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

CHAPTER 4
INTEGRATED FINDINGS AND DISCUSSION

Canada

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

—Public Health Agency of Canada

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4 INTEGRATED FINDINGS AND DISCUSSION

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PREAMBLE

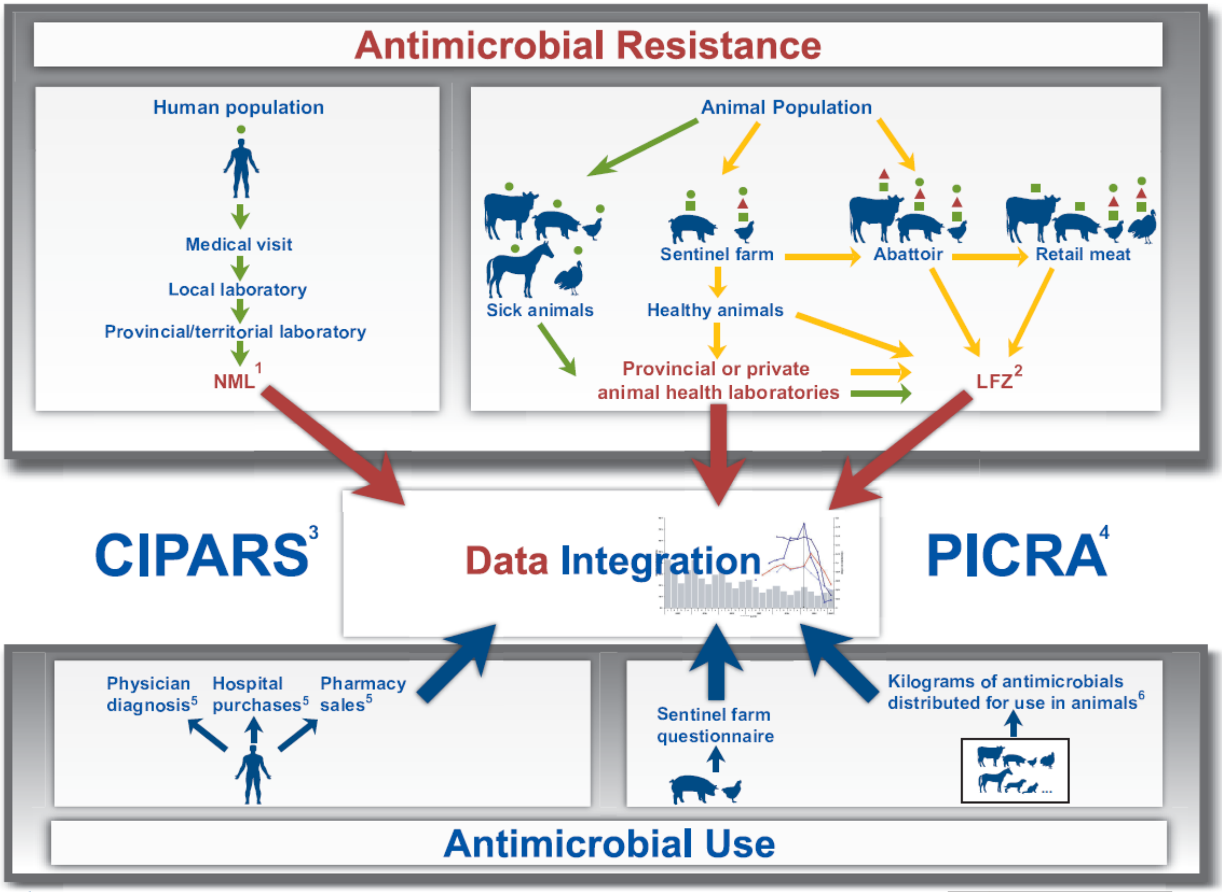
ABOUT CIPARS

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

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

CIPARS SURVEILLANCE COMPONENTS AND DATA SOURCE

Figure 1. Diagram of CIPARS surveillance components in 2013



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Active Surveillance
Passive Surveillance
Salmonella
Campylobacter
Escherichia coli

HOW TO READ THIS CHAPTER

INTEGRATION OF ANTIMICROBIAL RESISTANCE DATA

To identify the key stories arising from the 2013 CIPARS surveillance year, the CIPARS analysis team closely examines the data coming out of all the individual components of CIPARS together. Select findings included in this chapter involve "common themes" that span multiple surveillance components and species (including humans). For example, this might include similar trends in resistance for a given *Salmonella* serovar across components (agri-food and human). Alternatively, results might also reflect similar trends across components in terms of bacterial prevalence, yet very different rates of antimicrobial resistance.

Salmonella is the only bacteria for which data are available across all antimicrobial resistance surveillance components; as such, several of the integrated antimicrobial resistance findings presented in this chapter are about select *Salmonella* serovars. In addition, we carefully review the data about other potential human enteric pathogens. In 2013, findings about ciprofloxacin resistance in *Campylobacter* are presented despite having no data about resistance in *Campylobacter* isolates from human cases. Finally, we report on isolates that have concerning multiclass resistance profiles.

The main focus of the antimicrobial resistance integration is on antimicrobials of very high importance to human medicine (Category I) and other select clinically important antimicrobials. All of the data presented and summarized in this chapter have been reported previously in the CIPARS 2013 Annual Report, Chapter 2—Antimicrobial Resistance, Chapter 3—Antimicrobial Use In Animals[11], and in the Public Health Agency of Canada's (PHAC's) Human Antimicrobial Drug Use Report 2012/2013[12].

INTEGRATION OF ANTIMICROBIAL USE DATA

In working with Canadian and international stakeholders, CIPARS has made significant strides in collecting and reporting antimicrobial use in both the human and the agri-food sectors.

Human antimicrobial use information represents total antimicrobials dispensed through community pharmacies as well as total antimicrobials purchased by hospitals. In addition, information is also available to describe the indication/diagnoses for which an antimicrobial

[11] Government of Canada, 2015. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) Annual Report 2013. Available at: www.publications.gc.ca/pub?id=472507&sl=0. Accessed January 2015.
[12] Public Health Agency of Canada, 2014. Human antimicrobial drug use report 2012/2013. Available at: www.phac-aspc.gc.ca/publicat/hamdur-rumamh/2012-2013/index-eng.php. Accessed January 2015.

was recommended by office-based physicians. These data are purchased from IMS Health Inc. and detailed information is presented as part of the PHAC's Human Antimicrobial Drug Use Report[13].

Animal antimicrobial use information is provided by the Canadian Animal Health Institute (CAHI) and consists of antimicrobial quantities distributed for sale in Canada. These data do not account for antimicrobials imported under the own-use provisions or as active pharmaceutical ingredients. The latest information from CAHI is that the lost opportunity value due to own-use importation (OUI) and active pharmaceutical ingredients (API) was estimated to be 13% of the total of all animal health product sales. It should be noted that distribution data do not represent actual antimicrobial use in a given year; they reflect the volume of antimicrobials distributed by manufacturers. Furthermore, caution must be applied to avoid using national distribution (CAHI) data to infer any species-specific antimicrobial use practices; some antimicrobials are not used in some animal species, yet intensively used in others. Information on antimicrobial use in grower-finisher pigs (closest growth phase to the consumer; approximately 2 to 6 months of age) and broiler chickens is collected from sentinel farms as part of the CIPARS *Farm Surveillance* component. This data source provides commodity-specific information including the reasons for antimicrobial.

More information regarding the collection of sentinel farm and CAHI data can be found in the CIPARS 2013 Annual Report, Chapter 1—Materials and Methods.

For the first time in 2013, we have been able to integrate antimicrobial use and antimicrobial resistance data; both types of data are included in several of the selected stories presented in this chapter. All of the data presented and summarized in this chapter have been reported previously in the Chapter 2—Antimicrobial Resistance, Chapter 3—Antimicrobial Use[14], and in the PHAC Human Antimicrobial Drug Use Report 2012/2013[13].

Note: Some of this information differs slightly than what was presented in the Canadian Antimicrobial Resistance Surveillance System (CARSS) 2015 Report[14] as since the time of writing that report, some members of CAHI have updated their data.

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[13] Public Health Agency of Canada, 2015. PHAC Human Drug Use Report 2012/2013. Available at: www.phac-aspc.gc.ca/publicat/hamdur-rumamh/2012-2013/index-eng.php. Accessed June 2015.

[14] Government of Canada, 2015. Canadian Antimicrobial Resistance Surveillance System Report, 2015. Available at: http://healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/antibiotic-resistance-antibiotique/antimicrobial-surveillance-antimicrobioresistance-eng.php. Accessed May 2015.

SUMMARY—INTEGRATED FINDINGS AND DISCUSSION

Common threads surface throughout the analysis of CIPARS data. These findings may traverse host species (human, chicken, pigs, beef cattle, and turkey), the surveillance components [human, farm, abattoir (slaughterhouse), retail meat, and clinical animals], antimicrobial resistance and antimicrobial use, or a combination of these. This chapter aims to identify the most relevant of these findings and present data from multiple CIPARS sources together in an integrated manner.

SALMONELLA ENTERITIDIS; HUMAN INCIDENCE AND AGRI-FOOD RECOVERY

- No evidence that **resistant** *Salmonella* Enteritidis cases in humans are linked to Canadian agri-food sources.
- Retail chicken may be an important exposure source for people infected with **susceptible** *S*. Enteritidis in Canada.

RESISTANCE TO CATEGORY I β-LACTAMS[15] IN NON-TYPHOIDAL *SALMONELLA* AND GENERIC *ESCHERICHIA COLI*

- There is evidence of resistance to medically important antimicrobials among bacteria of food animal origin.
- Most of resistance to Category I β-lactams in people is observed in *S.* Heidelberg isolates.

CAMPYLOBACTER AND RESISTANCE TO CIPROFLOXACIN

- Ciprofloxacin resistance in *Campylobacter* shows changing regional patterns in retail chicken and turkey meat but there are limited data accessible to CIPARS about resistance in human clinical isolates.

MULTICLASS RESISTANCE AND OTHER ANTIMICROBIAL RESISTANCE TRENDS TO MONITOR

- Not all concerning resistance trends in bacteria from humans correlate clearly with what we are observing in bacteria from agri-food sources.

[15] Category I antimicrobials are those classified by Health Canada to be of very high importance to human medicine.

COMPARISONS OF ANTIMICROBIALS SOLD AND/OR INTENDED FOR USE IN HUMANS AND ANIMALS

- Quantities adjusted for populations and weights
  - In 2013, after adjusting for body weight and population size, the quantity of antimicrobials distributed and/or sold for use in animals was estimated to be 1.4 times greater than the quantity distributed to people.
  - When adjusted by populations and weights, the quantity of antimicrobials distributed for humans and animals has increased slightly since 2006.
- Total kilograms and relative frequency of antimicrobial classes distributed and/or sold for use in animals and people
  - In 2013, 80% of antimicrobials distributed and/or sold in Canada were intended for animal use.
  - While many of the same antimicrobial drugs are distributed and/or sold for use in both humans and animals, the relative amounts used differ between people and animals and between the different animal species.
- Reasons for use:
  - There are important differences in the primary reasons for antimicrobial use and how they are administered between humans and different livestock species.

INTEGRATED ANTIMICROBIAL RESISTANCE AND USE FINDINGS AND DISCUSSION

SALMONELLA ENTERITIDIS: HUMAN INCIDENCE AND AGRI-FOOD RECOVERY

In 2013, *Salmonella* Enteritidis was the most common serovar causing salmonellosis in people in Canada (2,019 isolates, 32% of all *Salmonella* isolates)[16]. It was the most frequent serovar observed in all provinces, representing between 25% (285/1,157) (Québec) and 59% (13/22) (Prince Edward Island) of all *Salmonella* isolates.

Overall, 16% (121/746) of *S*. Enteritidis isolates from humans submitted for antimicrobial resistance testing by CIPARS were resistant to 1 or more antimicrobials tested. The most common resistance pattern observed (10%, 74/746) was to nalidixic acid, a quinolone antimicrobial. Although nalidixic acid is a Category II antimicrobial, resistance to nalidixic acid can be an indicator of resistance to fluoroquinolones, which include Category I antimicrobials of very high importance to human medicine. The most common Category I resistance observed in *S*. Enteritidis in 2013 was to ciprofloxacin, a fluoroquinolone antimicrobial; 2% (11/746) of *S*. Enteritidis isolates were resistant to ciprofloxacin.

Less than 1 percent (3/746) of *S*. Enteritidis isolates were resistant to all of the Category I β-lactams tested (amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone).

In contrast with the human data, *S.* Enteritidis was not among the most common serovars observed in the animal and agri-food data in 2013. However, when isolated, this serovar was most frequently associated with broiler chickens and chicken meat than with any other animal species or food source (cattle, swine, and turkey).

Important regional differences were observed in the recovery of this serovar from retail chicken. In Western Canada (British Columbia and Saskatchewan), *S*. Enteritidis was the most common serovar recovered from retail chicken meat; 13% (15/118) of samples purchased in British Columbia and 12% (14/120) in Saskatchewan resulted in positive cultures for *S.* Enteritidis. *Salmonella* Enteritidis was rarely detected in Ontario or Québec; no retail chicken samples purchased in Ontario were contaminated with *S*. Enteritidis and just 1 *S*. Enteritidis isolate was recovered from samples purchased in Québec. The recovery of *S*. Enteritidis among chickens sampled at slaughter was 2% (14/672) nationally.

[16] Government of Canada. National Enteric Surveillance Program (NESP) Annual Summary 2013: Public Health Agency of Canada, Guelph, 2015.

Unlike *S*. Enteritidis isolates recovered from humans, of which 16% (119/746) were resistants to some antimicrobials, no isolates from routine retail, farm or abattoir surveillance were resistant to any of the antimicrobials tested. Among the animal clinical data, a single cattle isolate from Alberta was resistant to cefoxitin, chloramphenicol, and sulfisoxazole.

Figure 2 displays an overlay of human *S.* Enteritidis incidence and recovery by province (proportion of samples that yielded an *S*. Enteritidis isolate) from retail chicken. This figure shows that the apparent correlation between human incidence and recovery from retail chicken is stronger in Western Canada than in other regions, suggesting that regional differences in exposures affect the incidence of human *S*. Enteritidis. It should be noted that human incidence rates presented in Figure 2 include travel related cases. In Canada, approximately 30% of all *Salmonella* human cases have been found to be travel acquired; in 2011 to 2012, 32% (150/469) of *Salmonella* cases were travel-related (7.5 cases/100,000 person-years)[17]. Therefore, these human rates include cases for which a Canadian exposure cannot be measured or predicted.

Despite similar patterns of human incidence and recovery from retail chicken meat, different resistance patterns from these isolates suggest that resistant *S*. Enteritidis isolates infecting people may not be originating from the major agricultural food-producing animals and food commodities produced in Canada. Imported chickens/chicken meat are unlikely to influence this trend as the number of hatching eggs, chicks, and meat imported to Canada annually (i.e., data collected by the Canadian Food Inspection Agency and reported by Agriculture and Agri-Food Canada)[18] remained relatively stable and paralleled the increase in national production as the proportion of imports are set to certain levels (e.g., 17.4% of hatching eggs, 3.7% of broiler chicks, and approximately 15% of broiler meats: allocation of 7.5% and additional 7.5% imported through issuance of supplementary import permits)[19]. Retail chicken, however, may still be an important exposure source for people infected with susceptible *S*. Enteritidis in Canada. This is further supported by the phage types that are frequently recovered from humans and chicken sources: the main phage types in people in 2013 were 8, 13a, and 13, which were among the most common phage types observed in chicken in 2013 as well. These phage types are typically not resistant to the antimicrobials tested. Phage types among resistant *S.* Enteritidis isolates from humans were primarily 1, 4, atypical, and 6a, which were rarely seen among agri-food isolates.

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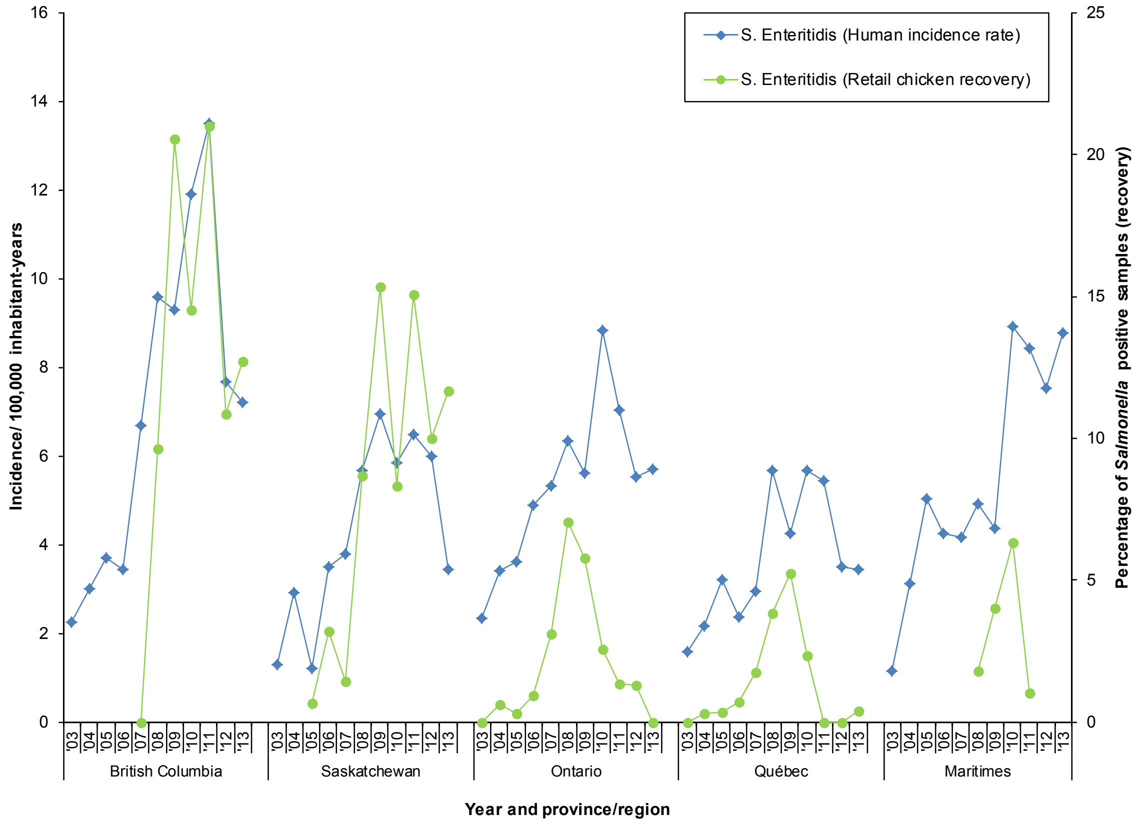
[17] Government of Canada. Canadian National Enteric Pathogen Surveillance System (FoodNet Canada) 2015. Guelph, ON: Public Health Agency of Canada.

[18] Government of Canada. Agriculture and Agri-Food Canada: Import and Export Reports. Available at: www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/poultry-and-eggs/poultry-and-egg-market-information-canadian-industry/imports-and-exports/?id=1384971854403#poultryexp. Accessed September 2015.

[19] Chicken Farmers of Canada. Chicken Data Booklet. Available at: www.chickenfarmers.ca/wp-content/uploads/2014/01/Data_Booklet_2013_web.pdf. Accessed September 2015.

Key Message: Resistant Salmonella* Enteritidis *isolates infecting people may not be originating from the major agricultural food-producing animals and food commodities produced in Canada tested by CIPARS. Retail chicken, however, may still be an important exposure source for people of susceptible S. Enteritidis in Canada.

Figure 2. Incidence of human *Salmonella* Enteritidis and proportion of retail chicken positive for *Salmonella* Enteritidis



Data source: National Enteric Surveillance Program (NESP) 2013 and CIPARS 2003 to 2013.
The Maritimes region includes New Brunswick, Nova Scotia, and Prince Edward Island.
In 2012, there were insufficient samples collected in the Maritimes due to unanticipated breaks in sampling. In 2013, full sampling resumed; results from these samples are pending and will be added to subsequent reports and presentations as soon as possible.

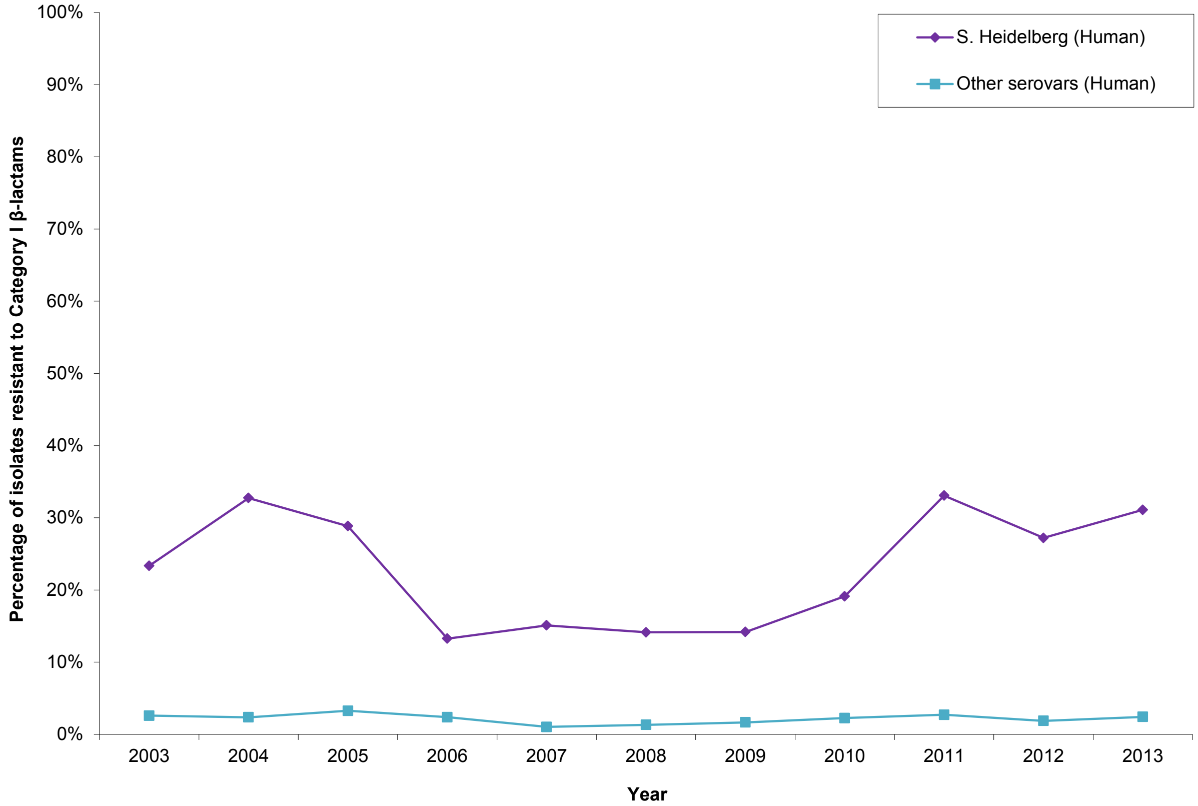
RESISTANCE TO CATEGORY I β-LACTAMS IN NON-TYPHOIDAL *SALMONELLA* AND GENERIC *ESCHERICHIA COLI*

Category I antimicrobials are those classified by Health Canada to be of very high importance to human medicine[20]. The β-lactam class of antimicrobials includes both penicillins and cephalosporins. This class of antimicrobials is commonly used to treat a variety of human and animal infections. The Category I β-lactams that are routinely tested by CIPARS include: amoxicillin-clavulanic acid, ceftiofur, and ceftriaxone. All discussion that follows refers to non-typhoidal *Salmonella* isolates only (all *Salmonella* serovars excluding Typhi and Paratyphi A or B).

Twenty-five percent (761/2,985) of all human non-typhoidal *Salmonella* infections were resistant to one or more antimicrobials tested. Six percent (192/2,985) of the human non-typhoidal *Salmonella* isolates tested by CIPARS in 2013 were resistant to at least 1 Category I β-lactam. Most resistance to Category I β-lactams in people occurred among *S*. Heidelberg isolates; 31% (130/418) of all 2013 *S*. Heidelberg isolates from human cases were resistant compared to just 2% (62/2,567) of all other serovars tested (Figure 3).

[20] Health Canada. 2009. Categorization of antimicrobial drugs based on importance in human medicine. Available at: www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php. Accessed February 2015.

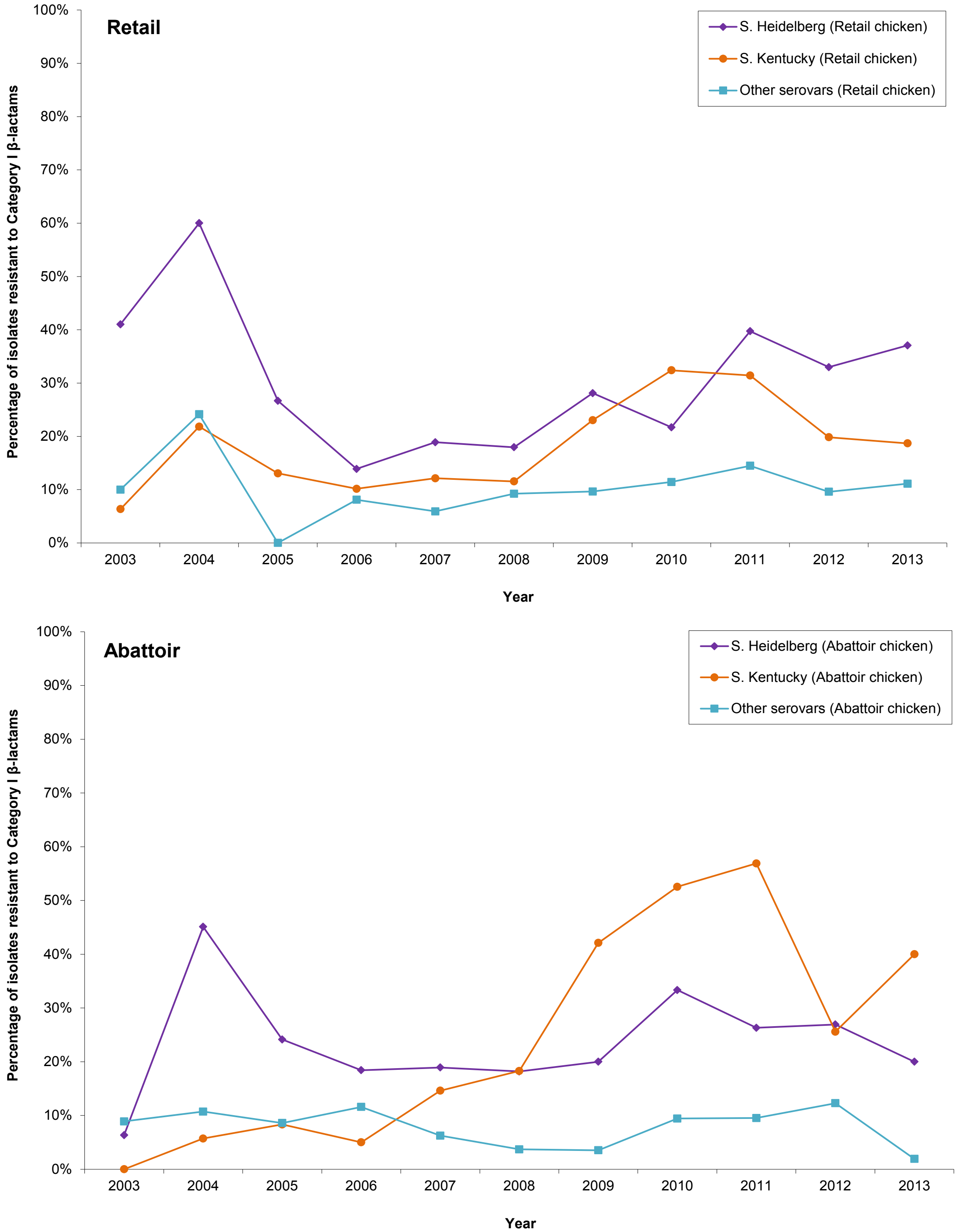
Figure 3. Resistance to Category I β-lactams among *Salmonella* Heidelberg and all other human non-typhoidal *Salmonella* serovars



Data source: CIPARS 2003 to 2013.

Resistance among *Salmonella* isolates to Category I β-lactams varied across the agri-food sectors in 2013. Similar to human isolates, among *Salmonella* isolates from chicken retail meat resistance to Category I β-lactams was most commonly observed in *S*. Heidelberg isolates in 2013 (Figure 4). This resistance was also observed in abattoir chicken isolates (Figure 4). Although not observed in the human data, since it is not a serovar that commonly causes human illness, resistance to Category I β-lactams was also observed among *S.* Kentucky isolates from retail and abattoir chicken isolates (Figure 4). Both *S*. Heidelberg and *S*. Kentucky are very common serovars in poultry; they are detected much less often in other animal species.

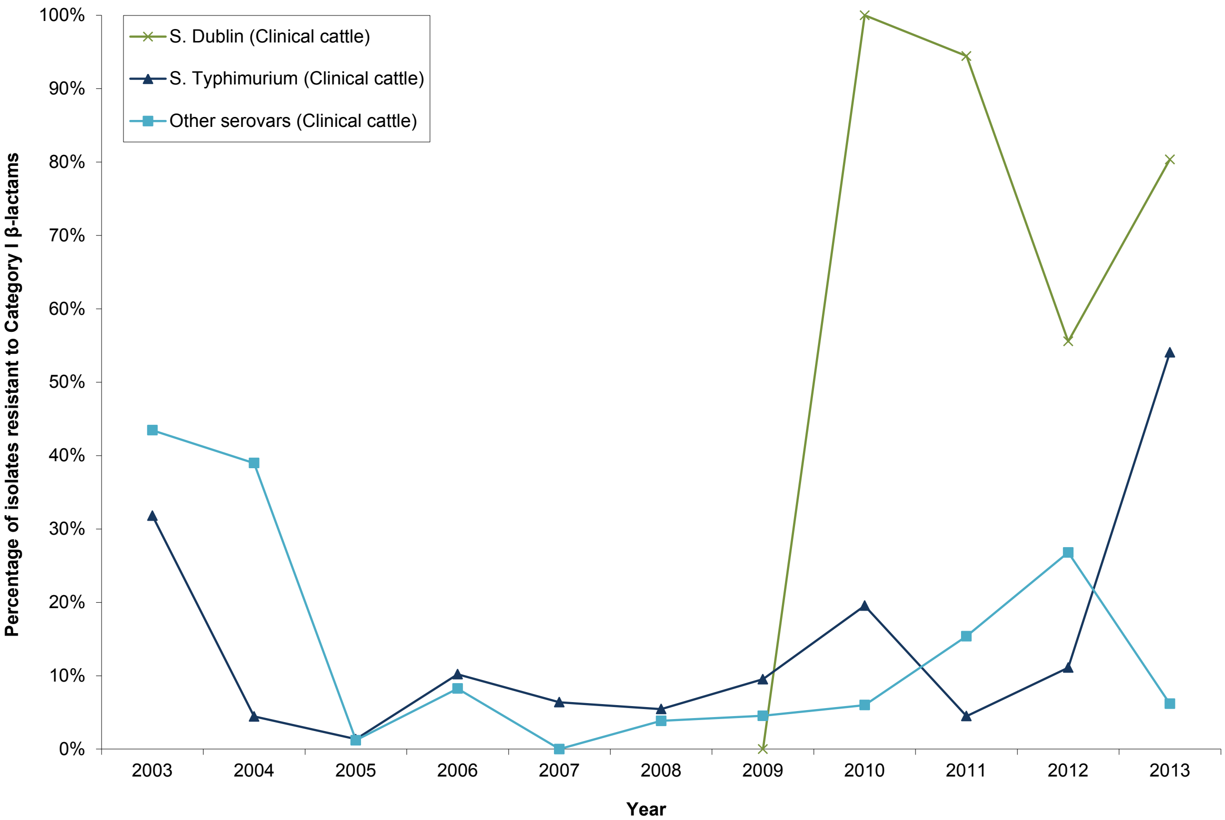
Figure 4. Resistance to Category I β-lactams among *Salmonella* Heidelberg, *Salmonella* Kentucky, and other serovars in retail chicken meat and abattoir chicken



Data source: CIPARS 2003 to 2013.

Although *Salmonella* is rarely recovered from beef cattle at slaughter or from retail beef, clinical cattle isolates were resistant to Category I β-lactams, particularly among the serovars *S*. Dublin and *S*. Typhimurium (Figure 5). The emergence of *S.* Dublin in Canada is discussed further later in this chapter.

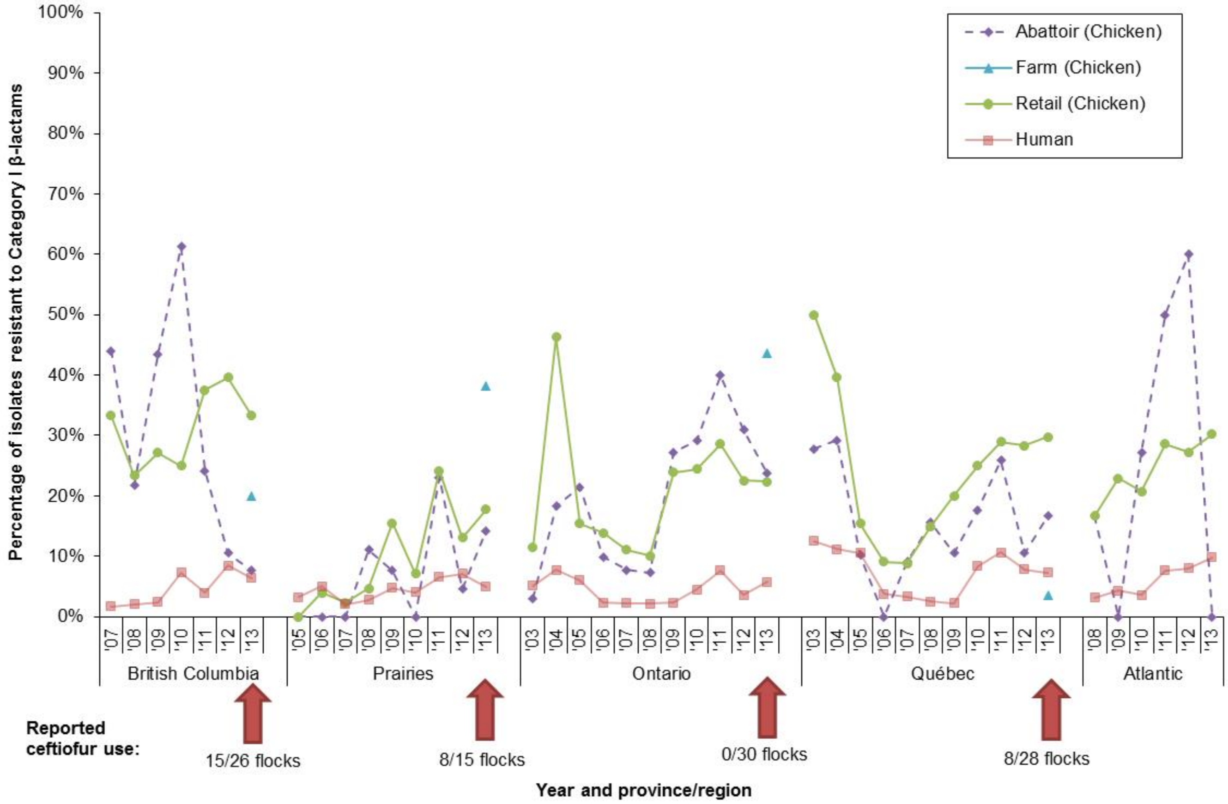
Figure 5. Resistance to Category I β-lactams among *Salmonella* Dublin, *Salmonella* Typhimurium, and other serovars in clinical cattle isolates



Data source: CIPARS 2003 to 2013.
Due to unknown animal sample history, clinical cattle isolates could be dairy, beef or veal isolates.

Resistance to Category I β-lactams in *Salmonella* from chicken is usually higher than in humans and varies over time and across regions (Figure 6). Apparent correlation between chicken abattoir and retail data was stronger in some regions (Prairies and Ontario) than others, while apparent correlation between retail food and human resistance were more consistent across the country (Figure 6).

Figure 6. Resistance to Category I β-lactams among *Salmonella* from human cases and chicken on-farm, at slaughter, and at retail along with reported ceftiofur use in participating broiler flocks

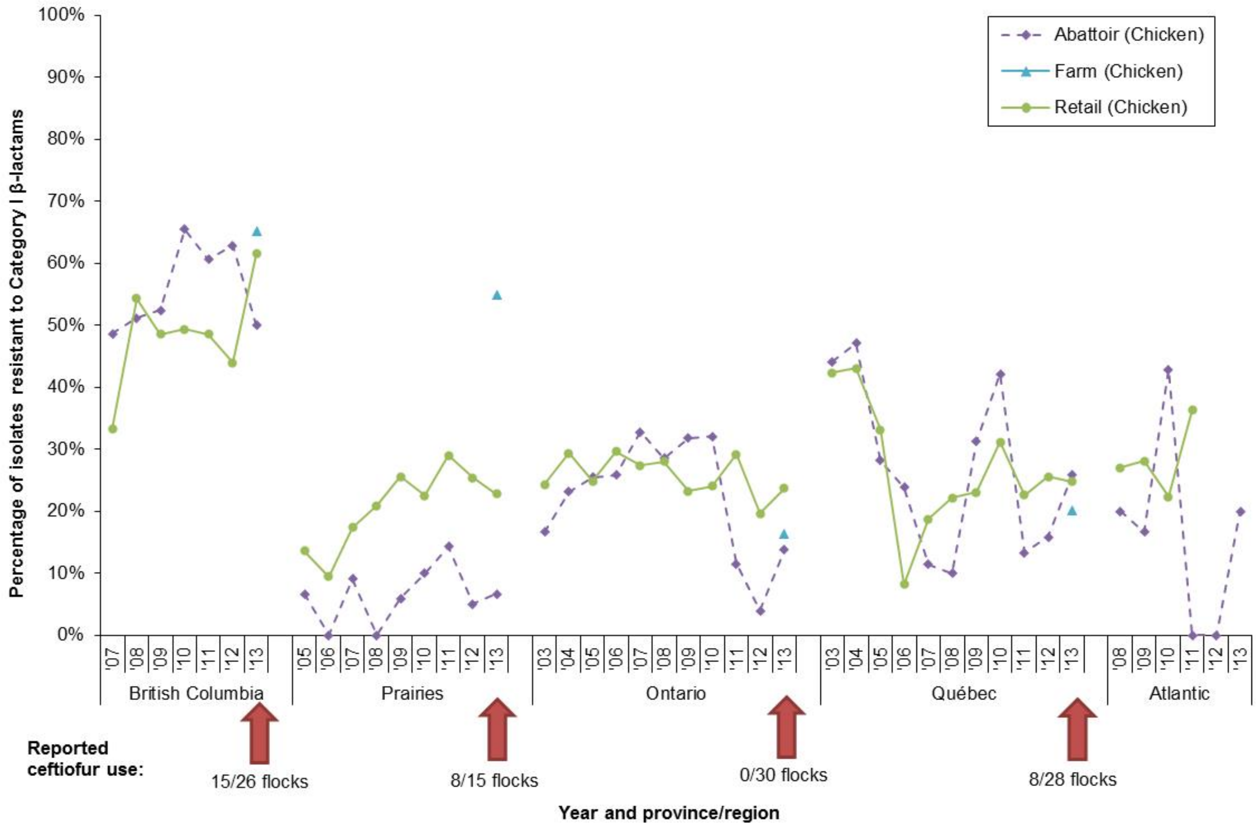


Data source: CIPARS 2003 to 2013.

The Atlantic region includes New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. The Prairies region includes Alberta, Saskatchewan, and Manitoba. Not all provinces are represented in each surveillance component.

For the first time in 2013, CIPARS has both antimicrobial resistance and antimicrobial use data from broiler chickens at the farm level. Among flocks reporting use data in 2013, the highest proportion of flocks (58%, 15/26) reported using ceftiofur in British Columbia and the lowest proportion of flocks (0%, 0/30) reported using ceftiofur in Ontario. However, the resistance trends observed in *Salmonella* showed different regional patterns. For example, Ontario reported no use of ceftiofur in 2013 but the highest proportion of Category I β-lactam resistant *Salmonella* isolates were observed in that province. This potentially had more to do with the *Salmonella* serovars that predominate in the different regions than an absence of correlation between antimicrobial resistance and use of this antimicrobial. More specifically, as mentioned above, *S.* Enteritidis from agri-food was susceptible to all antimicrobials tested and was more commonly observed in chicken from the Western regions, whereas Category I resistance was more common among *S*. Heidelberg and *S*. Kentucky isolates that were more frequently recovered from samples collected in Ontario, Québec, and Atlantic Canada. The *Salmonella* serovars recovered by CIPARS differs regionally and the data suggests that the serovars strongly influences the resistance patterns detected. In contrast to *Salmonella*, resistance to Category I β-lactams in *Escherichia coli* from chicken appears to correlate better with reported use on farms (Figure 7). Additionally, there was better apparent agreement between abattoir and retail data across the regions. With more years of farm data coming, we will be better able to investigate the relationships between antimicrobial use and antimicrobial resistance.

Figure 7. Resistance to Category I β-lactams among generic *Escherichia coli* from chicken on-farm, at slaughter, and at retail along with reported ceftiofur use in participating broiler flocks



Data source: CIPARS 2003 to 2013.

In conclusion, resistance to Category I β-lactams in *Salmonella* is driven by *S.* Heidelberg in people and by *S.* Heidelberg and *S.* Kentucky in chicken; *S.* Kentucky rarely causes infection in people. The antimicrobial use data for broiler chickens correlate better with resistance observed in generic *E. coli* isolates, perhaps because the *Salmonella* data were influenced by which serovars predominate in the regions. The stronger correlation between resistance in *E. coli* and reported use provides strong justification for maintaining surveillance of this commensal organism as an indicator of overall selective pressure.

Key Message: Resistance to Category* I β*-lactams in Salmonella is strongly influenced by what serovars are recovered. In humans, resistance is driven by S. Heidelberg and in chickens it is driven by S. Heidelberg and S. Kentucky. The antimicrobial use data for broiler chickens correlate better with resistance observed in generic Escherichia coli isolates, likely because ceftiofur resistance in Salmonella is influenced by which serovars predominate in the regions.

CAMPYLOBACTER AND RESISTANCE TO CIPROFLOXACIN

Campylobacter is a common cause of bacterial gastrointestinal disease in Canada. In 2013, there were 10,232 reported human cases to the Canadian Notifiable Disease Surveillance System[21] (rate=29.1 cases/100,000 population); it is estimated that most cases go unreported and that 145,000 infections occur annually[22]. Most human infections are caused by *C. jejuni*.

Along the food chain, CIPARS identified *Campylobacter* in all core components and species tested (Table 1). *C. jejuni* is most common in chicken, turkey, and cattle but most *Campylobacter* isolates recovered from pigs are *C. coli*.

Table 1. Proportion of agri-food samples that tested positive for *Campylobacter*, by surveillance component and animal species

Animal species	Number of samples (%)		
	Retail	Abattoir	Farm
Chicken	212/715 (30%)	137/662 (21%)	81/388 (20%)[a]
Pig	N/A	237/314 (76%)	N/A
Cattle	N/A	54/59 (92%)[b]	N/A
Turkey	72/625 (12%)	N/A	N/A

Data source: CIPARS, 2013.
N/A=Not applicable.
[a] Chicken farm data are pre-harvest (within the last 7 days before slaughter or greater than 30 days of age) only; *Campylobacter* is not recovered at chick placement.
[b] Cattle abattoir sample numbers were low in 2013 due to operational issues at 2 major plants.

Among all bacteria isolated by CIPARS, resistance to ciprofloxacin is of greatest concern in *Campylobacter*. Ciprofloxacin is a Category I fluoroquinolone antimicrobial of very high importance to human medicine that is commonly used in people to treat a variety of infections. At this time, there are no data available about resistance in human clinical *Campylobacter* isolates.

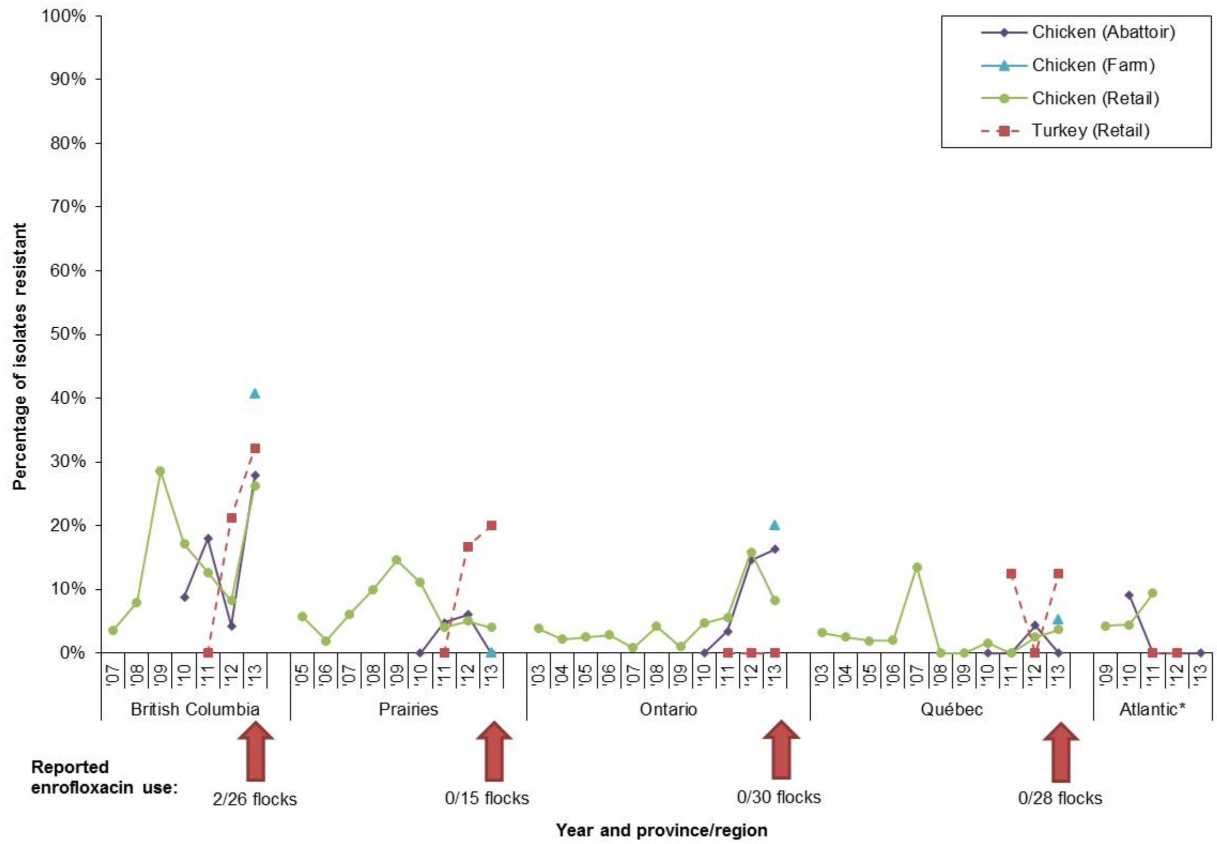
Danofloxacin and enrofloxacin are fluoroquinolones approved for use in livestock in Canada, specifically for treating respiratory disease in cattle and pigs; there are no other approved uses in livestock or poultry. In 2013, at the farm-level, 20% (16/81) of pre-harvest chicken *Campylobacter* isolates were resistant to ciprofloxacin. At slaughter, 5% (3/59) of beef cattle isolates recovered in 2013 were resistant to ciprofloxacin and 13% (33/254) of isolates from abattoir pigs were also resistant. Among chicken abattoir isolates nationally, 14% (19/138) were resistant in 2013, but ciprofloxacin resistance was only observed in isolates from birds raised in British Columbia and Ontario. At retail, across all regions sampled, 11% (25/220) of chicken and

[21] Canadian Notifiable Disease Surveillance System. Available at: www.dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/charts.php?c=pl. Accessed September, 2015.
[22] Thomas et al. 2013. Estimates of the burden of foodborne illness in Canada for 30 specified pathogens and unspecified agents, circa 2006. *Foodborne Pathog Dis*. 2013; 10(7): 639–648.

16% (12/76) of turkey isolates were resistant to ciprofloxacin in 2013. However, the regional levels of resistance were more varied.

Ciprofloxacin resistance in *Campylobacter* isolates from chicken and turkey varies over time and between regions (Figure 8). Most notably in 2013, resistance to ciprofloxacin in isolates from retail chicken meat significantly increased in British Columbia; retail turkey and abattoir chicken resistance also increased in British Columbia in 2013. Conversely, in Ontario in 2013, there was a decrease in the proportion of resistant retail chicken isolates compared to abattoir and farm chicken isolates.

Figure 8. Ciprofloxacin resistance in *Campylobacter* isolates from chicken and turkey over time and between regions with reported enrofloxacin use in participating broiler flocks



Data source: CIPARS 2003 to 2013.
*Sampling target not met.

Based on the use data collected from farms, British Columbia was the only region that reported any fluoroquinolone use in 2013; this province also had the highest level of resistance among *Campylobacter* farm, abattoir, and retail meat isolates. As noted, use of fluoroquinolones in poultry is "extra-label" use under veterinary prescription.

With only a single year of data, no firm conclusions about the association between fluoroquinolone use and resistance in broiler chickens can be made; CIPARS will continue to monitor use and resistance data from the broiler chicken sector. With limited available human antimicrobial resistance data for *Campylobacter*, and despite concerning trends in agri-food, we are still unable to assess the human burden of illness due to resistant *Campylobacter* infections.

Key Message: The pattern of ciprofloxacin resistance in Campylobacter recovered from retail chicken continues to change over time and between regions. With only a single year of data, no firm conclusions about the association between fluoroquinolone use and resistance in broiler chickens can be made; CIPARS will continue to monitor use and resistance data from the broiler chicken sector.

MULTICLASS RESISTANCE AND OTHER ANTIMICROBIAL RESISTANCE TRENDS TO MONITOR

SALMONELLA DUBLIN IN HUMANS AND CATTLE

In 2013, there were 8 *Salmonella* Dublin isolates in people. One half of these cases were from Québec. The human *S*. Dublin isolates were recovered from stool samples (3 isolates), blood (3 isolates), and urine (2 isolates). One *S*. Dublin isolate was resistant to all 7 antimicrobial classes tested and 4 isolates were resistant to 6 classes (only susceptible to the macrolides). Molecular analysis of isolates from Québec showed that all multiclass resistant isolates carried plasmid-borne CMY-2 gene, which mediates resistance to β-lactam antimicrobials (penicillins and cephalosporins)[23].

Salmonella Dublin was the second most common serovar from cattle clinical isolates forwarded to CIPARS in 2013. Among all 56 isolates, 13 (23%) were resistant to 6 antimicrobial classes, all except the macrolides. One of these multiclass resistant cattle isolates was from British Columbia and the remainders were from Québec. Initial whole genome sequencing of human and bovine isolates from Québec was able to differentiate multiclass resistant and susceptible isolates[24]. Further, multiclass resistant bovine and human isolates clustered together[24]. Additional molecular analysis of human and cattle isolates is ongoing.

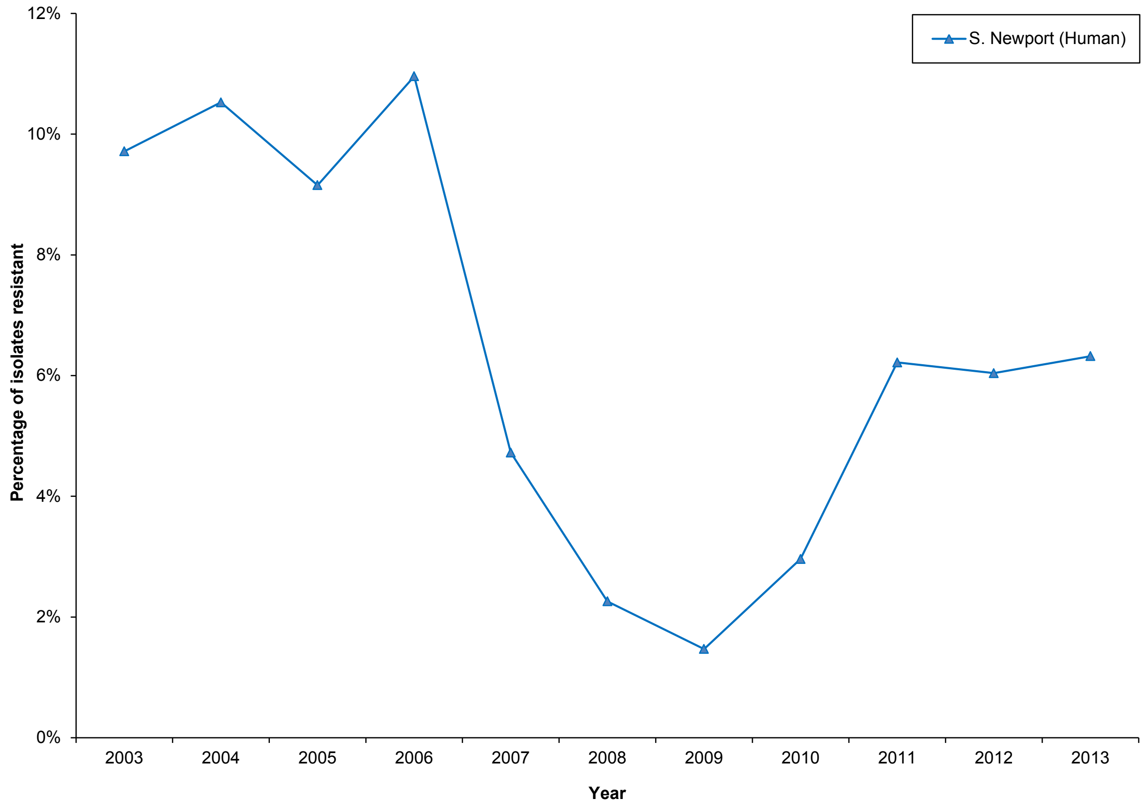
SALMONELLA NEWPORT IN 2013

In people, clonal expansion of a specific multiclass-resistant *S*. Newport re-emerged in 2010 (Figure 9). This re-emerging phenotype was resistant to ampicillin, streptomycin, sulfisoxazole, and tetracycline (ASSuT). For the first time in 2013, 1 isolate (Alberta) was resistant to all antimicrobial classes tested and 2 isolates from Québec showed an unusual resistance pattern and were only resistant to the macrolides tested. In spite of the concerns about multiclass

[23] Bekal S, Cote G, Nadeau M, Lefebvre B, Bharat A, Mandes R, Finley R, Tremblay C, Mulvey MR. 2014. Emergence of multidrug-resistant *Salmonella* Dublin from human and animal sources in Québec. *Can J Infect Dis Med Microbiol*. 2014; 25(2).

resistance in this *Salmonella* serovar, it is important to consider that 87% (73/88) of all *S*. Newport isolates from people in 2013 were not resistant to any of the antimicrobials tested.

Figure 9. Percentage of human clinical *Salmonella* Newport isolates resistant to ampicillin, streptomycin, sulfisoxazole, and tetracycline (ASSuT)



Data source: CIPARS 2003 to 2013.

In agri-food, we have not observed the multiclass resistant *S*. Newport isolates that are of concern in people. In 2013, no multiclass resistant clinical *S*. Newport isolates were detected in any species. No resistance at all was detected in isolates from farm or abattoir in any livestock species tested. Two isolates from retail turkey (1 from British Columbia and 1 from Saskatchewan) were resistant to 3 antimicrobial classes: β-lactams, aminoglycosides, and tetracyclines. The ongoing lack of multiclass resistance in isolates from agri-food sources suggests that domestically produced chicken, turkey, pork, and beef are not contributing to the multiclass resistant isolates that are causing infections in people. International travel or other food sources not captured by CIPARS are more likely to be driving this observation.

SALMONELLA 4,[5],12:I:- IN 2013

Salmonella 4,[5],12:i:- is a monophasic variant of *S*. Typhimurium. In humans, the most common phage types (PT) in 2013 were 193 (a notable increase since 2012), U291, and 191.

The most common resistance pattern observed for this serovar was resistance to ASSuT; this resistance profile was especially common among isolates of PT193.

In agri-food samples, this serovar was most commonly observed in samples from pigs. The most common phage types recovered from pigs in 2013 were 193 and 120. Among 16 PT193 isolates from pigs (farm, abattoir and clinical samples), 14 had the ASSuT pattern; among all other 4,[5],12:i:- isolates from pigs in 2013, just over half (16/30) had the ASSuT pattern. Phage type 193 isolates with a slightly different resistance pattern that included chloramphenicol and kanamycin were detected in samples from chickens on-farm (1 isolate), turkey clinical (1 isolate), and turkey retail (1 isolate) isolates. Similar to *S.* Newport, the link between human infections with resistant 4,[5],12:i:- and agri-food sources currently is unclear.

SALMONELLA TYPHIMURIUM PHAGE TYPE 104 IN 2013

Historically in people, *S.* Typhimurium phage type (PT) 104 was the main phage type linked with resistance to ACSSuT (ampicillin, chloramphenicol, streptomycin, sulfisoxazole, and tetracycline). The percentage of susceptible PT104 isolates increased from 19% (4/43) in 2012 to 32% (15/47) in 2013 and the percentage of ACSSuT resistant PT104 decreased from 65% (28/43) in 2012 to 49% (23/47) in 2013. With this shift in susceptibility among PT104 isolates, PT104b is replacing PT104 as the main phage type associated with ACSSuT resistance.

Among routine CIPARS agri-food components, *S*. Typhimurium is most commonly isolated from pigs (farm, slaughter, and clinical cases). In 2013, ACSSuT was observed in PT104, PT104b and PT104a isolates. In contrast to what was observed among the human isolates, there has been no apparent change in the occurrence of these 3 phage types from pigs or in the level of resistance among them. The reason for the shift in phage type and resistance in people remains unclear.

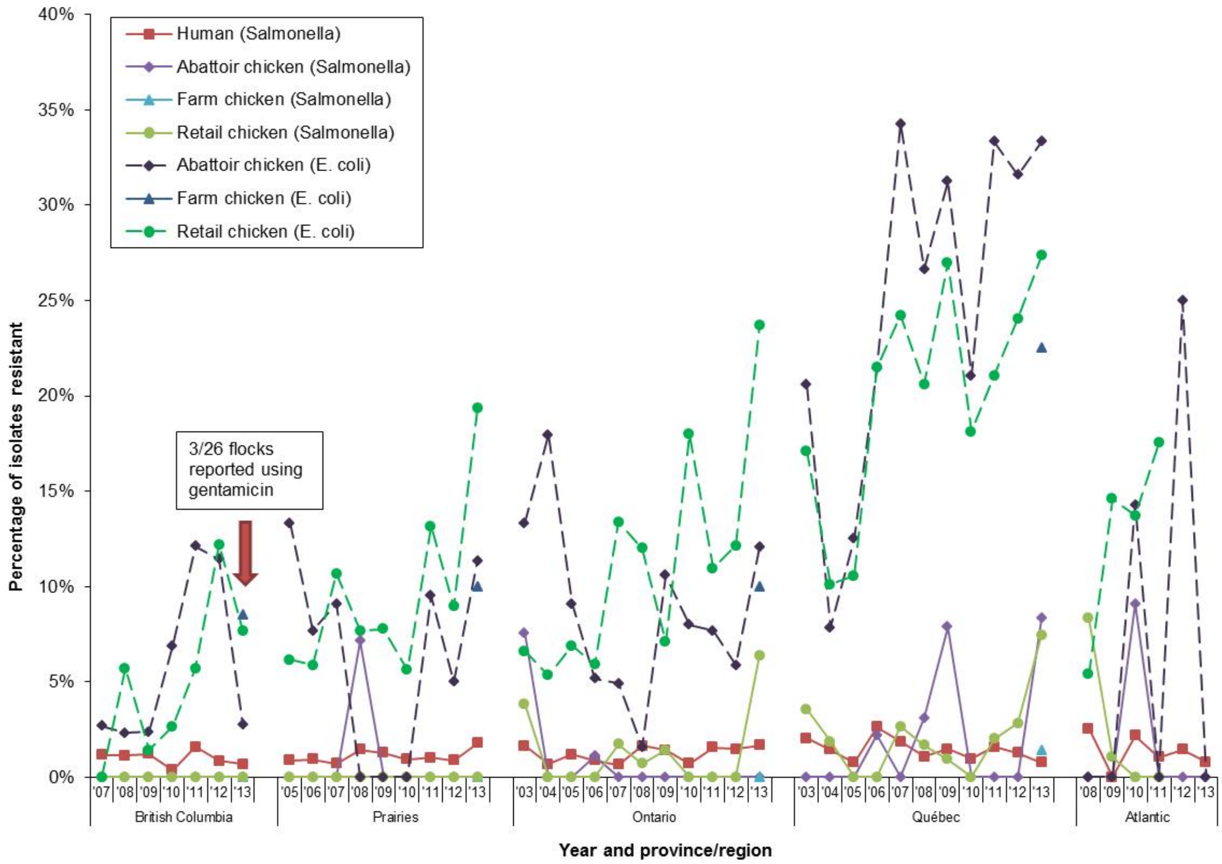
REGIONAL INCREASES IN RESISTANCE TO GENTAMICIN ACROSS BACTERIAL SPECIES

Low but changing levels of resistance to gentamicin were seen in isolates from people in 2013: gentamicin-resistance among *S*. Typhimurium isolates decreased but higher levels of resistance were observed among *S*. Newport and *S*. Heidelberg isolates. Due to these changes, we further investigated gentamicin resistance in agri-food sources. Overall, and across regions, gentamicin resistance was higher in agri-food isolates than in isolates from people (Figure 10). Very little resistance was observed among *Salmonella* isolates but there was a significant increase in gentamicin resistance among retail chicken *Salmonella* and *Escherichia coli* isolates from Ontario[24]. Higher resistance was concomitantly observed in generic *E. coli* isolates from chicken with significant increases in resistance among retail isolates from the Prairies and Ontario.

[24] Government of Canada. 2015. Government of Canada, 2015. Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) Annual Report 2013, Chapter 2—Antimicrobial Resistance. Available at: www.publications.gc.ca/pub?id=472507&sl=0. Accessed January 2015.

The only reported use of gentamicin on poultry farms was from British Columbia, but resistance among British Columbia chicken *E. coli* isolates was lower than in the other regions (Figure 10). Current correlation between antimicrobial use and resistance to gentamicin in chicken is unclear.

Figure 10. Percentage of human *Salmonella* and chicken *Salmonella* and *Escherichia coli* isolates resistant to gentamicin, by region



Data source: CIPARS 2003 to 2013.
The Atlantic region includes New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador.
The Prairies region includes Alberta, Saskatchewan, and Manitoba.

INTERPRETING TETRACYCLINE USE AND RESISTANCE DATA

High levels of tetracycline resistance are regularly observed in bacteria from multiple agri-food sectors, especially pigs. Upwards of 70% of *Salmonella* and generic *E. coli* isolates from pigs were resistant to tetracycline. Conversely, resistance to tetracycline among human *Salmonella* isolates was lower than all agri-food sectors captured by CIPARS; resistance in humans was usually between 10 and 20% for all non-typhoidal *Salmonella* isolates.

Tetracycline use is highlighted in the integrated antimicrobial use stories of this report. Briefly, tetracyclines are widely used in agri-food production, particularly in pigs and cattle but used less frequently used in people or chickens.

As is the case for several of the integrated stories in this section, use practices are not clearly correlated with resistance. There are several possible explanations for this apparent lack of correlation: i) multiple resistance genes have been identified that encode for resistance to tetracyclines and ii) although this class of antimicrobial is commonly used in both cattle and swine, resistance is higher in pigs than cattle; this may reflect differences in the type and duration of drug use between cattle and pigs.

The issue of tetracycline resistance serves to highlight that many questions about use, resistance, and the relationship between them still exist. For example, in spite of low reported use in poultry, roughly half of all *E. coli* isolates from chicken are resistant to tetracyclines. Similarly, although resistance in pigs is high, this class of antimicrobials is still commonly used.

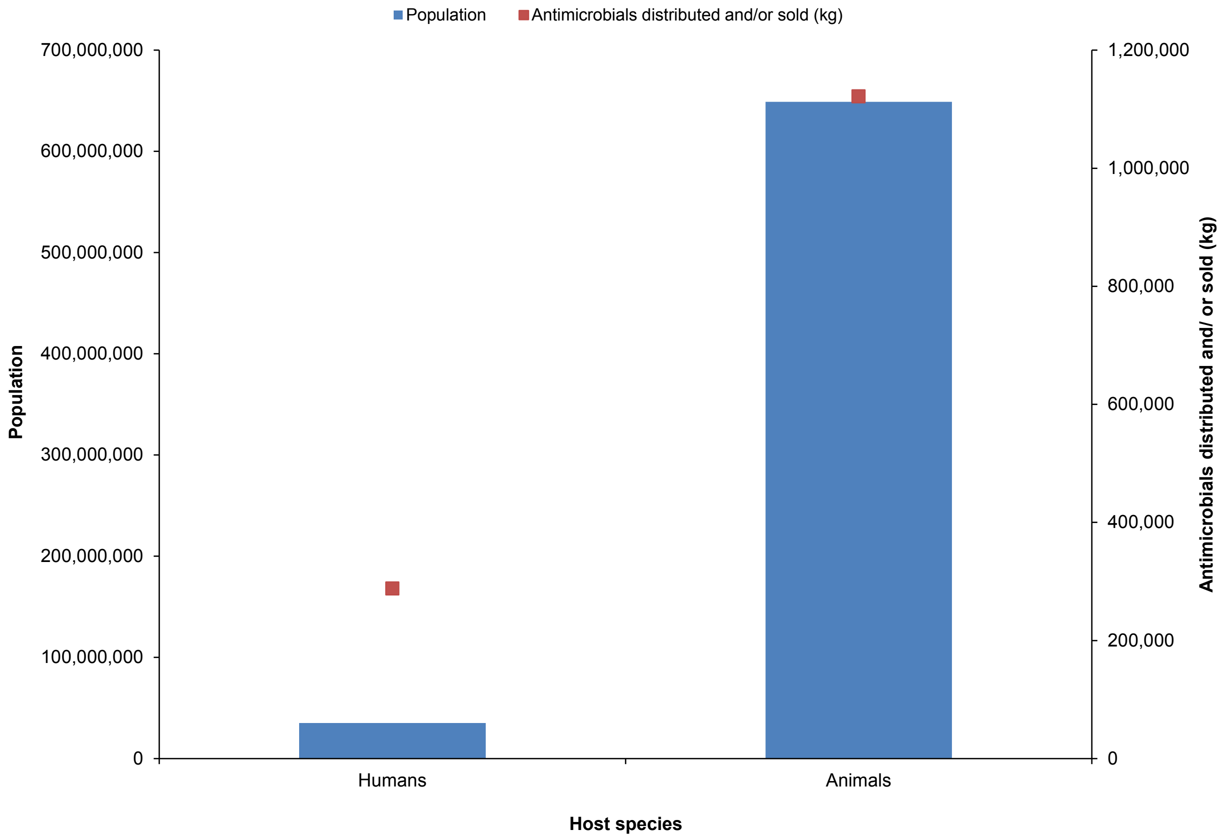
ANTIMICROBIALS SOLD AND/OR INTENDED FOR USE IN HUMANS AND ANIMALS

QUANTITIES ADJUSTED FOR POPULATIONS AND WEIGHTS

Canada is a major producer of food animals. As such, there are roughly 18 times more animals than people in Canada (Figure 11). Most of the animals represented in Figure 11 are poultry (approximately 600 million). Overall, the animal population is underestimated; we were unable to include the numbers of farmed fish because statistics on fish are reported as kilograms produced and not as individual animals.

When considering only medically important antimicrobials (Categories I, II and III), there are roughly 4 times more antimicrobials distributed for use in animals than sold for people (Figure 11). Not included here are the ionophores or chemical coccidiostats; these antimicrobials are not used in human medicine. When these classes of antimicrobials are included, they represent 24% (356, 790/1,478,492) of the total kilograms of antimicrobials distributed for use in animals. If these classes are included in the comparisons, approximately 5 times more antimicrobials are distributed for use in animals than sold for people.

Figure 11. Human and animal population estimates with total kilograms of antimicrobials distributed and/or sold



Data source: Human pharmacy and hospital and CAHI data, 2013, Statistics Canada, Agriculture and Agri-food Canada, and Equine Canada.
Ionophores and chemical coccidiostats excluded.

Because some animals are heavier than people and some are lighter, it is not appropriate to directly compare only population numbers for the purpose of contextualizing antimicrobial sales data. To account for differing population and animal sizes, CIPARS applied a crude denominator to the human and animal data to standardize the data and make the values more comparable. This is an approach similar to what the European Surveillance for Veterinary Antimicrobial Consumption (ESVAC) has been working on for the animal use data[25] and the Swedish Veterinary Antimicrobial surveillance program (SVARM) has used in the past for comparing human and animal use[26].

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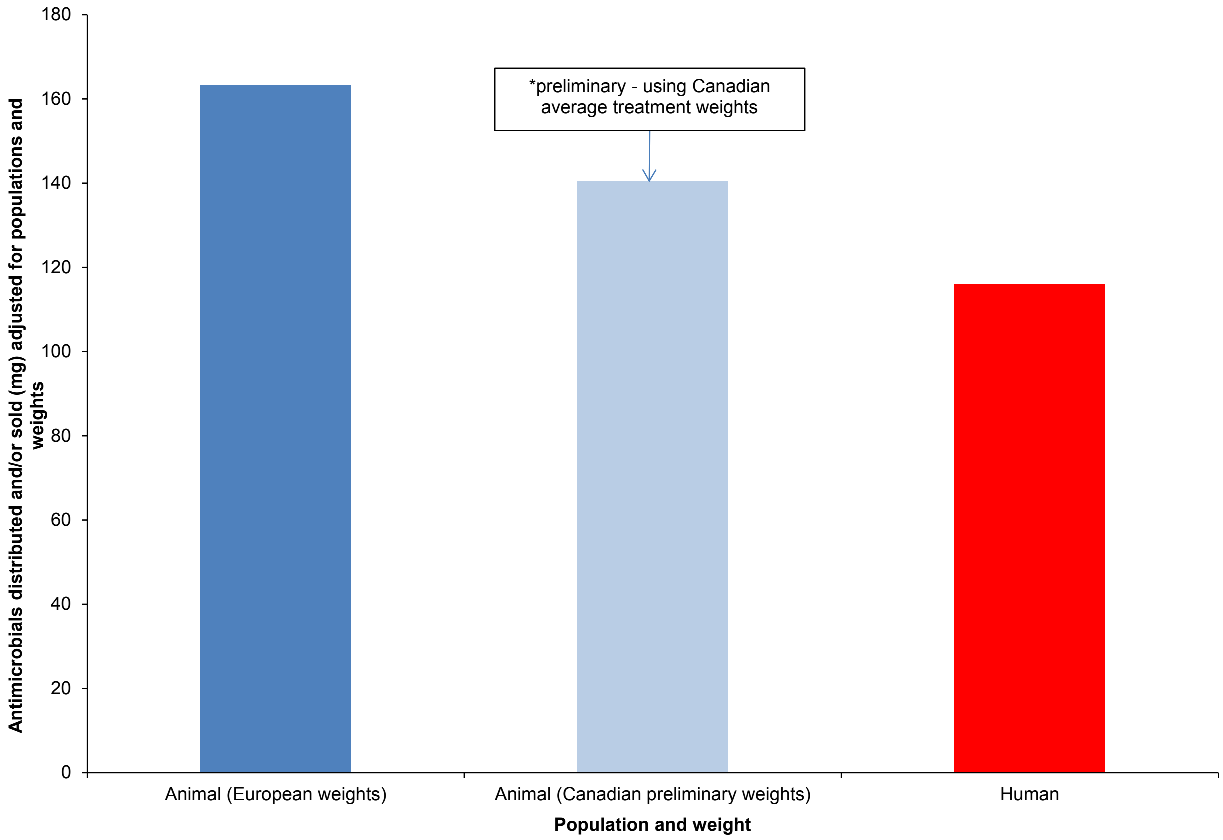
[25] European Medicines Agency. European Surveillance of Veterinary Antimicrobial Consumption (ESVAC). Sales of veterinary antimicrobial agents in 25 EU/EEA countries in 2011 (EMA/236501/2013). Available at: www.ema.europa.eu/docs/en_GB/document_library/Report/2013/10/WC500152311.pdf. Accessed January 2015.

[26] SWEDRES-SVARM. Use of antimicrobials and occurrence of antimicrobial resistance in Sweden. Available at: www.sva.se/upload/Redesign2011/Pdf/Om_SVA/publikationer/Swedres_Svarm2012.pdf. Accessed January 2015.

To adjust human sales by population and weight, the denominator included the Canadian population for 2013 multiplied by an average weight of 70 kg per person. For animals, we have 2 different weights used to create the denominators. First, we used European average weights of treatment; this is an approach used by ESVAC. In Figure 12, this comparison, between the red bar (human) and the darker blue bar (animal European weights) is presented. The quantity of antimicrobials distributed and/or sold for use in animals was approximately 1.4 times greater than the quantity distributed to people.

With a small group of stakeholders, we have been making progress towards developing Canadian specific average weights of treatment (included in the second denominator). This is presented in the light blue bar (Figure 12). Because certain production classes of animals are typically heavier in Canada than in Europe, for this comparison, the quantity distributed for use in animals was 1.2 times more than quantities sold for use in people.

Figure 12. Quantity of antimicrobials distributed and/or sold for use in animals and humans, adjusted for populations and weights

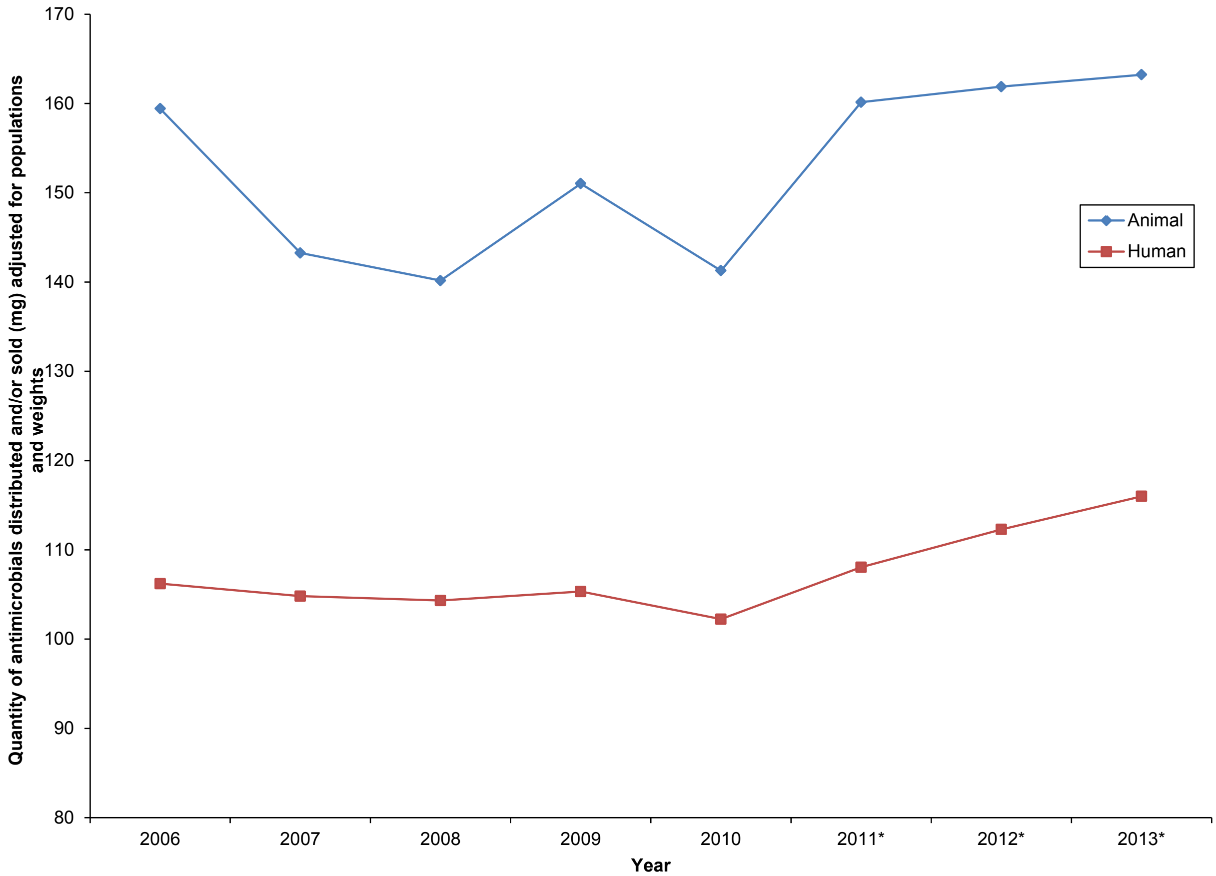


Data source: Human pharmacy and hospital, CAHI, Agriculture and Agri-food Canada, Statistics Canada, Equine Canada, 2013. European weights are based on ESVAC data while Canadian weights are based on industry expert opinion where possible.
Ionophores and chemical coccidiostats are excluded from the animal data.
Animal distribution data currently does not account for quantities imported for own use or as active pharmaceutical ingredients for further compounding; hence are underestimates of total quantities.

The quantity of antimicrobials adjusted by populations and weights[27] distributed for humans has increased slightly with few changes from year-to-year since 2006 (Figure 13). In contrast, the trends for animals have shown a greater degree of variation (year-to-year) (Chapter 3–Antimicrobial Use in Animals); though when 2013 data are compared to 2006 there has only been a 2% increase. This variation may be associated with shifts in population and/or disease pressure.

[27] The denominator used to adjust the sales data ("adjusted by populations and weights") is equivalent to the biomass of the population. In the European Surveillance of Veterinary Antimicrobial Consumption, this is labelled the "Population Correction Unit" or "PCU".

Figure 13. Quantity of antimicrobials distributed and/or sold for use in animals and humans, adjusted for populations and weights

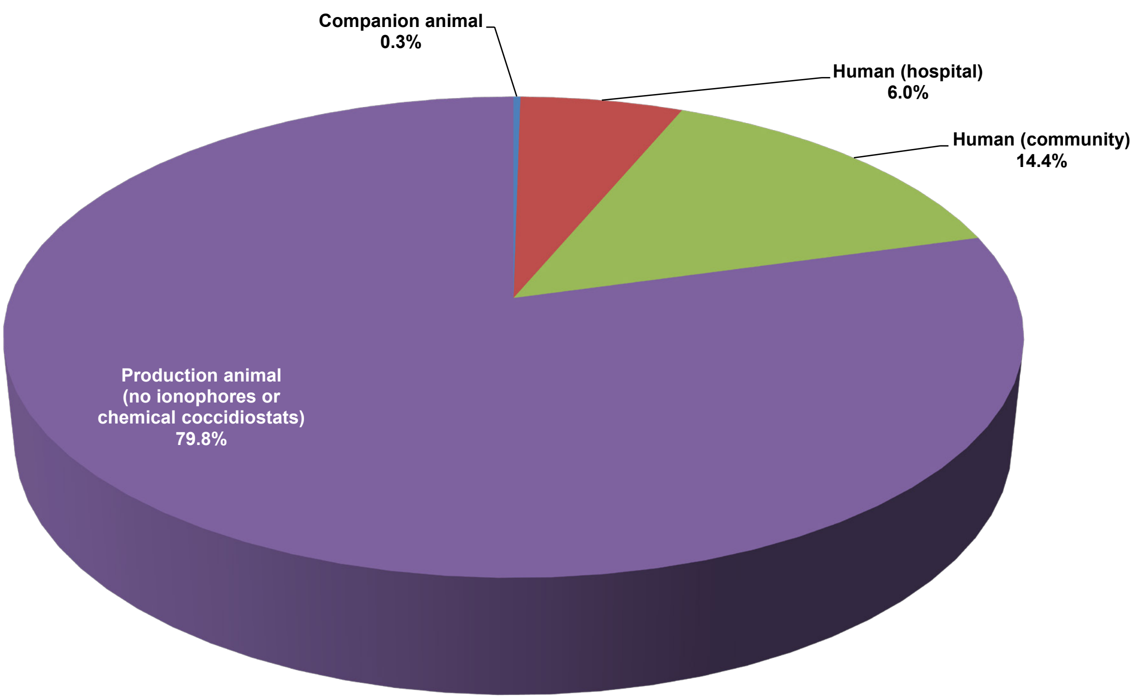


Data source: Human pharmacy and hospital and CAHI data, 2006 to 2013.
Ionophores and chemical coccidiostats are excluded from the animal data.
Animal distribution data currently does not account for quantities imported for own use or as active pharmaceutical ingredients for further compounding; hence are underestimates of total quantities distributed.
The weights used to adjust the animal distribution data were European standard weights.
* Parenteral products were added to the human data in 2011 (previously unavailable).

TOTAL KILOGRAMS AND RELATIVE FREQUENCY OF ANTIMICROBIAL CLASSES DISTRIBUTED AND/OR SOLD IN ANIMALS AND PEOPLE

Of the total kilograms of antimicrobials distributed and/or sold for use in people (287,909 kg) and animals (1,121,702kg; excluding ionophores and chemical coccidiostats), 80% were for use in animals (Figure 14). If the ionophores and chemical coccidiostats are included in the total kilograms, the percentage distributed and/or sold for use in animals increases to 84%. Animal distribution data currently does not account for quantities imported for own use or as active pharmaceutical ingredients for further compounding; hence these are underestimates of total quantities distributed. Canadian Animal Health Institute (CAHI) has recently estimated that for all animal pharmaceutical products, the loss of market share represented by own use importation or active pharmaceutical ingredient importation is roughly 13%. This estimate is for all animal health products; broader than just antimicrobials.

Figure 14. Proportion of total kilograms of antimicrobials distributed and/or sold in Canada, by sector

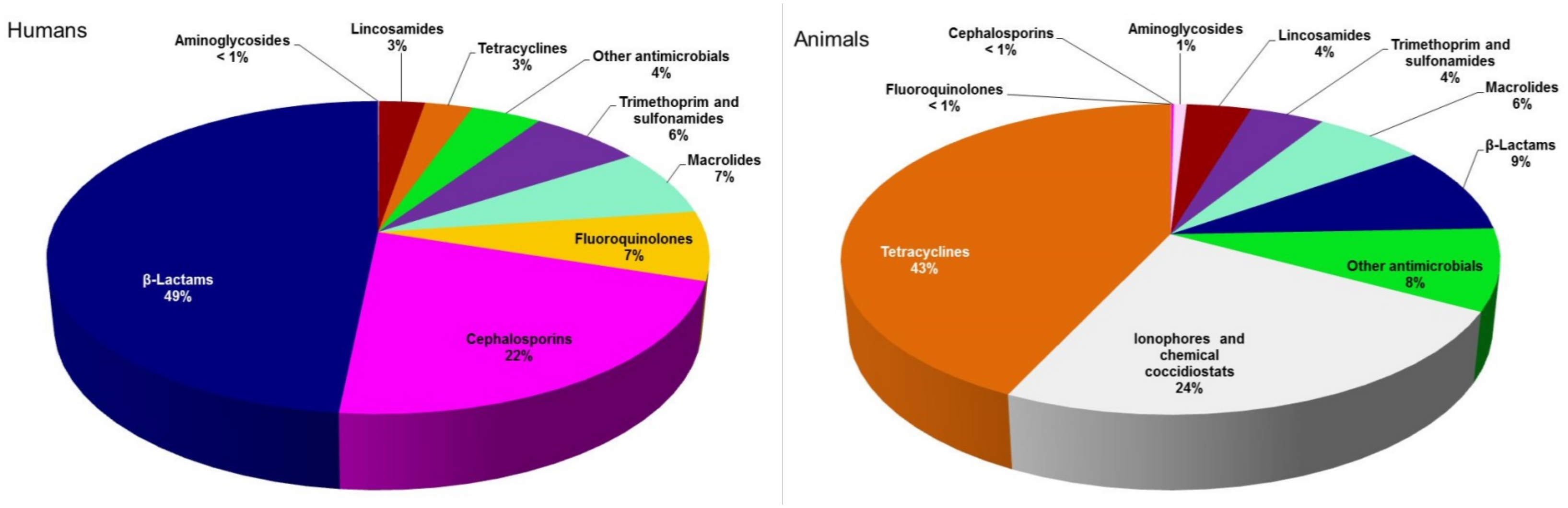


Data source: Human pharmacy and hospital and CAHI data, 2013.

While the same or similar products may be licensed for use in people and animals, there are differences in the types of antimicrobials distributed and/or sold in each sector (Figure 15). It is important to note that for tetracyclines and macrolides all sales were attributed to use in production animals (livestock, poultry, and horses); there were no reported sales of these antimicrobials classes for use in companion animals.

There are important differences in the relative quantity of antimicrobials distributed and/or sold in animals and people (Figure 15). In people, the predominant classes (by kilograms of active ingredients) are β-lactams, cephalosporins, fluoroquinolones, and macrolides. In animals, the predominant classes are tetracyclines, ionophores, "other antimicrobials", and β-lactams.

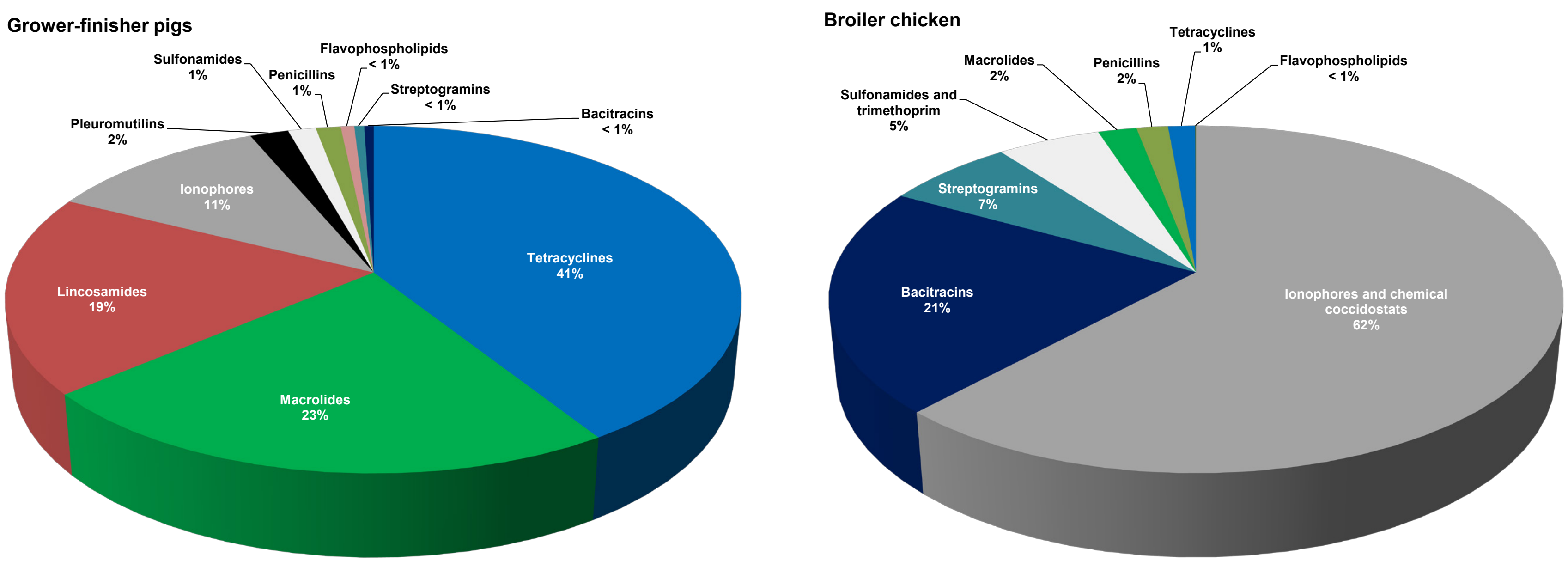
Figure 15. Relative proportion of antimicrobials distributed and/or sold for use in humans and animals, based on active ingredients (kg)



Data source: Human pharmacy and hospital and CAHI, 2013.
"Other antimicrobials" for humans include bacitracin, chloramphenicol, colistin, daptomycin, ertapenem, fixadomycin, fosfomycin, fusidic acid, imipenem and cilastatin, linezolid, meropenem, methenamine hippurate, methenamine mandelate, metronidazole, nitrofurantoin, and vancomycin.
"Other antimicrobials" for animals include bacitracins, bambermycin, chloramphenicol, clavulanic acid, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, ormetoprim, polymixin, tiamulin, and virginiamycin.

There are important differences in the types and relative quantities of antimicrobials reported for use between food animal sectors included in the *CIPARS Farm Surveillance* program (Figure 16). These data are from questionnaires administered on farm. The data gathered provide details about the antimicrobials used in grower-finisher pigs and broiler chicken: the quantity and/or frequency of use by route of administration and reason for use, over time (years) and across regions.

Figure 16. Relative use of antimicrobial classes in feed, including ionophores and chemical coccidiostats, based on active ingredients (kg), in grower-finisher pigs and broiler chickens, adjusted for populations and weights

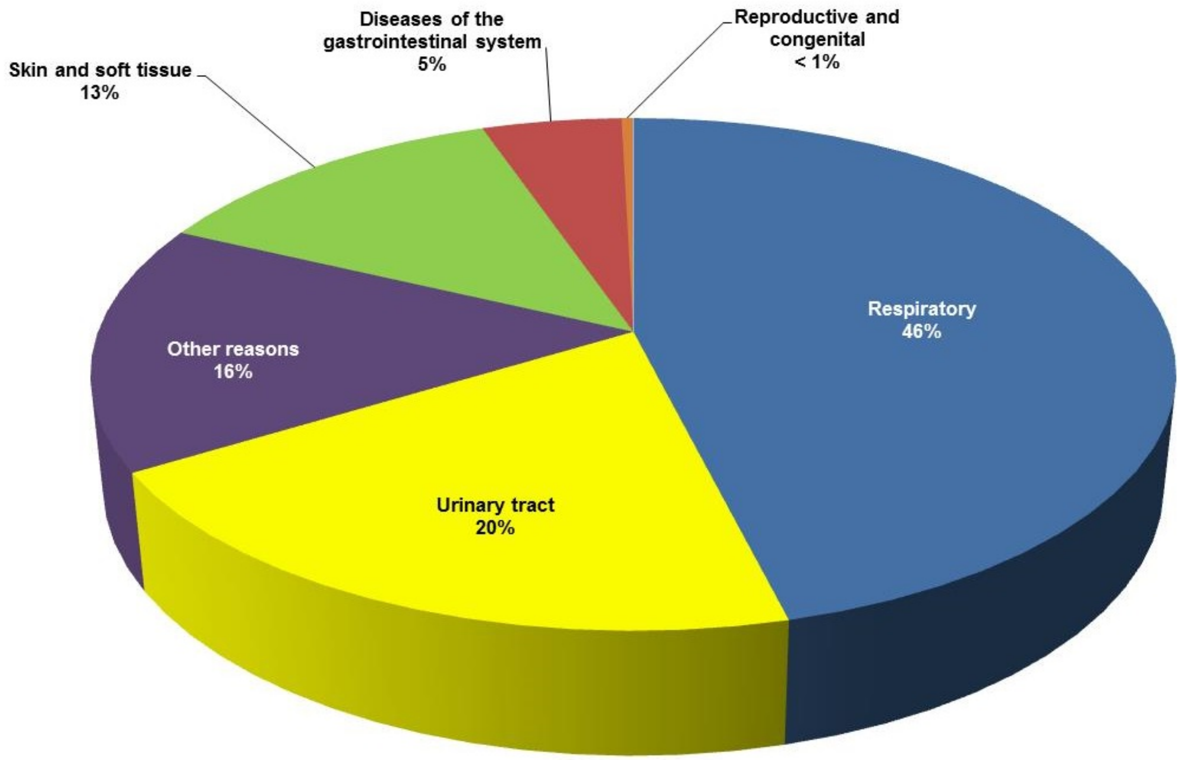


Data source: CIPARS *Farm Surveillance*, 2013.
There are several reasons why different antimicrobials and different dosages are used in people and animals. Understanding reasons for antimicrobial use and choice of antimicrobial can help direct potential use interventions.

REASONS FOR USE

Figure 17 depicts the reasons for human antimicrobial prescriptions as recorded by a sample of office based physicians. The data show that the primary reason for administering antimicrobials was for treatment of respiratory (bronchitis, sinusitis, upper respiratory tract infections and pneumonia) and urinary (upper and lower, pyelonephritis and cystitis) tract infections. More details are available in the PHAC Human Drug Use Report 2012/2013[28].

Figure 17. Reasons for human antimicrobial recommendations[a] by office-based physicians and proportion of office visits with antimicrobial recommendations, by disease classification



Data source: Physician recommendation dataset, PHAC Human Drug Use Report 2012/2013, 2007 to 2013.

[a] Drug recommendations are not necessarily tied to a prescription as the patient may have been against receiving an antimicrobial prescription or may have not filled out a prescription due to physician orders to wait a period of time or chose not to fill it.

Overall, most antimicrobial use in grower-finisher pigs and broiler chickens is administered through feed, of which the majority is for disease prevention (Figure 18). In broiler chickens in 2013, antimicrobials were used in feed on 71% (101/142) of farms and were mostly administered for the prevention of common bacterial diseases: necrotic enteritis (macrolides,

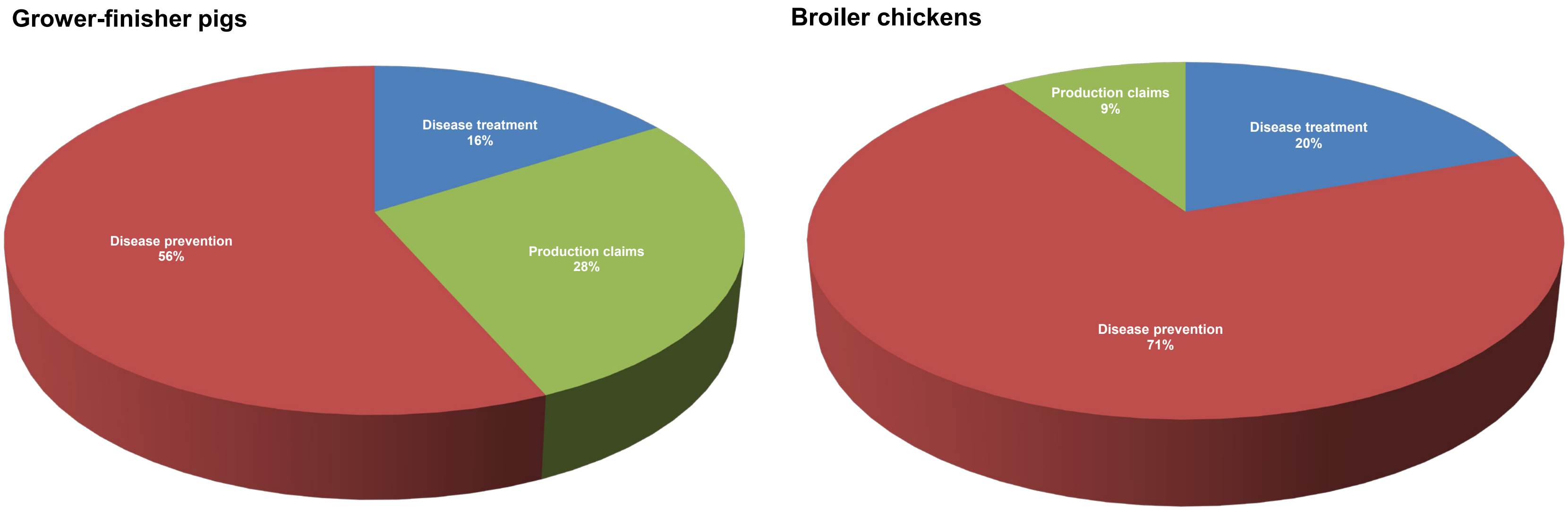
[28] Public Health Agency of Canada.2015. PHAC Human Drug Use Report 2012/2013. Available at: www.phac-aspc.gc.ca/publicat/hamdur-rumamh/2012-2013/index-eng.php. Accessed on: June 2015.

penicillins, streptogramins, and bacitracin) and coccidiosis (ionophores and chemical coccidiostats). Few flocks (9%) (13/142) reported using antimicrobials for production claims (i.e. growth promotion). For production claims, the drugs used were bacitracin, virginiamycin, bambermycin, and penicillin. However, some of the doses reported for bacitracin and virginiamycin that indicated production claims under reasons for use, were more closely aligned with inclusion rates for disease prevention[29].

Among participating grower-finisher pig farms in 2013, antimicrobials administered via feed for disease treatment, prevention, and production claims were reported by 16% (23/143), 56% (81/143), and 28% (40/143) of farms, respectively. Use of lincomycin and tylosin were reported mainly for prevention of enteric disease and use of chlortetracycline was reported for prevention of respiratory disease. The 4 antimicrobials most frequently reported for production claims were tylosin, ionophores, lincomycin, and chlortetracycline. Trend data comparing shifts in estimates of use in feed, adjusted for the population and weight, show a decline in the quantity of antimicrobials reported for disease prevention and an increase in the quantity reported for disease treatment (Figure 18). Not depicted here, 8% (8/99) of broiler chicken and 13% (12/89) grower-finisher pig farms reported zero use of antimicrobials by any route of administration.

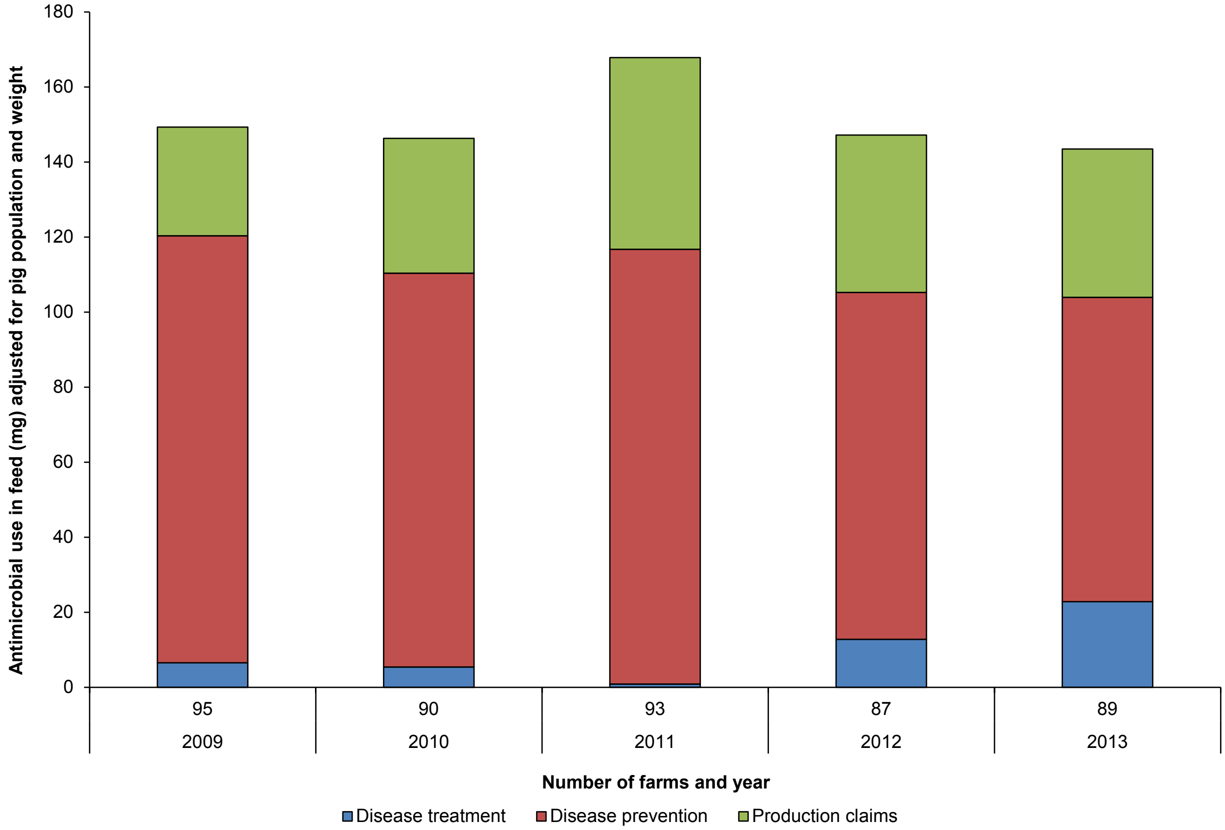
[29] Canadian Food Inspection Agency. Compendium of Medicating Ingredients Brochures. Available at: www.inspection.gc.ca/animals/feeds/medicating-ingredients/eng/1300212600464/1320602461227; Accessed January 2015.

Figure 18. Relative quantity of antimicrobials used in-feed in broiler chickens and grower-finisher pigs, by reasons for use



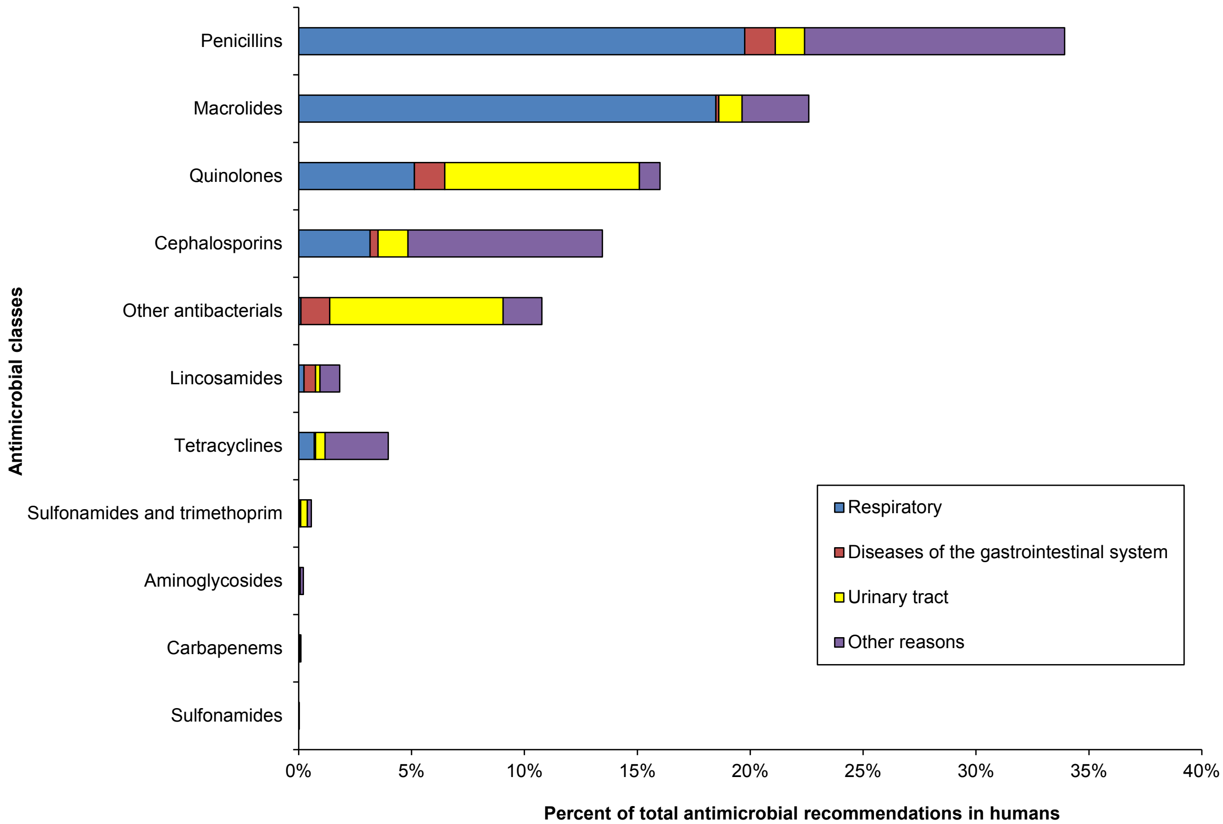
Data source: CIPARS *Farm Surveillance*, 2013.
Ionophores and chemical coccidiostats excluded.

Figure 18. Relative quantity of antimicrobials used in-feed in broiler chickens and grower-finisher pigs, by reasons for use (cont'd)



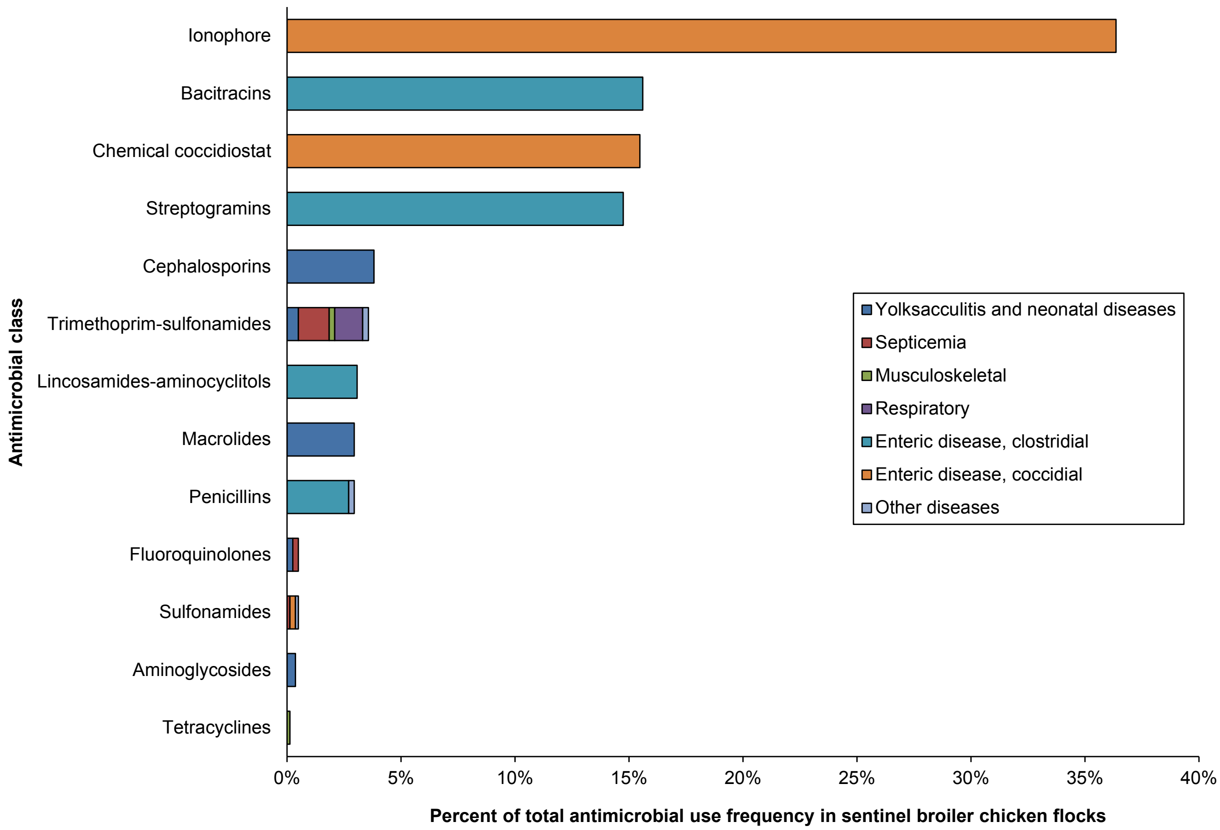
Data source: CIPARS *Farm Surveillance*, 2013.
Ionophores and chemical coccidiostats excluded.

Figure 19. Human antimicrobial recommendations by office-based physicians in 2013, by antimicrobial class and reason for recommendation



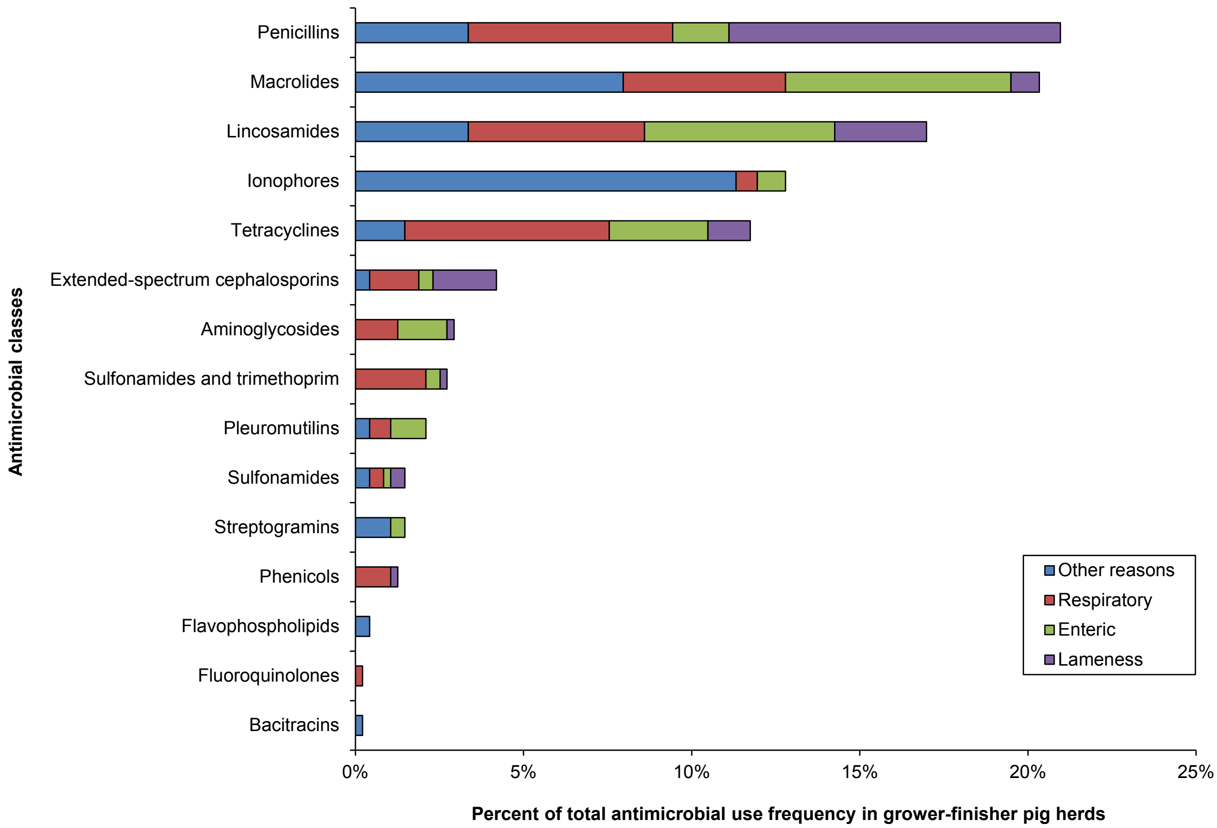
Data source: Physician recommendation dataset, PHAC Human Drug Use Report 2012/2013, 2007 to 2013.
"Other reasons" include skin and soft tissue infections, complications of pregnancy, childbirth, and puerperal stages, and congenital anomalities.
“Other antibacterials” include colistin, daptomycin, fidaxomicin, fosfomycin, fusidic acid, linezolid, methenamine, metronidazole, nitrofurantoin, nystatin, and vancomycin.

Figure 20. Antimicrobial use of specified antimicrobial classes and active ingredients, by secondary reason ("Disease prevention" and "Disease treatment") for use in broiler flocks



Data source: CIPARS *Farm Surveillance*, 2013.
Yolksacculitis and related lesions, such as navel infections, are primarily caused by Avian Pathogenic *Escherichia coli*; other neonatal diseases may be caused *by Salmonella, Enterococcus, Staphylococcus* and early clostridial infections at brooding period.
"Enteric disease, clostridial" are primarily caused by *Clostridium perfringens* causing necrotic enteritis leading to acute death in growing broilers.
"Enteric disease, coccidial" are primarily caused by protozoal organisms (*Eimeria* spp.) with enteric lesions ranging from mild to severe enteritis with or without necrosis and hemorrhages in certain parts of the avian intestines (e.g., *E. necatrix, E. tenella*).
"Other diseases" are unspecified syndromes or mixed infections.

Figure 21 Antimicrobial use of specified antimicrobial classes and active ingredients, by secondary reason ("Disease prevention" and "Disease treatment") for use in grower-finisher pigs



Data source: CIPARS *Farm Surveillance*, 2013.
Swine producers were instructed to select only 1 of 3 primary reasons for antimicrobial use: "Growth promotion", "Disease prevention" or "Disease treatment"; respondents could "Check all that apply" from a list of secondary reasons for an antimicrobial use ("Respiratory disease", "Enteric disease", "Lameness", and "Other") under either "Disease prevention" or "Treatment".
For this analysis, "Other reasons" include antimicrobial use for growth promotion (84%, 120/143) and the treatment of systemic infections (13%, 18/143); 3% (5/143) of "Other reasons" were unspecified.

While many of the same drugs are used in both humans and animals, the relative amounts used vary between people and animals and between the different animal species. There are also important differences in the primary reasons for antimicrobial use. For example, in grower-finisher pigs and broiler chickens, the majority of antimicrobials were used to prevent respiratory and intestinal disease, whereas in people, antimicrobials were more commonly prescribed to treat respiratory and urinary tract infections.

In humans, 48% (10,958,530/22,995,600) of the antimicrobial recommendations were made for the treatment of respiratory disease. These recommendations were primarily for penicillin and macrolide antimicrobials (Figure 19); the two most commonly recommended classes.

Quinolones were the class with the third highest recommendation rate, with 16% (3,680,780/22,995,600) of recommendations. Quinolones were primarily recommended for the treatment of urinary tract infections and respiratory tract infections. The majority of antimicrobial use (82%, 669/814) in broiler chickens was for the prevention of intestinal (enteric) diseases and were ionophores, bacitracins, chemical coccidiostats and streptogramins (Figure 20). In grower-finisher pig herds, 30% (144/477) of antimicrobial use was for the treatment or prevention of respiratory disease, primarily penicillins, tetracyclines, lincosamides and macrolides, and 26% (122/477) of use was for growth promotion, mainly ionophores and macrolides (Figure 21).

Since the beginning of CIPARS, we have been developing and expanding antimicrobial use surveillance in both humans and animals to improve the knowledge about antimicrobials used in Canada, including reasons for use. CIPARS is always exploring different antimicrobial use metrics and ways of presenting the data to best understand antimicrobial use and resistance.

Key Messages: In 2013, 80% of the Category I, II and III antimicrobials distributed and/or sold in Canada were intended for animal use. While many of the same antimicrobial drugs are distributed and/or sold for use in both humans and animals, the relative amounts used vary between people and animals and between the different animal species. There are also important differences in the primary reasons for antimicrobials use and how they are administered.