Antimicrobial use and resistance in livestock

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What is it?

Antimicrobials, more specifically antibiotics, are compounds that kill bacteria. They are used in people, companion and farm animals (McAllister & Waldner, 2020) as health management tools to treat, prevent and control disease and infection. Antimicrobial resistance is a natural occurrence whereby the genetic make-up of a microbe alters in a way that makes it unsusceptible to antimicrobials. Our use of antimicrobials in both human and animal medicine results in a need to use antimicrobials responsibly to ensure antimicrobial effectiveness and prevent resistance. Continuing the use of antimicrobials in animal medicine is essential for keeping humans healthy through the control of diseases and for maintaining strong animal welfare standards for the animals in our care.

Why it matters to the Ontario livestock industry:

Livestock producers need to make wise use of antimicrobials as part of the greater societal effort to minimize antimicrobial resistance. This effort will bring new management techniques to production in order to minimize disease and the need for antimicrobial use.

Health Canada's Veterinary Drug Directorate is responsible for a stringent assessment process that ensures;

- a product's safety to humans and the intended species,
- efficacy, and
- that it meets good manufacturing standards

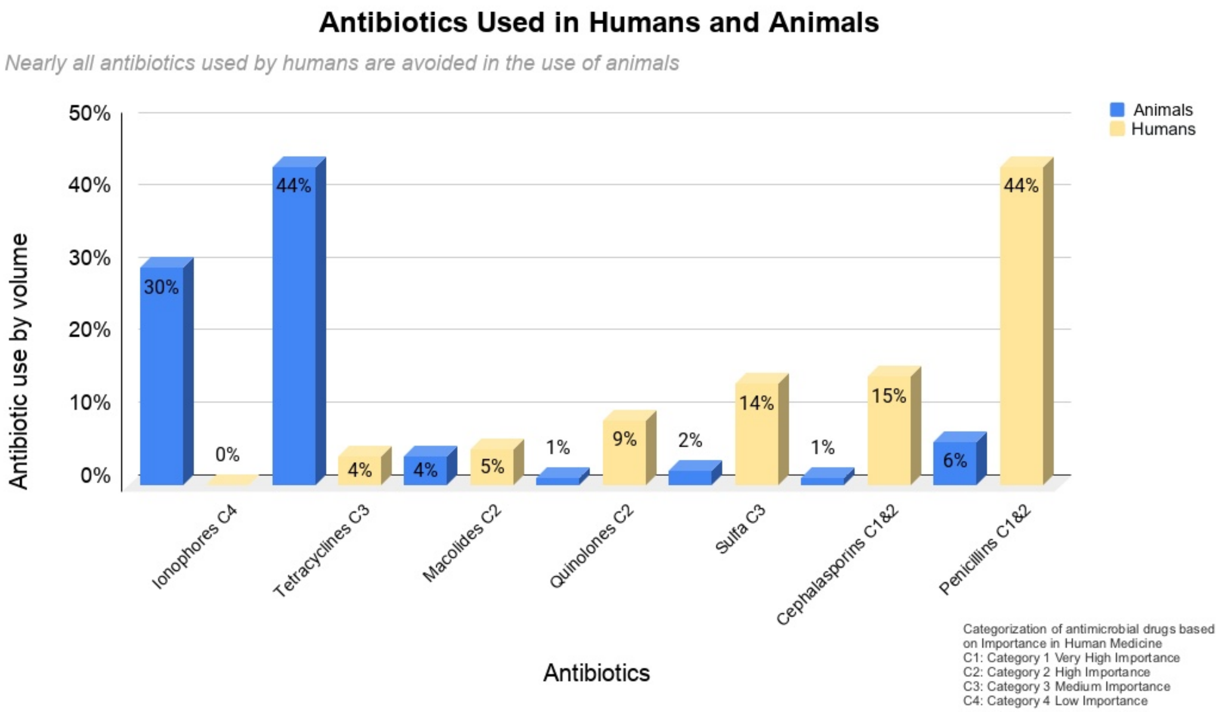
The assessment occurs prior to licensing to permit sale of antimicrobials used in animal medicine (McAllister & Waldner, 2020). The Public Health Agency of Canada estimates that 82 percent of all antimicrobial use in Canada is attributed to agriculture (Prescott et al., 2012). This is not surprising since the total biomass of farmed animals is greater than that of the human population.

Antibiotics are divided into four categories based on their importance to human health. Category 1 antimicrobials are those most important to human medicine and these are under strict regulations as they do not have alternative antimicrobials for treatment in case of resistance. Category 2 antimicrobials are of high importance to human medicine and are used to treat some serious infections. When needed, category 1 drugs can be used as alternatives for category 2 drugs. Category 3 antimicrobials are of medium importance and are used for treatment of bacterial infections, their alternative treatments include category 1 and 2 drugs. Category 1, 2, and 3 antimicrobials all require veterinary prescriptions for use in farm animals. Category 4 antimicrobials have low importance to human medicine as they are currently not used in human medicine and their use is not associated with bacteria resistance (Government of Canada, 2009).

Category	Concern to Human Medicine	Use in Human Medicine	Alternative Available	Veterinary Prescription Needed
1	**VERY HIGH IMPORTANCE**	Preferred option for treatment of serious human infections	No	Yes
2	**HIGH IMPORTANCE**	Preferred option for treatment of serious human infections (intermediate concern)	Yes	Yes
3	**MEDIUM IMPORTANCE**	Rarely used in human medicine, not preferred option for treatment of serious human infections	Yes, for human medicine, No for veterinary medicine.	Yes
4	**LOW IMPORTANCE**	Not used in human medicine	Not applicable	No

(Canadian Animal Health Institute, 2021)

In 2017, Canada introduced a new regulation to prohibit the sale of Medically Important Antimicrobials in livestock production without medical oversight from a veterinarian to avoid unnecessary use of antibiotics (McAllister & Waldner, 2020). Only Category 4 antimicrobials can be sold without veterinary prescription for use. Antimicrobials are used carefully and deliberately to minimize the crossover between animals and humans. The graph below displays how antibiotics are dispersed categorically, the more medically important to humans the antibiotic is, the less it is used with animals. Antimicrobials are necessary for use in livestock to help manage diseases that ensure the welfare of the herd and help to prevent the spread of disease to the public. Livestock are generally housed in herds or flocks. Thus, if one cow, chicken or pig gets sick, just as with humans, there is a likelihood that others in the group will have been exposed to the disease and thus need to have medical intervention.



Understanding risk:

The greatest concern for human health is any category 1 antimicrobials used in livestock, these are often only used as a last resort following use of lesser drugs as seen in the figure above. Creating clear distinctions between use of antimicrobials for humans and animals prevents risk of selecting any drug-resistant bacteria and ensures safe use in the future. Animal to human and human to animal transfer of disease classifies a disease as zoonotic and is the reason for risk management standards for antimicrobial use (Prescott et al., 2012). Poor antimicrobial stewardship among humans and in human institutions has contributed greatly to this issue. Farm animal producers share the same desire for safe and healthy food that consumers have. They also bear the responsibility for their animals, keeping them healthy and providing them with proper care. Producers understand the importance of using antimicrobials judiciously and safely.

Looking into overuse and the threat AMR poses, the Center for Disease Control (CDC) and IMS Health researched health care providers and their prescription habits of antibiotics. They found that about 266.1 million courses of antibiotics were prescribed in the US in 2014 (Hicks, et al., 2013). A 2016 CDC report found that one third of prescriptions being issued to people were unnecessary and patients could have been treated without antibiotics (Fleming-Dutra et al., 2016).

History of antimicrobial use:

- Antimicrobials have been used in medicine for centuries. Ancient Egyptians were known to use mold to treat their wounds (Ancient Times). The understanding of how the mold became effective as an antibiotic was discovered much later. In the late 1880s scientists began to understand and identify these antibiotics. In 1940, penicillin was discovered from mold and became available for medical use (Discovery and Development of Penicillin). This discovery has saved countless human lives.
- In the 20th century, livestock and poultry producers incorporated antibiotics into animal husbandry practices.
- The concept that humans can develop resistance to antimicrobials was discussed by Alexander Fleming in 1945 as the creation of new antibiotics slowed and use of existing antibiotics increased (Fleming, 1945).
- In 2017, Canada introduced regulation to prohibit the use of Medically Important Antimicrobials in livestock production without medical oversight from a veterinarian.

What can be done:

All antimicrobials used in livestock medicine have label directions for use. Reducing the use of antibiotics in livestock production must take into consideration: the category of antibiotic; the health of the animal patient, and the efficient production of a safe and wholesome product. Prophylactic use involves giving a small dose of antibiotic at a time of stress (e.g., transport) to prevent any disease. Producer groups and veterinarians are assessing management options to try and reduce the use of antimicrobials in livestock production.

The Beef Cattle Research Council (BCRC) conducted research examining the risk of microbes with antimicrobial resistance moving from feedlot animals to humans through manure, soil and water (Bergen, 2018). The mitigation method they found successful was composting manure. New research shows the presence of wetlands and microbiologically active soils with high levels of carbon, are catalysts for degrading antimicrobials and bacteria with resistant genes (McAllister & Waldner, 2020).

The following can be used as preventative measures to avoid disease and lower the need for antibiotics.

- Sound biosecurity (keep disease off the property and out of facilities)
- Vaccination programs
- Climate control (e.g., eliminate draughts, proper temperature)
- Management of young stock (e.g., ensure colostrum intake)
- Nutrition (balanced rations to prevention susceptibility to disease)
- Where possible include health in genetic selection
- Support innovation of new animal health management tools

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) was created by the Public Health Agency of Canada to monitor antimicrobial resistance in humans, in livestock before slaughter, and retail meat before consumption (Antimicrobial Resistance in Agriculture). Antimicrobial resistance was observed with Salmonella Enteritidis, found in healthy and sick chickens as well as chicken meat purchased in grocery stores. There were only a few isolates of this salmonella, however, CIPARS saw for the first time a highly-drug resistant salmonella from a chicken source ((CIPARS) 2018: Executive Summary). CIPARS has not published the 2019 report nor the 2020 report as of March 2021.

The Responsible Chicken Use Strategy was implemented by the Chicken Farmers of Canada (CFC) to maintain consumer confidence and demonstrate responsible antimicrobial use (AMU Strategy: A prescription for change). The CFC values antimicrobials as an essential tool for animal health and welfare. The Strategy's main points include research, surveillance, reduction and education as well as a timeline for the industry to eliminate the medically important to humans antimicrobials (category 1, 2 and 3) by 2019 which was accomplished. This strategy works to support producers through changes within the industry, legislation and accessing veterinary drugs.

Every time antibiotics are used there is a risk for selecting drug-resistant bacteria, regardless of whether it is used in animals or humans (Canadian Animal Health Institute, 2021). Protection of antibiotics is fundamental for the continued use in animals and humans for treatment in the future. Sufficient hygiene practices on farms, slaughterhouses, during distribution of food, in food preparation and finally at the consumer level are fundamental in minimizing the transmission of foodborne pathogens (Phillips et al., 2004).

Market Pull:

Market forces change over time and, in recent years, there has been some demand for livestock food products to be raised without antibiotics. It should be noted that the number one driving force as self-identified by consumers in their purchasing decisions is price. Raised without antibiotics may seem logical and simple to consumers but is actually very complex from a risk standpoint as it puts the welfare of animals, and their herd mates, in jeopardy. Even with excellent farm management, producers will experience sickness in their livestock.

Research Gaps:

- Management techniques that decrease microbial load in the environment in which livestock are raised, for example, anaerobic digestors for manure management.
- Feed additives that provide an immune boost to animals, reducing sickness
- Sensor data collection that provides early signs of sickness
- Genetic selection for high immune response

- Management of the generation before (the cow, the chicken that laid the egg to be a broiler) to improve the immune response of the young animals
- Young stock management
- How best to make use of new messenger RNA (mRNA) technology to improve health of livestock

Innovation Gaps:

- Facility design (e.g. ventilation)
- Rugged, cost effective sensors to collect data
- Improved access to veterinary services in remote areas (e.g. telehealth)

For more information & Additional resources

- Please contact LRIC at info@livestockresearch.ca or 519-766-5464.
- Health Canada's Antimicrobial Resistance - Veterinary Drugs
- Government of Canada's response to antimicrobial resistance
- Meat Institute AMU/AMR pamphlet
- The Canadian Animal Health Institute Position Statement on the use of Antimicrobials
- Beef Cattle Research Council: Antimicrobial Resistance

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