

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 4; April 2024; Page No. 609-615

Received: 17-01-2024
Accepted: 28-02-2024

Indexed Journal
Peer Reviewed Journal

Factors influencing antimicrobial prescribing behavior of veterinarians and its impact on their perception about antimicrobial use and resistance

¹G Vijayakumar, ²P Reeja George and ³N Vimal Rajkumar

¹Assistant Professor, Mecheri Sheep Research Station (MSRS), TANUVAS, Pottaneri, Salem District, Tamil Nadu, India

²Professor, Department of Veterinary and Animal Husbandry Extension, CoVAS, Mannuthy, KVASU, Thrissur, Kerala, India

³Associate Professor and Head, Farmers Training Centre (FTC), TANUVAS, Theni District, Tamil Nadu, India

DOI: <https://doi.org/10.33545/26180723.2024.v7.i4h.579>

Corresponding Author: G Vijayakumar

Abstract

Determining significant factors that influencing veterinarian's antimicrobial prescribing behavior can help to bridge the gap between prescribing recommendations and clinical utilization. Guidelines on prudent antimicrobial use in veterinary medicine have been developed to reduce inappropriate prescribing of antimicrobials which are primarily concerned with clinical and pharmacological indications for prescribing. A questionnaire study was conducted to evaluate the factors influencing veterinarian's antimicrobial prescribing decisions in large animal practice, as well as to assess whether non-clinical and non-pharmacological factors influence antimicrobial prescribing choice. The study findings demonstrated that clinical considerations influenced veterinarian's antimicrobial prescribing decisions more than non-clinical reasons. Clinical signs/symptoms as well as the critical nature of the illness were the most often used clinical considerations in determining whether to prescribe an antimicrobial or not. Pharmacological considerations have a greater influence on antimicrobial prescribing than non-pharmacological factors. The most significant pharmacological factors were the antimicrobial's spectrum of activity, the duration of therapy and the route as well as frequency of administration. Regression analysis between factors influencing prescribing behavior and veterinarian's perception revealed that clinical, pharmacological and non-clinical factors had a significant impact on explaining variations in veterinarian's perception of antimicrobial use and resistance.

Keywords: Veterinarians - factors influencing antimicrobial prescribing behavior- effect on their perception

Introduction

Antimicrobial resistance (AMR) is becoming more of a problem in both human and veterinary medicine. Antibiotic use in human and veterinary medicine particularly misuse has been linked to the selection and dissemination of antibiotic resistance strains in humans and animals. Monitoring antibiotic use and antibiotic resistance levels is critical for evaluating efforts to reduce selective pressure and the selection of resistant strains in animal health. The global desire to limit antibiotic use and hence selective pressures on microbes is pushing study into the factors influencing health professional's antimicrobial prescribing behaviors (Zhuo *et al.* 2018) [21].

A number of factors influence veterinary prescribing behavior. Surveys of veterinary prescribing in Europe identified that antimicrobial susceptibility testing results were the primary driver of veterinarian's prescribing behavior followed by their own experience. The perceived risk of antibiotic resistance development and the ease of administering the drug were also important factors influencing veterinarian's antibiotic selection decisions (De Briyne *et al.* 2013) [3]. Non-clinical factors influencing veterinary prescribing include farmer's demands and expectations, the veterinarian's experience and drug cost (Gibbons *et al.* 2013) [6]. According to a Dutch study,

veterinarians face several competing interests when prescribing antimicrobials including an obligation to alleviate animal suffering, financial reliance on clients, risk avoidance, public health concerns and personal convictions (Speksnijder *et al.* 2015) [17].

According to their significance for human medicine, antimicrobials have been categorized by the World Health Organization (WHO) and it is advised that some antimicrobial classes only be used in certain circumstances. A number of classes of antimicrobials that are registered for veterinary use including the third and fourth generation cephalosporins, fluoroquinolones and macrolides have been categorised as critically important antimicrobials (WHO, 2019) [20]. However, investigations carried out in Europe have shown that these antibiotics are frequently used by veterinarians to treat mastitis and respiratory conditions (De Briyne *et al.* 2014) [14]. Numerous strategies, recommendations and treatment guidelines on responsible use of antibiotics have been developed by a variety of national, European and international bodies (OIE, 2012) [12]. Prescribing guidelines to reduce the risk of emergence of AMR have been developed by most of the countries including India. These guidelines emphasise good stewardship of prescribing as a means to reduce the development of resistance. The aim of these strategies is to

encourage veterinarians to prescribe responsibly and prudently as well as to reduce antibiotic use. For any such strategy to be effective it is necessary to understand the factors influencing antibiotic prescribing behavior of veterinarians and the association between these factors with the perception of veterinarians regarding antimicrobial use and resistance. There were lack of data on the factors influencing antibiotic prescribing behavior of veterinarians across India, specifically in Kerala. In order to fill these evidence gaps, a study was conducted among the veterinarians engaged in large animal practice of Kerala state.

Materials and Methods

The questionnaire based cross-sectional analysis for the descriptive study was planned to be conducted among veterinarians of Kerala. The survey questionnaire was developed to explore the factors influencing veterinarian’s antimicrobial prescribing behavior as well as to provide insight into antimicrobial use and resistance perceptions. The perceptions of veterinarians regarding antibiotic use and resistance were examined using a "likert - scale" developed specifically for the study using the summated rating approach (Likert, 1932) [8].

Table 1: Likert- scale to measure the perception of veterinarians about antimicrobial use and resistance

Sl. No.	Statements	SA	A	UD	DA	SDA
1	At first instance, I avoid the use of antibiotics in treatment of animals.					
2	Many a time, I too overprescribe antimicrobials during my clinical practice. *					
3	Training programmes on the use of antimicrobials must be organized for vets to reduce their use.					
4	Broad spectrum antibiotics are a better choice for most bacterial infections. *					
5	The veterinarians must try other methods of treatment before prescribing antimicrobials.					
6	One need not wait for culture tests before treating a case with antimicrobials. *					
7	A higher frequency of use of antibiotics will decrease the efficacy of a drug					
8	The past experience of a veterinarian is more important in antimicrobial prescription when compared to lab tests. *					
9	In recent years, I have become more aware of the impacts of antimicrobial resistance.					
10	I think that the longer the duration of antimicrobial use, the better will be the response. *					
11	I am more concerned about antibiotic resistance in society when I prescribe antibiotics.					
12	I prefer to resort to cultural tests only after getting a poor response to an initial antibiotic therapy. *					
13	It is necessary to create more awareness about antimicrobial resistance.					
14	Antibiotics can be routinely used in large animal practice as they are safe drugs. *					

SA- Strongly Agree, A- Agree, UD – Undecided, DA- Disagree, SDA- Strongly Disagree *Negative statements

The factors influencing prescribing behavior was studied in two categories in the present study. The first was that variables affecting a veterinarian's choice to prescribe or administer an antibiotic to an animal or not, which was operationally defined as those factors influencing a veterinarian's decision to prescribe or administer an antibiotic to an animal or not in large animal practice. The relevant factors that were likely to influence veterinarian’s decisions on whether to prescribe an antibiotic to an animal or not were chosen based on an extensive literature review, the themes emerging from focus group discussions among veterinarians in large animal practice working in the Animal Husbandry Department, Kerala and consultation with experts as well as field practitioners. A total of 15 factors, four clinical and eleven non-clinical, were identified and included in the final questionnaire. Respondents were then asked to rate each factor's potential influence on their choice to prescribe or not an antimicrobial on a three-point scale: strong influence, moderate influence and no influence. Based on the responses, the factors with the greatest influence and those with the least influence have been identified and rated and interpretations were made.

The second category was that the factors influencing a veterinarian's decision to prescribe an antibiotic choice were operationally defined as those factors that influenced the veterinarian's decision to prescribe a specific antibiotic for use in large animal practice. The key factors that were likely to affect a veterinarian's decision to choose a specific antibiotic to be administered to a large animal were chosen based on a comprehensive literature review, focus group discussions and consultation with specialists as well as field veterinarians. A total of 14 criteria were identified and

incorporated into the final questionnaire. Respondents were then asked to rate the influence of each factor on their choice of an antibiotic on a three-point scale: strong influence, moderate influence and no influence. Based on the responses, the most and least influential factors were identified, ranked and interpreted.

The survey questionnaire containing google forms were sent to the list of veterinarians working in the Animal Husbandry Department in all the fourteen districts of Kerala state through mail and whatsapp messenger and were requested to complete the survey.

Sampling procedure

The current study's source population included veterinarians working in Animal Husbandry Department, Kerala and the study population included veterinarians who fulfilled the inclusion criteria of being field veterinarians. i.e., those veterinarians working in Veterinary Dispensaries (VD), Veterinary Hospitals (VH), Veterinary Polyclinics (VPC) and District Veterinary Centres (DVC) of the Animal Husbandry Department, Kerala. The questionnaire was sent with the request that it be completed only by veterinarians who were engaged in clinical large animal practice.

The sample size was calculated using the ‘Raosoft calculator’ (Raosoft: <http://www.raosoft.com/samplesize.html?nosurvey>). The sample size of 336 was estimated based on 50% response distribution, a 5% margin of error and a 95% confidence interval. The expected response proportion of 50% was assumed based on the fact that both responses and response rates were completely unknown, since there are no previously published similar studies from Kerala. Thereby, a

total of 1580 questionnaires were sent to the veterinarians selected through registered emails and/or personal contacts from Indian Veterinary Association (IVA) mailing list, 2021. The questionnaire was administrated by using the online interface of Google Forms (Google LLC, Mountain View, CA, USA) to the target population and the survey remained open from April to June 2022.

Results

Factors influencing the decision on whether to prescribe an antimicrobial or not

Results indicated that clinical factors (mean of mean scores - 2.67) were more influential in affecting the decision of veterinarians to prescribe or not when compared to nonclinical factor (mean of mean scores - 2.1). Among clinical factors, a decision to prescribe an antimicrobial was most often taken based on clinical signs or symptoms (2.95) and the critical nature of illness (2.88). The decision to prescribe an antimicrobial was also influenced to a lesser extent by consideration of the risk of promoting antimicrobial resistance in the animal (2.48). It was notable that the results of cultural and sensitivity tests (2.38) was the

factor that had the least influence on the decision of the respondents to prescribe an antimicrobial.

The non-clinical factors that influenced the respondent’s decision to prescribe an antimicrobial was their prior experience in managing similar problems (2.76) which of course would have contributed to a personal confidence in their diagnosis (2.69). Demand of the farmer for immediate relief (2.26), the lack of enough time to consider another option (2.09) and the care that the respondent took to avoid a mistake in diagnosis (2.08) were the other nonclinical factors that influenced respondent decision.

Other non-clinical factors that exerted lesser influence on the respondent decision to prescribe a antimicrobial included not being confident about the diagnosis (2.06), situations in which the farmer had already initiated administering an antimicrobial (2.05), longstanding acquaintance with the farmer (2.00), guideline recommendations (1.81), perception that if the condition of the animal did not improve, the respondent would be called again (1.80) and the need to ensure an impression in cases where the farmer was a new client (1.57).

Table 2: Ranking of factors influencing veterinarian’s decision on whether to prescribe an antimicrobial or not

Sl. No.	Factors	Mean score	Rank
I. Clinical factors			
1	Clinical signs or symptoms	2.95	1
2	Critical nature of illness	2.88	2
3	Risk of promoting antimicrobial resistance in the animal	2.48	3
4	Culture and susceptibility test results	2.38	4
	Mean of mean scores	2.67	
II. Non-clinical factors			
1	My prior experience in managing similar problems	2.76	1
2	When I am personally confident about my diagnosis	2.69	2
3	A perceived demand from the farmer for immediate relief / for the use of an antimicrobial	2.26	3
4	In certain instances lack of enough time to consider another option	2.09	4
5	When I do not want to make a mistake	2.08	5
6	When I am not really confident about the diagnosis	2.06	6
7	The fact that the farmer had already administered an antimicrobial	2.05	7
8	My longstanding acquaintance with the farmer	2.00	8
9	Guideline recommendations	1.81	9
10	The perception that if the condition of the animal does not improve, I will be called again	1.80	10
11	Farmer is a new client	1.57	11
	Mean of mean scores	2.11	

Factors influencing the decision to choose a particular antimicrobial

Results indicated that the predominance of pharmacological criteria (mean of mean scores - 2.65) over non-pharmacological factors (mean of mean scores -2.41) in the respondent decision making process with respect to the choice of a particular antimicrobial to prescribe. Influential pharmacological considerations in this regard included consideration of the spectrum of activity of the antimicrobial (2.88), as well as the duration of therapy (2.82) and the route as well as frequency of administration

(2.75). It is worth deliberating upon the fact that factor on the withdrawal period of an antimicrobial was the least considered pharmacological factor while arriving at a decision on the antimicrobial to prescribed.

Among the non-pharmacological factors that exerted greater influence on the decision of the veterinarian to choose an antibiotic were the clinical signs/disease condition (2.95) followed by previous experience of using a drug to treat a particular condition (2.82), availability of the antibiotic (2.60), cost of the antibiotic treatment protocol (2.56) and the results of culture and sensitivity test (2.40).

Table 3: Ranking of factors influencing the decision to choose a particular antimicrobial

Sl. No.	Factors	Mean Score	Rank
I. Pharmacological factors			
1	Spectrum of activity of the antibiotic	2.88	1
2	Duration of therapy	2.82	2
3	Route and frequency of administration	2.75	3
4	Possibility of antibiotic resistance development	2.59	4
5	Withdrawal period of the antibiotic	2.21	5
	Mean of mean scores	2.65	
II. Non-Pharmacological factors			
1	Clinical signs/disease condition	2.95	1
2	Previous experience of using a drug to treat a particular condition	2.82	2
3	Availability of antibiotic	2.60	3
4	Cost of the antibiotic treatment protocol	2.56	4
5	Culture and susceptibility test results	2.40	5
6	Antibiogram (local resistant pattern)	2.36	6
7	Ease of administration	2.34	7
8	Guideline recommendations	2.28	8
9	Marketing offers coming along with an antibiotic	1.46	9
	Mean of mean scores	2.41	

Non-pharmacological factors of relatively lesser influence included consideration of the local resistant pattern (2.36), ease of administration (2.34), guideline recommendations (2.28) and marketing offers coming along with an antibiotic (1.46).

Impact of factors influencing antimicrobial prescribing behavior on perception of veterinarians about antimicrobial use and resistance

The relative contribution of the four categories of factors affecting antimicrobial prescribing behaviour of

veterinarians to their overall perception about antimicrobial use and resistance was assessed by multiple linear regression. From the data presented in Table 3, it was inferred that out of the four categories of factors studied, clinical factors, pharmacological factors and non-clinical factors were significant at one percent level in explaining the variations in perception of the studied veterinarians. Of these, the negatively significant coefficient for non-clinical factors signified that as this variable increased, the dependent variable perception tended to decrease.

Table 4: Regression analysis between factors influencing prescribing behaviour and perception of veterinarians about antimicrobial use and resistance

Variable code	Factors	Regression coefficient	Std. error	t	P
	(Constant)	35.737	2.960	12.073	<0.001**
X ₁	Clinical factors	4.957	1.003	4.942	<0.001**
X ₂	Non-clinical factors	-3.235	0.773	-4.187	<0.001**
X ₃	Pharmacological factors	3.001	0.992	3.026	0.003**
X ₄	Non-Pharmacological factors	-1.115	1.054	-1.057	0.291
Dependent variable: Perception about antimicrobial use and resistance					
** (p<0.01), F= 16.579, p<0.001, R ² = 0.167					

The coefficient of determination was found to be 16.7 percent. This indicated that 16.7 percent of the total variability in the perception of veterinarians could be attributed to the four factors. The lower R squared value is in line with studies that attempt to predict human behavior, where R square values would typically be lower than 50 percent (Ballard, 2019) [1].

Discussion

Factors influencing the decision on whether to prescribe an antimicrobial or not

The results of this study pointed to the predominant role of clinical factors such as clinical signs/symptoms, critical nature of the illness and risk of promoting antimicrobial resistance in the animal in exerting the influence over veterinarian decision on whether to prescribe an antimicrobial or not. The findings are in concordance with those of Norris *et al.* (2019) [10], Odoi *et al.* (2021) [11], Samuels *et al.* (2021) [15] and Kalam *et al.* (2022) [7] who

reported that clinical signs and symptoms were the factors that exerted the most influence on the decision of veterinarians to prescribe an antimicrobial or not. The respondents did not rely on culture and sensitivity test results as this factor was considered to be the factor of least influence among other clinical factors. This finding is not in accordance with that of De Briyne *et al.* (2013) [3], Ekakoro and Okafor (2019) [5] and Odoi *et al.* (2021) [11] who reported that the majority of veterinarians relied on laboratory results which deciding whether or not to prescribe an antimicrobial. The possible reason for the lesser perceived influence of sensitivity test results on veterinarian antimicrobial prescribing could be due to lack of quick and efficient laboratory facilities to conduct culture and sensitivity tests at the field level in Kerala.

It was also evident from this study that non-clinical factors such as the veterinarian’s prior experience in managing similar problems and personal confidence in disease diagnosis were important non-clinical factors influencing

veterinarian prescribing decision. These findings are in line with those of McDougall *et al.* (2016)^[9], Coyne *et al.* (2018)^[2] and Patnaik *et al.* (2019)^[13] who reported that a veterinarian's previous experience with the response of a therapy was a significant factor influencing prescribing decisions and in line with Servia - Dopazo *et al.* (2021)^[16] who reported that personal confidence of the veterinarian in his/her diagnosis was the major non-clinical factor that exerted influence on the veterinarian prescription behaviour. Veterinarian decision to prescribe was influenced by a perceived demand from the farmer for immediate relief putting the veterinarian under pressure to prescribe in cases where antibiotics were not required. This findings was contrary to that reported from Australia where client expectations had only a marginal effect on veterinarian decision to prescribe (Norris *et al.*, 2019)^[10]. Item wise analysis of the statement relating to non-clinical factors influencing veterinarian prescribing decision indicated that in certain cases there was not enough time to consider another option and the veterinarian had to prescribe antimicrobial.

It was also evident from this study that certain non-clinical factors *viz.*, not being confident about the diagnosis and the perception that if the condition of the animal did not improve, the veterinarian would be called again for treatment were the least factors that influenced prescribing decision to the least extent. These findings are contrary to the findings of Gibbons *et al.* (2013)^[6] who reported that these factors exerted a major influence on the antimicrobial prescribing decision of the majority of the cattle practitioners in Ireland.

Analysis of the various factors that influenced the prescribing decision of veterinarians indicated that guideline recommendation did not have much influence on the prescribing decision of veterinarians. This finding is contrary to the findings of Spervovasilis *et al.* (2020)^[18] who reported in a study conducted among junior doctors in Greece that the use of guidelines was the most important factor influencing antimicrobial prescribing practices. The least influence of guideline recommendations could be due to lesser importance given by studied veterinarians for guidelines or unaware / unavailability of such guideline recommendations in the Kerala.

Factors influencing the decision to choose a particular antimicrobial

While choosing the antimicrobials, among pharmacological factors, spectrum of activity of the antibiotic remained the topmost criteria which is in accordance with the previous studies where spectrum of activity was the decisive for antibiotic selection among veterinarians of New Zealand (McDougall *et al.* (2016)^[9]). The other pharmacological criteria for choosing the antimicrobial were the duration of therapy, route and frequency of administration, possibility of antibiotic resistance development and withdrawal period which is in line with findings of Odoi *et al.* (2021)^[11] who reported in a study among veterinarians in United States of America that the factors that influenced the decision to choose an antibiotic were the route of administration, the expenses associated with the drug and the possible untoward reactions that could occur on administration of the drug. The present study also indicated that the choice of

antimicrobial to prescribe by veterinarians were influenced by several factors that were not related to the pharmacology of the drug. The non-pharmacological factors that had the most influence on the decision of veterinarians to choose an antibiotic were the clinical signs/disease condition which is in line with the findings of Kalam *et al.* (2022)^[7] who reported that the selection of appropriate antimicrobials by veterinarians in Bangladesh was influenced to a great extent by disease type or organism. The other non-pharmacological factors were the previous experience of using the drug to treat a particular condition, the availability of the antibiotic, the cost of the antibiotic treatment protocol and the results of the culture and susceptibility test results. These findings are in line with the findings of Vijay *et al.* (2021)^[19] who in a study among veterinarians in India reported that for majority of the veterinarians, their own personal experience with the drug was the most influential factor in deciding on the choice of an antibiotic followed by availability of antimicrobial in the market, cost of the drug and the cost of culture and sensitivity test results. Similarly in a study among cattle practitioners in Ireland, Gibbons *et al.* (2013)^[6] reported that more than half of the veterinarians always considered the non-pharmacological factor *i.e.*, the prior experience of using a drug to treat a particular condition when choosing an antimicrobial to prescribe. The lower use of antimicrobial culture and sensitivity test results in choosing antimicrobials was in accordance with the study on New Zealand veterinarians (McDougall *et al.*, 2016)^[9] as well as with the study among veterinarians in Bangladesh (Kalam *et al.* 2022)^[7] and contrary with the study among veterinarians in Europe (De Briyne *et al.* 2013)^[3]. This least influence of culture test results on choosing antimicrobials indicated the practice of less culture and sensitivity tests being done at field level among the veterinarians of Kerala. This could be due to lack of awareness among veterinarians and farmers about culture and sensitivity testing and lack of such facilities at field level in Kerala.

The non-pharmacological factors of least importance were the local resistant pattern and guideline recommendations. The marketing offers and recommendations from the pharmaceutical companies also had the least influence on the veterinarian decision to choose a particular antibiotic which is in line with findings of Vijay *et al.* (2021)^[19] who reported in a study among veterinarians in India that recommendations of pharmaceutical companies were criteria of least importance while making a choice of an antibiotic to prescribe. This finding is in contrast to those of previous studies where it was reported that half of the veterinarians studied reported that pharmaceutical companies did influence their antimicrobial prescribing choices (Postma *et al.*, 2016)^[14].

Impact of factors influencing antimicrobial prescribing behavior on perception of veterinarians about antimicrobial use and resistance

The results of the study indicated that clinical factors, non-clinical factors and pharmacological factors were found to be significant in explaining variations in perception of the studied veterinarians. Among these, non-clinical factors contributed negatively. This indicated that interventions in non-clinical factors would decrease the perception of veterinarians. Among four factors clinical and

pharmacological factors were the strongest predictors of perception of the veterinarians. The strength of influence of these factors can be explained as one unit increase in clinical and pharmacological factor would result in 4.957 and 3.001 units increase in perception respectively. This suggests that interventions in clinical and pharmacological factors would increase the perception of the veterinarians regarding antimicrobial use and resistance.

Conclusion

This study highlighted the multifactorial nature of the veterinarian's decision to prescribe antimicrobials and the choice of antimicrobial prescribed. While further investigation of these issues is necessary, it is important that the role played by non-clinical and non-pharmacological-related factors be recognised by regulatory authorities, veterinary surgeons and their clients, and that these issues are addressed when guidelines for antimicrobial use and intervention strategies to reduce antimicrobial consumption are being formulated.

Our results suggest non-clinical factors which are associated with veterinary antibiotic prescribing (e.g., prior experience, personal confidence in their diagnosis, demand of the farmer for immediate relief and the lack of enough time to consider another option etc.) which are potentially modifiable, and could thus be the target of future interventions designed to optimize antimicrobial use in this sector and decrease the prevalence of resistant development in animals and human beings alike.

This study has identified a number of common factors that influence veterinarian prescribing practices across Kerala which could help inform optimum information channels and areas for interventions and investment to maximise appropriate prescribing and minimise risk of resistance emergence.

References

- Ballard C. An ode to R-squared or, the statisticians Crusade: A duty-dance with determination. [Internet]; c2019. Available from: <https://towardsdatascience.com/an-ode-to-r-squared-804d8d0ed22c>.
- Coyne LA, Latham SM, Dawson S, Donald IJ, Pearson RB, Smith RF, *et al.* Antimicrobial use practices, attitudes and responsibilities in UK farm animal veterinary surgeons. *Preventive Veterinary Medicine.* 2018;161:115-126.
- De Briyne N, Atkinson J, Pokludova L, Borriello SP, Price S. Factors influencing antibiotic prescribing habits and use of sensitivity testing amongst veterinarians in Europe. *The Veterinary Record.* 2013;173:475-481.
- De Briyne N, Atkinson J, Borriello SP, Pokludova L. Antibiotics used most commonly to treat animals in Europe. *The Veterinary Record.* 2014;175:325-332.
- Ekakoro JE, Okafor CC. Antimicrobial use practices of veterinary clinicians at a veterinary teaching hospital in the United States. *Veterinary and Animal Science.* 2019;7:1-10.
- Gibbons JF, Boland F, Buckley JF, Butler F, Egan J, Fanning S, *et al.* Influences on antimicrobial prescribing behaviour of veterinary practitioners in cattle practice in Ireland. *The Veterinary Record.* 2013;172:14-19.
- Kalam M, Rahman M, Alim M, Shano S, Afrose S, Jalal FA, *et al.* Knowledge, attitudes, and common practices of livestock and poultry veterinary practitioners regarding the AMU and AMR in Bangladesh. *Antibiotics.* 2022;11:80-95.
- Likert R. A technique for the measurement of attitudes. *Archives of Psychology.* 1932;140:44-53.
- McDougall S, Compton CWR, Botha N. Factors influencing antimicrobial prescribing by veterinarians and usage by dairy farmers in New Zealand. *New Zealand Veterinary Journal.* 2016;65:84-92.
- Norris JM, Zhuo A, Govendir M, Rowbotham SJ, Labbate M, Degeling C, *et al.* Factors influencing the behaviour and perceptions of Australian veterinarians towards antibiotic use and antimicrobial resistance. *PLoS One.* 2019;14:1-19.
- Odoi A, Samuels R, Carter CN, Smith J. Antibiotic prescription practices and opinions regarding antimicrobial resistance among veterinarians in Kentucky, USA. *PLoS One.* 2021;16:1-18.
- OIE. Standards and guidelines can be found in the Terrestrial Animal Health Code (chapters 6.6., 6.7., 6.8., 6.9. and 6.10. and in the Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. (Guideline 2.1.). [Internet]; c2012. Available from: <http://www.oie.int>.
- Patnaik NM, Gupta J, Acharya P, Kar P. Use of antimicrobials for treatment of dairy animals by veterinarian and paravet in Punjab: a study on prescription pattern. *Indian Journal of Extension Education.* 2019;55:86-91.
- Postma M, Speksnijder DC, Jaarsma ADC, Verheij TJ, Wagenaar JA, Dewulf J. Opinions of veterinarians on antimicrobial use in farm animals in Flanders and the Netherlands. *The Veterinary Record.* 2016;179:68-79.
- Samuels R, Qekwana DN, Oguttu JW. Antibiotic prescription practices and attitudes towards the use of antimicrobials among veterinarians in the City of Tshwane, South Africa. *Peer J.* 2021;9:13-24.
- Servia-Dopazo M, Taracido-Trunk M, Figueiras A. Non-clinical factors determining the prescription of antibiotics by veterinarians: A systematic review. *Antibiotics.* 2021;10:133-153.
- Speksnijder DC, Jaarsma ADC, Van Der Gugten AC, Verheij TJ, Wagenaar JA. Determinants associated with veterinary antimicrobial prescribing in farm animals in the Netherlands: a qualitative study. *Zoonoses and Public Health.* 2015;62:39-51.
- Spernovasilis N, Ierodiakonou D, Milioni A, Markaki L, Kofteridis DP, Tsioutis C. Assessing the knowledge, attitudes and perceptions of junior doctors on antimicrobial use and antimicrobial resistance in Greece. *Journal of Global Antimicrobial Resistance.* 2020;21:296-302.
- Vijay D, Bedi JS, Dhaka P, Singh R, Singh J, Arora AK, *et al.* Knowledge, attitude, and practices (KAP) survey among veterinarians, and risk factors relating to antimicrobial use and treatment failure in dairy herds of India. *Antibiotics.* 2021;10:216-232.
- WHO [World Health Organization]. Critically

- Important Antimicrobials for Human Medicine. Ranking of Medically Important Antimicrobials for Risk Management of Antimicrobial Resistance due to non-human use. (6th Revision). Geneva; c2019. p. 45.
21. Zhuo A, Labbate M, Norris JM, Gilbert GL, Ward MP, Bajorek BV, *et al.* Opportunities and challenges to improving antibiotic prescribing practices through a one health approach: Results of a comparative survey of doctors, dentists and veterinarians in Australia. *BMJ Open.* 2018;8:1-12.