Antimicrobial Restriction in Animal Agriculture: A Challenge to Human and Animal Ethics

by

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ABSTRACT

Food animal medicine uses many of the same antimicrobials as human medicine in order to control the spread of disease and treat infections. Presently, there is no conclusive evidence that antimicrobial use in animal agriculture is directly responsible for antimicrobial resistance in human medicine. Despite this, many public and private agencies recommend reducing and restricting the use of antimicrobials in food animals out of an abundance of caution. This thesis aims to describe the ethical concerns for both humans and animals that arise out of such restrictions. Drawing extensively from the literature, I identify three key themes that encapsulate the shortcomings of antimicrobial use restriction efforts: the complex stakeholder relationships in animal agriculture, anthropocentrism, and the barriers within antimicrobial stewardship solutions. These three key themes are then used to guide an analysis of three different antimicrobial use policies: the Global Animal Partnership's Animal Welfare Standards, McDonald's Global Vision for Antimicrobial Stewardship, and the World Health Organization's Guidelines on the use of Medically Important Antimicrobials in Food-Producing Animals. Through these analyses, I conclude that all policy approaches, whether public or private, ought to expand their motivation beyond those of human medicine to include the interests of animals, and those that care for them. An ethical approach to antimicrobial use reduction must include access to treatment in the event of a disease outbreak or infection, as animals are blameless in their contribution to the burden of antimicrobial resistance. Both farmers and veterinarians need to be provided with concrete structural supports that allow for such treatment in order to prevent unnecessary euthanasia, burnout, and moral distress. Further, antimicrobial use reduction strategies cannot overlook barriers to implementation stemming from lack of available financial, educational and diagnostic resources. Looking ahead, there is ample opportunity for private and public organizations to lead the development of practical solutions that help to reduce the determinants of disease and the need for antimicrobial use, while protecting against human and animal harms.

RÉSUMÉ

La médecine des animaux destinés à l'alimentation utilise un bon nombre des mêmes antimicrobiens que la médecine humaine afin de contrôler la propagation des maladies et de traiter les infections. À l'heure actuelle, il n'y a aucune preuve concluante que l'utilisation d'antimicrobiens en agriculture animale est directement responsable de la résistance aux antimicrobiens en médecine humaine. Malgré cela, par une abondance de prudence, de nombreux organismes publics et privés recommandent de réduire et de restreindre l'utilisation des antimicrobiens chez les animaux destinés à l'alimentation. Cette thèse vise à décrire les préoccupations éthiques pour les humains et les animaux qui proviennent de telles restrictions. Tirant largement de la littérature, j'identifie trois thèmes clés qui résument les lacunes des efforts de restriction de l'utilisation des antimicrobiens: les relations complexes entre les parties prenantes dans l'agriculture animale, l'anthropocentrisme et les obstacles dans les solutions de gestion des antimicrobiens. Ces trois thèmes clés sont ensuite utilisés pour guider une analyse de trois politiques d'utilisation des antimicrobiens différentes: les normes de bien-être animal du Partenariat mondial pour les animaux (Global Animal Partnership's Animal Welfare Standards), la vision globale de McDonald pour la gestion des antimicrobiens (Global Vision for Antimicrobial Stewardship) et les directives de l'Organisation mondiale de la Santé sur l'utilisation des antimicrobiens d'importance médicale dans la production alimentaire animaux. À travers ces analyses, je conclus que toutes les approches politiques, qu'elles soient publiques ou privées, devraient élargir leur motivation au-delà de celles de la médecine humaine pour inclure les intérêts des animaux et ceux qui les soignent. Une approche éthique de la réduction de l'utilisation des antimicrobiens doit inclure l'accès au traitement en cas d'épidémie de maladie ou d'infection, car les animaux sont irréprochables dans leur contribution au fardeau de la résistance aux antimicrobiens. Les éleveurs et les vétérinaires doivent être équipés de supports structurels concrets qui permettent un tel traitement afin d'éviter l'euthanasie inutile, l'épuisement professionnel et la détresse morale. En outre, les stratégies de réduction de l'utilisation des antimicrobiens ne peuvent ignorer les obstacles à la mise en œuvre résultant du manque de ressources financières, éducatives et diagnostiques

disponibles. À l'avenir, les organisations privées et publiques ont amplement l'occasion de diriger le développement de solutions pratiques qui aident à réduire les déterminants de la maladie et la nécessité d'utiliser des antimicrobiens, tout en se protégeant contre les méfaits pour l'homme et les animaux.

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Chapter 1: Introducing the Problem

Introduction

Antimicrobial resistance has been described as the foremost health security challenge of the 21st century.[1] Antimicrobial drugs are used for the treatment, control and prevention of bacterial diseases in both humans and animals.[2] Human and veterinary medicine make use of many of the same classes of antimicrobial drugs, some of which are used to treat life-threatening infections in human patients.[2] If bacteria develop resistance to these drugs they can become ineffective, and in some cases there may not be alternative treatment options for patients.[2] Unsurprisingly, antimicrobial resistance increases the morbidity and mortality of infectious disease.[3] While primarily presented as a problem of human medicine, antimicrobial resistance may also pose problems for veterinary medicine.[3] It follows that antimicrobial resistance places both humans and animals at risk for a prolonged course of disease and death from an untreatable infection.[1] As a result, it is critical that we address antimicrobial resistance now, in order to preserve the effectiveness of the antimicrobials we currently have for the future.[1–3]

Within this thesis, the term antimicrobial will be used to describe any drug, whether naturally occurring or synthetic, that is capable of inhibiting the growth of or killing micro-organisms.[4,5] While some antimicrobial drugs act on viruses and fungi, this thesis is solely concerned with antibacterial drugs, and not antifungals or antivirals.[2] The term 'antimicrobial' will be considered equal to the term 'antibiotic'. Medically important antimicrobials will be used to refer specifically to classes of antimicrobial drugs that are used in human medicine.[5] Henceforth, antimicrobial use will be referred to as 'AMU', while antimicrobial resistance will

be referred to as ‘AMR’. Production systems abstaining from using any antimicrobials will be referred to as ‘raised without antibiotics’ or ‘RWA’. ‘Prohibitionist’ will be used to describe a philosophy of food animal production whereby the use of any antimicrobial drugs is strictly forbidden. Finally, ‘abolitionist’ will be used to describe individuals and organizations that believe animal agriculture must cease to be practiced.

A Brief History of Antimicrobial Use in Animal Agriculture

The introduction and growth of AMU in food animals is tied closely with global conflict, population growth, and increasing wealth. The first instance of AMU in animal agriculture came in 1938, with the licensing of sulphonamides for food animals. During World War II, the great requirements to feed the war effort led to the development of antibiotic treatment for mastitis in dairy cattle. The war also brought European and North American drug and feed manufacturers together in order to develop ways to increase productivity, curb disease and reduce the need for labour. These collaborations led to the realisation that medications could be administered in feed and water, alongside the discovery that antibiotic residues helped improve growth rates. These collaborative relationships remained after the end of the war, and led to the licensing of drugs for routine and therapeutic use in poultry, bees, fish, and cattle. Following the end of rationing, the strong post-war demand for meat led to agricultural growth and a vast increase in the sales of therapeutic and non-therapeutic drug. Drug manufacturers thus recognized the potential of the agricultural market for more profit growth than the field of human medicine, and continued to look for increased areas of use for antibiotic drugs.[6]

Post-war policies in Europe prioritized a reduced reliance on imported feed which, alongside a demand for labour outside of agriculture, required an increasingly productive livestock industry. To tackle this challenge, livestock production turned to more confined housing, and antimicrobial use increased. The United States government actively promoted antimicrobial in-feed technologies to increase yield and reduce hunger both at home and abroad, seen politically to promote Western values in support of their fight against

communism. Soon, easy access to antibiotics was viewed the world over as a way to further the improvement of agriculture and societal progress.[6]

The 1960s marked the initial shift in perspective away from viewing AMU as a triumph of agricultural progress, and towards seeing AMU as a potential problem. In 1968, British officials commissioned a report on AMU, the results of which prompted a series of reforms the following year. These included the requirement for a veterinary prescription for antibiotics used in medicine, and precautionary restrictions preventing the use of medically relevant drugs for growth promotion. The rest of western Europe followed with similar precautions shortly thereafter. Globally, however, there remained a lack of broad consensus on the appropriate approach to AMU, including a lack of shared goals and coordination. By the 1980s, development of new antimicrobial drugs had slowed significantly and Western nations began to grow concerned about the potential for a "post-antibiotic" era.[6] The first major reforms curbing use were enacted by Scandinavian countries in the 1980s, followed shortly thereafter by EU member countries, eventually leading to complete bans on growth promoters. Canada and the United States followed with their own similar restrictions only recently, in the 2010s.[6,7]

Taking a global perspective, increasing wealth continues to drive increasing AMU. Between 2000 and 2010, the total global consumption of antibiotics grew nearly 70%.[1] As people become increasingly affluent, they are able to purchase drugs to treat their own infections, resulting in a sharp increase in per capita consumption in LMICs between 2000 and 2010.[1] Additionally, the global demand for meat accompanies growing wealth, driving the need for an increasingly productive agriculture.[1] By 2010, China became the largest global user of agricultural antimicrobials, followed by the US, Brazil, India, and Germany.[6,8]

While the current global regulatory framework is mixed and lacks coordination, private industry has emerged as an advocate for reduced AMU. From retailers, to suppliers, to the fast food industry, businesses are offering products that restrict or prohibit the use of antibiotics, often labelled as "Organic" and "RWA," in order to address public concerns and offer an opportunity to swiftly reduce AMU.[6] Despite these decisive actions, the question of to what extent antimicrobials should be used in animal agriculture, and how their use relates to the

problems encountered in human medicine, remains unresolved.[7] While the past decade was marked with public and private policies introducing restrictions to AMU beyond growth promotion, the evidence supporting such decisions remains hotly debated.[7]

Research Question and Thesis Framework

The restriction and overall reduction of AMU in animal agriculture presents itself as a simple and straightforward solution to combatting AMR in human medicine, with few disadvantages. This thesis takes a critical look at this approach, and asks a central question: is it ethical to restrict the use of antimicrobials in food animals for the sake of human benefit? To answer this question, I seek to determine the relevant ethical considerations by describing the evidence that details the contribution of animal agriculture to AMR; by considering the perspectives of agricultural stakeholders, including farmers, veterinarians, consumers, and animals; and by conducting analyses of three different agricultural antimicrobial use programs. To begin, a narrative literature reviews is used to describe the evidence of the contribution of animal AMU on the burden of AMR. A narrative review is again employed in the second and third chapters, to give voice to agricultural stakeholders and the challenges that they face in antimicrobial stewardship. Three key themes are identified within the agricultural stakeholder literature, which provides the structure for these chapters. These themes are then used as lenses, through which three different approaches to AMU in animal production are analysed. These include the Global Animal Partnership's Animal Welfare Standards, McDonalds' Global Vision for Antimicrobial Stewardship, and the World Health Organization's [WHO] Guidelines on the use of Medically Important Antimicrobials in Food-Producing Animals. These three approaches to antimicrobial stewardship represent the food retail industry, the fast-food industry, and public policy recommendations, all of which have influence over every day agricultural practices. The use of the three themes inductively identified by the author in Chapters 2 and 3 as the structure for analyses derives from the lack of ethics frameworks available for this subject matter, as the thesis question centers on a practical problem not yet

commonly discussed within ethics literature. The themes were selected based on perceived importance and prevalence across geographical boundaries and production species. With the identification of these themes and subsequent analysis of agricultural animal production approaches, this thesis aims to inform researchers, policy makers, and industry of current ethical shortcomings in the approach to antimicrobial stewardship in animal agriculture and to provide preliminary positive recommendations on forward directions in order to help improve the lives of agricultural stakeholders, while still supporting the global goal of reducing antimicrobial resistance.

Literature Review

Throughout Canada, the US, and Europe the 2010s were marked with policies introducing restrictions to AMU for growth promotion and beyond, with a goal of curbing all AMU.[7] Canada reduced the use of antimicrobials in food animals by 12% between 2016 and 2017, with much of this reduction stemming from the swine and broiler industries.[9] Canadian domestic data from 2018 indicates that 78% of antimicrobials sold were intended for food animals, while 21% of antimicrobials were intended for humans.[10] It is important to recognize that the animal population (not including fish) is 21 times larger than the human population.[10] Adjusted for difference in biomass, animals in Canada received 1.4 times the amount of antimicrobials as humans.[10] Presently, the concern of AMR relative to food animal medicine is largely focused on pathogens with zoonotic potential, bacteria known to enter the food chain, and those that contain mobile genetic elements that encode resistance.[3] The primary focus is placed on *Salmonella enterica*, *Campylobacter*, livestock affiliated methicillin resistant *Staphylococcus aureus* (LA-MRSA), *E.coli*, *Enterococcus*, and other Enterobacteriaceae.[3]

The Impact of Antimicrobial Use Reduction on AMR

It is difficult to assess the impact of initiatives that reduce AMU in food animals on the prevalence of AMR.[11] It is common for farms and geographic regions to institute multiple use reduction measures at the same time, making it difficult to causally associate observed trends in AMR with one particular intervention.[11] Trials evaluating the impact of AMU restriction initiatives have often found that AMU-reducing interventions led to reductions in the prevalence of resistant bacteria, compared to conventional control groups, though in some cases no difference in resistance has been observed.[12] Of note, trial data suggests that the restriction of the use of all antimicrobials does not lead to a difference in prevalence of resistant microbes compared to interventions where therapeutic antimicrobial use is allowed.[12]

A domestic example that highlights the difficulty in determining the impact of antimicrobial use restrictions and reductions comes from the Canadian chicken industry. The use of category I antimicrobials has been discontinued in the poultry industry, which includes 3rd generation cephalosporins. Canadian surveillance data noted in 2018 that this use restriction appeared to result in a reduction in human AMR. Between the onset of the ban in 2014 and 2018, the *Salmonella* isolates recovered from sick people were less resistant to 3rd generation cephalosporins, with a similar trend also seen in Salmonella and E. coli isolates from chickens at slaughter. Despite this apparent correlated decrease in resistance, surveillance data also observed a small increase in *Salmonella* resistant to 3rd generation cephalosporins in healthy chickens on Canadian farms, despite the fact that these drugs were not in use.[10]

Turning to examples in cattle, fecal and environmental samples collected from Canadian and American beef feedlots and dairy farms operating under conventional and RWA systems found a larger average number of antibiotic resistant genes (ARGs) in conventional production systems than in RWA.[13] Numerous mechanisms for resistance were associated with production practices, with some more abundant in conventional samples and others more abundant in RWA samples.[13] Additionally, some classes of resistance were found in conventional samples, even though farm managers did not report using those antimicrobial drugs.[13] Similarly, a higher prevalence of multi-drug resistant (MDR) bacteria has been reported in conventional versus organic broiler chicken and swine farms, which suggests that conventional AMU practices are

more selective of MDR than the practices of farms with zero AMU.[14] Notably, some bacterial isolates from organic swine and poultry production have shown resistance to antimicrobials, such as ampicillin, erythromycin, and tetracycline, despite the lack of selection pressure from antimicrobial use.[14] This data further supports the notion that ARGs can be selected for without using the respective antimicrobial, and demonstrates that genetic resistance is retained by bacterial populations long after acquisition of resistance genes, especially in the presence of other selection pressures.[13,14] In contrast, a recent Canadian trial comparing RWA and conventional swine farms found that piglets from RWA farms have significantly reduced incidences of Tetracycline ARGs and MDR ARGs compared to conventional piglets.[15] The authors of this research suggest that RWA production in swine could possibly reduce resistance to tetracyclines, a commonly used drug, as well as the number of multi-drug resistant gene groups.[15] With that said, the differences in AMR status between conventional versus antibiotic-free farms can result from factors beyond just antimicrobial use, including management factors and farm size, which may provide selection pressures.[14]

Additional influences on AMR can also include geographic location. A study evaluating the fecal microbiota of pigs reared in conventional and organic systems throughout EU countries found that geographic location was a stronger determinant of AMR genes than the production system itself.[16] Significantly more resistant genes were found in pigs raised in southern Europe compared to Northern Europe, regardless of AMU, which could be due to general differences in environment, farm management and husbandry between countries.[16] Time of year has also been found to influence AMR. In a study comparing conventional and antibiotic-free beef feedlots, seasonal effect was found to have a stronger influence than production system on the prevalence of pathogens and resistant bacteria in manure samples.[17] Tetracycline resistant *E. coli*, for example, had highest detection levels in the summer, and with no difference in prevalence present between RWA and conventional cattle.[17] This same trend was observed in sulfamethoxazole-trimethoprim-resistant *E. coli*, and generic *Salmonella*. The results depicted very similar microbiomes in conventional and RWA cattle, with only three of the 14 identified resistance mechanisms found to be more prevalent in conventional feedlots.[17] The authors predict, based on their data, that any major restrictions to AMU in the beef

industry are not likely to yield consistently detectable reductions in AMR across all classes of antimicrobials. [17]

The lack of high-quality research evaluating the impact of various on-farm antimicrobial stewardship initiatives on animal and human resistance is a widely identified, considerable problem.[11,12,14] While randomized controlled trials are described in the literature as unethical to run (despite the required conditions regularly existing in industry), observational studies are feasible, yet have historically had small sample sizes and lacked sound methodology.[14] Research into strategies employed by farmers operating with limited access to antimicrobials is also not as robust as desired, and fails to provide conclusive evidence of alternative management strategies, housing systems, and effective antibiotic alternatives, amongst others, that reduce both selection pressure of AMR and need for AMU.[11,14] Additionally problematic is the reality that the available research stems predominantly from European and North American countries, with limited representation from China, Brazil and India despite their global dominance in AMU consumption.[12] Finally, trials do not always focus on the potential harms to animals within AMU restriction interventions.[12]

Despite the prevalence of AMU restriction and overall reduction strategies in food animals as part of initiatives to combat AMR, it may never be possible to determine the overall contribution of animal agriculture on AMR faced in human medicine.[18] It has been determined that AMU on farms contributes to AMR in animals by way of natural selection, where both pathogenic bacteria and commensal microbes can evolve to survive in the presence of antibiotics, and can share the genes coding for this resistance among other bacteria.[1,8,18,19] With that said, AMR does not follow a straightforward model of causality, due in part to the many selection pressures beyond AMU, and the numerous indirect modes of transmission.[8,18,19] Influencing factors contributing to the development and spread of resistance include farm management, animal diets, housing environment, species and strain of bacteria, and type of antimicrobial used.[18] Not all AMU leads to AMR, and stopping AMU may not lead to the reduction of resistance.[13,14,18] There is strong evidence that resistant commensal microbes of animal origin can colonize people that come into direct contact with these animals, such as

farmers, packing plant workers, and veterinarians.[12,18] These commensal microbes can then transfer their resistant genes to human commensal microbes and even to human pathogenic bacteria.[18] What is not clear is how regularly these transfers happen amongst those who work with food animals, and what on-farm factors influence the frequency of transfer.[18] In a meta-analysis of 13 human impact studies, the prevalence of antibiotic-resistant bacteria in humans in contact with animals was 24% lower in trial groups with reduced AMU, compared with conventional control groups.[12] When it comes to the general, non-farming population however, there is considerably less evidence for more indirect transmission.[12] It is unclear just what fraction of resistant genes found in humans originate from human verses food animal sources.[12,18] As a result, despite the evidence that resistance can be transmitted between animals and humans, the resulting human public health risk of AMU in food animals is still undetermined.[18]

MRSA

Staphylococcus aureus has long been a pathogen of concern in human medicine, and is seen as the primary cause of hospital acquired (nosocomial) infections.[20] Many individuals carry *S. aureus* asymptomatically, only developing infections after the bacteria is able to pass through skin or mucous barriers, with clinical results ranging from mild to life-threatening.[21] Antibiotic resistance in *S. aureus* was observed almost immediately after the introduction of penicillin in the 1940s, achieved by producing the enzyme beta-lactamase (beta-lactam resistance).[20] Methicillin was introduced in the 1950s, and despite the resistance of methicillin to beta-lactamase, methicillin resistant *S. aureus* was detected soon after.[20] In southern Europe, MRSA infections are commonplace in healthcare settings, representing up to half of all documented *S. aureus* infections.[20] Aggressive targeting programs in northern European countries such as the Netherlands and Denmark have seen nosocomial MRSA infection rates drop below one percent of total *S. aureus* infections.[20,22] In Canada, roughly 4.2% of hospital patients will become infected with MRSA.[23]

Prior to the 2000s, all MRSA infections were assumed to be of human origin, and only rarely observed in animals.[19,20,22] Since the mid 2000s however, livestock-associated methicillin resistant *Staphylococcus aureus* (LA-MRSA) has posed an increasing concern in Europe.[20,22] In 2005, a persistent MRSA infection in a Dutch infant was traced to the pigs on her parents' farm.[20] Following further study, it was discovered that much of the national swine herd carried MRSA asymptomatically.[20] With this knowledge, both Denmark and the Netherlands expanded their targeting programs to include livestock farmers and workers, considered to have a higher risk of colonization, requiring mandatory LA-MRSA screening and pre-emptive isolation prior to using healthcare services.[20,22]

It is thought that the clonal lineage of MRSA carried by livestock, clonal complex 398 (CC398), originated in humans as a methicillin susceptible *S. aureus* and acquired resistance after introduction into livestock as part of host adaptation, before being reintroduced into humans.[24] It is known that MRSA CC398 commonly colonizes swine, poultry and cattle without any associated clinical infection.[25] As it possesses poor host specificity, it also commonly colonizes the humans that work with these animals, such as farmers, veterinarians and butchers, presenting a modern occupational hazard for those in direct contact with livestock.[20,25] Clinically, it poses similar risks to human patients as non-livestock associated *S. aureus*, but unlike hospital or community acquired MRSA, little is known about the transmissibility of LA-MRSA CC398.[22,24,26] In regards to the nature of resistance of LA-MRSA CC398, it tends to have a multi-resistant phenotype, commonly resistant to oxacillin, erythromycin, and clindamycin.[24] Of note, roughly half of LA-MRSA CC398 isolates in Europe are resistant to both copper and zinc, common feed additives that have been used as alternatives to antibiotics since the EU ban on growth promoters in the mid 2000s.[24] The widespread use of the metals in feed may have helped create a favourable environment for the spread of LA-MRSA CC398 among livestock.[24]

The burden of disease resulting from MRSA CC398 and the overall occupational risk for those in livestock industries is poorly defined, due in part to a lack of reported incidence of livestock related LA-MRSA infections as this data is not collected in many countries.[21] A German

research group published a review in attempt to define the burden of disease posed by MRSA CC398 and identify potential interventions to prevent spread and infection.[21] The researchers found a general lack of data in the literature, with only 12 case reports of LA-MRSA infections in individuals with livestock contact, the majority of whom worked in the swine industry.[21] These few reports indicated that infection usually follows asymptomatic carriage of LA-MRSA, with infection resulting from an event that allows bacteria to cross skin or mucous membranes such as a surgical procedure, an animal bite, or breast feeding.[21] On the whole, much more information is available on the rate of asymptomatic carriage in livestock farmers and workers, but little is available on symptomatic infections.[21] The authors concluded that the true occupational incidence of LA-MRSA infections remains unknown. Similarly, there is a lack of conclusive data on effective measures to prevent colonization, such as biosecurity protocols or personal protective equipment, leaving those in the livestock industry without guidance on how to avoid becoming a carrier of LA-MRSA.[21]

It is understood that the main risk for carriage of LA-MRSA in humans is direct exposure to animal carriers. Infections resulting from LA-MRSA have been reported across Europe, stemming predominantly in rural areas regardless of country.[26] The infection rates of LA-MRSA within hospitals has been largely associated with location in a livestock dense region.[27] With that said, not much is known about the transmission of MRSA CC398 independent of livestock, leading German researchers to conduct a one year long case controlled study at German hospitals in livestock producing regions.[25] During the study period, 21% of all identified MRSA patients were colonized with LA-MRSA CC398.[25] The majority of these patients had direct contact with animals, while the remainder lived on or near farms.[25] Occupational and residential contact with livestock was identified as a risk factor for carrying LA-MRSA CC398, while hospitalization in the past six months was a risk factor for carrying non-LA-MRSA. The data from this study suggests that overall, LA-MRSA CC398 is still mostly disseminated to people via livestock, either through direct or indirect contact, and is not transmitted to people outside of livestock farming environments.[25]

When it comes to human to human transmission, the transmissibility of LA-MRSA CC398 within hospitals has also been poorly described, prompting a team of Dutch researchers to investigate nosocomial transmission of both LA-MRSA CC398 and classical, non-LA-MRSA isolates in Dutch hospitals.[22] The data indicated that LA-MRSA CC398 is 72% less transmissible than other MRSA genotypes within Dutch hospitals, suggesting that LA-MRSA presents less of a risk for nosocomial spread than classical MRSA, requiring less stringent infection control.[22] The authors were unable to explain the reason for the large difference in transmission rates, which may be influenced by characteristics of the pathogen itself, or differences in patient demographics.[22]

Evaluation of hospitalized German MRSA patients revealed differences in the demographics of individuals colonized or infected with LA-MRSA compared to classical MRSA. Those colonized and clinically infected with LA-MRSA tend to be younger, often are male, have shorter hospital stays, and are rarely admitted to the intensive care unit.[26] Generally speaking, these demographics speak to a healthier patient population, which likely helps to explain the observed low burden of infection in LA-MRSA positive carriers.[26] The available information on LA-MRSA CC398, though limited compared to classical MRSA, suggests that it presents less of a risk to the general population than hospital associated MRSA, and points to knowledge gaps about primary prevention of colonization for those working with or living near livestock, who are at risk of being both vectors and victims of LA-MRSA.

Biosecurity

While there are many mixed viewpoints regarding the potential of restrictive AMU measures on farms to prevent AMR, there is a consensus on the benefit of strong biosecurity measures to prevent pathogen introduction and infection.[3,11,23] Biosecurity describes the measures taken to prevent the introduction and the spread of infectious agents on a farm, with measures divided into external and internal biosecurity.[3] External biosecurity is a primary prevention strategy that entails blocking the introduction of infectious agents and resistant

pathogens, while internal biosecurity concerns preventing the spread of pathogens within the farm environment.[3,11] All biosecurity measures are aimed at limiting infectious disease and preventing the introduction and spread of AMR on a farm.[3] A joint scientific opinion published by the European Medicines Agency and the European Food Safety Authority recommends incorporation of such measures into a multi-faceted approach to help reduce the development of AMR, alongside use reduction measures, while noting that a lack of available data does not allow for a quantification of the impact of such initiatives.[11]

Beyond individual farms, resistant bacteria that emerges in one country can quickly spread to others.[23] This is facilitated by human and animal travel, medical tourism, migration, and global trade.[23] As a result, no country is immune from the harms of antimicrobial resistance. Part of the Canadian strategy on infection prevention and control includes improved biosecurity in both human and agricultural sectors.[23] This includes hand and respiratory hygiene, good sanitation of the working environment, regular sterilization of equipment, proper food safety and food handling, immunization programs, and outbreak tracing and management.[23] In many agricultural industries there are already biosecurity and on-farm food safety programs in place, with some mandatory and some run voluntarily by industry groups.[23]

Biological vectors play a key role both in the introduction and spread of resistant microbes. Wildlife, migratory birds, and rodents are all capable of carrying resistant microbes and zoonotic pathogens over long distances.[1,3] Insects can also act as mechanical and biological vectors of resistant pathogens, introducing new organisms to farms via their bodies and their feces, and spreading them between animals, flocks, herds, and batches.[3,28] Dispersal of insects originating on poultry and cattle farms have been found as far as 125km from the source farm, implying a potentially significant range for spread of any carried pathogens.[28] With this in mind, integrated pest management programs are integral to internal and external biosecurity measures in order to prevent the introduction and spread of antimicrobial resistance.[28]

Other key factors on-farm that can influence risk of AMR development and spread include animal flow, livestock replacement source, staff hygiene and protective equipment, farm size, visitor protocols, and overall animal health status.[3] The risk of resistance in

commensal microbes is increased when farms are close in proximity to other livestock operations, when staff work with other livestock, when farms are publicly accessible, and when equipment is shared with other farms.[3] External biosecurity protocols, such as changing clothes and shoes, and structuring the daily work flow from most immune incompetent to most immune competent and healthy are factors associated with productive farms with low antimicrobial use.[3]

Cleaning and disinfection procedures on-farm also present a key opportunity to help control, or exacerbate, antimicrobial resistance. Some resistant bacteria may be less susceptible to disinfectants, with some disinfectants additionally co-selecting for genetic elements that confer resistance to both disinfectants and antimicrobials.[3] Despite the clear importance of good biosecurity to prevent development and proliferation of AMR and reduce the need for AMU, there is very little literature that formally evaluates the risk factors associated with aspects of biosecurity and resistance.[3] Conversely, much of the literature focuses on the transfer of antimicrobial resistance from livestock to humans, with little regard for the introduction of resistant microbes to animals.[3]

Conclusion

Based on the available literature, it can be concluded that AMU in food animals can result in AMR in food animals. Further, these resistant microbes, whether commensals or pathogenic bacteria, can be transferred to humans that work in close proximity to food animals. The genetic elements that code for resistance can further be transferred from animal microbes to human microbes, thus presenting a risk for anyone in direct contact with livestock. The risk of food animal AMU to the burden of AMR in the greater, non-farming population remains undetermined. Evidence from LA-MRSA suggests that livestock-associated resistant microbes are not widely found in urban populations and, in the case of LA-MRSA, appear to have a lower rate of transmission between humans compared to classical nosocomial MRSA. While limiting or restricting the use of antimicrobials can reduce the burden of AMR in food animals, this may

not always be the case, as genetic resistance can be maintained without the presence of antimicrobials, and other farm management and environmental factors, including biosecurity measures and farm hygiene, can provide selection pressure. Presently, there is little evidence to suggest that limiting AMU in food animals will have a significant impact on AMR in humans outside of the animal agriculture industry.

Chapter 2: Taking a Multi-Stakeholder Perspective

Introduction

The production of animal protein and the rearing of food animals is not a simple process of inputs and outputs. It follows, then, that strategies addressing the problem of AMU and AMR in livestock production must be equally complex. Black and white solutions are unlikely to succeed as they fail to recognize the myriad reasons behind AMU in animal farming, and the possible consequences of use reduction. This chapter is dedicated to investigating the motives, interests, and experiences of the various human and animal stakeholders that make up animal production in order to inform possible ways to improve stewardship initiatives, as well as to highlight shortcomings in current approaches to the problem. I will first explore the complex relationships between the human actors involved in food animal production, the conflicts that arise between these stakeholders, and the consequences that follow. As animals are the recipients of all AMU reduction strategies, I will examine the anthropocentrism that is inherent in calls for AMU reduction, and give consideration to animal interests. Finally, I will discuss different approaches that aim to reduce AMU in livestock production, including strategies that target upstream determinants of AMU, as well as those that target the behaviour of stakeholders involved in animal treatment. Throughout, I will draw on literature from different production contexts, ranging from Canadian broiler production, to Danish swine farming, to beef production in the UK. While there are distinct differences in production between the

various livestock industries and different countries, the chief focus is on the common themes revealed by these studies that transcend context and help to inform more nuanced solutions for the future.

Complex Stakeholder Relationships

Numerous stakeholders are involved in livestock production, and in the everyday decision making around AMU. Farmers, veterinarians and food animals form a triadic relationship often referred to as a Veterinarian-Client-Patient Relationship (VCPR).[29] Both veterinarians and farmers work together to improve and maintain animal health, with their patients as the recipients of their actions. Within the context of antimicrobial stewardship, these three stakeholders are the individuals that such public and private AMU initiatives rely on to act, and to be acted upon. Beyond this triad, veterinarians have further obligations to public health, while farmers have the responsibility of producing safe, quality food that meets government standards and satisfies the desires of their customers. Animals themselves, though unable to voice their perspectives, are an integral part of all these considerations and have their own additional interests in their well-being. This wide net of stakeholders, and the obligations that they have to each other, creates a complex web of relationships that influences the way antimicrobials are used in food animal production. In order to achieve reductions in AMU and resistance, we must understand the perspectives of these key stakeholders and the challenges that they face.

Veterinarians, Farmers and Animals

The Blame and Responsibility of Farmers and Veterinarians

The task of implementing antimicrobial stewardship policies ultimately falls onto livestock producers and farm workers, who are responsible for animal care. Producers must work in concert with veterinarians as health policies in many countries, including Canada, require a veterinary prescription for all antimicrobials, regardless of their importance to human medicine.[29] But despite the role of the veterinarian in prescribing, farmers often diagnose and treat an animal on their own for the sake of practicality, using what they already have on-farm (from prior prescriptions).[30] Whereas in human medicine medical practitioners are the ones making treatment decisions, routine farm animal care involves the farmer in treatment planning and administration, either in collaboration with or independent from, their veterinarian. The relationship between farmers and veterinarians is therefore complex. While they share the same common goal and the same burden of responsibility for promoting animal health while preventing antimicrobial resistance, they face the daily realities of animal care and antimicrobial stewardship from different perspectives and with different professional responsibilities. This can lead to tension and blame-laying between these two stakeholders, whose unified effort is considered necessary for success.

In exploring this tension, interviews with British farmers and livestock veterinarians revealed that both actors are fully aware of the risks antimicrobial resistance poses to human and animal health, and are cognizant of the importance of their roles in contributing to or reducing antimicrobial resistance through antimicrobial stewardship.[30] Individually, there is a recognition that beyond health and welfare, antimicrobial resistance is a legitimate threat to their future livelihood.[30] Despite this, these stakeholders do not generally perceive antimicrobial resistance to be a present threat to their own farms or veterinary practices, but more of a problem for future generations.[30] The problem, in this sense, is not just the potential reduced effectiveness of antimicrobials, but also the potential reduced ability to preserve animal health and welfare due to future restrictions on use in livestock.[30] Some farmers fear that treating animals will become both more costly and less feasible in future years, imagining that restrictions could eventually require each individual animal to be seen by a veterinarian prior to treatment.[30] This fear isn't entirely unfounded. New regulations coming into play in the EU in 2022 will see all veterinary prescriptions tied to a clinical examination, with each

prescription having validity for only 5 days, and including only enough medication for the treatment of the assessed illness, instead of a full bottle or container of the prescribed medication.[31]

Both farmers and veterinarians have expressed the belief that the livestock sector has been unfairly blamed, putting them on the receiving end of restrictions and negative narratives not equally placed on other fields.[30] While those interviewed admitted they do not like to use antibiotics, they all felt that they had to.[30] The public perception of agriculture as a problematic player in contributing to AMR, perceived as a result of targeting and blame, gave both the farmer and veterinarian respondents anxiety about the pressure to entirely avoid AMU, which they felt would result in animal welfare problems.[30] Both agreed that antimicrobial stewardship is much easier said than done, as each find themselves in situations where there is no viable alternative, making it difficult for AMR to be the priority.[30]

Vets and farmers both expressed responsibility towards promoting antimicrobial stewardship and improving antimicrobial usage, seeing it as a joint effort between the two professions.[30] Neither veterinary nor farmer respondents dismissed the benefits of improving management, infrastructure, vaccine programs and breeding programs in order to reduce the need for antimicrobials on-farm, and some even expressed how this joint goal had led to tangible changes in their own farming operations.[30]

On the topic of stewardship, farmers indicated that they are reliant on information from experts on how to proceed, but are on the receiving end of inconsistent messaging from different expert groups, including vets, government, industry groups and media coverage, making it unclear which path to stewardship is the right one.[30] There is a lack of trust amongst farmers in public media reporting on matters of animal agriculture, with government and industry more trusted to take the lead on stewardship, even though farmers generally lack faith in either running successful animal health campaigns.[30] This lack of trust is supported by research that revealed that the debate around antimicrobial resistance is framed differently in media depending on the target audience, as farming media outlets often focus on areas of voluntary improvement, while more outlets targeted at a wider market tend to focus on the

systemic failings of agriculture and the risk it poses for human health.[7] One interviewed farmer indicated that he felt the responsibility of knowledge extension was ultimately with the veterinarians at the end of the day.[30] Veterinarians similarly acknowledged that conflicting advice from veterinarians and other farm advisors give farmers mixed messages.[32] Further, they recognised the need for a more united message of stewardship within the profession so that they can avoid prescribing against their own judgement just to keep their clients from moving to other clinics.[30] For a joint effort to be mounted, all veterinary professionals need to be on the same page in regards to antimicrobial usage and resistance.[33] Without united agreement on how to approach stewardship, veterinarians see policy initiatives as unfair to both farmers and veterinarians as they hamper their ability to be competitive, while it is also making it unlikely that any individual country will make much of an impact alone.[33]

Both vets and farmers admitted their frustration over the lack of global coordination, feeling like their individual actions were undermined by other industries or countries who were not doing their part.[30] In many cases, this type of blame was placed onto human medicine, referring to inadequate prescribing practices of physicians, and how patients may not always finish a course of antibiotics.[2,5] As many veterinarians have never encountered treatment failures in their practice they were skeptical of the contribution by their own profession, and saw antimicrobial resistance as more a problem of human medicine.[30,33] Others blamed their peers in the farming and veterinary industry for not taking things seriously enough through their prescribing and their inconsistent advice, or in the case of farmers, their inappropriate drug choices or dosages, undermining the attempt at collaborative progress.[30]

The Role of the Veterinarian

Veterinarians are viewed as being highly influential on AMU in farm animals through their prescribing practices and, as a result, considerable pressure is placed on them to assume responsibility for stewardship. Food animal veterinarians see themselves as having a curative

role, but recognize that increasingly they also provide advice on disease prevention and promoting health and welfare.[33] There is an impression that farmers expect vets to actively do something in the case of a sick animal, so while treatment may not always be appropriate, it provides a psychological benefit for the client.[30] Vets also get frustrated in their roles as advisors for disease prevention, and in turn as antimicrobial stewards, as they are powerless to ensure that their clients enforce necessary changes to improve herd health.[33] When animals predictably fall sick, they feel obligated to treat in order to reduce suffering. Notably, veterinarians feel that attitudes of farmer clients are changing regarding stewardship, with farmers more open to discussing improving stewardship on-farm.[33]

Veterinarians are often viewed as working in a relationship with farmer clients, and animal patients, each sharing differing duties to the other. Some argue that this view is too limiting, and that the veterinary role includes obligations beyond health care provision and animal advocate.[34] Many feel they are also entrepreneurs, focusing on their business and their duties to their employees. This adds a level of awareness of the business consequences of damaging a relationship with a farmer client, which influences everyday decision making.[34] Vets are also colleagues and competitors with other veterinarians, and frequent differences of opinion creates opportunity for conflict, including the risk of losing a client to a practice with a more favourable opinion, be it more progressive or more old fashioned. Others see themselves as playing a role of social worker for farmers, as they are often one of the few people that visit from outside the farm. Part of their job is to listen to the concerns of the farmer, even beyond the context of animal care.[34] Further, food animal veterinarians strongly associated with being part of the fabric of agriculture, working within the food industry to promote food security.[34]

Obligations of Veterinary Practice

Veterinarians must follow personal, societal and professional ethics.[35] Professional ethics are set apart from the rest as a veterinarian pledges to uphold societal good within their role-defined obligations.[35]

Veterinarians practicing in Canada swear their oath according to the Canadian Veterinary Medical Association's principles of veterinary medical ethics. At its core, veterinarians swear to promote animal health and welfare, to prevent and relieve animal suffering, to protect the health of the public and the environment, to advance comparative medical knowledge, and to perform their duty in keeping with principles of veterinary ethics [36]. The code of ethics states that first and foremost, veterinarians should consider the needs of their patients in relieving disease, suffering or disability while minimizing fear and pain [36]. They must balance the needs of the patient with the welfare of the client, and must ensure owner consent is obtained before treatment is carried out [36]. They must provide care that is appropriate and adequate, all the while seeking to ensure the protection of public health and general animal health and welfare [36].

Unsurprisingly, these numerous obligations frequently result in conflict. The tension that is felt between trying to serve both the patient and the client has been referred to as the fundamental question of veterinary medical ethics, as these competing responsibilities provide no obvious way to prioritize one over the other.[35] Veterinarians act as proxy decision makers alongside animal owners or stock keepers, advocating for the patient while also serving the client's best interests, knowing that ultimately, the final decision rests with the animal owner.[35] This is made more difficult by the ambiguity of the moral status of animal patients, with the differing beliefs on the importance of animals within the veterinary profession, and between veterinarians and farmers, a constant source of ethical tension.[35]

The Weight of Animal Interests

Within the context of daily practice, the lack of clarity on the moral significance of animal interests is a source of conflict, including in disputes surrounding patient welfare. Farmers and veterinarians may position their beliefs around the "5 Freedoms" framework, which provides guidance on the provisions necessary to avoid unnecessary suffering and promote farm animal welfare. Drawing from this framework, many may feel that as long as their animals are free from discomfort, fear, pain, hunger or thirst, and are able to express normal behaviours, then they are being raised ethically.[37,38] However, some veterinarians or farmers do not view a lack of suffering as directly translating to good welfare, particularly in environments of confinement. When veterinarians and farmers disagree on the moral weight of an animal's experiences, it can lead to disagreements on how to proceed.[37] Competing interests are reconciled based on their relative weights, with human interests typically outweighing animal ones, but as animal interests gain strength it is harder for veterinarians to justify overriding them.[37] In the case of farming, human and animal interests generally align, as sick and injured animals do not bring profit to farmers.[37] Still, interests do fall out of alignment, and it is then that the veterinarian must advocate for both.[37] Per Tannenbaum, vets are often put into situations that mirror an attorney being asked to represent both sides in a lawsuit, then proceed to play both judge and jury.

Disagreements surrounding the moral value of animals also occur within the veterinary profession.[39] Animals and their interests are sometimes argued as being morally significant on their own, but others argue for an anthropocentric approach, suggesting that they are only significant so far as they serve people and their needs.[35] Vets cannot feasibly serve both animals as well as people only when it is in the animal's interest, because the animals are ultimately kept in service of people, whether that is companionship, food, entertainment etc.[37] As a result, society requires veterinarians to practice animal medicine sometimes in the service of people, sometimes in the service of animals, and sometimes in the service of both.[37] The overall consideration of animal interests, or lack thereof, will be explored later in this chapter.

Broader Considerations

Farming as a Profession

Though not formally organized, farming is a profession, much like medicine, teaching, or law.[40] Farmers are entrusted by society to provide a safe supply of food in a way that respects the environment and animal welfare.[40] Consumers of food are increasingly separated from its production, with roughly only two percent of the population working in agriculture.[40] Those who are distanced from farming often picture 'Old MacDonald's Farm', a small, mixed species farm using extensive production practices, and the modern agricultural industry has done little to correct this view.[40] Within this old standard of production, husbandry was at the heart of the symbiotic human-animal relationship.[40] As long as farmers took care of their animals, giving them the most comfortable lives possible and taking care of their needs, the animals took care of them through provision of their physical work, their products, and their lives.[40] But gradually, within the last century, the focus shifted from symbiosis to productivity and efficiency, with the emergence of modern animal science research.[40]

The technologies that arose from the field of animal science allowed for farmers to raise animals more intensively, removing them from environments optimized for the animals, and placing them in environments optimized for production.[40] Husbandry has been replaced by industry, and farmers have followed the advice of animal science.[40] As consumers look to engage with farmers and gain information about the origins of their food, it is beholden to agriculture that industry, and farmers themselves, take the lead and react to the emerging concerns for food animal health and welfare, as consumers have the power to drive industry change.

Consumers as Stakeholders

Consumer perceptions of food animal production are important, even if their perceptions may not always be correct. Consumers drive the demand for different food products, which farmers cannot afford to ignore, lest they risk losing their business. Both commercial food retailers and individual consumers have the ability to introduce market alternatives and shape change beyond government policy initiatives. Yet, in an increasingly urbanized world where consumers are detached from agricultural practice, they have incomplete knowledge of farming practices and little information to inform their preferences. People must put their trust in veterinary and agricultural professionals to produce food that is the best for the animals, the environment, and the consumer themselves. In the absence of such knowledge and trust, niche marketing programs can attempt to fill this gap with consumers, sometimes at the detriment of other stakeholders.

In a survey of American consumers, "only half of respondents had trust in meat, dairy, and egg industries to treat animals well".[41] As consumers increasingly lose trust in agricultural industries and farmers, they are shifting the onus onto food retailers, such as grocery brands and restaurants, to ensure high food safety and welfare standards accompany their products.[42] In the same survey, over 80% of respondents indicated that they would be likely to choose a restaurant because it serves welfare-certified animal products, and pay more for those products.[41]

With decreasing trust in the food system, consumers are placing mounting pressure on retailers for more information on how their food is produced.[43] As a result, retailers are increasingly playing a role in antimicrobial stewardship. In the United Kingdom, for example, grocery stores have introduced AMU guidelines for their supplier farms, with some going so far as to publish their usage data within their supply chains.[44] With all these private production schemes and guidelines concerns have arisen regarding how credible these animal health and welfare standards truly are within such programs, the details of which are not always publicly available.[44] Within industry, the numerous quality assurance programs required can be viewed as potential barriers to agricultural trade, while many in the production side are critical of the additional burden placed on farmers to comply with yet another set of standards, in addition to

the government and industry enforced production standards they also adhere to.[44] From the consumer perspective, new production programs have led to a flurry of different label claims representing different interests, including AMU.[45] The onslaught of different labels may be confusing due to the variety of language used, and may cause consumers to be concerned when a product does not sport any label relating to antibiotic use as this could lead them to believe such products contain harmful residues.[43,45] Despite the desire for more information, consumers may now be presented with too many details per item, overwhelming the purchaser with information they may not understand, or describing characteristics they may never have previously known about or considered.[43]

While retail production schemes may target consumer demands, these demands may not originate from a practical understanding of antimicrobial usage on farms, and how this impacts human and animal health. In the context of RWA broilers, consumers perceive there to be personal health benefits associated with consuming RWA meat because it will not contain any antibiotic residues, a risk that does exist with conventional product.[43] In this context, the concern for health does not stem from consuming resistant bacteria, but rather directly consuming antimicrobials.[43] This train of thought may follow from the notion that eating antibiotics in animal products directly leads to antimicrobial resistance in humans, therefore consuming RWA products avoids this causal link.[43]

Consumers are increasingly concerned about animal welfare, and the types of husbandry practices used on farms.[41] When it comes to labelling information, consumers are most concerned about knowing whether or not the animal was raised with antibiotics, and whether or not the animal suffered.[41] Those who purchase conventional and organic products share the same chief concerns of taste, nutrition, safety (including the presence of antibiotic residues), and price point.[46] For those who regularly purchase organic products, the perception of improved nutrition, safety, and less hormone and antibiotic residues are key motivating characteristics alongside improved animal welfare.[46]

Different production schemes and label claims can drive the price of a product above that of the conventional alternative. In high incomes countries, consumers who do not

purchase niche marketed products, such as certified organic or RWA, cite price to be the biggest limitation.[41,46] This does not mean that individuals who are unable to afford such products do not have any regard for good animal welfare, high standards of food safety, or nutrition. In reality, consumers of conventional and RWA products share the same priorities in purchasing decisions, with lower-income consumers forced into making purchases that they may feel conflict with their ideals.[41,46] Generally, when confronted with two similar items, consumers tend to choose the cheaper of the pair.[42]

A recent survey of Canadian consumers found that, when considering two similar non-conventional items, price was not the only motivator behind their purchase decisions. Respondents had an increased willingness to pay for chicken raised in both RWA and responsible use programs (where no antimicrobials are used that are important to human medicine) compared to conventional chicken.[47] When respondents were given limited information about each production model they were willing to pay higher premiums for RWA chicken than for chicken raised in a responsible use program.[47] When researchers provided respondents with more detailed information about each production program – topics such as mandatory withdrawal times, the requirement for veterinary prescriptions, and the removal of sick RWA birds from the supply chain - they found the gap between willingness to pay for the niche programs shrunk.[47] Notably, after learning more about production respondents were willing to pay higher premiums for responsible use chicken, and lower premiums for RWA chicken.[47] This demonstrates that consumers place value on antimicrobial stewardship, but can have limited knowledge about antibiotic use on farms. When consumers are provided with more information, they value responsible use production models over prohibitionist models.[47]

When evaluating the motivations behind purchase choices, the above research suggests that those who purchase organic and RWA products are primarily concerned about their own individual benefits, stemming from a perception that these products are safer and more nutritious, and secondarily are driven by concerns of animal welfare. Not all consumers trust that these concerns can be met via conventional products, while only more affluent individuals may be able to afford niche products that address these concerns. Niche marketed products

attempt to serve the demands of consumers, which though well intentioned, may not always be beneficial to the human and animal stakeholders involved in production (this will be discussed further in the next chapter). On this point, recent research suggests that providing consumers with additional information about different realities of production programs can help to inform their purchase decisions and may lead to increased customer support of more nuanced AMU models.

Relational Conflicts and Moral Consequences

Recognition of the challenges faced by different stakeholders involved in food animal production and antimicrobial stewardship is key to understanding how to improve responsible AMU while being respectful of potential impacts to the individuals involved. To understand the complexity of the stakeholder relationships in livestock production, it is important to be cognisant of how conflicts between stakeholders can have unintended negative consequences that personally impact these individuals.

The Conflicting Demands Faced by Veterinarians

Numerous competing interests and obligations lead veterinarians to face different types of conflict. Veterinarians are caught between the demands of consumers, the needs of farmers that raise food animals under RWA conditions to meet market demands and maintain a viable business, all while trying to fulfill their obligations to their animal patients. Veterinarians thus face ethical dilemmas, in which it is unclear how to best reconcile competing obligations and determine the best course of action.[39] A moral or ethical conflict describes when a veterinarian is aware of the correct course of action, but is unable to enact it because of internal or external constraints.[39] Common examples include when a client is unable to provide adequate care for

the patient, due to lack of skill or financial means, or conflicting opinions between veterinary colleagues. The stress resulting from being constrained from following the perceived correct path is commonly referred to as moral distress.[39] Moral distress was first described in the field of nursing ethics, and later was described in the field of animal ethics by Rollin in the context of animal shelter workers tasked with euthanizing unwanted shelter animals.[39,48] Unlike in nurses, there is yet to be a validated scale for moral distress in veterinarians, however this does not mean that moral distress is not a concern in the field of veterinary medicine.[39] The profession is aware of high levels of mental health challenges and career burnout faced by veterinarians, and knows that carrying emotional burdens can degrade moral sensitivity, leading veterinarians to stop engaging in moral conflicts.[39]

In veterinary practice, patient owners ultimately have the final say regarding care as the property owner.[49] Vets are sometimes asked to do something in practice that feels like the wrong thing to do, with varying levels of compliance.[49] One situation where veterinarians and farmers may be placed in this position is a scenario where infection cannot be treated due to lack of access to antimicrobial treatment. Both farmers and veterinarians working under schemes of antimicrobial restriction have identified that there are times when the RWA label takes priority over animal health and welfare.[50] Treatment of diseased animals prevents them from being marketable in an antibiotic free program, which can put pressure on producers to choose adherence to the program over animal health.[50] It has been speculated that the economic loss that comes from forfeiture of special market access can cause delays in treatment, prolonging unnecessary suffering of sick animals.[51] Further, there is anecdotal evidence that along with delaying treatment, animals in need of antibiotics are euthanized in response to production environments that do not allow AMU given the logistical difficulty of separating, raising and marketing these few treated animals outside of their production program, and the emotional difficulty of watching them suffer.[*] The ramifications of these regular sources of distress impacts practitioners' approach to practice, with a loss of empathy

[*] This has been witnessed by the author, and individuals known to the author.

for both their patients and their clients over time.[49] Many veterinarians feel they have no choice but to prioritize the needs of their clients over those of their patients.[49] Ultimately, the moral distress regularly faced by practicing veterinarians as a result of ethically challenging requests results in both compassion fatigue, feelings of professional burnout and contributes to poor mental health.[36,48,52]

Private Practice Economics

While many veterinarians may be confronted with questions of what they morally owe their animal patients, and what is the ethical path to follow, these may not be the predominant source of moral distress in their daily practice.[34] Economic factors resulting from the structure of private practice are not only a barrier to antimicrobial stewardship, but also a key source of moral distress. For many, distress stems from moral conflicts surrounding the potential loss of client income, or the financial constraints of a client, where ethically the veterinarian knows the right thing to do, but it is difficult or impossible to act upon.[35,49] Veterinarians generally feel they know the correct course of action as an animal advocate but recognize that pursuing this may not always be advantageous from a business perspective.[34] Learning how to cope with this limitation and the feeling of powerlessness that accompanies these situations is seen as key to avoiding indifference, moral distress and career burnout.[34] As a result, care delivery is seen as requiring a pragmatic approach, navigating all the different duties and roles they play, while operating in environments limited by factors beyond their control.[34]

Moral distress is similarly experienced by health care workers in humanitarian aid settings.[53] Aid organization policies, local mandates, and political agendas alongside resource scarcity and cultural norms can present ethical challenges and barriers to delivery of care.[53] While clinicians may understand the rationale behind a policy that prevents treatment of certain patients, in practice it can feel like a violation of ethical obligations, preventing the implementation of professional autonomy, and perceived beneficence.[53] Volunteers'

immediate desire to provide care can conflict with the values that organizational policies are meant to uphold. Much like veterinarians, this can challenge individuals' professional identities, as actions that feel intrinsic to their roles as health care providers cannot always be enacted because of a lack of resources or political barriers.[53]

Livestock production involves numerous stakeholders. Farmers and veterinarians share responsibility for animal health and welfare, including AMU, though many feel that their professions have been unfairly blamed for what they see is problem of human medicine. Regardless, they recognise that without international cooperation within and between agricultural and non-agricultural stakeholders, antimicrobial stewardship initiatives are unlikely to be successful. Consumers, though increasingly distanced from farming, can shape the direction of production markets through their personal preferences, influencing how farmers and veterinarians can care for their animals in retail production programs. The competing obligations of veterinarians and farmers to each other, their clients, and their patients, alongside the moral ambiguity of animals, creates tension between these actors. The conflicts that arise, including conflicts surrounding appropriate antimicrobial treatment, can result in moral distress, negatively impacting all involved.

ANTHROPOCENTRISM

In the consideration of strategies to reduce AMU and preserve effectiveness, one voice remains missing. While the welfare of human patients is at the heart of antimicrobial strategies in animal agriculture, the concerns of the veterinary patient are often forgotten. Public policy and media coverage of AMU and resistance rarely reference animal health as a motivator to reduce resistance, reflecting an anthropocentric framing of the problem.[7] While animals cannot directly voice their concerns or desires in the case of illness or health, many philosophers have argued for their interests on their behalf.

Animal Rights Theory

Tom Regan famously argues that animals have rights, just as humans do.[54] He describes how most humans are moral agents, able to refer to moral principles to determine what ought to be done, deliberate and determine the correct course of action, then choose freely whether or not to act as they see they are called to morally.[54] It is because of these abilities that moral agents are able to held morally accountable for their actions.[54] Moral patients differ from moral agents, as they lack the required sophistication to control their behaviour in a way that would provide them with moral accountability. Moral patients are unable to deliberate about what is right or wrong, and are unable to choose to act based on moral principles.[54] While they are able to cause harm to others, this harm is not a result of deliberately wrongful acts. Infants, children, and the intellectually disabled fall into the category of moral patients, and so too do animals.[54]

In formulating his rights theory, Regan proposes a novel way of valuing individuals, stating that both moral patients and moral agents are what he calls 'subjects of a life.'[54] This term describes how beings have inherent value beyond their experiences, including their beliefs, their needs and wants, and their welfare interests.[54] As subjects of a life, both moral agents and patients have value independent from the utility they bring to others.[54] Everyone and everything that is a subject of a life is so equally. The ramifications of taking the subject of a life view includes providing equal respect for the interests of individuals with equal inherent value.[54] Treating animals with respect is not an act of kindness or compassion, but rather an act of justice, as their interests must be equally considered when determining the correct course of action. Put bluntly, he states, "the myth of the privileged moral status of moral agents has no clothes."[54]

Beauchamp also defends the claim that animals, like people, have rights. But unlike many animal rightists, he does not propose a prohibitionist approach to the human use of animals, but rather offers an account that would alter the way we use animals.[55] Beauchamp defines rights as being the same as in humans, as "justified claims to something that individuals and groups can legitimately assert against other individuals or groups".[55] Rights are always held

against others, with the possession of a right completely independent of the ability to assert that right (individuals do not need to know that they have rights in order to have them).[55] Beauchamp states that it is prejudicial and presumptuous to assume that basic rights afforded to humans do not extend to animals.[55] Fundamental rights protect basic interests, such as protection from pain and suffering, the freedom of movement, the right to food and water, and other interests shared by humans and animals alike. To remove the anthropocentrism intrinsic to rights theory, he refers to the protection of these fundamental interests as basic rights, instead of human rights.[55] Some of these basic rights are centered around vulnerability to harms, such as the obligations of parents to children, or similarly farmers to their animals. By asserting rights to protections, this asserts an individual's moral status, acknowledging their interests and deeming them worthy of protection.[55]

There is a correlation between rights and obligation, where one may possess the right to not be caused pain and suffering by others, others have the obligation not to cause pain and suffering.[55] It can then be said that when humans have obligations to animals, whatever they may be, then these animals have correlative rights.[55] When it comes to genuine obligations, Beauchamp is clear in stating that there are no exceptions to the correlative rights owed to animals, barring rare occasions where rights may be infringed upon by other justified moral considerations, such as hunting for survival.[55] Ultimately, an obligation must be fulfilled unless it conflicts with an equal or greater right, where we must strive for the greatest possible balance of right over wrong.[55] Finally, Beauchamp conceives of four categories of possible animal rights. The rights to non-maleficent treatment, describing the right to not be caused pain or suffering and to protected from harms of controlled human activities; the rights to have basic needs met, such as appropriate housing, relationships and food; the rights of non-constraint, necessitating healthy space allowances and the opportunity to roam and range; and the rights from human agreements, which encompasses the rights to the correlative obligations set forth in government regulations and institutional policies, the enforcement of these obligations, and the right to veterinary care as authorized by human agreements.[55]

In the case of raised without antibiotic production, or other restrictive policy environments, failing to treat an animal with an infection violates numerous animal rights, as conceived by Beauchamp. Withholding treatment is an infringement on the right to non-maleficent treatment, as it fails to protect against both pain and the harms from controlled human activities, in this case production agriculture. The rights from human agreements are also breached, as not all possible veterinary care is made available to the animal in question, in this case violated in order to uphold the obligations to government regulations or institutional policies. The question remains whether these rights are justifiably violated because the considerations of human interests driving these policies and programs have a greater moral weight, or if these infringements incorrectly balance rights over wrongs. In light of the lack of strong evidence connecting food animal AMU with AMR in the broader human population to support such policies, these violations currently do not hold.

Looking beyond rights, Peter Singer's equality principle stipulates that we must consider the interests of all species and prioritize those suffering most. Considering this principle, we must ask whether animal interests are sufficiently considered requires when prohibiting AMU among animals in the name of human health. If humans and animals suffer from similar infections, curable by similar drugs, then it is reasonable to assume that their suffering from untreated infections is similar. Animals, unable to conceptualize being sacrificed for the greater good of public health, may arguably suffer more. Alternatively, a human with an infection resistant to treatment may experience greater suffering due to the knowledge that their pain may not be ended quickly and may lead to ongoing future pain or even death. The interests of humans and animals are difficult to balance, and the decision to weight potential human suffering greater than animal suffering ought to be done only after equal consideration. In current practice, animal suffering is rarely, if ever, given equal consideration when AMR policies are deliberated.

Intellect and Moral Standing

Bernard Rollin points out that humans have a long, self-serving history of extending mental capacities and thought to non-human animals. We do so out of our own interests, as it allows us to not only predict their behaviours, but also to control them. However, giving consideration to the mental status of animals is problematic morally and practically, and as a result they are often kept out of spheres of moral consideration both by philosophers and by society. In fact, much work has been done by scientists in order to demonstrate that animals do not have a full range of mental experiences. Rollin points out that, despite our desire to view animals as without sentience or cognition, "for centuries animals were held morally and legally responsible for their actions, subject to trial, punishment, death, and yet at the same time had no legal protection whatsoever". When considering why we have continuously avoided our moral obligations to animals, he postulates that it is too difficult to assign moral status to animals in a culture that is built around their exploitation. Perhaps we are so reliant on their services in so many aspects of our lives, their interests are no longer visible to us. For those in science and in society, the ideology that excludes animals from moral consideration is highly convenient, allowing us to reap great rewards from their use.[56]

Traditionally, animals have been viewed more like slaves to humankind, rather than regarded as moral agents. Aristotle, for example, referred to animals as slaves by nature, naturally inferior therefore morally inferior. But while their mental deficiencies have been previously used to employ animals in our service, their helplessness and reduced mental faculties ought to serve as an argument for increased protection and care, not less. At face value, animals are unable to provide consent, cannot voice their interests, are defenseless, vulnerable, and ultimately morally blameless. Other individuals who fit such characteristics include children and the intellectually disabled, both of whom are awarded increased protections.[57] When it comes to the suffering of humans versus the suffering of non-humans, Linzey states, "traditional ethics privileges human suffering over all other kinds of suffering". While animal suffering is traditionally viewed as objectionable, it is a second class kind of suffering that pales in comparison to human suffering, and therefore not as morally significant.[57,58] This is justified based on animals' lesser cognition and their lack of self-identity, unable to reminisce on the past or envision the future.[58] We know, biologically, that humans,

other mammals, and at least some birds are capable of both pain and suffering. (Here pain is described as the unpleasant response to a noxious stimulus, while suffering is beyond physical pain, and can include mental anguish, anxiety, distress, fear and trauma. Suffering often accompanies pain, but it is distinct, and can occur with or without physical pain.) Yes, there are differences in the ways that humans and non-human animals experience pain and suffering, but the question remains whether these are morally significant. Linzey argues that just because we perceive animals to be naturally inferior, does not mean that they are morally inferior. As moral agents, humans are called to know that nature is not a moral compass and sometimes it is right to act against natural hierarchy. Vulnerability to human power is not an acceptable justification for exclusion from moral concern.[57]

Anthropocentrism in policies concerning animal health is not unique to the issue of antimicrobial usage and resistance. A recent Dutch study revealed anthropocentric normative assumptions of professionals working in zoonotic disease control policy, a field that also involves the concerns of human and animal health. At face value, health professionals across human and veterinary professions understand that issues of One Health call for multidisciplinary collaboration in order to successfully address and improve human, animal and environmental health. In practice, however, using One Health framing does not change the reality that concerns of public health and human welfare are typically used as a "moral trump card" to drive policy action. Human interests are placed hierarchically above those of animals, with concerns regarding harms to animals only a consideration once human harms have been eliminated. In a parallel to antimicrobial stewardship initiatives, those in the veterinary profession note that farmers (and animals) pay the price for zoonotic control initiatives, while the benefits are felt predominantly in the sphere of human health.[59]

Moral Reciprocity in Animals

Animals have typically been regarded in Western society as lacking inherent value or moral standing, here purely for human service.[60] Many try to justify the argument that animals

are means, not ends, pointing out that they are not human, nor are they rational beings, seen as prerequisites to morality.[60] Such arguments seek to diminish animal suffering based on the fact that animals are not moral agents.[57]. In the case of humans, we have established mutual reciprocity for the actions of moral agents, and happily provide exceptions to moral patients, such as babies and children, not expecting them to share the same obligations.[54,60] Peter Singer points to flaws in the expectation of reciprocity in ethical contracts. Like infants, animals are traditionally left out of ethical contracts because they are simply unable to observe the conduct of others and reciprocate through their own controlled conduct.[61] But from this view, the reason for inclusion in ethical contracts is for self-interest.[61] He provides the example of an action that benefits a current generation, but will undoubtedly harm future generations. If reciprocity is the key to ethical consideration, then we would feel unincumbered to bring harm to future generations since they cannot act in a way that will benefit us now.[61] It is clear this is unacceptable, and that ethics goes beyond reciprocity, and beyond including only individuals who can enter into such contracts.[61]

Regan points out that moral patients can be on the receiving end of the actions of moral agents, and can be wronged by them (or treated rightly), but moral agents cannot be wronged by moral patients.[54] It follow logically then that animals have the status of being morally blameless and innocent.[57] We can acknowledge moral obligations that we have to animals that they themselves are incapable of recognizing towards us.[57] As moral patients, animals do not have a sense of right or wrong, and therefore cannot be held morally responsible for their actions.[57] Therefore, inflicting suffering on animals is unmerited and highly problematic.[57]

A utilitarian may object to this view, stating that nothing deserves suffering, but there are times where animal suffering is warranted to serve the greater good.[57] Linzey argues that this view does not invalidate the necessary considerations. They give the example of self defense in the case of a dog attack, where the harm to the dog in question is justified, but does not justify harming all dogs, and does not provide us with a legitimate argument for punishing animals for harms they cause.[57] At the end of the day, our nearly all encompassing control over

animals, including the choice on whether they exist at all, the shape of their lives, and how they are exploited, means that we have near total moral responsibility for them.[57]

Consider, then, the reality of animals raised in environments of antimicrobial restriction. While policies seek to control the actions of moral agents, from veterinarians to farmers to consumers, they are ultimately felt by the animals themselves. But if animals are morally blameless, then how can they be expected to bear the brunt of the harms of antimicrobial stewardship? Just as we cannot justify harming all dogs after being attacked by just one, we cannot necessarily justify harming all animals because some carry resistant bacteria, which may or may not have transferred to humans or other animals. By denying sick animals access to treatment, we are effectively punishing a moral patient who is not personally responsible for the burden of disease in livestock, nor the animal contribution to human health. This critique is not meant to suggest that all efforts to reduce AMU in food animals should be abandoned, but that the reciprocity built into stewardship strategies ought to be further considered to avoid forcing animals to pay a price for the actions of moral agents. Perhaps this will involve initiatives to support management and housing improvements and better serve fundamental rights, while reducing burden of disease and hopefully the need for treatment. Ultimately, the literature tells us that current antimicrobial restriction practices which burden the blameless are morally unacceptable.

Conclusion

The complex relationships between farmers, veterinarians, animals, and consumers reveals that responsibility for AMU cannot be attributed to just one stakeholder. Within these roles and relationships, there is a recognition of shared responsibility for a global problem, but there is also finger pointing between actors, with those in agriculture feeling that they have been unjustly blamed for the struggles of human medicine. These interwoven relationships can lead to conflict, which can negatively impact the individuals involved, causing moral distress, loss of empathy and career burnout. Animals also face consequences at the hands of stakeholder decisions, though the interests of animals are not often discussed alongside the

problem of AMU and AMR. Anthropocentrism and the concern for human health and suffering is deeply rooted in public and private initiatives that address AMU in farming, where human suffering is prioritized even though it is morally reprehensible to punish animals, who are not morally culpable, for their contribution to resistance in human health.

Chapter 3: Antimicrobial Stewardship Solutions and Related Barriers

Numerous approaches are proposed and employed to reduce AMU in food animals. These solutions fall on a spectrum surrounding the problem of AMU, offering upstream and downstream approaches. Upstream solutions seek to address the determinants of inappropriate or unnecessary AMU in an attempt to make systemic change, while midstream and downstream solutions attempt to treat the problem by modifying behaviour, including penalizing undesirable behaviour. Several solutions are explored below, alongside the associated challenges encountered by stakeholders.

Upstream Challenges and Solutions

Prohibit Animal Agriculture

In what could be considered the most upstream solution to the problem of antimicrobial usage, numerous philosophers and activists have called for the end of all animal agriculture. Peter Singer argues that discriminating and exploiting on the basis of species is just as bad as discriminating on the basis of sex or race, and dubs this 'speciesism'.[61] He reasons that equality should be expanded to include non-human animals, stating that if a being suffers, then there is no possible moral justification for ignoring this suffering.[61] In fact, all like suffering should be

counted as equal, to the extent that comparisons between suffering can be made. This principle of equality extends to any being that is capable of suffering and enjoyment; if something cannot suffer, then we do not have to account for their interests.[61] Singer states that determining the validity of interests based on intelligence or rationality is as arbitrary as decisions based on skin colour, and that the capacity for suffering and enjoyment, or sentience, is the true reasonable boundary.[61] Cavalieri presents a similar case to Singer's, stating that a purely biological argument is fallible, as we know that other biological factors, such as sex or ethnicity, both previously used to describe the hierarchy of morality, are not valid factors for ethical discrimination.[60]

In cases of opposing interests, Singer calls us take care in comparing interests of different species, as suffering may differ in a similar scenario between different species, but ultimately that we must consider both equally, and then prioritize those who are suffering more.[61] In the context of animal agriculture, Singer flatly states that consuming animals as food is a minor human interest, more of an act of luxury, with only a few exceptions in the cases where it is needed for survival.[61] When comparing this minor interest against the animal lives involved in food production and their welfare, Singer asserts that the principle of equal considerations does not allow for these human interests to justify the sacrifice of major animal interests.[61] In order to avoid speciesism, Singer feels we must stop intensivist agriculture, where animals suffer most of their lives in order to provide us with cheap food. For those who are unable to access animal protein products raised without suffering, he says that there is no choice but to stop supporting intensivist animal agriculture though a vegetarian diet.[61] He acknowledges that this will be difficult, but that this difficulty need only be endured once, unlike animals suffering in these farms who are harmed indefinitely.[61]

Tom Regan's abolitionist views, and those of many animal rightists, prohibit most human uses of animals, with followers of animal rights philosophy actively seeking to end the operation of zoos, animal farming, animal entertainment and lab animal research.[55] They call us to look beyond the idea that humans are superior, and instead look towards rights doctrines that protect human and animal interests.[60] For animal rightists, the current gap in standards for

humans and animals cannot be defended, and animals must be awarded a shift from objects to subjects in order to enjoy basic rights.[60] This shift would follow a necessary change in legal status away from property, effectively making animal agriculture, biomedical experimentation, or commercial use forbidden.[60]

Fellow prohibitionists, including Stuart Rachels, strongly feel that modern, intensivist farming is endlessly cruel, and that we must boycott these farms. They argue for compassionate eating, prohibiting the practices of intensivist farming, and allowing only for humane methods of farm production.[62] For those living with access only to a food market dominated by largescale agriculture it is seemingly impossible to support kinder forms of animal production, and a vegetarian diet is the only the remaining option.[62] In Rachels argument against meat eating, he recognizes that if animal farming is ended, none of these animals in question will exist, or have the opportunity to exist, which some argue is objectionable for the animals. He dismisses this objection, stating that the utility of farmed animals is so low, it is better for them to never exist than to suffer their whole life.[62]

Rachels extends his abolitionist argument beyond the problem of animal suffering, stating that industrial agriculture is also bad for human health and welfare. Significant infectious disease outbreaks, including avian influenza H5N1 and the H1N1 swine flu, have origins on intensivist farms.[62] Rachels supports an end to farming for the protection of human health, as farms are ideal environments for the mutation and spread of zoonotic disease. He hypothesizes that one day agriculture may be responsible for a great global pandemic, causing the death of millions of people, and that even a slight risk of this possibility is enough to justify an end to animal agriculture.[62] Finally, he points to the burden of antimicrobial resistance, stating,

> "Industrial farming also promotes drug-resistant disease due to its massive use of antibiotics. Doctors know to prescribe antibiotics sparingly, even to sick patients, but on factory farms, antibiotics are put pre-emptively in the feed…In the United States, about three million pounds of antibiotics are given to humans each year, but animals receive many times that amount."[62]

Following Rachels abolitionist arguments, putting an end to animal farming would put an end to the cited irresponsible AMU, further benefiting human health.[62] Animal rightists and abolitionists alike both an end to animal farming as the best solution to reducing AMR. An absence of farm animals would undeniably solve the conflicts between reducing or eliminating AMU, and promoting animal health while preventing pain and suffering. It is worth noting, however, that ending all animal agriculture is a monumental task, with ripple effects felts beyond the dinner table through to seemingly endless societal conveniences and technologies. As a result, the abolition of farming cannot be easily orchestrated, and is an initiative that may take many years before it is realized, if it is ever. In the meantime, the problem of AMU and restriction in food animals remains. Through the lens of animal rights, the current targeted reduction of antibiotic use in food animal medicine in order to benefit human health only furthers the gap in standards and does not protect animal interests, making it indefensible. It is how we handle this very real conflict in the present circumstances that is the chief concern of this work.

Require Diagnostic Testing

Practicing antimicrobial stewardship includes avoiding unnecessary treatment with antimicrobials, and avoiding treatment with an inappropriate drug for the causal microbe in order to prevent the development of resistant bacteria. Diagnostic testing is viewed as a key strategy in order to arrive at an accurate diagnosis and provide effective, targeted treatments based on susceptibility. Some countries are incorporating this strategy into mandatory veterinary procedures, including in Denmark where regulation dictates the mandatory diagnostic process for herd level treatment in swine production.[31] If a practitioner wishes to provide herd or group level oral treatment for any respiratory diseases in swine, they must first use take samples and receive a lab diagnosis.[31] With that said, veterinary feedback reveals that the current structure of diagnostic tests lacks practicality and accessibility, resulting in minimal utilization in disease events where not mandatory.

In the Netherlands, veterinarians readily recognise the importance of diagnostic tests in confirming a diagnosis and guiding choice of treatment.[33] Despite these benefits, diagnostic testing is rarely used due to impracticalities.[30,33] Like many areas of improvement, cost is a major deterrent to ordering tests, as tests themselves are generally much more expensive than treating with antibiotics. Timeliness is also a significant concern, as test results can take several days to be returned.[30] In the case of a seriously ill animal, all veterinarians want to treat immediately in order to provide relief.[33] Delaying treatment results in higher mortality, as patients either succumb to illness, or are euthanized to end their suffering.[33] In this context, farmers do not often see any added value in receiving diagnostic results, especially if treatment has already begun.[33] Diagnostic testing is a potentially important upstream strategy in preventing inappropriate AMU, but to become widely adopted it first needs to overcome the identified barriers. This could include improving the speed of testing where the delays are not due to the time required for a culture, but due to insufficient resources such as the quantity and capacity of animal health labs. The accessibility of diagnostics could also be broadened via subsidies to ensure that tests are more affordable than the corresponding antimicrobials used to treat the infection in question in order to incentivize their use. If antimicrobial reduction in livestock is to be a goal of government and industry alike, then the resources needed to make upstream changes that reduces the need to treat ought to be provided.

Implement Economic Incentives

Unsurprisingly, economics is a limiting factor to veterinary interventions and farm improvements, presenting a barrier to antimicrobial stewardship. Financial limitations are cited as the most common limiting factor in farm improvements, with veterinarians placed between the economic demands of farming and patient well-being. [33,34] Farm animal vets can feel financial pressure from farmers to hand over a prescription for a drug that they may want to avoid due to medical importance, but that suit the production environment.[30] Examples include drugs with shorter withdrawal times to reduce the number of days milk (or the animal itself)

cannot be shipped, as drugs with less human medical importance can have longer withdrawal times.[30] Further, vets also feel the pressure to maintain a positive relationship with their clients.[30] They see the refusal to treat as potentially damaging to their reputation, particularly when they know that veterinary colleagues would chose to treat, so the client could simply call up another vet if they were unhappy with their decision.[30] Many feel conflicted in their role as antimicrobial stewards, tasked with balancing the demands of public health, while also trying to maintain client satisfaction, and ensure that their businesses remain competitive.[33] These challenges are largely born out of the current fee-for-service structure of private veterinary practice, where the business relies on client retention. Though it may not be feasible to change, it is imperative to recognize that some upstream influences of AMU are a result of the structure of the veterinary health care system, and may not exist to the same degree under a public healthcare model where competition between clinics is not a factor.

In the Netherlands, economics was seen by veterinarians as the key driver of AMU in food animals. Cost cutting in other aspects of production, such as cheap quality feed, insufficient labour, and delaying infrastructure improvements renders farms more sensitive to infectious disease.[33] The reality of the economics of farming is such that it is more affordable for farmers to cut these costs, and treat the resulting disease with antimicrobials, than it is to make the necessary improvements to prevent disease.[32] They also pointed out the expense of vaccines, resulting in some farmers being less willing to employ them as method of prevention. In many cases, a vaccine may cost two euros per head, whereas the treatment with antimicrobials cost only one euro per head.[33] In response, some regulatory strategies dictate the level of tax charged on medicines to either incentivize or disincentivize their use. In Denmark and Belgium, for example, the VAT is set at 11% for antimicrobials classified as critically important to human medicine; those of lesser importance, such as penicillin, are taxed at just 0.8%; while vaccines are sold tax free in order to encourage their use.[31] This approach could be extended further, to ensure that vaccines, where available, are always more cost effective than the related antimicrobial treatment for the disease in question.

Finally, farmers feel that veterinary services are too expensive to call them out for management advice and preventative interventions, with some expressing the sentiment that the increasing restriction on antimicrobials on farms would make farming unsustainable, suggesting that a future where a vet must assess every animal before it is treated is impractical and costly beyond means. This ties into pressure felt from industry to increasingly produce more product for less cost, which clashes with the demands to produce with less antimicrobials. While many farmers welcome industry and consumer interests into the improvement of on-farm antimicrobial stewardship, they feel that the overwhelming demand for cheap meat and milk ultimately prevents the desired farm improvements. As long as the demand for cheap food from highly productive farms persists, farms will likely need to use more antimicrobials than at present as the need for intensive farming, and its necessity for short cuts, increases.[30] Looking for potential solutions, farmers see supermarkets and food retailers as having a lot of power to make a positive change. These stakeholders could drive improvements through production schemes focused on responsible AMU, while also providing financial support through better farmgate pricing that could help push these changes forward and compensate for the increased cost of production that results from investment in preventative measures.[30,50]

Educate Farmers

Economic barriers aside, vets recognise that it is difficult to change human behaviour, farmers included.[32] Many practicing food animal veterinarians see farmers as a key barrier to antimicrobial stewardship, adjusting the way they practice medicine to accommodate their clients abilities. Each farmer varies in their own skill level at identifying sick animals, their ability to administer medications through different routes, their workload, and the amount of staff they have available.[30,33] These factors influence what veterinarians prescribe in order to maximize therapy compliance in order to create a tailored approach.[30,33] Dutch veterinarians place blame on the lack of farmers' knowledge on identifying early signs of illness in their stock, missing windows where early supportive care could help mitigate future treatment.[33] They feel

that farmers ought to be better educated on animal health and animal care, and perhaps be provided with guiding veterinary protocols which they are mandated to follow.[33] Similarly, German veterinarians see farmers as an influencing factor beyond their control.[34] Some felt that a portion of all farmers lack the appropriate education or skill when it comes to identifying animal illness or suffering, and placed blame on agricultural colleges for focusing more on farming economics than on animal husbandry.[34] Others pointed to the excessive workload faced by farmers, influenced by the lack of available farm labourers and financial pressures, leaving producers with too many jobs and too little time in the day. Vets suggested that when producers are stretched too thin, the level they are able to work at is hampered, leading to inaccurate work and opportunity for health problems.[34] This challenge of finding an appropriately skilled workforce is one faced throughout agriculture. Farming demographic data from the European Union reveals that the vast majority of EU farmers enter the profession with practical experience, but only approximately one third of farmers have some form of institutional agricultural education.[63] Some European countries attempt to address education gaps, by offering agricultural vocational education programs that span from secondary and post-secondary school, distinct from the study of agricultural science degrees at universities.[63] In Canada, David Fraser has proposed turning animal production into a formal profession, which could lead to a certification system requiring a demonstration of competence to peers in the field, while also increasing the public value associated with the occupation.[64] Unfortunately, neither address the economic pressures to produce food cheaply that makes it difficult to hire sufficient skilled labour or invest in preventative measures to improve animal health.

Putting the Horse Before the Cart: Downstream Challenges and Solutions

Limit AMU through Regulation

One strategy to sustain effectiveness and minimize the development of resistance among humans involves regulating use and reducing the need and ability to prescribe. Health

Canada has restricted the use of antimicrobials for growth promotion in food animals as of December 1st, 2018.[65] At the same time, Health Canada mandated that all medically important antimicrobials sold for veterinary use can only be accessed through a prescription, and can no longer be purchased over the counter.[66] Further, all antimicrobials administered in-feed and in-water must now be labelled with responsible use statements.[66] Additionally, as of January 1st, 2019 reporting of sales volumes of medically important antimicrobial active pharmaceutical ingredients by manufacturers, importers and compounders was made mandatory.[67] Health Canada introduced these regulatory changes as part of Canada's necessary effort to protect human and animal health, promote responsible use, and align Canada with international best practices of stewardship.[66]

Europe provides additional regulatory examples employed as part of antimicrobial stewardship plans. Traditionally, veterinarians both prescribe and dispense medications. As a result, regulatory focus on the sale of antimicrobials by veterinarians has sought to disincentivize their prescription by reducing or eliminating profit from antimicrobials, or entirely de-coupling prescribing from dispensing. In France, for example, it is illegal to give a discount or sale price on antimicrobials, while in Denmark veterinarians cannot profit off of the sales of antimicrobials and are only able to prescribe and provide enough antimicrobials for the treatment needed at hand.[31,44,68] At the time of introduction, Danish veterinarians had to drastically reimagine their business models, as veterinary drugs (including antimicrobials) were a significant source of income. This resulted in increased costs of call and service fees, with clinics supported by the subsequently introduced government mandated monthly farm visits.[31,68]

Use reduction targets provide another example of downstream strategies. Denmark operates a public benchmarking system that ranks AMU between farms and veterinary clinics, penalizing those who exceed their allocated maximum threshold.[44,69] The Netherlands employs a similar benchmarking system, and in 2010 the Dutch government set public targets for AMU reduction in farm animals with a goal of 70% reduction by 2015, based on the use statistics in 2009.[32] In order to achieve their targets, the government created interventions tailored to

reduce prescribing by veterinarians, despite the dearth of data on the influences of veterinary prescribing behaviour. In response, efforts have been made to understand food animal veterinarians' attitudes towards these interventions, and their perceived impacts on practice.[32,70] Surveys revealed that practitioners believe the most important measures to reduce antimicrobial usage include upstream interventions, such as improving feed quality and housing environments, as well as benchmarking usage and prescribing patterns in intensivist industries.[32] Suboptimal housing conditions are seen as the cause of much AMU on farms, suggesting that a reduction in AMU could come from improvements in animal housing, climate and management methods, and by disease prevention through improved biosecurity measures.[70] Some point to diagnostic testing as a way to avoid unnecessary or non-targeted treatments, alongside correct administration. Notably, farmers have control over most of these actions, not the veterinarians.[33] When speaking on the decoupling of prescribing with dispensing, it is perceived by veterinarians as a threat to the ability to earn an income in the future, with most doubtful that decoupling will have much effect on the reduction of use.[32,70]

Dutch food animal veterinarians revealed that as part of new prescribing policies they had made concerted efforts to reduce routine preventative prescribing.[33] Additionally, they admitted to focusing more on individual than group treatments when possible (noting that this was difficult to get farmer buy in due to the expense) and providing supportive therapy for patients with only mild symptoms, waiting for more severe illness before treating.[33] Some felt that vaccine sales had partially replaced antimicrobial sales stimulus, but overall did not feel that separating prescribing from sales would have any impact on improving antimicrobial stewardship, as animals will always get sick and always need treatment.[33] In terms of their busines model, all felt reluctant to increase their call fees to make up for loss of drug sale revenue, as they worried this would discourage clients from having them out. Overall, when considering what impacted their behaviour, these veterinarians were more motivated by the problems they faced daily, fearing the deterioration of patient health and welfare and the dissatisfaction and financial losses of their clients, both of which out-weighed the more abstract concerns of antimicrobial resistance.[33]

The increasing regulation of the veterinary profession as a means to combat AMR has prompted broader concerns among veterinarians.[34] Firstly, vets find that the increasingly restrictive nature of regulatory requirements are simply difficult to meet.[34] Further, they do not find the requirements to always be comprehensible, with some lacking any meaningful interpretation.[34] Finally, the increasing bureaucratization of the veterinary profession is seen to come at the expense of animals, with practitioners feeling as though they are running out of options when it comes to available therapies for their patients.[34] While regulatory strategies that target the ability to give and receive an antimicrobial by prescription appear as logical ways to reduce use, those who are being regulated have little faith that such directives will have a significant impact until upstream factors are addressed. From the perspective of prescribing veterinarians, if the determinants of AMU are in place, then they will always need to prescribe treatments, regardless of regulatory barriers in place.

Stigmatize AMU

An area of rising concern, though perhaps not often considered, is the stigma increasingly associated with the farming profession stemming from concerns over antimicrobial resistance. Throughout Europe there is growing public concern about antimicrobial resistance.[71] In Denmark and the Netherlands, countries seen as leaders in combating resistance and reducing on-farm AMU, early focus on combatting resistant bacteria was placed on improving hospital biosecurity.[31,71] Hospitals have taken pains to isolate farmers from other patient groups, going so far as to require them to use separate entrances.[71] Other countries have taken less institutionalized approaches, using strategies focused around behavioural change in livestock producers, including targeted education and communication campaigns, shared across public platforms.[31] These use reduction strategies are built around the idea of shared responsibility, encouraging all actors in the food system buy into and adopt stewardship initiatives.[31]

In Denmark, there has been a focus on the spread of MRSA originating from pig farms, and subsequently a focus on the use of antimicrobials by Danish pig farmers. Despite having some of the lowest use of antimicrobials in pig farming globally, health professionals have become increasingly critical when addressing pig farmers or discussing the farming profession and the public health risks it poses. Interviews conducted with Danish pig farmers and public health professionals recently unpacked how current public messaging and institutional regulations have stigmatized farmers and their family members.[71]

The interviewed health professionals were quite critical of farmers, suggesting that they do not perceive MRSA infections as problematic because it does not affect them or their pigs, or that they simply lack the will to change their perspective and their actions. Some went further, to suggest that farmers are just not that intelligent when it comes to treating pigs. Herd level treatment was a common sticking point, with human health professionals drawing a normative difference between themselves versus veterinarians and farmers. Further blame was placed on the veterinary sector for not being more concerned about AMR nor being publicly critical of farming practices, suggesting that human and veterinary physicians belong to two completely different worlds without any recognition of shared goals. Ultimately, these human health experts viewed farmers as morally inferior people who are willingly deaf to science, put up with bad animal welfare and risk human health all for personal gain. These opinions, when aired publicly through debates and discussion, resonate with the Danish lay population. [71]

When Danish pig farmers were interviewed, they revealed how this public image, as described by human health experts, shapes their daily life. They are viewed publicly as morally negligent, risking the health of others not only through their profession but also through their participation in broader society outside of farming. In an agricultural region of Denmark, citizens anonymously distributed flyers to farmers' houses and put up posters in local grocery stores declaring that there is no 'cure for people working on pig farms', and those that work in the swine industry should not have contact with anyone who is not an MRSA carrier. Danish daycares and schools are the recipients of social pressure from non-farming parents who

request that the facilities take special precautions to ensure their children are protected from children of farmers to avoid MRSA infection, akin to the segregation in hospitals.[71]

The reality of social isolation continues to adulthood, as farmers reported hiding their profession from non-farmers, or simply socializing exclusively with other farmers who would not treat them as lesser than. Farmers were angered by the prevailing social stigma, particularly because of the perception of all farmers as a uniform, unsophisticated group of problematic attributes against which they must defend themselves. Additionally, respondents also revealed an internal stigma. Some resisted recognition of this negative image, while others, saw themselves in the image of farmers described by the public, and accepted themselves and their farms as risks to society. Younger farmers in particular were more self-critical, and rejected the trope of farmers as a unanimous and problematic group, and could identify themselves as responsible producers who defied the public image of pig farmers. The nature of public discussion and the avoidance behaviour of non-farmers made some farmers anxious about the future for their children, and concerned over the potential of being expelled from general society.[71] It was observed that the more public health experts expressed a delineation of 'us', the non-farming public, versus 'them', pig farmers, the stronger farmers felt a social differentiation from the rest of the non-farming world.[71,72]

Stigma is not limited to farmers, and is also experienced by food animal veterinarians. Some perceive animal husbandry and production professions as being criminalized by a society that is increasingly distanced from agriculture.[34] These veterinarians see societal pressures as hypocritical, demanding a standard of high welfare foods at low cost, something they feel is unachievable.[34] Others note that the respect they receive from international colleagues for practicing in a country with very low AMU is in stark contrast to their treatment at home, where they face negative public reception.[72]

Not unique to the problem of antimicrobial resistance, stigma is an identified antagonist of public health that undermines public health efforts.[73] When appeals to personal responsibility are integrated throughout public health messaging they can imply that a failure to a adopt appropriately healthy or responsible behaviours renders those

irresponsible individuals a burden to society.[74] Individual culpability suggests that there is a direct causal link between an individual's actions and the health outcome, which resonates with people's notion of agency, but does not account for the fact that individuals do not have control over the structural forces that influence their behaviour. Individuals on the receiving end of responsibility messages can develop feelings of guilt, shame and frustration when they cannot enact the changes that are demanded of them, which raises further ethical concerns. Appeals that seek to motivate behaviour changes by stressing the moral obligations to others also raise ethical concerns as it calls into question how much one individual is responsible for the adverse outcomes of others who refuse to or cannot comply, much like farmers who feel they are held accountable for the actions of other farmers with high AMU.[74]

The stigma of farmers and veterinarians related to their use of antibiotics shares numerous parallels with the stigma surrounding people who are obese.[73] Similarly, negative stereotypes and misperceptions about overweight individuals are pervasive in Western society and include assumptions about their intelligence, their discipline, and their willpower. These perceptions suggest that stigmatizing these individuals is justified because they themselves are responsible for their excess weight, and stigma can serve to motivate them to pursue healthier behaviours. Despite the prevalence of this stigma, it is not a beneficial public health tool as we know that many determinants of obesity are beyond the control of individuals. Not only does stigma not reduce obesity nor improve health, it poses health risks to those stigmatized, creates disparities, and makes it more difficult to implement effective measures that reduce obesity.[73] Much like the need for public discussion surrounding the complex etiology of obesity, prevailing societal messaging around AMU on farms needs to explore the complexity behind past and present use on-farm, in order to help efforts to reduce use. The continued presence of internalized stigma may reduce receptivity to possible effective interventions, while pervasive stigma in society prevents the inclusion of the perspective of those who are stigmatized. Successful campaigns must shift from targeting individual behaviour to addressing the necessary broad, structural changes that act as determinants of AMU. Unless people have the

necessary resources to change their behaviour, it is unrealistic and unjust to expect individual actions to be successful.[73]

On the whole, farming and veterinary stakeholders find some midstream approaches such as sales and use monitoring to be helpful in tracking progress of AMU reduction, but see behaviour-targeting approaches that rely on stigma to be harmful. Attempting to limit AMU by creating barriers to access is an approach that puts the cart before the horse. Short of an end to animal agriculture, farmers and vets feel that upstream improvements are needed in order to achieve a reduction in AMU, as downstream interventions only serve to make care more difficult but ultimately do not change the daily challenges they face.

Conclusion

Many current and proposed solutions to the problem of excessive AMU in food animal production focus on upstream solutions that cannot be easily enacted, such as the end of animal agriculture; or focus on creating downstream barriers to use, such as regulation of the veterinary profession, restricting use, or targeting individual behaviour via social stigma. Few solutions provide the necessary resources to address the determinants of AMU on-farm, despite the fact that these determinants have been repeatedly identified by farmers and veterinarians alike. In the next chapter, the themes identified in the above chapters will be used in case analysis of current private and public production frameworks that seek to reduce AMU in food animal production.

CHAPTER 4: CASE ANALYSES

INTRODUCTION

The previous chapters identified three common themes that describe the challenges of and shortcomings of antimicrobial stewardship initiatives. The themes of complex stakeholder relationships, anthropocentrism, and the upstream and downstream spectrum of approaches to reducing AMU were derived from the perspectives of stakeholders working in food animal production, who are tasked with implementing stewardship initiatives. This chapter will use these three themes as lenses through which three current approaches to antimicrobial stewardship will be analysed: the Global Animal Partnership's [GAP] Animal Welfare Standards, which is the audit program used for meat retailed at Whole Foods Market, McDonald's Global Vision for Antimicrobial Stewardship, and the World Health Organization's [WHO] Guidelines on the use of Medically Important Antimicrobials in Food-Producing Animals. These three approaches to antimicrobial stewardship represent the food retail industry, the fast-food industry, and public policy recommendations, all of which have influence over agricultural practices. Given the great variation in production practices, timelines, and health challenges between different food animal industries, for comparison's sake all analyses will focus on meat chicken production. The reason for the selection of chicken stems from rapid growth of the antibiotic-free chicken market; the population based, all-in all-out approach to production, where birds are raised and marketed as a whole flock, rather than as individuals; and based on the professional experience of the author, who is trained in poultry welfare auditing by the Professional Animal Auditor Certification Organization (PAACO).[45,75] While an analysis of stewardship initiatives in further food animal species is warranted, it is outside the scope of this thesis.

The commercial production of meat chickens, known as broilers, follows an intensive production model. Broilers are grown indoors in large, climate controlled barns year round and are provided with artificial lighting.[76] Birds are raised on a bedded floor, and are free to move

around the barn and access feed and water Ad Libitum.[76] In Canada, chicken farming is a supply managed industry, where farmers purchase a production quota that enables them to produce a set amount of chicken, with national and provincial production quotas determined based on demand.[76,77] Canada has just over 2,800 chicken farmers, and 90% of their farms are family owned and operated.[76] Broilers are typically marketed at two kilograms of live weight, around five to six weeks of age.[77] Farmers generally raise five to six flocks in their barn each year, with the average Canadian flock consisting of 30,000 birds.[77] In 2019, Canadian chicken farmers raised 756, 985, 000 head of broilers, translating to 1.76 billion kilograms live weight.[76] The largest share of chicken consumption in Canada is retail, making up roughly two thirds of consumption, while the fast food market makes up roughly one quarter of consumption.[76] The national producer board, Chicken Farmers of Canada, maintains a food safety and animal care audit program based on the National Farm Animal Care Council's Poultry Code of Practice (known from here on as the Code of Practice) that is internally audited by provincial board staff annually, and externally audited by PAACO certified auditors.[78–80] In response to rising concerns surrounding antimicrobial use in the chicken supply chain, Chicken Farmers of Canada set an internal policy to eliminate the use of Category I antibiotics in Canadian production by 2014, and to eliminate the preventative use of Category II antibiotics by the end of 2018, both of which they achieved.[81–83] They currently have a goal to eliminate the preventative use of Category III antimicrobials in the future, with a target date yet to be determined.[81] The category system or ranking used in Canada only slightly differs slightly from the WHO categorization, but still ranks antimicrobials based on importance to human medicine. Category I and II covers all the drugs listed on the WHO Highest Priority Critical Importance list, as well as some on the High Priority Critical Importance list.[84,85]

Whole Foods Market and Global Animal Partnership's Animal Welfare Certified ™ Program

Whole Foods is a chain of grocery retailers specializing in "natural foods", with over 500 locations across the United States, Canada, and the United Kingdom.[86] Whole Foods Market uses the tagline "no antibiotics, ever" to describe their meat standards, demonstrating a prohibitionist approach to AMU.[87] They also promote an animal welfare based approach to production, stating that, as a reflection of their interest in broiler welfare, all chicken sold across departments is certified by Global Animal Partnership [GAP].[88] GAP is a nonprofit organization that administers an animal welfare auditing program, called Animal Welfare Certified™, that it audited by authorized third-party certifiers.[89] For broilers, they administer a program titled "Global Animal Partnership's 5-Step® Animal Welfare Standards for Chickens Raised for Meat".[89] The 5-Step component refers to the different levels of welfare certification they offer, based on increasingly extensive chicken production methods. For the purposes of this analysis, only Steps 1 and 2 will be analyzed, as these apply to production environments where birds are housed indoors, which is most applicable for the Canadian production climate.[89]

The entirety of the of the "Global Animal Partnership's 5-Step® Animal Welfare Standards for Chickens Raised for Meat" document is publicly available on the GAP website. The relevant GAP standards that specifically pertain to antimicrobial treatment include the following:

Section 1.3: Medication

1.3.1 Chickens that are given antibiotics, ionophores, beta agonists, sulfa drugs and/or arsenic-based drugs are prohibited from being marketed as G.A.P. Certified.

1.3.2 A written protocol must be in place to identify and ensure that any chickens treated with antibiotics, ionophores, beta agonists, sulfa drugs and/or arsenic-based drugs are not marketed as G.A.P. Certified.

Section 1.4: Treatment

1.4.1 Sick or injured chickens must be promptly treated or euthanized according to Section 1.

1.4.3 Veterinarian-prescribed treatments must be administered according to veterinarian guidance.

1.4.6 Operations must have an internal and external parasite control program that can be implemented if parasites are impacting bird health and welfare.[89]

Complex Relationships

Whole Foods Market is openly driven by consumer demands, alongside their own desire for good animal welfare.[87] They appeal directly to consumer interests, stating on their corporate website that their customers deserve to feel good about the foods that they purchase.[87] They go on to say that they care about how their animals are raised, using standards with animal welfare in mind which are certified by GAP.[87] They reiterate their interest in consumer concerns, stating that their customers deserve to be informed about the meat that they buy. In the interest of transparency, they provide direct links to the GAP website, which provides access to the animal welfare audit standards for broilers, alongside those for other farm animal species.[88] GAP itself states that the organization collaborates with multiple stakeholders to develop their welfare standards, including experts from the field of animal welfare research, the poultry industry, chicken farmers, and feedback from public comments. They voice their dedication to continually evolving their standards as new information becomes available, committing to reviewing and revising their standards.[89]

Neither Whole Foods Market nor GAP engage with the topic of irresponsible antibiotic use or the development of resistance.[87–89] Neither AMU nor AMR is included in the cited reasons for adopting an antibiotic-free approach to broiler production, suggesting that consumer concerns are the primary motivating factors driving both companies' approach to animal agriculture. Despite a stated focus on meeting consumer demands on transparency and

food quality, Whole Foods Market does not include background information on how raising broilers without the use of antimicrobials impacts welfare, or how it improves meat quality in such a way that consumers can feel good about the product. Whole Foods Market has the opportunity to fill in the information gaps that exists with consumers who are distanced from agricultural production and desire more information. Engaging with customers on topics relating to broiler welfare and antimicrobial resistance presents alternative way to advertise and communicate with their customers, instead of capitalizing on a lack of information about animal production or any apprehensions consumers may have surrounding food safety and nutrition.

The GAP broiler standards do not recognize the potential for any conflicts that can arise between farmers, veterinarians, and the production system in the context of antibiotic free production. They do not address the competing obligations held by these stakeholders, nor their moral obligations to the chickens. Producers may be incentivized to delay treatment or euthanize sick birds in hopes that the majority of diseased birds will recover and be marketable. Failing to recognize that these problems are part of antibiotic-free production systems does not benefit farmers, veterinarians, or animals, and instead prioritizes consumer interests at the expense of others.

Anthropocentrism

There is a general lack of consideration of animal perspectives, specifically of sick animals, within this antibiotic-free approach. The GAP standards state that animals must be treated when sick, but neither GAP nor Whole Foods Market provide evidence of how these birds will be supported within the system once treated, simply stating that they are not sold as GAP certified birds, or purchased by Whole Foods.[87,89] Both state that welfare is a priority, yet there is no remark on the connection between disease, treatment and welfare. Consistent with the lack of consideration of animal perspectives, there is no mention of the potential problem of AMR in broilers as a motivator to restrict AMU. Further, their selection of which

antimicrobials to ban is not selected based on relative importance to human or veterinary medicine. Instead, they have adopted a blanket approach, banning anything that can be classified as an antimicrobial, regardless of who uses it and for what purpose.

As part of the GAP production standard, all forms of mortality are recorded.[89] The audit criteria is predominantly concerned with chickens that are found dead, and sets target thresholds of this mortality that are not to be exceeded.[89] A similar threshold does not exist for chickens that are euthanized. The focus on found mortality over euthanized mortality could incentivize euthanizing sick birds. The GAP standards on treatment explicitly state that any sick birds must either be treated, or promptly euthanized, with failure to comply considered a major non-conformance.[89] Culled chickens are not held against any target thresholds, while the remaining birds remain untreated and marketable. This could be problematic if antimicrobial treatment has the potential to cure an infection, rendering euthanasia inappropriate and unnecessary. Still, in a case where the majority of the flock is suffering from a bacterial infection, producers may be incentivized to delay treatment, euthanizing individual birds that are not recovering, as it may be more profitable to experience high mortality and market the remaining flock as GAP certified than it is to treat and market the flock at conventional prices.

The GAP standards surrounding AMU appear to be largely informed by the perception of consumers that consuming chicken that was treated with any antimicrobial drug is bad and does not promote good welfare. It does not appear that these consumer interests have been weighed equally, or at all, against the interests of chickens raised within this program. This is not a case of privileging human suffering over that of animals, as this program does not concern itself with AMR in either population. Instead, this program privileges consumer preferences of food quality characteristics over animal interests, including the suffering of sick birds. As noted by representatives from Compassion in World Farming, an NGO concerned with farm animal welfare, "while 'antibiotic-free' is easily understood and appealing to the consumer, it is not an easy solution and an 'antibiotic-free' approach should only be undertaken responsibly and with due consideration for the conditions in which the animals are reared."[90] While the GAP program does require some rearing conditions that exceed the conventional standards in

Canada, discussed further below, the approach to antimicrobial use may rely too heavily on these upstream strategies, as they have not given much consideration to what may happen if they are not successful in preventing bacterial infections.

An additional indication that the approach is concerned more with consumer perceptions than animal interests is the creation of a standard where all antimicrobials are prohibited, including those used for parasite control, such as ionophores.[89] Ionophores are classified as antibiotics as they are derived from micro-organisms and have antibacterial activity, and as a result cannot be used in any product labelled as "raised without the use of antibiotics" in Canada.[4] With that said, they are not used in human medicine, and are not used in broilers to treat bacterial infections.[2,85] The World Health Organization does not include ionophores on their list of critically important antimicrobials for human use, and Health Canada categorizes them as antimicrobials of low importance.[2,85] In chickens, ionophores are used to prevent and treat coccidiosis, caused by an infection of intestinal parasites that are commonly present in poultry facilities.[91] Signs of infection include slowed growth rate and weight loss, diarrhea, and high mortality.[91] Intestinal damage due to infection can lead to necrotic enteritis, caused by a secondary infection with *Clostridium perifringens*.[92] Methods of control include vaccination and the rotational use of anti-coccidial drugs, which includes ionophores, alongside strategic management.[91] Limiting treatment options presents difficulties for producers to fulfill the GAP standard on maintaining a parasite control program.[89] This provides another demonstration of the prioritization of an easily understandable label claim that may not serve to benefit chicken welfare.

Upstream and Downstream Efforts

A focus on upstream management efforts to improve bird health and welfare is clear within the GAP standards. Relevant to all tiers of welfare certification, GAP stresses the importance in selecting appropriate broiler genetics.[89] Present requirements mandate Step 1 and Step 2 producers to select breeds that have good leg health and low mortality, with a

maximum growth rate not exceeding 68 grams per day.[89] In 2016, GAP announced that by 2024 all chickens certified under their audit programs must be of higher welfare genetics, which will include slower growth rates.[89] In order to support the development of such birds, they partnered with the University of Guelph to determine the desirable genetic traits associated with each welfare step level, with results to be included in the next iteration of their broiler welfare standards.[89] By investing in research to identify broiler welfare measures, and associated genetic traits that may contribute to a positive welfare state, they are demonstrating their dedication to upstream efforts that promote bird health and welfare and reduce the need for AMU.

Various additional aspects of the GAP broiler standards focus on audit criteria that influence animal health. Many of these requirements are in line with the requirements in the Code of Practice for poultry in Canada.[80] The requirements for air and litter quality are generally in line with the Code of Practice, alongside the standards for written animal health plans, biosecurity programs, and the requirements for rodent and wildlife control.[80,89] Ultimately, many of the GAP management and husbandry requirements do not differ significantly from those required of all broiler flocks in Canada.

With that said, one key area where they do differ is stocking density. The GAP standards state that, "chickens must have enough space to express natural behavior, including standing, turning around, and preening, without touching another chicken."[89] They achieve this goal by setting a maximum stocking density, determined at the time heaviest weight, of 29 kg/m^2.[89] In contrast, the Code of Practice states that birds can be housed at a stocking density that does not exceed 31 kg/m^2, an additional 2 kg/m^2 than is allowed under GAP standards.[80] Further, the Code of Practice states that density can be increased up to 38 kg/m^2 if particular housing conditions exist, based around more highly scrutinized monitoring of bird health and barn conditions and the support of data that indicates bird welfare is not compromised.[80] Compared to these conditions, broilers raised under GAP standards are provided with an additional 9 kg/m^2 of space, which has the potential to reduce stress, minimize spread of disease, and reduce the need for AMU.[90]

A final area of focus that can be utilized to help reduce the need for antimicrobial treatment is detailed record keeping. A key parameter that is important to production is the collection of mortality data, as mentioned previously. GAP has established acceptable annual average flock mortality thresholds, set at 6% for Step 1 certified farms, and 5% for Step 2 and Step 3 certified farms.[89] Per Chicken Farmers of Canada's animal care program, birds marketed at five weeks of age should not exceed a flock mortality of 4.10%, and birds marketed at six weeks not exceeding mortality of 4.52% (based on a mixed sex flock).[79] When comparing the two, the GAP standards allow for a higher mortality rate for birds found dead compared to the requirements applied to conventional farms, which perhaps is a necessary adjustment for a production system that does not allow antimicrobial use, but suggests that their upstream supports are not sufficient to improve bird health and welfare to reduce disease and illness.

Focusing more on downstream strategies, GAP approaches antimicrobial use through a prohibitionist approach, not allowing the use of any antibiotics in any animals that are marketed as GAP certified.[89] This approach applies to therapeutic and non-therapeutic uses, and failure to comply with this standard potentially threatens a farm's ability to remain certified.[89] In the event that an individual or group of chickens are treated, the only guidance provided states that there must be a written protocol in place in order to identify these chickens to ensure they are not marketed as GAP certified.[89] Given that broilers are reared in an all-in all-out production style, with the whole flock marketed at once, it is unclear how a producer could easily find an avenue to market these birds outside of their contract. When only a small number of birds are involved, it is easy to understand how these birds would be euthanized, as treating them would present the producer with additional difficulties in housing and marketing. In the event that the whole flock is treated, they would not be able to fulfill their contract and would need to find another buyer for their birds in a limited amount of time. As referenced previously, this situation lends itself to delays in treatment in the hopes that it may not be necessary, potentially compromising animal welfare.

CONCLUSION

Whole Foods Market sells chicken that GAP welfare standards, which includes a complete prohibition of all antibiotic use. This approach to antimicrobial use appears to be heavily influenced by consumer interests and label claims. The lack of access to antibiotic treatment for birds intended to be GAP certified presents a serious welfare concern. The GAP standards indirectly acknowledge that chickens in their program can get sick, as they have a policy mandating treatment or euthanasia of sick birds, yet they do not provide any supports for how to manage treated birds within the system, including marketing. It is noteworthy that while GAP standards encourage sick birds to be treated, then separated, they do not provide any guidance on the actual approach to treatment. This is congruent with the lack of reference to AMR and overuse of AMU in their motivation for the standards, as stewardship does not appear to be a driver of this program. Finally, It is strength of these standards that they avoid making oversimplified references to upstream initiatives such as improved biosecurity or good hygiene. GAP concretely lays out housing and management efforts to help reduce use, including more suitable genetics and lower stocking densities. They may rely on these too much, however, and as a result have underdeveloped their program in the event of disease, failing to provide support not only for animals, but also farmers and vets. If GAP and Whole Foods Markets see value in marketing chicken from birds that have never been treated with antimicrobials, then they ought to provide support for producers in the event that they do need to provide treatment to some or all of their flock, in order to encourage transparency from producers on matters of antimicrobial use, and to protect animal welfare. Given that only select cuts of meat from antibiotic-free animals are marketed under these label claims, with the less desirable cuts marketed under conventional labels, packers processing GAP certified birds already have established business avenues to sell conventional product.[45] Perhaps a program could be established for GAP certified broilers where treated birds are distinctly identified when shipped and are processed separately, with all resulting products diverted to the conventional market. Such a program would support both producers and animal welfare, while still providing consumers with their desired antibiotic-free product.

McDonald's

The McDonald's Corporation is global fast-food company headquartered in the United States. They operate 38,000 restaurants globally, with over 1,400 locations within Canada.[93,94] McDonald's introduced their antimicrobial use framework, entitled "Global Vision for Antimicrobial Stewardship in Food Animals", in 2015.[95] This vision, included below, is meant to act as a framework for all species specific polices, and is guided by the goal of preserving the future effectiveness of antibiotics through current practices.[96] In 2017, this was followed up by an antibiotics use policy in broiler chickens for all global supply markets.[97] This policy states that all antibiotics that are designated as Highest Priority Critically Important Antimicrobials [HPCIA] by the WHO will be entirely eliminated from their global supply by 2027.[95] Additionally, they made clear that the routine use of preventative antibiotics as well as the use of antibiotics for the purposes of growth promotion are prohibited within their supply chain.[95] Within the context of Canadian production, all of the goals were achieved at the end of 2018, consistent with the independent antimicrobial use policy of Chicken Farmers of Canada.[81–83,95]

McDonald's Vision for Antimicrobial Stewardship [VAS] is condensed into seven key criteria:

I. Antibiotics can only be used in conjunction with a veterinary-developed animal health care program.

II. Source raw material (meat) from Food Animals (beef, chicken, pork, dairy cows and laying hens) that are not treated with HPCIA.

III. Antibiotics identified as High Priority Critically Important, Critically Important, Highly Important and Important for human medicine and currently approved for veterinary use, should not be used as first line treatment, and only be used after susceptibility testing of the diseased animals has shown other classes of Antibiotics to be ineffective as determined by the attending veterinarian.

IV. Source raw material (meat) (beef, chicken, pork, dairy cows and laying hens) from Food Animals that are not treated with Antibiotics used solely for Growth Promotion.

V. Routine Prevention use of Antibiotics is not permitted. For clarity, however, System Suppliers may continue to use Ionophores subject to applicable laws and regulations.

VI. Utilize animal production practices that reduce, and where possible eliminate, the need for Antibiotic therapies in Food Animals and adopt existing best practices and/or new practices that would result in subsequent reductions of Antibiotic use.

VII. Benchmarking and measurement of Antibiotic usage is required to track performance. Successful strategies resulting in antibiotic use reductions will be shared broadly within the McDonald's System.[96]

COMPLEX RELATIONSHIPS

McDonald's demonstrates a recognition of the importance of a collaborative, global approach to tackling AMR. On the matter of antimicrobial use and resistance, they describe AMR as a critical issue of global public health. They state that they have a corporate responsibility in addressing the challenge of AMR in order to ensure effectiveness for future generations. They go further, acknowledging that overuse in both humans and animals has led to the development of resistance. As part of their response, they claim that they have partnered with their suppliers, farmers, veterinarians, and academic researchers in order to develop protocols for use of antibiotics within their supply chain. McDonald's describes their approach to AMU as one of responsible use, committed to administering antimicrobials according to the guidelines set forth by the WHO, the World Organization for Animal Health, amongst other human and animal health bodies. Following guidance that considers both human and animal health, they developed their VAS based on a One Health approach, with an emphasis on collaborative and multi-disciplinary approaches to stewardship at local, national

and international levels in order to promote human, animal and environmental health. They further emphasize the need for the global involvement of numerous stakeholders when tackling AMR by working with researchers, farmers, NGOs, and veterinarians.[95]

On the topic of improving animal welfare, they cite the concerns of their customers alongside the concerns of the producers in their supply chain as their motivation for taking an active role in improving animal health and welfare. When it comes to broiler welfare in particular they take a multi-stakeholder approach, with policy driven by their Chicken Sustainability Advisory Council, formed in 2018. Per McDonald's, this council is made up of poultry genetics experts, farm management consultants, academic researchers in the field of animal welfare, including Temple Grandin, representatives from NGOs, including the RSPCA, alongside consultation with producers and consumers.[98]

Despite their engagement with a variety of stakeholders, they do not address the potential for conflict between farmers and veterinarians when it comes to treatment decisions, nor the resulting moral distress. Under this responsible use structure, there is still the possibility for occasions where farmers and veterinarians will disagree on the appropriate course of action, such as which antibiotic to use as a first line treatment, or whether a preventative treatment could be considered routine. With farmers obligated to follow McDonald's prescribed approach to treatment, this potentially introduces another competing obligation that must be reconciled with animal care. It would be wise for McDonald's to recognize the potential for disagreement, and to provide structure for resolving potential conflicts.

Looking more closely at the VAS, the first criteria requires an animal health plan developed with a veterinarian in order to use antimicrobials.[95,96] The need for veterinary oversight is cited as being necessary for the selection of an appropriate treatment, whether that is therapeutic or preventative, and any further reassessment of treatment necessary.[95] McDonald's additionally recognizes the role farmers play in animal care, writing, "McDonald's recognizes the importance of decisions made by food animal producers in managing the animals entrusted to their care."[96]

As addressed in the previous chapter, both producers and veterinarians feel as though their fields have been unfairly targeted as the main cause of AMR in human medicine. McDonald's acknowledges that the body of evidence supporting the reduction of AMU in food animal medicine is ever growing and will continue to evolve. Granting that consensus and approach will vary depending on geographic location, they commit to gaining alignment with different stakeholders globally in order to find a path forward.[96] This partially speaks to the concerns of farmers and veterinarians, who feel that strategies that solely focus on animal agriculture with varying levels of stringency, depending on location, are a flawed approach that will not lead to positive change. Despite this, McDonald's is in part motivated by the concern for human AMR, and their policy effectively continues to place onus on animal agriculture to help solve a human medicine issue, despite the lack of supporting evidence.

Anthropocentrism

The McDonald's corporate website states that they believe in the ethical treatment of animals, which applies to all animals within their supply chain.[99] Speaking on their approach to their antibiotic use policy, they state, "we know that animals, like people, get sick and when they do, effective treatment includes use of the narrowest range of antibiotics, based on the professional opinion and diagnosis of the veterinarian."[95] This statement demonstrates a consideration of how AMU policies can impact the animals to which they are applied.[95] They expand this policy, writing:

> Treatment of sick animals supports our decades-long commitment to improving the health and welfare of animals in our supply chain. As such, our position on the use of antibiotics is one of responsible use. With this in mind, we remain committed to treating animals when needed.[95]

Their inclusion of animal interests is further demonstrated by the fact that their policy was developed not solely in consultation with the WHO guidance, but also guidance from animal health organizations. This corresponds with their guiding principles of animal health and welfare, which asserts that not treating a sick animal is incongruent with their approach to welfare and the belief that animals must be cared for throughout the entirety of their lives.[95,96] With the exception of HPCIAs, the program does not prevent the appropriate treatment or, when warranted, prevention of disease.[95,96]

Despite the above, which suggests an approach to antimicrobial stewardship that very much considers the impacts on animal health and welfare, the first guiding principle that directs their VAS is "people first". [95,96] This principle directly informs the third criteria of the VAS, which states that antibiotics with any importance to human medicine can only be used once all potential alternatives that are not important to human medicine have been exhausted, and susceptibility testing has been performed by the attending veterinarian.[96] Though well intentioned, this tiered approach could potentially lead to compromised welfare, akin to what farmers in the Netherlands experienced when a similar method was implemented. In the book *Big Chicken* by Maryn McKenna, Dutch broiler producers describe the challenge of realising that the drug allowed as a first line treatment would not work for ill chicks.[100] Based on experience from past flocks, they knew that their second and third choice drugs were needed, but could not be accessed until after the results of a diagnostic test were returned.[100] The farmers were eventually able to use the third choice treatment one week after testing, when the result was available, at which point they had already lost many birds to disease.[100] To the credit of McDonald's, they do acknowledge that antibiotics differ in terms of importance in human and animal medicine, stating that they took these differences under consideration when they reviewed and ultimately adopted the WHO classifications of medically important antimicrobials.[96] Their choice to build their program based on the priorities human medicine is likely connected to the fact that they view AMR as a problem of human medicine, with no acknowledgment that it can also negatively impact veterinary medicine.[95]

Upstream and Downstream Efforts

McDonald's VAS is part of their broader collection of animal welfare standards, which falls under the purview of the Chicken Sustainability Advisory Council.[99] They describe taking a whole-system approach to improving animal welfare to support the overarching goal of their VAS to reduce, and eventually eliminate the need for AMU.[95,98] They plan to achieve this goal by employing their responsible use approach, which involves refining the process of selection and administration, reducing use, and replacing antibiotics with long-term solutions that prevent disease.[95] They promote good husbandry and hygiene, routine health monitoring, and vaccination amongst valuable prevention strategies that should be focused on as part of animal care.[95] This is reflected in the VAS, with criteria three through seven focused on strategies to reduce AMU.[96]

McDonald's requires a tiered approach to antibiotic use within the VAS, and asks that antibiotics are only used after susceptibility testing has indicated other, non-medically important antibiotics are ineffective.[96] They do not, however, provide any further information on how they will support the diagnostic process to expedite the turnaround time, allowing for more prompt treatment of diseased birds. As they have openly stated that they see themselves as leaders with the potential to move the industry forward, their inclusion of diagnostic testing as a pre-requisite to treatment with a critically important antimicrobial presents an opportunity for the company to improve diagnostic capacity, and invest in the development of rapid testing. The use of a gene sequencing device akin to currently available nanopore field sequencing instruments could provide a tool for bacterial identification and detection of resistance genes, offering a method for veterinarians and farmers to identify appropriate treatment options within hours of sampling.[101] Given the global scope and influence of McDonald's, it may be feasible for them to utilize third generation sequencing technologies as part of their approach to treatment if they dedicated the means to develop them as a veterinary diagnostic tool.

McDonald's focus on treating only sick or at risk animals, and not condoning blanket preventative treatment or use for growth promotion, is another method of preventing the inappropriate use.[95,96] Notably, they do provide exceptions for ionophores, which are used as an antiparasitic to treat coccidiosis, an enteric parasitic infection.[95] This is a very pragmatic exception, given the importance of parasite management to broiler health, and the recognition that ionophores are not used in human medicine.[2,85]

Record keeping is a core principle within the McDonald's VAS, as evidenced by the final VAS criteria of benchmarking.[95,96] This not only allows them to track total drug use, but also to assess the amount of necessary or appropriate treatments, and identify approaches to prevention and treatment that are successful and worth being shared with other producers. They state that they are focused on expanding their data collection continuously, and as of February 2019, they have tracked "antibiotic use in over 2.9 billion birds from 80 suppliers for 88 separate medicines, resulting in significant reductions in antibiotic use across our supply chain."[95]

Capacity building is an additional area of upstream influence, and McDonald's openly recognizes the importance of continuing education for all stakeholders within their supply chain. This includes monitoring and observation of successful approaches utilized by leading producers to then be shared with others, as well as their vocal support of educational and producer collaboration programs that are already implemented within existing business structures in the industry.[95,96] They state that they support the implementation of all such education and training programs, but do not appear to have their own educational programs.[96] They clearly recognize the importance of continuing education, but mostly support this as an external initiative.

One key concern of multiple stakeholders, discussed in the previous chapter, is the economic limitations to making upstream improvements to housing, husbandry, and other preventative health measures such as vaccines. While McDonald's openly supports approaches that prevent the need for AMU, they do not explain how they will provide for producers and veterinarians in making these changes. Potential options could include increased farm gate

pricing, or internal funding opportunities that incentivize particular changes that they have found to be impactful within their supply chain, both of which would demonstrate their acknowledgment of the increased cost of production associated with their desired approach to broiler production. As farmers often cite low prices and the desire for cheap food as barriers to changing their production practices, it is worth noting that as a fast-food business that provides economically accessible foods to consumers, McDonald's does play a role in perpetuating an agricultural system that is focused on efficient, low-cost production. Their recognition that current practices can be problematic from animal and human health and welfare perspectives is important, but they should also address their role in sustaining a problematic system.

Conclusion

Through their Vision for Antimicrobial Stewardship, McDonald's demonstrates their capacity to lead positive change in the industry with their responsible use approach. They are aware of their influence in the field of animal welfare, and their responsibility as large, global purchasers of animal protein. They are receptive to customer concerns, but consumers are not the main influence over McDonald's approach to AMU, having engaged with numerous stakeholders within the farming, veterinary, livestock industry and research communities, as well as non-profit welfare groups. Additionally, they incorporate the interests of animal stakeholders, recognizing that despite best efforts, animals still can get sick and it is part of our moral obligations to farmed animals to treat them when this occurs. The result is a guidance document that combines initiatives that attempt to prevent the need for treatment, efforts that guide the approach to treatment, and approaches that ban the use of growth promoters and blanket preventative treatments. By describing AMR as a collective problem, with the potential for a collective solution, they have avoided suggesting that those working within the sector are bad people or stigmatizing the act of treating animals with antibiotics where appropriate.

With that said, the VAS is not without its weaknesses. The focus on producer education is minimal, and mostly relies on external programs administered through producer groups and other support structures. While McDonald's incorporates diagnostic and susceptibility testing into their treatment approach, they do not explain how they will support producers and veterinarians with access to faster testing. Additionally, they do not acknowledge or provide supports for the distress that may arise for farmers and veterinarians during this time. Finally, they do not describe how they will support farmers in making changes to their production system that will help prevent the need for treatment.

It should be noted that McDonald's is not new to acting as a leader in raising welfare standards. When McDonald's announced in 2015 that they would be transitioning to cage-free housing systems for laying hens, 200 additional companies made very similar commitments shortly following their announcement.[102] They have additionally been recognized as leaders of corporate change with respect to animal welfare, as the 2015 Business Benchmark on Farm Animal Welfare identified McDonald's as a clear leader in animal welfare progress.[103] With this comprehensive, responsible use approach to antimicrobial stewardship within their supply chain they have the potential to create a domino effect, leading other businesses to adopt pragmatic and animal welfare centered approaches to reducing antimicrobial use in food animals.

WHO Guidelines on the Use of Medically Important Antimicrobials in Food Producing Animals

As part of their global action plan on antimicrobial resistance, the WHO released guidelines on the use of medically important antimicrobials in food producing animals.[104] The guidelines are based around their previously published list of critically important antimicrobials for human medicine, ranked from highest priority critically important, high priority critically important, highly important, important, and non-important.[85] Both rank and recommendations came about after the first WHO workshop on antimicrobial resistance in the early 2000s, in which

they identified the types of antimicrobials used for prophylactic or therapeutic treatment in animals that were either related or identical to those used in human medicine.[85] Recognizing the severity of resistant pathogens in humans, the ranking of medically important antimicrobials provides a framework for prudent use in all fields of medicine, while the guidelines provide strategies to mitigate the human health risks associated with antimicrobial use in food animals.[85] The WHO guidelines are as follows:

1. We recommend an overall reduction in use of all classes of medically important antimicrobials in food-producing animals.
2. We recommend the complete restriction of use of all classes of medically important antimicrobials in food-producing animals for growth promotion.
3. We recommend complete restriction of use of all classes of medically important antimicrobials in food-producing animals for prevention of infectious diseases that have not yet been clinically diagnosed.
4.
    a. We suggest that antimicrobials classified as critically important for human medicine should not be used for control of the dissemination of a clinically diagnosed infectious disease identified within a group of food-producing animals.
    b. We suggest that antimicrobials classified as highest priority critically important for human medicine should not be used for treatment of food-producing animals with a clinically diagnosed infectious disease. [104]

Complex Relationships

The WHO took an evidence-based approach when crafting these guidelines, informed and approved by academic researchers and experts in relevant fields of human and animal

health. The supporting evidence for these guidelines draws largely on two commissioned systematic reviews and three narrative reviews of the available literature.[5,12,104] Both the reviews and the published guidelines admit to a somewhat weak body of supporting evidence, owing in large part to a limited number of published studies that evaluate the impacts of changes in antimicrobial use on the presence of antimicrobial resistance genetic elements or resistant bacteria in either animals or humans.[5,104] Nonetheless, they justify their recommendations by asserting that human health benefits strongly outweigh any potential harmful or undesirable outcomes.[104] They do not describe what any of these harmful outcomes might be.

In creating the guidelines, the WHO formed a guidance development group made up of a variety of contributors.[104] Their role was to appraise the evidence from the commissioned systematic reviews, advise on interpretation, formulate the final recommendations, and approve the final guideline document.[104] The WHO states that they looked to include diverse expertise, as well as to involve the major groups affected by the recommendations.[104] The group was comprised of experts in fields ranging from public health policy, epidemiology, agricultural economics, human and veterinary medicine, along with one animal ethicist.[104] All were employed at academic institutions or governmental health agencies at the time of participation.[104] Neither farmers, nor veterinarians in private practice, nor livestock industry representatives were included in the group. Notably, two of the participating members were authors on one of the commissioned narrative reviews that contributed to the guideline development, and may have had a risk of bias, though this is not acknowledged in the guidelines document.[104]

Per the WHO, the main audience for these guidelines are policy makers and regulatory officials in WHO member countries, which includes Canada.[104] Despite the lack of evidence of involvement of agricultural production stakeholders or consumers, they state that these guidelines are also meant to inform “veterinarians, food producers, livestock production organizations…and consumers”.[104] While these guidelines are clearly intended to affect

numerous stakeholders, they were not created with the perspectives of all of these stakeholders in mind.

As a result, the ramifications of these guidelines when implemented are not well understood within this guidance document. There is no mention of the moral obligations to animals, the contractual obligations of producers, the veterinarian-client-patient relationship, or the possible conflicts that can arise between these stakeholders. Further, there is no acknowledgement that veterinarians and farmers can experience moral distress as a result of these conflicts, particularly when treatment of sick birds is delayed, or when birds are euthanized unnecessarily. The limited recognition of the role of the veterinarian operating within the construct of these guidelines is found in the remarks of each recommendation, where the WHO acknowledges that use of the antibiotics in question may be justified when a veterinarian judges it to be so based on the results of recent culture and sensitivity testing.[104] There is no reference to the judgement or involvement of farmers in the treatment process.

When discussing gaps in the research, the WHO does acknowledge that work needs to be done to identify effective methods for implementing antimicrobial stewardship programmes in the livestock industry, which includes understanding the values and preferences of those affected by stewardship initiatives such as theirs.[104] Given that the WHO recognizes the practical relevance of the perspectives and experiences of agricultural stakeholders tasked with implementing stewardship programs, it is unclear why they would not have involved more of these perspectives when developing their own guidelines.

Anthropocentrism

The WHO guidelines are openly anthropocentric, primarily motivated by concerns for current and future human health. Their recommendations are driven by the need to mitigate the adverse health effects that result from the use of medically important antimicrobials in food animals, namely the selection, dissemination and transfer of resistant bacteria from food animals to humans.[104] The goal of the guidelines is to preserve long term effectiveness of all

antimicrobials that are important to human medicine, particularly those where there are limited treatment alternatives.[104] They do additionally state that their guidelines will help to preserve the effectiveness in veterinary medicine, however this motivation is not referenced as frequently when justifying each guideline recommendation, nor is it based on any strong evidence.[5,104] Ultimately, there is limited concern for animal health and welfare in comparison to human health and welfare, and few attempts are made to consider the animal perspective.

When it comes to the evidence informing these guidelines, only one of the narrative reviews consulted in development of the guidelines was focused on any unintended consequences associated with restrictions of AMU in food animals.[5] This review mostly focused on antibiotics used for growth promotion purposes, drawing from European examples of implemented restriction.[5] They found that prohibiting growth promoters is not harmful, with only minimal and temporary health problems that can be offset by employing preventative measures to minimize vulnerability to disease, alongside more targeted prudent use.[5] Influenced by this review, the WHO repeatedly states in justification of each guideline that unintended consequences are small and limited, though they do not mandate the supports needed in order for limited consequences to be actualized.[104] The guidelines also do not describe potential consequences to animal and health welfare, instead referring to compromised welfare as more of an abstract concept. In the remarks regarding the fourth guidelines, they state that exceptions to the restrictions around treatment and control using critically important drugs can be made to avoid harms to animal health and welfare.[104] This implicitly acknowledges potential harms to health and welfare when restricting access to control and treatment options. This is perplexing, as the justification for the fourth guideline states that their recommendations have little to no undesirable consequences.[104] This contradiction suggests that the consideration of the impacts of their recommendations on food animals was not a priority in the development of these guidelines.

When describing the process of translating evidence into recommendations, they state that they balanced potential benefits and harms, considered the values and preferences of affected populations, and were concerned with equity.[104] It is evident that these considerations

were centered around human interests, as any potential harms to humans are repeatedly privileged over those of animals. Further, they do not explore the question of equity and moral responsibility in creating guidelines that seek to alter the approach animal health, potentially causing harm in the name of promoting human health.

The guidelines are structured around the WHO list of critically important antimicrobials.[85,104] As a result, they are only concerned with drugs used in human medicine. As such, the use of ionophores and other non-medically important drugs are not prohibited, which allows for the use of established control and treatment programs for coccidiosis in broilers and other poultry.[85] Finally, all four guidelines have an implied recognition that animals do get sick and include allowances for antimicrobial use in the context of disease prevention, control and treatment when it is deemed appropriate by veterinary judgement and supported by a diagnostic test.[104] While these guidelines ultimately endorse restriction of all medically important antimicrobials in food animal production, it is valuable that they do not prohibit their use during instances of demonstrated clinical need.

Upstream and Downstream Efforts

The first recommendation made by the WHO applies a consequentialist approach in justifying reduced antimicrobial usage of any kind in food animals, in order to maximize benefits for the current and future human population. They state that this recommendation is strong, despite weak evidence, because the potential benefits to human health outweigh any potential harmful or undesirable outcomes.[104] The supporting reviews suggest that broad spectrum restrictions of use, instead of focused restrictions on individual drugs or classes, appear to be more effective at reducing resistance.[5,104] In support of this recommendation, they state that a variety of measures can be used to achieve and overall reduction in AMU. They say this includes the implementation of all their guidelines, which prohibit AMU, as well as adopting measures that reduce the need for antimicrobials.[104] They suggest that disease prevention strategies, good hygiene and improved biosecurity, and better use of vaccines will

enable reduced AMU.[104] They also endorse benchmarking, reducing profit from drug sales, and other strategies that target prescriber behaviour.[104] These upstream improvements have all been identified by agricultural stakeholders, but the barriers and limitations to their implementation are not acknowledged by the WHO, and are instead presented as though they are easily done. The WHO recognizes that upstream efforts are important to reducing AMU, yet only focus on use restrictions in their official recommendations.

The third recommendation requires a complete restriction of prophylactic use for diseases that have not yet been clinically diagnosed.[104] Again they cite the benefits of broad over targeted restriction on having the largest impact on reducing AMR, adding that the potential harms to animal health and welfare appear to be small.[104] The fourth guideline focuses on infection control and therapeutic treatments, presented as suggestions instead of recommendations as a result of the very low supporting evidence.[104] They suggest that, even after a disease is clinically diagnosed, critically important drugs should not be used to control the spread of disease though a group, and HPCIAs should not be used for therapeutic treatment.[104]

When discussing implementation, they acknowledge that when a veterinarian judges that AMU is merited, an exception can be allowed in order to avoid harms to animal health and welfare.[104] In this case, antimicrobial use should follow a tiered approach, starting with those least important to human medicine based on the WHO CIA list.[104] Further, all exceptions permitting treatment must be confirmed by diagnostic and susceptibility testing.[104] This is reasonable, and despite the prohibitive wording of these guidelines, reveals support for the prevention of inappropriate use. Unfortunately, they do not provide insight on how to access faster results, nor do they discuss the consequences of failing to prevent disease spread for animals, farmers, veterinarians. They do acknowledge that the feasibility of these treatment exceptions is linked to one's access to culture and sensitivity testing, and may introduce inequity in regions without diagnostic testing capacity.[104] It is positive that they recognize the difficulties in accessing diagnostic testing, however, they go on to state that these challenges are marginal compared to the gains of implementation.[104] This is very much in contrast to the

experiences of farmers and veterinarians as discussed in the previous chapter, and demonstrates how the lack of inclusion of agricultural production stakeholders in the guideline development process led to a lack of understanding of the pragmatic challenges of antimicrobial stewardship.

The WHO guidelines are followed by a brief discussion of areas that require further research. This includes determining the most cost-effective initiatives that reduce AMU, developing an improved understanding of how restricting AMU for disease control and treatment in food animals effects the presence of resistant bacteria in humans and animals, and finally, the development of rapid diagnostic and sensitivity testing.[104] These are valid areas of concern that do need more evidence and support, echoing the opinions of farmers and veterinarians discussed in the previous chapter. With that said, it is curious that the authors understood that these challenges must be overcome in order to support reduced AMU, yet still chose a downstream, prohibitive guideline structure. While it is positive that they recognize these challenges, it is unfortunate that they did not incorporate them more into their guidelines, instead of suggesting that they are marginal and inconsequential.

Conclusion

The WHO guidelines are marked by a number of internal inconsistencies. They place importance on having an evidence-based approach, which helps to ensure their guidelines avoid influence by ill-informed public perceptions. Despite this, they admit that they lack the evidence to support some of their published recommendations. They recognize the importance of using a multi-stakeholder approach, yet did not engage stakeholders outside of academia and government, notably not including any farmer voices. The guidelines are anthropocentric, motivated by the desire to protect human health. They simultaneously imply that their recommendations could cause harms to animal health and welfare, leading them to allow for treatment exceptions, while also stating that welfare compromises are few and far between. The same trend appears when they acknowledge the numerous upstream challenges that must

be overcome in order to reduce AMU, only to describe these as minor considerations when justifying their approach. There is a clearly demonstrated recognition of the need for upstream efforts to reduce the need to treat food animals with antimicrobials within the information accompanying the guidelines, but the guidelines focus exclusively on downstream interventions. Overall, the WHO guidelines are not a cohesive set of recommendations. They often touch on key criteria that hold the potential to reduce AMU in food animal production, and in turn AMR, but they fail to directly address these challenges and incorporate these perspectives into their formal recommendations.

Closing Thoughts

The approaches to antimicrobial use in food animals of GAP, McDonald's and the WHO each possess their own strengths and weaknesses. Common shortcomings include the lack of focus on the education of farmers in order to improve husbandry and early identification of sick birds, and an absence of acknowledgment that AMR has the potential to negatively impact animals just as it does people. Further, none of these programs recognize the negative ramifications of restricting or prohibiting antimicrobial use on the veterinarian-client-patient relationship, with no acknowledgment of the potential for conflict surrounding treatment and euthanasia decisions, and the associated moral distress. When it comes to the impetus for their programs, McDonald's and the WHO diverge from GAP, as the former aspire to reduce AMU in order to preserve the effectiveness of antimicrobials, while the latter is driven by consumer concerns. While all three programs draw on evidence in the literature and multiple stakeholder perspectives to support their guidelines, McDonald's draws from the widest variety of viewpoints and is the only program to directly recognize the autonomous role of farmers in animal care and treatment. The WHO is primarily influenced by concerns for human medicine and the expertise of academic researchers, while GAP draws on animal welfare research to support comprehensive preventative measures. McDonald's also incorporates these evidence bases, but goes further to also include farmer, veterinarian and animal interests. While all three programs make allowances for animals in need of treatment, the McDonald's VAS is the only

program to directly acknowledge that, despite best efforts, animals can get sick and should be treated in keeping with good animal welfare.

All three programs are inherently anthropocentric, privileging either consumer preferences or human health. These programs could equally benefit from discussion and reflection regarding the moral implications of regulating the approach to food animal health care in response to human interests. Open recognition that programs of this kind directly impact animals, who are morally blameless, in an attempt to rectify for past malpractice in veterinary or human medicine would be a good place to start. With that said, McDonald's VAS makes considerable efforts to include animal perspective in their policy, imagining how their requirements could harm animal health and welfare. In contrast, GAP and the WHO downplay the potential for harmful consequences to health and welfare under a restrictive production environment.

When it comes to preventing the need for antimicrobial use, GAP is the only program to lay out detailed guidelines on how to reduce disease pressure and adjust management. The two most noteworthy specifications include a significantly lower stocking density than is used in most commercial farms, and the selection of bird genetics that favour good welfare outcomes. The shortcomings of the GAP program come from their reliance on these preventative measures, as they mandate a complete prohibition of AMU in marketed birds, and fail to build in supports for farmers, veterinarians and animals in the event that treatment is needed. While they lack the same prescriptive preventative actions as in the GAP standards, McDonald's has a more well-rounded approach, focusing on preventing use, while also describing how antimicrobial use should be approached in the event that treatment is needed. There is a broad recognition by GAP, McDonald's and the WHO that improvements in housing, husbandry, biosecurity, and preventative medicine will help to reduce the need for AMU. Unfortunately, all refer to these strategies as if they are easily implemented. Diagnostic testing in particular is emphasized by both McDonald's and the WHO guidelines. While it is positive that these programs acknowledge the potential benefit for reducing inappropriate AMU, they do not recognize the significance of the challenges that stand in the way of feasibility. Overall, there is

a lack of in-depth understanding of the challenges associated with the implementation of these upstream strategies that could be resolved by incorporating a greater consideration for the experiences of veterinarians and farmers.

On the whole, these three approaches to AMU in food animals each demonstrate different strengths in leadership, both in the public and private sphere. They additionally highlight glaring weaknesses in current stewardship initiatives which, when combined with each strength, provide guidance for building comprehensive and nuanced policies for raising broilers (and other food animals) with as few antimicrobials as possible.

Chapter 5: Conclusion

Returning to the central question of this thesis, it can be concluded that is it not ethical to entirely restrict access to antimicrobials in animal agriculture for the benefit of human medicine. While the current literature suggests benefits of curbing total use, complete restrictions include numerous shortcomings. An ethical approach must include access to therapeutic treatments, as well as treatments that prevent the spread of illness within a group of animals. Therapeutic treatments should not only be allowed, they should be encouraged when indicated. This serves a benefit not only to animal health and welfare, but contributes to the wellbeing of farmers and veterinarians and their relationship with each other. Evidence suggests that when it comes to contributing to the burden of AMR in food animals, therapeutic AMU does not differ significantly from prohibitionist production practices. This reality can be shared in consumer messaging to assuage their concerns about inappropriate antimicrobial use and animal welfare. The burden of the decision to treat or not to treat a sick animal should not be carried by either farmers or veterinarians. Rather, those purchasing food animals raised in a production scheme that prohibits AMU ought to provide structure that facilitates the sale of a treated animal into the conventional market, in order to prevent sick animals from being left without treatment or euthanized unnecessarily.

This thesis does not dispute the benefits of reducing AMU in human and veterinary medicine in an effort to help preserve the effectiveness of antimicrobials. Nevertheless, given the available evidence, the actual contribution of animal agriculture to the burden of AMR in humans is still unknown, as discussed in Chapter 1. While AMU contributes to the development of AMR in food animals, a complete restriction of AMU does not always lead to a proportionate reduction in AMR. Evidence suggests that reducing the numerous selection pressures on-farm, including reduced AMU, strict biosecurity and farm hygiene practices, and limited transmission between people and animals, is necessary to truly reduce the development and spread of resistance. Farmers, vets and agricultural workers face the greatest risk of carrying livestock associated resistance, while the risk to the general population is currently undefined. While further evidence will help to strengthen antimicrobial stewardship initiatives, it is clear that reducing and restricting AMU in animal agriculture will not solve AMR in human medicine.

The heavy focus on food animal medicine as a key source of AMR has led to farmers and veterinarians feeling unfairly blamed and disillusioned with stewardship efforts that fail to recognize the impacts on agricultural stakeholders. Animal care and treatment is not limited to veterinarians, and regularly involves farmers and farm workers. As highlighted in Chapter 2, farmers and vets work together in order to serve the needs of animals, while also balancing their duties and obligations to their respective professions, consumers, and society at large. For this reason, responsibility over implementing initiatives to reduce AMU cannot be assigned to just one stakeholder. When farmers and veterinarians are restricted in their ability to treat animals, or market treated animals, they are forced to navigate conflicting obligations, the result of which can cause moral distress and career burnout. Giving consideration to livestock as agricultural stakeholders, it is apparent that public discussions and policy guidance dictating AMU in animal agriculture are centered around protecting human health, with the concern for human AMR privileged over the potential suffering of food animals, or the distress of farmers and vets. The result is an anthropocentric approach to a problem that impacts both humans and animals. When animals are denied access to clinically indicated antimicrobial treatments they are effectively punished for their potential contribution to AMR, despite being morally blameless. This approach to antimicrobial stewardship is ethically unjustifiable.

Many current and proposed approaches of preserving the effectiveness of antimicrobials focus on solutions upstream of use, in an effort to prevent the need for treatment. While some of these strategies are promising, such as diagnostic testing, other approaches, such as the call for the abolition of animal agriculture, are impracticable in the short term and do not address the current challenges facing food animals and those who care for them. Some strategies instead focus on blocking access to treatment through regulation of farmers and veterinarians, and negatively stigmatizing their professions in society. Per Chapter 3, these latter approaches are generally unwelcome by farmers and veterinarians, are often seen as unproductive, and can be harmful to their wellbeing, all of which negatively impact the progress of a united antimicrobial stewardship. Those working in food animal production see upstream initiatives that address the determinants of AMU as integral to reducing antimicrobial use, though they currently face numerous economic, educational, and structural barriers to effective implementation.

Present day public and private antimicrobial use policies place considerable focus on the motivations of public health and the concerns of consumers. As a result, there is a complete lack of consideration of the impact of such policies on the relationship between farmers and veterinarians, the fulfillment of their obligations to the animals, and the conflicts that restrictive policies create. Policies generally fail to openly acknowledge that AMR impacts animals and the field of veterinary medicine just as it does humans, as evidenced by the approaches of GAP, McDonald's and the WHO analysed in Chapter 4. In some cases, the anthropocentric view of the problem of AMR also prevents guidance from acknowledging that, despite best efforts, animals can and do get sick and require treatment, although McDonald's Vision for Antimicrobial Stewardship is a notable exception. While the support for preventing the need for AMU appears strong, this support is not often accompanied by concrete, evidence based strategies to improve animal health and address management related determinants of AMU, nor the resources needed to enact such changes. Finally, programs that do not permit the marketing of animals that have been treated with antimicrobials may incentivize withholding necessary treatment and the provision of unnecessary euthanasia, in order to maintain farm certification and market access within the production program. This is a key weak point of

current prohibitionist programs, demonstrated by the GAP Animal Welfare Certification program, and should be no longer considered as an acceptable approach to animal care.

Going forward, it would be prudent to focus discussion and action on the prevention of the need for AMU, instead of simply implementing barriers to access in order to achieve reductions in use. Upstream strategies identified in the literature are similarly identified by those working on the ground. From biosecurity, to husbandry, to housing improvements and preventative health measures, farmers and veterinarians are open to implementing pragmatic, positive changes so long as they are provided with the necessary resources. This responsibility falls on academics, to conduct strong research in order to provide evidence based guidance and technological support; government and private industry, to provide both financial and epistemic support in order to facilitate these approaches; and further to the agricultural community, who must actively engage in contributing to these efforts. In order to foster a positive and collaborative partnership between those in animal agriculture and those in public health, the propagation of blame and stigma must be removed from discourse. Further, discussions must consider the ramifications of action, or lack thereof, for all patients regardless of species. When building policy around the use of antimicrobials in any medical field, we must start with the recognition that sometimes patients contract bacterial infections, that many of these infections can be treated with an antimicrobial therapy, and that a failure to do so harms both patient and carer. This is common ground from which those in animal agriculture and public health can unite, in order to work together to promote health and protect the effectiveness of the antimicrobials upon which both humans and food animals rely.

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