25	16	22.6					76.8			0.6		8.4	14.2					
		Québec	126	≤ 0.25	8	21.4					77.0		1.6		3.2	8.7	8.7	0.8				
		Maritimes	185	≤ 0.25	16	27.0					72.4		0.5		1.1	13.0	11.9	1.1				
	Ciprofloxacin	British Columbia	70	≤ 0.015	0.03	0.0	88.6	4.3		4.3	2.9											
		Saskatchewan	90	≤ 0.015	≤ 0.015	0.0	94.4	1.1		1.1	3.3											
		Ontario	155	≤ 0.015	≤ 0.015	0.0	94.8	1.9			2.6	0.6										
		Québec	126	≤ 0.015	≤ 0.015	0.0	92.1	4.8			3.2											
		Maritimes	185	≤ 0.015	≤ 0.015	0.0	94.1	0.5	1.1	1.6	2.2		0.5									
	Amikacin	British Columbia	70	2	4	0.0							2.9	60.0	30.0	7.1						
		Saskatchewan	90	2	4	0.0								63.3	31.1	5.6						
		Ontario	155	2	4	0.0							3.2	60.0	34.2	2.6						
		Québec	126	4	4	0.0							0.8	47.6	48.4	2.4	0.8					
		Maritimes	185	2	4	0.0						0.5	6.5	60.0	30.3	2.7						
	Ampicillin	British Columbia	70	> 32	> 32	61.4							5.7	15.7	17.1				61.4			
		Saskatchewan	90	4	> 32	35.6							15.6	32.2	16.7				35.6			
		Ontario	155	4	> 32	40.6							6.5	36.8	14.8	1.3			40.6			
		Québec	126	4	> 32	41.3							4.8	36.5	17.5				41.3			
		Maritimes	185	4	> 32	42.2							5.4	30.3	21.6	0.5			42.2			
	Cefoxitin	British Columbia	70	8	> 32	48.6								8.6	35.7	7.1		11.4	37.1			
		Saskatchewan	90	4	> 32	23.3							1.1	15.6	48.9	7.8	3.3	3.3	20.0			
		Ontario	155	4	> 32	22.6							0.6	18.7	47.1	10.3	0.6	5.2	17.4			
		Québec	126	4	> 32	23.0							0.8	20.6	46.0	8.7	0.8	8.7	14.3			
		Maritimes	185	4	> 32	26.5							0.5	15.1	43.8	10.8	3.2	5.9	20.5			
	Gentamicin	British Columbia	70	1	4	1.4						34.3	52.9	1.4	7.1	2.9		1.4				
		Saskatchewan	90	1	1	7.8						41.1	51.1					7.8				
		Ontario	155	1	2	7.1					0.6	31.6	57.4	2.6		0.6	1.3	5.8				
		Québec	126	1	> 16	27.0						22.2	50.0			0.8	4.8	22.2				
		Maritimes	185	1	16	14.6					1.6	38.4	42.7	2.7			11.9	2.7				
II	Kanamycin	British Columbia	70	≤ 8	≤ 8	2.9										97.1				2.9		
		Saskatchewan	90	≤ 8	> 64	17.8										76.7	5.6			17.8		
		Ontario	155	≤ 8	> 64	12.3										84.5	3.2			12.3		
		Québec	126	≤ 8	> 64	11.9										79.4	7.1	1.6		11.9		
		Maritimes	185	≤ 8	16	9.2										82.2	8.1	0.5		9.2		
	Nalidixic acid	British Columbia	70	2	4	7.1							11.4	71.4	10.0			2.9	4.3			
		Saskatchewan	90	2	4	4.4							13.3	75.6	6.7				4.4			
		Ontario	155	2	4	3.2							11.0	77.4	8.4				3.2			
		Québec	126	2	2	3.2						0.8	16.7	73.8	5.6				3.2			
		Maritimes	185	2	4	3.8						1.1	10.3	73.0	10.8	0.5	0.5		3.8			
	Streptomycin	British Columbia	70	≤ 32	> 64	34.3												65.7	8.6	25.7		
		Saskatchewan	90	≤ 32	> 64	36.7												63.3	4.4	32.2		
		Ontario	155	≤ 32	> 64	40.6												59.4	6.5	34.2		
		Québec	126	64	> 64	56.3												43.7	12.7	43.7		
		Maritimes	185	≤ 32	> 64	36.2												63.8	11.9	24.3		
	Trimethoprim-sulfamethoxazole	British Columbia	70	≤ 0.12	0.25	2.9				82.9	11.4	2.9				2.9						
		Saskatchewan	90	≤ 0.12	0.25	5.6				84.4	8.9	1.1				5.6						
		Ontario	155	≤ 0.12	> 4	11.0				77.4	7.7	3.9				11.0						
		Québec	126	≤ 0.12	> 4	15.9				69.8	10.3	3.2	0.8			15.9						
		Maritimes	185	≤ 0.12	> 4	15.1				64.3	12.4	7.0	1.1		0.5	14.6						
	Chloramphenicol	British Columbia	70	4	8	7.1								4.3	52.9	35.7			7.1			
		Saskatchewan	90	4	8	4.4									67.8	26.7	1.1		4.4			
		Ontario	155	4	8	5.2								5.2	61.3	26.5	1.9		5.2			
		Québec	126	4	8	2.4								3.2	67.5	25.4	1.6		2.4			
		Maritimes	185	4	8	5.9								6.5	48.1	38.9	0.5	0.5	5.4			
	Sulfisoxazole	British Columbia	70	≤ 16	> 256	30.0											58.6	11.4				30.0
		Saskatchewan	90	≤ 16	> 256	26.7											61.1	12.2				26.7
III		Ontario	155	≤ 16	> 256	28.4											60.6	9.7	1.3			28.4
		Québec	126	32	> 256	48.4											46.0	5.6				48.4
		Maritimes	185	32	> 256	38.4											49.2	11.4	1.1			38.4
	Tetracycline	British Columbia	70	≤ 4	> 32	45.7									52.9	1.4		4.3	41.4			
		Saskatchewan	90	> 32	> 32	51.1									45.6	3.3			51.1			
		Ontario	155	8	> 32	49.0									49.0	1.9		1.9	47.1			
		Québec	126	> 32	> 32	60.3									39.7		0.8	1.6	57.9			
		Maritimes	185	≤ 4	> 32	40.0									59.5	0.5	0.5	5.4	34.1			
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*, 2009.

	Antimicrobial	n	Percentiles		% R	Distribution (%) of MICs (µg/mL)														
			MIC 50	MIC 90		≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	171	4	32	31.6							2.9	24.0	27.5	13.5	0.6	24.0	7.6			
	Ceftiofur	171	0.50	> 8	28.7				1.8	23.4	36.8	5.3	1.8	2.3	12.9	15.8					
	Ceftriaxone	171	≤ 0.25	16	31.0					64.9	0.6	2.9	0.6	1.8	12.9	12.9	3.5				
	Ciprofloxacin	171	≤ 0.015	≤ 0.015	0.0	94.2	1.2	0.6	0.6	2.9	0.6										
II	Amikacin	171	2	4	0.0						0.6	3.5	59.6	33.3	2.9						
	Ampicillin	171	4	> 32	43.3							9.9	29.8	16.4	0.6			43.3			
	Cefoxitin	171	8	> 32	31.6							0.6	14.0	35.1	18.1	0.6	7.6	24.0			
	Gentamicin	171	1	16	11.7					1.8	37.4	45.0	2.3		1.8	3.5	8.2				
	Kanamycin	171	≤ 8	> 64	14.6										81.3	3.5	0.6		14.6		
	Nalidixic acid	171	2	4	4.7						1.2	15.2	73.1	5.8			1.2	3.5			
	Streptomycin	171	≤ 32	> 64	45.0												55.0	7.0	38.0		
	Trimethoprim-sulfamethoxazole	171	≤ 0.12	0.50	9.4				78.4	8.8	2.9		0.6	0.6	8.8						
III	Chloramphenicol	171	4	8	8.2								5.8	62.6	22.8	0.6		8.2			
	Sulfisoxazole	171	≤ 16	> 256	35.7											58.5	5.8				35.7
	Tetracycline	171	≤ 4	> 32	43.9									55.6	0.6		2.3	41.5			
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*, 2009.

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	11	0.125	16	27.3			18.2	54.5						9.1	18.2			
Ciprofloxacin	*Campylobacter coli*	Saskatchewan	7	0.125	8	14.3			14.3	71.4						14.3				
Ciprofloxacin	*Campylobacter coli*	Ontario	7	0.25	0.25	0.0				14.3	85.7									
Ciprofloxacin	*Campylobacter coli*	Québec	4	0.064	0.25	0.0			75.0		25.0									
Ciprofloxacin	*Campylobacter coli*	Maritimes	5	0.125	16	40.0			40.0	20.0						20.0	20.0			
Ciprofloxacin	*Campylobacter jejuni*	British Columbia	65	0.125	16	27.7			21.5	49.2	1.5					9.2	18.5			
Ciprofloxacin	*Campylobacter jejuni*	Saskatchewan	41	0.125	16	14.6			14.6	61.0	9.8					2.4	9.8			2.4
Ciprofloxacin	*Campylobacter jejuni*	Ontario	94	0.125	0.125	1.1			21.3	70.2	6.4	1.1				1.1				
Ciprofloxacin	*Campylobacter jejuni*	Québec	48	0.125	0.25	0.0			18.8	58.3	22.9									
Ciprofloxacin	*Campylobacter jejuni*	Maritimes	42	0.125	0.25	0.0			11.9	50.0	35.7	2.4								
Ciprofloxacin	*Campylobacter* spp.	British Columbia	1	8	8	100.0										100.0				
Ciprofloxacin	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Ciprofloxacin	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
Telithromycin	*Campylobacter coli*	British Columbia	11	0.25	1	0.0				9.1	54.5	9.1	18.2	9.1						
Telithromycin	*Campylobacter coli*	Saskatchewan	7	0.5	4	0.0					14.3	57.1		14.3	14.3					
Telithromycin	*Campylobacter coli*	Ontario	7	4	16	14.3					14.3		28.6		42.9		14.3			
Telithromycin	*Campylobacter coli*	Québec	4	1	4	0.0					25.0		50.0		25.0					
Telithromycin	*Campylobacter coli*	Maritimes	5	1	1	0.0					40.0		60.0							
Telithromycin	*Campylobacter jejuni*	British Columbia	65	1	1	0.0					6.2	41.5	49.2	1.5	1.5					
Telithromycin	*Campylobacter jejuni*	Saskatchewan	41	1	1	0.0					2.4	39.0	53.7	4.9						
Telithromycin	*Campylobacter jejuni*	Ontario	94	1	2	3.2				1.1	8.5	34.0	44.7	5.3	1.1	2.1	3.2			
Telithromycin	*Campylobacter jejuni*	Québec	48	1	4	6.3					2.1	33.3	45.8	6.3	4.2	2.1	6.3			
Telithromycin	*Campylobacter jejuni*	Maritimes	42	1	4	7.1						33.3	31.0	16.7	9.5	2.4	7.1			
Telithromycin	*Campylobacter* spp.	British Columbia	1	1	1	0.0							100.0							
Telithromycin	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Telithromycin	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
Azithromycin	*Campylobacter coli*	British Columbia	11	0.064	0.064	0.0		36.4	54.5	9.1										
Azithromycin	*Campylobacter coli*	Saskatchewan	7	0.064	0.25	0.0		28.6	42.9	14.3	14.3									
Azithromycin	*Campylobacter coli*	Ontario	7	0.125	> 64	14.3		14.3	14.3	28.6	28.6									14.3
Azithromycin	*Campylobacter coli*	Québec	4	0.064	0.125	0.0			75.0	25.0										
Azithromycin	*Campylobacter coli*	Maritimes	5	0.064	0.125	0.0			60.0	40.0										
Azithromycin	*Campylobacter jejuni*	British Columbia	65	0.064	0.125	0.0		21.5	63.1	10.8	4.6									
Azithromycin	*Campylobacter jejuni*	Saskatchewan	41	0.064	0.125	0.0		17.1	58.5	24.4										
Azithromycin	*Campylobacter jejuni*	Ontario	94	0.064	0.125	4.3	1.1	18.1	46.8	26.6	2.1		1.1							4.3
Azithromycin	*Campylobacter jejuni*	Québec	48	0.064	0.25	8.3		22.9	33.3	25.0	10.4									8.3
Azithromycin	*Campylobacter jejuni*	Maritimes	42	0.064	0.25	7.1			59.5	26.2	7.1									7.1
Azithromycin	*Campylobacter* spp.	British Columbia	1	0.125	0.125	0.0				100.0										
Azithromycin	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Azithromycin	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
Clindamycin	*Campylobacter coli*	British Columbia	11	0.25	0.25	0.0			9.1	9.1	72.7	9.1								
Clindamycin	*Campylobacter coli*	Saskatchewan	7	0.25	1	0.0				42.9	42.9		14.3							
Clindamycin	*Campylobacter coli*	Ontario	7	0.125	16	14.3			14.3	42.9			28.6				14.3			
Clindamycin	*Campylobacter coli*	Québec	4	0.25	0.25	0.0				50.0	50.0									
Clindamycin	*Campylobacter coli*	Maritimes	5	0.25	2	0.0				20.0	40.0			40.0						
Clindamycin	*Campylobacter jejuni*	British Columbia	65	0.125	0.25	0.0			10.8	49.2	40.0									
Clindamycin	*Campylobacter jejuni*	Saskatchewan	41	0.125	0.25	0.0			9.8	65.9	22.0	2.4								
Clindamycin	*Campylobacter jejuni*	Ontario	94	0.125	0.25	2.1		1.1	6.4	47.9	37.2	3.2		1.1	1.1	1.1	1.1			
Clindamycin	*Campylobacter jejuni*	Québec	48	0.125	0.5	2.1			6.3	58.3	22.9	4.2		2.1	4.2	2.1				
Clindamycin	*Campylobacter jejuni*	Maritimes	42	0.125	0.25	2.4			7.1	47.6	35.7	2.4		2.4	2.4			2.4		
Clindamycin	*Campylobacter* spp.	British Columbia	1	0.25	0.25	0.0					100.0									
Clindamycin	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Clindamycin	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
Erythromycin	*Campylobacter coli*	British Columbia	11	0.25	0.5	0.0				18.2	45.5	27.3	9.1							
Erythromycin	*Campylobacter coli*	Saskatchewan	7	0.25	2	0.0				14.3	42.9	14.3	14.3	14.3						
Erythromycin	*Campylobacter coli*	Ontario	7	2	> 64	14.3				14.3		14.3	14.3	42.9						14.3
Erythromycin	*Campylobacter coli*	Québec	4	0.5	2	0.0					25.0	50.0		25.0						
Erythromycin	*Campylobacter coli*	Maritimes	5	0.5	1	0.0					40.0	20.0	40.0							
Erythromycin	*Campylobacter jejuni*	British Columbia	65	0.5	0.5	0.0				3.1	33.8	55.4	7.7							
Erythromycin	*Campylobacter jejuni*	Saskatchewan	41	0.5	1	0.0				2.4	31.7	53.7	12.2							
Erythromycin	*Campylobacter jejuni*	Ontario	94	0.5	1	4.3				1.1	26.6	55.3	8.5	3.2			1.1		1.1	3.2
Erythromycin	*Campylobacter jejuni*	Québec	48	0.5	2	8.3					22.9	50.0	14.6	4.2						8.3
Erythromycin	*Campylobacter jejuni*	Maritimes	42	1	2	7.1					4.8	42.9	28.6	16.7						7.1
Erythromycin	*Campylobacter* spp.	British Columbia	1	1	1	0.0							100.0							
Erythromycin	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Québec	0	0	0	0.0														
Erythromycin	*Campylobacter* spp.	Maritimes	0	0	0	0.0														

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

Table B.16 (continued). Distribution of minimum inhibitory concentrations for antimicrobials in *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2009.

	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	11	1	1	0.0						45.5	54.5							
	Gentamicin	*Campylobacter coli*	Saskatchewan	7	0.5	1	0.0						71.4	28.6							
	Gentamicin	*Campylobacter coli*	Ontario	7	0.5	1	0.0						57.1	42.9							
	Gentamicin	*Campylobacter coli*	Québec	4	1	1	0.0						50.0	50.0							
	Gentamicin	*Campylobacter coli*	Maritimes	5	1	1	0.0						40.0	60.0							
	Gentamicin	*Campylobacter jejuni*	British Columbia	65	1	1	0.0						49.2	50.8							
	Gentamicin	*Campylobacter jejuni*	Saskatchewan	41	1	1	0.0						34.1	65.9							
	Gentamicin	*Campylobacter jejuni*	Ontario	94	1	1	0.0						34.0	66.0							
	Gentamicin	*Campylobacter jejuni*	Québec	48	1	1	0.0						50.0	50.0							
	Gentamicin	*Campylobacter jejuni*	Maritimes	42	1	1	0.0					2.4	23.8	73.8							
	Gentamicin	*Campylobacter* spp.	British Columbia	1	1	1	0.0							100.0							
	Gentamicin	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Gentamicin	*Campylobacter* spp.	Québec	0	0	0	0.0														
II	Gentamicin	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
	Nalidixic acid	*Campylobacter coli*	British Columbia	11	8	> 64	27.3									45.5	27.3			9.1	18.2
	Nalidixic acid	*Campylobacter coli*	Saskatchewan	7	≤ 4	64	14.3									71.4		14.3		14.3	
	Nalidixic acid	*Campylobacter coli*	Ontario	7	8	16	0.0									14.3	42.9	42.9			
	Nalidixic acid	*Campylobacter coli*	Québec	4	≤ 4	8	0.0									75.0	25.0				
	Nalidixic acid	*Campylobacter coli*	Maritimes	5	≤ 4	> 64	40.0									60.0					40.0
	Nalidixic acid	*Campylobacter jejuni*	British Columbia	65	≤ 4	> 64	27.7									56.9	13.8	1.5			27.7
	Nalidixic acid	*Campylobacter jejuni*	Saskatchewan	41	≤ 4	> 64	14.6									63.4	22.0				14.6
	Nalidixic acid	*Campylobacter jejuni*	Ontario	94	≤ 4	8	1.1									80.9	17.0	1.1			1.1
	Nalidixic acid	*Campylobacter jejuni*	Québec	48	≤ 4	8	0.0									77.1	22.9				
	Nalidixic acid	*Campylobacter jejuni*	Maritimes	42	≤ 4	8	0.0									61.9	35.7	2.4			
	Nalidixic acid	*Campylobacter* spp.	British Columbia	1	64	64	100.0													100.0	
	Nalidixic acid	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Québec	0	0	0	0.0														
	Nalidixic acid	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
	Florfenicol	*Campylobacter coli*	British Columbia	11	1	1	0.0						18.2	72.7	9.1						
	Florfenicol	*Campylobacter coli*	Saskatchewan	7	1	2	0.0						14.3	57.1	28.6						
	Florfenicol	*Campylobacter coli*	Ontario	7	2	2	0.0						14.3		85.7						
	Florfenicol	*Campylobacter coli*	Québec	4	1	2	0.0							75.0	25.0						
	Florfenicol	*Campylobacter coli*	Maritimes	5	1	1	0.0							100.0							
	Florfenicol	*Campylobacter jejuni*	British Columbia	65	1	1	0.0						9.2	89.2	1.5						
	Florfenicol	*Campylobacter jejuni*	Saskatchewan	41	1	2	0.0						4.9	78.0	17.1						
	Florfenicol	*Campylobacter jejuni*	Ontario	94	1	1	0.0						10.6	83.0	5.3	1.1					
	Florfenicol	*Campylobacter jejuni*	Québec	48	1	2	0.0						14.6	75.0	10.4						
	Florfenicol	*Campylobacter jejuni*	Maritimes	42	1	2	0.0						7.1	66.7	26.2						
	Florfenicol	*Campylobacter* spp.	British Columbia	1	1	1	0.0							100.0							
	Florfenicol	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Florfenicol	*Campylobacter* spp.	Québec	0	0	0	0.0														
III	Florfenicol	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
	Tetracycline	*Campylobacter coli*	British Columbia	11	0.5	32	18.2					36.4	27.3	18.2					9.1	9.1	
	Tetracycline	*Campylobacter coli*	Saskatchewan	7	64	> 64	71.4					28.6							14.3	42.9	14.3
	Tetracycline	*Campylobacter coli*	Ontario	7	1	> 64	42.9						42.9	14.3							42.9
	Tetracycline	*Campylobacter coli*	Québec	4	> 64	> 64	50.0					25.0	25.0								50.0
	Tetracycline	*Campylobacter coli*	Maritimes	5	> 64	> 64	60.0					40.0									60.0
	Tetracycline	*Campylobacter jejuni*	British Columbia	65	64	> 64	60.0				4.6	23.1	9.2	1.5	1.5			1.5	6.2	30.8	21.5
	Tetracycline	*Campylobacter jejuni*	Saskatchewan	41	64	> 64	58.5				4.9	29.3	7.3					4.9	2.4	34.1	17.1
	Tetracycline	*Campylobacter jejuni*	Ontario	94	0.25	> 64	38.3				14.9	41.5	2.1	2.1		1.1			2.1	20.2	16.0
	Tetracycline	*Campylobacter jejuni*	Québec	48	64	> 64	62.5			2.1	10.4	18.8	6.3						6.3	18.8	37.5
	Tetracycline	*Campylobacter jejuni*	Maritimes	42	64	> 64	52.4				23.8	21.4		2.4						19.0	33.3
	Tetracycline	*Campylobacter* spp.	British Columbia	1	0.25	0.25	0.0					100.0									
	Tetracycline	*Campylobacter* spp.	Saskatchewan	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Ontario	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Québec	0	0	0	0.0														
	Tetracycline	*Campylobacter* spp.	Maritimes	0	0	0	0.0														
IV																					

Information on how to interpret the MIC tables is provided at the beginning of Appendix B.
Campylobacter spp. include unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table B.17. Distribution of minimum inhibitory concentrations for antimicrobials in *Enterococcus* isolates from chicken; *Retail Meat Surveillance,* 2009.

Antimicrobial	Species	Prov.	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	512	1,024	2,048	> 2,048
Ciprofloxacin	*Enterococcus faecalis*	BC	63	1	2	3.2						3.2	60.3	33.3	3.2										
		SA	86	1	2	0.0						1.2	58.1	40.7											
		ON	151	1	2	0.7						2.0	58.3	39.1	0.7										
		QC	126	1	2	1.6						3.2	58.7	36.5	1.6										
	Enterococcus faecium	BC	2	4	4	100.0									100.0										
		SA	1	2	2	0.0								100.0											
		ON	4	4	4	50.0							50.0		50.0										
		QC	1	4	4	100.0									100.0										
	Enterococcus spp.	BC	7	1	1	0.0						42.9	57.1												
		SA	5	1	2	0.0						40.0	40.0	20.0											
		ON	9	0.5	4	22.2					33.3	22.2	22.2		22.2										
		QC	4	1	1	0.0						25.0	75.0												
Daptomycin	*Enterococcus faecalis*	BC	63	1	2	0.0					3.2	9.5	73.0	14.3											
		SA	86	1	1	0.0						7.0	87.2	5.8											
		ON	151	1	1	0.0						9.3	83.4	6.6	0.7										
		QC	126	1	1	0.0						8.7	84.9	6.3											
	Enterococcus faecium	BC	2	2	2	0.0								100.0											
		SA	1	2	2	0.0								100.0											
		ON	4	2	4	0.0						25.0		50.0	25.0										
		QC	1	2	2	0.0								100.0											
	Enterococcus spp.	BC	7	1	4	0.0					14.3	14.3	28.6	28.6	14.3										
		SA	5	2	2	0.0					40.0			60.0											
		ON	9	2	4	0.0					22.2	11.1	11.1	33.3	22.2										
		QC	4	1	2	0.0					25.0	25.0	25.0	25.0											
Linezolid	*Enterococcus faecalis*	BC	63	1	2	0.0						1.6	54.0	44.4											
		SA	86	1	2	0.0							55.8	44.2											
		ON	151	1	2	0.0							55.0	45.0											
		QC	126	1	2	0.0							51.6	48.4											
	Enterococcus faecium	BC	2	1	1	0.0							100.0												
		SA	1	1	1	0.0							100.0												
		ON	4	1	1	0.0							100.0												
		QC	1	1	1	0.0							100.0												
	Enterococcus spp.	BC	7	1	2	0.0						14.3	57.1	28.6											
		SA	5	1	2	0.0						20.0	60.0	20.0											
		ON	9	1	2	0.0						11.1	77.8	11.1											
		QC	4	1	2	0.0						25.0	50.0	25.0											
Tigecycline	*Enterococcus faecalis*	BC	63	0.12	0.25	0.0			14.3	68.3	17.5														
		SA	86	0.12	0.25	0.0			4.7	53.5	41.9														
		ON	151	0.12	0.25	0.0			6.6	63.6	29.8														
		QC	126	0.12	0.25	0.0			6.3	61.1	32.5														
	Enterococcus faecium	BC	2	0.25	0.25	0.0				50.0	50.0														
		SA	1	0.12	0.12	0.0				100.0															
		ON	4	0.12	0.25	0.0				75.0	25.0														
		QC	1	0.12	0.12	0.0				100.0															
	Enterococcus spp.	BC	7	0.12	0.25	0.0			28.6	42.9	28.6														
		SA	5	0.06	0.25	0.0			60.0	20.0	20.0														
		ON	9	0.12	0.12	0.0			33.3	66.7															
		QC	4	0.12	0.12	0.0			50.0	50.0															
Vancomycin	*Enterococcus faecalis*	BC	63	1	2	0.0						1.6	68.3	30.2											
		SA	86	1	2	0.0							59.3	39.5	1.2										
		ON	151	1	2	0.0							60.9	39.1											
		QC	126	1	2	0.0						1.6	61.1	34.9	2.4										
	Enterococcus faecium	BC	2	0.5	0.5	0.0						100.0													
		SA	1	0.5	0.5	0.0						100.0													
		ON	4	0.5	0.5	0.0						100.0													
		QC	1	0.5	0.5	0.0						100.0													
	Enterococcus spp.	BC	7	1	8	0.0						42.9	14.3	14.3	14.3	14.3									
		SA	5	0.5	1	0.0						80.0	20.0												
		ON	9	0.5	1	0.0						77.8	22.2												
		QC	4	1	4	0.0						50.0	25.0		25.0										
Erythromycin	*Enterococcus faecalis*	BC	63	2	> 8	49.2					22.2	4.8	20.6	3.2		1.6	47.6								
		SA	86	> 8	> 8	59.3					26.7	1.2	10.5	2.3			59.3								
		ON	151	> 8	> 8	54.3					23.8	3.3	17.2	1.3			54.3								
		QC	126	> 8	> 8	61.1					21.4	4.0	7.1	6.3		0.8	60.3								
	Enterococcus faecium	BC	2	> 8	> 8	50.0					50.0						50.0								
		SA	1	2	2	0.0								100.0											
		ON	4	> 8	> 8	75.0						25.0					75.0								
		QC	1	1	1	0.0							100.0												
	Enterococcus spp.	BC	7	1	> 8	14.3					28.6	14.3	14.3	14.3	14.3		14.3								
		SA	5	1	2	0.0					40.0		20.0	40.0											
		ON	9	≤ 0.25	> 8	44.4					55.6						44.4								
		QC	4	1	> 8	25.0					50.0		25.0				25.0								
Gentamicin	*Enterococcus faecalis*	BC	63	≤ 128	≤ 128	0.0														100.0					
		SA	86	≤ 128	≤ 128	4.7														95.3				4.7	
		ON	151	≤ 128	≤ 128	7.9														91.4	0.7	0.7	1.3	6.0	
		QC	126	≤ 128	512	10.3														89.7		4.8	2.4	3.2	
	Enterococcus faecium	BC	2	≤ 128	≤ 128	0.0														100.0					
		SA	1	≤ 128	≤ 128	0.0														100.0					
		ON	4	≤ 128	≤ 128	0.0														100.0					
		QC	1	≤ 128	≤ 128	0.0														100.0					
	Enterococcus spp.	BC	7	≤ 128	≤ 128	0.0														100.0					
		SA	5	≤ 128	≤ 128	0.0														100.0					
		ON	9	≤ 128	1,024	11.1														88.9			11.1		
		QC	4	≤ 128	≤ 128	0.0														100.0					
Kanamycin	*Enterococcus faecalis*	BC	63	≤ 128	> 1,024	19.0														79.4	1.6			19.0	
		SA	86	≤ 128	> 1,024	18.6														80.2		1.2	1.2	17.4	
		ON	151	≤ 128	> 1,024	23.8														73.5	0.7	2.0	0.7	23.2	
		QC	126	≤ 128	> 1,024	22.2														77.8				22.2	
	Enterococcus faecium	BC	2	> 1,024	> 1,024	50.0														50.0				50.0	
		SA	1	≤ 128	≤ 128	0.0														100.0					
		ON	4	512	> 1,024	25.0														50.0		25.0		25.0	
		QC	1	≤ 128	≤ 128	0.0														100.0					
	Enterococcus spp.	BC	7	≤ 128	> 1,024	14.3														85.7				14.3	
		SA	5	≤ 128	≤ 128	0.0														100.0					
		ON	9	≤ 128	> 1,024	44.4														55.6			11.1	33.3	
		QC	4	512	> 1,024	25.0														50.0		25.0		25.0	

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

Table B.17 (continued). Distribution of minimum inhibitory concentrations for antimicrobials in *Enterococcus* isolates from chicken; *Retail Meat Surveillance*, 2009.

Antimicrobial	Species	Prov.	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	512	1,024	2,048	> 2,048
Lincomycin[a]	*Enterococcus faecium*	BC	2	16	16	100.0											100.0								
		SA	1	16	16	100.0											100.0								
		ON	4	16	16	100.0											100.0								
		QC	1	16	16	100.0											100.0								
	Enterococcus spp.	BC	7	16	16	100.0											100.0								
		SA	5	16	16	100.0										20.0	80.0								
		ON	9	16	16	88.9							11.1			11.1	77.8								
		QC	4	16	16	100.0											100.0								
Penicillin	*Enterococcus faecalis*	BC	63	4	4	0.0							1.6	46.0	52.4										
		SA	86	4	4	0.0								47.7	52.3										
		ON	151	4	4	0.0								37.1	62.9										
		QC	126	4	4	0.0								38.1	61.9										
	Enterococcus faecium	BC	2	16	16	100.0											100.0								
		SA	1	2	2	0.0								100.0											
		ON	4	16	16	75.0							25.0				75.0								
		QC	1	4	4	0.0									100.0										
	Enterococcus spp.	BC	7	2	8	0.0					14.3	14.3		28.6	28.6	14.3									
		SA	5	2	> 16	20.0						20.0	20.0	40.0				20.0							
		ON	9	1	16	11.1					22.2	11.1	44.4	11.1			11.1								
		QC	4	8	16	25.0								25.0	25.0	25.0	25.0								
Quinupristin-dalfopristin[a]	*Enterococcus faecium*	BC	2	32	32	100.0										50.0		50.0							
		SA	1	8	8	100.0										100.0									
		ON	4	16	16	75.0							25.0				75.0								
		QC	1	16	16	100.0											100.0								
	Enterococcus spp.	BC	7	4	8	57.1							14.3	28.6	28.6	28.6									
II		SA	5	2	8	40.0						20.0		40.0	20.0	20.0									
		ON	9	2	16	33.3						11.1	11.1	44.4	11.1		22.2								
		QC	4	4	8	50.0							50.0		25.0	25.0									
Streptomycin	*Enterococcus faecalis*	BC	63	≤ 512	> 2,048	27.0																73.0		1.6	25.4
		SA	86	≤ 512	> 2,048	31.4																68.6		1.2	30.2
		ON	151	≤ 512	> 2,048	22.5																77.5	1.3	0.7	20.5
		QC	126	≤ 512	> 2,048	34.9																65.1	3.2	2.4	29.4
	Enterococcus faecium	BC	2	1,024	1,024	100.0																	100.0		
		SA	1	≤ 512	≤ 512	0.0																100.0			
		ON	4	1,024	2,048	75.0																25.0	50.0	25.0	
		QC	1	2,048	2,048	100.0																		100.0	
	Enterococcus spp.	BC	7	≤ 512	> 2,048	28.6																71.4			28.6
		SA	5	≤ 512	≤ 512	0.0																100.0			
		ON	9	≤ 512	> 2,048	33.3																66.7	11.1	11.1	11.1
		QC	4	≤ 512	1,024	25.0																75.0	25.0		
Tylosin	*Enterococcus faecalis*	BC	63	4	> 32	49.2								42.9	7.9				49.2						
		SA	86	> 32	> 32	59.3							1.2	37.2	2.3				59.3						
		ON	151	> 32	> 32	54.3							2.0	41.7	2.0				54.3						
		QC	126	> 32	> 32	61.1							1.6	34.9	2.4				61.1						
	Enterococcus faecium	BC	2	> 32	> 32	50.0								50.0					50.0						
		SA	1	2	2	0.0								100.0											
		ON	4	> 32	> 32	75.0								25.0					75.0						
		QC	1	8	8	0.0										100.0									
	Enterococcus spp.	BC	7	2	> 32	14.3							14.3	71.4					14.3						
		SA	5	1	8	0.0							60.0	20.0		20.0									
		ON	9	2	> 32	44.4							11.1	44.4					44.4						
		QC	4	4	> 32	25.0								50.0	25.0				25.0						
Chloramphenicol	*Enterococcus faecalis*	BC	63	8	8	3.2									4.8	88.9	3.2		3.2						
		SA	86	8	8	0.0										98.8	1.2								
		ON	151	8	8	0.7									1.3	95.4	2.6		0.7						
		QC	126	8	8	3.2									1.6	92.9	2.4		3.2						
	Enterococcus faecium	BC	2	8	8	0.0									50.0	50.0									
		SA	1	8	8	0.0										100.0									
		ON	4	8	8	0.0									50.0	50.0									
		QC	1	4	4	0.0									100.0										
	Enterococcus spp.	BC	7	4	8	0.0									71.4	28.6									
		SA	5	4	8	0.0									80.0	20.0									
		ON	9	4	8	0.0								11.1	44.4	44.4									
		QC	4	8	8	0.0									50.0	50.0									
Nitrofurantoin	*Enterococcus faecalis*	BC	63	16	16	0.0										36.5	54.0	3.2	6.3						
		SA	86	8	16	0.0										53.5	43.0	1.2	2.3						
		ON	151	16	16	1.3										47.7	45.7	0.7	4.6	1.3					
		QC	126	8	16	0.0										65.1	34.1		0.8						
	Enterococcus faecium	BC	2	> 64	> 64	50.0													50.0	50.0					
		SA	1	> 64	> 64	100.0														100.0					
III		ON	4	> 64	> 64	75.0											25.0			75.0					
		QC	1	64	64	0.0													100.0						
	Enterococcus spp.	BC	7	16	> 64	42.9									14.3	28.6	14.3			42.9					
		SA	5	> 64	> 64	80.0													20.0	80.0					
		ON	9	64	> 64	22.2												11.1	66.7	22.2					
		QC	4	64	> 64	25.0										25.0	25.0		25.0	25.0					
Tetracycline	*Enterococcus faecalis*	BC	63	> 32	> 32	79.4							19.0	1.6				4.8	74.6						
		SA	86	> 32	> 32	83.7							16.3				1.2	5.8	76.7						
		ON	151	> 32	> 32	86.8							13.2					7.9	78.8						
		QC	126	> 32	> 32	84.9							14.3	0.8			0.8	8.7	75.4						
	Enterococcus faecium	BC	2	> 32	> 32	100.0													100.0						
		SA	1	> 32	> 32	100.0													100.0						
		ON	4	> 32	> 32	75.0							25.0						75.0						
		QC	1	≤ 1	≤ 1	0.0							100.0												
	Enterococcus spp.	BC	7	≤ 1	> 32	42.9							57.1					14.3	28.6						
		SA	5	32	> 32	60.0							20.0			20.0		20.0	40.0						
		ON	9	> 32	> 32	66.7							22.2			11.1			66.7						
		QC	4	> 32	> 32	50.0							50.0						50.0						
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.

Pigs

Table B.18. Distribution of minimum inhibitory concentrations for antimicrobials in *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2009.

	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	147	≤ 1	8	0.0							76.9	4.1	0.7	12.2	6.1					
	Ceftiofur	147	1	1	0.0						18.4	74.1	7.5								
	Ceftriaxone	147	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	147	≤ 0.015	0.03	0.0	73.5	24.5	2.0													
II	Amikacin	147	1	2	0.0						9.5	59.2	29.9	1.4							
	Ampicillin	147	≤ 1	> 32	19.7							69.4	7.5	2.7		0.7	0.7	19.0			
	Cefoxitin	147	2	4	0.0							12.2	49.7	32.7	4.1	1.4					
	Gentamicin	147	0.50	0.50	1.4					38.8	54.4	4.8	0.7				1.4				
	Kanamycin	147	≤ 8	> 64	11.6										88.4			0.7	10.9		
	Nalidixic acid	147	4	4	0.0								34.0	59.9	6.1						
	Streptomycin	147	≤ 32	> 64	39.5												60.5	9.5	29.9		
	Trimethoprim-sulfamethoxazole	147	≤ 0.12	0.25	3.4				77.6	15.0	4.1				3.4						
III	Chloramphenicol	147	8	> 32	15.0									25.9	56.5	2.7		15.0			
	Sulfisoxazole	147	64	> 256	34.7											12.2	29.3	23.1	0.7		34.7
	Tetracycline	147	≤ 4	> 32	46.3									53.7		0.7	8.2	37.4			
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*, 2009.

	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	124	≤ 1	8	0.0							61.3	12.1	5.6	12.9	8.1					
	Ceftiofur	124	1	1	0.0					0.8	20.2	71.0	6.5	1.6							
	Ceftriaxone	124	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	124	≤ 0.015	0.03	0.0	79.8	16.1	4.0													
II	Amikacin	124	1	2	0.0						8.1	62.9	25.8	3.2							
	Ampicillin	124	≤ 1	> 32	29.0							54.0	12.9	2.4	0.8	0.8	0.8	28.2			
	Cefoxitin	124	2	4	0.0							17.7	38.7	36.3	1.6	5.6					
	Gentamicin	124	≤ 0.25	0.5	0.8					57.3	35.5	4.8	1.6				0.8				
	Kanamycin	124	≤ 8	> 64	21.0										79.0				21.0		
	Nalidixic acid	124	4	4	0.0							0.8	25.8	65.3	8.1						
	Streptomycin	124	≤ 32	> 64	44.4												55.6	4.8	39.5		
	Trimethoprim-sulfamethoxazole	124	≤ 0.12	> 4	12.1				61.3	16.9	5.6	0.8	3.2	1.6	10.5						
III	Chloramphenicol	124	8	> 32	12.1								2.4	20.2	54.8	10.5		12.1			
	Sulfisoxazole	124	64	> 256	42.7											5.6	23.4	27.4	0.8		42.7
	Tetracycline	124	> 32	> 32	67.7									32.3		0.8	6.5	60.5			
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*, 2009.

	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	226	2	16	3.5							47.8	8.0	4.4	13.7	22.6	1.8	1.8			
	Ceftiofur	226	1	2	4.0						7.1	78.8	9.3	0.9	1.3	2.7					
	Ceftriaxone	226	≤ 0.25	≤ 0.25	4.0					95.6	0.4				1.3	2.2	0.4				
	Ciprofloxacin	226	≤ 0.015	0.03	0.0	89.8	7.5	2.7													
II	Amikacin	226	2	2	0.0						1.3	43.4	51.8	2.7	0.4	0.4					
	Ampicillin	226	2	> 32	44.2							42.9	8.4	3.5		0.9	0.9	43.4			
	Cefoxitin	226	2	8	3.5							9.7	49.1	29.6	8.0		1.8	1.8			
	Gentamicin	226	0.50	1	4.4					23.9	58.0	11.1	0.4	0.4	1.8	2.7	1.8				
	Kanamycin	226	≤ 8	> 64	25.7										73.9		0.4		25.7		
	Nalidixic acid	226	4	4	0.0								50.0	43.8	6.2						
	Streptomycin	226	64	> 64	61.1												38.9	17.7	43.4		
	Trimethoprim-sulfamethoxazole	226	≤ 0.12	> 4	15.9				61.9	18.1	3.1	0.4	0.4		15.9						
III	Chloramphenicol	226	8	> 32	31.9									16.8	46.5	4.9		31.9			
	Sulfisoxazole	226	> 256	> 256	66.4											2.7	19.0	11.5	0.4		66.4
	Tetracycline	226	> 32	> 32	73.9									26.1		0.4	6.2	67.3			
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*, 2009.

	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	38	4	8	0.0								42.1	39.5	18.4						
		Saskatchewan	29	4	4	3.4								24.1	69.0	3.4			3.4			
		Ontario	136	4	8	0.0							2.2	25.0	52.2	19.9	0.7					
		Québec	41	4	8	0.0								29.3	41.5	29.3						
		Maritimes	81	4	8	1.2							3.7	25.9	54.3	14.8		1.2				
	Ceftiofur	British Columbia	38	0.50	0.50	0.0				2.6	42.1	55.3										
		Saskatchewan	29	0.50	0.50	3.4				3.4	34.5	58.6					3.4					
		Ontario	136	0.50	0.50	0.0				2.2	36.0	61.0	0.7									
		Québec	41	0.50	0.50	0.0				7.3	31.7	53.7	7.3									
I		Maritimes	81	0.50	0.50	0.0				4.9	33.3	60.5	1.2									
	Ceftriaxone	British Columbia	38	≤ 0.25	≤ 0.25	0.0					100.0											
		Saskatchewan	29	≤ 0.25	≤ 0.25	3.4					96.6						3.4					
		Ontario	136	≤ 0.25	≤ 0.25	0.0					100.0											
		Québec	41	≤ 0.25	≤ 0.25	0.0					100.0											
		Maritimes	81	≤ 0.25	≤ 0.25	0.0					100.0											
	Ciprofloxacin	British Columbia	38	≤ 0.015	≤ 0.015	0.0	100.0															
		Saskatchewan	29	≤ 0.015	≤ 0.015	0.0	100.0															
		Ontario	136	≤ 0.015	≤ 0.015	0.0	97.1	2.9														
		Québec	41	≤ 0.015	≤ 0.015	0.0	97.6	2.4														
		Maritimes	81	≤ 0.015	≤ 0.015	0.0	95.1	2.5	1.2	1.2												
	Amikacin	British Columbia	38	2	4	0.0							10.5	42.1	42.1	2.6	2.6					
		Saskatchewan	29	2	4	0.0								55.2	44.8							
		Ontario	136	2	4	0.0							2.2	61.0	34.6	1.5	0.7					
		Québec	41	2	4	0.0								70.7	26.8	2.4						
		Maritimes	81	2	4	0.0						3.7	2.5	61.7	30.9	1.2						
	Ampicillin	British Columbia	38	2	4	7.9							13.2	44.7	34.2				7.9			
		Saskatchewan	29	4	> 32	10.3							3.4	37.9	48.3				10.3			
		Ontario	136	2	> 32	18.4							5.1	48.5	25.7	0.7	1.5		18.4			
		Québec	41	4	> 32	19.5							12.2	36.6	26.8	4.9			19.5			
		Maritimes	81	2	> 32	12.3							17.3	39.5	28.4	2.5			12.3			
	Cefoxitin	British Columbia	38	4	8	0.0							5.3	28.9	55.3	10.5						
		Saskatchewan	29	4	4	3.4								27.6	65.5	3.4			3.4			
		Ontario	136	4	8	0.0							1.5	19.1	66.2	13.2						
		Québec	41	4	8	0.0							2.4	31.7	46.3	19.5						
		Maritimes	81	4	4	0.0							3.7	30.9	58.0	7.4						
	Gentamicin	British Columbia	38	1	2	5.3						36.8	52.6	5.3				5.3				
		Saskatchewan	29	1	1	0.0						41.4	58.6									
		Ontario	136	1	1	0.7						38.2	57.4	2.9	0.7			0.7				
		Québec	41	1	1	0.0						43.9	51.2	4.9								
		Maritimes	81	0.50	1	2.5					2.5	51.9	42.0	1.2			2.5					
II	Kanamycin	British Columbia	38	≤ 8	≤ 8	2.6										97.4				2.6		
		Saskatchewan	29	≤ 8	≤ 8	3.4										93.1	3.4			3.4		
		Ontario	136	≤ 8	≤ 8	3.7										94.1	2.2			3.7		
		Québec	41	≤ 8	≤ 8	7.3										90.2	2.4			7.3		
		Maritimes	81	≤ 8	≤ 8	7.4										91.4	1.2			7.4		
	Nalidixic acid	British Columbia	38	2	2	0.0						2.6	7.9	89.5								
		Saskatchewan	29	2	4	0.0							3.4	86.2	10.3							
		Ontario	136	2	4	0.0							14.7	73.5	11.8							
		Québec	41	2	4	0.0						4.9	9.8	73.2	12.2							
		Maritimes	81	2	4	1.2							13.6	72.8	11.1	1.2			1.2			
	Streptomycin	British Columbia	38	≤ 32	64	18.4												81.6	10.5	7.9		
		Saskatchewan	29	≤ 32	> 64	17.2												82.8	6.9	10.3		
		Ontario	136	≤ 32	> 64	23.5												76.5	4.4	19.1		
		Québec	41	≤ 32	> 64	17.1												82.9		17.1		
		Maritimes	81	≤ 32	> 64	24.7												75.3	12.3	12.3		
	Trimethoprim-sulfamethoxazole	British Columbia	38	≤ 0.12	0.50	7.9				86.8	2.6	2.6				7.9						
		Saskatchewan	29	≤ 0.12	0.25	3.4				86.2	10.3					3.4						
		Ontario	136	≤ 0.12	0.25	7.4				84.6	8.1					7.4						
		Québec	41	≤ 0.12	1	9.8				80.5	4.9	2.4	2.4			9.8						
		Maritimes	81	≤ 0.12	0.25	7.4				76.5	14.8	1.2				7.4						
	Chloramphenicol	British Columbia	38	4	8	5.3								2.6	65.8	23.7	2.6	5.3				
		Saskatchewan	29	4	8	6.9								10.3	69.0	13.8		6.9				
		Ontario	136	4	8	7.4								5.1	55.9	29.4	2.2	4.4	2.9			
		Québec	41	4	16	2.4								14.6	41.5	29.3	12.2	2.4				
		Maritimes	81	8	8	4.9								3.7	38.3	49.4	3.7	3.7	1.2			
	Sulfisoxazole	British Columbia	38	≤ 16	> 256	21.1											73.7	5.3				21.1
		Saskatchewan	29	≤ 16	> 256	20.7											75.9		3.4			20.7
III		Ontario	136	≤ 16	> 256	20.6											75.0	4.4				20.6
		Québec	41	≤ 16	> 256	24.4											65.9	9.8				24.4
		Maritimes	81	≤ 16	> 256	23.5											65.4	7.4	3.7			23.5
	Tetracycline	British Columbia	38	≤ 4	> 32	34.2									65.8				34.2			
		Saskatchewan	29	≤ 4	> 32	34.5									65.5		3.4		31.0			
		Ontario	136	≤ 4	> 32	35.3									63.2	1.5	0.7	3.7	30.9			
		Québec	41	≤ 4	> 32	26.8									73.2			2.4	24.4			
		Maritimes	81	≤ 4	> 32	48.1									50.6	1.2	1.2	3.7	43.2			
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*, 2009.

	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	160	4	8	1.3							1.9	22.5	47.5	25.6	1.3	0.6	0.6			
	Ceftiofur	160	0.50	0.50	1.3				2.5	38.8	55.6	1.9			1.3						
	Ceftriaxone	160	≤ 0.25	≤ 0.25	1.3					98.8				0.6	0.6						
	Ciprofloxacin	160	≤ 0.015	≤ 0.015	0.0	98.1	1.9														
II	Amikacin	160	2	4	0.0							6.9	67.5	22.5	3.1						
	Ampicillin	160	4	> 32	33.1							6.9	39.4	19.4		1.3		33.1			
	Cefoxitin	160	4	4	1.3							1.3	28.1	63.1	3.8	2.5		1.3			
	Gentamicin	160	0.50	1	1.9					2.5	51.3	41.3	3.1			1.3	0.6				
	Kanamycin	160	≤ 8	> 64	11.3										88.1	0.6		0.6	10.6		
	Nalidixic acid	160	2	2	0.0							10.0	81.9	8.1							
	Streptomycin	160	≤ 32	> 64	46.9												53.1	13.8	33.1		
	Trimethoprim-sulfamethoxazole	160	≤ 0.12	> 4	11.9				62.5	17.5	5.0	1.9	1.3		11.9						
III	Chloramphenicol	160	8	32	22.5								3.8	42.5	27.5	3.8	15.0	7.5			
	Sulfisoxazole	160	> 256	> 256	50.6											42.5	6.9				50.6
	Tetracycline	160	> 32	> 32	76.9									21.9	1.3	0.6	5.6	70.6			
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*, 2009.

	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	2,057	4	8	1.2							4.2	28.3	39.4	26.0	0.9	1.1	0.0			
	Ceftiofur	2,057	0.25	0.50	0.1				5.8	56.0	36.5	1.4	0.1		0.1	0.0					
	Ceftriaxone	2,057	≤ 0.25	≤ 0.25	0.1					99.2	0.3	0.3	0.0		0.1						
	Ciprofloxacin	2,057	≤ 0.015	≤ 0.015	0.0	98.7	1.0	0.1		0.1					0.0						
II	Amikacin	2,057	2	4	0.0						0.2	13.6	65.4	19.1	1.4	0.2					
	Ampicillin	2,057	4	> 32	34.1							12.5	35.0	16.2	1.6	0.6	0.6	33.5			
	Cefoxitin	2,057	4	4	0.6						0.0	2.1	33.2	56.2	7.1	0.8	0.3	0.2			
	Gentamicin	2,057	0.50	1	0.9					5.4	60.1	32.0	1.3	0.0	0.1	0.6	0.3				
	Kanamycin	2,057	≤ 8	> 64	13.1										86.7	0.1	0.0	0.8	12.3		
	Nalidixic acid	2,057	2	4	0.2						0.7	12.1	76.8	10.1	0.1		0.1	0.0			
	Streptomycin	2,057	≤ 32	> 64	36.4												63.6	13.5	22.9		
	Trimethoprim-sulfamethoxazole	2,057	≤ 0.12	> 4	12.2				69.9	13.3	3.8	0.4	0.4	0.0	12.1						
III	Chloramphenicol	2,057	8	32	17.8								3.9	39.1	34.5	4.7	11.5	6.4			
	Sulfisoxazole	2,057	32	> 256	45.2											39.0	13.3	2.5	0.0		45.2
	Tetracycline	2,057	> 32	> 32	76.4									23.0	0.6	0.3	3.1	73.1			
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*, 2009.

	Antimicrobial	Species	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	512	1024	2048	> 2048
	Ciprofloxacin	*Enterococcus faecalis*	1,397	1	2	2.1					0.2	3.4	59.0	35.3	**1.6**	**0.6**								
	Ciprofloxacin	*Enterococcus faecium*	48	1	4	16.7						14.6	47.9	20.8	**12.5**	**4.2**								
	Ciprofloxacin	*Enterococcus* spp.	467	0.5	1	0.2				0.4	9.0	57.8	28.7	3.9	**0.2**									
	Daptomycin	*Enterococcus faecalis*	1,397	1	2	0.0						5.2	80.2	14.0	0.6									
	Daptomycin	*Enterococcus faecium*	48	2	4	0.0						8.3	8.3	43.8	37.5	2.1								
	Daptomycin	*Enterococcus* spp.	467	2	4	0.0						19.1	22.9	42.0	15.4	0.6								
	Linezolid	*Enterococcus faecalis*	1,397	1	2	0.0						0.7	57.6	41.6	0.1									
I	Linezolid	*Enterococcus faecium*	48	2	2	0.0							43.8	56.3										
	Linezolid	*Enterococcus* spp.	467	1	2	0.0						12.2	58.5	29.3										
	Tigecycline	*Enterococcus faecalis*	1,397	0.12	0.25	0.0		0.1	2.3	52.3	44.3	1.0												
	Tigecycline	*Enterococcus faecium*	48	0.12	0.25	0.0			18.8	52.1	27.1	2.1												
	Tigecycline	*Enterococcus* spp.	467	0.12	0.25	0.0	0.6	4.3	20.6	55.7	17.1	1.7												
	Vancomycin	*Enterococcus faecalis*	1,397	1	2	0.0						0.9	79.0	19.8	0.2									
	Vancomycin	*Enterococcus faecium*	48	≤ 0.5	2	0.0						75.0	14.6	10.4										
	Vancomycin	*Enterococcus* spp.	467	≤ 0.5	1	0.0						56.7	37.3	3.2	1.1	1.7								
	Erythromycin	*Enterococcus faecalis*	1,397	> 8	> 8	77.7						5.4	14.6	2.4		**0.1**	**77.6**							
	Erythromycin	*Enterococcus faecium*	48	2	> 8	22.9						37.5	10.4	25.0	4.2	**2.1**	**20.8**							
	Erythromycin	*Enterococcus* spp.	467	> 8	> 8	61.9						34.9	1.9	0.6	0.6	**0.4**	**61.5**							
	Gentamicin	*Enterococcus faecalis*	1,397	≤ 128	≤ 128	7.4													92.0	0.6	**1.6**	**2.7**	**3.1**	
	Gentamicin	*Enterococcus faecium*	48	≤ 128	≤ 128	0.0													100.0					
	Gentamicin	*Enterococcus* spp.	467	≤ 128	≤ 128	4.9													94.2	0.9	**1.3**	**1.3**	**2.4**	
	Kanamycin	*Enterococcus faecalis*	1,397	≤ 128	> 1024	29.3													69.2	1.3	0.1	**0.1**	**29.3**	
	Kanamycin	*Enterococcus faecium*	48	≤ 128	> 1024	12.5													62.5	18.8	6.3		**12.5**	
	Kanamycin	*Enterococcus* spp.	467	≤ 128	> 1024	15.6													83.7	0.6		**0.4**	**15.2**	
	Lincomycin[a]	*Enterococcus faecium*	48	> 8	> 8	89.6							6.3	4.2		**18.8**	**70.8**							
	Lincomycin	*Enterococcus* spp.	467	> 8	> 8	97.2							0.2	1.5	1.1	**0.6**	**96.6**							
II	Penicillin	*Enterococcus faecalis*	1,397	4	4	0.3						0.1	0.6	24.7	73.0	1.4	**0.2**	**0.1**						
	Penicillin	*Enterococcus faecium*	48	4	16	10.4						6.3	27.1	12.5	35.4	8.3	**8.3**	**2.1**						
	Penicillin	*Enterococcus* spp.	467	2	16	13.5						20.3	25.3	17.3	15.0	8.6	**8.1**	**5.4**						
	Quinupristin-dalfopristin[a]	*Enterococcus faecium*	48	2	4	14.6							35.4	50.0	**10.4**	**4.2**								
	Quinupristin-dalfopristin	*Enterococcus* spp.	467	4	8	57.8							11.1	31.0	**25.9**	**23.6**	**8.1**	**0.2**						
	Streptomycin	*Enterococcus faecalis*	1,397	≤ 512	> 2048	41.0															59.0	**1.2**	**1.8**	**38.0**
	Streptomycin	*Enterococcus faecium*	48	≤ 512	2048	18.8															81.3	**8.3**	**2.1**	**8.3**
	Streptomycin	*Enterococcus* spp.	467	≤ 512	> 2048	25.7															74.3	**3.6**	**8.8**	**13.3**
	Tylosin	*Enterococcus faecalis*	1,397	> 32	> 32	77.8							1.1	19.3	1.6	0.3		**0.1**	**77.7**					
	Tylosin	*Enterococcus faecium*	48	4	> 32	20.8							12.5	22.9	35.4	6.3	2.1		**20.8**					
	Tylosin	*Enterococcus* spp.	467	> 32	> 32	63.2					0.6	1.5	2.6	26.3	5.1	0.4	0.2	**0.6**	**62.5**					
	Chloramphenicol	*Enterococcus faecalis*	1,397	8	32	11.2								0.1	3.9	75.5	9.3	**2.8**	**8.4**					
	Chloramphenicol	*Enterococcus faecium*	48	4	8	0.0									52.1	47.9								
	Chloramphenicol	*Enterococcus* spp.	467	8	8	3.9								4.1	43.5	46.9	1.7	**3.0**	**0.9**					
	Nitrofurantoin	*Enterococcus faecalis*	1,397	8	16	1.3										71.7	21.1	4.7	1.2	**1.3**				
III	Nitrofurantoin	*Enterococcus faecium*	48	64	64	8.3										2.1	20.8	12.5	56.3	**8.3**				
	Nitrofurantoin	*Enterococcus* spp.	467	32	> 64	22.3									1.3	18.4	6.9	33.0	18.2	**22.3**				
	Tetracycline	*Enterococcus faecalis*	1,397	> 32	> 32	95.2									4.7	0.1	**0.5**	**1.8**	**92.9**					
	Tetracycline	*Enterococcus faecium*	48	≤ 4	> 32	33.3								66.7			**2.1**	**4.2**	**27.1**					
	Tetracycline	*Enterococcus* spp.	467	> 32	> 32	83.7									12.6	3.6	**3.6**	**7.5**	**72.6**					
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*, 2009.

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	60	≤ 1	> 32	26.7							70.0	3.3				6.7	20.0			
	Ceftiofur	60	1	> 8	26.7						21.7	51.7				26.7					
	Ceftriaxone	60	≤ 0.25	32	26.7					73.3					6.7	10.0	8.3	1.7			
	Ciprofloxacin	60	≤ 0.015	≤ 0.015	0.0	100.0															
II	Amikacin	60	2	2	0.0							35.0	63.3	1.7							
	Ampicillin	60	≤ 1	> 32	26.7							63.3	10.0					26.7			
	Cefoxitin	60	4	> 32	26.7							30.0	18.3	21.7	3.3		11.7	15.0			
	Gentamicin	60	0.50	8	8.3					16.7	66.7	3.3		1.7	3.3	1.7	6.7				
	Kanamycin	60	≤ 8	≤ 8	8.3										91.7				8.3		
	Nalidixic acid	60	2	4	0.0								65.0	33.3	1.7						
	Streptomycin	60	≤ 32	> 64	30.0												70.0	11.7	18.3		
	Trimethoprim-sulfamethoxazole	60	≤ 0.12	≤ 0.12	1.7				98.3						1.7						
III	Chloramphenicol	60	8	8	1.7									41.7	56.7			1.7			
	Sulfisoxazole	60	32	> 256	28.3											6.7	58.3	6.7			28.3
	Tetracycline	60	≤ 4	> 32	31.7									68.3				31.7			
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*, 2009.

	Antimicrobial	n	Percentiles MIC 50	Percentiles MIC 90	% R	Distribution (%) of MICs (µg/mL) ≤ 0.015	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	> 256
I	Amoxicillin-clavulanic acid	23	8	16	4.3							39.1		4.3	26.1	26.1		4.3			
	Ceftiofur	23	1	1	4.3						26.1	65.2		4.3		4.3					
	Ceftriaxone	23	≤ 0.25	≤ 0.25	8.7					91.3				4.3		4.3					
	Ciprofloxacin	23	≤ 0.015	0.25	0.0	56.5	8.7			34.8											
II	Amikacin	23	2	16	0.0							34.8	30.4		4.3	21.7	8.7				
	Ampicillin	23	> 32	> 32	60.9							34.8	4.3					60.9			
	Cefoxitin	23	2	4	4.3							34.8	39.1	21.7				4.3			
	Gentamicin	23	0.50	> 16	39.1					13.0	43.5	4.3					39.1				
	Kanamycin	23	≤ 8	> 64	39.1										60.9				39.1		
	Nalidixic acid	23	4	8	0.0								43.5	21.7	34.8						
	Streptomycin	23	≤ 32	64	34.8												65.2	26.1	8.7		
	Trimethoprim-sulfamethoxazole	23	≤ 0.12	> 4	39.1				60.9						39.1						
III	Chloramphenicol	23	8	> 32	30.4									43.5	26.1			30.4			
	Sulfisoxazole	23	> 256	> 256	52.2											8.7	30.4	8.7			52.2
	Tetracycline	23	≤ 4	> 32	34.8									60.9	4.3			4.3	30.4		
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*, 2009.

Age (year)	Number (%) of isolates	Province	Number (%) of isolates
Less than 5	303 (9)	British Columbia	466 (14)
5 to 12	263 (8)	Alberta	386 (11)
13 to 17	139 (4)	Saskatchewan	204 (6)
18 to 29	453 (13)	Manitoba	292 (9)
30 to 49	534 (16)	Ontario	1,225 (36)
50 to 69	467 (14)	Québec	562 (17)
70 and more	259 (8)	Nova Scotia	97 (3)
Not specified	976 (29)	New Brunswick	111 (3)
		Prince Edward Island	16 (< 1)
		Newfoundland and Labrador	35 (1)
Total	**3,394 (100)**		**3,394 (100)**

Table C.2. Distribution of isolates of primary human *Salmonella* serovars from humans, by source; *Surveillance of Human Clinical Isolates*, 2009.

Specimen source	Number (%) of isolates						
	Enteritidis	Heidelberg	Paratyphi A and B	Typhi	Typhimurium	Other serovars	Total
Stool	901 (83)	253 (66)	13 (24)	38 (24)	366 (88)	1,070 (83)	2,641 (78)
Blood	37 (3)	44 (12)	39 (72)	113 (71)	5 (1)	60 (5)	298 (9)
Urine	21 (2)	20 (5)		3 (2)	8 (2)	75 (6)	127 (4)
Abscess	1 (< 1)						1 (< 1)
Anatomy part	1 (< 1)				2 (<1)	4 (<1)	7 (< 1)
Other body fluid	3 (< 1)						3 (< 1)
Unknown	128 (12)	64 (17)	2 (4)	6 (4)	36 (9)	81 (6)	317 (9)
Total	**1,092 (100)**	**381 (100)**	**54 (100)**	**160 (100)**	**417 (100)**	**1,290 (100)**	**3,394 (100)**

Table C.3. Summary of antimicrobial susceptibility in the most common *Salmonella* serovars from humans and the agri-food sector; CIPARS, 2009.

Species	Most common serovars				
	Total (n)	Susceptible to all antimicrobials	1 to 4 antimicrobials in resistance pattern	5 to 8 antimicrobials in resistance pattern	9 to 15 antimicrobials in resistance pattern
Surveillance of Human Clinical Isolates					
	n = 3,394	**n = 2,532**	**n = 613**	**n = 241**	**n = 8**
	Enteritidis (1,092)	Enteritidis (948)	Enteritidis (139)	Typhimurium (92)	Newport (2)
	Typhimurium (417)	Typhimurium (278)	Typhi (100)	Heidelberg (50)	Typhimurium (2)
	Heidelberg (381)	Heidelberg (240)	Heidelberg (91)	Typhi (26)	Infantis (1)
Humans	I 4,[5],12:i:- (186)	Newport (130)	I 4,[5],12:i:- (63)	I 4,[5],12:i:- (24)	Kentucky (1)
	Typhi (160)	I 4,[5],12:i:- (99)	Typhimurium (45)	Enteritidis (5)	Stanley (1)
	Newport (136)	Saintpaul (61)	Hadar (42)	Kentucky (5)	Worthington (1)
	Saintpaul (68)	Javiana (53)	Paratyphi A and B (41)		
		Infantis (51)			
Retail Meat Surveillance					
	n = 473	**n = 231**	**n = 140**	**n = 102**	
	Heidelberg (153)	Enteritidis (94)	Kentucky (64)	Heidelberg (42)	
	Kentucky (123)	Heidelberg (68)	Heidelberg (43)	Kentucky (40)	
	Enteritidis (94)	Kentucky (19)	Hadar (16)	Infantis (3)	
Chicken	Hadar (27)	Hadar (9)	I 8,20:i:- (3)		
	Typhimurium (12)	Typhimurium (7)	Schwarzengrund (3)		
	Schwarzengrund (10)	Thompson (6)	Typhimurium (3)		
		Infantis (5)			
		Schwarzengrund (5)			
		Worthington (5)			
Abattoir Surveillance					
	n = 230	**n = 106**	**n = 71**	**n = 53**	
	Kentucky (95)	Enteritidis (43)	Kentucky (40)	Kentucky (39)	
	Heidelberg (50)	Heidelberg (23)	Heidelberg (18)	Heidelberg (9)	
Chickens	Enteritidis (44)	Kentucky (16)	Hadar (7)	Typhimurium (2)	
	Hadar (9)	Typhimurium (5)	I 8,20:-:z6 (2)		
	Typhimurium (8)	I 4,[5],12:i:- (3)			
		Thompson (3)			
	n = 147	**n = 72**	**n = 53**	**n = 22**	
	Typhimurium (31)	Infantis (11)	Derby (20)	Typhimurium (16)	
	Derby (26)	Brandenburg (8)	Typhimurium (9)	Krefeld (3)	
	Brandenburg (13)	Derby (6)	Brandenburg (5)	Anatum (1)	
	Infantis (11)	Typhimurium (6)	Worthington (5)	Mbandaka (1)	
	Worthington (8)	Enteritidis (4)	Hadar (3)	Ohio (1)	
	Schwarzengrund (5)	Schwarzengrund (4)	Mbandaka (2)		
Pigs	Anatum (4)	Give (3)			
	Enteritidis (4)	Havana (3)			
	Give (4)	Worthington (3)			
	Hadar (3)	Anatum (2)			
	Havana (3)	Bovismorbificans (2)			
	Krefeld (3)	Putten (2)			
	Mbandaka (3)				
Farm Surveillance					
	n =124	**n = 36**	**n = 65**	**n = 23**	
	Typhimurium (41)	Infantis (7)	Typhimurium (20)	Typhimurium (20)	
	Derby (25)	Derby (6)	Derby (18)	Derby (1)	
	Brandenburg (12)	Senftenberg (5)	Brandenburg (10)	I 4,[5],12:i:- (1)	
	Infantis (7)	I 4,12:-:e,n,z15 (3)	I 4,[5],12:i:- (4)		
Pigs	I 4,[5],12:i:- (5)	Brandenburg (2)	Schwarzengrund (3)		
	Senftenberg (5)	Bovismorbificans (1)	Bovismorbificans (2)		
	Schwarzengrund (4)	Schwarzengrund (1)			
	Bovismorbificans (3)	Typhimurium (1)			
	I 4,12:-:e,n,z15 (3)				

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, 2009.

Species	Most common serovars				
	Total (n)	Susceptible to all antimicrobials	1 to 4 antimicrobials in resistance pattern	5 to 8 antimicrobials in resistance pattern	9 to 15 antimicrobials in resistance pattern
Surveillance of Animal Clinical Isolates					
Cattle	**n = 131** Typhimurium (84) Heidelberg (7) I 6,14,18:-:- (5) Kentucky (4) Cerro (3) Dublin (3) Oranienburg (3)	**n = 49** Typhimurium (12) I 6,14,18:-:- (5) Heidelberg (4) Kentucky (4) Cerro (3) Oranienburg (3) Enteritidis(1) (2) Give (2) Montevideo (2) Senftenberg (2) Braenderup (1) Dublin (1) Enteritidis (1) Haardt (1) I 4,[5],12:i:- (1) I 6,7:-:e,n,z15 (1) Infantis (1) Thompson (1) Uganda (1)	**n = 25** Typhimurium (17) Heidelberg (3) Dublin (2) Muenchen (1) Schwarzengrund (1) Worthington (1)	**n = 55** Typhimurium (54)	**n = 2** Newport (1) Typhimurium (1)
Chickens	**n = 280** Enteritidis (127) Heidelberg (41) Kentucky (40) Typhimurium (16) I Rough:g,m:- (7) I 4,[5],12:i:- (6)	**n = 219** Enteritidis (126) Heidelberg (34) Typhimurium (12) I Rough:g,m:- (7) Kentucky (7)	**n = 35** Kentucky (25) Heidelberg (3) I 4,[5],12:i:- (2) I Rough:z10:e,n,x (2) I 8,20:-:z6 (1) Senftenberg (1) Worthington (1)	**n = 22** Kentucky (8) Derby (4) Typhimurium (4) Heidelberg (3) Agona (1) I 4,[5],12:i:- (1) Rissen (1)	**n = 4** Indiana (2) Enteritidis (1) Heidelberg (1)
Pigs	**n = 226** Typhimurium (98) Derby (27) Infantis (12) Brandenburg (8) Schwarzengrund (8) I 4,[5],12:i:- (7) Mbandaka (7) Worthington (6) Bovismorbificans (5)	**n = 56** Infantis (11) Typhimurium (9) Brandenburg (4) Derby (4) Mbandaka (3) Schwarzengrund (3) Worthington (3) California (2) Enteritidis (2) Give (2) Ohio var.14+ (2) Soerenga (2)	**n = 86** Derby (23) Typhimurium (22) Schwarzengrund (5) Bovismorbificans (3) Brandenburg (3) I 4,[5],12:-:- (3) Johannesburg (3) Mbandaka (3) Worthington (3) I 6,8:r:- (2)	**n = 75** Typhimurium (64) I 4,[5],12:i:- (5) Krefeld (2)	**n = 9** Typhimurium (3) Bovismorbificans (2) Ohio (2) Brandenburg (1) Putten (1)
Turkeys	**n = 60** Schwarzengrund (30) Heidelberg (4) Senftenberg (4) Hadar (3) Worthington (3) Agona (2) Give (2) I 4,[5],12:-:- (2) Ouakam (2)	**n = 31** Schwarzengrund (26) Give (2) Kiambu (1) Senftenberg (1) Tennessee (1)	**n = 13** Schwarzengrund (3) Worthington (3) Ouakam (2) Hadar (1) I 19:-:- (1) Johannesburg (1) Mbandaka (1) Senftenberg (1)	**n = 13** Heidelberg (3) Hadar (2) I 4,[5],12:-:- (2) Senftenberg (2) Agona (1) Anatum (1) Kentucky (1) Schwarzengrund (1)	**n = 3** Agona (1) Bredeney (1) Heidelberg (1)
Horses	**n = 23** Heidelberg (9) Hadar (5) Thompson (2) Typhimurium (2) Daytona (1) Mbandaka (1) Newport (1) Oranienburg (1) Orion var.15+ (1)	**n = 6** Thompson (2) Daytona (1) Newport (1) Oranienburg (1) Typhimurium (1)	**n = 7** Hadar (5) Mbandaka (1) Orion var.15+ (1)	**n = 9** Heidelberg (8) Typhimurium (1)	**n = 1** Heidelberg (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.4. Summary of selected resistance patterns involving multiple antimicrobials in bacterial isolates from humans and the agri-food sector; CIPARS, 2009.

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 = 1,092)	948/1,092 (87%) 948/3,394 (28%)			1/1,092 (< 1%) 1/3,394 (< 1%)				
	Salmonella Heidelberg (n = 381)	240/381 (63%) 240/3,394 (7%)	46/381 (12%) 46/3,394 (1%)		1/381 (< 1%) 1/3,394 (< 1%)				
	Salmonella Paratyphi A and B (n = 54)	12/54 (22%) 12/3,394 (< 1%)		1/54 (2%) 1/3,394 (< 1%)					
	Salmonella Typhi (n = 160)	34/160 (21%) 34/3,394 (1%)	1/160 (< 1%) 1/3,394 (< 1%)	8/160 (5%) 8/3,394 (< 1%)					
	Salmonella Typhimurium (n = 417)	278/417 (67%) 278/3,394 (8%)	5/417 (1%) 5/3,394 (< 1%)	68/417 (16%) 68/3,394 (2%)	4/417 (< 1%) 4/3,394 (< 1%)	13/417 (3%) 13/3,394 (< 1%)	2/417 (< 1%) 2/3,394 (< 1%)		
	Other serovars (n = 1,290)	1,020/1,290 (79%) 1,020/3,394 (30%)	31/1,290 (2%) 31/3,394 (< 1%)	9/1,290 (< 1%) 9/3,394 (< 1%)	1/1,290 (< 1%) 1/3,394 (< 1%)	3/1,290 (< 1%) 3/3,394 (< 1%)	4/1,290 (< 1%) 4/3,394 (< 1%)		1/1,290 (< 1%) 1/3,394 (< 1%)
Retail Meat Surveillance									
Beef	*Escherichia coli* (n = 652)	528/652 (81%)	3/652 (< 1%)	1/652 (< 1%)	4/652 (< 1%)	1/652 (< 1%)	2/652 (< 1%)		
Chicken	*Salmonella* Enteritidis (n = 94)	94/94 (100%) 94/473 (20%)							
	Salmonella Heidelberg (n = 153)	68/153 (44%) 68/473 (14%)	41/153 (27%) 41/473 (9%)						
	Salmonella Typhimurium (n = 12)	7/12 (58%) 7/473 (1%)	1/12 (8%) 1/473 (< 1%)	1/12 (8%) 1/473 (< 1%)					
	Other serovars (n = 214)	62/214 (29%) 62/473 (13%)	37/214 (17%) 37/473 (8%)						
	Escherichia coli (n = 626)	162/626 (26%)	130/626 (21%)	1/626 (< 1%)	11/626 (2%)		17/626 (3%)	4/626 (< 1%)	4/626 (< 1%)
Pork	*Escherichia coli* (n = 325)	186/325 (57%)	1/325 (< 1%)	9/325 (3%)	3/325 (< 1%)	2/325 (< 1%)			
Abattoir Surveillance									
Beef cattle	*Escherichia coli* (n = 119)	76/119 (64%)							
Chickens	*Salmonella* Enteritidis (n = 44)	43/44 (98%) 43/230 (19%)							
	Salmonella Heidelberg (n = 50)	23/50 (46%) 23/230 (10%)	9/50 (18%) 9/230 (4%)						
	Salmonella Typhimurium (n = 8)	5/8 (63%) 5/230 (2%)	1/8 (13%) 1/230 (< 1%)	1/8 (13%) 1/230 (< 1%)					
	Other serovars (n = 128)	35/230 (15%)	26/230 (11%)						
	Escherichia coli (n = 171)	47/171 (27%)	35/171 (20%)	1/171 (< 1%)	3/171 (2%)		11/171 (6%)	1/171 (< 1%)	1/171 (< 1%)
Pigs	*Salmonella* Enteritidis (n = 4)	4/4 (100%) 4/147 (3%)							
	Salmonella Typhimurium (n = 31)	6/31 (19%) 6/147 (4%)		7/31 (23%) 7/147 (5%)		9/31 (29%) 9/147 (6%)			
	Other serovars (n = 112)	62/112 (55%) 62/147 (42%)			1/112 (< 1%) 1/147 (< 1%)	3/112 (3%) 3/147 (2%)			
	Escherichia coli (n = 160)	22/160 (14%)		9/160 (6%)	1/160 (< 1%)		2/160 (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, 2009.

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%) 1/124 (< 1%)							
	Salmonella Heidelberg (n = 1)	1/1 (100%) 1/124 (< 1%)							
	Salmonella Typhimurium (n = 41)	1/41 (2%) 1/124 (< 1%)		5/41 (12%) 5/124 (4%)	2/41 (5%) 2/124 (2%)	9/41 (22%) 9/124 (7%)			
	Other serovars (n = 81)	33/81 (41%) 33/124 (27%)			1/81 (1%) 1/124 (< 1%)	1/81 (1%) 1/124 (< 1%)			
	Escherichia coli (n = 2,057)	336/2,057 (16%)		59/2,057 (3%)	33/2,057 (2%)	13/2,057 (< 1%)			
Surveillance of Animal Clinical Isolates									
Cattle	*Salmonella* Enteritidis (n = 4)	4/4 (100%) 4/131 (3%)							
	Salmonella Heidelberg (n = 7)	4/7 (57%) 4/131 (3%)							
	Salmonella Typhimurium (n = 84)	12/84 (14%) 12/131 (9%)	7/84 (8%) 7/131 (5%)	13/84 (15%) 13/131 (10%)	13/84 (15%) 13/131 (10%)	20/84 (24%) 20/131 (15%)	1/84 (1%) 1/131 (< 1%)		
	Other serovars (n = 36)	29/36 (81%) 29/131 (22%)	1/36 (3%) 1/131 (< 1%)						1/36 (3%) 1/131 (< 1%)
Chickens	*Salmonella* Enteritidis (n = 144)	143/144 (99%) 143/280 (51%)		1/144 (< 1%) 1/280 (< 1%)					
	Salmonella Heidelberg (n = 41)	34/41 (83%) 34/280 (12%)	3/41 (7%) 3/280 (1%)	1/41 (2%) 1/280 (< 1%)					
	Salmonella Typhimurium (n = 16)	12/16 (75%) 12/280 (4%)	1/16 (6%) 1/280 (< 1%)	3/16 (19%) 3/280 (1%)					
	Other serovars (n = 79)	30/79 (38%) 30/280 (11%)	15/79 (19%) 15/280 (5%)				2/79 (3%) 2/280 (< 1%)		
Pigs	*Salmonella* Enteritidis (n = 2)	2/2 (100%) 2/226 (< 1%)							
	Salmonella Heidelberg (n = 1)								
	Salmonella Typhimurium (n = 98)	9/98 (9%) 9/226 (4%)	3/98 (3%) 3/226 (1%)	26/98 (27%) 26/226 (12%)	7/98 (7%) 7/226 (3%)	25/98 (26%) 25/226 (11%)			
	Other serovars (n = 125)	45/125 (36%) 45/226 (20%)	1/125 (< 1%) 1/226 (< 1%)	3/125 (2%) 3/226 (1%)	1/125 (< 1%) 1/226 (< 1%)	7/125 (6%) 7/226 (3%)			4/125 (3%) 4/226 (2%)
Turkeys	*Salmonella* Heidelberg (n = 4)		3/4 (75%) 3/60 (5%)					1/4 (25%) 1/60 (2%)	
	Other serovars (n = 56)	31/56 (55%) 31/60 (52%)	11/56 (20%) 11/60 (18%)				1/56 (2%) 1/60 (2%)		
Horses	*Salmonella* Heidelberg (n = 9)		1/9 (11%) 1/23 (4%)						
	Salmonella Typhimurium (n = 2)	1/2 (50%) 1/23 (4%)		1/2 (50%) 1/23 (4%)					
	Other serovars (n = 12)	5/12 (42%) 5/23 (22%)							

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, 2002–2009.

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						
	Saskatchewan	2005	**79%**	120/151						
		2006	**76%**	123/161						
		2007	**78%**	118/151						
		2008	**76%**	134/177						
		2009	**83%**	135/163						
	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						
	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						
	Maritimes	2004	**67%**	16/24						
		2007	**52%**	16/31						
		2008	**70%**	39/56						
		2009	**69%**	137/200						
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
	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
	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
	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
	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		

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 are not presented because information on the number of samples undergoing bacterial culture 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, 2002–2009.

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				
	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				
	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				
	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				
	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				
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		
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				
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				
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

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 are not presented because information on the number of samples undergoing bacterial culture 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.

Table C.6. Distribution of *Salmonella* isolates across provinces; *Surveillance of Animal Clinical Isolates*, 2009.

Species	British Columbia	Alberta	Manitoba	Ontario	Québec	Nova Scotia	Prince Edward Island	Newfoundland and Labrador
	Number (%) of isolates							
Cattle (n = 131)	17 (13)	28 (21)	12 (9)	38 (29)	27 (21)		2 (2)	7 (5)
Chickens (n = 280)	55 (20)	31 (11)	73 (26)	83 (30)	38 (14)			
Pigs (n = 226)	9 (4)		40 (18)	61 (27)	106 (47)	6 (3)	4 (2)	
Turkeys (n = 60)	10 (17)		34 (57)	11 (18)	5 (8)			
Horses (n = 23)	4 (17)	2 (9)	2 (9)	14 (61)	1 (4)			

No *Salmonella* isolates from animal clinical submissions were received from Saskatchewan and New Brunswick.

Antimicrobial Use

Humans

Table C.7. Quantity of active ingredients of oral antimicrobials dispensed by Canadian retail pharmacies, 2000–2009.

	Antimicrobial	ATC Class	Total active ingredients (kg)									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
I	Amoxicillin and enzyme inhibitor	Combinations of penicillins, including β-lactamase inhibitors	7,148.28	7,295.71	7,114.06	7,492.67	7,491.56	8,414.31	7,327.38	8,021.73	8,693.64	9,226.06
I	Cefixime	Third-generation cephalosporins (J01DD)	441.47	412.56	372.50	321.45	275.37	282.37	274.85	303.43	322.03	341.62
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	19,887.45
I	Vancomycin	Glycopeptides (J01XA)	25.90	28.25	32.23	40.56	70.36	79.17	75.77	83.99	83.73	92.64
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	6,029.97
I	Linezolid	Linezolid (J01XX)	NPD	1.55	4.91	10.82	17.29	23.26	22.44	25.34	26.11	31.40
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	53,534.52	53,445.93	54,514.38	56,323.55
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	14,201.96	13,987.12	14,106.88	13,770.75
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	5,159.24	4,777.53	4,358.02
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	24,305.64
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	7,129.01
II	Sulfamethoxazole and trimethoprim, sulfadiazine and trimethoprim	Combinations of sulfonamides and trimethoprim, including derivatives (J01EE)	26,196.41	23,815.65	21,549.97	20,179.30	19,226.17	18,858.59	15,433.23	15,085.01	15,137.72	15,065.30
II	Azithromycin, clarithromycin, erythromycin	Macrolides (J01FA)	25,163.98	23,844.04	21,665.44	22,138.28	21,168.11	22,746.49	22,653.74	22,523.94	22,791.17	22,912.47
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	5,746.53
II	Tobramycin	Aminoglycosides (J01GB)	29.66	0.36	0.04	< 0.01	0.01	NPD	15.03	20.21	20.16	22.91
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
II	Erythromycin-sulfisoxazole	Sulfonamide combinations, excluding trimethoprim (J01RA)	2,745.17	1,910.05	1,251.28	843.14	548.87	494.05	104.71	76.33	25.67	0.02
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

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, 2000–2009.

	Antimicrobial	ATC Class	Total active ingredients (kg)									
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	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	9,305.23
	Chloramphenicol	Amphenicols (J01BA)	0.78	0.99	0.20	NPD	0.06	0.01	NPD	NPD	NPD	NPD
	Trimethoprim	Trimethoprim and derivatives (J01EA)	315.71	297.29	310.34	307.34	288.32	265.98	265.88	261.01	242.58	247.57
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
	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
	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	1,622.82
	Fosfomycin	Fosfomycin (J01XX)	64.76	74.26	48.00	35.71	26.28	20.78	17.78	11.00	1.97	5.04
NC	Methenamine	Methenamine (J01XX)	389.51	356.69	350.35	296.88	282.20	253.34	249.14	261.99	163.43	210.98
		Total (J01)	**207,280.44**	**203,691.77**	**194,522.04**	**194,923.13**	**189,674.87**	**194,167.12**	**192,238.56**	**191,848.71**	**194,428.77**	**196,649.29**

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. NC = Not classified. NPD = No prescriptions dispensed.

Demographics and Health

Humans

Table C.8. Population demographics in Canada, 2008 and 2009.

Province / territory	Post-census population estimates 2008[a]	Post-census population estimates 2009[a]	Percentage change in 2009[c]	Population density/km^2 (2009)[b]
British Columbia	4,384,000	4,459,900	1.73	4.82
Alberta	3,591,800	3,671,700	2.22	5.72
Saskatchewan	1,013,900	1,029,300	1.52	1.74
Manitoba	1,205,500	1,219,200	1.14	2.20
Ontario	12,934,500	13,072,700	1.07	14.24
Québec	7,750,700	7,826,900	0.98	5.73
New Brunswick	747,000	750,000	0.40	10.50
Nova Scotia	937,200	940,300	0.33	17.63
Prince Edward Island	139,600	141,200	1.15	24.95
Newfoundland and Labrador	506,400	508,900	0.49	1.36
Yukon	33,100	33,700	1.81	0.07
Northwest Territories	43,700	43,600	-0.23	0.04
Nunavut	31,600	32,200	1.90	0.02
Canada	**33,319,100**	**33,729,700**	**1.23**	**3.71**

NA = Not available.
Some statistics from the 2008 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 April 2012.
[b] Population density per square kilometre in 2009 was calculated on the basis of the population in 2009 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 April 2012.
[c] Percentage change was calculated as ([2009 value - 2008 value] / 2008 value) X 100.

Agri-Food

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, 2008	Number of animals Jan. 1, 2009	Percentage change in 2009[a]	Product produced in 2009[b] (metric tonnes) Jan. 1, 2009	Per-capita consumption in 2009[c,d]
Cattle	**109,901[e]**	**13,870,000[f]**	**13,195,000[f]**	**-4.87**	**1,216,830[f]**	**Beef = 28.60 kg**
Beef cows	83,000	4,981,900	4,649,500	-6.67	Calves = 35,100	Veal = 1.05 kg
Dairy cows	17,515	984,300	978,500	-0.59		Fluid milk = 81.28 L
Heifers (≥ 1 year old)	72,929					Cream = 8.40 L
Heifers for beef replacement	45,407	595,000	537,000	-9.75		Cheese = 12.22 kg
Heifers for dairy replacement	16,585	471,100	450,600	-4.35		
Heifers for slaughter or feeding	23,998	982,900	834,500	-15.10		
Steers (≥ 1 year old)	36,695	1,101,600	1,067,600	-3.09		
Calves (< 1 year old)	98,107	4,506,400	4,433,400	-1.62		
Bulls (≥ 1 year old)	71,958	246,800	243,900	-1.18		
Swine	**11,497[g]**	**13,810,000[h]**	**12,180,000[h]**	**-11.80**	**1,945,200[h]**	**Pork = 23.36 kg**
Sows and bred gilts	5,831	1,482,500	1,371,200	-7.51		
Boars	5,133	29,700	23,800	-19.87		
Nursing and weaner pigs	5,560					
Grower and finisher pigs	8,937					
Pigs < 20 kg		4,471,900	3,688,600	-17.52		
Pigs 20–60 kg		3,962,000	3,618,800	-8.66		
Pigs > 60 kg		3,863,900	3,477,600	-10.00		

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 ([2009 value – 2008 value] / 2008 value) X 100.

[b] Total cold dressed weight, not including edible offal.

[c] Statistics Canada. Food Statistics 2009. Cat. No. 21-020-XIE. Available at www.statcan.gc.ca/pub/21-020-x/21-020-x2009001-eng.pdf. Accessed November 2011.

[d] Food available for consumption (eviscerated).

[e] 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 March 2012.

[f] 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 March 2012.

[g] 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 March 2012.

[h] Statistics Canada. Hog Statistics – Second quarter 2010. Cat. No. 23-010-X, Vol. 9, No. 3. Available at www.statcan.gc.ca/pub/23-010-x/23-010-x2010003-eng.pdf. Accessed March 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, 2008	Number of animals Jan. 1, 2009	Percentage change in 2009[a]	Product produced in 2009[b] (metric tonnes) Jan. 1, 2009	Per-capita consumption in 2009[c,d]
Poultry		**663,690,000[i]**	**658,683,000[i]**	**-0.75**	**1,202,557[i]**	**Poultry = 37.66 kg** **Eggs = 10.92 kg**
Hens and chickens	22,712[j]	640,833,000	637,035,000	-0.59	Chicken = 1,036,054	Chicken = 31.34 kg
Broilers, roasters, and cornish hens	8,831					Stewing hens = 1.77 kg
Turkeys	3,174	22,857,000	21,648,000	-5.29	Turkey = 166,503	Turkey = 4.55 kg
Sheep	**11,031[k]**	**825,300[l]**	**808,200[l]**	**-2.07**	**16,360[l]**	**Lamb and mutton = 1.17 kg**
Ewes	10,309	532,500	522,100	-1.95		
Rams	8,175	24,200	23,800	-1.65		
Lambs	9,117					
Replacement lambs		81,800	77,900	-4.77		
Market lambs		186,800	184,400	-1.28		
Fish					**140,804[m]**	**Fish = 5.43 kg**
Finfish					Salmon = 100,209 Trout = 7,014 Other finfish = 1,216	Fresh and frozen sea fish = 2.18 kg Fresh water fish = 0.33 kg Processed sea fish = 2.12 kg
Shellfish					Clams = 1,869 Oysters = 8,766 Mussels = 20,924 Scallops = 388 Other shellfish = 418	Shellfish = 0.79 kg

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 ([2009 value – 2008 value] / 2008 value) X 100.

[b] Total cold dressed weight, not including edible offal.

[c] Statistics Canada. Food Statistics 2009. Cat. No. 21-020-XIE. Available at www.statcan.gc.ca/pub/21-020-x/21-020-x2009001-eng.pdf. Accessed March 2012.

[d] Food available for consumption (eviscerated).

[i] Statistics Canada. Poultry and Egg Statistics January to March 2011. Cat. No. 23-015-X, Vol. 8, No. 1. Available at: www.statcan.gc.ca/pub/23-015-x/23-015-x2011001-eng.pdf. Accessed March 2012.

[j] 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 March 2012.

[k] 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 March 2012.

[l] 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 March 2012.

[m] 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 March 2012. Aquaculture product produced in 2009 was calculated by using Total finfish and Total shellfish values.

Table C.10. Number of births, slaughters, international imports and exports, and farm deaths for Canadian cattle, pigs, and sheep.

Variable	Cattle[a]	Swine[b]	Sheep[c]
Births	4,958,000	31,903,300	828,700
Slaughters[d]	3,705,200	21,806,500	740,600
Percentage change in slaughters in 2009[e]	-3.74	0.46	0.19
International imports	54,200	3,300	33,600
Percentage change in imports in 2009[e]	9.94	26.92	-14.29
International exports	1,066,600	6,375,800	0
Percentage change in exports in 2009[e]	-33.25	-31.86	0.00
Deaths and condemnations	530,400	1,463,400	124,400
Percentage change in deaths and condemnations in 2009[e]	-12.33	-11.50	0.08

Some statistics from the 2008 CIPARS report are slightly different than those reported here. These changes were made to reflect updates in the 2011 Cattle and Hog Statistics reports.

[a] 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 November 2011. The number of births are not true aggregate as 2 inventories (January to June and July to December) were added up to make an annual total.

[b] Statistics Canada. Hog Statistics – Third quarter 2011. Cat. No. 23-010-X, Vol. 10, No. 4. Available at www.statcan.gc.ca/pub/23-010-x/23-010-x2011004-eng.pdf. Accessed November 2011.

[c] Statistics Canada. Sheep Statistics 2011. Cat. No. 23-011-X, Vol. 10, No. 2. Available at www.statcan.gc.ca/pub/23-010-x/23-010-x2011004-eng.pdf. Accessed November 2011.

[d] For swine data: represents slaughter but may include pigs destined for export (varies by province).

[e] Percentage change was calculated as ([2009 value – 2008 value]/2008 value) X 100.

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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