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Popular Article

Antimicrobial Resistance: A Growing Threat

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Abstract

Antimicrobial resistance is an important concern for the public health authorities at global level. In recent decades, the overuse and misuse of antimicrobials in animal health have contributed significantly to the rise of resistant bacteria, posing a serious threat to both animal welfare and public health. Additionally, inadequate infection prevention and control measures in animal production facilities contribute to the spread of resistant bacteria among animals. In this article, we delve into the intricate dynamics of antimicrobial resistance in animal health, examining the underlying causes, exploring its impacts on animal welfare and human health, and discussing potential interventions and strategies to mitigate its effects. By raising awareness and fostering collective action, we can strive towards a future where antimicrobials remain effective tools in safeguarding animal health, human health, and environmental sustainability.

Introduction

Antimicrobial resistance (AMR) refers to the ability of bacteria in animals to develop mechanisms that render antimicrobial drugs, often antibiotics, ineffective. These drugs were once successful in combating infections in animals, but due to AMR, they are no longer able to eliminate the bacteria or stop their growth. This presents a significant challenge for animal health professionals as it complicates treatment plans and can lead to serious consequences for animal health and potentially public health as well.

Since the discovery of penicillin in the late 1920s, hundreds of antimicrobial agents have been developed for therapeutic use. Antimicrobials have become indispensable tools for decreasing morbidity and mortality associated with a host of infectious disease and, since the introduction of antimicrobials into veterinary medicine, animal health and productivity have improved significantly. However, loss of efficacy through the emergence and dissemination of bacterial antimicrobial resistance is reported frequently. It was not unexpected phenomenon. In

fact, Alexander flaming warned against the misuse of penicillin in his 1945 Nobel Prize lecture.

The Rise of Antimicrobial Resistance

The use of antimicrobials in animal health is common practice in veterinary medicine. These medications are crucial for treating infections and promoting animal welfare in agriculture, aquaculture, and companion animal care. However, the misuse and overuse of antimicrobials have contributed to the emergence of resistant bacteria in animals.

One of the main drivers of antimicrobial resistance in animal health is the inappropriate use of antibiotics, including their use for growth promotion in livestock and prophylactic treatment in aquaculture. In addition, poor infection prevention and control measures in animal production facilities can lead to the spread of resistant bacteria among animals.

Addressing Antimicrobial Resistance in Animal Health

Efforts to combat antimicrobial resistance in animal health require a multifaceted approach involving stakeholders at various levels. Veterinary professionals play a crucial role in promoting responsible antimicrobial use through education, antimicrobial stewardship programs, and adherence to guidelines for prudent use.

Furthermore, regulatory measures are essential to control the use of antimicrobials in animals, including restrictions on non-therapeutic use and oversight of antimicrobial sales and distribution. Encouraging alternatives to antimicrobials, such as vaccination, biosecurity measures, alternative medicine and improved animal husbandry practices, can also help reduce reliance on these medications.

Collaboration between the human health, animal health, and environmental sectors is key to addressing antimicrobial resistance comprehensively. This One Health approach recognizes the interconnectedness of human, animal, and environmental health and emphasizes the need for coordinated action to mitigate the spread of resistant bacteria.

Biochemical Mechanism of Resistance

There are four main mechanisms of antimicrobial resistance:

1. **Limiting uptake of a drug:** Bacteria can develop mechanisms to prevent antibiotics from entering the cell. This can be done by changing the structure of the cell wall or by pumping the antibiotic out of the cell.
2. **Modifying a drug target:** Bacteria can mutate the target of an antibiotic, making it more difficult for the antibiotic to bind. This is a common mechanism of resistance to antibiotics that target cell wall synthesis.
3. **Inactivating a drug:** Bacteria can produce enzymes that break down antibiotics. This is a common mechanism of resistance to beta-lactam antibiotics, such as penicillin.

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4. **Active drug efflux:** Bacteria can develop pumps that actively transport antibiotics out of the cell. This can reduce the concentration of the antibiotic inside the cell to a level that is no longer effective.

Types of Antimicrobial Resistance

Antimicrobial resistance (AMR) can be categorized into two main types: Natural/Intrinsic resistance and Acquired resistance.

1. **Natural/Intrinsic Resistance:** Natural or intrinsic resistance refers to the inherent ability of certain bacterial species or strains to withstand the effects of specific antimicrobial agents. This type of resistance is often encoded in the bacterial genome and is not acquired through external factors such as exposure to antibiotics. Examples of natural resistance include the inability of Gram-negative bacteria to be affected by macrolides. Natural resistance can vary among bacterial species and is an intrinsic characteristic that influences their susceptibility to antimicrobial treatments.
2. **Acquired Resistance:** Acquired resistance occurs when bacteria acquire genes or mutations that confer resistance to antimicrobial agents. This type of resistance can result from horizontal gene transfer, where bacteria exchange genetic material containing resistance genes with other bacteria in their environment. Mutation is a stable and heritable gene change that occurs spontaneously and randomly among microorganism. Acquired resistance mechanisms include the production of enzymes that inactivate antibiotics (e.g., beta-lactamases that break down beta-lactam antibiotics), efflux pumps that expel drugs from bacterial cells, and alterations in drug targets to reduce drug binding efficacy. Acquired resistance is a dynamic process that can occur rapidly under selective pressure from antimicrobial use, leading to the emergence and spread of resistant bacterial strains. This contributes to the overall challenge of antimicrobial resistance and necessitate strategies that encompass prudent antimicrobial use, surveillance of resistant strains, development of new antimicrobial agents, and implementation of infection prevention and control measures to combat the spread of resistant bacteria.

Examples of Veterinary Antimicrobial Resistance of Public Health Significance

According to WHO, Antimicrobial resistance is one of the top global public health and development threats. It is estimated that bacterial AMR was directly responsible for 1.27 million global deaths in 2019 and contributed to 4.95 million deaths.

1. Resistance in *Salmonella*
2. Methicillin-resistant *Staphylococcus aureus* (MRSA)

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Surveillance Programs and the Role of Diagnostic Laboratories

There are many surveillance programs includes, National Antimicrobial Resistance Monitoring System (NARMS) and the collaboration in animal health globally. India has given due cognizance to the problem of Anti-microbial resistance and to tackle this issue, Government of India launched a "National Programme on AMR Containment" during the 12th five-year plan (2012-2017) which is being coordinated by National Centre for Disease Control. Under the programme, National Antimicrobial Surveillance network (NARS-Net) has been established to determine the magnitude and trends of AMR in different geographical regions of the country. The network labs under NARS-Net are required to submit AMR surveillance data of seven priority bacterial pathogens of public health importance: *Klebsiella spp.*, *Escherichia coli*, *Staphylococcus aureus*, and *Enterococcus spp.*, *Pseudomonas spp.*, *Acinetobacter spp.*, *Salmonella enterica* serotypes Typhi and Paratyphi.

Susceptibility testing of clinical isolates is a cornerstone for prudent use of antimicrobials and adequate management of clinical cases. However, because of the geographically local and temporarily limited nature with different sampling and susceptibility testing methodologies, it is difficulty to draw reliable conclusions on the global antimicrobial resistance situation in veterinary medicine. Constant efforts are made by the Clinical and Laboratory Standard Institute (CLSI) to develop agreeable veterinary standards for susceptibility testing methodologies. There is a great need for diagnostic laboratories to adhere to them in order to provide reliable and reproducible susceptibility data for clinicians and others.

Control of Antimicrobial Resistance

It is a quite questionable that new class of antimicrobial agents will be available for veterinary use in the coming years. Therefore, continued efforts should be made to preserve their efficacy. Many professional associations, governmental agencies worldwide, and international committees are developing guidelines for the responsible and prudent use of antimicrobial agents in veterinary medicine and agriculture. For example, the World Organization for Animal Health, American Veterinary Medical Association, and numerous producer and veterinary practitioner groups have developed programme to help veterinarians to make sound decision.

Maintenance and improvement of good management practice in companion animal and food animal husbandry are cornerstones in the reduction of antimicrobial use and the control of antimicrobial resistance. Additionally, rational use of antimicrobials and role of alternative medicine like ethnoveterinary practices, homeopathy, and pre and probiotics remains to be thoroughly assessed and defined.

In conclusions, the optimism of the early period of antimicrobial discovery has been tempered by the emergence of bacterial strains resistant to these therapeutics. Today, clinically

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important bacteria exhibit not only single drug resistance but also multiple antibiotic resistance, the legacy of past decades of antimicrobial use and misuse. This modern predicament of widespread antimicrobial resistance has led the World Health Organization to warn that the benefits of these agents may be lost without comprehensive and concreted action to combat the present problem and reverse anticipated developments. Consequently, better designed studies are needed to assess the real antimicrobial resistance situation in veterinary pathogens at every level, from the farm all the way up to the national and international level. Resistant is an inevitable biological phenomenon: the challenge is to circumvent this persistent and serious obstacle to effective medical and veterinary chemotherapy.

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