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Assessment of preparedness for antimicrobial resistance in the veterinary department of a district in South India

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Abstract

Background and Aim: Antimicrobial resistance (AMR) is one of the top ten public health challenges affecting humans worldwide. Antibiotic use in livestock, agriculture, and fisheries is a significant yet often overlooked contributor to AMR. This study aimed to evaluate the preparedness of the veterinary department for AMR in a district in South India.

Materials and Methods: The cross-sectional study involved all veterinary personnel in the department, with 73 participants (administrative officials, veterinary doctors, and para veterinarians). Data were collected using a validated questionnaire and an observational checklist to assess infection prevention and control (IPC) practices. Specific questionnaires were administered to veterinary doctors and para veterinarians to evaluate their knowledge, attitudes, and practices (KAP) regarding antibiotic use and resistance. Administrators were also surveyed regarding measures to prevent, detect, and respond to AMR.

Results: Administrative veterinary officers displayed significant disparities in knowledge and preparedness regarding AMR-related domains. This indicated a gap in communication and coordination to combat AMR at the administrative level. The shortage of veterinary doctors was noted, which paved the way for para-veterinarians to be involved in antibiotic prescription. Adherence to biomedical waste management and IPC practices were observed. The KAP survey revealed adequate knowledge and positive attitudes among veterinary doctors regarding antibiotic use, although familiarity with AMR action plans and antibiotic stewardship was limited.

Conclusion: The veterinary department excels in infection control and medical countermeasures but needs to improve its implementation of preventive measures, early detection, surveillance, and human resources.

Keywords: antibiotic stewardship, antimicrobial resistance, food security, one health approach, veterinary department.

Introduction

The discovery of penicillin in the 1940s marked the beginning of the antimicrobial era, revolutionizing modern medicine by reducing the risk of infections and sepsis [1]. Antimicrobials, including antibiotics, antivirals, antifungals, and antiparasitic agents, act by limiting or eliminating the growth of microorganisms [2]. Eventually, the microbes evolve genetically and metabolically, leading to the development of resistance to these agents. This phenomenon, known as antimicrobial resistance (AMR), increases the risk of disease transmission, severe illness, and death [3]. Infections such as tuberculosis, brucellosis, and salmonellosis are becoming more challenging to treat, resulting in prolonged illness, increased mortality, and higher healthcare costs [3]. AMR among animal pathogens, such as *Staphylococcus, Streptococcus,* and *Escherichia coli,* which are causative agents for animal illnesses such as bovine mastitis and colibacillosis can exacerbate disease severity, diminish productivity, and pose significant economic losses, thereby threatening global food security [4]. Antibiotic use is projected to increase by 67% worldwide between 2010 and 2030 [5]. AMR has emerged as a significant public health threat resulting from the inappropriate and indiscriminate use of antimicrobials in human medicine and non-human sectors, such as agriculture and animal health [2]. AMR is an increasing worldwide concern, with an estimated 700,000 deaths per year due to drug-resistant infections. Without effective therapies, this number could exceed 10 million by 2050 [6]. The economic impact is equally alarming, with potential loss of up to US$100 trillion by 2050 [2]. AMR disproportionately affects poor and disadvantaged populations in low- and middle-income countries [7]. AMR can hinder the attainment of Sustainable Development Goals (SDGs) by 2030 due to its extensive impact on SDG-related themes, which include societal challenges, economics, education, and health care [8].

Antibiotic use in livestock, agriculture, and fisheries contributes to AMR [9]. Antimicrobial usage in food animals was estimated to be approximately

131,000 tons worldwide in 2013 and is projected to grow to around 200,000 tons by 2030 [10]. Globally India ranks fourth for the highest use of antibiotics in food animals, making up to 3% of the total [11]. Given the multifaceted nature of AMR, the One Health approach, which integrates human, animal, and environmental health sectors, is crucial for addressing the problem of AMR [12]. The World Health Organization (WHO), in partnership with the Food and Agricultural Organization and the Office International des Epizooties, often known as the "Tripartite Alliance," recognized the seriousness of the AMR worldwide challenge and advocated the idea of a "One Health" approach. This partnership actively promoted best practices to lower AMR levels and limit its spread. The United Nations Environment Program joined the alliance in October 2022, and the One Health Quadripartite Joint Plan of Action was implemented [3]. The member countries of the 2015 World Health Assembly committed to the framework released by the WHO as the "Global Action Plan (GAP) on AMR." The GAP focuses on several methods, including improving surveillance, promoting research activities, lowering infection rates, rationalizing antibiotic use, raising awareness regarding AMR, and better medicines [13]. In 2017, the WHO Expert Committee on the Selection and Use of Essential Medicines proposed the Access-Watch-Reserve (AWaRe) categorization of antibiotics as a tool for evaluating the overall consumption of antibiotics and monitoring the implementation and effects of antibiotic stewardship policies at the local, national, and global levels [14]. European countries, such as Denmark and the Netherlands, have successfully implemented national programs to reduce antibiotic use in farms, leading to lower levels of drug-resistant infections among humans and animals [15]. In India, despite efforts in human health to address AMR, such as the National Action Plan on AMR (NAP-AMR) by the Ministry of Health and Family Welfare in 2017 and antibiotic stewardship by the Indian Council of Medical Research, with the exception of the Food Safety and Standards Authority of India's ban on the use of antibiotics in food-producing animals, there are no robust species-specific standards for antibiotic usage, thereby leading to the rise of AMR due to irrational use of antibiotics in the livestock sector and is likely to pose an unnoticed burden in the country. [11].

The present study was designed to analyze the existing status of preparedness for AMR at the local level, which will help understand the measures taken for AMR containment in the veterinary sector.

Materials and Methods

Ethical approval and Informed consent

The study was approved by the Institutional Ethics committee of Kasturba Medical College and Kasturba Hospital (IEC NO: 663/2023). The confidentiality and privacy of the participants were maintained throughout the study. After explaining about the study to the participants a written consent was obtained from each participant.

Study period and location

The cross-sectional study involved 73 veterinary personnel from the Department of Animal Husbandry and Veterinary Services in a South Indian district from January 2024 to June 2024. The district name is kept anonymous as per the authorities' instructions. The district is divided into nine administrative blocks.

Survey design

The study included all veterinary personnel (administrative officials, veterinary doctors, and para-veterinarians) through complete enumeration. The tools developed for the study were validated by veterinary public health experts.

Infection prevention and control (IPC) practices in nine veterinary facilities (one per block) were assessed using an observational checklist. Veterinary doctors and para-veterinarians completed questionnaires to evaluate their knowledge-attitude-practices (KAP) regarding antibiotic use and resistance, while administrators documented AMR prevention, detection, and response measures using a semi-structured questionnaire.

In the KAP survey of veterinary doctors, responses were scored as follows: 1 for correct answers, positive attitudes, and good practices, and 0 for incorrect answers, negative attitudes, and poor practices. "Don't know" responses were also scored zero. Individual KAP scores were calculated and summed to obtain the total KAP scores. The median of the total scores determined the cut-off for categorization: scores below 14 indicated poor knowledge, 14 or higher indicated adequate knowledge; scores below 13 indicated a negative attitude, 13 or higher indicated a positive attitude; scores below 5 indicated bad practices and 5 or higher indicated good practices.

IPC practices were assessed across five domains: Biomedical waste management, examination/consultation room hygiene, cleaning techniques, IPC practices followed by veterinary personnel, and general IPC provisions. Each provision received a score of 1 if present. The domain scores were computed by summing the individual question scores in each domain. The highest possible score for each domain was calculated by multiplying the number of veterinary facilities by the number of questions in each domain. The domain percentage scores were derived by dividing the total domain score by the highest possible score and multiplying by100.

Statistical analysis

The data were analyzed using Microsoft Excel 2019 (Microsoft Office, Washington, USA) and Jamovi software 2.3.13 (https://www.jamovi.org/). The results are presented in the form of percentages and frequencies.

Results

Sociodemographic characteristics of the study participants

All 10 administrators interviewed were males; one (10%) was a senior administrative veterinary officer overseeing the entire district, while 9 (90%) were block-level administrative officers. 6 (60%) administrators had postgraduate qualifications. In terms of experience, 3 (30%) had 7–12 years and 13–18 years of experience, respectively, with 2 (20%) being posted in the district office and 8 (80%) being in veterinary hospitals. Of the 27 veterinary doctors interviewed, 23 (85%) were males, and 16 (59%) were chief veterinary officers. Of the 27 veterinary doctors, 15 (55%) completed post-graduation, and 8 (29%) had 13–18 years of experience. Thirteen (48%) were posted in Veterinary Hospitals. Among the 44 para-veterinarians, 43 (98%) were males, and 32 (76%) were designated as Veterinary Inspectors. 21 (48%) had a Diploma, and 14 (32%) had 25–30 years of experience. 19 (43%) were posted in Veterinary Hospitals (Tables-1–3).

Table-1: Demographic characteristics of the administrative officials.

Variable	Frequency (n = 10)	Percentage
Gender		
Male	10	100
Designation		
Senior administrative veterinary officer	1	10
Block-level administrative veterinary officer	9	90
Highest qualification		
Graduation	4	40
Post graduation	6	60
Work experience		
7–12 years	3	30
13–18 years	3	30
19–24 years	1	10
25–30 years	1	10
31–36 years	2	20
Workstation		
DD office	2	20
Veterinary hospital	8	80

Table-2: Demographic characteristics of the veterinary doctors.

Variable	Frequency (n = 27)	Percentage
Gender		
Male	23	85
Female	4	15
Designation		
Deputy director (clinical)	1	4
Chief veterinary officer	16	59
Senior veterinary officer	4	15
Veterinary officer	6	22
Highest qualification		
Graduation	12	44
Post graduation	15	56
Work experience		
0–6 years	3	11
7–12 years	6	22
13–18 years	8	29
19–24 years	6	22
25–30 years	2	8
31–36 years	2	8
Workstation		
Veterinary polyclinic	2	8
Veterinary hospital	13	48
Veterinary dispensary	11	40
Breeding centers	1	4

Comparison of AMR prevention, detection, and response measures: Senior versus block-level administrative veterinary officials

Prevent domain

The senior administrative veterinary officer scored higher than the block-level officials in AMR awareness and policies. Unlike senior officers, none of the block-level officials knew of collaborations with academic institutions to formulate awareness tools for farming communities, and 8 (89%) reported no outreach sessions for safe antibiotic use. In addition, only 5 (56%) block-level officials knew about AMR action plans, and 2 (22%) were more aware of guidelines for antibiotic residues in animal food products than their senior counterparts (Figure-1).

Detect domain

There was coordination and communication between the two cadres regarding the timely reporting of outbreaks and the referral of cases to higher facilities. The senior administrative officer outperformed the block-level officials in laboratory-related technical areas. The average duration between the transfer of animal samples to laboratories and report dissemination was 48 h or more, as reported by administrative officials. Both officials had a lower score in the surveillance domain due to their lack of knowledge about online databases or surveillance systems for AMR pathogens (Figure-2).

Response domain

Medical countermeasures and infection control measures were good at the district level. The senior administrative veterinary officer was involved in promoting collaboration between the human and veterinary departments regarding AMR. Administration at the district level had less receptivity to changing AMR scenarios, particularly in conducting prescription audits and inspecting feed-producing factories for antibiotics in the feed (Figure-3).

Comparison between administrative officials and veterinary doctors regarding the measures taken to reduce AMR

Administrative officials at the district level had higher scores in technical areas, such as knowledge regarding action plans related to AMR and training regarding AMR and antibiotic usage, than veterinary doctors who were responsible for the implementation of measures related to AMR at the field level. Administrative officials adhered more strongly to IPC

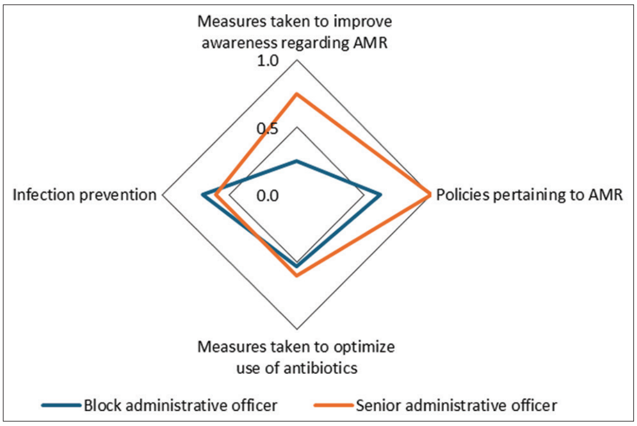

Figure-1: Comparison of measures undertaken by senior and block-level administrative veterinary officials to prevent antimicrobial resistance.

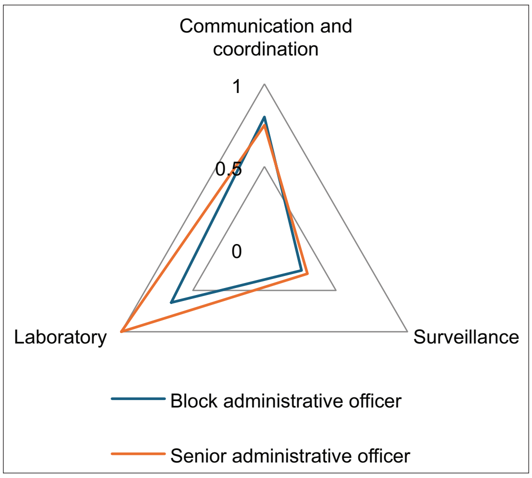

Figure-2: Comparison of measures undertaken by senior and block-level administrative veterinary officials regarding antimicrobial resistance detection.

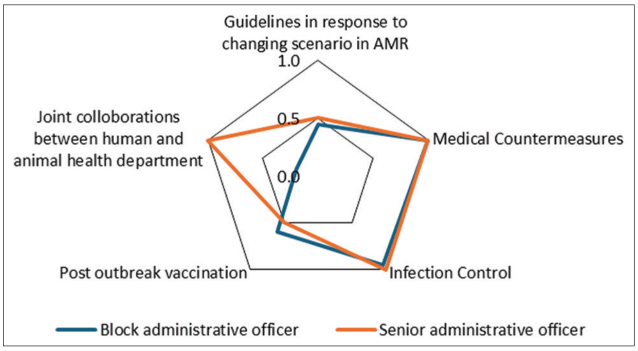

Figure-3: Comparison of measures undertaken by senior and block-level administrative veterinary officials regarding antimicrobial resistance response.

guidelines than veterinary doctors. On the other hand, veterinary doctors were more aware of antibiotic susceptibility testing (AST) facilities. The district officials' knowledge related to prescription audits was low (Figure-4).

Assessment of IPC practices in veterinary facilities

Biomedical waste management and general IPC practice domains demonstrated the highest adherence

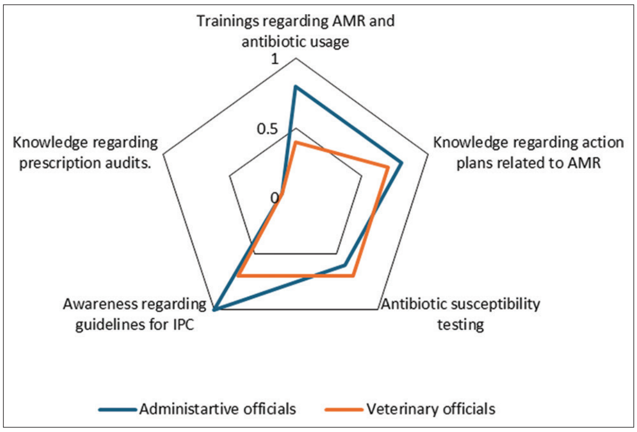

Figure-4: Comparison between administrative officials and veterinary doctors regarding the measures taken against antimicrobial resistance in the study district.

Table-3: Demographic characteristics of the para veterinarians.

Variable	Frequency (n = 44)	Percentage
Gender		
Male	43	98
Female	1	2
Designation		
Livestock Development Officer,	5	12
Livestock Officer	7	16
Senior Veterinary Inspector	16	36
Junior Veterinary Inspector	16	36
Highest qualification		
High School/Secondary Education	4	9
Pre-University Course/ Senior Secondary education	10	23
Diploma	21	48
Graduation	8	18
Post graduation	1	2
Work experience		
0–6 years	5	12
7–12 years	2	4
13–18 years	3	7
19–24 years	9	20
25–30 years	14	32
31–36 years	7	16
37–42 years	4	9
Workstation		
Veterinary hospital	19	43
Veterinary dispensary	9	20
Primary veterinary center	13	30
Others	3	7

percentage, i.e., 78% and 74%, respectively. There was less adherence to professional garments by veterinary doctors and para-veterinarians while providing services in 7 (78%) veterinary facilities. Hence, this domain exhibits a low percentage of 37%. None of the veterinary facilities had a provision for animal isolation in case of infectious disease outbreaks (Figure-5).

Manpower in veterinary facilities

In block-level veterinary facilities, 8 (73%) in-charge veterinary doctors and 2 (18%) veterinary

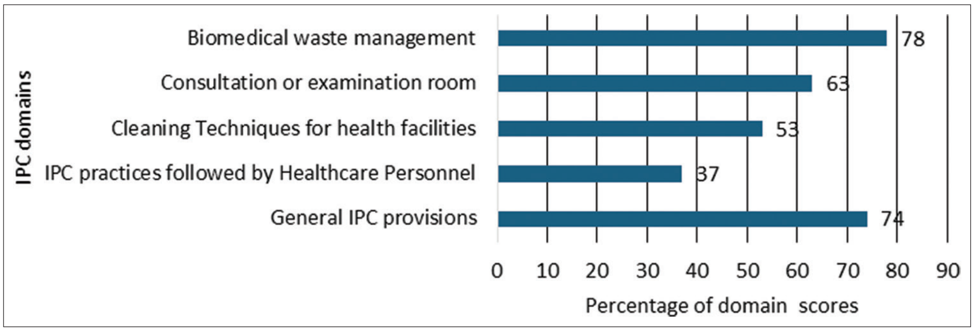

Figure-5: Percentage of domain scores according to infection prevention and control practices in veterinary facilities.

doctors for veterinary service provision posts were filled against the required 11 posts. Of the 26 para veterinarian posts, only 9 (35%) were appointed. Only 2 (18%) of the 11 animal attendant posts were filled. No Group D staff were recruited, and their services were outsourced.

Assessment of KAP among veterinary doctors

In the study, 20 (74%) participants opposed using antibiotics to stimulate growth. All acknowledged that misuse of antimicrobials can lead to resistance and were aware of AMR. Thirteen (48%) participants were aware of action plans to combat AMR, and 18(67%) were aware of regional laboratory facilities for AST. The mean knowledge score was 14.1 ± 1.83, with 18 (67%) participants demonstrating adequate knowledge regarding antimicrobial use and AMR.

All participants agreed that thorough animal examinations and weight estimations were necessary before antibiotic administration. Significantly, 26 (96%) veterinary doctors agreed that they play a key role in proper antibiotic use. It was noted that 20 (74%) veterinary doctors disagreed with banning medically important antibiotics for animals. The mean attitude score was 12.9 ± 1.97, with 16 (59%) demonstrating a positive attitude toward proper antimicrobial use and AMR prevention.

Of 27 veterinary doctors, 12 (44%) prescribed antibiotics for 5 days. 14 (52%) made such prescriptions based on drug availability in veterinary facilities. Alternative medicine use was reported by 19 (70%) veterinary doctors. Penicillin derivatives and fluoroquinolones were commonly used by 6 (27%) veterinary doctors (Figure-6). Only 9 (33%) veterinary doctors were aware of antibiotic stewardship and understood its principles. The mean practice score was 4.44 ± 0.75, with 12 (44%) adhering to good prescription practices (Tables-4 and 5).

Prioritization of AMR reduction strategies by veterinary doctors

All participants were asked to prioritize 7 strategies listed for reducing AMR in ascending order, i.e., the smaller the number assigned, the higher the priority. The 7 strategies were further divided into prevent, detect, and respond domains for analysis. The mode of the priority assigned by the participants was calculated for each solution. The veterinary doctors

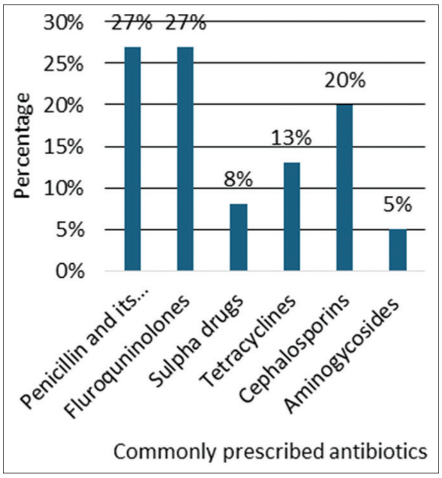

Figure-6: Commonly prescribed antibiotics by veterinary doctors during routine practice.

assigned higher priority to solutions with a preventive aspect. Of 27veterinary doctors, 13 (48%) supported an increased focus on extension services, vaccination, deworming, and nutritional improvements to reduce infectious diseases and, consequently, antibiotic use (Table-6).

Assessment of the KAP of para veterinarians

All participants agreed on the prescription of antibiotics with the correct dosage and duration. All participants sought advice from a veterinary doctor before prescribing antibiotics. 22 (50%) of them were aware of the term AMR, 12 (55%) of 22 para veterinarians had attended antibiotic usage and AMR training, and 14 (66%) of them mistakenly believed that new antibiotics were always being discovered and available.

Regarding attitude, all para veterinarians agreed that thorough animal examination and accurate weight-based dosing were essential before prescribing antibiotics. They also emphasized the importance of following appropriate withdrawal periods to reduce antibiotic residues in animal products.

Of the 44 para veterinarians, 42 prescribe antibiotics in their routine practice. Among the participants, 28 (64%) agreed that antibiotics were prescribed based on their availability in veterinary facilities. Alternative medicine use was reported by 39 (89%) para veterinarians (Table-7).

Table-4: Responses of the veterinary doctors to knowledge, attitudes, and practices regarding antibiotic use and AMR.

No.	Question	Response	Frequency (n = 27)	Percentage
		Knowledge		
1	Antibiotics are used to treat	Bacterial*	16	59
		Bacterial, viral	2	8
		Bacterial, viral, fungal, and parasitic	9	33
2	Antibiotics should be prescribed at the appropriate dosage and duration for all animal species.	Agree*	27	100
3	Antibiotics should be discontinued once the animals stop showing symptoms of infection.	Agree	5	19
		Disagree*	22	81
4	Administering antibiotics to healthy animals can prevent future illness	Disagree*	27	100
5	Antibiotics can be used in animals to promote growth	Agree	7	26
		Disagree*	20	74
6	If one animal in a herd falls sick, other animals in the herd must be given antibiotics to prevent the spread of the disease.	Agree	5	19
		Disagree*	22	81
7	If antibiotics are misused, bacteria will evolve resistance to them.	Agree*	27	100
8	Animals infected with resistant pathogens are difficult to treat	Agree*	25	92
		Disagree	1	4
		Don't know	1	4
9	A resistant pathogen can spread among animals and humans.	Agree*	27	100
10	Awareness of the term AMR	Yes*	27	100
11	AMR is a global issue	Agree*	27	100
12	AMR may be associated with irrational use of antibiotics in the animal sector	Agree*	26	96
		Disagree	1	4
13	Information regarding attending training or workshops on antibiotic use and AMR from the department within the last 5 years	Yes*	15	56
		No	12	44
14	Awareness of existing action plans developed to combat AMR	Yes*	13	48
		No	14	52
15	Awareness of the guidelines described by the Department of IPC in veterinary facilities	Yes*	21	78
		No	6	22
16	Awareness of laboratory facilities for AST	Yes*	18	67
		No	9	33%
17	Awareness regarding any system for monitoring antibiotic sales (prescription audits)	Yes*	3	11
		No	24	89
		Attitude		
1	Antibiotic resistance is not an issue because new antibiotics are always discovered and are available in the market.	Agree	1	4
		Disagree*	26	96
2	Antimicrobials are safe drugs that can be commonly prescribed.	Agree	8	30
		Disagree*	19	70
3	Veterinarians play a major role to play in ensuring proper antibiotic use.	Agree*	26	96
		Disagree	1	4
4	Thorough examination of animals is required before prescribing or administering antibiotics.	Agree*	27	100
5	An antibiotic susceptibility test is required before the administration of antibiotics	Agree*	22	81
		Disagree	5	19
6	Broad-spectrum antibiotics are the correct choice for any bacterial infection	Agree	10	37
		Disagree*	17	63
7	Prescribe antibiotics for prophylactic/ metaphylactic treatment of animals in herds or flocks	Agree	8	30
		Disagree*	19	70
8	Prescribe antibiotics for any infectious case	Agree	18	67
		Disagree*	9	33

(Contd...)

Table-4: *(Continued).*

No.	Question	Response	Frequency (n = 27)	Percentage
		Attitude		
9	Following an appropriate withdrawal period is crucial for reducing the presence of antibiotic residues in animal products.	Agree*	25	92
		Disagree	2	8
10	Use of medically important antibiotics (to humans) in animals should be prohibited	Agree*	7	26
		Disagree	20	74
11	Antibiotics must be changed when therapeutic failure is perceived following the use of an antibiotic	Agree	23	85
		Disagree*	4	15
12	Consider whether an infection heals on its own before prescribing antibiotics.	Agree*	23	85
		Disagree	3	11
		Don't know	1	4
13	Administer antibiotics to animals after determining body weight properly instead of the recommended dosage.	Agree*	26	96
		Don't know	1	4
14	Farmers blame veterinarians if antibiotics are not prescribed even when it is not necessary	Agree	13	48
		Disagree*	13	48
		Don't know	1	4
15	Farmers use already prescribed antibiotics when the disease recurs	Agree	22	81
		Disagree*	3	11
		Don't know	2	8
16	Quacks or local chemists' veterinary practices contribute to antibiotic resistance	Agree*	27	100
17	Practicing good farm hygiene can help reduce the incidence of infectious diseases, which in turn can reduce the use of antibiotics.	Agree*	27	100
18	More focus on extension services, that is, vaccination, deworming, and measures to improve the nutrition of animals can help reduce the incidence of infectious diseases, which in turn can reduce the use of antibiotics.	Agree*	27	100
		Practice		
1	Antibiotics are prescribed based on their availability.	Agree	14	52
		Disagree*	13	48
2	Use of any guidelines, manuals, or textbooks for prescribing antibiotics	Yes*	26	96
		No	1	4
3	Factors influencing antibiotic administration decisions	Previous experiences*	13	48
		Previous experiences+on consultation with peers*	14	52
		At the farmer's request	0	-
4	Issue of antibiotic drug expiry at the veterinary facility	Yes	10	37
		No*	17	63
5	Disposal of expired drugs	Returned to the manufacturing company*	4	15
		Given to the biomedical waste management team	23	85
		Disposed of general waste	0	-
		Disposed to sewage and canals.	0	-
		The landfill method	0	-
6	Awareness of the term antibiotic stewardship	Yes*	9	33
		No	18	67

*Correct answer, *Positive attitude, *Good practice , AMR=Antimicrobial resistance, AST=Antibiotic susceptibility testing

Table-5: Classification of the veterinary doctors according to knowledge, attitude, and practice scores.

Domain	Score range	Categorization	Frequency	Percentage
Knowledge	14–17	Adequate	18	67
	10–13	Poor	9	33
Attitude	13–16	Positive	16	59
	9–12	Negative	11	41
Practice	5–6	Good	12	44
	3–4	Poor	15	56

Table-6: Categorization of preventive, detection, and response strategies among the veterinary doctors.

Domain	Mode of priority assigned to the solution	Frequency	Percentage
Prevent			
More rigorous extension services, including vaccination, deworming, and improved nutrition, to prevent the occurrence of diseases and outbreaks	1st priority	13	48
Improving IPC practices in farms and veterinary facilities	2nd priority	8	30
Educating health professionals and the general community about the concepts of AMR	3rd priority	9	33
Improving and rationalizing antibiotic use in the animal sector	4th priority	6	22
Detect			
Improvement in laboratory capacity for the identification of resistant bacteria	1st priority	5	19
Implementation of systems to monitor AMR and usage	6th priority	8	27
Response			
Sustainable investment in research and development of new drugs and vaccines	7th priority	13	48

AMR=Antimicrobial resistance, IPC=Infection prevention and control

Discussion

This is the first study conducted in South India to evaluate the preparedness of veterinary department to tackle the problem of AMR.

This study revealed significant differences in AMR-related technical knowledge and practices between senior and block-level administrative veterinary officers. This indicates a gap in the administrative communication and coordination to combat AMR. The NAP-AMR, 2017 emphasizes developing tools for farmers to be aware of antibiotic use and biosafety [11]. However, none of the block-level officials reported collaborations with academic institutions for such tools, and 8 (89%) claimed no outreach sessions were conducted, unlike the Senior Officer. Awareness of the action plan was noted in 13 (48%) veterinary doctors and 6 (60%) administrators, whereas a study in Assam highlighted that only 2% of veterinary doctors were aware of a national AMR plan [16].

NAP-AMR highlighted the need to improve laboratory capacities for AST [11]. However, 4 (44%) block-level officers were unaware of the AST capabilities, leading to lower scores than senior officers. In addition, 6 (60%) administrative officials reported a delay in disseminating laboratory results, contrary to the 12-h standard set by the Veterinary Council of India [17]. Twenty two (81%) veterinary doctors agreed on the necessity of antibiotic susceptibility tests before administering antibiotics, yet only 18 (67%) veterinary doctors knew about regional laboratory facilities for such testing, indicating a communication gap regarding available resources. This gap could hinder the effective adoption of AST practices.

The relevance of the One Health approach in AMR management, involving the human, animal, and environmental sectors, was recognized by the senior officers and only by 2 (22%) block level officials. One health approach to address the public health problem of AMR has yet to gain momentum in the district.

When implementing the measures related to combating AMR in the district, the study highlighted the disparities in attendance at training between administrative and veterinary officials in the department. As the veterinary doctors were directly involved in animal healthcare, they were aware of AST, whereas administrative officials were more aware of the IPC regulations.

In the district, there was a lacuna in human resources in the veterinary department, which in turn deprived of opportunities for veterinary doctors in the district. This also paved the way for antibiotic prescription by para veterinarians under the indirect supervision of veterinary doctors and made livestock owners rely on old prescriptions and quacks for the usage of antibiotics. This finding is in concordance with a review study conducted by Mutua *et al*. [18].

Table-7: Responses of para veterinarians to knowledge, attitudes, and practices regarding antibiotic use.

No.	Question	Response	Frequency (n = 44)	Percentage
	Knowledge			
1	Antibiotics should be prescribed at the appropriate dosage and duration for all animal species.	Agree	44	100
2	Antibiotics should be discontinued once the animals stop showing symptoms of infection.	Agree	29	66
		Disagree	15	34
3	Administering antibiotics to healthy animals can prevent future illness	Agree	19	43
		Disagree	25	57
4	Antibiotics can be used in animals to promote growth	Agree	18	41
		Disagree	24	55
		Don't know	2	4
5	If one animal in a herd falls sick, other animals in the herd must be administered antibiotics to prevent the spread of the disease.	Agree	19	43
		Disagree	25	57
6	If antibiotics are misused, bacteria will evolve resistance to them.	Agree	29	66
		Disagree	9	20
		Don't know	6	14
7	Animals infected with resistant pathogens are difficult to treat	Agree	32	73
		Disagree	3	7
		Don't know	9	20
8	A resistant pathogen can spread among animals and humans.	Agree	41	93
		Disagree	3	7
9	Awareness of the guidelines described by the Department of IPC in health facilities	Yes	42	96
		No	2	4
10	Awareness of any system for monitoring antibiotic sales (prescription audits)	Yes	2	4
		No	42	96
11	Awareness of the term "Antimicrobial Resistance"	Yes	22	50
		No	22	50
	Attitude			
1	Antimicrobials are safe drugs that can be commonly prescribed.	Agree	39	89
		Disagree	5	11
2	Thorough examination of animals is required before prescribing or administering antibiotics.	Agree	44	100
3	Prescribe antibiotics for any infectious case	Agree	37	84
		Disagree	7	16
4	Following an appropriate withdrawal period is crucial for reducing the presence of antibiotic residues in animal products.	Agree	44	100
5	Use of medically important antibiotics (to humans) in animals should be prohibited	Agree	25	57
		Disagree	19	43
6	Consider whether an infection heals on its own before prescribing antibiotics.	Agree	26	59
		Disagree	18	41
7	Administer antibiotics to animals after determining body weight properly instead of the recommended dosage.	Agree	44	100
8	Farmers blame para veterinarians if antibiotics are not prescribed even when it is not necessary	Agree	21	48
		Disagree	23	52
9	Farmers use already prescribed antibiotics when the disease recurs	Agree	33	75
		Disagree	9	20
		Don't know	2	5
10	Practicing good farm hygiene can help reduce the incidence of infectious diseases, which in turn can reduce the use of antibiotics.	Agree	39	89
		Disagree	5	11
11	More focus on extension services, that is, vaccination, deworming, and measures to improve the nutrition of animals can help reduce the incidence of infectious diseases, which in turn can reduce the use of antibiotics.	Agree	44	100
	Practice			
1	Antibiotics are prescribed for how many days?	3 days	16	38
		5 days	10	24
		7 days	3	7
		Until symptoms subside	13	31
2	Antibiotics are prescribed based on their availability.	Agree	28	64
		Disagree	14	36
3	Use of guidelines, manuals, or textbooks for prescribing antibiotics?	Yes	41	98
		No	1	2

(Contd...)

Table-7: *(Continued).*

		Practice		
4	Seeking expert (veterinarian/specialist) advice before prescribing antibiotics	Yes	42	100

IPC=Infection prevention and control

It was found that only 22 (50%) para veterinarians included in the study were aware of AMR.

In the current study, most of the veterinary doctors believe that AMR is linked to irrational antibiotic use in animals. Nigerian study found that 81% of the participants recognized AMR risk from non-therapeutic antimicrobial usage [19]. Moreover, 9 (33%) veterinary doctors reported using antibiotics for bacterial, viral, fungal, and parasitic infections, which is often justified for treating secondary bacterial infections in animals with primary viral infections [20].

Consistent with NAP-AMR's proposal to regulate non-therapeutic antimicrobial usage [11], 20 (74%) veterinary doctors disagreed with the use of antibiotics for growth enhancement in animals. The study found that 18 (67%) veterinary doctors had adequate knowledge regarding antimicrobial usage and AMR, whereas a study in Bhutan reported that only 39% of participants had adequate knowledge [21]. NAP-AMR recommended restricting the use of critically important antibiotics for humans in food-producing animals [11]. However, most veterinary doctors in the study disagreed, citing the importance of safeguarding animal health and the impracticality of such restrictions.

The Kerala AMR Strategic Action Plan promotes the use of antibiotic alternatives, such as herbal drugs [9]. The study found that 19 (70%) veterinary doctors and 39 (89%) para veterinarians used Ayurveda, Homeopathy, and traditional medicine systems to treat or prevent diseases. Most agreed that these alternatives have reduced antibiotic use for specific health conditions.

The study observed that most veterinary doctors prescribed antibiotics for 5 days, similar to the findings in Bhutan. However, the Bhutan study revealed insufficient evidence to determine the optimal length of antibiotic prescriptions [21]. The duration of treatment depends on factors such as the patient's immune status, antibiotic mechanism of action, and type of microorganisms involved [22]. Most veterinary doctors in the study routinely used Penicillin and its derivatives and fluoroquinolones, which is consistent with a study in Kenya [23].

Antimicrobial stewardship (ABS) programs effectively reduce antimicrobial use while maintaining veterinary productivity [24]. Only 9 (33%) veterinary doctors knew about antibiotic stewardship, which is comparable to a study in Nigeria where 17.1% of the participants were aware of the same [25]. All participants who knew about ABS believed that its implementation in the veterinary sector could reduce AMR risk, highlighting the need for ABS programs in the veterinary sector.

Veterinary doctors believe that they play a crucial role in proper antibiotic use and AMR prevention. They emphasized the importance of preventive strategies, including more extension of veterinary services (vaccination, deworming, and improved animal nutrition) and better farm hygiene practices, and believed that implementation of these measures should be carried out on a priority basis.

Conclusion

The study discovered that the veterinary department's preparedness to address the AMR problem was considerably good in the response domain, specifically infection control and the supply of medical countermeasures. However, more emphasis needs to be placed on implementing preventive measures, actions that ensure early detection of resistant pathogens, and surveillance systems. Tackling the issue of AMR in veterinary departments is imperative to maintaining progress toward the SDGs.

Authors' Contributions

SUK and NV: Conceived the idea and designed the study. SUK: Data collection and analysis. SUK and NV: Data analysis and drafted the manuscript. Both authors have read and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

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References

1. Nicolaou, K. and Rigol, S. (2018) A brief history of antibiotics and select advances in their synthesis. *J. Antibiot. (Tokyo)*, 71(2): 153–184.
2. O'Neill J. (2016) Tackling Drug-resistant Infections Globally: Final Report and Recommendations. Review on Antimicrobial Resistance. HM Government and Wellcome

Trust, London.
3. World Health Organization. (2020) Antimicrobial Resistance. World Health Organization, Geneva. Available from: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance. Retrieved on 28-05-2024.
4. FAO. (2024) Surveillance data of the Indian Network for Fishery and Animal Antimicrobial Resistance (INFAAR): An Analytical Report 2019–2022. New Delhi.
5. Yin, J., Wang, Y., Xu, X., Liu, Y., Yao, L. and Sun, Q. (2021) The progress of global antimicrobial resistance governance and its implication to China: A review. *Antibiotics* (*Basel*), 10(11): 1356.
6. World Economic Forum. (2020) How to Stop Drug-resistant Superbugs from Causing Next Pandemic. World Economic Forum, Cologny.
7. Ahmad, M. and Khan, A.U. (2019) Global economic impact of antibiotic resistance: A review. *J. Glob. Antimicrob. Resist*., 19: 313–316.
8. Gajdács, M., Urbán, E., Stájer, A. and Baráth, Z. (2021) Antimicrobial resistance in the context of the sustainable development goals: A brief review. *Eur. J. Investig. Health Psychol. Educ.*, 11(1): 71–82.
9. Kerala Antimicrobial Resistance Strategic Action Plan. (2018) Government of Kerala. Available from https://leap.unep.org/en/countries/in/national-legislation/kerala-antimicrobial-resistance-strategic-action-plan-karsap#:~:-text=This%20Strategic%20Action%20Plan%20aims%20at%20involving%20Kerala,order%20to%20to%20reduce%20antimicrobial%20residues%20in%20environment. Retrieved on: 28-05-2024.
10. Walia, K., Sharma, M., Vijay, S. and Shome, B.R. (2019) Understanding policy dilemmas around antibiotic use in food animals and offering potential solutions. *Indian J. Med. Res.*, 149(2): 107–118.
11. World Health Organization. (2017) Library of National Action Plans on Antimicrobial Resistance. World Health Organization, Switzerland.
12. McEwen, S.A. and Collins, P.J. (2018) Antimicrobial resistance: A one health perspective. *Microbiol. Spectr.*, 6: 2.
13. World Health Organization. (2016) Global Action Plan on Antimicrobial Resistance. World Health Organization, Geneva, Switzerland.
14. World Health Organization. (2023) AWaRe Classification of Antibiotics for Evaluation and Monitoring of Use. World Health Organization, Geneva.
15. Patel, S.J., Wellington, M., Shah, R.M. and Ferreira, M.J. (2020) Antibiotic stewardship in food-producing animals: Challenges, progress, and opportunities. *Clin. Ther.*, 42(9): 1649–1658.
16. Eltholth, M., Govindaraj, G., Das, B., Shanabhoga, M.B., Swamy, H.M., Thomas, A., Cole, J., Shome, B.R., Holmes, M.A. and Moran, D. (2022) Factors influencing antibiotic prescribing behavior and understanding antibiotic resistance among veterinarians in Assam, India. *Front. Vet. Sci*., 26(9): 864813.
17. Veterinary Council of India. (2016) Minimum Standards of Veterinary Practice Regulations. Report No.: VCI-Draft-MSVPR2016-Dt.08.07.16. Veterinary Council of India, New Delhi. Available from: https://www.pashudhanpraharee.com/wp-content/uploads/2021/03/VCI-Draft-copy-of-MSVPR2016-Dt.08.07.16_1.pdf. Retrieved on: 28-05-2024.
18. Mutua, F., Sharma, G., Grace, D., Bandyopadhyay, S., Shome, B. and Lindahl, J. (2020) A review of animal health and drug use practices in India, and their possible link to antimicrobial resistance. *Antimicrob. Resist. Infect. Control*, 9(1): 103.
19. Aworh, M.K., Kwaga, J.K.P. and Okolocha, E.C. (2021) Assessing knowledge, attitude, and practices of veterinarians toward antimicrobial use and stewardship as drivers of inappropriate use in Abuja, Nigeria. *One Health Outlook*, 3(1): 25.
20. Egorov, A. (2018) The problem of bacterial complications post respiratory viral infections. *Microbiol. Indep. Res. J*., 5(1): 12–21.
21. Wangmo, K., Dorji, T., Pokhrel, N., Dorji, T., Dorji, J. and Tenzin, T. (2021) Knowledge, attitude, and practice on antibiotic use and antibiotic resistance among the veterinarians and para-veterinarians in Bhutan. *PLoS One*, 16(5): e0251327.
22. Wilson, H.L., Daveson, K. and Del Mar, C.B. (2019) Optimal antimicrobial duration for common bacterial infections. *Aust. Prescr*., 42(1): 5–9.
23. Mukokinya, M.A., Opanga, S., Oluka, M. and Godman, B. (2018) Dispensing of antimicrobials in Kenya: A cross-sectional pilot study and its implications. *J. Res. Pharm. Pract.*, 7(2): 77–82.
24. Harbarth, S., Balkhy, H.H., Goossens, H., Jarlier, V., Kluytmans, J., Laxminarayan, R., Saam, M., Van, B.A. and Pittet, D. (2015) Antimicrobial resistance: One world, one fight! *Antimicrob. Resist. Infect. Control*, 4: 49.
25. Anyanwu, M.U. and Kolade, O.A. (2017) Veterinarians' perception, knowledge and practices of antibiotic stewardship in Enugu State Southeast, Nigeria. *Not. Sci. Biol.*, 9(3): 321–331.

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