

# Dairy and Feedlot Antimicrobial Use and Resistance

National Farmed Animal Health & Welfare Council  
 Council Forum – November 26, 2019

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## This presentation...

- **Feedlot Beef**
  - Antimicrobial use
  - Antimicrobial Resistance (CIPARS Farm-Feedlot)
  - Antimicrobial Resistance (CIPARS Abattoir-Beef)
- **Dairy Herds**
  - Antimicrobial use
- **Implementation 2 new farm-based AMU/R surveillance programs**
  - Feedlot Beef
  - Dairy (CaDNetASR)
- **Need for standards: data and reporting**
- **Summary**



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## Antimicrobial Use in Feedlot Beef<sup>1</sup>

Which antibiotics, how and why are they used?



Antimicrobial by Route of Administration	Antimicrobial Class	VDD Category	Primary Reason for Use
<b>Injection</b>			
Ceftiofur	Beta-lactam	I	BRD Treatment
Enrofloxacin	Quinolone	I	Relapse BRD Tx
Florfenicol	Phenicol	II	BRD Treatment
Tilmicosin	Macrolide	II	BRD Prev./Tx
Tulathromycin	Macrolide	II	BRD Prev./Tx
Tylosin	Macrolide	II	Implant Site Abscess Prev.
Trimethoprim-sulfadoxine	Sulfonamide	II	BRD Treatment
Oxytetracycline	Tetracycline	III	BRD Prev./Tx
<b>In-Feed</b>			
Tylosin	Macrolide	II	Liver Abscess Prev.
Chlortetracycline	Tetracycline	III	Liver Abscess Prev. Histophilosis Prev.

BRD = Bovine Respiratory Disease; Tx = Treatment; Prev. = Prevention

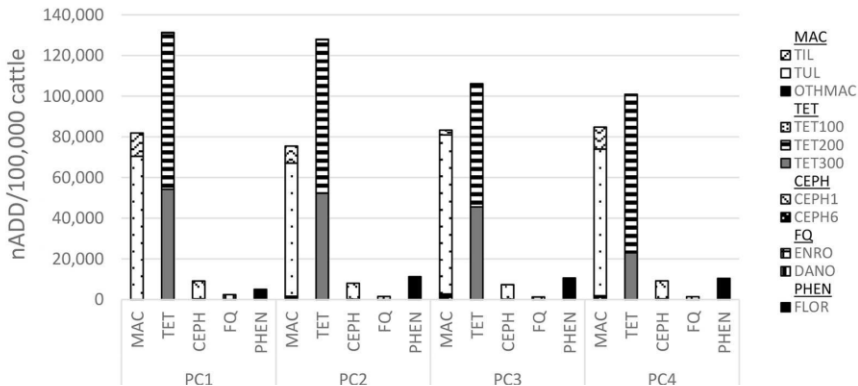
<sup>1</sup>Modified from: Benedict KM, Gow SP, McAllister TA, Booker CW, Hannon SJ, et al. (2015) Antimicrobial Resistance in Escherichia coli Recovered from Feedlot Cattle and Associations with Antimicrobial Use. PLOS ONE 10(12): e0143995.

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## Antimicrobial Use Quantification (nADD/100,000 cattle): Individually dosed AMU by placement cohort (PC), antimicrobial class<sup>a</sup>, and specific type of antimicrobial drug<sup>b</sup>, cattle placed 2008–2012.



Brault SA, Hannon SJ, Gow SP, Warr BN, Withell J, Song J, Williams CM, Otto SJG, Booker CW and Morley PS (2019) Antimicrobial Use on 36 Beef Feedlots in Western Canada: 2008–2012. Front. Vet. Sci. 6:329. doi: 10.3389/fvets.2019.00329

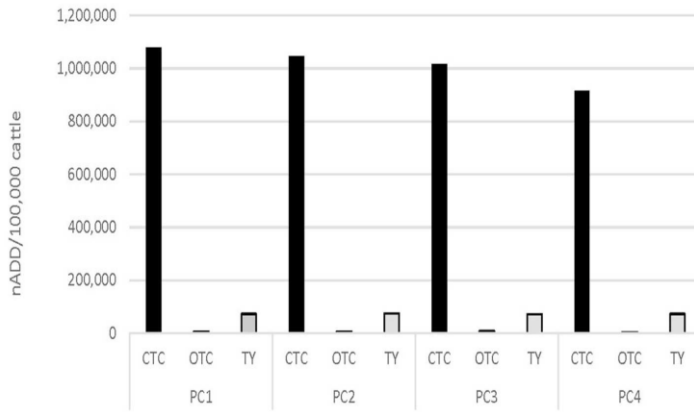


<sup>a</sup>MAC = macrolides, TET = tetracyclines, CEPH = third generation cephalosporins, FQ = fluoroquinolones, PHEN = phenicol; PEN = penicillin, and SULF = sulfonamides not depicted due to low usage;

<sup>b</sup>TIL = tilmicosin 10 mg/kg, TUL = tulathromycin 2.5 mg/kg, OTHMAC = gamithromycin 6 mg/kg, TET100 = oxytetracycline 6.67 mg/kg, TET200 = oxytetracycline 20 mg/kg, TET300 = oxytetracycline 30 mg/kg, CEP1 = ceftiofur hydrochloride or sodium, 1 mg/kg, CEP6 = ceftiofur crystalline free acid 6.6 mg/kg, DANO = danofloxacin 6 mg/kg, ENRO = enrofloxacin 7.7 mg/kg, FLOR = florfenicol 40 mg/kg

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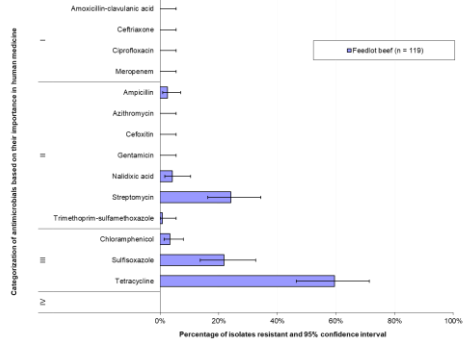
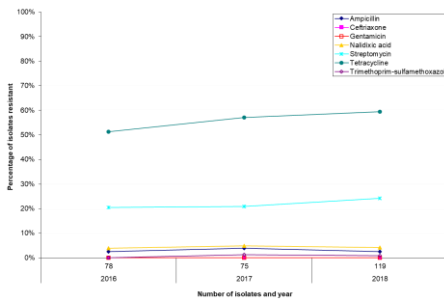
**Antimicrobial Use Quantification (nADD/100,000 cattle):**  
In-feed antimicrobial drug use by placement cohort (PC)<sup>a</sup>, and antimicrobial class<sup>b</sup>, cattle placed 2008–2012 (Brault et al, 2019)



<sup>a</sup>Placement cohort comprised of cattle placed in the feedlot between 1 November and 31 October of consecutive years.  
<sup>b</sup>CTC, chlortetracycline; OTC, oxytetracycline; TY, tylosin.

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**Antimicrobial Resistance: *E. coli*, n=119 isolates**  
 Feedlot Beef FNC Alberta Site (CIPARS Farm-Feedlot Beef, 2018)



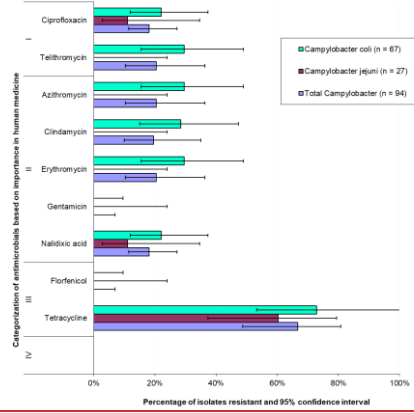
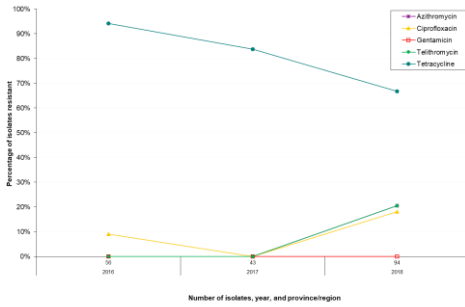
Year	2016	2017	2018
Number of isolates	78	75	119
<b>Antimicrobial</b>			
Ampicillin	3%	4%	2%
Ceftriaxone	0%	0%	0%
Gentamicin	0%	0%	0%
Nalidixic acid	4%	5%	4%
Streptomycin	21%	21%	24%
Tetracycline	51%	57%	60%
Trimethoprim-sulfamethoxazole	0%	1%	1%

**Take Home:**

- No Category I
- TET highest levels of resistance at 60%
- No significant differences

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**Antimicrobial Resistance: *Campylobacter*, n=94 isolates**  
 Feedlot Beef FNC Alberta Site (CIPARS Farm-Feedlot Beef, 2018)



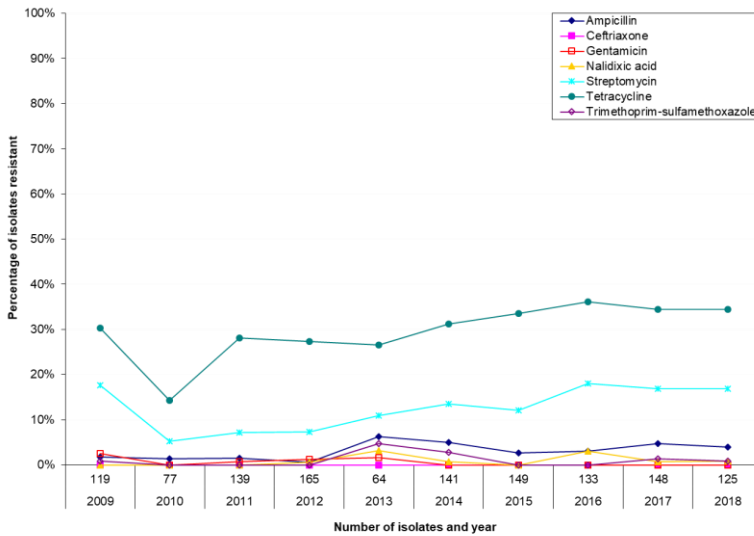
Province / region	FNC Alberta		
Year	'16	'17	'18
Number of isolates	56	43	94
<b>Antimicrobial</b>			
Azithromycin	0%	0%	20%
Ciprofloxacin	9%	0%	18%
Gentamicin	0%	0%	0%
Telithromycin	0%	0%	20%
Tetracycline	94%	84%	67%

**Take Home:**

- CIP ↑; TEL ↑; AZI ↑
- TET highest levels of resistance at 67% (↓ 27% from 2016)

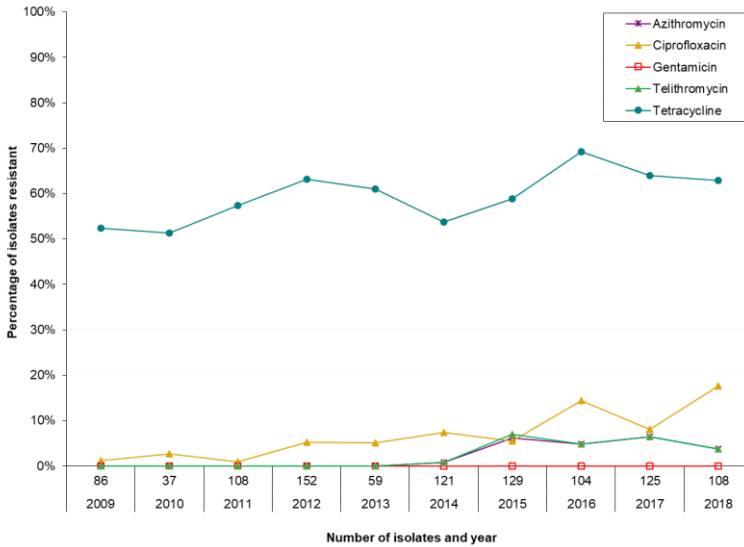
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**Antimicrobial Resistance: *E. coli***  
 (CIPARS Abattoir-Beef, 2009-2018)



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### Antimicrobial Resistance: *Campylobacter* (CIPARS Abattoir-Beef, 2009-2018)



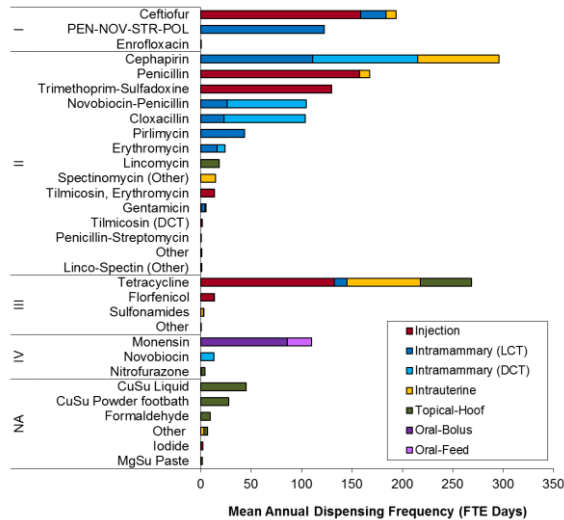
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### Antimicrobial Use in Dairy Herds

Dispensing frequencies by Ontario dairy veterinarians, 2001<sup>1</sup>



Roman Numerals:  
Categorization of  
Antimicrobial Drugs  
Based on Importance in  
Human Medicine,  
Veterinary Drugs  
Directorate, Health  
Canada



Questionnaire results pertained to dispensing frequencies for **lactating and dry dairy cows** only; data do not include use in calves or replacement heifers

<sup>1</sup>Léger DF, Newby NC, Reid-Smith R, Anderson N, Pearl DL, Lissimore KD, Kelton DF. Estimated antimicrobial dispensing frequency and preferences for lactating cow therapy by Ontario dairy veterinarians. *Can Vet J.* 2017 Jan;58(1):26-34. PMID: 28042151; PMCID: PMC5157734.

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## Antimicrobial Use in Dairy Herds

National-level estimate of antimicrobial drug use rate, 2007-2008<sup>1</sup>



Category <sup>a</sup>	Drug Class	Herds (%)	ADD <sup>b</sup>	ADUR <sup>c</sup>
I	Cephalosporins-1st Generation	76 (87)	3,451	0.85
II	Cephalosporins-3rd Generation	80(90)	8,949	2.20
I/II	Cephalosporins-All	87 (98)	12,400	3.05
II	Penicillins	85 (96)	10,421	2.56
I/II	All β-lactams	89 (100)	22,821	5.62
I	Penicillin Combination <sup>d</sup>	84 (94)	8,942	2.20
III	Tetracyclines	57 (64)	7,445	1.83
II	Trimethoprim-sufadoxine combination	68(76)	3,539	0.87
II	Lincosamides	52 (58)	3,414	0.84
II	Macrolides	31 (35)	1,163	0.28
II	Phenicols	29 (33)	694	0.17
II	Aminoglycosides	10 (11)	429	0.10
IV	Ionophores	4 (5)	318	0.07
I	Fluoroquinolones	4 (5)	11	0.003
III	Sulfonamides	2 (2)	9	0.002
II	Lincomycin-spectinomycin Combination	1 (1)	9,464	2.33
<b>Overall</b>		<b>89 (100)</b>	<b>58,249</b>	<b>14.35</b>

<sup>a</sup>Categorization of Antimicrobial Drugs Based on Importance in Human Medicine, Veterinary Drugs Directorate, Health Canada

<sup>b</sup>Number of animal defined daily doses (grams/day)= average label dose x weight of a standard cow, heifer or calf.

<sup>c</sup>Antimicrobial drug use rate (ADUR) = ADD/1,000 cow-days.

<sup>d</sup>Intramammary preparation containing penicillin G procaine, dihydrostreptomycin sulfate, novobiocin sodium, polymyxin B sulfate

<sup>1</sup>Modified from: V. Saini, J.T. McClure, D. Léger, S. Dufour, A.G. Sheldon, D.T. Scholl, H.W. Barkema (2012). Antimicrobial use on Canadian dairy farms. J. Dairy Sci. 95 :1209–1221 (<http://dx.doi.org/10.3168/jds.2011-4527>)

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## Antimicrobial Use in Dairy Herds

National-level estimate of intramammary antimicrobial drug use rate, 2007-2008<sup>1</sup>



Category <sup>a</sup>	Drug Class	Dry Cow Therapy		Clinicla Mastitis Therapy		National Level ADUR <sup>b</sup>
		Herds (%)	ADUR <sup>b</sup>	Herds (%)	ADUR <sup>b</sup>	
I	Cephalosporins-1st Generation	42 (47)	0.27	64 (72)	0.27	0.83
II	Cephalosporins-3rd Generation	----	----	28 (31)	----	0.09
II	Penicillins	83 (93)	1.28	----	----	1.28
I	Penicillin Combination <sup>c</sup>	----	----	84 (94)	2.20	2.20
II	Lincosamides	----	----	52 (58)	0.66	0.66
II	Macrolides	3 (3)	0.003	1 (1)	0.001	0.004
I/II	All β-lactams	87 (98)	1.55	71 (98)	0.66	2.21
<b>Overall</b>		<b>87 (98)</b>	<b>1.55</b>	<b>87 (98)</b>	<b>3.52</b>	<b>5.07</b>

<sup>a</sup>Categorization of Antimicrobial Drugs Based on Importance in Human Medicine, Veterinary Drugs Directorate, Health Canada

<sup>b</sup>Antimicrobial drug use rate (ADUR) = ADD/1,000 cow-days.

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**NEW CIPARS INITIATIVES**  
**Canadian Feedlot Cattle**



- 3rd Party Collaboration/Funding:**
- Funding sources: Alberta Canadian Agricultural Partnership, Alberta Cattle Feeders, Bayer, Beef Farmers of Ontario, Ontario Canadian Agricultural Partnership, McDonalds, Saskatchewan Agriculture, Saskatchewan Cattle Feeders, Vetoquinol
  - Administered by: ACFA, BCRC, and BFO

- Framework Development (2018):**
- Developed in conjunction with expert group of industry representatives and feedlot veterinarians

- Research and Surveillance Objectives:**
- 1 Provide representative estimates of AMU and AMR in the Canadian finishing feedlot sector;
  - 2 Provide a unified approach to monitor trends in AMU and AMR over time;
  - 3 Investigate associations between AMU and AMR periodically on a targeted basis based on emerging AMR trends;
  - 4 Provide collated industry data for the assessment of the potential public and animal health risk of AMU in the Canadian finishing feedlot sector.

- Implementation Status:**
- ✓ Framework implemented in July 2019
  - ✓ Funding available until 2022
  - ✓ Feedlots (40) enrolled in major fed cattle producing provinces of AB, SK, and ON



- Next Steps:**
- Procure stable funding beyond 2022

**NEW CIPARS INITIATIVES**  
**Canadian Dairy Network for Antimicrobial Stewardship and Resistance (CaDNetASR)**



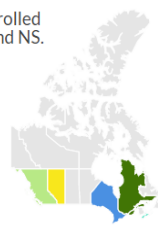
- Collaboration/Funding:**
- Universities (6) and PHAC-CIPARS
  - Funded through DFC Dairy Research Cluster funding (CAP) with support from PHAC



- Framework Development (2018-present):**
- Expert Panel and Industry Steering Committee

- Research and Surveillance Objectives:**
- 1 To assess farm AMU records, GCA, and vet dispensing;
  - 2 To assess farm AMR using three different methods;
  - 3 To develop evidence-based AMU decision tools; support improved stewardship (AMS) practices on dairy farms;
  - 4 To assess the impacts of changes in AMU/AMS practices on animal health and welfare indicators.
    - UCalgary: BC/AB 80 herds/prov., DCT/CMT project
    - UGuelph: Calf management project, in all 5 regions
  - 5 Establish multi-commodity surveillance framework to inform human health risk assessment

- Implementation Status:**
- ✓ Framework implemented; Year 2 of 5
  - ✓ Dairy herds (150) enrolled in BC, AB, ON, QC, and NS.



- Next Steps:**
- Procure stable funding

## Need for standardization in how AMU data are collected, stored, extracted and reported?

- **Count-Based:**
  - % farms using an antimicrobial: how extensively the drug is used across Canada
  - % animals exposed or % rations medicated and duration: how intensively a drug is used on farm
- **Weight-Based**
  - Kilograms of AMU - reflects overall exposure to the drug
    - BUT 1 kg of Antimicrobial A ≠ 1 kg Antimicrobial B, more kg might be needed on a daily basis of A than B
- **Dose-Based**
  - Defined Daily Dose (ADD... DDDvet) – tells us how many standard doses were given
  - Adjusts for differences in dose/strength between drugs
  - Helps us to better understand trends and exposure
- **Denominator**
  - Provides context and facilitates comparisons
  - PCU: Quantity of antimicrobials administered per kg of 'animal'; adjusts for population and weight, e.g. Mg/PCU (per 100,000 cattle)
  - Animal-Time: Adjusts for the variation in the time at risk and number of animals exposed, e.g. DDDvet per 1000 animal-days (ADUR)
- **Do we want to compare between different studies, farms, species, regions... countries?**
  - Need for standardization?

## Summary



- **Feedlot Cattle**
  - Cat. I antimicrobials were administered by injection, primarily to treat BRD
  - Cat. II & III antimicrobials were administered in feed to prevent liver abscesses and Histophilosis
  - There was evidence that the quantity (**nADD/100,000 cattle**) of AMU by injection and in feed was declining
  - AMR trends (3 yrs) in *E. coli* and *Campylobacter* from feedlot cattle indicated high level but stable/declining resistance to TET and possible emerging resistance to FLQ and MAC; abattoir data (10 yrs) indicated similar trends.
- **Dairy Cattle**
  - Vet. survey data - *Mean Annual Dispensing Frequency (MADF)* - and herd level bin audit data - *Antimicrobial Drug Use Rate (ADUR: ADD/1,000 cow-days)* - indicated that  $\beta$ -lactams (Cat. I & II; 1st & 3rd gen. cephalosprins, penicillins) were the classes with the highest rates of use by injection, and by intramammary and intrauterine infusions.
  - Potentiated sulfonamides and tetracyclines had the next highest ADUR.
- **Two new collaborative surveillance initiatives** are being implemented in 2019 to establish ongoing farm level programs to support antimicrobial stewardship in the feedlot and dairy sectors.
- **Data/Reporting Standards**
  - Depending on the objectives, there may be a need for data and reporting standards



## Contact Information



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CIPARS Website: [www.phac-aspc.gc.ca/cipars-picra/index-eng.php](http://www.phac-aspc.gc.ca/cipars-picra/index-eng.php)  
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