

Antimicrobial Resistance: Combat Strategies

Aditi Vishwakarma

(M.V.Sc. Microbiology)

College of Veterinary Science and Animal Husbandry, Jabalpur
Nanaji Deshmukh Veterinary Science University, Jabalpur, M.P.

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The discovery of antibiotics has transformed the field of medicine by turning once-lethal bacterial infections into manageable conditions, saving countless lives in both humans and animals. These drugs have become essential in veterinary medicine, helping to improve the productivity of livestock, enhance animal health, and support global food security. However, the improper use of antimicrobials has led to the rise of antimicrobial resistance, which is now one of the most serious threats to both animal and human health. The overuse and misuse of antibiotics in humans, animals, and agricultural settings have contributed to the emergence of resistant microorganisms. Antimicrobial resistance refers to the ability of certain microorganisms to survive and grow despite being exposed to drugs that are meant to kill or stop their growth. These drugs are crucial because they help control harmful pathogens in animals, preventing illness and death, and helping to reduce economic losses due to decreased productivity. Several factors contribute to the development of resistance to antimicrobial drugs. These include the overuse or incorrect dosing of these drugs, their use without a proper prescription from a veterinarian, routine use as growth promoters in livestock, poor biosecurity and hygiene practices, incomplete treatment courses, and the use of substandard drugs. Resistant pathogens can spread from animals to humans through food products like meat, milk, and eggs, or through direct contact with animals or via environmental factors, creating serious biosafety concerns. This issue is a global challenge known as the One Health approach, which recognizes the interconnectedness of animal, human, and environmental health. Efforts to combat antimicrobial resistance should include the careful and appropriate use of antimicrobials, prevention of infections, and awareness and monitoring of antimicrobial use.

The development of antimicrobial resistance is influenced by various factors, starting from the frequent or unnecessary use of antibiotics, which creates selection pressure that allows resistant microbes to survive and proliferate while others are eliminated. This can be avoided by consulting a veterinarian and following a proper diagnosis through culture and sensitivity testing. Treating infections without identifying the specific pathogen or its drug sensitivity can result in ineffective treatments and the unnecessary use of broad-spectrum antibiotics. Broad-spectrum antibiotics can kill beneficial bacteria, increasing selection pressure and promoting resistance among multiple bacterial species.

Self-medicating or using antibiotics without medical guidance may lead to the improper selection of drugs, increasing the risk of resistance. Even when following a proper prescription and diagnosis, administering drugs in lower than recommended doses or stopping treatment before completion can also lead to the development of resistance. Another factor is the routine use of antibiotics as growth promoters in livestock feed, where low doses are used continuously, exposing bacteria to subtherapeutic levels and favouring the emergence of resistant strains.

Some of the important pathogens in veterinary medicine that have developed resistance include:



- *Escherichia coli*: This bacterium can easily acquire resistance genes through plasmids.
- Multidrug-resistant and ESBL-producing strains are increasing in prevalence and have significant zoonotic importance. It causes infections such as mastitis, diarrhoea, urinary tract infections, and septicaemia in various animals like calves, piglets, poultry, and companion animals.
- *Salmonella* spp.: Infections such as enteritis, septicaemia, abortion, and foodborne illness have developed resistance to tetracycline, ampicillin, sulphonamides, and fluoroquinolones.
- These bacteria can spread from animals to humans through contaminated food, making it a major One Health concern.
- *Staphylococcus aureus*: This bacterium causes mastitis, wound infections, skin infections, and abscesses, including methicillin-resistant *S.*
- *aureus* (MRSA), which is resistant to most beta-lactam antibiotics. Persistent mastitis can reduce milk production, leading to economic losses and posing a zoonotic risk.
- *Campylobacter* spp.: These bacteria cause enteritis in poultry, cattle, sheep, dogs, and humans.
- Increased antibiotic use has led to resistance against fluoroquinolones and macrolides. Poultry serves as a major reservoir, and contaminated meat is a key source of human infection, making it a public health concern.
- *Pasteurella* spp.: These bacteria cause respiratory diseases like bovine respiratory disease (BRD), haemorrhagic septicaemia, and fowl cholera.

Resistance to tetracycline, penicillin, and macrolides is increasing, making treatment more difficult and leading to significant economic losses in livestock.

The World Organisation for Animal Health (WOAH) is a leading organization working to address antimicrobial resistance through the One Health approach. It maintains a global database on antimicrobial use in animals and collaborates with the World Health

Organization (WHO), Food and Agriculture Organization (FAO), and United Nations Environment Programme (UNEP) through the Quadripartite partnership.

WOAH has implemented several strategies to address antimicrobial resistance:

- WOAH Global Strategy on AMR and Prudent Use of Antimicrobials: First launched in 2016 and aligned with the WHO global action plan, the strategy was updated in 2026 for the period 2026–2036 to strengthen global action. The updated plan includes four strategic pillars: improving awareness, strengthening surveillance and research, governance and capacity building, and implementing international standards.
- WOAH Antimicrobial Resistance Working Group (AMRWG): Established in 2019, this group develops international AMR policies, reviews emerging scientific evidence, supports One Health initiatives, and guides other countries in AMR control.
- Global Database on Antimicrobial Use (AMU): WOAH maintains the largest global database on antimicrobial use in animals, collecting and analyzing data to monitor consumption trends, identify excessive use, and support policy-making.
- International Standards for Responsible Use of Antimicrobials: WOAH develops standards that provide guidance on responsible antimicrobial prescription, stewardship, disease prevention through vaccination, and AMR surveillance.
- Veterinary Services Capacity Building (PVS Pathway): This initiative focuses on training veterinarians, improving laboratory capacities, and supporting the

- implementation of AMR action plans.
- vi. World Antimicrobial Awareness Week (WAAW): WOAHA participates annually in WAAW, promoting awareness among veterinarians, farmers, and the general public.
 - vii. WVA-WOAH Global Repository of Guidelines for Responsible Use of Antimicrobials: This joint initiative between the World Veterinary Association and WOAH provides clinical treatment guidelines, stewardship resources, and educational materials.

The management of antimicrobial resistance includes the:

1. Rational use of antimicrobial drugs- which involves prescribing the correct drug, dose, route, and duration, and using them only when clinically necessary. Prophylactic or empirical use should be avoided unless required.
2. Culture and Antimicrobial Susceptibility Testing (AST)- culturing and identifying the causative pathogen before treatment helps to select antibiotics based on susceptibility results. This reduces unnecessary use of broad- spectrum antimicrobials.
3. Antimicrobial Stewardship- it is a systematic and coordinated effort by healthcare professionals to optimize the use of antimicrobials. Antimicrobial stewardship promotes the responsible use of antimicrobials by:
 - Monitoring prescriptions and establishing strict clinical protocols
 - De- escalation and dose optimization of antimicrobials
 - Reviewing therapy and receiving feedback regularly
 - Preserving the effectiveness of existing drugs
4. Vaccination- it is the process of administering a vaccine to help the immune system develop protection which helps in disease prevention before occurrence. It reduces need for antibiotic treatment and decreases selection pressure that increases AMR.
5. Improved Biosecurity and Farm Hygiene- certain managerial changes helps to reduce disease incidence in farms to reduce need of antibiotics. Isolation of sick animals, maintenance of proper sanitation and disinfection, control farm visitors and animal movement, reduce overcrowding, and improve housing conditions.
6. Infection prevention and Control (IPC)- it relies on key practices like hygiene, PPE kits, and surface disinfection to stop the spread of germs. It also involves:
 - early diagnosis and treatment
 - quarantine of infectious animals
 - proper disposal of carcass
 - effective vector and pest control
7. Surveillance and Monitoring- surveillance helps to formulate evidence-based treatment guidelines, tracking resistance patterns in animal pathogens, reporting emerging resistant strains to national surveillance systems and monitoring antimicrobial consumption.
8. Regulation of Antimicrobial use- ban or limit the use of medically important antibiotics as growth promoters and restrict over-the-counter sales. It also ensures quality control of veterinary medicine and enforces withdrawal periods before marketing animal products.
9. Farmer and Veterinarian Education- the Extension department plays a crucial role in promoting education to the farmers about AMR and imparting knowledge about the importance of completion of prescribed treatment. The farmers should be taught about discouraging self-medication and



training them about disease prevention and biosecurity.

10. One Health Approach- One Health Approach is an integrated approach that recognizes that human, animal, and environmental health are interconnected. Antimicrobial resistance should be managed through coordinated efforts involving:

- Veterinarians
- Physicians
- Farmers
- Microbiologists
- Environmental scientists
- Policy makers

11. Whole-Genome Sequencing (WGS) Surveillance: WOAHP promotes One Health integrated genomic surveillance, laboratory strengthening, and international data sharing to improve AMR control. It complements phenotypic antimicrobial susceptibility testing and identifies resistant genes, virulence factors, and mobile genetic elements. This enables detection of emerging resistant strains and the spreading pattern of resistance. The genomic analysis is important for outbreak investigation and disease control.

AMR is a silent but rapidly growing threat that weakens decades of progress in veterinary science. Antibiotics are precious and limited resources, and their effectiveness must be preserved through responsible use, and its prevention can be possible through the One Health framework. Protecting antibiotics and spreading awareness today is essential to slow down the emergence of resistant strains and protect the health of animals, humans, and future generations. These key management strategies will help in overcoming the issue of Antimicrobial Resistance according to the root cause of resistance.