STM JOURNALS

Research & Reviews: Journal of
Veterinary Science and Technology

ISSN: 2319-3441 (Online)
ISSN: 2349-3690 (Print)
Volume 13, Issue 3, 2024
September–December
DOI (Journal): 10.37591/RRJoVST

https://journals.stmjournals.com/rrjovst

Review RRJoVST

Antimicrobial Resistance in Veterinary Medicine

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Abstract

Antimicrobial resistance is a worldwide public health issue that impacts both human and animal populations. The use of antibiotics in veterinary medicine plays a significant role in the development and spread of antimicrobial resistance, contributing to resistant pathogens that impact both animals and humans. Antibiotics are widely utilized in animal husbandry, not only for treating diseases but also for preventing illness and enhancing growth in livestock. While this practice supports animal health and productivity, it has contributed to the rise of antibiotic-resistant bacteria that can spread to humans through direct contact, consumption of contaminated food, and environmental routes. The misuse and excessive use of antibiotics in veterinary medicine speed up the development of resistant bacterial strains, making it harder to treat infections in both animals and humans. This article examines the mechanisms behind resistance development, emphasizing how antibiotic use in animals contributes to antimicrobial resistance in zoonotic pathogens like Salmonella, Campylobacter, and Escherichia coli. It also highlights the one health approach, which acknowledges the interdependence of human, animal, and environmental health in addressing antimicrobial resistance. Case studies of methicillin-resistant Staphylococcus aureus in animals and multidrug-resistant Salmonella in poultry highlight the public health risks associated with veterinary antibiotic use. Strategies for mitigating antimicrobial resistance, including reducing antibiotic usage, adopting better animal husbandry practices, and exploring alternatives, such as vaccines and probiotics, are discussed. The role of veterinary professionals in promoting responsible antibiotic use through stewardship programs and public education is emphasized. In conclusion, addressing antimicrobial resistance requires a collaborative approach that involves both veterinary and human health sectors, underscoring the need for continued research, monitoring, and policy development to combat the antimicrobial resistance crisis effectively.

Keywords: Veterinary medicine, AMR, conjugation, transformation, penicillin

INTRODUCTION

Antimicrobial resistance (AMR) is the capability of microorganisms, like bacteria, to withstand the effects of antibiotics that would normally kill them or stop their growth. This phenomenon presents a worldwide health risk, as it makes infections more difficult to treat, resulting in higher mortality rates, extended illnesses, and increased healthcare costs [1]. In veterinary medicine, antibiotics are essential for treating and preventing diseases in animals. They are also used to enhance growth in livestock, which can result in their overuse and misuse. The extensive use of antibiotics in animals leads to the emergence of resistant bacteria, which can be transmitted to humans through direct contact, the consumption of animal products, or environmental contamination. This creates significant public health concerns, as AMR in veterinary pathogens can impact the effectiveness of treatments for human infections, linking animals and human health in the broader context of AMR [2, 3].

In veterinary medicine, antibiotics are frequently used to preserve animal health in diverse sectors,

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Received Date: October 18, 2024
Accepted Date: October 26, 2024
Published Date: October 30, 2024

Citation: Kashif Aqueel Rizvi. Antimicrobial Resistance in Veterinary Medicine. Research & Reviews: Journal of Veterinary Science and Technology. 2024; 13(3): 11–15p.

such as livestock, pets, and aquaculture. The most frequently used antibiotics in animal husbandry include tetracyclines, penicillins, macrolides, sulfonamides, and aminoglycosides. These antibiotics help manage infections caused by a wide range of bacterial pathogens that threaten animal health and productivity [4].

The Role of Antibiotics in Veterinary Medicine

Antibiotics are used in three main ways: therapeutically, prophylactically, and as growth promoters. Therapeutically, antibiotics are administered to treat animals already infected with bacterial diseases, ensuring a swift recovery and preventing the spread of infections. Prophylactically, they are used to prevent disease outbreaks in healthy animals, especially in large-scale farming operations where animals live in close quarters and are prone to infections. Additionally, antibiotics have been widely used as growth promoters in livestock, where low doses are added to feed to enhance growth rates and improve feed efficiency. However, this practice has been criticized for contributing significantly to the development of AMR. Many countries are now limiting or banning the use of antibiotics for growth promotion to reduce the risk of AMR spreading from animals to humans [5, 6].

Mechanisms of AMR

AMR arises when bacteria gain the ability to withstand antibiotics that would typically kill them or prevent their growth. This resistance develops through two main mechanisms: genetic mutations and horizontal gene transfer. Genetic mutations occur randomly in a bacterium's DNA, causing alterations that diminish the effectiveness of antibiotics. Horizontal gene transfer enables bacteria to obtain resistance genes from other bacteria through direct contact (conjugation), absorption of free DNA from the environment (transformation), or transfer through bacteriophages (transduction). This transfer can spread resistance traits rapidly within bacterial populations, including across different species (Figure 1) [7].

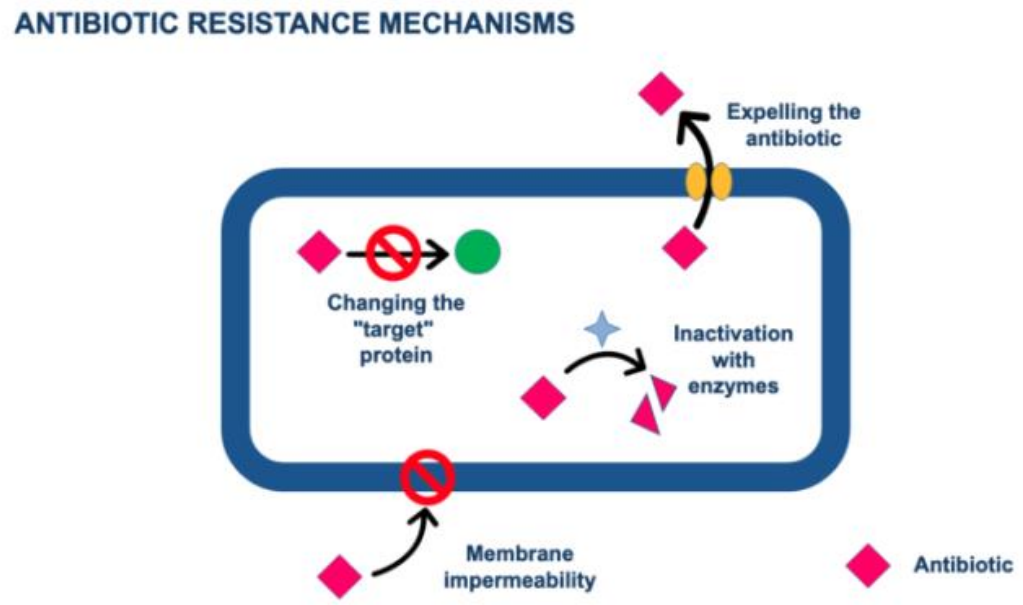

Figure 1. Mechanism of AMR.
Source: https://aboutsmallruminants.com/antimicrobial-resistances-strategies-antibiotics/

Environmental factors play a significant role in driving AMR, particularly the overuse and misuse of antibiotics in both veterinary and human medicine. In veterinary settings, the excessive use of antibiotics, especially for non-therapeutic purposes like growth promotion or disease prevention in healthy animals, contributes to the selection of resistant bacterial strains. Similarly, in human

medicine, improper use, such as incomplete courses of antibiotics or using them for viral infections, exacerbates the problem. The widespread presence of antibiotics in the environment through animal waste, water systems, and agricultural runoff also creates conditions for resistant bacteria to thrive and spread, linking human, animal, and environmental health in the context of AMR [8, 9].

Impact of Antibiotic Use in Animals on AMR in Humans

The use of antibiotics in animals significantly impacts AMR in humans, primarily through the transmission of resistant bacteria. Resistant pathogens can transfer from animals to humans via several routes, including direct contact with animals, ingestion of contaminated meat or animal products, and environmental contamination, such as through animal waste in soil and water sources. Zoonotic diseases like *Salmonell*a, *Escherichia coli*, and *Campylobacter* are of particular concern, as these bacteria can develop resistance in animals and then infect humans, making treatment more difficult.

The one health perspective highlights the interconnectedness of human, animal, and environmental health in addressing AMR. It emphasizes that resistant bacteria in animals can easily cross over to humans and spread in the environment, creating a cycle that amplifies the AMR crisis. A coordinated, cross-sector approach is essential to effectively combat this global health threat [10].

Case Study

Methicillin-resistant Staphylococcus aureus (MRSA)

MRSA is a prominent example of AMR that impacts both animals and humans. Originally identified as a human pathogen, MRSA has been found in various animals, including livestock, pets, and horses. Animals can serve as reservoirs for MRSA, passing the resistant bacteria to humans through direct contact or contaminated environments. This is especially concerning for individuals who have close interactions with animals, such as farmers, veterinarians, and pet owners. MRSA infections are difficult to treat due to resistance to common antibiotics, posing serious health risks and highlighting the need for vigilance in both veterinary and human medicine to control its spread.

Multidrug-Resistant Salmonella and Campylobacter in Poultry

The poultry industry has become a significant source of multidrug-resistant Salmonella and Campylobacter strains, posing serious public health risks.

These pathogens can develop resistance due to the widespread use of antibiotics in poultry farming, used for both therapeutic reasons and to promote growth. As a result, resistant strains can contaminate poultry products during processing and distribution, leading to human infections upon consumption. Infection with multidrug-resistant Salmonella and Campylobacter can result in severe gastrointestinal illness, often requiring hospitalization and leading to prolonged illness and increased healthcare costs. The emergence of resistance complicates treatment options, as common antibiotics may prove ineffective, resulting in longer recovery times and a higher burden on healthcare systems. This scenario underscores the critical need for improved antibiotic stewardship in poultry farming and heightened surveillance to monitor and control the spread of resistant strains from animals to humans [11].

Strategies for Mitigating AMR

To mitigate AMR, reducing antibiotic use in animals is essential. Implementing improved animal husbandry practices, such as better nutrition, housing, and health management, can enhance animal welfare and reduce disease incidence, subsequently decreasing the reliance on antibiotics. Biosecurity measures, including stringent hygiene protocols and disease surveillance, are crucial in preventing infections from occurring in the first place. Vaccination programs can also play a pivotal role in protecting livestock from infectious diseases, further minimizing the need for antibiotics as a preventive measure.

Various international and national regulations have been established to limit antibiotic use in livestock. Organizations, such as the World Health Organization (WHO), the World Organization for Animal Health (OIE), and the U.S. Food and Drug Administration (FDA) have established guidelines to promote responsible antibiotic use in veterinary medicine. These regulations often include restrictions on the use of certain antibiotics for growth promotion, monitoring antibiotic usage, and encouraging veterinary oversight in prescribing antibiotics. By fostering responsible practices and regulatory frameworks, these strategies aim to curtail the emergence and spread of AMR, protecting both animal and human health [12–17].

The Role of Veterinary Professionals Stewardship Programs

Veterinary professionals play a critical role in addressing AMR through various initiatives. One key strategy is the implementation of stewardship programs that promote responsible antibiotic prescribing and usage. These programs promote adherence to guidelines among veterinarians that highlight the prudent use of antibiotics, ensuring they are prescribed only when needed and in suitable dosages. Educating farmers and pet owners is also crucial for promoting a culture of responsible antibiotic use. Veterinary professionals can provide training and resources to stakeholders, highlighting the consequences of misuse and the importance of alternative practices, such as vaccination and improved animal husbandry. This education can empower farmers and pet owners to make informed decisions that prioritize animal health while minimizing reliance on antibiotics [13, 14].

Monitoring and surveillance programs are essential for tracking resistance patterns in veterinary pathogens. These programs collect data on antibiotic usage and resistance rates, enabling veterinarians and public health officials to identify trends and implement timely interventions. By integrating surveillance data with clinical practices, veterinary professionals can contribute to a comprehensive understanding of AMR and facilitate the development of targeted strategies to combat this pressing issue. Through these efforts, veterinary professionals can help safeguard both animal and human health against the threat of AMR [15, 16, 18].

CONCLUSIONS

In summary, AMR represents a major threat to global health, with the use of antibiotics in veterinary medicine playing a key role in its development and dissemination. The article has highlighted how antibiotics are employed in various animal sectors, the mechanisms by which resistance develops, and the impact of antibiotic use in animals on AMR in humans. Notably, case studies, such as MRSA exemplify the interconnectedness of human and animal health in the context of AMR. To effectively combat this pressing issue, collaborative efforts between veterinary and human medicine are essential. The one health approach underscores the need for integrated strategies that address AMR holistically, recognizing the shared environment of humans, animals, and ecosystems. It is imperative for stakeholders across all sectors – veterinarians, healthcare professionals, policymakers, and the public – to work together to implement responsible antibiotic stewardship, enhance education on antibiotic use, and establish robust surveillance programs. By fostering these collaborative initiatives, we can mitigate the AMR crisis and protect the health of both humans and animals for generations to come.

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