Intention of veterinary doctors towards antimicrobial usage and resistance: applying 'theory of planned behaviour' for scaling

Neela Madhav Patnaik¹, Jancy Gupta², Saikat Maji³, Parag Acharya⁴ and Arghyadeep Das⁵

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Abstract: With the rise in standard of living, animal protein rich diet for human consumption is rising rapidly in India. Antimicrobials are regularly used in livestock production systems for therapeutic, sub-therapeutic and prophylactic purpose which increase selection pressure on microbes to become resistant. Research is needed to understand veterinary doctor's psychological factors that influence decision-making on antimicrobial use for treating diseased animals in dairy farms empirically. To understand the intentions of veterinary doctors towards antimicrobial use in dairy farming, the research was carried out in purposively selected Punjab state and data was collected from 60 veterinary doctors and 180 dairy farmers. Theory of Planned behaviour (TPB) based Likert type behavioural intention scale was developed in the context of antimicrobial use and antimicrobial resistance issues in dairy sector. The three components of the TPB *i.e.* outcome attitude, subjective norm and perceived behavioural control; based on which the behavioural intention scale was prepared. The final behavioural scale administered to the veterinary doctors in the study area constituted of 20 statements. Disagreement was seen in case of 48 percent veterinarians whose opinion was against the ban of antimicrobial use for sub-therapeutic purpose. Almost 58 percent of the veterinary doctors disapproved that they feel pressure

from pharmaceutical company, moral, peers etc. while prescribing antimicrobials. Majority (83 %) of the veterinary doctors were in agreement that following best practices while administering antimicrobials is generally difficult. The veterinary doctors drivers and barriers that points towards intention of antimicrobials use is the crux which can help the policy makers to gain some insight to tackle this burning problem of antimicrobial resistance.

Keywords: Antimicrobial drug resistance, Dairy, Scale, Theory of Planned Behaviour, Veterinary Doctor

Introduction

Rising income levels in low- and middle-income countries has resulted in the unprecedented growth in the demand for animal protein (Tilman et al. 2011). In livestock production systems, most antimicrobials produced globally are used as prophylactics and growth promoters and much lesser context for disease treatment (Davies, 2009; Bush et al. 2011; Marshall and Levy, 2011). In India, the use of antimicrobials is restricted to therapeutic and prophylactic use in dairy sector. Overuse and sub-optimal use of antimicrobials in the livestock sector can be attributed for development of Antimicrobial Resistance (AMR) (Barbosa and Levy, 2000). It is beyond doubt that a number of factors are responsible for treatment of disease by veterinary doctors in animals and prescription of antimicrobials. WHO (2007) elucidated increase in resistance to infections in veterinary medicine which may harm both the livestock and humans. There is a close relationship between resistance in animals and its effect on human health. Food supply in the form of milk and milk products, poultry etc. are some of the common media through which resistant bacteria may be ingested by humans. Reports of antimicrobial residues in milk have been on the rise (Uninkrishnan et al. 2005; Scopetta et al. 2016; WHO, 2014). Study by Jones et al. (2015) stated veterinarian as the single most influential source of information for the farmer on antimicrobial use compared to farming press, nutritionist/farm adviser and pharmaceutical representatives. Majority (70%) of the dairy farmers sought information from a veterinarian before administering antibiotics for treatment of their disease stricken animals (Sawant et al. 2005). Livestock farmers believed that veterinarians/ animal health workers should be responsible for administration of antimicrobials

^{1,2} Dairy Extension Division, ICAR- National Dairy Research Institute, Karnal, Haryana – 132001

³Department of Extension Education, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh –221 005

⁴Livestock Production and Management, College of Veterinary Science, Rampura Phul, GADVASU, Ludiana, Punjab –151 103

⁵Dairy Economics, Statistics and Management Division, ICAR- National Dairy Research Institute, Karnal, Haryana – 132 001

Neela Madhav Patnaik (✉)
Dairy Extension Division, ICAR- National Dairy Research Institute,
Karnal, Haryana – 132 001
Email- neela.patnaik@gmail.com

to animals (Ojo et al. 2016). These highlights the faith and credibility veterinary doctors command from the dairy farmers in consulting their dairy animals. In such a scenario it is important to identify the driver and motivating variables affecting veterinary doctors decision making capacity regarding antimicrobial use behaviour in livestock which is crucial for prudent antimicrobial use. Studies by Cortoos et al. (2012), McIntosh and Dean (2015) substantiate the fact of carrying out behavioural research on veterinarians using the Theory of Planned Behaviour (TPB) framework. The intention of Nordic veterinarians was inclined towards treating diseases such as mastitis with antimicrobials; a gradual surge in disease events would occur due to increased antimicrobial use (Espetvedt et al. 2013). Thus understanding the attitude of veterinary doctors and underlying factors influencing their decision making in judicious antimicrobial use in dairy sector can prove to be a useful discipline in implementation of stewardship programs. The present field level study, a small scale survey aims looks into the extent of responsible antimicrobial use behaviour among veterinary doctors of Punjab in dairy farming. AMR studies from social science point of view focussed on field level stakeholders have been a nascent discipline slowly gaining momentum in recent years to compliment the basic AMR findings. The importance of smaller studies at regional levels has been highlighted by Kakkar et al. (2017) suggesting these regional studies helps in understanding the antimicrobial use pattern thus generating useful baseline data for surveillance and awareness programs at national level. At the outset, the study also points towards identifying the factors which would facilitate veterinarians in performing prudent antimicrobial use and its consequent impact upon dairy farmers.

Materials and Methods

Sampling and data collection

Punjab state was purposively selected for the study due to highest milk productivity and per capita availability of milk (BAHS, 2019). Multistage stratified random sampling technique was employed to select three districts (Ludhiana, Amritsar, and Pathankot). Two blocks from each district and two villages from each block were chosen. Fifteen dairy farmers possessing at least 2 milch animals were selected from each village. Thus the study covered 180 dairy farmers who were asked "Whom do you consult for treatment when your dairy animal fall sick?" The probing question was meant to informally understand the social networks and information exchange relationships existing in the sampled village w.r.t animal health management. Based on the feedback of the dairy farmers, the veterinary doctor was preferentially consulted compared to paravets and quacks as the treatment source for livestock. The snowball sampling method was employed to select 20 veterinary doctors from each district of thus constituting a total of 60 veterinary doctors. In each district, snowballing was done till the sample size reached 20 veterinary

doctors. The reason behind the choice of snowball sampling method was to include veterinary doctors who were regularly providing extension services to farmers from diverse institutions such as state livestock department; Krishi Vigyan Kendra and veterinary polyclinics. Descriptive research design was followed for the study. Likert type behavioural intention scale was developed following the Theory of Planned Behaviour model as the theoretical framework of the study elucidated by Francis et al. (2004).

Rank Based Quotient (RBQ)

For the present study RBQ method given by Sabarathnam (1988) was used to identify the credibility of the personnel according to the dairy farmers for treatment of sick animals by ranking them in order of preference.

$$R.B.Q = \frac{\sum_{i=1}^n f_i(n+1-i)}{N * n} \times 100$$

Where,

f_i = Frequency of farmers reporting a particular personnel under i^{th} rank

N = number of farmers

n = number of personnel identified to be ranked

i = rank of the personnel

Theoretical model

The theoretical background of the behavioural study is the TPB framework used for identification of the facilitating and limiting factors for veterinarians antimicrobial use behaviour (Ajzen, 1991; Fishbein and Yzer, 2003; Garforth et al. 2013) as depicted in **fig.1**. The psychological variables in the TPB framework are internal in nature and elicited either directly by asking veterinary doctors about their overall attitude regarding antimicrobial use behaviour or indirectly by asking about behavioural beliefs and outcome evaluations of their prescription and treatment practices. The three constructs of TPB are as follows:

- i. Outcome attitude (towards the behaviour) refers to the evaluation of overall antimicrobial use behaviour of veterinary doctors. It has two sub-components: behavioural beliefs and outcome evaluations which signal positive and negative effects of antimicrobials and how it affects the attitude of veterinarians towards antimicrobial use in livestock.
- ii. Subjective norms (about the behaviour) refer towards the evaluation of veterinary doctors social pressure to perform or not to perform the antimicrobial use behaviour.
- iii. It has two sub components: normative beliefs and motivation to comply implying

Fig. 1 Theory of Planned Behaviour model (Ajzen, 1991 and Ajzen, 2012)

the social referents influence on veterinarians information and treatment pattern and the extent to which they comply with respect to their peers and social referents.

iii. Perceived behavioural control (of the behaviour) refers to the extent to which the veterinary doctors feel they are able to enact the antimicrobial use behaviour. It has two aspects: control beliefs and perceived power. The two sub components deduce the necessary skills and knowhow possessed by the veterinarians regarding antimicrobial use and the extent to which the veterinarians have control over enacting the antimicrobial use behaviour.

Steps followed in development of the Behavioural intention scale for Veterinarians

Item Collection

Items to be part of the scale were collected following an exhaustive review of literature, consultation with experts and visit to Animal Health Complex of NDRI and LUVAS, Hisar for interacting with the veterinary doctors. The items so framed were subjected to Edwards 14 principles criterion for editing the items. Initial set of items/statements constituting the behavioural intention scale was 26 in number.

Item Relevancy Test

The statements of the behavioural intention scale were framed taking into account the three dimensions of TPB *i.e.* outcome attitude, subjective norms and perceived behavioural control following the guidelines given by Francis et al. (2004). The initial set of statements framed for the behavioural intention scale was sent to 50 experts with different domain expertise in the field of dairy and animal husbandry and social sciences to test relevancy of statements. For this, google form was created to gather response from experts in addition to personal visits. For each statement, the experts were requested to judge them on a

dichotomous response category *i.e.* whether the statement is relevant or irrelevant. Out of 50 experts, response was received from 32 experts in the stipulated period of two months. Mean Relevancy Score (MRS) was calculated for each statements by compiling the response generated from the 32 experts. MRS was calculated based on the formula given by Kumar and Popat (2016). The cut-off limit for the statement to be considered as relevant was fixed at 0.80 as stated by Maiti et al. (2021). Out of the 26 statements subjected to relevancy test from experts, 2 statements (statement no. 5 and 19) were dropped as their MRS value was below 0.80 as shown in Table-1.

$$\text{MRS} = \frac{\text{No. of experts judging a statement as 'relevant'}}{\text{Total no. of experts judging the statement}}$$

Collection of Data

According to the suggestions obtained from the experts, the statements were modified and the suggestions were duly incorporated. A five point continuum (Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree) Likert type scale was developed. This behavioural intention scale was administered to 60 veterinary doctors of Ludhiana, Amritsar, and Pathankot who were primarily field level veterinarians working in state livestock department of Punjab. Personal interview were carried out with the veterinarians by the researcher to collect the data on the scale items.

Item Analysis

Analysis of scale items is necessary so as to select the statements to be part of the final behavioural intention scale. For positive statements the scoring pattern was 5, 4, 3, 2 and 1 for Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (DA) and Strongly Disagree (SDA) respectively. But for item analysis for the negative statements, the scoring pattern of statements were reversed *i.e.* 1, 2, 3, 4 and 5 for Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (DA) and Strongly Disagree (SDA)

respectively. Item analysis procedure based on t-value given by Edwards (1969) was followed in this study. For this, the score obtained by each respondent on the 24 statements were summed up. Based on the total scores obtained, the respondents were arranged in descending order. The total respondents were then

categorised into three group's *i.e.* top 25 percent respondents with high scores; 25 percent respondents with low scores and the rest 50 percent are the middle group. But the two groups representing the high and low scores are the criterion groups which are used in evaluating the statements for calculating the t-

Table 1 Item relevancy test result of the initial selected statements of the behavioural scale (n=32)

S.NO.	Statements	MRS
A	Outcome Attitude	
1	India should ban the use of antimicrobials for sub therapeutic purpose as many countries have already banned sub therapeutic use	0.94
2	Diagnostic tests are highly essential for disease confirmation & choosing the right antimicrobial	1.00
3	Diagnostic tests take a lot of time for the results	0.84
4	The focus on crossbreeding has resulted in an increased use of antimicrobials	0.88
5	Increased use of antimicrobials has proven to be important for increasing milk production through prompt treatment of diseases	0.66*
6	In livestock, various categories of antimicrobials are used for therapeutic (<i>i.e.</i> treat illness), prophylactic (<i>i.e.</i> control or prevent illness) and sub therapeutic (<i>i.e.</i> improve feed efficiency)	0.84
7	The achievements of modern medicine are put at risk by antimicrobial resistance	1.00
8	Antimicrobial resistance is a direct result of antimicrobial use: the greater the volume of antimicrobials used the greater the risk of antimicrobial resistance	0.94
9	Livestock sector is often criticized due to the misuse of antimicrobials in allopathic treatment	0.84
10	Ethno veterinary medicine can be a good alternative to allopathic treatment	0.94
11	Ethno veterinary medicine is in danger of extinction due to advancement of modern veterinary medicine	0.84
12	There is minimum separation of the types of antimicrobials used in humans & animals	0.94
13	Use of critically important drugs for humans such as 3rd & 4th generation cephalosporin and fluoroquinolones in dairy sector to be restricted	0.88
B	Subjective Norms	
14	Veterinary doctor is expected to prescribe antimicrobials for treatment of dairy animal diseases mostly in coming years due to rise in disease incidences	0.88
15	From the veterinary doctor perspective, it is expected from them to prescribe antimicrobials when consulted by dairy farmer	0.94
16	Veterinary doctors feel some kind of pressure (pharmaceutical company, moral, peers etc.) while prescribing antimicrobials	0.88
17	Scientist of SAUs or ICAR institutes recommend that a veterinary doctor must go for antimicrobial prescription after diagnostic tests only	0.91
18	Paravets generally overprescribe antimicrobials which is a concern for veterinary doctors	0.75*
19	Dairy farmers expect that veterinary doctors should go for antimicrobial prescription so as to provide quick relief to their dairy animals	0.88
C	Perceived Behavioural Control	
20	Following best practices while administering antimicrobials is generally difficult on the part of the veterinary doctor	0.94
21	Allopathic treatment is more preferred in livestock sector compared to other treatment methods	0.97
22	Antimicrobials are expensive and it should be recommended to minimize its usage to reduce costs	0.97
23	Past experience of veterinary doctor plays a major role in diagnosis of disease	0.94
24	Narrow spectrum antimicrobials to be preferred over broad spectrum ones	0.88
25	Lack of R&D in discovery of new drugs limits the choice of narrow spectrum antimicrobial prescription	0.91
26	Generally very few choices are available with veterinarians while prescribing antimicrobials to diseased dairy animals	0.94

* Statements are dropped from the behavioural intention scale as their Mean Relevancy Score were below the cut-off point 0.80

value as suggested by Edwards (1969). Then t-value is calculated by the formula given below:-

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum_{i=1}^n (X_H - \bar{X}_H)^2 + \sum_{i=1}^n (X_L - \bar{X}_L)^2}{n(n-1)}}$$

Where,

$\bar{X}_H$ = mean score of the statement for the high group

$\bar{X}_L$ = mean score of the statement for the low group

n = Number of subject in low and high group

Reliability and validity of the behavioural intention scale

The test of reliability was carried out in SPSS 21 by following the Cronbach alpha method which is a widely followed measure for internal consistency among the scale statements. Cronbach alpha

value obtained was 0.71 (e" 0.60) which satisfies that the scale is reliable as value >0.60 is considered to be acceptable (Griethuijsen et al. 2014). For testing the relevancy of the items, the experts judgement was carried out. This item relevancy testing step fulfils the content validation of the behavioural intention scale.

Results and Discussion

Brief profile of the dairy farmer and veterinary doctor

The dairy farmers were categorised according the Census of India (2011) criteria into three categories of young aged (<35 years), adult/middle aged (36-50 years) and old aged (>51 years). A perusal of Table-2 indicates that just above half (51.11 %) of the respondents belonged to middle age category. In the old aged group were about 28 percent farmers while young aged farmers were 20.56 percent. Dairy farmers with no formal schooling were 7.22 percent in the study area. About 38 and 24 percent respondents have completed secondary and senior secondary education respectively. Majority (83.89 %) of the respondents

Table 2 Brief profile of the dairy farmer and veterinary doctor

S.No.	Variables	Category	Percent (%)
A.	Dairy Farmer (n=180)		
1.	Age	Young (<35)	20.56
		Middle (36-50)	51.11
		Old (>51)	28.33
2.	Education of dairy farmer	No formal schooling	7.22
		Primary	9.45
		Middle	11.11
		Secondary	37.78
		Senior Secondary	24.44
		Graduate & above	10.00
3.	Gender	Male	83.89
		Female	16.11
4.	Dairy farming experience	Low (<12 years)	32.77
		Medium (12-25 years)	36.12
		High (> 25 years)	31.11
B.	Herd Composition and Milk	Production Parameters	Mean
5.	Herd Size (in nos.)	Indigenous cattle	2
		Crossbred cattle	4
		Buffalo	5
6.	Daily milk yield (in litres)	Indigenous cattle	4.05
		Crossbred cattle	9.84
		Buffalo	5.75
C.	Veterinary Doctor (n=60)		Percent (%)
1.	Age	Young (<35)	15.00
		Middle (36-50)	46.67
		Old (>51)	38.33
2.	Gender	Male	78.33
		Female	21.67
3.	Highest qualification	B.V.Sc. and A.H	73.33
		M.V.Sc.	26.67
4.	Mean Service experience (in years)		19

surveyed were male while the proportion of female respondents was few at 16.11 percent. The dairy farming experience of the respondents was analysed by following cumulative square root frequency method of categorization into low, medium and high dairy farming experience. About 36 percent of the dairy farmers had a medium farming experience ranging from 12-25 years while 33 percent of the respondents possessed less than 12 years of dairy farming experience. The study revealed that the herd profile of the study area was on average two indigenous cattle, four crossbred cattle and five buffalo reared by the dairy farmer. Tharparkar, Red Sindhi and Sahiwal were the Indigenous cattle breeds reared by the farmers in the study area. The Crossbreds reared were Jersey, Holstein Friesian, and Karan-Fries. The Buffalo breeds reared included Murrah, Nili-Ravi and non-descript breeds prominently found in Amritsar and Pathankot districts. The average milk production per animal per day for indigenous cattle, crossbred and Buffalo were 4.05, 9.84 and 5.75 litres respectively.

In case of veterinary doctors, about 47 percent were in middle age category while 38 percent were old aged as depicted in Table-2. Majority (78.33 %) of the surveyed veterinary doctors were male while 21.67 percent were female. As far as highest qualification of the veterinary doctors were concerned, majority (73.33 %) had completed B.V.Sc. and A.H while 26.67 percent had reported M.V.Sc. as the highest qualification attained. The mean years of service of the veterinary doctors was 19 years in the study area.

Credibility of sources of treatment perceived by dairy farmer

A list of stakeholders providing healthcare services to dairy farmers was identified by consulting experts and secondary review of literature. In addition to that, field visit to four villages in Karnal district adopted by NDRI, Karnal, Haryana were also carried out to gain better understanding of the treatment sources from dairy farmers. The list constituting the stakeholders was incorporated into the final interview schedule administered to the dairy farmers in the study areas of Punjab. The dairy farmers were asked to rank various stakeholders having considerable influence and credibility in the purview of health care and management of their diseased animals. As far as treatment of diseased animal was concerned veterinary doctor was ranked the most credible source followed by paravet by the dairy farmers of the study area (Table-3). The researchers upon triangulation with the progressive dairy farmers and other non-sampled dairy farmers of the study area villages found that most of the dairy

farmers were having the contact of their local veterinary doctor and the farmers stated that the veterinary doctors were prompt in delivering health services when contacted. Over-the-Counter sale persons were preferred by dairy farmers prominently in Pathankot district for treating diseased animals. The reason stated by the Pathankot dairy farmers was that since they were having small herds that too local buffalo breeds; hence their dependence of institutional veterinary services was quite limited. The milk vendor, milk co-operative official were ranked at the lower side as the farmers perceived them relatively less credible in giving suggestions/advice related to health aspects. The results regarding the credibility of veterinary doctor as treatment source commensurate with the findings of Ison and Rutherford (2014).

Behavioural intention of Veterinary Doctors towards antimicrobial use and resistance issue in dairy

The five point behavioural intention scale comprising 24 statements were administered to the selected sample for item analysis and understanding the behaviour of veterinary doctors towards antimicrobial use and resistance issue in dairy. As show in Table-4, the behavioural intention scale consisted of an appropriate mix of statements depicting three dimensions of TPB *i.e.* outcome attitude; subjective norms and perceived behavioural control. According to Edwards (1969), statements with t-value $e^{1.75}$ is the criterion for selection of item as it indicates that the average response to the statement by the high and low score group of respondents differ significantly. Consequently, it can be seen from **Table-4** that four statements were dropped from the final scale. Thus the final behavioural intention scale for the veterinary doctors comprised of 20 statements.

The attitude of the veterinary doctor being favourable towards usage of antimicrobial was due to the fact they believed in providing quick relief and prompt recovery to the ailing animals by administering antimicrobials. Ison and Rutherford (2014) study had similar findings which reported United Kingdom veterinarians had positive attitude towards administering anti-inflammatory drugs for pain relief in livestock animals. Almost 48 percent of the veterinarians disagreed or strongly disagreed with the statement '*India should ban the use of antimicrobials for sub therapeutic purpose*'. The veterinarians in Punjab were against banning the antimicrobials use in India by stating that the per capita availability of milk is low in our country. Ban on antimicrobials can have severe impacts in developing country

Table 3 Ranking of treatment sources based on their credibility as perceived by dairy farmers in the study area (n=180)

Sl. No.	Health Management Stakeholder	RBQ Values	Rank
1	Milk Co-Operative official	34.86	VI
2	Over - the- Counter(OTC) sales personnel	53.26	III
3	Paravet	78.84	II
4	Private Milk vendor	45.08	V
5	Progressive Dairy farmers	50.41	IV
6	Veterinary Doctor	92.73	I

Table 4 Scale item analysis and intention of veterinary doctors towards antimicrobial use in dairy (n=60)

Sl. No.	Statements	t-value	Mean score	SDA	DA	UD	A	SA
A.	Outcome Attitude							
1	India should ban the use of antimicrobials for sub therapeutic purpose as many countries have already banned sub therapeutic use	2.10	2.72	16.67	31.67	28.33	10.00	13.33
2	Diagnostic tests are highly essential for disease confirmation & choosing the right antimicrobial	3.12	3.47	8.33	10.00	35.00	23.33	21.67
3	Diagnostic tests take a lot of time for the results	1.28**	—	—	—	—	—	—
4	The focus on crossbreeding has resulted in an increased use of antimicrobials	2.64	4.25	0.00	1.67	16.67	36.67	45.00
5	In livestock, various categories of antimicrobials are used for therapeutic (i.e. treat illness), prophylactic (i.e. control or prevent illness) and sub therapeutic (i.e. improve feed efficiency)	4.80	4.48	0.00	0.00	0.00	51.67	48.33
6	The achievements of modern medicine are put at risk by antimicrobial resistance	3.04	4.47	0.00	0.00	0.00	53.33	46.67
7	Antimicrobial resistance is a direct result of antimicrobial use: the greater the volume of antimicrobials used the greater the risk of antimicrobial resistance	1.47**	—	—	—	—	—	—
8	Livestock sector is often criticized due to the misuse of antimicrobials in allopathic treatment	1.91	2.68	10.00	38.33	28.33	20.00	3.33
9	Ethno veterinary medicine can be a good alternative to allopathic treatment	2.84	4.43	0.00	6.67	8.33	20.00	65.00
10	Ethno veterinary medicine is in danger of extinction due to advancement of modern veterinary medicine	1.74**	—	—	—	—	—	—
11	There is minimum separation of the types of antimicrobials used in humans & animals	4.26	4.08	0.00	10.00	20.00	21.67	48.33
12	Use of critically important drugs for humans such as 3rd & 4th generation cephalosporin and fluoroquinolones in dairy sector to be restricted	5.04	1.60	51.67	36.67	11.67	0.00	0.00
B.	Subjective Norms							
13	Veterinary doctor is expected to prescribe antimicrobials for treatment of dairy animal diseases mostly in coming years due to rise in disease incidences	2.64	4.18	0.00	8.33	8.33	40.00	43.33
14	From the veterinary doctor perspective, it is expected from them to prescribe antimicrobials when consulted by dairy farmer	3.07	4.07	0.00	8.33	18.33	31.67	41.67
15	Veterinary doctors feel some kind of pressure (pharmaceutical company, moral, peers etc.) while prescribing antimicrobials	6.15	2.35	33.33	25.00	20.00	16.67	5.00
16	Scientist of SAUs or ICAR institutes recommend that a veterinary doctor must go for antimicrobial prescription after diagnostic tests only	3.58	4.32	0.00	0.00	11.67	45.00	43.33
17	Dairy farmers expect that veterinary doctors should go for antimicrobial prescription so as to provide quick relief to their dairy animals	4.85	4.20	0.00	3.33	18.33	33.33	45.00
C.	Perceived Behavioural Control							
18	Following best practices while administering antimicrobials is generally difficult on the part of the veterinary doctor	2.83	4.22	0.00	6.67	11.67	35.00	46.67
19	Allopathic treatment is more preferred in livestock sector compared to other treatment methods	0.74**	—	—	—	—	—	—
20	Antimicrobials are expensive and it should be recommended to minimize its usage to reduce costs	4.38	1.46	63.33	26.67	10.00	0.00	0.00
21	Past experience of veterinary doctor plays a major role in diagnosis of disease	2.94	4.00	5.00	11.67	15.00	15.00	53.33
22	Narrow spectrum antimicrobials to be preferred over broad spectrum ones	1.97	4.22	41.67	41.67	13.33	3.33	0.00
23	Lack of R&D in discovery of new drugs limits the choice of narrow spectrum antimicrobial prescription	2.85	4.32	0.00	0.00	15.00	38.33	46.67
24	Generally very few choices are available with veterinarians while prescribing antimicrobials to diseased dairy animals	5.75	4.32	0.00	1.67	21.67	20.00	56.67

** Statements (3, 7, 10 and 19) are dropped from the behavioural intention scale as their t-value was below 1.75.

SDA- Strongly Disagree DA- Disagree UD- Undecided A- Agree SA- Strongly Agree

like India due to poor housing, husbandry and biosecurity measures (Delia, 2015). The ban of growth promoters was possible in European countries (Marshall and Levy, 2011) due to better adoption of good practices and maintaining healthy herd. Majority (70 %) of the veterinary doctors agreed or strongly agreed that *'there is minimum separation in the antimicrobials used in treatment of livestock and those used in human health sector'*. About 88 percent of the respondents strongly disagreed or disagreed regarding restricting the *'use of critically important drugs for humans such as 3rd & 4th generation cephalosporin and fluoroquinolones in dairy sector'* while WHO (2007) has listed them as critical drugs for human health ought to be restricted in dairy sector. In many cases for treating dairy animals, the veterinarians reported of prescribing 3rd and 4th generation drugs thus blurring the gap between human and veterinary drugs. The respondents (45 percent) in the study area agreed or strongly agreed essentiality of diagnostic tests *viz.* sensitivity tests for better decision making and right choice of antimicrobials. But there were some limitations as Patnaik et al. (2019) reported that the limiting factors hindering veterinary doctors from performing sensitivity tests were sampling difficulties of the infections, the urgency of the situation for prescribing antimicrobial and concerns regarding the clinical relevance of in vitro tests. Majority (85%) of the veterinarians supported the fact that *'ethno-veterinary treatment practices could be a good alternative to allopathy'* as they can complement the allopathic treatment practices in coming years thus minimizing the antimicrobial use practices. About 48 percent of the veterinarians disagreed or strongly disagreed with the statement *'livestock sector is often criticized due to the misuse of antimicrobials in allopathic treatment'* whereas almost 28 percent were undecided. Since antimicrobial use has a direct effect on AMR, the respondents lacked awareness of AMR as an emerging threat posing serious concern to human and dairy sector alike in India. In recent times, under the scheme of ICAR Niche Area of Excellence on 'Antibiotic Resistance: Animal Human Interface'; Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) has carried out several successful initiatives to address the concerns regarding resistance issue in veterinary sector. GADVASU (2021, April, 2) has released an 'Awareness Guide on Antimicrobial Resistance' as a learning source for field level veterinarians in order to sensitize them regarding the rising concerns of antimicrobial resistance. In addition to that, GADVASU has conducted many workshops (GADVASU, 2021 March 27), seminars and FGDs for tackling the AMR threat. But these initiatives cannot act as a one stop solution and such type of actions ought to be promoted in future times also to minimize AMR. Awareness can be inculcated through various training programs for veterinarians and dairy farmers through the scientists from SAU/ICAR so that they go for rational usage of antimicrobials.

The statements related to subjective norm (SN) did not have favourable effect on veterinary doctors antimicrobial administration and treatment practices. About 58 percent of the

respondents disagreed or strongly disagreed that *'veterinary doctors feel some kind of pressure (pharmaceutical company, moral, peers etc.) while prescribing antimicrobials'*. The study was in contrast to the findings of McIntosh and Dean (2015) who reported SN played a major role in veterinarians prescription of antimicrobials. The contrasting result in the present study may be attributed veterinarians treatment pattern; which was not much affected by their peer group and referents approval/disapproval towards their prescription pattern. Majority (73.34 %) of the veterinarians agreed or strongly agreed that it is expected from them by farmers to prescribe antimicrobials in case of handling livestock treatment cases at farmers doorstep or at veterinary dispensary. Patnaik et al. (2020) reported that in most of health emergency cases, dairy farmers preferred allopathic treatment for their animals due to their effectiveness in curing diseases even though the overuse/sub optimal use of antimicrobials can result in drug resistant to infections. The respondents in the study area stated prompt treatment to diseased dairy animals gives best results in terms of farmers complying with the veterinarians post antimicrobial treatment instructions. These findings were in similar lines to Espetvedt et al. (2013) who reported that Nordic veterinarians strongly believed immediate administration of antimicrobials to treat sick livestock with mastitis would result in reduced herd somatic cell counts and give best outcomes.

Perceived behavioural control (PBC) statements revealed that veterinary doctors perceived of not possessing complete control over their treatment practice. About 83 percent of the respondents agreed or strongly agreed that *'following best practices while administering antimicrobials is generally difficult on the part of the veterinary doctor'*. The veterinarians stated that a number of factors were also involved in treatment decision making such as equipments available at dispensary, transportation for field visit, medicine and vaccine storage facilities and adequate staff. The PBC statements were important as it signalled towards the veterinarians prescription and treatment practices towards antimicrobial use in dairy. These findings corroborated with that of Limbert and Lamb (2002), Cortoos et al. (2012) found PBC to be an important factor in case of veterinarians full control over antimicrobials use which was due to the fact that in those study the veterinarians were private practitioners who were in full control of their treatment practices. The private practitioners were specialists in specific animals delivering services to their clients. On the contrary in our study, the veterinary doctors were working in public sector (State department, KVKs and Vety. Polyclinics) following institutional mandates and guidelines and were providing services to multiple species of dairy animals. Majority (68.33 %) of the respondents agreed or strongly agreed that *'past experience of veterinary doctor plays a major role in diagnosis of disease'*. Along with prior experience of disease treatment, the prescribing behaviour of veterinary doctors was dependent on ease of availability of the drugs, and providing quick relief to sick animals. Gibbons et al. (2012), Bryne et al. (2013) and Norris

et al. (2019) in their respective studies have also reported prior experience of the disease treatment as important factor in drug administration. Majority (90 %) of the veterinary doctors disagreed or strongly disagreed with the statement '*antimicrobials are expensive and it should be recommended to minimize its usage to reduce costs*'. The respondents reported that price of the antimicrobial and marketing offers from pharmaceutical companies were least affecting their treatment decision. For the statement '*narrow spectrum antimicrobials to be preferred over broad spectrum ones*' majority (83.34 %) of the respondents disagreed or strongly disagreed. A follow up open ended question was posed to the sampled veterinary doctors *i.e.* to name the most common antimicrobial class prescribed or administered by them. Ceftiofur, Ceftriazone, Ceftizoxim, Enrofloxacin, Gentamycin, Marbofloxacin, Methoxazole, Oxytetracycline, Streptopenicilin, Sulphadimene etc. were some of the most common antimicrobial class prescribed by veterinarians in the study area. The prescription of broad spectrum drugs was more prevalent than narrow spectrum drugs as reported by the respondents in the study area but this may lead to selection pressure of AMR. Marquardt and Li (2018) reported that use of broad spectrum antimicrobials leads to killing of beneficial commensal bacterial thus evolving resistance to drugs.

Conclusions

In developing country like India, antimicrobial resistance may act as a hindrance to its growth affecting the healthcare and dairy sector to a large extent. To mitigate the effects of AMR requires a holistic approach combining the field level behavioural aspects in addition to basic research. Understanding the consultation pattern of dairy farmers based on perceived credibility of treatment sources is an information pathway for targeted approach towards prudent antimicrobial use in dairy sector. Dairy farmers stated that in case of treating major ailments of sick animals, veterinary doctor was ranked most credible source. Paravets were ranked second and they mostly dealt with those diseases which were minor in nature involving least technicality. The credibility for veterinarians in treatment and healthcare management aspects signals that they can act as a medium for dissemination of antimicrobial related issues information to farmers. Though research evidence suggests that misuse of antimicrobials in livestock can contribute to resistance related problems, the surveyed veterinary doctors lacked awareness regarding AMR as an emerging problem in case of India. Awareness drives and training programs are needed to sensitize the veterinary doctors regarding ill effects of antimicrobial use which should be aimed towards their behaviour modification. The disagreement on ban of antimicrobial use by veterinary doctors highlights their concern towards poor farm management and animal husbandry practices of by dairy farmers. Surveillance and stewardship programs should be carried out to curb the adversities due to AMR by active participation of the

stakeholders in dairy such as dairy farmers, veterinary doctors, paravets and dairy co-operatives.

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