University of Prince Edward Island

Faculty of Veterinary Medicine
Summary of Dissertation

Submitted in Partial Fulfilment
of the Requirements for the

DEGREE OF DOCTOR OF PHILOSOPHY

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Implementation and analysis of an on-farm surveillance system for enteric bacteria in Canadian dairy herds

Antimicrobial resistance (AMR) is an increasing concern for public and animal health. This thesis aimed to describe the development and implementation of the Canadian Dairy Network for Antimicrobial Stewardship and Resistance, an on-farm surveillance system focused on collecting data on antimicrobial use (AMU) and AMR on Canadian Dairy Farms. Data were collected yearly from a convenience sample of 144 dairy herds from five different provinces in Canada. Fecal samples from pre-weaned calves, post-weaned heifers, lactating cows and manure storage were collected. Additionally, herd management and farm-level AMU information were gathered. Fecal samples were cultured for generic E. coli, Campylobacter spp., and Salmonella spp. Susceptibility testing was done using a broth microdilution system method. Regression models were built to explore the association of AMU and AMR in E. coli and Campylobacter spp. Our results revealed that AMR in E. coli and Campylobacter spp. was widespread among dairy herds, while for Salmonella spp., it appeared to be clustered by region and farm. For E. coli, a higher proportion of resistance was observed in pre-weaned calves. Resistance to highly important antimicrobials was very low in Salmonella spp. isolates. Overall, AMU varied substantially among the dairy farms. Our study demonstrated that although intramammary AMU accounted for the highest proportion of the total AMU, only systemic AMU was associated with AMR in E. coli. For Campylobacter spp., only total AMU was associated with tetracycline resistance. Some limitations, such as using a convenience sample of dairy farms, could impact the external validity of our results. Additionally, data were collected at single timepoints on study farms which prevents the determination of the causal relationship between AMU and AMR. The results highlighted the potential for the advancement of AMU stewardship practices, with the goal of a more judicious employment of antimicrobials in dairy farms promoting more sustainable and responsible husbandry practices.

Publications

Fonseca M, Heider LC, Stryhn H, McClure JT, Léger D, Rizzo D, Warder L, Dufour S, Roy J, Kelton DF, Renaud D, Barkema HW and Sanchez J. Intramammary and systemic use of antimicrobials and their association with resistance in generic Escherichia coli recovered from fecal samples from Canadian dairy herds: A cross-sectional study, *Preventive veterinary medicine* 216, 105948 (2023). 10.1016/j.prevetmed.2023.105948

Fonseca M, Heider LC, Stryhn H, McClure JT, Léger D, Rizzo D, Warder L, Dufour S, Roy J, Kelton DF, Renaud D, Barkema HW and Sanchez J. Antimicrobial use and its association with the isolation of and antimicrobial resistance in Campylobacter spp. recovered from fecal samples from Canadian dairy herds: A cross-sectional study, *Preventive veterinary medicine* 215, 105925 (2023). 10.1016/j.prevetmed.2023.105925

Fonseca M, Mendonça LC, Souza GN, Cesar DE, Carneiro JC, Brito EC, Mendonça JF, Brito MAVPe and Guimarães AS. Epidemiology of mastitis and interactions of environmental factors on udder health in the compost barn system, *Arquivo brasileiro de medicina veterinária ezootecnia* 75, 14-26 (2023). 10.1590/1678-4162-12798

Fonseca M, Heider LC, Léger D, McClure JT, Rizzo D, Dufour S, Kelton DF, Renaud D, Barkema HW and Sanchez J. Canadian Dairy Network for Antimicrobial Stewardship and Resistance (CaDNetASR): An On-Farm Surveillance System, *Frontiers in veterinary science* 8, 799622 (2022). 10.3389/fvets.2021.799622

Fonseca MDM, Maia JMS, Varago FC, Gern JC, Carvalho WA, Silva SR, Mosqueira VCF, Brandão HM and Guimarães AS. Cloxacillin nanostructured formulation for the treatment of bovine keratoconjunctivitis, *Veterinary and Animal Science* 9, 100089 (2020). 10.1016/j.vas.2020.100089

Dorneles EMS, **Fonseca MDAM**, Abreu JAP, Lage AP, Brito MAVP, Pereira CR, Brandão HM, Guimarães AS and Heinemann MB. Genetic diversity and antimicrobial resistance in Staphylococcus aureus and coagulase-negative Staphylococcus isolates from bovine mastitis in Minas Gerais, Brazil, *MicrobiologyOpen* 8, e00736-n/a (2019). 10.1002/mbo3.736

Manuscripts submitted

Fonseca M, Heider LC, Stryhn H, McClure JT, Léger D, Rizzo D, Muckle CA, Dufour S, Kelton DF, Renaud D, Barkema HW and Sanchez J. Frequency of isolation and phenotypic resistance of fecal Salmonella recovered from healthy dairy cattle in Canada. *Submitted to Journal of Dairy Science in July 2023.*

Collaboration in scientific publications

Warder LMC, Heider LC, Léger DF, Rizzo D, McClure JT, de Jong E, McCubbin KD, Uyama T, **Fonseca M**, Jaramillo AS, Kelton DF, Renaud D, Barkema HW, Dufour S, Roy J and Sánchez J. Quantifying antimicrobial use on Canadian dairy farms using garbage can audits, *Frontiers in veterinary science* 10, 1185628 (2023). 10.3389/fvets.2023.1185628

Presentations

Fonseca M, Heider LC, Stryhn H, McClure JT, Léger D, Rizzo D, Warder L, Dufour S, Kelton DF, Renaud D, Barkema HW and Sanchez J. *Systemic use of antimicrobials and their association with resistance in generic Escherichia coli recovered from fecal samples from Canadian dairy herds: A cross-sectional study*. **Canadian Emerging Veterinary Scholars Summit (CEVSS), 2022**. Oral presentation.

Fonseca M, Heider LC, Stryhn H, McClure JT, Léger D, Rizzo D, Warder L, Dufour S, Kelton DF, Renaud D, Barkema HW and Sanchez J. *Risk factors for the isolation and resistance to ciprofloxacin and tetracycline in Campylobacter spp. recovered from fecal samples from Canadian dairy herds: A cross-sectional study*. **UPEI Graduate Studies and Research Conference, 2022**. Oral presentation.

Fonseca M, Heider LC, Leger D, Rizzo D, Dufour S, Barkema HW, Kelton DF, Renaud D, McClure JT, Keefe G, Muckle A, Stryhn H, Sanchez J. *Sources of variation for the isolation of antimicrobial resistant Campylobacter spp. from Canadian dairy herds*. **16th**

International Symposium of Veterinary Epidemiology and Economics (ISVEE 16), 2022. Oral presentation.

Fonseca M, Heider LC, Leger D, Rizzo D, Dufour S, Barkema HW, Kelton DF, Renaud D, McClure JT, Sanchez J. *CaDNetASR: An On-farm Surveillance System for Antimicrobial Stewardship and Resistance on Dairy Farms in Canada*. **16th International Symposium of Veterinary Epidemiology and Economics** (ISVEE 16), 2022. Poster presentation.

Fonseca M, Ritter C, Proudfoot K, Heider LC, Sanchez J. *Describing dairy producers' perceptions towards antimicrobial use and animal welfare in Atlantic Canada*. **16th International Symposium of Veterinary Epidemiology and Economics** (ISVEE 16), 2022. Poster presentation.

Fonseca M, Heider LC, Léger D, McClure JT, Rizzo D, Dufour S, Kelton DF, Renaud D, Barkema HW and Sanchez J. *Surveillance of antimicrobial use and antimicrobial resistance on dairy farms across Canada.* One Health Antimicrobial Stewardship Conference, 2021. **Oral presentation**.

Biographical Data

My name is Mariana, and I am originally from Brazil, where I got my DVM and Master's degrees. During my DVM degree, I had the opportunity to participate in an internship program in Denmark, working on a dairy farm for 18 months, where I gained a lot of experience in my professional and personal life. After finishing my master's degree, I won a screening grant from Aarhus University to work as a guest researcher at the Department of Animal Science (Epidemiology and Management). I am currently a Ph.D. candidate at the University of Prince Edward Island (Health Management Department). The project I am working on for my Ph.D. is an on-farm surveillance system for antimicrobial use (AMU) and antimicrobial resistance (AMR) in Canadian dairy farms. The main objective of our research program is to establish the infrastructure required to support a national surveillance system for the ongoing collection of data regarding AMU, AMR, and the effectiveness of stewardship practices on Canadian dairy farms. During the years 2020 and 2021, I also supervised summer students in the AVC Summer Research and Leadership Program. I am in the last year of my graduate program, working with epidemiological models to identify risk factors for resistance in *Campylobacter* spp., *E. coli*, and *Salmonella* spp.

Born in Juiz de Fora, Minas Gerais, Brazil.

Awards

2022 – Second best oral presentation at the Canadian Emerging Veterinary Science Summit 2022 – Canadian Emerging Veterinary Scholars Summit - CEVSS (University of Calgary)

2022 – Third best oral presentation at the UPEI Graduate Studies Research Conference

2022 – Ian Dohoo Travel Award

2022 – Student Research travel funding

2019 – Sir James Dunn Animal Welfare Graduate Scholarship

2019 – NSERC: CREATE in Milk Quality Program Scholarship