# Effects of Animal Agriculture on Disease Spread

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## Introduction

The post-COVID-19 world has become more aware of the possibility of disease outbreaks and potential future health risks than in previous years. Issues concerning the future welfare of populations have come to the forefront of the public mind. Developing resistance to antibiotic drugs is a leading cause for concern. The animal agriculture industry uses antibiotics to increase the welfare of livestock animals and to prevent or treat disease. Criticisms arise regarding the implications of antibiotic use within food animals as it concerns human health through zoonotic transmission, and the distribution of disease from animals to humans and vice versa (Cella et al., 2023). While there are various animal-specific antibiotics, many of the antibiotics used in animal agriculture are the same antibiotics used to treat humans. Widespread antibiotic usage in livestock creates the risk for antibiotic resistance; while providing benefits for animal welfare and production, the consequence of antibiotic resistance and potential human disease outbreaks is a major concern.

## What is Antibiotic Resistance?

Antibiotics are a widely distributed drug due to their ability to provide treatment for a variety of bacterial infections and prevent the spread of disease. Antibiotic resistance is a growing health concern for all populations, both humans and animals. Resistance is described as the ability of bacteria to grow and evolve, to reduce, or to eliminate the effectiveness of antibiotics (Cella et al., 2023). The phenomenon of antibiotic resistance has been long documented since first becoming prevalent in the 1960s (Economou and Gousia, 2015). Reasons for the further evolution of antimicrobial resistance include the misuse and overuse of antibiotics in humans and animals, international travel, overseas trade of goods including livestock animals, and the lack of new medicinal development and alternative options (Argudín et al., 2017). Since some older antibiotics have large issues with resistance, newer novel antibiotics are slowly being developed to combat current forms of resistance in all species.

The health of humans is directly correlated to the health of animals, and the development of resistance to antibiotics challenges the future of current medical practices. One Health is a contemporary all-encompassing strategy for the simultaneous medical treatment of animal, human, and environmental health outbreaks (Cella et al., 2023). One Health recommends a holistic

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My name is Danielle Walters, I am an undergraduate student from Saint Louis, Missouri. I am pursuing a bachelor's degree in animal sciences with a minor in captive wild animal management at the University of Missouri–Columbia. Postgraduate I plan to apply to graduate school to obtain a master's degree in animal science and obtain a position in the conservation field.

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approach and the integration of communication between human healthcare professionals, veterinarians, and rural communities regarding the proper administration of antibiotics within all regions of health (Cella et al., 2023). The positive correlation between the health of the planet and its populations sets a precedent for maintaining communal health with the support of antibiotic drugs.

Antibiotics are commonly used for human infections including strep throat, urinary tract infections, upper respiratory tract infections/pneumonia, and mastitis. Mastitis is seen in both humans and livestock, most notably in dairy cattle. Misuse of antibiotics occurs when the drugs are overprescribed or prescribed for incorrect use such as the treatment of viral infections. The continued degradation of the effectiveness of antibiotics leads to significant concerns for post-surgery patients, immunocompromised individuals, and a concern for the control of disease outbreaks (Cella et al., 2023). According to the Centers for Disease Control and Prevention, in 2013 it was approximated that infections derived from antimicrobial-resistant bacteria totaled 23,000 casualties annually in the United States (Chang et al., 2015). Over the next six years, the affected number grew significantly within the US alone. In 2019, it was estimated a total of 1.27 million deaths were due to antibiotic resistance, making the issue one of the top global threats to current and future generations (Lake et al., 2022). Further figures suggest that by the year 2050, antibiotic-resistant-related deaths will reach 10 million globally (Tian et al., 2021). The use and misuse of antibiotics can lead to poor outcomes for both human and animal medicine practice.

**Antibiotic Use in Animal Agriculture**

Antibiotic use in animal agriculture promotes animal welfare and is used for disease-preventative purposes but still contributes to the widespread issue of antibiotic resistance. Veterinarians administer antibiotics to treat, control, and prevent illness in livestock species, and for therapeutic purposes like relieving pain caused by illness and improving production (Karavolias et al., 2018). Without the use of antibiotics in animals, welfare would decline significantly due to the increased severity of illness/infection and prolonged periods of suffering (Karavolias et al., 2018). Overcrowding and stress within large-scale livestock operations have a negative effect on the immune systems of affected animals. Higher stress levels and poor immune system responses lead to a higher chance of infection (Karavolias et al., 2018). Antibiotics have shown over time to be necessary within animal agriculture to maintain welfare and promote healthy herds, but there remains a feeling of unease due to the implications on humans.

Criticism regarding the use of antibiotics in animal agriculture believes that the industry is a leading factor in the rise of resistance. Approximately 80% of antibiotics used in the United States annually are administered to livestock species as growth supplementation and for preventative measures which, are not always clinically indicated from a medical standpoint (Chang et al., 2015). While the administration of low-dose antibiotics for weight gain is still practiced in the United States, it was banned by Europe in 2006 (Economou and Gousia, 2015). Another example of suboptimal antibiotic usage in animals is the administration of antibiotics to dairy cows at the end of the lactation cycle to prevent mastitis. Administration of the preventative antibiotic drug occurs for all animals, not only the ones currently exhibiting signs of an active infection.

The correlation between high resistance rates both in animals and humans has been displayed in numerous studies A research group reported a comparable relationship between food-animal and human resistance rates, highlighting that a decrease in the use of antibiotics in animals caused a decrease in resistance to the animals and humans in direct contact with those animals (Vidovic and Vidovic, 2020). Antibiotic abuse in livestock species presents several concerns for both the animals and humans. Overuse of antibiotics affects the health of livestock by damaging the immune system, giving further chance of infection, and leaving drug residue within manure and the surrounding environment (Tian et al., 2021). Despite the ability of antibiotics to cure and prevent infection, overuse can increase infection rates, cause secondary infection, and even lead to severe infections such as sepsis/organ failure in humans.

**Effects of Antibiotic Resistance on Humans**

Antibiotic resistance can be transmitted to humans from livestock species in three different methods. The primary routes of transmission occur through:

direct contact with livestock animals, contaminated water, and food;
secondary human contact; and
horizontal gene transfer (Chang et al., 2015).

Individuals who have frequent direct contact with resistant livestock species are at a higher risk of antibiotic resistance transfer (Tang et al., 2017). Strains of livestock-specific resistant Staphylococcus aureus have been reported in farmers and individuals closely in contact with contaminated pigs (Economou and Gousia, 2015). Due to the increased health risks within the environment maintaining adequate farm labor can be an increased challenge.

Another form of direct animal contact is through the consumption of food animals. The use of antibiotics in food animals, mainly swine and poultry, was noted to have transmitted vancomycin-resistant bacteria to humans through protein (El-Dien and Ahmed, 2018). Contaminated water sources have the further ability to transmit resistance as both a drinking source and through the consumption of fish. Seafood can be a carrier of bacteria with resistant genes derived from living in polluted water sources. Cross-contamination/pollution provides another route of access for resistance into the food chain system (Tian et al., 2021). The degradation and pollution of water pose a threat to survivability for all populations, as well as leaving antibiotic resistance residue within the animal protein.

The second method of the acquisition of resistant pathogens from animals occurs through human-to-human contact. Similar to other forms of bacteria, modes of resistant bacteria transmission include touching infected surfaces, direct/close contact with sick individuals, airborne routes such as coughing/droplets, and through mucus membranes. Lack of proper diagnosis of infection and inadequate isolation measures allow the spread of resistant organisms to other non-infected individuals (Cella et al., 2023). The third mode of antibiotic resistance from livestock to humans occurs by horizontal gene transfer. Horizontal gene transfer is a process in which resistance is transferred among bacteria giving a significant spread of resistant genes as they mutate from organism to organism (Vidovic and Vidovic, 2020). Bacteria become more resistant as they mutate degrading the effectiveness of certain classes of antibiotics as resistance is developed.

**Correlation Between Antibiotic Resistance and Disease Transmission**

The future of both human and animal populations and their health is dependent on the outcome of antibiotic resistance. The recent COVID-19 pandemic brought attention to the possibility of antibiotic resistance being a plausible contributor to the next global pandemic. Animal husbandry relies on antibiotics to prevent, treat, and control disease within a large group of animals. A study evaluating the correlation between animal use of antibiotics and the presence of antibiotic-resistant genes in humans suggests animal agriculture has a more significant impact on the spread of resistance than the human medical counterpart (Hu et al., 2014). There is a classification of animal-only antibiotics named ionophores, which the Food and Drug Administration identified as “non-medically important” for humans as they do not factor into the issue of antimicrobial resistance (Karavolias et al., 2018). Despite the ionophore antibiotic class being deemed as not influential to resistance in humans, poultry producers are not able to use the specific drug class within production under the regulations of the United States Department of Agriculture and its antibiotic-free label (Karavolias et al., 2018). The multiple modes of transmission from animal to human correlate to a higher risk of resistance distribution.

In addition to animal agriculture, human medicine provides an additional source of antibiotic resistance. According to One Health, following the COVID-19 pandemic the overprescribing of antimicrobials greatly increased especially in second and third-world countries (Cella et al., 2023). A 2021 study determined the effects of antibiotics during the COVID-19 pandemic displayed a higher rate of resistance genes in infected patients (Lai et al., 2021). The study provided support and displayed resistance stemming from human use of antibiotics through the example of resistance

development in the recent pandemic. The transmission of resistance comes from both human use and from the use within animal husbandry.

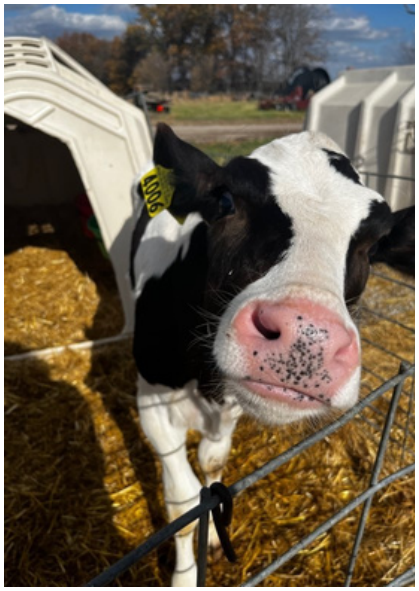
**Summary**

Antibiotic resistance is a concern for all. The decline in the ability of antibiotics to treat bacterial infections raises unease regarding the future of Western medicine. The rapid development of resistance has been shown to have stemmed from the overuse and misuse of antibiotic drugs in both human and animal medicinal applications (Argudín et al., 2017). Animal agriculture administers antibiotics for many factors primarily to treat, prevent, and cure certain bacterial infections (Karvolias et al., 2018). However, the abuse of such antibiotics can fortify resistance and ultimately be transmitted to humans. Modes of transmission from livestock to humans include direct contact with animals, passage through polluted water and protein, human-to-human contact, and horizontal gene transfer (Chang et al., 2015). The use of antibiotics is essential for maintaining the welfare of livestock animals however, human medicine also contributes to the issue of resistance.

The overuse and consequential misuse of antibiotics in both the animal agriculture industry and human medicine practices lead to the development of antibiotic resistance. The World Health Organization describes antibiotic resistance as not only a major concern for world health but also poses a severe danger to both the production of food and the total global supply (Cella et al., 2023). Treatment of non-bacterial infections remains a leading factor in the misuse of antibiotic drugs. Following the COVID-19 pandemic, antibiotic resistance has become and remained a point of discussion concerning the eventual state of modern medicine. Proper antibiotic stewardship remains a necessary step toward maintaining the effectiveness of antibiotics currently in use.

**Recommendation**

Animal agriculture and human medicine are both responsible for the development of antibiotic resistance. The first step towards managing the further evolution of resistance is to practice good antibiotic stewardship and provide alternative care methods for maintaining livestock health. The correlation between animal agriculture and the possible next widespread disease outbreak exists; however, it is not the sole contributor. Practicing good antibiotic stewardship by only prescribing for needed or necessary infections is essential to lowering the rate of development and eventual inter-species transmission of resistance. However, there are other options for maintaining animal health rather than reliance on antibiotics.



*Dairy calf pictured within its individual calf pen with hutch.*

The One Health ideology connects the health of animals, humans, and the environment. The principle of One Health not only applies to the outside environment but also to the captive environment of the animals. Management of the environment where the livestock animals are produced is fundamental to promoting animal health, practices including cleanliness, housing, concentration of animals, and nutrition. Studies have shown that issues such as overcrowding and stress caused by handling lead to an increase in disease susceptibility and negatively affected the welfare of the animals (Karavolias et al., 2018). The issue would be lessened or resolved through the reduced use of antibiotics. Two separate studies reported a relationship between antibiotics in livestock, stating a reduction in the use of antibiotic drugs was paralleled by lower rates of resistance documented in humans with direct contact with affected animals (Vidovic and Vidovic, 2020). Resistance will continue to be a factor for generations to come, but finding alternative options for treatment would be favorable for slowing the rate of transmission and avoiding disease outbreaks.

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