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Antibiotic Resistance and Stewardship in Small Animal Practice - A Review

Sharon N Mbindyo*; Tequiero O Abuom; Jafred MA Kitaa

Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi, 29053-00625, Kangemi, Kenya.

***Corresponding Author(s): Sharon N Mbindyo**

Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi, 29053-00625, Kangemi, Kenya.

Tel: +254702142585; Email: snmbindyo@gmail.com

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Abstract

This review identifies key antibiotic-resistant bacteria in small animals and highlights the importance of antibiotic stewardship programs in small animal practice. The use of antibiotics is crucial in the treatment of infections in small animals; however, their injudicious use has led to increased reports of antibiotic resistance raising significant public health concerns. There is need for small animal practitioners to understand the occurrence, emergence, and spread of resistance and implement the principles of the antibiotic stewardship programs.

Introduction

Globally, Antibiotic Resistance (ABR) is a public health threat [1-3]. Over the last one century, antibiotic use has transformed human and animal medical practice by providing patients with protection from bacterial infections [2]. However, the frequent and injudicious use of antibiotics in humans and animals has led to the emergence of resistant bacteria [4-6].

This resistance is driven by an increased selective pressure on bacterial populations, which causes mortality and growth stasis of nonresistant organisms [7] and the resultant resistant bacteria spread their resistant genes [8,9]. The rise and spread of antibiotic-resistant organisms has been linked to a rise in disease severity as a result of reduced treatment efficacy, longer hospitalization, and increased treatment costs [10,11].

This review aims at describing the major antibiotic-resistant organisms in small animals and the role of antibiotic stewardship in preventing the spread of antibiotic-resistant bacteria in small animal practice.

Antibiotic use in small animal medicine

Surveys of antibiotic use in dogs in developed countries showed that beta-lactam antibiotics are frequently prescribed [12-15] and cats are more exposed to the third-generation cephalosporin [15-17]. Antimicrobials including antibiotics are

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often prescribed for the treatment of various diseases in small animals as well as prophylaxis postoperatively [18]. However, inappropriate antibiotic use in these animals is a cause for the emergence of antibiotic-resistant bacteria [12,19]; thus, prudent antibiotic use is an important approach in addressing antibiotic resistance [20]. Guidelines for antibiotic use such as Federation of Veterinarians of Europe guidelines (https://www.fecava.org/sites/default/files/files/fve_antimicrobials_pets_final_small.pdf).

have been developed internationally and nationally to help small animal practitioners towards prudent antibiotic use. Additionally, these guidelines indicate diagnostic criteria and therapy of the most common bacterial diseases in small animals [21,22].

In Sub-Saharan Africa, antibiotic use in small animals has comparativelybeen less analyzed relative to food animals. At present, some studies have demonstrated use of antibiotics in cats and dogs [23,24]; however these studies only cover one country which limits comparisons between countries. Studies from multiple countries with standardized methodology can increase our understanding of antibiotic use in small animals which will ultimately lead to responsible use of antibiotics [19].

Antibiotic resistance in small animals

As in humans, antibiotic use in animals results in the emergence and spread of resistant bacteria to humans through direct contact with animals or through environmental spread [25,26]. Although foodborne transmission is the most frequently studied route, direct contact transmission with pets, especially dogs and cats is important [27,28] for veterinarians and owners, especially children.

Antibiotic Resistance (ABR) is a major challenge facing small animal medicine [9]. As pets, dogs and cats are potential sources of spread of multidrug-resistant organisms due to the common use of antibiotics and their constant contact with humans [29-31]. This is of greatest concern in geriatric and other immunocompromised patients [32-34]. Various Multidrug-Resistant (MDR) bacteria of concern have been isolated in dogs and cats worldwide during the past decade. They include Methicillin-Resistant *Staphylococcus Aureus* (MRSA), Methicillin-Resistant *Staphylococcus Pseudointermedius* (MRSP), MDR *Acinetobacter baumannii*, Escherichia Coli Producing Extended-Spectrum β-Lactamase (ESBL), *Klebsiella pneumoniae*, and carbapenemase-producing *Escherichia coli* [35-39]. Resistance to antibiotics belonging to the third generation cephalosporins, fluoroquinolone, and carbapenem classes has been detected in bacteria isolated from dogs in the Netherlands, Australia, and Germany [37,40,41].

A study conducted in a veterinary teaching hospital in South Africa [23] revealed the presence of zoonotic MDR-Staphylococcus spp. in cats resistant to all β-lactams while a study done in Tanzania [42] reported antibiotic-resistant thermophilic *Campylobacter* in the intestines of household dogs. While in Kenya, a study [43] isolated MDR *Staphylococcus aureus*, MDR Proteus spp. and MDR *Pseudomonas* spp. from dogs.

For MDR infections, there is resistance to antibiotics licensed for veterinary use increasing the risk of therapeutic failure and potential euthanasia [44,45]. Many of the multidrug-resistant organisms are found in both humans and small animals, presenting a potential risk of zoonotic transmission of these organisms from infected small animals to humans [46]. Studies on MDR Proteus spp. have shown that antibiotic-resistant bacteria or genes can be transferred from humans to dogs [4,5].

Antibiotic stewardship in small animal practice

Approximately 50% of antibiotics in human medicine are inappropriately or unnecessarily prescribed [47] and it is likely that this percentage is similar in small animal medicine. The use of an antibioticincreases the likelihood of development of resistant populations to develop among bacteria in animals [48]. This has led to an increased awareness of the crucial role for antibiotic stewardship in preventing the spread of MDR bacteria in small animals [10].

Antibiotic stewardship considers the "benefit of antibiotic use to the patient while minimizing the development of antibiotic resistance and adverse effects on the patient from unnecessary therapy" [49].The drivers of antibiotic resistance include antibiotic use and abuse in the human, animal, and environmental sectors and the spread of resistant bacteria and genes within and between these sectors; therefore, given the interdependent human, animal, and environmental aspects of antibiotic resistance, it is imperative to take 'One Health' approaches when addressing it [50,51]. A Task Force for Antimicrobial Stewardship in Companion Animal Practice was formed by the American Veterinary Medical Association (AVMA) in 2015 to guide for implementing antimicrobial stewardship in small animal practice. This membership consists of professionals from different disciplines such as government, public health, clinical practice, pharmacology and infectious disease. The goal of the task force has been to consider the emerging impact of MDR organisms in small animal practice and design approaches to address this challenge [46]. However, it has been reported that antibiotic stewardship was the least implemented program in the fight against antibiotic resistance in animals in Sub-Saharan African countries [52].

Antibiotic Stewardship Programs (ASPs) integrate prevention and control of common infectious agents; use evidence-based approach in the judicious use of antibiotics, with continual evaluation of treatment outcomes, while respecting owner's resources [53,54]. Antibiotic stewardship programs require training and research by international and national veterinary organizations and animal health industries [10]. However, there are some barriers that hinder implementation of antibiotic stewardship programs: These include inadequate use of culture and susceptibility antibiotic testing; lack of standardized methods for assessing antibiotic stewardship program outcomes, and economic sustainability [10].

It been suggested that small animal practitioners perform diagnostic laboratory tests and have proper documentation to justify antibiotic treatment [55]. Veterinary pharmacists influence prescribing decisions thus playing an essential role in enhancing antimicrobial stewardship initiatives [56,57]. Recommendation of provision of antibiotic stewardship programs at affordable costs have also been made [55]. Effective monitoring of antibiotic use also a criticalelement in reducing the development of Antibiotic Resistance (ABR) [58]. At the university level, antibiotic stewardship should be advanced as the principles serve as good examples for veterinary practice [59].

Conclusion

Misuse of antibiotics in the treatment of bacterial infections in small animals has led to the resistance of significant bacterial populations with grave implications for animal and pub-

lic health. The veterinary profession can reduce the selection pressures that favor the spread of antibiotic-resistant bacterial pathogens by accurately identifying patients who need antibiotic therapy, using local epidemiological and laboratory data to guide the selection of empiric therapy, avoiding agents with overlapping activity, adjusting antibiotics therapy when culture results become available, monitoring for toxicity, and optimizing the dose, route, and duration of therapy. Small animal practitioners also need to develop interdisciplinary antimicrobial stewardship teams as awareness campaigns on antimicrobial stewardship are carried out.

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