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Research Article

Meta-analysis of Antimicrobial use in Animals and their Public Health Significance at Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, Borno State, Nigeria

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ABSTRACT

A retrospective review of clinical record books from January 2021 to December 2023 was conducted to evaluate the antimicrobials administered and the associated disease conditions. The antimicrobials were administered in both large and small clinics, as well as the avian clinic at the Senator Ali Modu Sheriff Veterinary Hospital (SAMSVH) in Maiduguri, Borno State, Nigeria. Descriptive statistics were used to analyse the data, and the results are presented in the figures. It was observed that the most commonly used antimicrobials at SAMSVH Maiduguri included oxytetracycline, enrofloxacin, penicillin-streptomycin, sulphonamides, and tylosin. Penicillin-streptomycin was the most frequently used in large animal clinics. In contrast, gentamicin was used in small clinics, and neomycin-Plus was used in an avian clinic. Also, most of the disease conditions reported in the large animal, small animal, and avian clinic are infectious diseases caused by bacteria, viruses, parasites, and fungi. These included septicaemia, respiratory tract infections, helminthosis, coccidiosis, pestes des petits ruminants, foot and mouth disease, canine distemper, urinary tract infections, infectious bursal disease, fowl typhoid, Newcastle disease, among others. Goitre, orchitis, phimosis, and cataract are the least recorded diseases in the large animal clinic; feline panleukopenia and rectal prolapse are similarly least reported in the small animal clinic within the period under review. The infrequent use of antimicrobials such as ceftriaxone, amoxicillin, and diminazene in clinics is likely attributable to fewer documented cases for their respective clinical indications, limited confirmatory laboratory diagnostics, or the high cost associated with these medications.

Keywords: Antimicrobial use; Avian clinic; Large animal clinic; Meta-analysis; Small clinic

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INTRODUCTION

Antimicrobials (AMs) are compounds produced by microorganisms like bacteria, fungi, and actinomycetes that kill or inhibit the growth of bacterial organisms (Saini *et al*., 2024). The use of AMs has been reliably applied in modern medicine in the treatment, improvement, and production efficiency of animals, humans, and plants (Edwards *et al.*, 2021). Antimicrobial resistance (AMR) occurs when these microorganisms no longer respond to antimicrobial medicines due to overuse and/or misuse of the antimicrobials (Devasahayam *et al.*, 2010). The rise in both commensal and pathogenic microorganisms worldwide, along with the recent scarcity of novel antimicrobial medications, has made AMR a serious public health issue (Frimodt-Møller, 2004). Increased AMR has a detrimental effect on livestock production by decreasing farm productivity and raising the expense of disease treatment (Tang *et al.*, 2017). Scientists have a growing consensus that the problem of AMR in humans is exacerbated by antimicrobial use antimicrobial use (AMU)/AMR in animals (Marshall and Levy, 2011). It is a normal practice, most especially in a hospital setting, that the use of antimicrobials in the treatment and management of infectious diseases is guided by a

laboratory susceptibility test. Senator Ali Modu Sheriff Veterinary Hospital (SAMSVH) is the largest and most renowned veterinary hospital located within the central area of Maiduguri, Borno State, Nigeria. The SAMSVH consists of large animal, small animal, and avian clinic, among other units responsible for diagnosing, treating, and managing diseases of different animal species. The large animal clinic treats food-producing animals like cattle, sheep, goats, and equines. The small animal clinic manages canines, felines, and other non-ruminants, while the avian clinic is involved with birds. Apart from the structure and facilities that have been in existence for over 3 decades, the hospital is manned by professionals trained in different veterinary disciplines. The hospital has been witnessing an influx of clients, along with their patients. However, there is a dearth of information regarding the frequencies of different antimicrobials used in the management and treatment of infectious diseases at the hospital. This study assesses the frequency of antimicrobials used at SAMSVH clinics from January 2021 to December 2023.

MATERIALS AND METHODS

Study Area

This study was conducted at the SAMSVH, Maiduguri, Borno State. Maiduguri is a cosmopolitan town located in the north-eastern part of Nigeria. The area stands at an elevation of 354 meters above sea level, on latitudes 11° 49 51.9528'' N and longitudes 13° 9' 3.4812'' E, within the Sahel zone, with a total land mass of 50,778 square kilometres (NGSA, 2020). Maiduguri has a population density of 1,738 people per square kilometre, and a total population of 521,492 (NPC, 2006). The temperature ranges between 35- 40 °C for most parts of the year, with two distinct seasons: a rainy season with a mean annual rainfall of 647mm from July to October, average humidity of 31°C and a prolonged dry season for the rest of the year (NGSA, 2020). The state derives great economic activity from its rich livestock and fishery production (NPC, 2006).

Study Design

The study was conducted as a retrospective analysis using clinical records from Senator Ali Modu Sheriff Veterinary Hospital. The clinical record books were assessed and evaluated for various antimicrobial uses and the disease conditions treated in the large, small, and avian clinics from January 2021 to December 2023.

Data Analysis

The data obtained from those records were analysed using Microsoft Excel version 16, expressed in percentage, and presented in Figures.

RESULTS

Mean frequencies of antimicrobial use in the large animal clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

The most frequently used antimicrobials in the large animal clinic were penicillin-streptomycin (17.5 %), oxytetracycline (16.4 %), enrofloxacin (15.6%), sulphurdimidine (12%), albendazole (10.8%), tylosin (9.2 %), while the least used are crystalline penicillin (4.1 %), diminazene (2.3 %), amoxicillin (0.3 %) as presented in Figure 1.

Mean fequencies of disease conditions treated in the large animal clinic at the Senator Ali Modu Sheriff Veterinary hospital, Maiduguri, from January 2021 to December 2023

The most frequently recorded disease conditions observed in large animals during the review period included respiratory tract infection (13%), septicaemia (11.5%), coccidiosis (7.5%), and Pestes des Petits Ruminants (PPR) as 7.6 %. In contrast, other conditions, such as foot rot, foot and mouth disease (FMD), vaginal prolapse, uterine prolapse, tetanus, contagious ecthyma, pregnancy toxemia, and babesiosis, had a percentage frequency of less than 5%, as presented in Figure 2.

Mean frequencies of antimicrobial use in the small animal clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

The most frequently used antimicrobials in the small animal clinic included Gentamycin (21.4 %), Penicillin-streptomycin (11.9%), Oxytetracycline (10.7 %), Ivermectin (11.6 %), Albendazole (10.8%), and Sulphadimidine (8 %). The least frequently used antimicrobial in this unit includes Enrofloxacin (4.5 %), Tylosin (2.5), Crystalline penicillin (3.0 %), Chlorophenicol (3.2 %), Diminazene aceturate (2.0%), Amoxicillin (4.2), Ceftroxone (2.1) as presented in Figure 3.

Mean fequencies of disease conditions treated in the small animal clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

The most frequently recorded disease conditions observed in large animals during the review period include helminthosis (20 %), canine distemper (19.7 %), fracture (19.3%), respiratory tract infection (15 %), babesiosis (14 %), dysentery (11.7 %), urinary tract infection (9.7 %), pruritis (9.7 %) and menge (9 %). Other disease conditions such as Feline panleukopenia, dermatitis, partial paralysis, mastitis, rectal prolapse, shock, haematoma, otitis, and epistaxis have a frequency of less than 9 %.

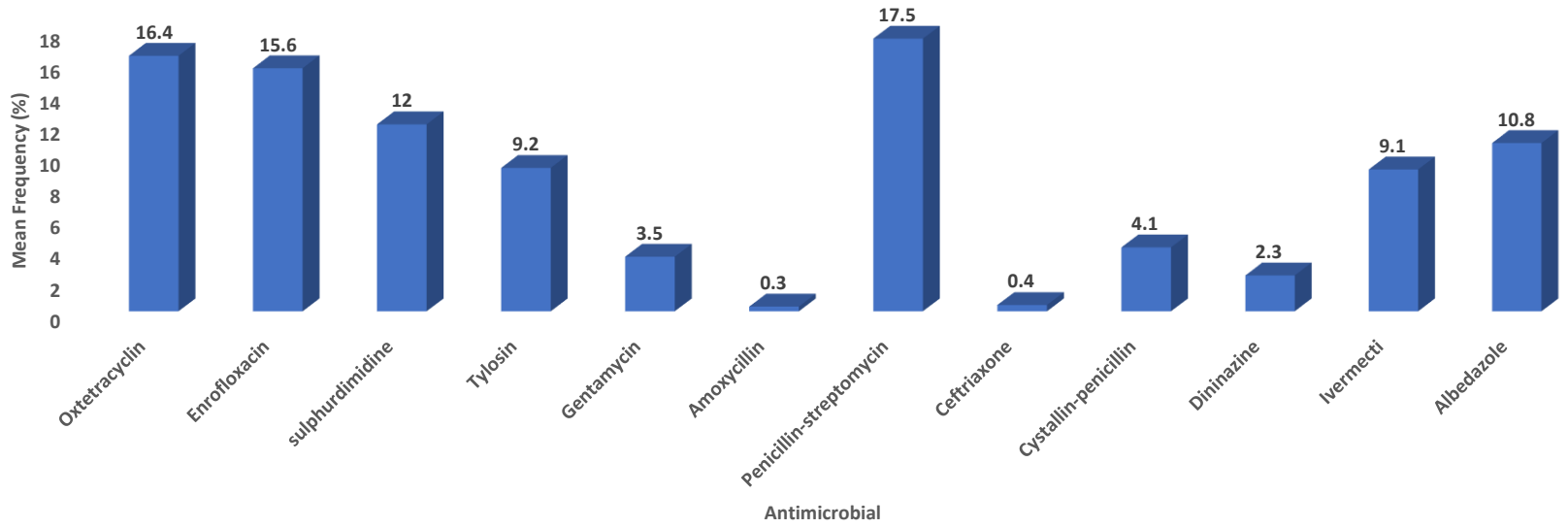

Figure 1. Mean frequencies of antimicrobial use in the large animal clinic of the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

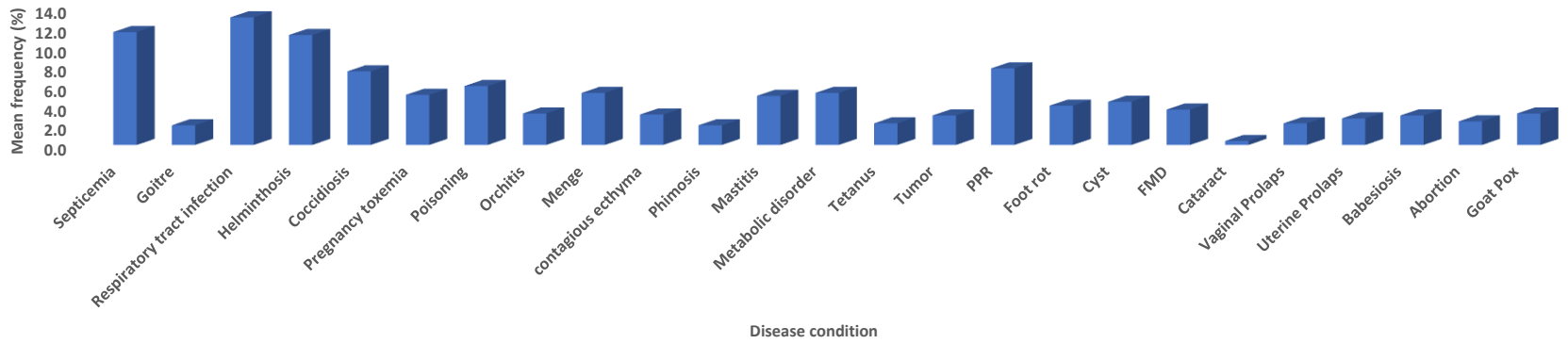

Figure 2. Mean frequencies of disease conditions treated in the large animal clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023
Keys: FMD- foot and mouth disease, PPR- Pestes des Petits Ruminants

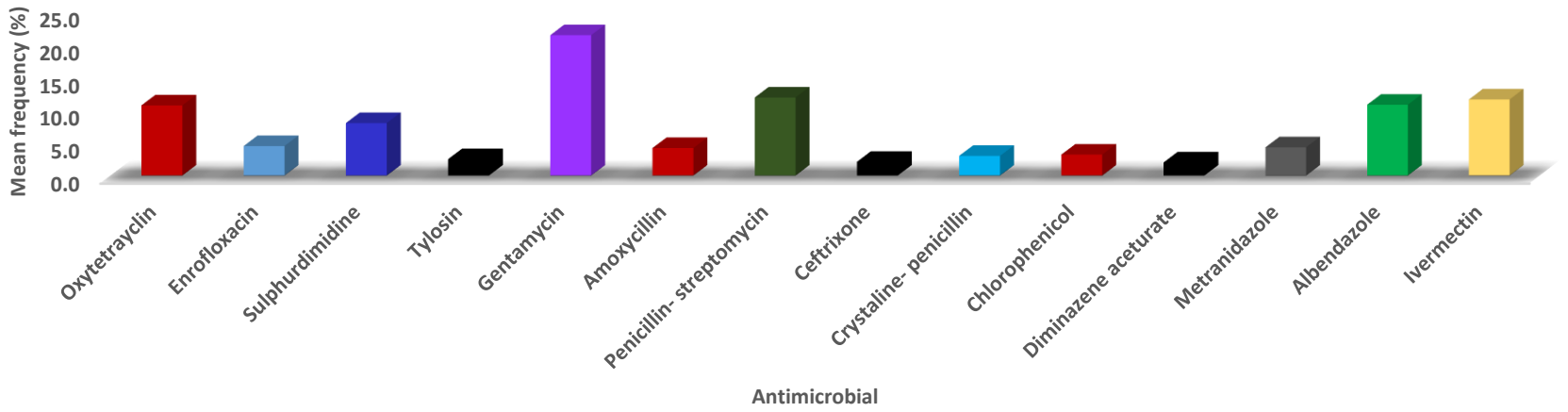

Figure 3. Mean frequencies of antimicrobial use in the small animal clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

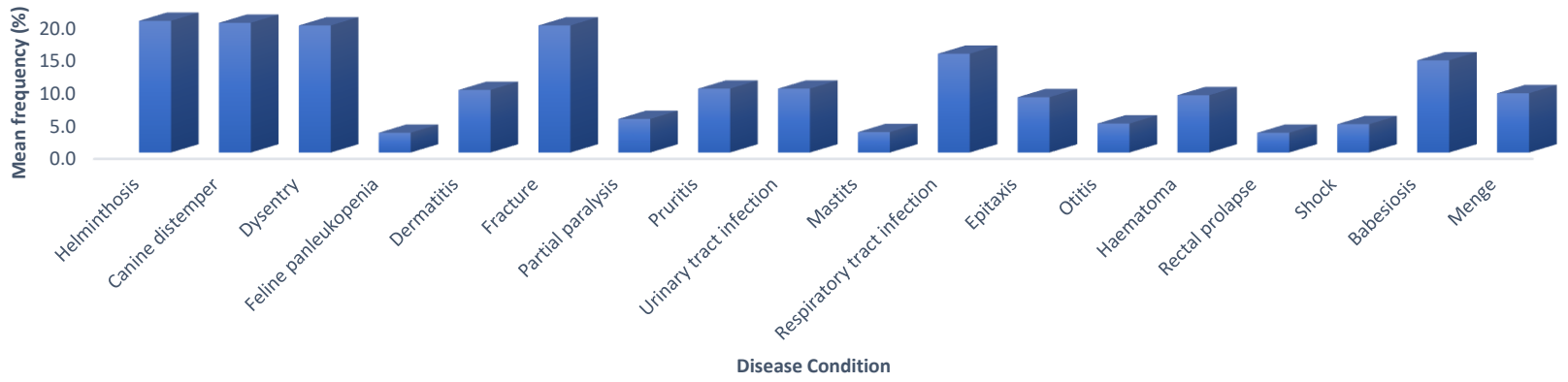

Figure 4. Mean frequencies of disease conditions treated in the small animal clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

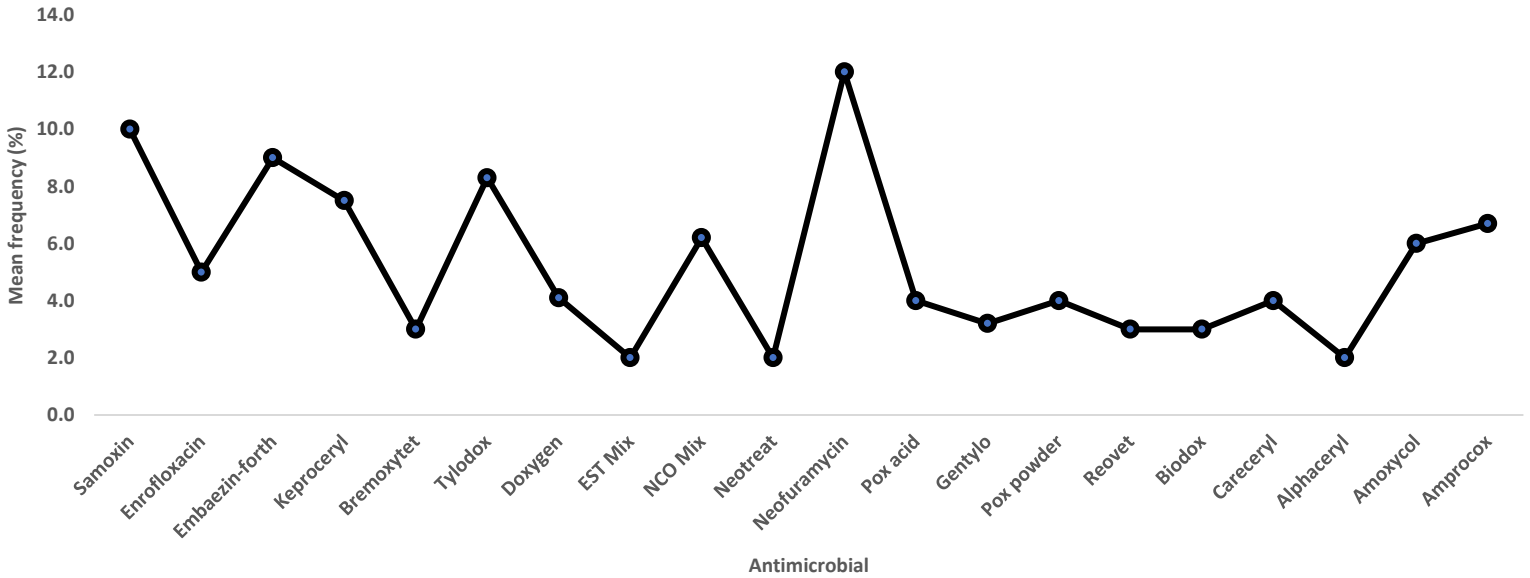

Figure 5: Mean frequencies of antimicrobial use in the avian clinic at the Senator Ali Modu Sheriff Veterinary Hospital, Maiduguri, from January 2021 to December 2023

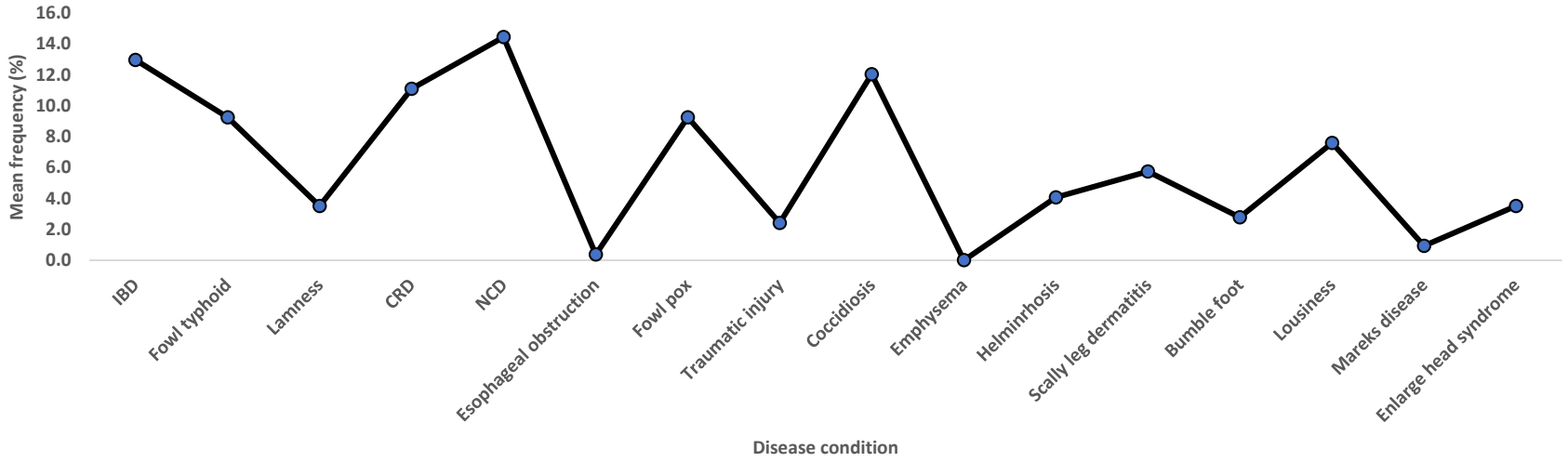

Figure 6: Mean frequencies of disease conditions treated in the avian animal clinic at the Senator Ali Modu Sheriff Veterinary hospital, Maiduguri, from January 2021 to December 2023
Keys: IBD = Infectious bursal disease; CRD = Chronic respiratory disease, fowl typhoid, NCD = Newcastle disease

DISCUSSION

Veterinarians and stakeholders are now focusing on combating antibiotic resistance and promoting appropriate usage of antibiotic-free animal husbandry to improve animal health, welfare, and productivity (Fairles, 2013). In this review, the most commonly used antimicrobials, within the review period (2021 – 2023), were oxytetracycline, enrofloxacin, penicillin-streptomycin, sulphonamides, and tylosin, with penicillin-streptomycin being the most frequently used in large animal clinics, gentamicin in small clinics, and neomycin-Plus in avian clinic. The meta-analysis in this review align with Ihedioha *et al.* (2020), who reported that the most frequently used antibiotics included a penicillin-streptomycin combination (36.53%), oxytetracycline (32.08%), gentamicin (19.78%), and sulphadimidine (5.35%); other antimicrobial used were less than 5% each in a retrospective on the use of antimicrobial at the Veterinary teaching hospital, University of Nigeria Nsukka, from January 2013 to December 2019. Also, in this review, most of the disease conditions reported in both large and small animals as well as the avian clinic were infectious diseases caused by bacteria, viruses, parasites, and fungi (Jane and Craig, 2011; David *et al.*, 2019; Kimeli *et al.*, 2025). These disease conditions included septicaemia, respiratory tract infection, helminthosis, coccidiosis, PPR, FMD, canine distemper, urinary tract infection (UTI), IBD, fowl typhoid, NCD, among others. Oxytetracycline, a broad-spectrum tetracycline antibiotic produced by *Streptomyces rimosus*, dominated the veterinary antibiotics market in 2024, widely used to treat Gram-positive and negative bacterial infections in animals (Ezeibe, 2024; GVR, 2024). These antimicrobials are either formulated alone (Samoxin) or in combination with other active ingredients, as seen in Keproceryl, Neotreat, Neofuramycin-Plus, Reovet, Alphaceryl, and Careceryl for the treatment and management of infectious diseases in avian and other animal species. These combinations are indicated to broaden the spectrum of activity and combat multidrug-resistant microorganisms (Tamma *et al.*, 2012; Mehta *et al.*, 2014). The growing application of oxytetracycline as observed in this meta-analysis could be attributed to its broad spectrum of its activities as it is used in treating actinobacillosis, bacterial enteritis, pneumonia, bovine respiratory disease complex, diphtheria, interdigital necrobacillosis (foot rot), pododermatitis, keratoconjunctivitis, leptospirosis, metritis, acute abortion outbreaks, feline infectious anaemia, linked with *Chlamydophila, Campylobacter*, or *Coxiella burnetiid,* as well as skin and soft tissue infections as reported by Mark (2015) and Ezeibe (2024).

Enrofloxacin belongs to the fluoroquinolone family, a quinolone subfamily that targets bacterial topoisomerase, inhibiting their function and halting DNA replication (Trouchon and Lefebvre, 2016). Enrofloxacin is a broad-spectrum antimicrobial that is effective against most gram-negative and gram-positive bacteria but not against anaerobic bacteria (CVMP, 2007). It is available in oral and injectable forms for various species, including farm animals.

The increased usage of enrofloxacin in this review may be due to its indication in the treatment of anaplasmosis, digestive, urinary, joint, genital, mammary, ocular and dermal infections in ruminants, small animals and birds as reported by Cinquina (2003), Trouchon and Lefebvre (2016), and Fuchs *et al.* (2022). Penicillin-Streptomycin is a combination solution of aminoglycoside and β-lactam antibiotics. Penicillin induces cell wall lysis and cell death by disrupting the osmotic pressure gradient, while streptomycin alters the permeability of the cell wall by irreversibly binding to the 30S ribosome subunit, interfering with protein synthesis and cellular respiration (Germovsek *et al.*, 2017; Fisher and Mobashery, 2020). This combination synergistically enhances their range of activities and increases their efficacy compared to when used exclusively (Yee *et al.*, 1986). The increased use of penicillin-streptomycin in this review may be linked to a higher incidence of diseases such as mastitis and respiratory and urinary tract infections, and prophylactic in surgery. These conditions are associated with microbial infections, including *Staphylococcus aureus*, *Streptococcus agalactiae, Escherichia* coli, *Klebsiella,* and *Mycoplasma bovis*, as identified in both large and small animal clinics. The findings in this review are in tendem with the findings of Tufa et al. (2023) and Beaudoin et al. (2023), who report the use of Penicillin-Streptomycin in large and small animal practice.

Sulphadimidine is an antimicrobial that comes in different preparations, such as injectables, tablets, and boluses, and is combined with some active ingredients like diaminopyrimidines and vitamins such as Embarzin-forth. The increased use of sulphadimidine across the 3 different clinics observed in this review may be linked to its indications for the treatment and management of diseases associated with colibacillosis, Eimeria-induced enteritis, respiratory, genitourinary tract, and soft tissue infections in ruminants, small animals, and poultry, as reported by Campbell (1999); Keeton and Navarre (2018) and (Attree *et al.*, 2021). Tylosin is a 16-membered macrolide, bacteriostatic that inhibits protein synthesis by binding to the 50S ribosomal subunit in bacteria (Papich, 2016). It is available in both liquid and powdered forms for injection and oral use, with most of the powdered formulations prepared in combination with some active composition such as Tylodox$^{(R),}$ containing tylosin+doxycycline, and Gentylo$^{(R),}$ gentamycin + tylosin. Tylosin is a potent antibiotic that targets gram-positive bacteria such as *staphylococci, streptococci*, and *corynebacteria*, as well as some gram-negative bacteria such as *campylobacter, E. coli,* some *spirochaetes,* and *Mycoplasma* species in avian and mammalian hosts (Papich, 2016; Garmyn *et al.*, 2019). As observed in this review, the increased use of tylosin in the large and avian clinic may be linked to the treatment and management of disease conditions such as septicaemia and respiratory tract infection: Mastitis, CRD, and the respiratory form of NCD in avian as reported by Garmyn *et al.* (2019) in chickens and Dabbir (2020) in sheep and goats. Goiter, orchitis, phimosis, and cataract are the least recorded diseases in the large animal clinic; feline panleukopenia and rectal prolapse are similarly underreported in the small animal clinic. Similarly, these clinics rarely use antimicrobials like ceftriaxone, amoxicillin, and diminazine. The infrequent use of these antimicrobials in the large animal clinic is likely due to a lesser number of documented cases for their clinical indications, limited availability, or the high cost of the medications.

CONCLUSION

This meta-analysis indicated that most of the disease conditions recorded in the SAMSVH Maiduguri are infectious origin. Also, most antimicrobials used are antibiotics, including oxytetracycline, enrofloxacin, penicillin-streptomycin, sulphonamides, tylosin, and neomycin-plus across the clinics. The clinics rarely use ceftriaxone, amoxicillin, and diminazene, which may be due to limited clinical indications, availability, and high costs. The findings also indicated the public significance of the effective use of antimicrobials in combating AMR in livestock and other animals.

Conflict of Interest

The authors declare that they have no conflict of interest.

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