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Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)

ANTIMICROBIAL RESISTANCE SHORT REPORT

2010

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

Canada

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Public Health Agency of Canada

Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2010 – Antimicrobial Resistance Short Report

Également disponible en français sous le titre :

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

For further information or to provide comments please send an email to:

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Suggested Citation

Government of Canada. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) 2010 Short Report. Guelph, Ontario: Public Health Agency of Canada, 2012.

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 2010

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

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We gratefully acknowledge the provincial reference laboratories for their longstanding support and for providing data and bacterial isolates for CIPARS.

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- Saskatchewan Laboratory and Disease Control Services (Greg Horsman)
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- Newfoundland Public Health Laboratory (Lourens Robberts)

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, Carol McClure, Matthew Saab, and Cynthia Mitchell)
- Prince Edward Island Food Technology Centre
- Centre for Coastal Health

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

Abattoir-Industry Participants

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

Farm Surveillance Participants

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

Provincial Animal Health Laboratories

- Animal Health Centre, British Columbia Ministry of Agriculture and Lands (Sean Byrne)
- Government of Alberta, Agriculture and Rural Development (Rashed Cassis)
- Saskatchewan Health, Saskatchewan (Paul Levett)
- Veterinary Services Branch Laboratory, Manitoba (Neil Pople)
- The Animal Health Laboratory, University of Guelph, Ontario (Durda Slavic)
- Vita-Tech Canada Inc., Ontario (Hani Dick)
- Direction des laboratoires d'expertises du Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (Marie Nadeau)
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- Veterinary Pathology Laboratory, Nova Scotia (Lyn Ferns)
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Other Participants

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

We are grateful to the US 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 2010.

Public Health Agency of Canada

Ashleigh Andrysiak
Louise Bellai
Mark Blenkinsop
Manon Caron
Gail Christie
Sindy Cleary
Ann-Marie Cochrane
Linda Cole
Denise Coleman
Marie-Claude Deshaies
Claudia Dulgheru
Chris Frost
Meghan Fuzzen
Georges Golding
Stefan Iwasawa
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Canadian Pork Council
CIPARS Farm Swine Advisory Committee

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Preamble

About CIPARS

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) is pleased to present this short report on the prevalence and trends in antimicrobial resistance in selected bacterial organisms isolated from humans and the agri-food sector for the 2010 calendar year.[1] The CIPARS short reports will replace preliminary reports, as the short reports will now contain final data rather than preliminary, unless otherwise specified.

CIPARS Objectives

- Provide a unified approach to monitor trends in antimicrobial resistance and antimicrobial use in humans and animals.
- Disseminate timely surveillance data.
- 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.

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 development of antimicrobial resistance in *Salmonella* isolated from humans at the provincial/territorial level. This component was established in 2002.

Hospital-based or 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* cultures to the Provincial Public Health Laboratories (PPHLs) is voluntary and passive. A high proportion (84% in 2001)[2] of *Salmonella* isolates are forwarded to the PPHLs, but this proportion may vary among laboratories.

To ensure a statistically valid sampling plan, all human *Salmonella* isolates (outbreak-associated and non-outbreak-associated) received by the PPHLs in Saskatchewan, Manitoba, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador were forwarded to the National Microbiology Laboratory. 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 PPHLs forwarded all human isolates of *S*. Typhi to the National Microbiology Laboratory due to the organism's clinical importance. The Yukon, Northwest Territories, and Nunavut, which do not have a PPHL counterpart, forwarded their isolates to one of the existing PPHLs. For this reason, data for the 3 territories are included in the overall number of isolates from the PPHL to which the isolates were submitted, unless the Territory was specified.

As of 2010, the antimicrobial susceptibility testing protocol of the human clinical isolates was modified and now includes testing for 7 specific *Salmonella* serovars: Heidelberg, Enteritidis, Typhimurium, I 4,[5],12:i:-, Paratyphi A, Paratyphi B, and Typhi. For the more populated provinces (British Columbia, Alberta, Ontario and Québec) only half of the Enteritidis isolates submitted during the first 15 days of the month were

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[1] Any additional isolates received after completion of this short report and included in the 2010 Annual report will be highlighted.
[2] Report of the 2001 Canadian Laboratory Study, National Studies on Acute Gastrointestinal Illness, Division of Enteric, Foodborne and Waterborne Diseases, 2002.

tested because of the high number of isolates submitted by their PPHLs. All other *Salmonella* serovars were stored and will be available for testing in the event of any future public health concerns.

Retail Meat Surveillance **(beef, chicken, and pork)**

The objectives of the CIPARS *Retail Meat Surveillance* component are to provide data on antimicrobial resistance and to monitor temporal variations in resistance among selected bacteria found in raw meat at the provincial/region level. *Retail Meat Surveillance* began in 2003 in Ontario and Québec, followed by establishment of routine retail sampling activities in other provinces as resources became available (Saskatchewan in 2005, British Columbia in 2007, and the Maritimes region [New Brunswick, Nova Scotia, and Prince Edward Island] in 2008). Retail food represents a logical sampling point for surveillance of antimicrobial resistance because it is the endpoint of food animal production, and thus is indicative of human exposure. Retail surveillance provides a measure of human exposure to antimicrobial-resistant bacteria through consumption of meat products from selected commodities. The scope of the surveillance framework can be modified (e.g. food commodities, bacteria, or geographic region) as necessary and functions as a research platform for investigation of specific questions regarding antimicrobial resistance in the agri-food sector.

The commodities of interest for this component were raw meat products most commonly consumed by Canadians. These commodities and the products sampled included poultry (chicken legs or wings [skin on]), pork (chops), and beef (ground beef).The unit of analysis in *Retail Meat Surveillance* was bacterial isolate recovered from raw meat. Bacteria of interest in chicken were *Campylobacter*, *Salmonella*, and generic *Escherichia coli*. As of January 1, 2010, no attempt has been made to isolate *Enterococcus* from retail-level chicken samples as no vancomycin-resistant enterococci, which are strains of particular public health concern, have been detected in retail isolates since CIPARS began. From beef and pork, 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 phases of the program. *Salmonella* was isolated from pork, primarily to provide recovery estimates for this commodity for other Public Health Agency of Canada programs. These *Salmonella* strains were also submitted for antimicrobial susceptibility testing; however, given the low numbers recovered annually, results are not presented on an annual basis. Instead, those results have been pooled and are presented over a multi-year period in the interest of precision.

The sampling protocol 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/region. In 2010, retail meat samples were collected weekly in Ontario and Québec and bi-weekly in British Columbia, Saskatchewan, and the Maritimes region. Prevalence estimates were used to determine the number of samples to be collected, which was based on an expected yield of 100 isolates per commodity per province/region per year plus 20% to account for lost or damaged samples. Because sampling was less frequent in British Columbia, Saskatchewan, and the Maritimes region relative to sampling in Ontario and Québec, the target of 100 isolates per year may not have always been achieved in those provinces/region.

Abattoir Surveillance **(beef cattle, chickens, and pigs)**

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 supply and to monitor temporal variations in the prevalence of antimicrobial resistance in these bacteria. *Abattoir Surveillance* includes only animals that originated from premises within Canada.

For this component, the unit of analysis was the bacterial isolate, each of which was cultured from the caecal contents (not carcasses) of slaughtered food animals. Caecal contents were used to avoid misinterpretation related to cross-contamination and to better reflect antimicrobial resistance in bacteria that originated from the farm. Established in September 2002, this component initially targeted generic *Escherichia coli* and *Salmonella* from 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 to include a human pathogen in beef cattle surveillance and, following the approval of a fluoroquinolone for use in cattle, to provide information on fluoroquinolone resistance. *Campylobacter* surveillance was initiated in broiler chicken in 2010 out of concern about fluoroquinolone and ceftiofur resistance in isolates previously recovered from chicken through CIPARS *Retail Meat Surveillance*. The sampling method was designed with the goal that, across Canada, 100 isolates of *Campylobacter* and 150 isolates each of *Salmonella* and *E. coli* would be recovered from each animal species over a 12-month period to avoid any potential seasonal bias in bacteria prevalence and antimicrobial susceptibility.

Over 90% of all food-producing animals in Canada are slaughtered in federally inspected abattoirs annually. Forty federally inspected slaughter plants (5 beef cattle plants, 23 poultry plants, and 12 swine plants) from across Canada participated in 2010.

Farm Surveillance **(pigs)**

The objectives of the CIPARS *Farm Surveillance* component are to provide data on antimicrobial use and resistance, monitor temporal variations in the development of antimicrobial resistance, investigate associations between antimicrobial use and resistance in isolates from swine farms, and provide data for human-health risk assessments.

This initiative is based on a sentinel farm framework that provides herd-level data on antimicrobial use and pooled fecal samples collected from pens of grower-finisher pigs for bacterial isolation and antimicrobial susceptibility testing. For this component, the unit of analysis for the antimicrobial resistance data was the bacterial isolate. These data were adjusted for clustering at the herd-level. The bacteria of interest were *Salmonella*, generic *Escherichia coli*, and *Enterococcus*.

In 2006, the CIPARS *Farm Surveillance* component was implemented in swine herds across 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 surveillance infrastructure because the Canadian Quality Assurance (CQA®) program had been extensively implemented by the industry, there had not been a recent outbreak of foreign animal disease in pigs, and there was a similar initiative in swine in the United States (Collaboration in Animal Health and Food Safety Epidemiology).

In 2010, 22 swine veterinarians enrolled 91 client producers with CQA® validated operations that produced more than 2,000 market pigs per year, and were representative of the demographic and geographic distribution of herds in the veterinarian’s swine practice. Criteria for exclusion were as follow: herds regarded as organically raised, herds in which edible residual material was fed, or herds that were raised on pasture. These criteria helped ensure that the herds enrolled were representative of the majority of swine operations in Canada. In each of the participating provinces, the number of CIPARS sentinel sites was proportional to the national total of grower-finisher units. An exception was Alberta, where additional herds were enrolled with provincial support.

Surveillance of Animal Clinical Isolates **(cattle, chickens, pigs, turkeys, and horses)**

The objective of the CIPARS *Surveillance of Animal Clinical Isolates* component is to detect new and/or emerging antimicrobial resistance patterns or new serovar/resistance pattern combinations in *Salmonella*. This component of CIPARS is based on submissions from veterinarians and/or producers to veterinary diagnostic laboratories. Sample collection and submission practices, as well as *Salmonella* isolation protocols, vary among laboratories.

Salmonella isolates were sent by private veterinary and provincial animal health laboratories from across the country to the *Salmonella* Typing Laboratory at the Laboratory for Foodborne Zoonoses (LFZ), Guelph, Ontario. An exception was Québec, where isolates from animal health laboratories were sent to the Direction des laboratoires d’expertises du Ministère de l’Agriculture, des Pêcheries et de l’Alimentation du Québec, Saint-Hyacinthe for serotyping. Isolates and serotyping results from Québec were then forwarded to the LFZ to undergo phage typing and antimicrobial resistance testing.

Unlike the *Surveillance of Human Clinical Isolates* component, the proportion of *Salmonella* isolates forwarded to the LFZ from private and provincial animal health laboratories was not determined by a national sampling scheme and therefore varied within and between provinces. As well, isolates were not solely of clinical origin; some may also have been collected from animal feed, the animal's environment, or non-diseased animals from the same herd. The results for cattle, chickens, pigs, turkeys, and horses are reported in this report. Cattle isolates could have originated from dairy cattle, milk-fed or grain-fed veal, or beef cattle. Chicken isolates were largely from layer hens and broiler chickens, but may have originated from primary layer breeders or broiler breeder birds as well.

Feed and Feed Ingredients

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

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

What's New in the 2010 Report

Changes to CIPARS Antimicrobial Resistance Surveillance Component

- The antimicrobial susceptibility testing protocol of the human clinical isolates was modified and now focuses on 7 *Salmonella* serovars: Heidelberg, Enteritidis, Typhimurium, I 4,[5],12:i:-, Paratyphi A, Paratyphi B, and Typhi.
- Bacterial culture and antimicrobial susceptibility testing of *Enterococcus* isolates from retail chicken meat was discontinued as of January 1, 2010. Antimicrobial resistance surveillance of this bacterial species at the retail level may be reintroduced at a later date.
- Bacterial culture and antimicrobial susceptibility testing of *Campylobacter* isolates from abattoir chickens was initiated in January 2010.

Methodological Changes

- A molecular method (genus- and species-specific Multiplex PCR) was used in replacement of the standard method (biochemical tests) for all *Campylobacter* isolates to perform identification and speciation.
- Half of the *Salmonella* Enteritidis human clinical isolates submitted by the most populated provinces (British Columbia, Alberta, Ontario, and Québec) during the first 15 days of the month

were tested due to the high number of isolates submitted by their provincial public health laboratories.

Important Notes

Antimicrobial Groupings

- Category of importance in human medicine: Antimicrobials were categorized on the basis of importance in human medicine (Veterinary Drugs Directorate, Health Canada; categories revised in April 2009).[1]

Additional Notes

- Additional animal clinical isolates might be tested after the publication of this report. In this case, updated results will be presented in the 2010 Annual Report.
- *Surveillance of Animal Clinical Isolates* and antimicrobial resistance figures: Confidence intervals are not displayed for this component because samples are not obtained randomly and may not represent independent observations. Therefore, the results may not reflect true prevalence of antimicrobial resistance, but can be used to highlight the occurrence of emerging or re-emerging resistance.

[1] http://www.hc-sc.gc.ca/dhp-mps/consultation/vet/consultations/amr_ram_hum-med-rev-eng.php

Antimicrobial Resistance

Humans

Salmonella (n = 2,294)

Salmonella Enteritidis

(n = 996)

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

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 135	n = 110	n = 61	n = 98	n = 293	n = 112	n = 70	n = 75	n = 19	n = 23	%
I	Amoxicillin-clavulanic acid	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
I	Ceftiofur	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
I	Ceftriaxone	0 (0)	1 (1)	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
I	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0
II	Ampicillin	4 (3)	3 (3)	1 (2)	3 (3)	5 (2)	2 (2)	1 (1)	2 (3)	1 (5)	1 (4)	2
II	Cefoxitin	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	1 (1)	2 (3)	0 (0)	0 (0)	0 (0)	< 1
II	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	< 1
II	Kanamycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	< 1
II	Nalidixic acid	9 (7)	9 (8)	4 (7)	2 (2)	38 (13)	25 (22)	5 (7)	8 (11)	1 (5)	2 (9)	12
II	Streptomycin	2 (1)	1 (1)	0 (0)	3 (3)	3 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
II	Trimethoprim-sulfamethoxazole	2 (1)	0 (0)	1 (2)	1 (1)	6 (2)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	1
III	Chloramphenicol	0 (0)	1 (1)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	< 1
III	Sulfisoxazole	4 (3)	2 (2)	1 (2)	3 (3)	8 (3)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2
III	Tetracycline	6 (4)	3 (3)	1 (2)	3 (3)	7 (2)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	3
IV												

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

[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces. For BC, AB, ON and QC only half of the *S*. Enteritidis isolates submitted during the first 15 days of the month were tested due to the high number of isolates submitted by their provincial public health laboratories.

Salmonella Heidelberg

(n = 476)

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

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

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

[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces (see Appendix A of the 2008 CIPARS Annual Report).

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

(n = 163)

Table 3. Resistance to antimicrobials in *Salmonella* I 4,[5],12:i:- isolates; *Surveillance of Human Clinical Isolates*, 2010.

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

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

[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces (see Appendix A of the 2008 CIPARS Annual Report).

Salmonella Paratyphi A and Paratyphi B

(n = 30)

Table 4. Resistance to antimicrobials in *Salmonella* Paratyphi A and Paratyphi B isolates; *Surveillance of Human Clinical Isolates*, 2010.

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

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Provincial abbreviations are defined in the Appendix.
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 is associated with severe typhoid-like fever. *Salmonella* Paratyphi B var. L (+) tartrate+ is commonly associated with gastrointestinal illness.
No *S*. Paratyphi A or *S*. Paratyphi B isolates were received from Manitoba, New Brunswick, Prince Edward Island or Newfoundland and Labrador.

[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces (see Appendix A of the 2008 CIPARS Annual Report).

Salmonella Typhi

(n = 178)

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

	Antimicrobial	Number (%) of isolates resistant										Canada
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 33	n = 19	n = 2	n = 13	n = 91	n = 18	n = 0	n = 1	n = 1	n = 0	%
I	Amoxicillin-clavulanic acid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ceftiofur	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ceftriaxone	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	5 (5)	1 (6)		0 (0)	0 (0)		4
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Ampicillin	5 (15)	4 (21)	0 (0)	3 (23)	15 (16)	1 (6)		0 (0)	0 (0)		16
	Cefoxitin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Gentamicin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Kanamycin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)		0
	Nalidixic acid	29 (88)	18 (95)	2 (100)	12 (92)	80 (88)	12 (67)		1 (100)	1 (100)		87
	Streptomycin	5 (15)	4 (21)	0 (0)	3 (23)	14 (15)	1 (6)		0 (0)	0 (0)		15
	Trimethoprim-sulfamethoxazole	5 (15)	4 (21)	0 (0)	3 (23)	17 (19)	1 (6)		0 (0)	0 (0)		17
III	Chloramphenicol	5 (15)	4 (21)	0 (0)	3 (23)	17 (19)	1 (6)		0 (0)	0 (0)		17
	Sulfisoxazole	5 (15)	4 (21)	0 (0)	3 (23)	17 (19)	1 (6)		0 (0)	0 (0)		17
	Tetracycline	0 (0)	0 (0)	0 (0)	3 (23)	1 (1)	0 (0)		0 (0)	0 (0)		1
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 the Appendix.
No *S*. Typhi isolates were received from New Brunswick and Newfoundland and Labrador.

Salmonella Typhimurium

(n = 451)

Table 6. Resistance to antimicrobials in *Salmonella* Typhimurium isolates; *Surveillance of Human Clinical Isolates*, 2010.

	Antimicrobial	Number (%) of isolates resistant										Canada[a]
		BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	
		n = 35	n = 48	n = 54	n = 15	n = 189	n = 73	n = 15	n = 17	n = 0	n = 5	%
I	Amoxicillin-clavulanic acid	0 (0)	1 (2)	0 (0)	0 (0)	4 (2)	3 (4)	0 (0)	0 (0)		0 (0)	2
	Ceftiofur	0 (0)	1 (2)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)		0 (0)	2
	Ceftriaxone	0 (0)	1 (2)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)		0 (0)	2
	Ciprofloxacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0
II	Amikacin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	0
	Ampicillin	11 (31)	20 (42)	5 (9)	4 (27)	47 (25)	15 (21)	3 (20)	3 (18)		1 (20)	25
	Cefoxitin	0 (0)	1 (2)	0 (0)	0 (0)	3 (2)	2 (3)	0 (0)	0 (0)		0 (0)	2
	Gentamicin	1 (3)	0 (0)	0 (0)	0 (0)	2 (1)	2 (3)	1 (7)	0 (0)		0 (0)	1
	Kanamycin	6 (17)	13 (27)	0 (0)	4 (27)	17 (9)	8 (11)	1 (7)	1 (6)		0 (0)	12
	Nalidixic acid	0 (0)	2 (4)	1 (2)	0 (0)	5 (3)	2 (3)	1 (7)	0 (0)		0 (0)	3
	Streptomycin	12 (34)	17 (35)	5 (9)	1 (7)	52 (28)	22 (30)	1 (7)	3 (18)		0 (0)	27
	Trimethoprim-sulfamethoxazole	2 (6)	2 (4)	1 (2)	0 (0)	5 (3)	6 (8)	1 (7)	0 (0)		0 (0)	4
III	Chloramphenicol	7 (20)	8 (17)	3 (6)	0 (0)	45 (24)	12 (16)	1 (7)	3 (18)		0 (0)	19
	Sulfisoxazole	13 (37)	22 (46)	4 (7)	4 (27)	54 (29)	23 (32)	2 (13)	3 (18)		0 (0)	30
	Tetracycline	11 (31)	18 (38)	5 (9)	4 (27)	50 (26)	19 (26)	2 (13)	4 (24)		0 (0)	27
IV												

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
Provincial abbreviations are defined in the Appendix.
No *S*. Typhimurium isolates were received from Prince Edward Island.

[a] Estimated percentages for Canada have been corrected for non-proportional submission protocols among provinces (see Appendix A of the 2008 CIPARS Annual Report).

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

Province / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	135 (53.6)	122	8	2	3					2	4					4	2			9	6
Typhimurium	35 (13.9)	22		2	11			1	6	12	11					13	2	7			11
Typhi	33 (13.1)	4	24		5					5	5					5	5	5		29	
Heidelberg	31 (12.3)	14	15	2							17	15	16	15	16						2
I 4,[5],12:i:-	16 (6.3)	6	4	1	5					6	6	2	2	2	2	6	1	2			8
Paratyphi A and B	2 (0.8)		1		1					1	1					1		1		1	1
Total	**252 (100)**	**168**	**52**	**7**	**25**			**1**	**6**	**26**	**44**	**17**	**18**	**17**	**18**	**29**	**10**	**15**		**39**	**28**
Alberta																					
Enteritidis	110 (38.3)	98	9	1	2					1	3	1	1	1	1	2		1		9	3
Heidelberg	73 (25.4)	61	6	6						1	11	5	6	5	5	2					4
Typhimurium	48 (16.7)	23	2	5	18				13	17	20	1	1	1	1	22	2	8		2	18
I 4,[5],12:i:-	35 (12.2)	15	17	1	2			1		2	6	3	3	3	3	2				1	17
Typhi	19 (6.6)	1	14		4					4	4					4	4	4		18	
Paratyphi A and B	2 (0.7)		2																	2	
Total	**287 (100)**	**198**	**50**	**13**	**26**			**1**	**13**	**25**	**44**	**10**	**11**	**10**	**10**	**32**	**6**	**13**		**32**	**42**
Saskatchewan																					
Enteritidis	61 (42.7)	55	5	1							1					1	1			4	1
Typhimurium	54 (37.8)	48		1	5					5	5					4	1	3		1	5
I 4,[5],12:i:-	15 (10.5)	9	6																		6
Heidelberg	10 (7.0)	9	1								1	1	1	1	1						
Typhi	2 (1.4)		2																	2	
Paratyphi A and B	1 (0.7)	1																			
Total	**143 (100)**	**122**	**14**	**2**	**5**					**5**	**7**	**1**	**1**	**1**	**1**	**5**	**2**	**3**		**7**	**12**
Manitoba																					
Enteritidis	98 (56.6)	93	1	2	2					3	3		1		1	3	1			2	3
Heidelberg	25 (14.5)	19	6								6	5	5	5	5						
I 4,[5],12:i:-	22 (12.7)	10	6	6						6	8	2	2	2	2						4
Typhimurium	15 (8.7)	11			4				4	1	4					4					4
Typhi	13 (7.5)	1	9			3				3	3					3	3	3		12	3
Total	**173 (100)**	**134**	**22**	**8**	**6**	**3**			**4**	**13**	**24**	**7**	**8**	**7**	**8**	**10**	**4**	**3**		**14**	**14**
Ontario																					
Enteritidis	293 (37.7)	246	39	5	3					3	5					8	6	2		38	7
Typhimurium	189 (24.3)	128	5	11	41	4		2	17	52	47	4	3	3	3	54	5	45		5	50
Heidelberg	157 (20.2)	95	51	10	1			2	4	12	53	32	32	32	32	6	2	3		1	4
Typhi	91 (11.7)	11	62	4	13	1				14	15					17	17	17	5	80	1
I 4,[5],12:i:-	29 (3.7)	18	4	1	6			1	1	7	10	3	4	3	4	7	1	3			6
Paratyphi A and B	18 (2.3)	10	7	1										1						8	
Total	**777 (100)**	**508**	**168**	**32**	**64**	**5**		**5**	**22**	**88**	**130**	**39**	**39**	**39**	**39**	**92**	**31**	**70**	**5**	**132**	**68**
Québec																					
Heidelberg	129 (35.1)	77	42	10				2		8	50	27	27	27	27	3					2
Enteritidis	112 (30.4)	85	25	2							2	2	2	1	2	1	1			25	2
Typhimurium	73 (19.8)	45	3	11	14			2	8	22	15	3	2	2	2	23	6	12		2	19
I 4,[5],12:i:-	31 (8.4)	7	2	3	19				6	21	21	1	1	1	1	22	2	4			20
Typhi	18 (4.9)	6	11		1					1	1					1	1	1	1	12	
Paratyphi A and B	5 (1.4)	4	1																	1	
Total	**368 (100)**	**224**	**84**	**26**	**34**			**4**	**14**	**52**	**89**	**33**	**32**	**31**	**32**	**50**	**10**	**17**	**1**	**40**	**43**
New Brunswick																					
Enteritidis	70 (57.9)	62	8								1			2						5	
Heidelberg	28 (23.1)	20	3	5				1	1	4	7	2	2	2	2	1					1
Typhimurium	15 (12.4)	12		1	2			1	1	1	3					2	1	1		1	2
I 4,[5],12:i:-	8 (6.6)	6	1		1					1	2	1	1	1	1	1					1
Total	**121 (100)**	**100**	**12**	**6**	**3**			**2**	**2**	**6**	**13**	**3**	**3**	**5**	**3**	**4**	**1**	**1**		**6**	**4**
Nova Scotia																					
Enteritidis	75 (67.6)	65	10								2									8	
Typhimurium	17 (15.3)	13		1	3				1	3	3					3		3			4
Heidelberg	14 (12.6)	8	3	3				2	2	2	4	2	2	2	2	2					3
I 4,[5],12:i:-	2 (1.8)	2																			
Paratyphi A and B	2 (1.8)	1	1																1	1	
Typhi	1 (0.9)		1																	1	
Total	**111 (100)**	**89**	**15**	**4**	**3**			**2**	**3**	**5**	**9**	**2**	**2**	**2**	**2**	**5**		**3**	**1**	**10**	**7**

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

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

Province / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial														
							Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Prince Edward Island																					
Enteritidis	19 (70.4)	17	2								1									1	
Heidelberg	6 (22.2)	5	1								1										
I 4,[5],12:i:-	1 (3.7)	1																			
Typhi	1 (3.7)		1																	1	
Total	**27 (100)**	**23**	**4**								**2**									**2**	
Newfoundland and Labrador																					
Enteritidis	23 (71.9)	21	1	1				1	1		1									2	
Typhimurium	5 (15.6)	4	1								1										
Heidelberg	3 (9.4)	2	1								1										
I 4,[5],12:i:-	1 (3.1)		1								1	1	1	1	1						
Total	**32 (100)**	**27**	**4**	**1**				**1**	**1**		**4**	**1**	**1**	**1**	**1**					**2**	

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

Figure 1. Temporal variation in resistance to selected antimicrobials in human isolates of *Salmonella* serovars Enteritidis, Heidelberg, and I 4,[5],12:i:-; *Surveillance of Human Clinical Isolates*, 2003–2010.

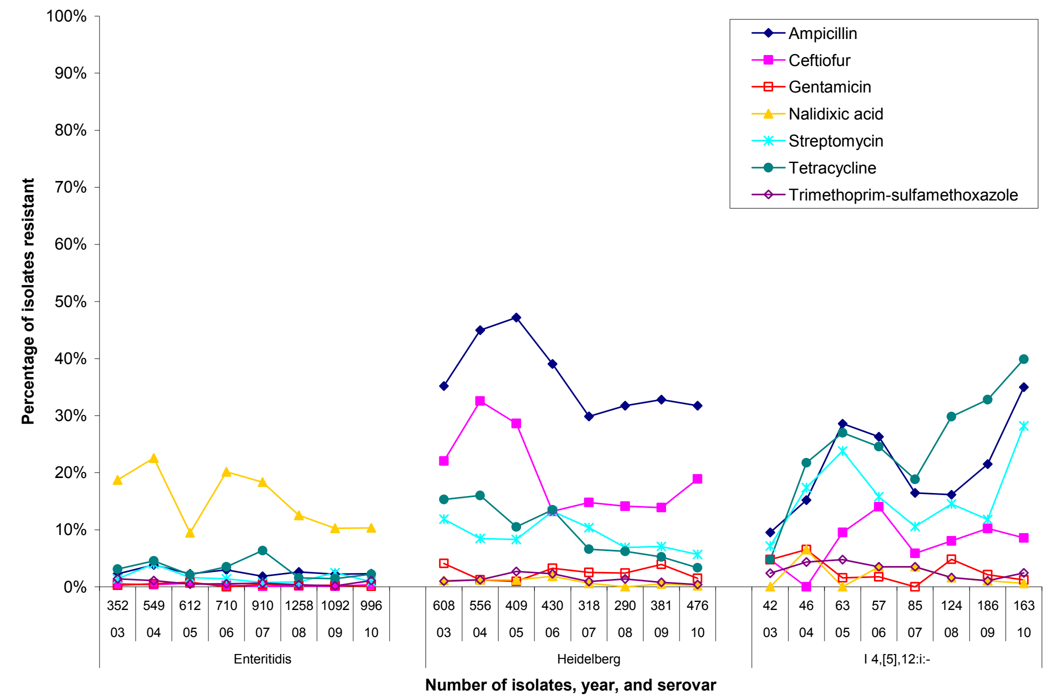
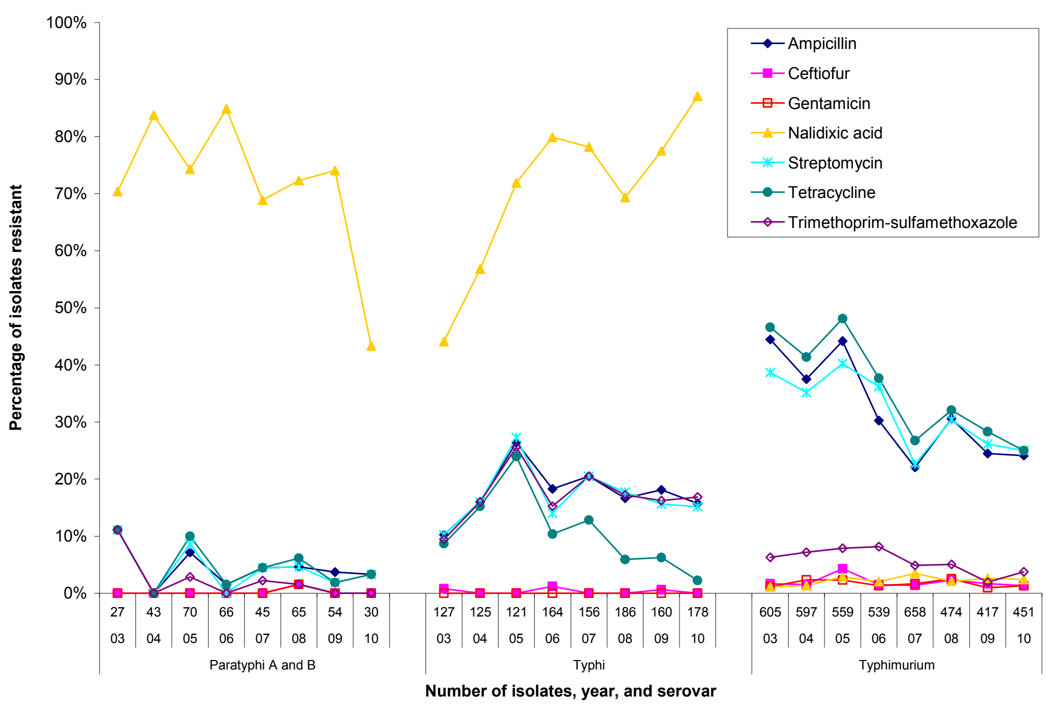


Figure 2. Temporal variation in resistance to selected antimicrobials in human isolates of *Salmonella* serovars Paratyphi A and Paratyphi B, Typhi, and Typhimurium; *Surveillance of Human Clinical Isolates*, 2003–2010.



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

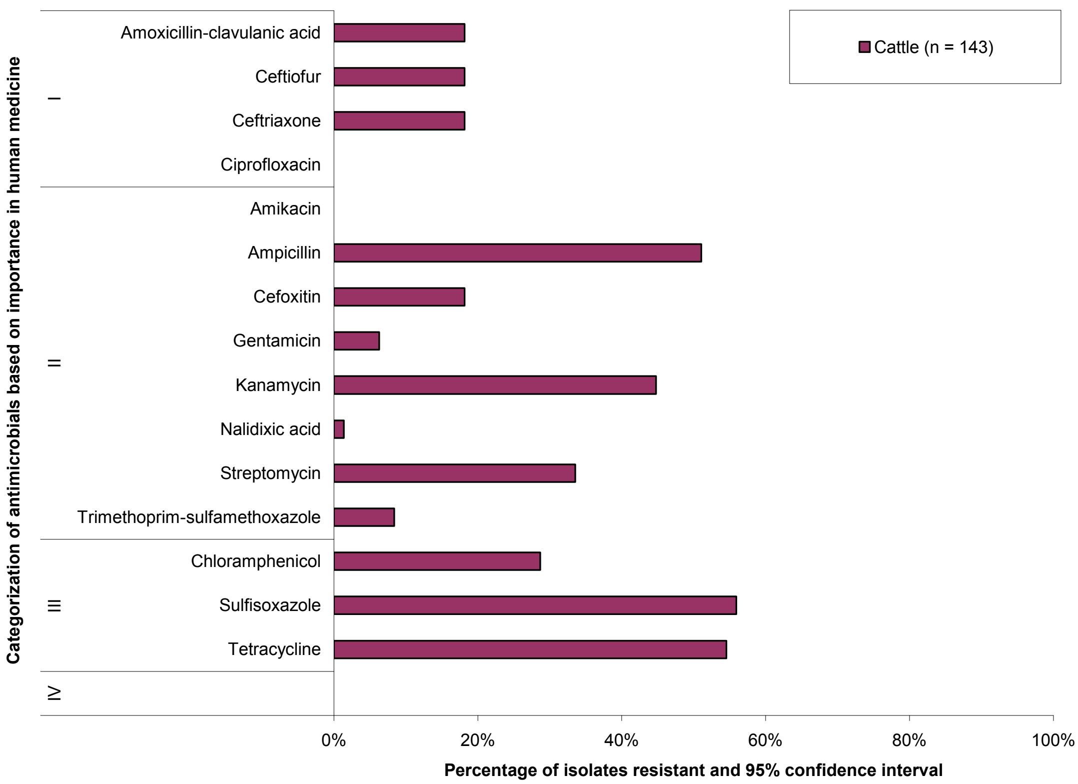
Beef Cattle

Salmonella

Surveillance of Animal Clinical Isolates

(n = 143)

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



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

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

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Typhimurium var. 5-	48 (33.6)	2		1	45				45	22	45	15	15	15	15	46	1	15			46
Typhimurium	39 (27.3)	20		2	17				10	17	15	2	2	2	2	19	8	16		2	18
Enteritidis	10 (7)	10																			
Dublin	6 (4.2)				6			6	6	1	6	6	6	6	6	6		6			6
Heidelberg	5 (3.5)	5																			
I 4,[5],12:i:-	5 (3.5)	2			3				2	3	3	1	1	1	1	3	1	3			3
Infantis	4 (2.8)	4																			
Mbandaka	4 (2.8)	2		2						2						2					2
Muenster	3 (2.1)	3																			
Less common serovars	19 (13.3)	14	2		3			3	1	3	4	2	2	2	2	4	2	1			3
Total	**143 (100)**	**62**	**2**	**5**	**74**			**9**	**64**	**48**	**73**	**26**	**26**	**26**	**26**	**80**	**12**	**41**		**2**	**78**

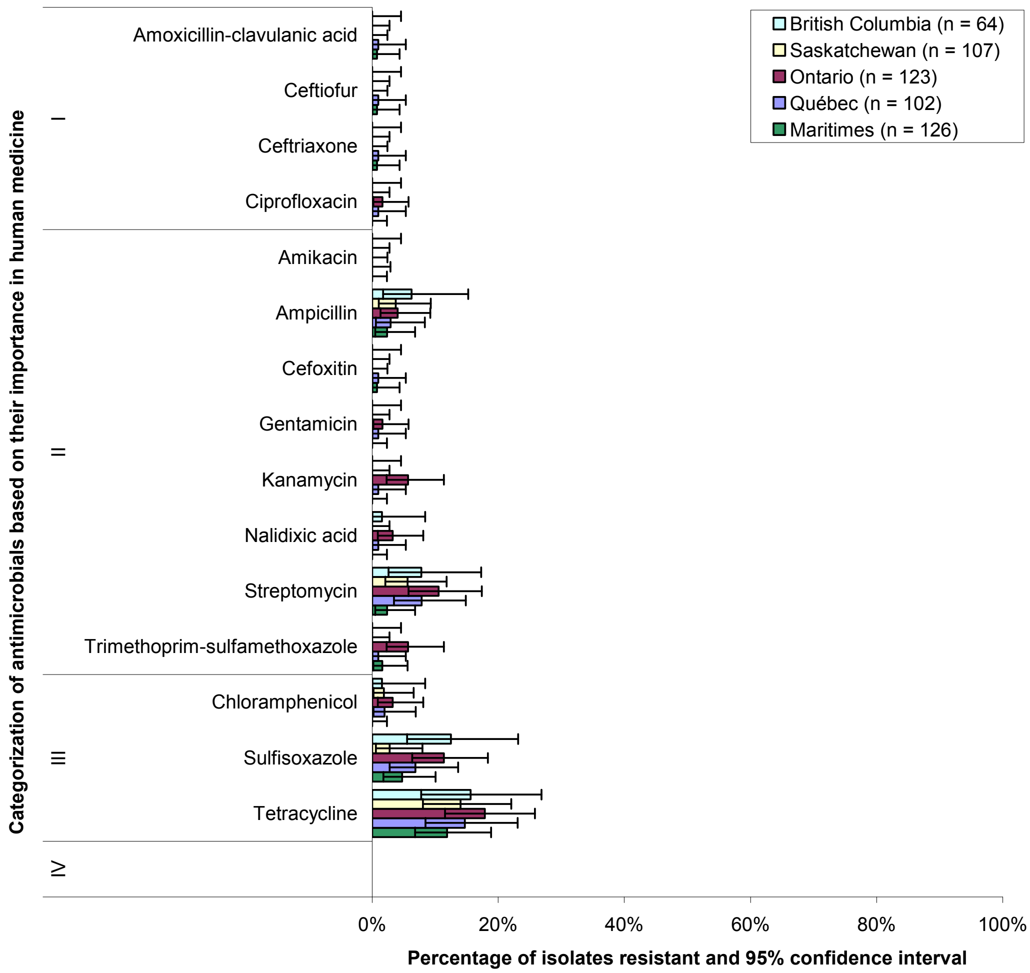
Serovars represented by less than 2% of isolates were classified as “Less common serovars”.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Escherichia coli

Retail Meat Surveillance

(n = 522)

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



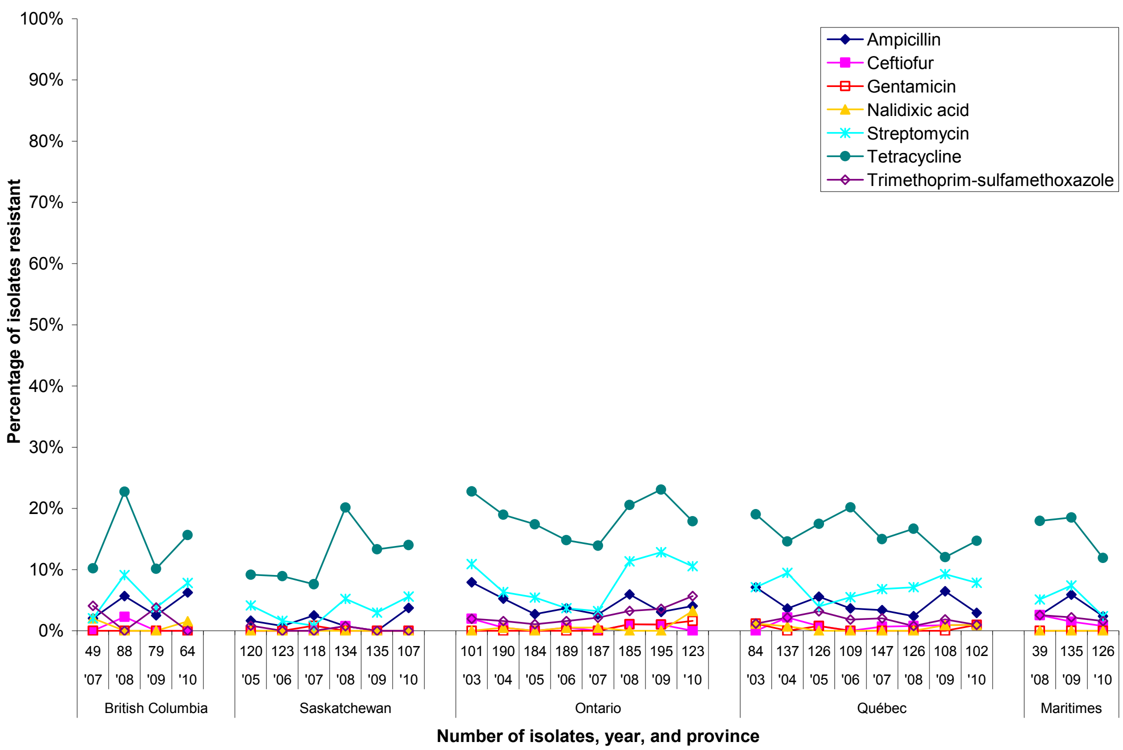
The Maritimes region includes New Brunswick, Nova Scotia, and Prince Edward Island.

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

Province	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial														
							Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia	64 (12.3)	53	2	6	3					5	4					8		1		1	10
Saskatchewan	107 (20.5)	92	7	6	2					6	4					3		2			15
Ontario	123 (23.6)	100	6	12	3	2		2	7	13	5					14	7	4	2	4	22
Québec	102 (19.5)	85	5	11	1			1	1	8	3	1	1	1	1	7	1	2	1	1	15
Maritimes	126 (24.1)	111	7	7	1					3	3	1	1	1	1	6	2				15

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

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



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

Abattoir Surveillance

(n = 77)[1]

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

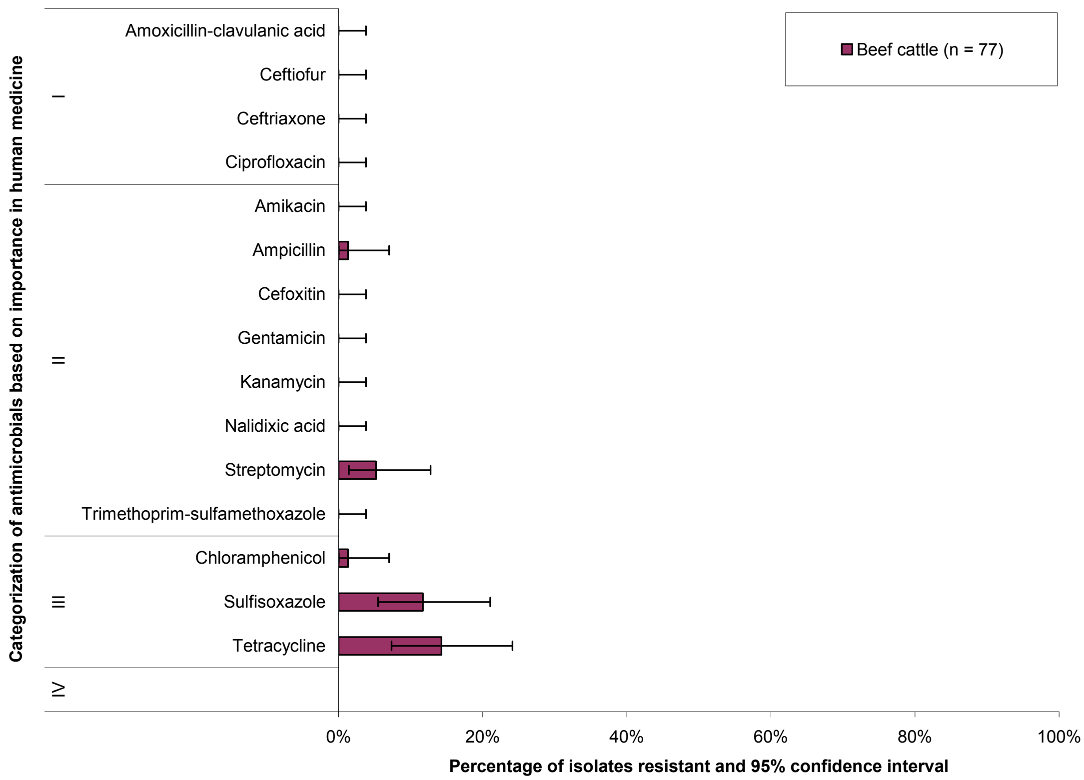


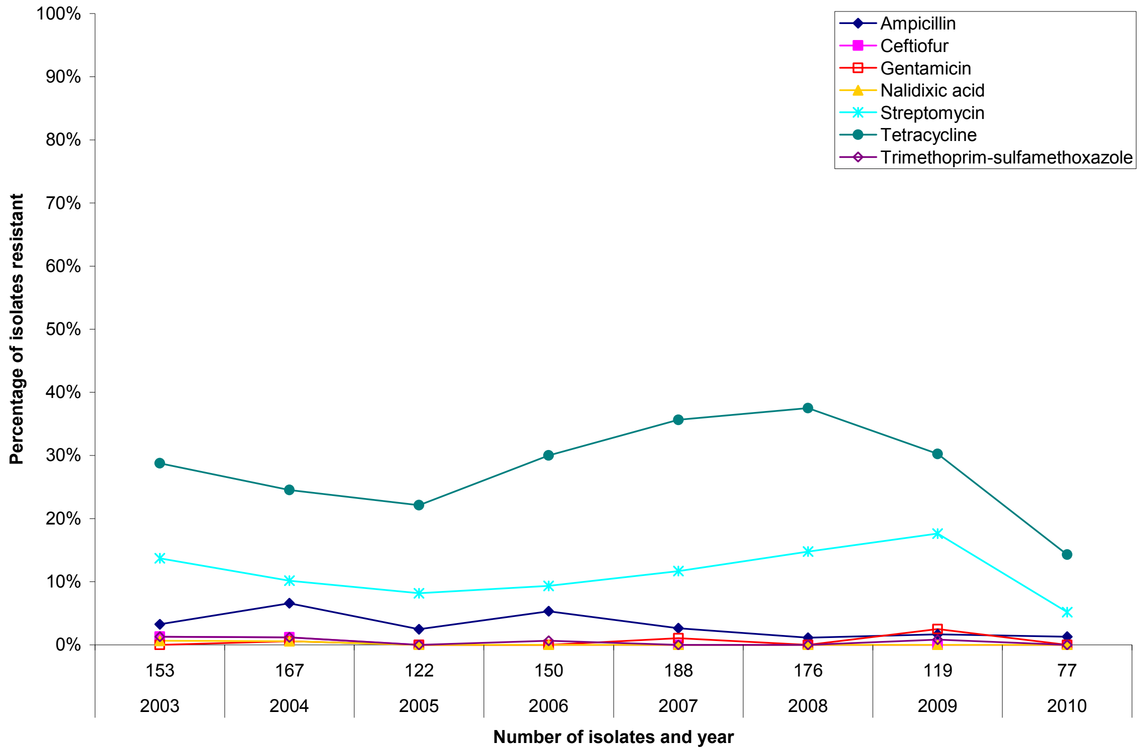
Table 10. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from beef cattle, chickens, or pigs; *Abattoir Surveillance*, 2010.

Species	Number of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Beef cattle	77	65	2	9	1					4	1					9		1			11
Chickens	119	24	21	53	21			12	18	59	63	46	45	47	41	47	12	10		5	62
Pigs	199	34	36	88	41				30	71	73	4	4	4	4	92	28	36			143

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

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

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



Campylobacter

Abattoir Surveillance

(n = 37)[1]

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

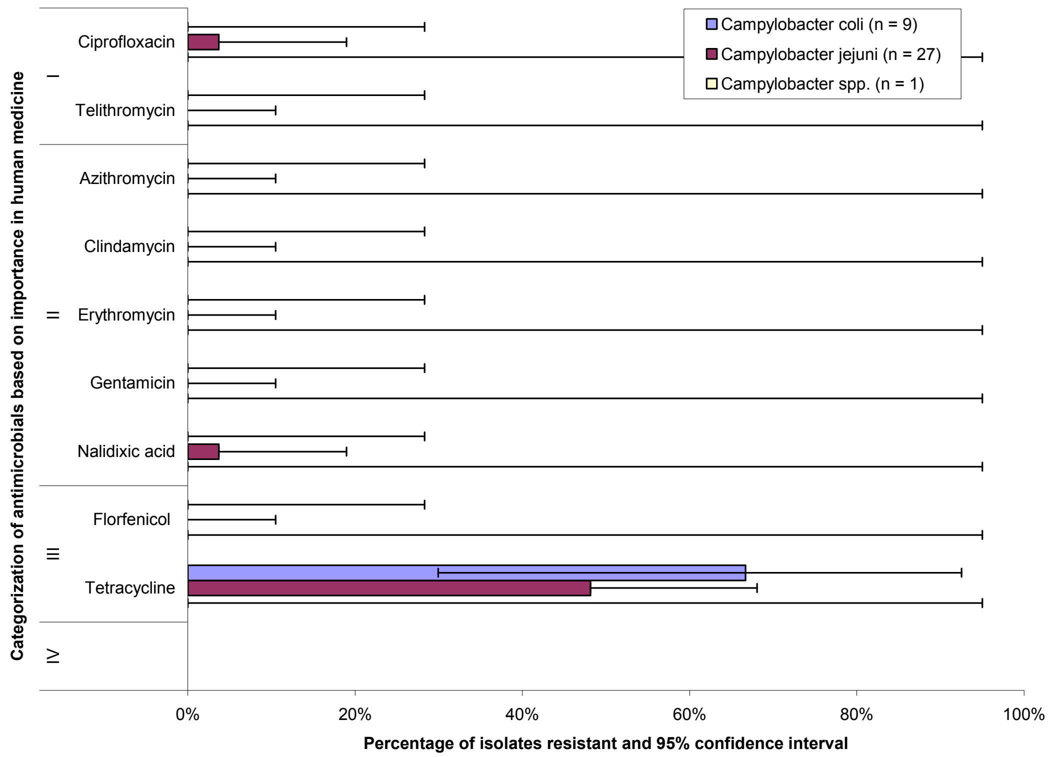


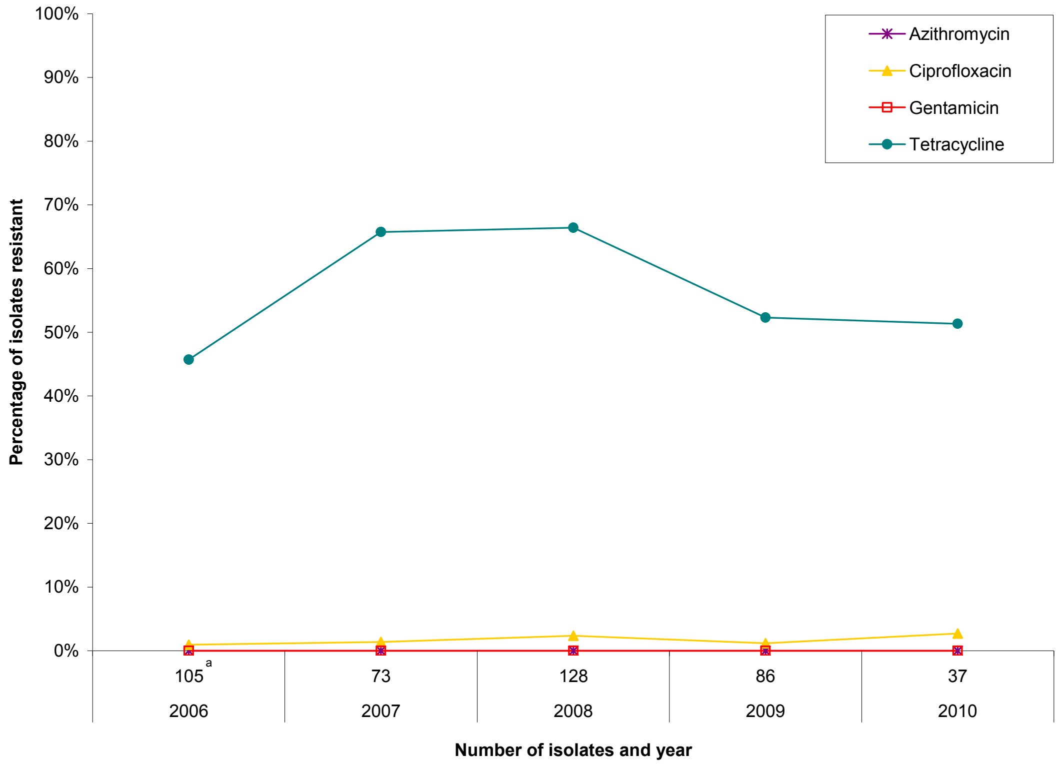
Table 11. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from beef cattle; *Abattoir Surveillance*, 2010.

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

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

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

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



In 2010, the number of samples received from abattoir beef cattle was much lower than anticipated due to a 55% drop in submissions related to unavoidable operational issues at 2 major participating abattoirs.
[a] This number of isolates includes isolates from the end of year 2005 (n = 23).

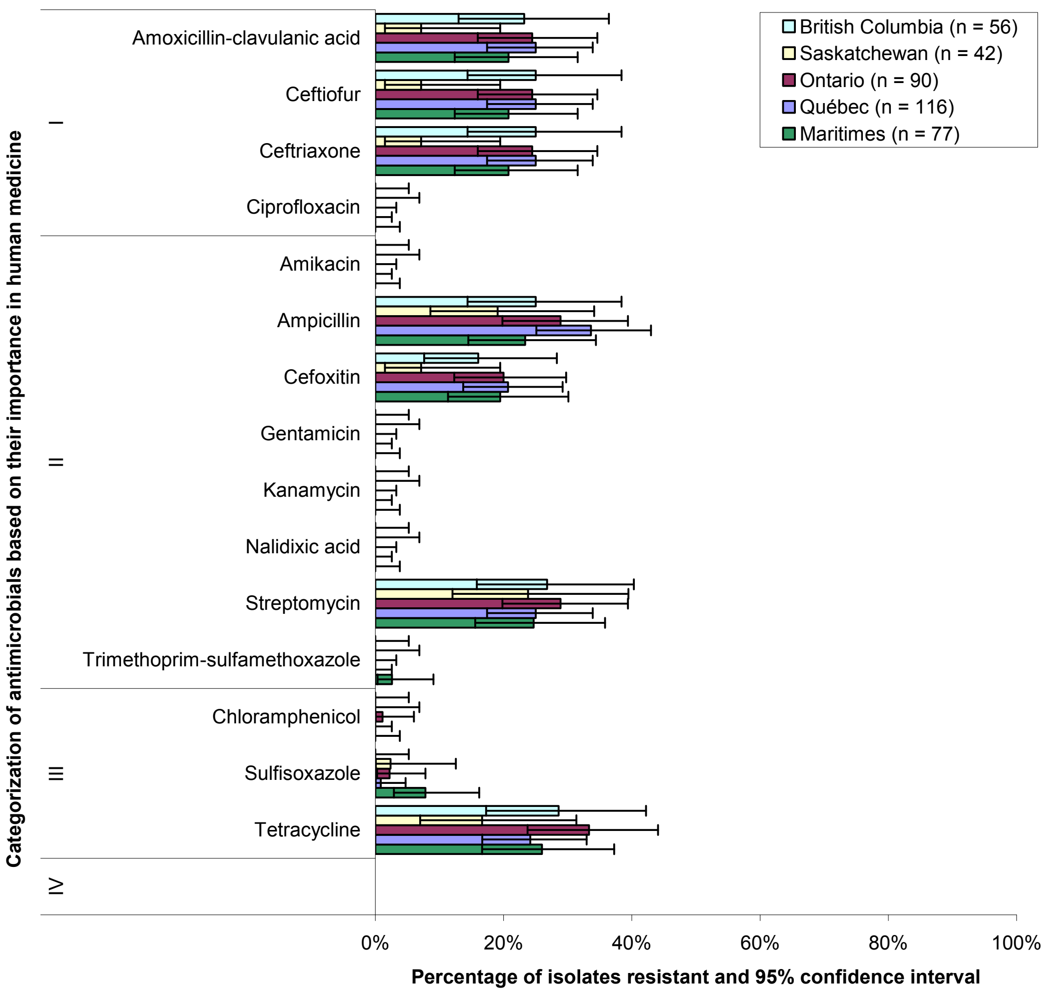
Chickens

Salmonella

Retail Meat Surveillance

(n = 381)

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



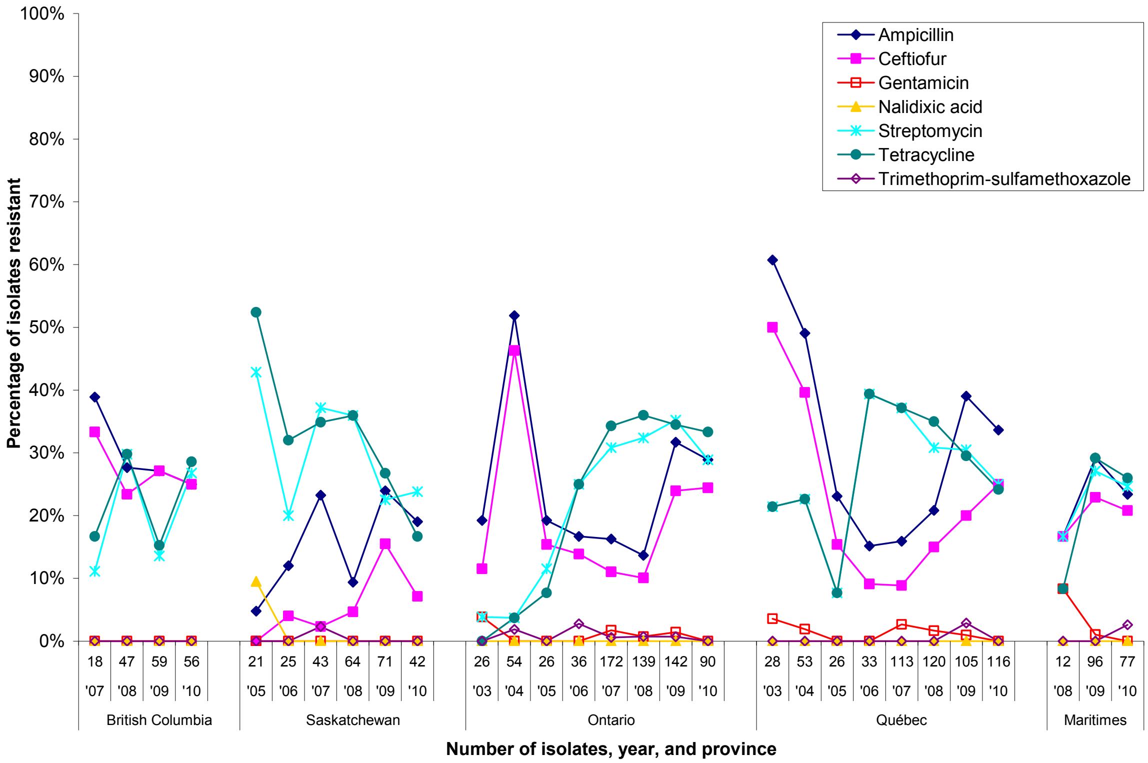
The Maritimes region includes New Brunswick, Nova Scotia, and Prince Edward Island.

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

Province or region / serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial														
							Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia																					
Enteritidis	24 (42.9)	24																			
Kentucky	18 (32.1)	1	3	14						14	12	11	12	7	12						15
Heidelberg	4 (7.1)	2	2								2	2	2	2	2						
Hadar	3 (5.4)	2		1						1											1
Less common serovars	7 (12.5)	7																			
Total	**56 (100)**	**36**	**5**	**15**						**15**	**14**	**13**	**14**	**9**	**14**						**16**
Saskatchewan																					
Enteritidis	11 (26.2)	11																			
Heidelberg	8 (19.0)	3	3	2						2	5	1	1	1	1						
Hadar	3 (7.1)			3						3											3
Braenderup	2 (4.8)	2																			
Kentucky	2 (4.8)			2						2	1	1	1	1	1						2
Kiambu	2 (4.8)	2																			
Mbandaka	2 (4.8)	2																			
Schwarzengrund	2 (4.8)	2																			
Thompson	2 (4.8)		1	1						2						1					
Typhimurium	2 (4.8)	2																			
Agona	1 (2.4)			1						1	1										1
Albany	1 (2.4)	1																			
I 4,[5],12:i:-	1 (2.4)		1																		1
IIIa 23:g,z51:-	1 (2.4)	1																			
Infantis	1 (2.4)	1																			
Montevideo	1 (2.4)		1								1	1	1	1	1						
Total	**42 (100)**	**27**	**6**	**9**						**10**	**8**	**3**	**3**	**3**	**3**	**1**					**7**
Ontario																					
Kentucky	31 (34.4)	11	2	18						18	12	12	12	8	12						18
Heidelberg	18 (20.0)	9	8	1							8	4	4	4	4	1					1
Hadar	9 (10.0)		2	7						7											9
Enteritidis	6 (6.7)	6																			
Typhimurium	6 (6.7)	6																			
Schwarzengrund	5 (5.6)	4	1								1	1	1	1	1						
Typhimurium var. 5-	4 (4.4)	4																			
Thompson	3 (3.3)	2	1								1	1	1	1	1						
Kiambu	2 (2.2)	2																			
Less common serovars	6 (6.7)	1	4		1					1	4	4	4	4	4	1		1			2
Total	**90 (100)**	**45**	**18**	**26**	**1**					**26**	**26**	**22**	**22**	**18**	**22**	**2**		**1**			**30**
Québec																					
Heidelberg	49 (42.2)	29	18	2						2	20	10	10	9	10						
Kentucky	29 (25)	8	1	20						20	10	10	10	8	10						21
Enteritidis	7 (6.0)	7																			
Hadar	4 (3.4)			4						4											4
Albany	3 (2.6)	1	2								2	2	2	2	2						
Litchfield	3 (2.6)	2	1								1	1	1	1	1						
Thompson	3 (2.6)	2	1								1	1	1		1						
Less common serovars	18 (15.5)	12	3	3						3	5	5	5	4	5	1					3
Total	**116 (100)**	**61**	**26**	**29**						**29**	**39**	**29**	**29**	**24**	**29**	**1**					**28**
Maritimes																					
Heidelberg	27 (35.1)	16	9	2						3	7	6	6	6	6	3	2				
Kentucky	20 (26)	4	2	14						12	7	6	6	5	6	1					14
Enteritidis	12 (15.6)	12																			
Albany	4 (5.2)		4								4	4	4	4	4						
Hadar	4 (5.2)			4						4											4
Less common serovars	10 (13.0)	8		2												2					2
Total	**77 (100)**	**40**	**15**	**22**						**19**	**18**	**16**	**16**	**15**	**16**	**6**	**2**				**20**

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

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



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

Abattoir Surveillance

(n = 142)

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

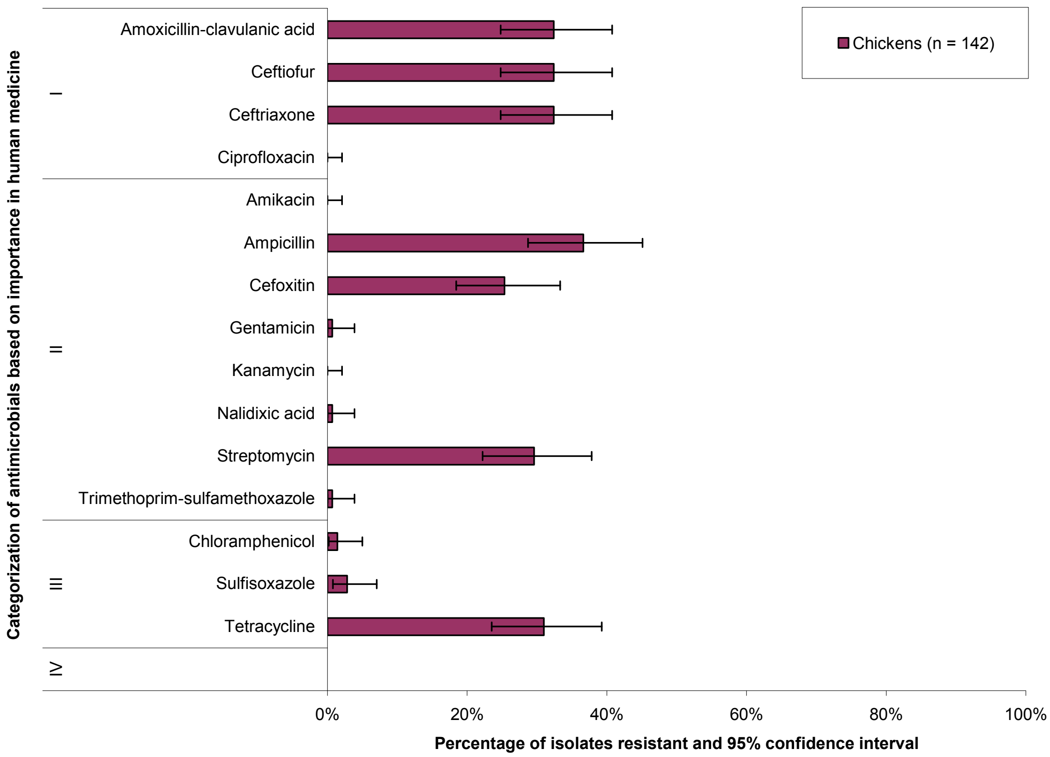
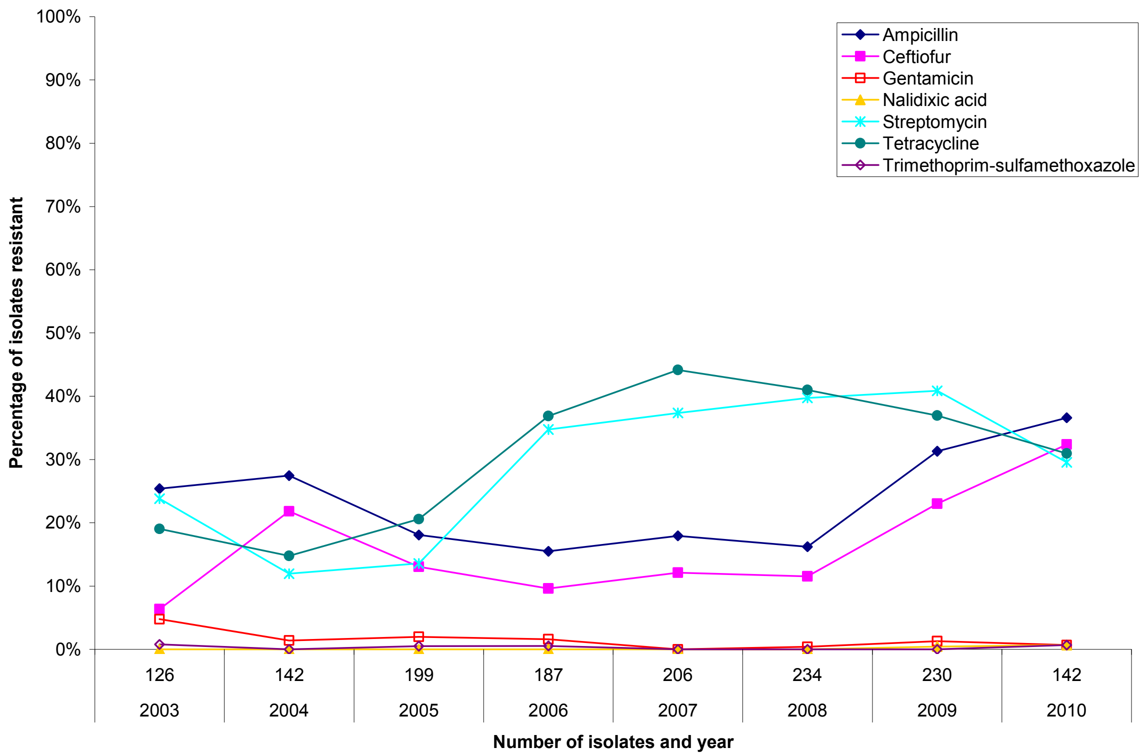


Table 13. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from chickens; *Abattoir Surveillance,* 2010.

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Kentucky	59 (41.5)	14	9	35	1					36	31	31	31	21	31					1	38
Heidelberg	30 (21.1)	13	17								16	10	10	10	10	1	1				
Enteritidis	25 (17.6)	25																			
Typhimurium	6 (4.2)	6																			
Litchfield	4 (2.8)	4																			
Hadar	3 (2.1)	1		2						2											2
Less common serovars	15 (10.6)	8	3	2	2			1		4	5	5	5	5	5	3		2			4
Total	**142 (100)**	**71**	**29**	**39**	**3**			**1**		**42**	**52**	**46**	**46**	**36**	**46**	**4**	**1**	**2**		**1**	**44**

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.

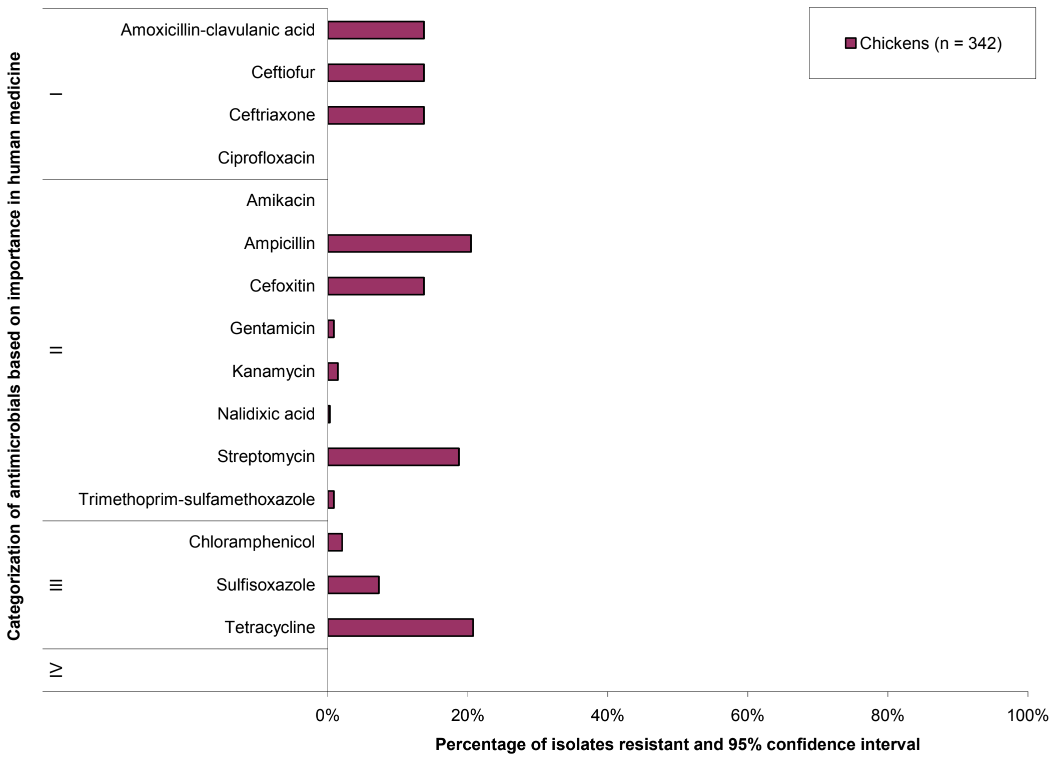
Figure 13. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from chickens; *Abattoir Surveillance*, 2003–2010.



Surveillance of Animal Clinical Isolates

(n = 342)

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



Confidence intervals are not displayed for animal clinical data because samples were not obtained randomly and may not represent independent observations

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

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Enteritidis	114 (33.3)	110	2	1	1			1		1	2	1	1	1	1	2		1		1	2
Heidelberg	95 (27.8)	63	24	8					1	4	30	13	13	13	13	4					5
Kentucky	68 (19.9)	16	10	42						38	26	26	26	26	26						47
Typhimurium	13 (3.8)	10			3				1	3	3					3	1	3			3
Mbandaka	9 (2.6)	2		7						7						7					7
I 4,[5],12:i:-	8 (2.3)	6	1	1					1		1	1	1	1	1						1
Less common serovars	35 (10.2)	21	3	8	3			2	2	11	8	6	6	6	6	9	2	3			6
Total	**342 (100)**	**228**	**40**	**67**	**7**			**3**	**5**	**64**	**70**	**47**	**47**	**47**	**47**	**25**	**3**	**7**		**1**	**71**

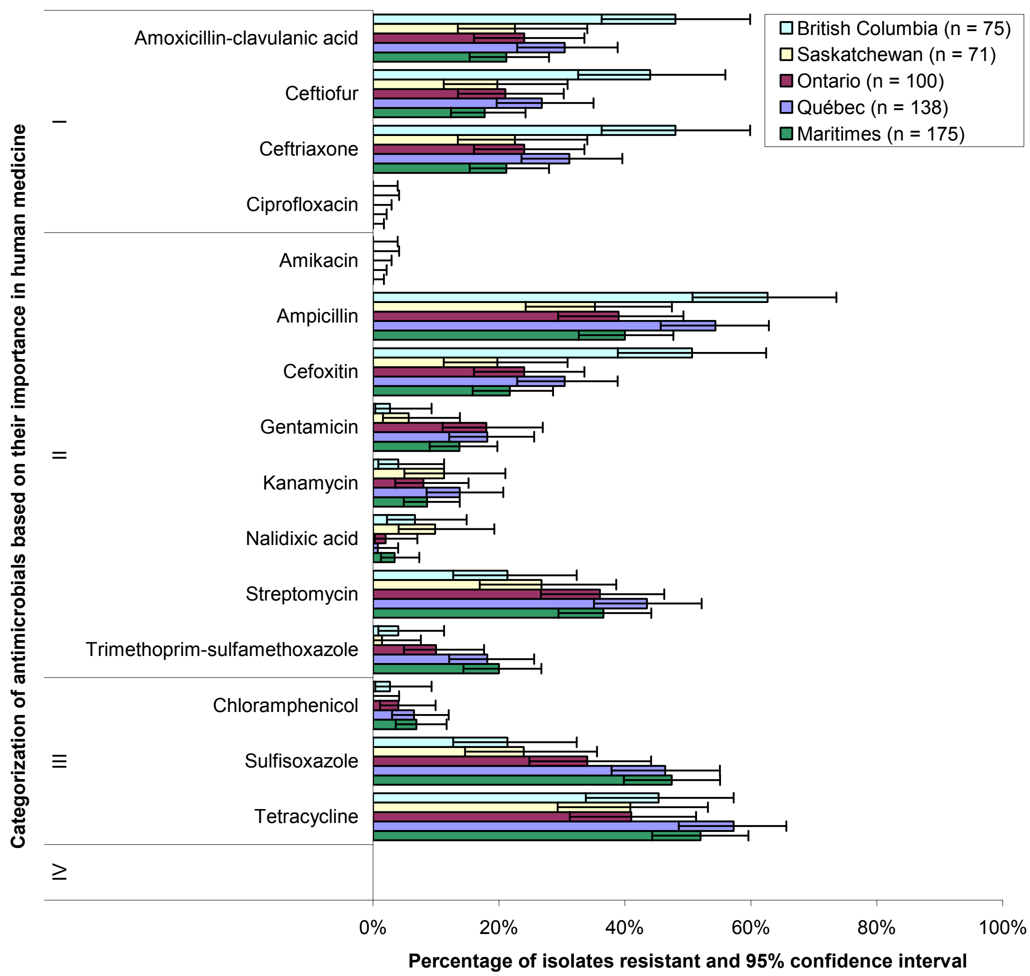
Serovars represented by less than 2% of isolates were classified as "Less common serovars".
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Escherichia coli

Retail Meat Surveillance

(n = 559)[1]

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



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

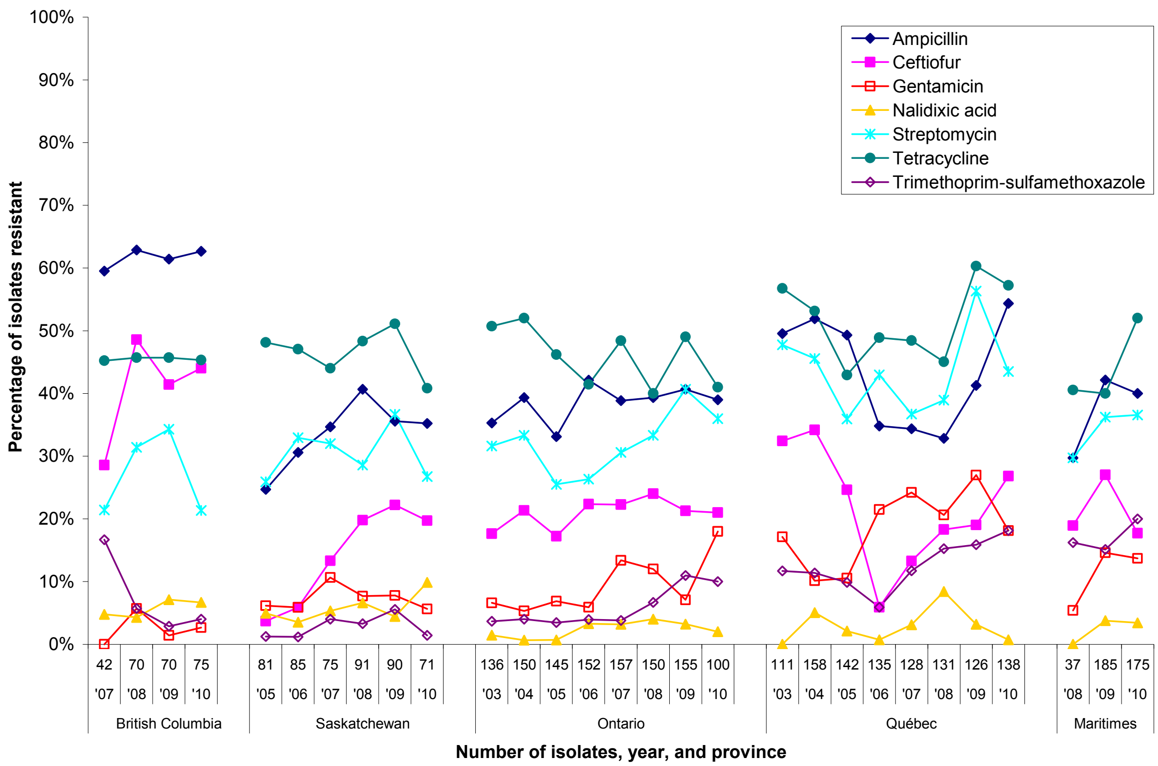
[1] One isolate from the Maritimes could not be cultured after freezing, leaving 559 isolates available for antimicrobial susceptibility testing.

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

Province	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia	75 (13.4)	17	25	23	10			2	3	16	47	36	36	38	33	16	3	2		5	34
Saskatchewan	71 (12.7)	20	17	32	2			4	8	19	25	16	16	14	14	17	1			7	29
Ontario	100 (17.9)	29	22	40	9			18	8	36	39	24	24	24	21	34	10	4		2	41
Québec	138 (24.7)	24	25	64	25			25	19	60	75	42	43	42	37	64	25	9		1	79
Maritimes	175 (31.3)	47	29	59	39	1		24	15	64	70	37	37	38	31	83	35	12		6	91

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

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



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

Abattoir Surveillance

(n = 119)

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

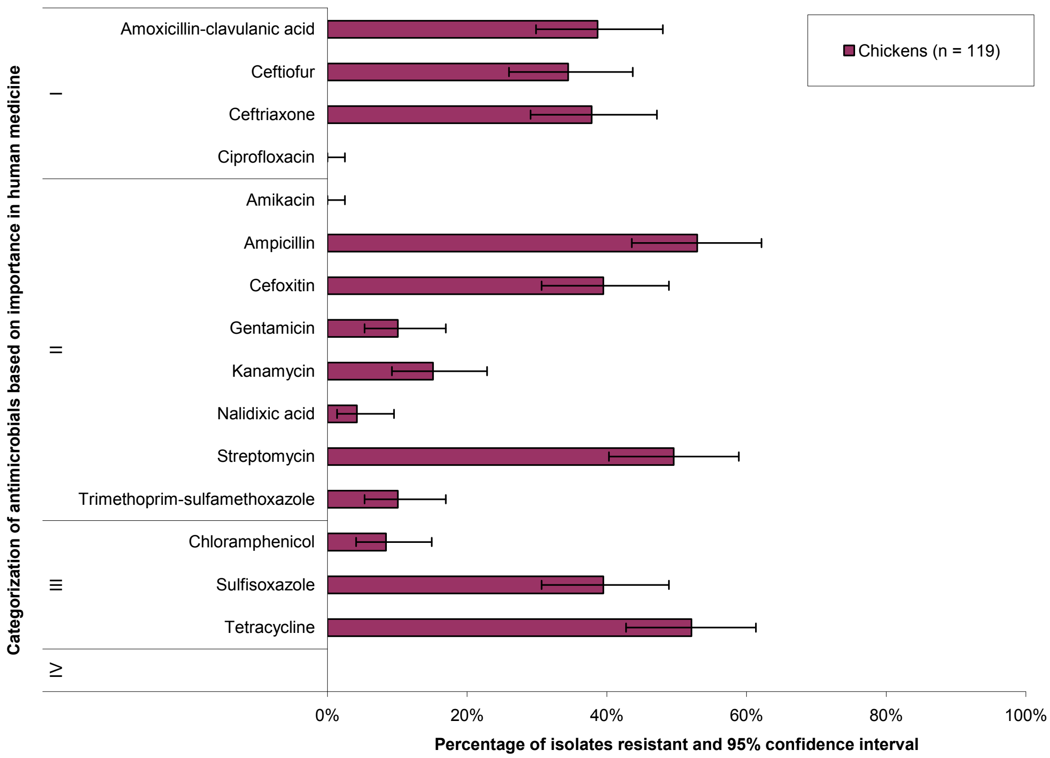
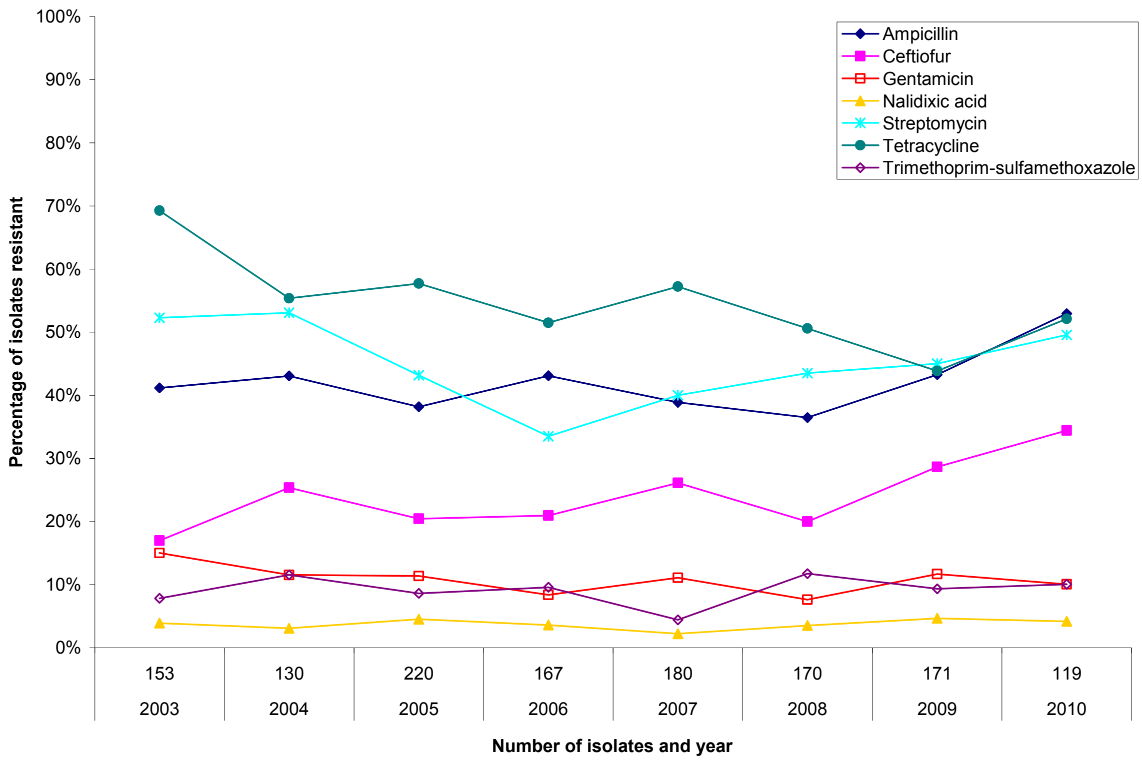


Figure 18. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from chickens; *Abattoir Surveillance*, 2003–2010.



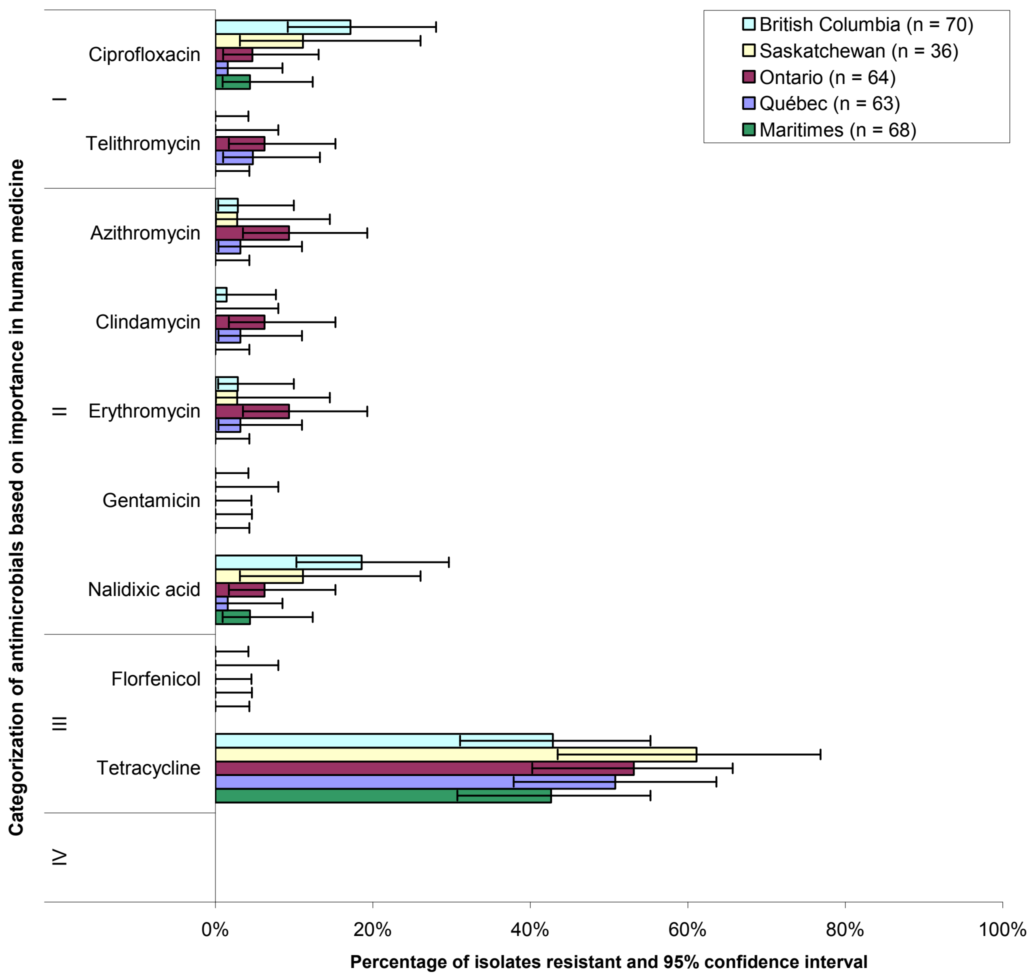
Results regarding the number of antimicrobial classes in resistance patterns of abattoir *E. coli* isolates from chickens can be found in Table 10.

Campylobacter

Retail Meat Surveillance

(n = 301)[1]

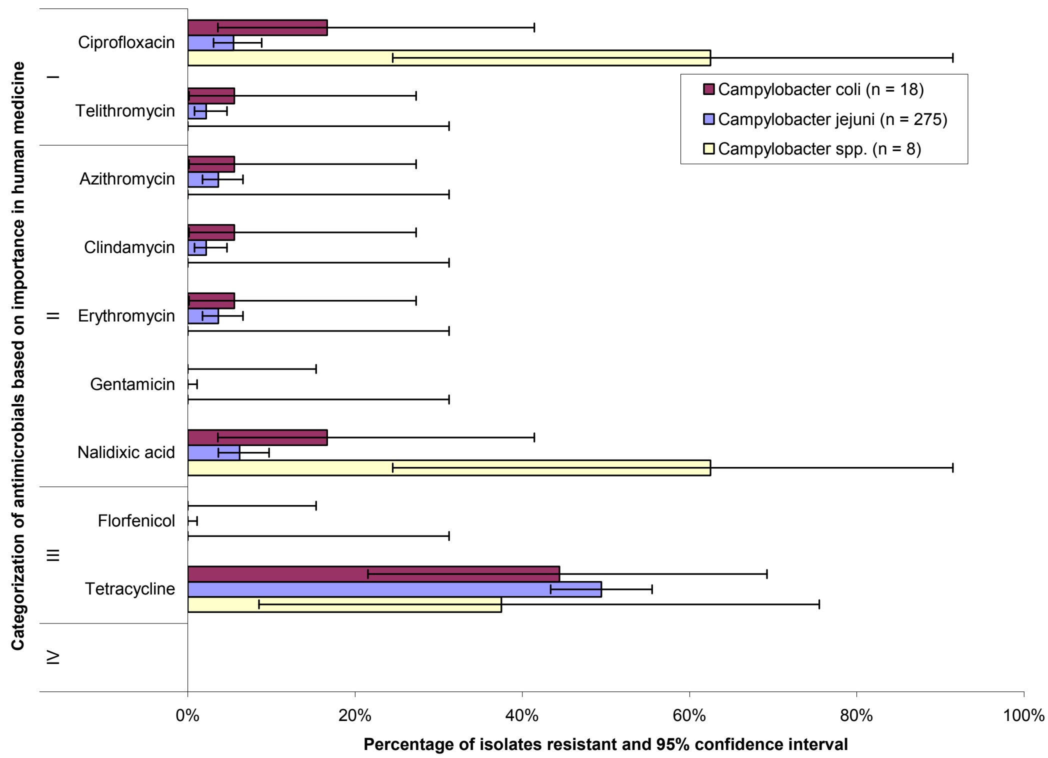
Figure 19. Resistance to antimicrobials in *Campylobacter* isolates from chicken, by province; *Retail Meat Surveillance*, 2010.



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

[1] One isolate from Saskatchewan and 2 from the Maritimes could not be cultured after freezing, leaving 301 isolates available for antimicrobial susceptibility testing.

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



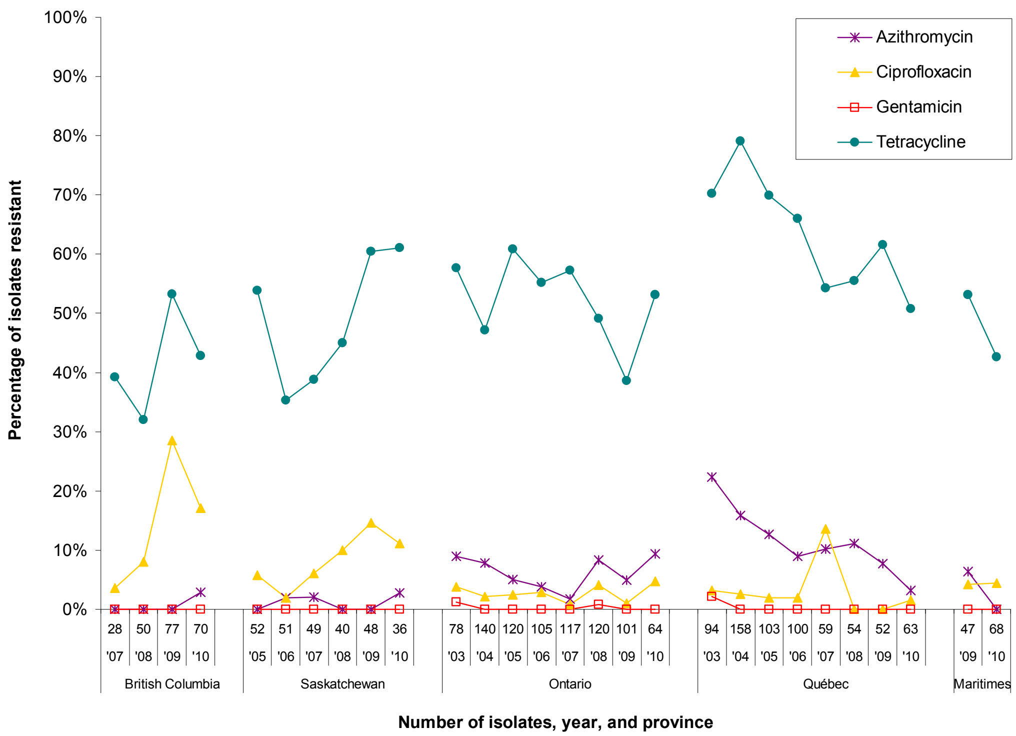
Campylobacter spp. includes unidentified species, some of which may be intrinsically resistant to nalidixic acid.

Table 16. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from chicken; *Retail Meat Surveillance*, 2010.

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

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

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



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

Abattoir Surveillance

(n = 111)

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

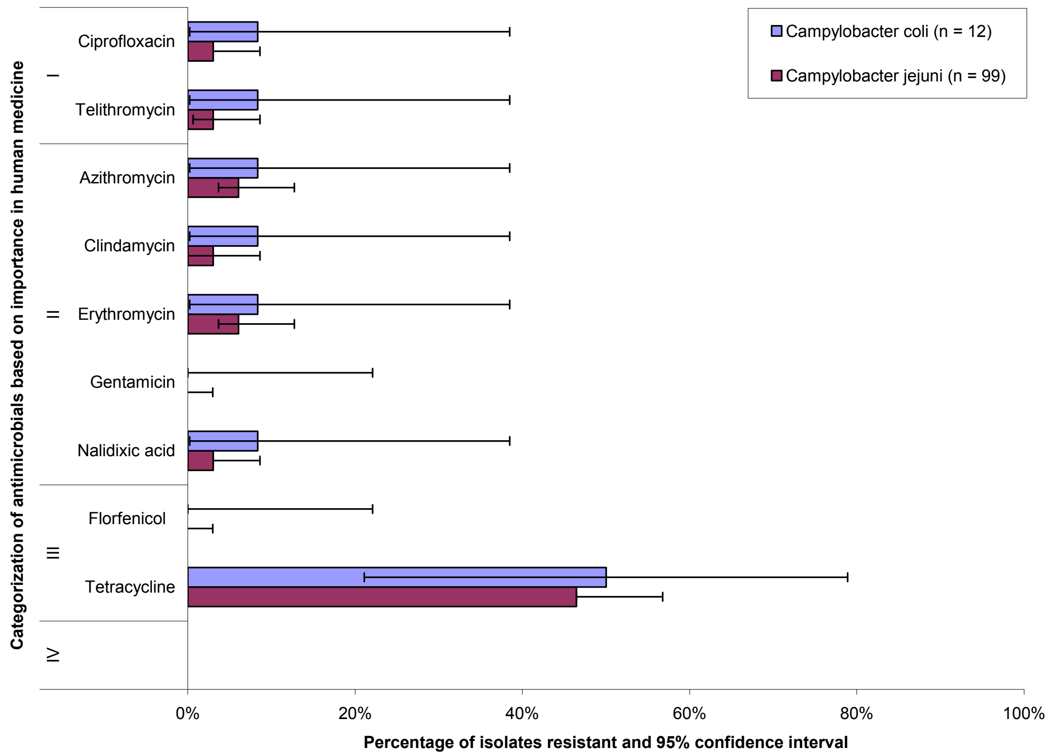


Table 17. Number of antimicrobial classes in resistance patterns of *Campylobacter* isolates from chickens; *Abattoir Surveillance*, 2010.

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

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

Pigs

Salmonella

Abattoir Surveillance

(n = 182)

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

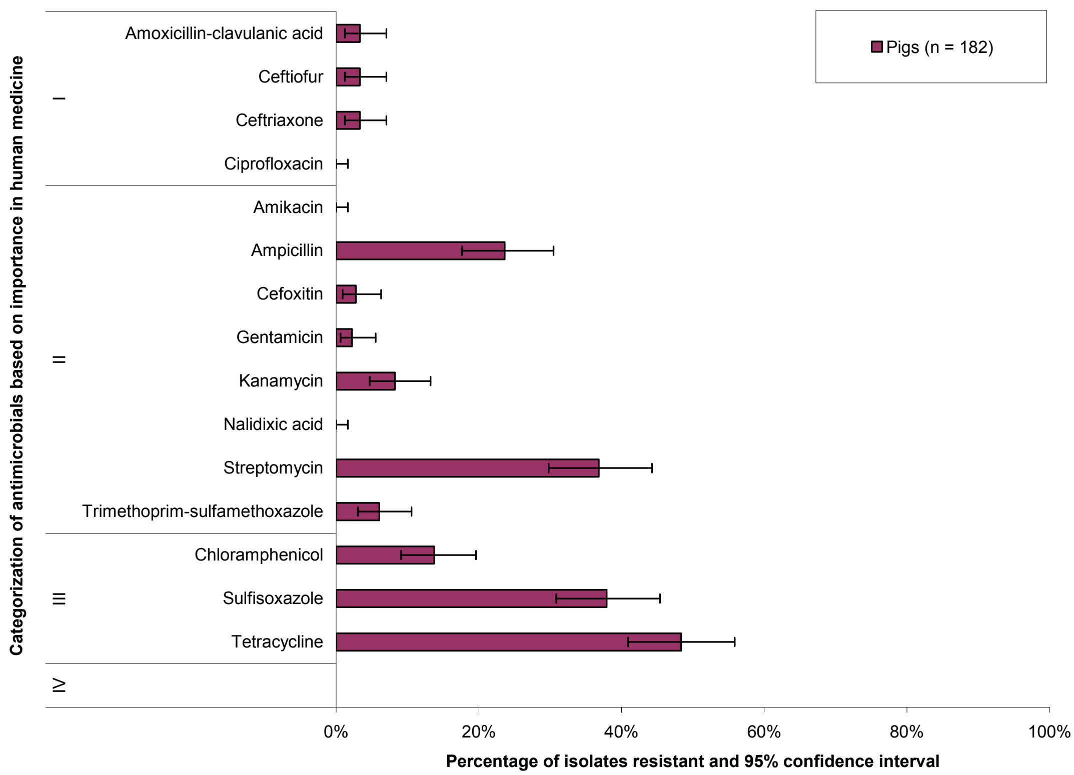
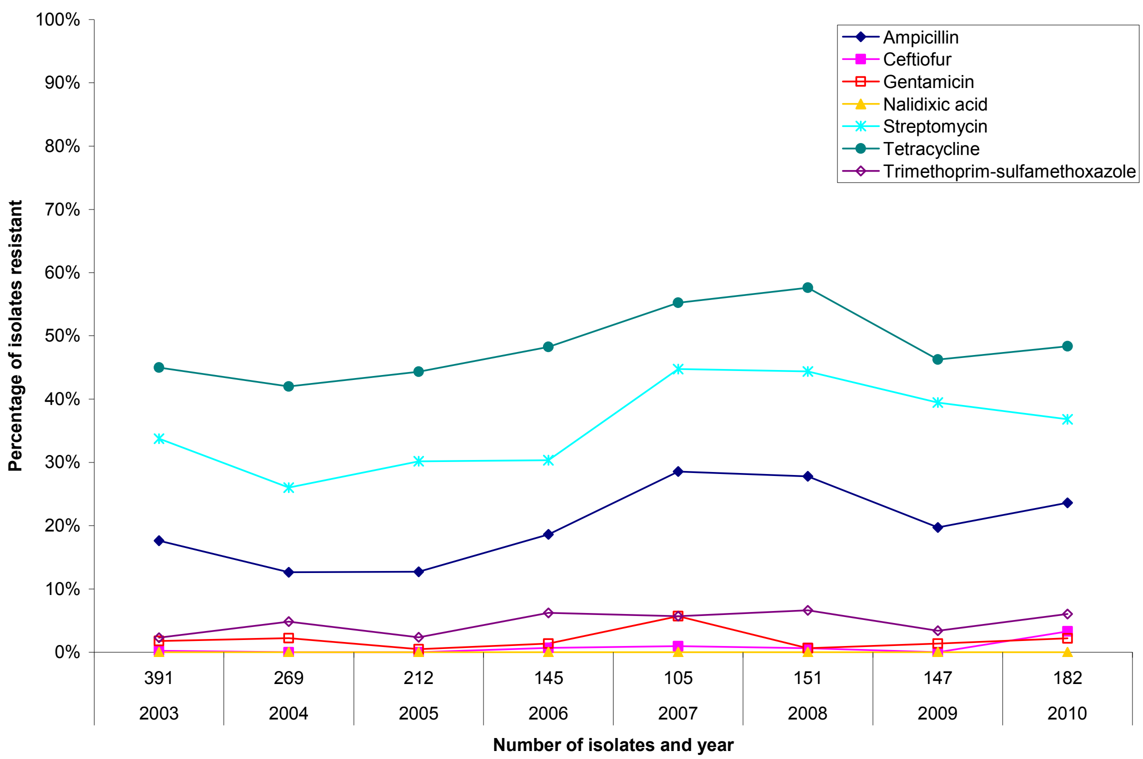


Table 18. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Abattoir Surveillance*, 2010.

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Derby	36 (19.8)	7	6	23					1	22	1					25	4				25
Infantis	22 (12.1)	16	4		2				2	1	5	3	3	3	3	2	2				2
Typhimurium var. 5-	21 (11.5)	1	1	6	13				5	16	15	2	1	1	1	18	4	12			19
Typhimurium	16 (8.8)	2	1	3	10					11	12					11		9			13
Brandenburg	15 (8.2)	11	1	3					1	1	1							1			4
Worthington	13 (7.1)	7	6																		6
Schwarzengrund	11 (6.0)	7		3	1					4	1	1	1	1	1	4		1			4
Mbandaka	6 (3.3)	2		3	1			3	3	4	1					4					4
Agona	5 (2.7)	4		1												1					1
Give	4 (2.2)	3			1				1	1						1		1			1
Ohio	4 (2.2)	3		1				1	1		1										1
Less common serovars	29 (15.9)	20	1	6	2				1	7	6		1		1	3	1	1			8
Total	**182 (100)**	**83**	**20**	**49**	**30**			**4**	**15**	**67**	**43**	**6**	**6**	**5**	**6**	**69**	**11**	**25**			**88**

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



Farm Surveillance

(n = 101)

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

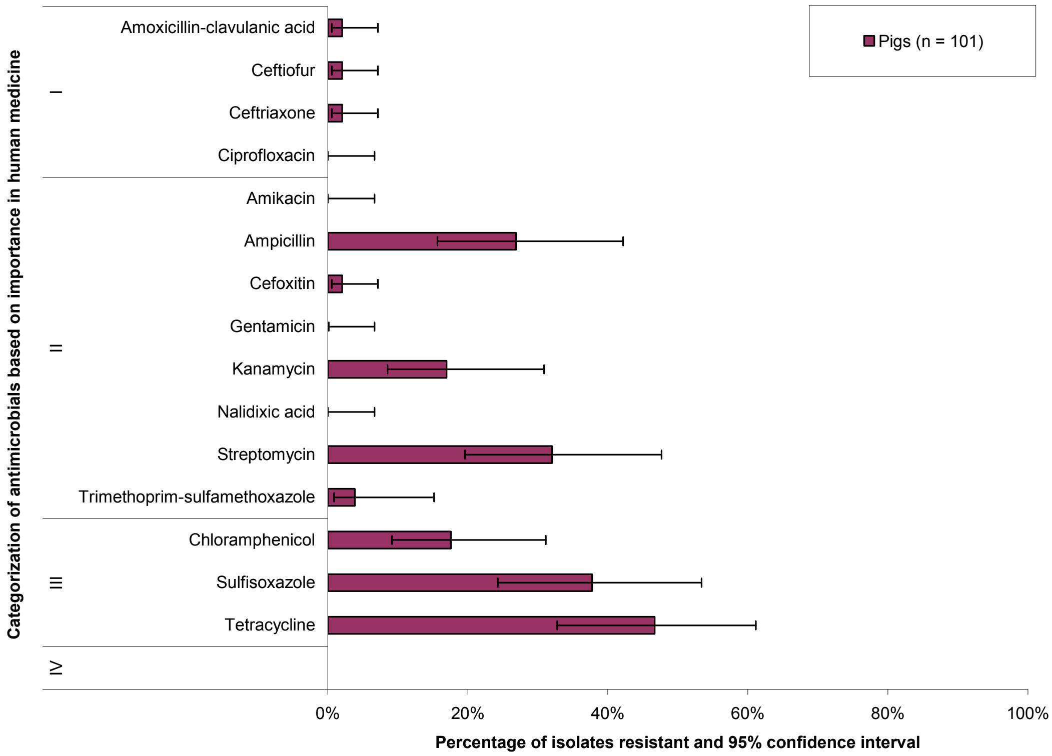
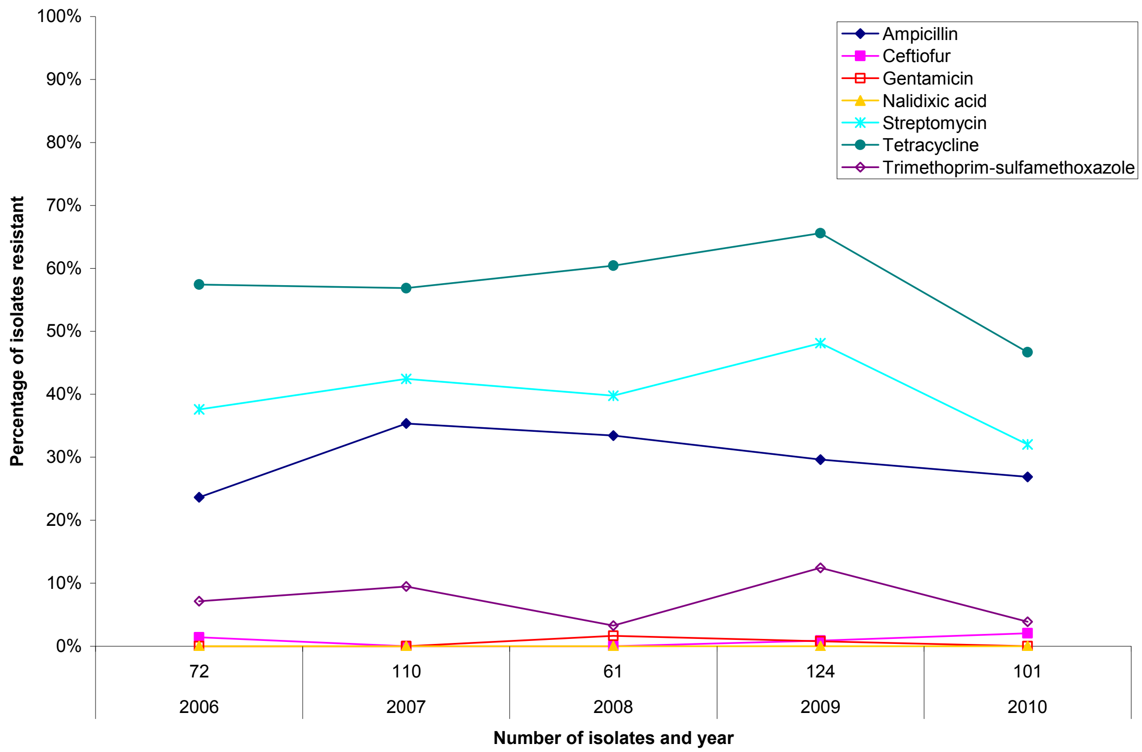


Table 19. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from pigs; *Farm Surveillance,* 2010.

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Typhimurium var. 5-	31 (30.7)	2	1	5	23				12	22	27	1	1	1	1	24	2	20			26
Derby	19 (18.8)	1	3	15					3	15						15					8
Infantis	14 (13.9)	11	3																		3
Brandenburg	11 (10.9)	6	5																		5
I 4,[5],12:i:-	6 (5.9)	1	3	1	1					2	1					1					5
Typhimurium	4 (4.0)			1	3				3	3	3					4	1	4			3
Bovismorbificans	2 (2.0)	2																			
Manhattan	2 (2.0)	2																			
Mbandaka	2 (2.0)	1		1						1						1					1
Ohio	2 (2.0)				2				1	2	1	1	1	1	1	2		2			2
Less common serovars	8 (7.9)	6		2												2					2
Total	**101 (100)**	**32**	**15**	**25**	**29**				**19**	**45**	**32**	**2**	**2**	**2**	**2**	**49**	**3**	**26**			**55**

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.

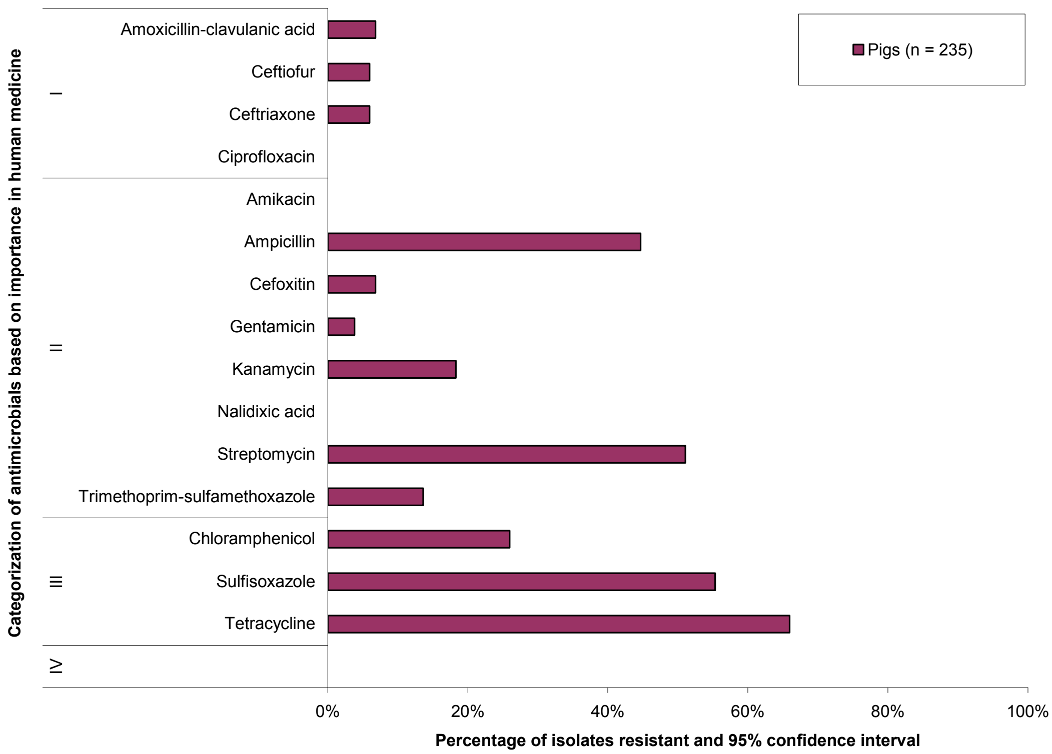
Figure 26. Temporal variation in resistance to selected antimicrobials in *Salmonella* isolates from pigs; *Farm Surveillance*, 2006–2010.



Surveillance of Animal Clinical Isolates

(n = 235)

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



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

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

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

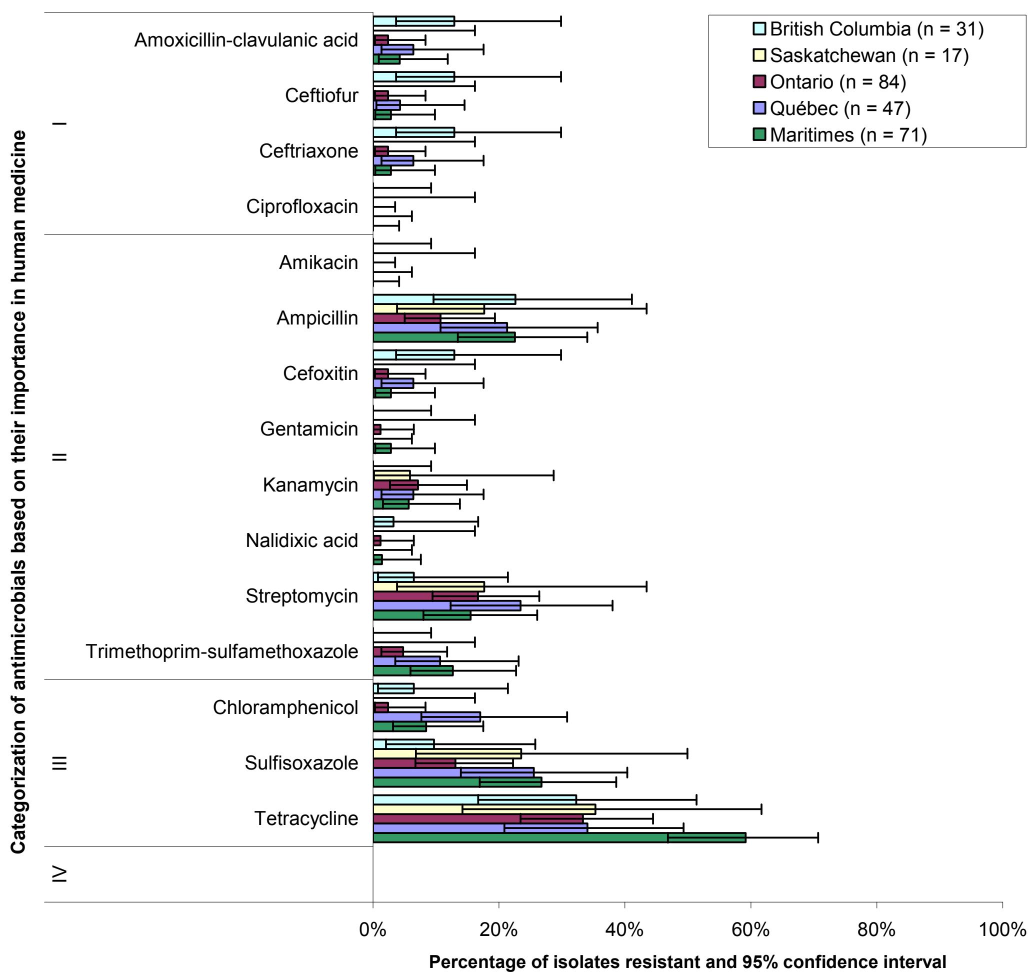
Serovars represented by less than 2% of isolates were classified as “Less common serovars”.
Red, blue, and black numbers indicate isolates resistant to antimicrobials in Categories I, II, and III of importance in human medicine, respectively.

Escherichia coli

Retail Meat Surveillance

(n = 250)[1]

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



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

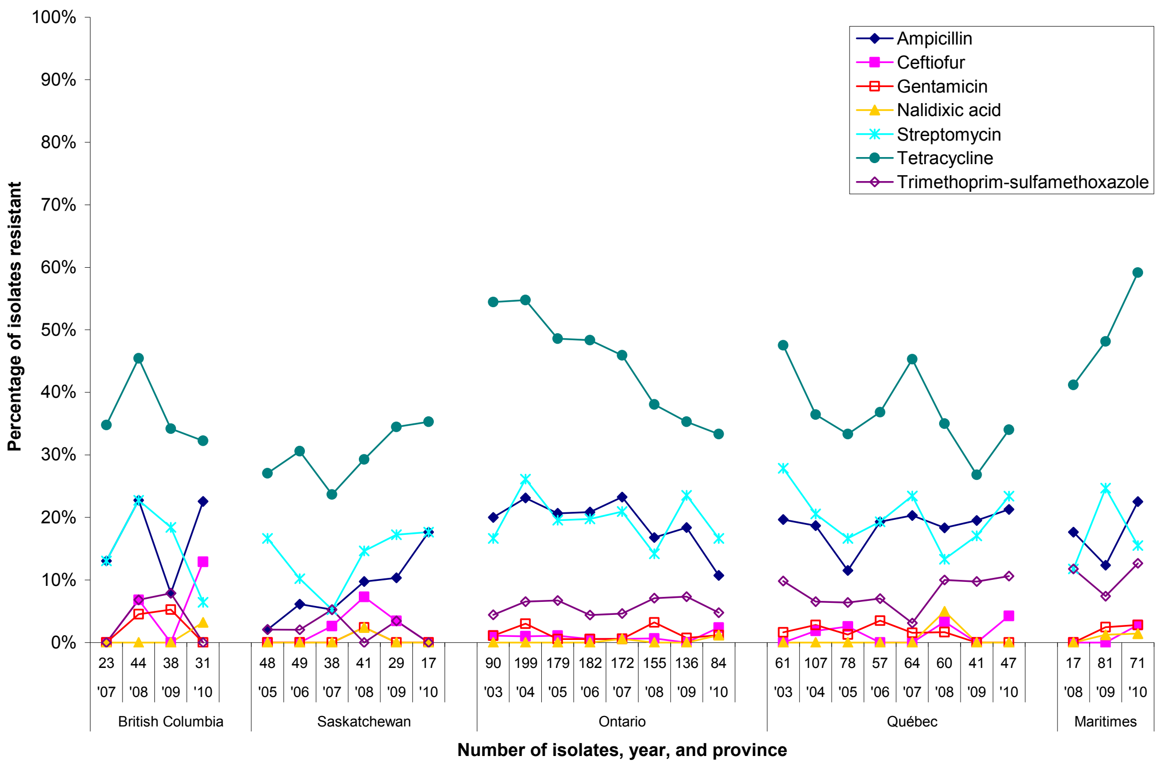
[1] Three isolates from the Maritimes could not be cultured after freezing, leaving 250 isolates available for antimicrobial susceptibility testing.

Table 21. Number of antimicrobial classes in resistance patterns of *Escherichia coli* isolates from pork; *Retail Meat Surveillance*, 2010.

Province	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
British Columbia	31 (12.4)	19	5	5	2					2	7	4	4	4	4	3		2		1	10
Saskatchewan	17 (6.8)	10	3	3	1				1	3	3					4					6
Ontario	84 (33.6)	54	13	10	7			1	6	14	9	2	2	2	2	11	4	2		1	28
Québec	47 (18.8)	26	3	12	6				3	11	10	3	3	3	2	12	5	8			16
Maritimes	71 (28.4)	23	19	22	7			2	4	11	16	3	2	2	2	19	9	6		1	42

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

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



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

Abattoir Surveillance

(n = 199)

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

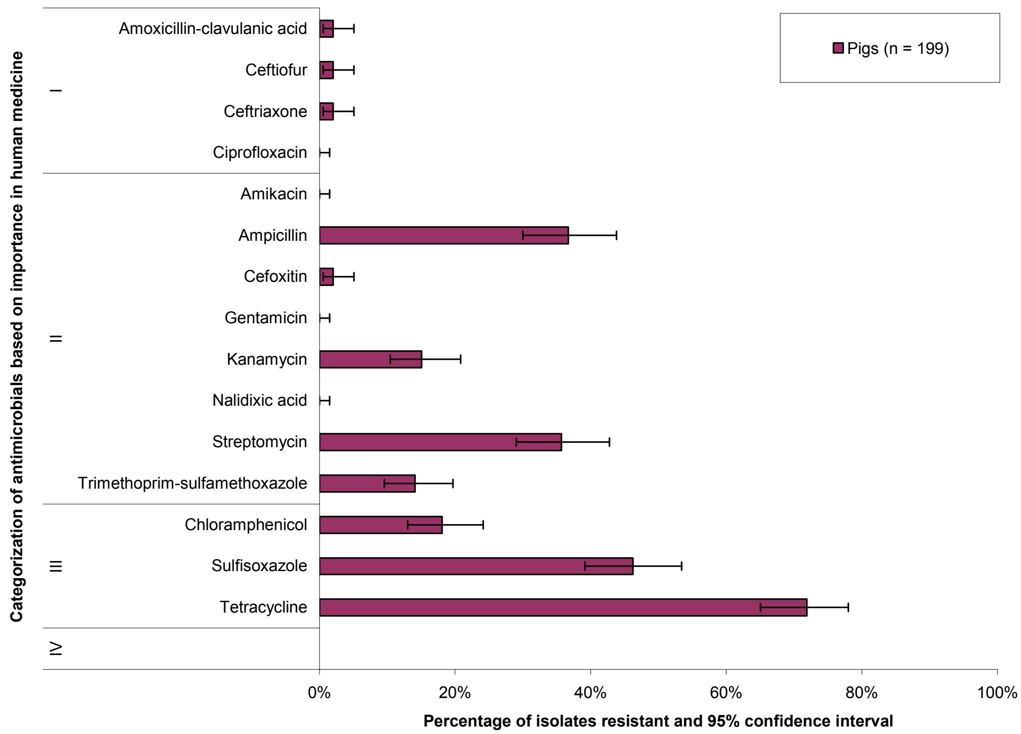
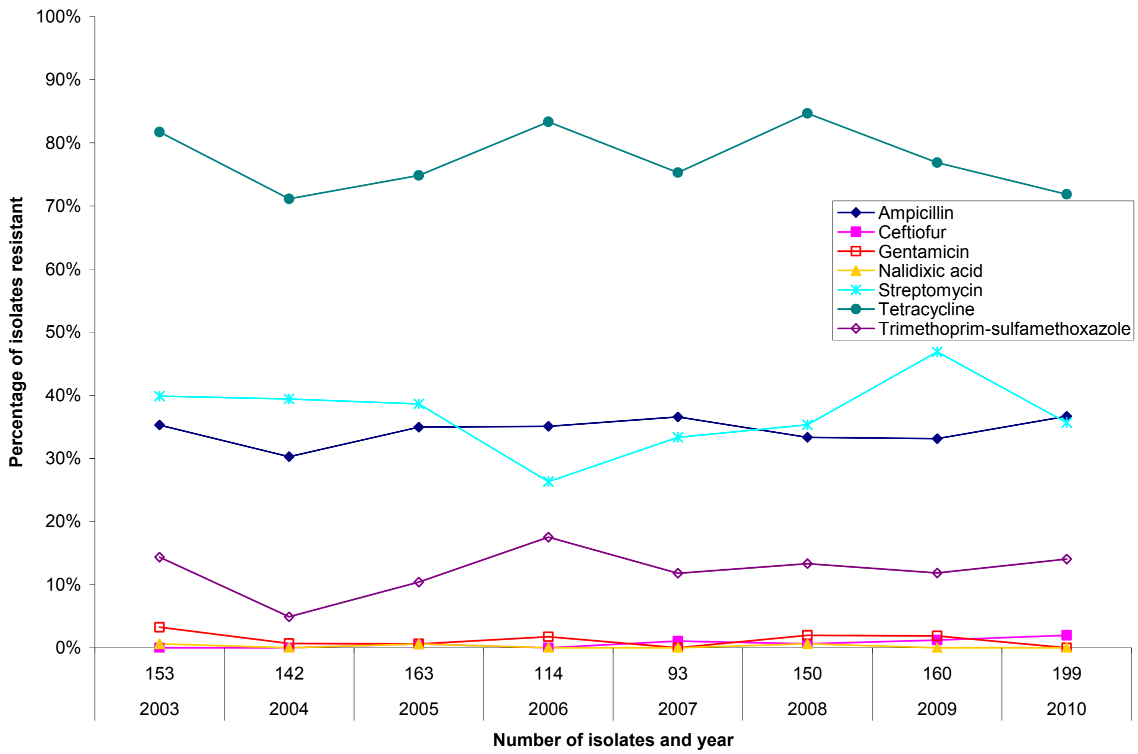


Figure 31. Temporal variation in resistance to selected antimicrobials in *Escherichia coli* isolates from pigs; *Abattoir Surveillance*, 2003–2010.

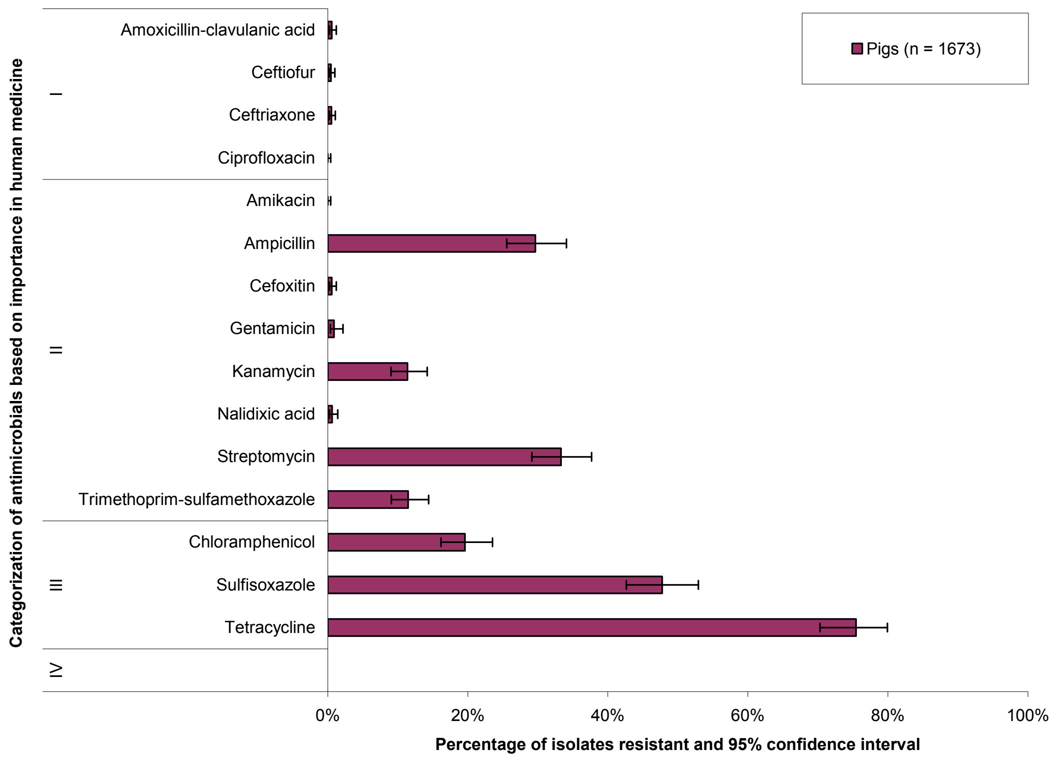


Results regarding the number of antimicrobial classes in resistance patterns of abattoir *E. coli* isolates from pigs can be found in Table 10.

Farm Surveillance

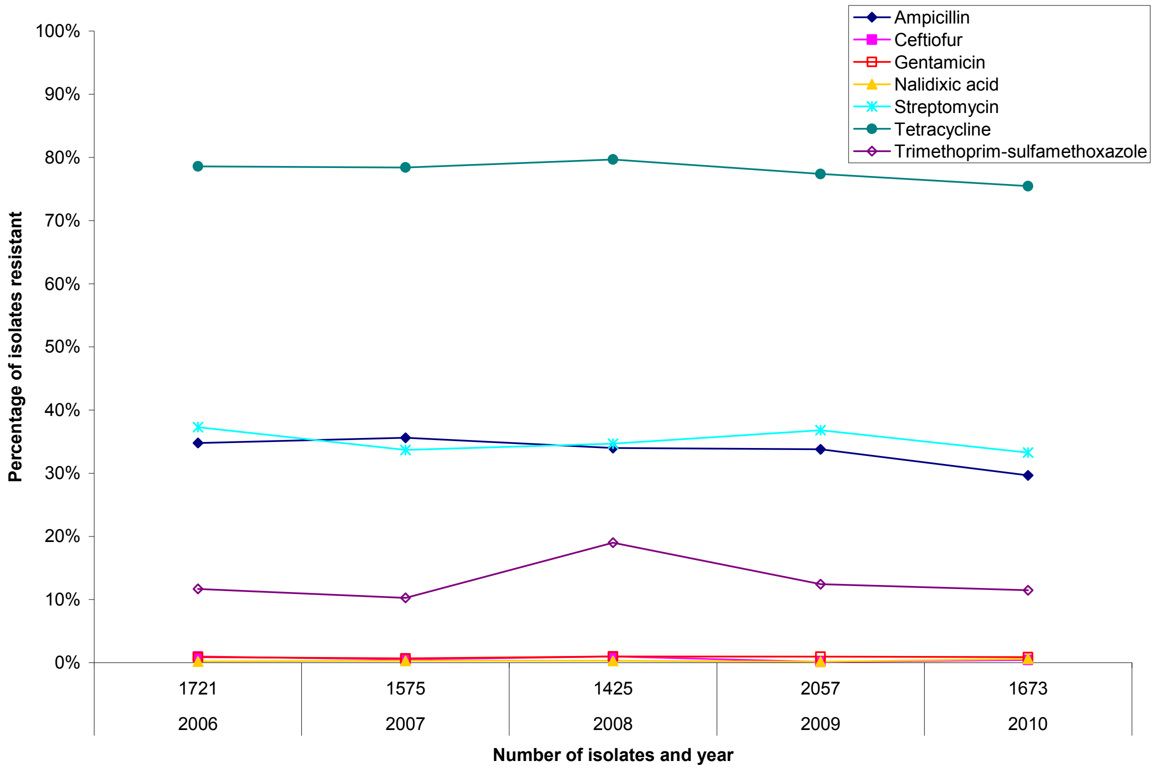
(n = 1,673)[1]

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



[1] Up to 3 generic *E. coli* isolates per positive sample were kept for analysis. The expected number of total isolates was 1,698 (566 x 3) but 25 isolates could not be cultured after freezing, leaving 1,673 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 in *Farm Surveillance* is to ensure adequate power to investigate the association between antimicrobial resistance and antimicrobial use.

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

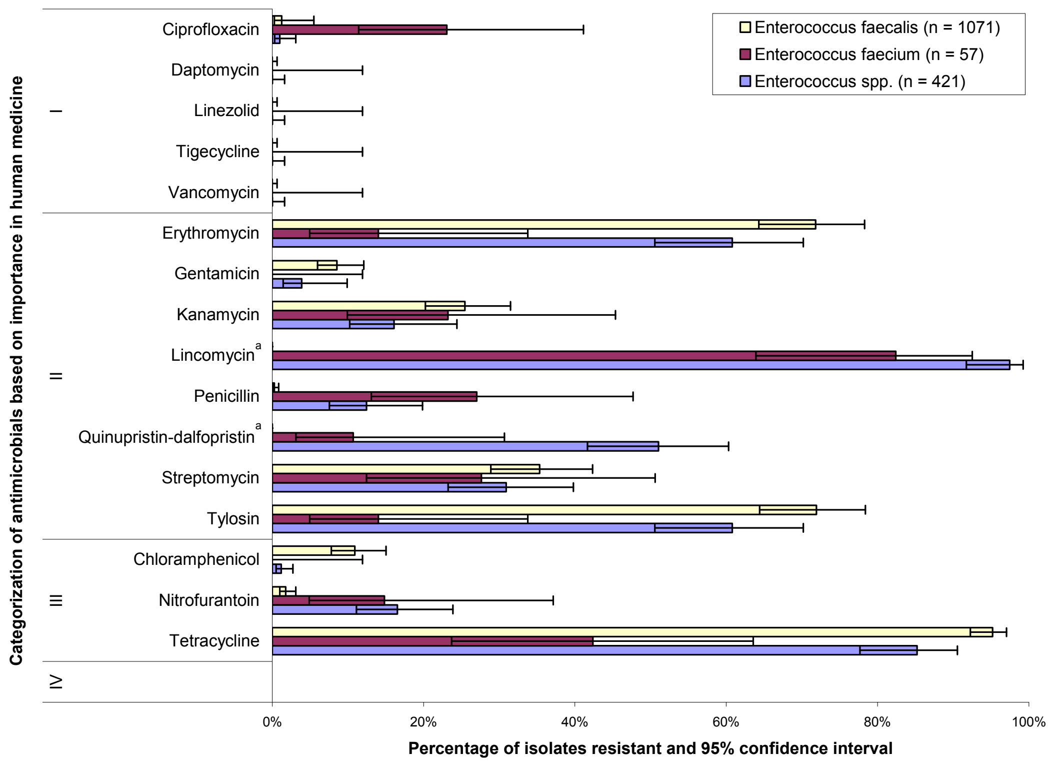


Enterococcus

Farm Surveillance

(n = 1,549)[1]

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



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

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[1] Up to 3 *Enterococcus* isolates per positive sample were kept for analysis. The expected number of total isolates was 1,635 (545 x 3) but 86 isolates could not be cultured after freezing, leaving 1,549 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 in *Farm Surveillance* is to ensure adequate power to investigate the association between antimicrobial resistance and antimicrobial use.

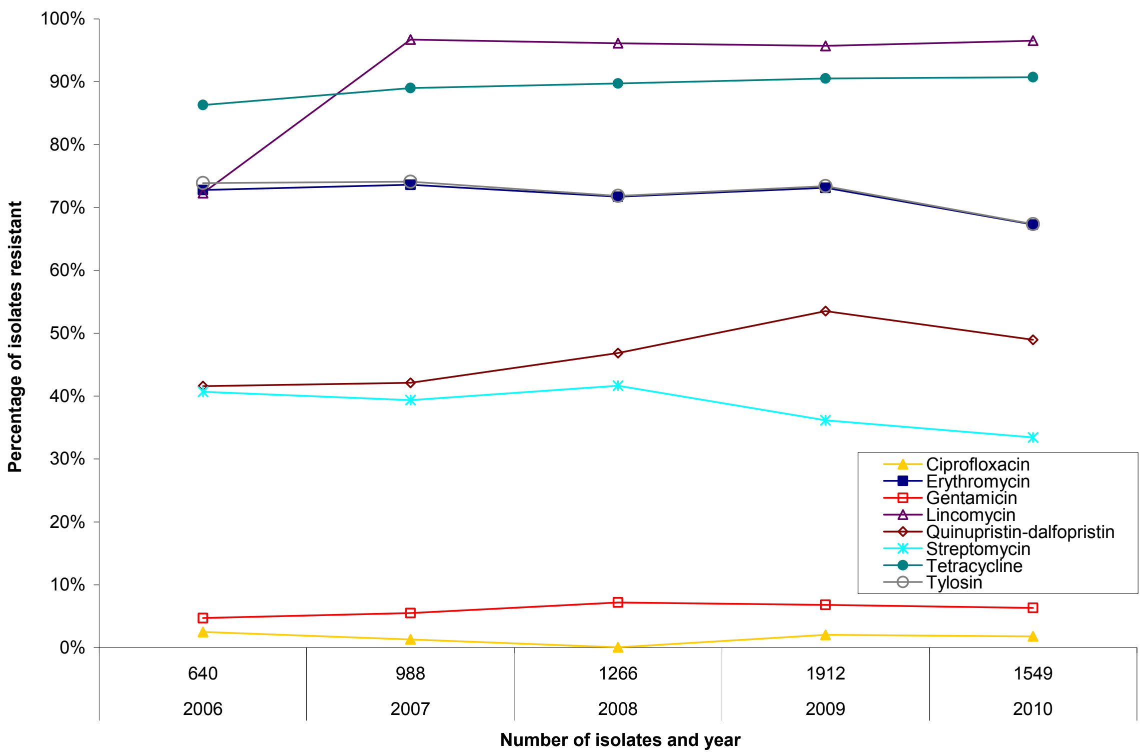
Table 22. Number of antimicrobial classes in resistance patterns of *Enterococcus* isolates from pigs; *Farm Surveillance*, 2010.

Species	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial																
							Aminoglycosides			Glycopeptides	Glycylcyclines	Lincosamides	Lipopeptides	Macrolides		Nitrofurans	Oxazolidinones	Penicillins	Phenicols	Quinolones	Streptogramins	Tetracyclines
		0	1	2–5	6–9	10–13	GEN	KAN	STR	VAN	TIG	LIN[a]	DAP	ERY	TYL	NIT	LNZ	PEN	CHL	CIP	QDA[a]	TET
Enterococcus faecalis	1,071 (69.1)	45	213	813			85	261	374					788	789	17		3	113	11		1019
Enterococcus spp.	421 (27.2)	11	46	317	47		13	60	115			408		260	260	62		60	5	4	216	353
Enterococcus faecium	57 (3.7)	4	19	28	6			15	20			48		10	10	8		19		11	7	31
Total	**1,549 (100)**	**60**	**278**	**1,158**	**53**		**98**	**336**	**509**			**456**		**1,058**	**1,059**	**87**		**82**	**118**	**26**	**223**	**1,403**

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



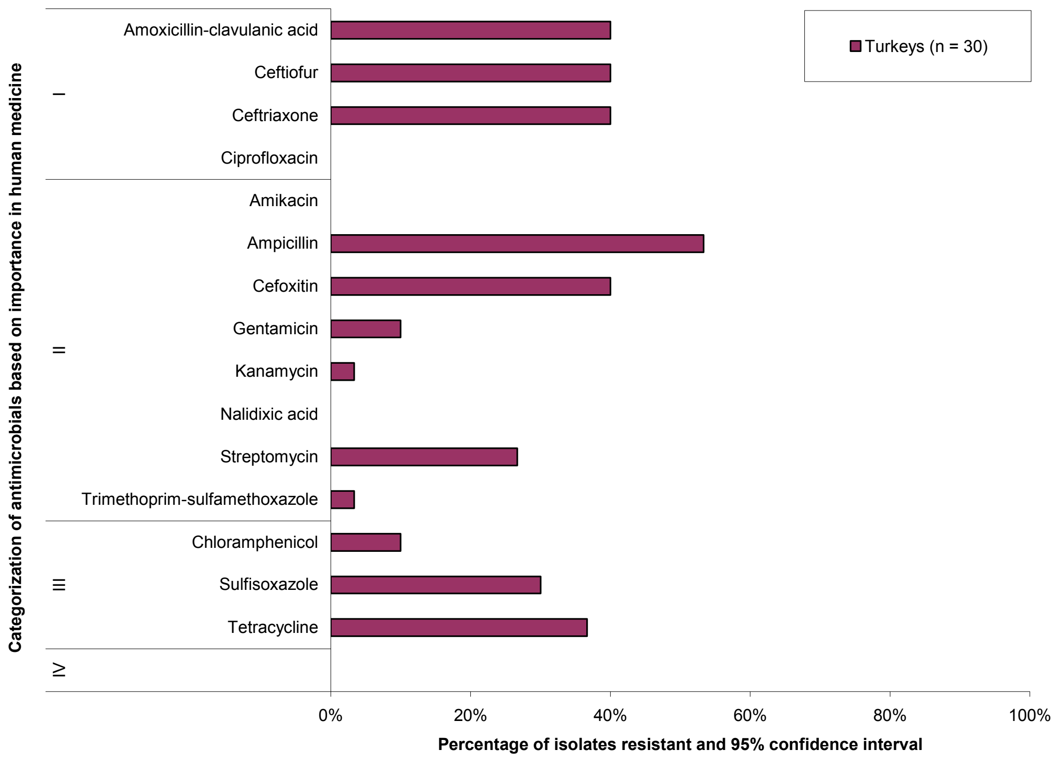
Turkeys

Salmonella

Surveillance of Animal Clinical Isolates

(n = 30)

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



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

.

Table 23. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from turkeys; *Surveillance of Animal Clinical Isolates*, 2010.

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial: Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Agona	7 (23.3)	1	3	1	2					2	5	5	5	5	5	3	1	2			3
Senftenberg	5 (16.7)		3	2				2		2	4	4	4	4	4	1					
Heidelberg	4 (13.3)	2	2																		2
Hadar	3 (10.0)		1	2						2											3
Saintpaul	2 (6.7)		1		1					1	2	1	1	1	1	1		1			1
Schwarzengrund	2 (6.7)	2																			
Typhimurium	2 (6.7)		2								2	2	2	2	2						
Typhimurium var. 5-	2 (6.7)			2							2					2					
Johannesburg	1 (3.3)			1												1					1
Montevideo	1 (3.3)			1				1	1	1						1					1
Muenster	1 (3.3)		1								1										
Total	**30 (100)**	**5**	**13**	**9**	**3**			**3**	**1**	**8**	**16**	**12**	**12**	**12**	**12**	**9**	**1**	**3**			**11**

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

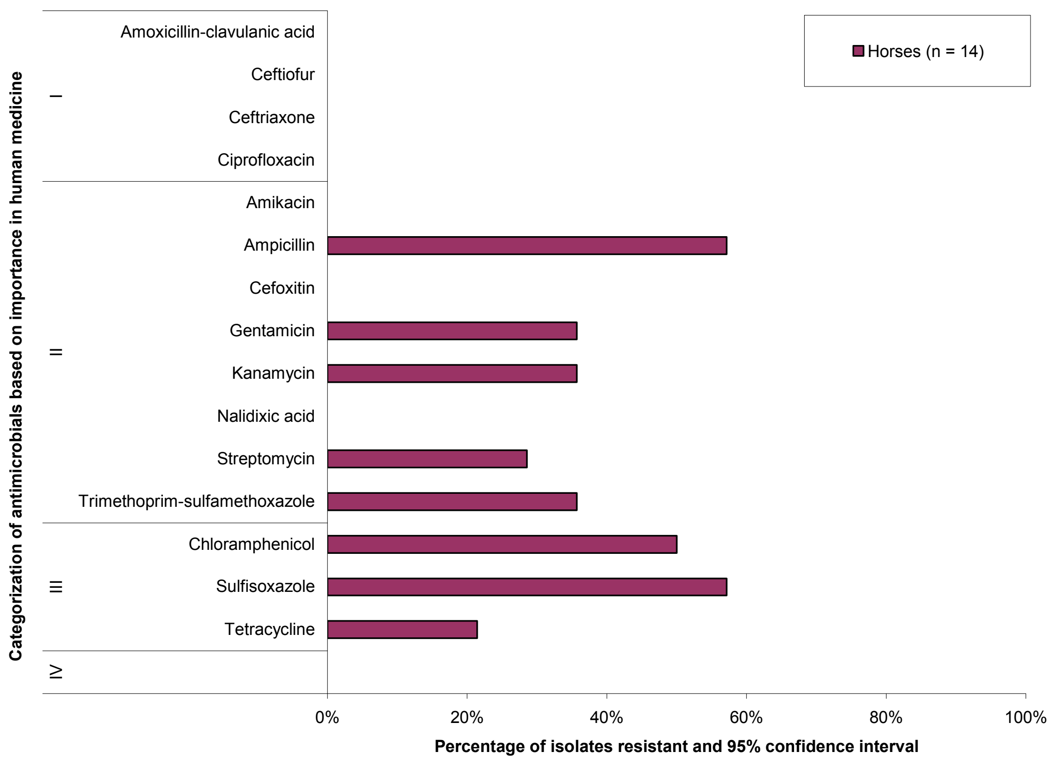
Horses

Salmonella

Surveillance of Animal Clinical Isolates

(n = 14)

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



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

Table 24. Number of antimicrobial classes in resistance patterns of *Salmonella* isolates from horses; *Surveillance of Animal Clinical Isolates*, 2010.

Serovar	Number (%) of isolates	Number of isolates by number of antimicrobial classes in the resistance pattern					Number of isolates resistant by antimicrobial class and antimicrobial															
							Aminoglycosides				β-lactams					Folate pathway inhibitors		Phenicols	Quinolones		Tetracyclines
		0	1	2–3	4–5	6	AMK	GEN	KAN	STR	AMP	AMC	CRO	FOX	TIO	SSS	SXT	CHL	CIP	NAL	TET
Heidelberg	5 (35.7)			1	4			5	5	1	5					5	5	4			
Typhimurium	3 (21.4)				3					3	3					3		3			3
Muenster	2 (14.3)	2																			
Braenderup	1 (7.1)	1																			
Enteritidis	1 (7.1)	1																			
Oranienburg	1 (7.1)	1																			
Saintpaul	1 (7.1)	1																			
Total	**14 (100)**	**6**		**1**	**7**			**5**	**5**	**4**	**8**					**8**	**5**	**7**			**3**

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)

Results from the surveillance component *Feed and Feed Ingredients* were not presented in this report because the 31 *Salmonella* isolates recovered were not resistant to any of the antimicrobials tested.

Appendix

Recovery Rates

Table A.1. Bacterial recovery rates of samples collected through the CIPARS agri-food components, 2002-2010.

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered/number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Retail Meat Surveillance										
Beef	British Columbia	2005	**93%**	27/29						
		2007	**79%**	49/62						
		2008	**77%**	88/115						
		2009	**71%**	79/112						
		2010	**51%**	64/125						
	Saskatchewan	2005	**79%**	120/151						
		2006	**76%**	123/161						
		2007	**78%**	118/151						
		2008	**76%**	134/177						
		2009	**83%**	135/163						
		2010	**80%**	107/134						
	Ontario	2003	**66%**	101/154	**2%**	2/84	**3%**	2/76	**91%**	69/76
		2004	**80%**	190/237						
		2005	**81%**	184/227						
		2006	**81%**	189/235						
		2007	**71%**	184/227						
		2008	**78%**	185/236						
		2009	**79%**	195/248						
		2010	**69%**	123/177						
	Québec	2003	**57%**	84/147	**0%**	0/33	**0%**	0/33	**80%**	28/35
		2004	**56%**	137/245						
		2005	**56%**	126/225						
		2006	**50%**	109/215						
		2007	**68%**	147/216						
		2008	**59%**	126/214						
		2009	**54%**	108/201						
		2010	**46%**	102/223						
	Maritimes	2004	**67%**	16/24						
		2007	**52%**	16/31						
		2008	**70%**	39/56						
		2009	**69%**	137/200						
		2010	**69%**	126/183						

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities.
Human and animal clinical *Salmonella* data were not presented as the information on the number of samples cultured and isolates recovered was unavailable to CIPARS.
The Maritimes region includes New Brunswick, Nova Scotia, and Prince Edward Island.

Table A.1 (continued). Bacterial recovery rates of samples collected through the CIPARS agri-food components, 2002-2010.

CIPARS Component/ Animal species	Province	Year	Percentage (%) of isolates recovered and number of isolates recovered/number of samples submitted							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Retail Meat Surveillance										
Chicken	British Columbia	2005	**95%**	19/20	**13%**	5/39	**69%**	27/39	**100%**	20/20
		2007	**98%**	42/43	**22%**[a]	18/81	**35%**	28/80	**100%**	34/34
		2008	**90%**	70/78	**32%**	47/145	**34%**	50/145	**100%**	78/78
		2009	**95%**	70/74	**40%**	59/146	**53%**	78/146	**97%**	72/74
		2010	**89%**	75/84	**34%**	56/166	**42%**	70/166		
	Saskatchewan	2005	**98%**	81/83	**14%**	21/153	**37%**	53/145	**98%**	83/85
		2006	**98%**	85/86	**16%**	25/153	**33%**	51/155	**98%**	85/87
		2007	**97%**	75/77	**31%**[a]	43/141	**35%**	49/141	**100%**	77/77
		2008	**99%**	91/92	**40%**	64/161	**25%**	41/161	**100%**	92/92
		2009	**98%**	90/92	**47%**	71/150	**32%**	48/150	**100%**	92/92
		2010	**90%**	71/79	**32%**	42/132	**28%**	37/132		
	Ontario	2003	**95%**	137/144	**16%**	27/167	**47%**	78/166	**99%**	143/144
		2004	**95%**	150/158	**17%**	54/315	**45%**	143/315	**100%**	158/158
		2005	**95%**	145/153	**9%**	26/303	**40%**	120/303	**99%**	150/152
		2006	**97%**	152/156	**12%**	36/311	**34%**	104/311	**98%**	154/156
		2007	**98%**	157/161	**54%**[a]	172/320	**37%**	117/320	**100%**	161/161
		2008	**96%**	150/156	**45%**	139/311	**39%**	121/311	**99%**	154/156
		2009	**95%**	155/164	**43%**	142/328	**31%**	101/328	**100%**	164/164
		2010	**86%**	100/116	**39%**	90/232	**28%**	64/232		
	Québec	2003	**89%**	112/126	**16%**	29/171	**55%**	94/170	**100%**	125/125
		2004	**96%**	157/161	**17%**	53/320	**50%**	161/322	**100%**	161/161
		2005	**95%**	142/149	**9%**	26/300	**34%**	103/299	**100%**	150/150
		2006	**94%**	135/144	**12%**	33/288	**35%**	100/288	**100%**	144/144
		2007	**90%**	129/144	**40%**[a]	113/287	**21%**	59/287	**99%**	143/144
		2008	**91%**	131/144	**42%**	120/287	**19%**	54/287	**100%**	144/144
		2009	**94%**	126/134	**39%**	105/267	**20%**	52/266	**99%**	132/134
		2010	**93%**	138/148	**39%**	116/296	**21%**	63/296		
	Maritimes	2004	**100%**	13/13	**4%**	1/25	**40%**	10/25	**100%**	13/13
		2007[b]	**91%**	29/32	**22%**[a]	7/32				
		2008[b]	**68%**	38/56	**22%**	12/56				
		2009[b]	**94%**	187/199	**49%**	97/199	**29%**	57/199		
		2010	**93%**	176/190	**41%**	77/190	**37%**	70/190		
Pork	British Columbia	2005	**31%**	10/32						
		2007	**29%**	23/79	**1%**	1/79				
		2008	**30%**	44/148	**2%**	3/148				
		2009	**26%**	38/145	**1%**	2/145				
		2010	**19%**	31/166	**1%**	2/167				
	Saskatchewan	2005	**30%**	48/162						
		2006	**30%**	49/165	**2%**	3/134				
		2007	**25%**	38/154	**2%**	3/154				
		2008	**23%**	41/176	**1%**	1/176				
		2009	**18%**	29/164	**0%**	0/164				
		2010	**12%**	17/142	**1%**	1/142				
	Ontario	2003	**58%**	90/154	**1%**	1/93	**0%**	0/76	**87%**	66/76
		2004	**71%**	198/279						
		2005	**59%**	179/303						
		2006	**59%**	182/311	**< 1%**	1/255				
		2007	**54%**	172/320	**2%**	6/319				
		2008	**50%**	155/312	**2%**	7/310				
		2009	**41%**	136/328	**2%**	8/327				
		2010	**38%**	84/224	**0%**	0/224				
	Québec	2003	**42%**	61/147	**3%**	1/32	**9%**	3/32	**82%**	28/34
		2004	**38%**	109/290						
		2005	**26%**	79/300						
		2006	**20%**	57/287	**0%**	0/232				
		2007	**22%**	64/287	**1%**	3/288				
		2008	**21%**	60/287	**2%**	5/286				
		2009	**15%**	41/268	**1%**	3/268				
		2010	**16%**	47/296	**1%**	4/296				
	Maritimes	2004	**58%**	14/24						
		2007	**39%**	13/31	**3%**	1/30				
		2008	**30%**	17/56	**2%**	1/56				
		2009	**41%**	82/200	**3%**	5/199				
		2010	**39%**	74/190	**4%**	8/190				

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities.

The Maritimes region includes 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 A.1 (continued). Bacterial recovery rates of samples collected through the CIPARS agri-food components, 2002-2010.

Composante du PICRA/ Espèce	Province	Année	Pourcentage (%) d'isolats détectés et le nombre d'isolats détectés/nombre d'échantillons soumis							
			Escherichia coli		*Salmonella*		*Campylobacter*		*Enterococcus*	
Surveillance en abattoir										
Bovins de boucherie		2002	**97%**	76/78	**1%**	3/78				
		2003	**97%**	155/159	**< 1 %**	1/114				
		2004	**98%**	167/170						
		2005	**97%**	122/126			**66%**	23/35		
		2006	**100%**	150/150			**36%**	31/87		
		2007	**99%**	188/190			**39%**	75/190		
		2008	**97%**	176/182			**71%**[c]	129/182		
		2009	**94%**	119/126			**68%**	86/126		
		2010	**97%**[d]	77/79			**53%**[d]	37/70		
Poulets		2002	**100%**	40/40	**13%**	25/195				
		2003	**97%**	150/153	**16%**	126/803				
		2004	**99%**	130/131	**16%**	142/893				
		2005	**99%**	218/220	**18%**	200/1,103				
		2006	**100%**	166/166	**23%**	187/824				
		2007	**99%**	180/181	**25%**	204/808				
		2008	**99%**	170/171	**28%**	234/851				
		2009	**100%**	171/171	**27%**	230/851				
		2010	**99%**	119/120	**24%**	142/599	**19%**	111/599		
Porcs		2002	**97%**	38/39	**27%**	103/385				
		2003	**98%**	153/155	**28%**	395/1393				
		2004	**99%**	142/143	**38%**	270/703				
		2005	**99%**	163/164	**42%**	212/486				
		2006	**98%**	115/117	**40%**	145/359				
		2007	**98%**	93/95	**36%**	105/296				
		2008	**100%**	150/150	**44%**	151/340				
		2009	**98%**	160/163	**45%**	147/327				
		2010	**98%**	199/203	**44%**	182/410				
Surveillance à la ferme										
Porcs		2006	**99%**	459/462	**20%**	94/462			**81%**	374/462
		2007	**100%**	612/612	**21%**	136/612			**81%**	495/612
		2008	**99%**	481/486	**13%**	61/486			**92%**	448/486
		2009	**99%**	695/698	**18%**	124/698			**97%**	680/698
		2010	**99%**	566/569	**18%**	101/569			**96%**	545/569

Results in the grey-shaded areas indicate samples that were not cultured, or isolates that were recovered but not submitted as part of CIPARS core surveillance antimicrobial susceptibility testing activities.

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

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

Antimicrobial Susceptibility Breakpoints

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

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Amoxicillin-clavulanic acid	1.0/0.5 – 32/16	≤ 8/4	16/8	≥ 32/16
	Ceftiofur	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-S21.
[b] No Clinical and Laboratory Standards Institute interpretive criteria for Enterobacteriaceae were available for this antimicrobial. Breakpoints were based on the distribution of minimal inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.

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

	Antimicrobial	Range tested (μg/mL)	Breakpoints[a] (μg/mL)		
			S	I	R
I	Ciprofloxacin	0.12 – 4	≤ 1	2	≥ 4
	Daptomycin[b]	0.25 – 16	≤ 4	N/A	N/A
	Linezolid	0.5 – 8	≤ 2	4	≥ 8
	Tigecycline[c]	0.015 – 0.5	≤ 0.25	0.5	≥ 1
	Vancomycin	0.25 – 32	≤ 4	8 – 16	≥ 32
II	Erythromycin	0.25 – 8	≤ 0.5	1 – 4	≥ 8
	Gentamicin (high-level)	128 – 1,024	≤ 500	N/A	> 500
	Kanamycin (high-level)[b]	128 – 1,024	≤ 512	N/A	≥ 1,024
	Lincomycin[b]	1 – 8	≤ 2	4	≥ 8
	Penicillin	0.25 – 16	≤ 8	N/A	≥ 16
	Quinupristin-dalfopristin	0.5 – 32	≤ 1	2	≥ 4
	Streptomycin (high-level)[b]	512 – 2,048	≤ 1,000	N/A	> 1,000
	Tylosin[b]	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 V indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate resistance. R = Resistant. N/A = Not applicable.
[a] CLSI M100-S21 Table 2D. M7-A8-MIC Testing section.
[b] No Clinical and Laboratory Standards Institute (CLSI) interpretive criteria for *Enterococcus* were available for this antimicrobial. Breakpoints were based on the distribution of minimal inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.
[c] Based on the resistance breakpoint from the European Committee on Antimicrobial Susceptibility Testing because no interpretative criteria were available from the CLSI for tigecycline.

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

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

Roman numerals I to IV indicate the ranking of antimicrobials based on importance in human medicine as outlined by the Veterinary Drugs Directorate.
S = Susceptible. I = Intermediate susceptibility. R = Resistant. N/A = Not applicable.
[a] CLSI M45-A2.
[b] No Clinical and Laboratory Standards Institute interpretive criteria for *Campylobacter* were available for this antimicrobial. Breakpoints were based on the distribution of minimal inhibitory concentrations and were harmonized with those of the National Antimicrobial Resistance Monitoring System.
[c] For florfenicol, only a susceptible breakpoint has been established. In this report, we therefore only report the proportion of isolates non-susceptible.

Abbreviations

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/Territories and Regions

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

Maritimes region

New Brunswick

Nova Scotia

Prince Edward Island