Knowledge, attitude and practice towards antibiotic use and resistance among the veterinarians in Bangladesh

Running title: Knowledge, attitude and practice towards antibiotic use and resistance

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NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
Abstract

Background

The emergence of antimicrobial resistance (AMR) is growing public health concern around the world. When a number of studies have emphasized the Knowledge, Attitude and Practice (KAP) regarding antibiotic use and resistance in humans, little attention has been paid to the veterinary sector. The aim of this study was to understand the KAP towards antibiotic use and resistance among the veterinarians in Bangladesh.

Methods

A cross-sectional online based questionnaire survey was conducted from August to September 2020 among the registered veterinary practitioners. A self-administered Google form questionnaire consists of 46 questions on knowledge, attitude and practice regarding antibiotic use and their resistance.

Results

A total of 208 registered veterinarians participated in this study. 85.1% of the participants were male and 55% of the participants had a Masters degree. Around 50% of the veterinarians were poultry practitioners. All respondents were familiar with antimicrobials. 91.35% of the participants knew that antibiotics can not cure viral infections while 97.6% believed that frequent antibiotic prescription rendered them less effective. Participants claimed that only they are eligible to prescribe drugs for the treatment of animals. Of the total participants, 87.02% believed that a local antimicrobial guideline would be more effective than an international one while...
around 80% disagreed with adding antibiotics with feed/water as a growth promoter in livestock. However, gaps in practices were highlighted, suggesting training deficiencies.

**Conclusion**

The study for the first time conducted in Bangladesh dictates the future interventions like courses, workshops, and seminars on antibiotic usage and resistance are needed to ameliorate the awareness and change the behavior of veterinarians with regards to the rational use of antibiotics while also considering individual motivations and justifications for using antibiotics.

**Introduction**

The global development of intensive farming has led to an upsurge in antimicrobial use (AMU) that leads to the emergence and spread of antimicrobial resistance (AMR) [1]. Irrational use of antibiotics in animals are considered one of the key drivers of AMR evolution [2]. Antibiotics are used as therapeutic as well as growth promotion purposes in animal farming practices. Worldwide consumption of antibiotics in animals are very high and it is expected to rise 67% by 2030 [1]. Most antibiotics are used in both human and animals interface, so the emergence of resistance through veterinary use is likely to have consequences on human health [3–5].

Bangladesh has been experiencing a high incidence of AMR [6,7]. Misuse and abuse of antibiotics are common both in humans and in animals in Bangladesh [6, 8–10]. A study with 73 poultry farms in Bangladesh reported higher usage of antibiotics without prescribing by registered veterinarians. The same study found the presence of residual antibiotics in 26% of the tested samples [10]. A study report revealed that majority of the antibiotics used in the poultry
farms were falls under Watch and Reserve group rather than Access [11]. Studies identified registered veterinarians also concerned with prescribing of higher classes of antibiotics [12,13]. The WHO recommends an overall reduction of medically important antimicrobial use in food-producing animals, as well as a complete cessation for disease prevention and growth promotion of food-producing animals [14]. The Government of Bangladesh has enacted “animal and fish feed act 2010” which prohibited the use of antibiotics in animal and fish feed [15], but subsequent studies showed that such laws were not properly enforced and the use of antibiotics with animal feeds is quite common [8–10]. This shows that unless raising awareness, motivational and ownership among the veterinarians, farmers, feed sellers, drug sellers, misuse of antibiotics in livestock will most likely continue to persist.

And any change in practice must start with the animal healthcare providers, followed by changes in the antibiotic usage among the farmers. To make effective and sustainable strategies, recommendations and treatment guidelines to maximize the therapeutic efficacy and reduce AMR in both human and animals, assessing the knowledge, attitude and practice (KAP) of veterinary practitioners are pertinent. Many countries has already been conducted similar studies to do deep this issue in a numbers perspective related to human and animals [16–20]. On the other hand, such study is still lacking from Bangladesh. In Bangladesh, the KAP regarding antibiotic use and resistance among veterinary students has been reported previously [21]. Therefore, in this study, we have explored the KAP of the veterinarians of Bangladesh regarding antibiotic use and resistance. To our best knowledge, this is the first antibiotic KAP study among the Bangladeshi veterinarians.
Materials and methods

A cross-sectional study was conducted for two months from August to September, 2020 among the registered veterinary practitioners of Bangladesh listed by the Bangladesh Veterinary Council (BVC)-government regulatory body of veterinary legislation and certification for veterinary practices in Bangladesh and practicing at field level to treat and prescribe the antibiotics for the animals.

Questionnaire development

An online based maximum 20 minutes long questionnaire was developed using the Google Forms platform by a multidisciplinary team consisting of microbiologist, public health specialist and epidemiologist. The questionnaire comprised of four sections: the first one consisted of the demographic information of the veterinarians, second section included 14 questions on knowledge on antibiotics and AMR, third section contained 14 questions on attitudes and fourth section had 18 questions on practices regarding antibiotic use and their resistance. The majority of the answers were in multiple choice format. The questionnaire was pretested among the scientists at the Antimicrobial Resistance Action Center (ARAC), Bangladesh Livestock Research Institute (BLRI). The questionnaire was circulated to the participants and requested them to provide the comments, suggestions and criticism. Finally, minor changes has been made in compliance with participants response and was circulated to the participants. All the participants in the pilot study were not allowed or included in the final survey. At all the stages of data collection and analysis, we maintained anonymous information for the survey. The participation in the survey was completely non-compulsory and unpaid. The study protocol was
reviewed and approved by the ARAC, Animal Health Research Division, BLRI, Bangladesh
(Approval no: 05/06/2020:06).

Data collection

Through social media like Facebook, LinkedIn etc. the questionnaire was posted and circulated in different veterinary professional groups. The social media based survey was launched on August 05, 2020. In mid-September, 2020, the online questionnaire link of questionnaire was also messaged or emailed to each registered veterinarian to boost the response rate.

Statistical analysis

Quantitative data were entered into MS excel-2013 (Microsoft Corporation, Redmond, WA 98052, USA) and analyzed in STATA/IC-13 (StataCorp, 4905, Lakeway Drive, College station, Texas 77845, USA). Descriptive analysis was conducted to determine the frequency and percentage of responses regarding knowledge, attitude and practices. We used Chi-square test or the Fisher exact test to identify the potential association between qualitative variables with different age groups of the veterinary practitioners. The statistical significance was set at $p <0.05$.

Results

Participants’ characteristics

A total number of 208 veterinarians responded and took part in the questionnaire survey from all eight administrative divisions of Bangladesh. Most of the participants were male (N=177;
85.1%), and 93.75% (N=195) were below 36 years of age. About 44% (N=92) had a Doctor of Veterinary Medicine (DVM) degree while about 55% (N=114) had a Master’s degree. Half of the veterinarians were poultry practitioners and the rest were large, small and pet animal practitioners. Around 31% (N=65) had an experience of greater than 5 years. Detailed characteristics of the participants are presented in Table 1.

Table 1. Sociodemographic characteristics of the participants

| Characteristic                | Number (n) | Percentage (%) |
|------------------------------|------------|----------------|
| Gender                       |            |                |
| Male                         | 177        | 85.10          |
| Female                       | 31         | 14.90          |
| Education                    |            |                |
| DVM                          | 92         | 44.23          |
| Masters                      | 114        | 54.81          |
| PhD                          | 2          | 0.96           |
| Age                          |            |                |
| 25-30 Years                  | 109        | 52.40          |
| 31-35 Years                  | 86         | 41.35          |
| 36-40 Years                  | 12         | 5.77           |
| Above 40 Years               | 1          | 0.48           |
| Field of expertise           |            |                |
| Poultry practitioner         | 108        | 51.92          |
| Pet animals’ practitioner    | 18         | 8.65           |
| Large & Small Animals’ Practitioner | 82   | 39.42          |
| Type of Service              |            |                |
| Private Services             | 155        | 74.52          |
| Governmental service         | 53         | 25.48          |
| Years of practice            |            |                |
| 0-1 Year                     | 39         | 18.75          |
| 1-3 Year                     | 63         | 30.29          |
| 3-5 Years                    | 41         | 19.71          |
| Above 5 Years                | 65         | 31.25          |
| Job location (Division)      |            |                |
| Dhaka                        | 59         | 28.37          |
| Chittagong                   | 71         | 34.13          |
| Rangpur                      | 17         | 8.17           |
| Khulna                       | 3          | 1.44           |
| Rajshahi                     | 30         | 14.42          |
| Barisal                      | 8          | 3.85           |
| Mymensingh                   | 15         | 7.21           |
| Sylhet                       | 5          | 2.40           |

Knowledge on antibiotics and AMR

Almost all respondents were familiar with antimicrobials and antibiotics, but 17.31% were unaware that antibiotics are different from antimicrobials (Table 2). Although most participants
(91.35%) knew that antibiotics cannot cure viral infections, 33.65% believed the use of antibiotics would speed up recovery from common cold, cough, and other viral infections. All of the vets were aware of antibiotic resistance and 97.6% knew that frequent prescription of antibiotics can render them less effective. However, some practitioners (6.73%) were unaware of the concept of antibiotic susceptibility testing. In addition, the knowledge of antibiotics, appropriate uses, resistance, antibiotics efficacy with organisms and effectiveness of biosecurity for reduction of antibiotics use were pointed out similar depth of clear perception in all categorized different aged vets (Table 3).

**Table 2. Veterinarian’s knowledge on antibiotic use and resistance**

| Questions                                                                 | Number (n) | Percentage (%) |
|---------------------------------------------------------------------------|------------|----------------|
| 1. Are you familiar with antimicrobials? (Ans-Yes)                        | Yes        | 208            | 100            |
|                                                                           | No         | 0              | 0              |
| 2. Are you familiar with antibiotics? (Ans-Yes)                           | Yes        | 207            | 99.52          |
|                                                                           | No         | 1              | 0.48           |
| 3. Do you think antibiotics are different from antimicrobials? (Ans-Yes)  | Yes        | 169            | 81.25          |
|                                                                           | No         | 36             | 17.31          |
|                                                                           | Blank/No Answer | 3       | 1.44           |
| 4. Do you know about antibiotic withdrawal period? (Ans-Yes)              | Yes        | 206            | 99.04          |
|                                                                           | No         | 2              | 0.96           |
| 5. Do you know about antibiotic susceptibility testing? (Ans-Yes)         | Yes        | 193            | 92.79          |
|                                                                           | No         | 14             | 6.73           |
|                                                                           | Blank      | 1              | 0.48           |
| 6. Do you know about antibiotic resistance? (Ans-Yes)                     | Yes        | 208            | 100.00         |
|                                                                           | No         | 0              | 0.00           |
| 7. Do you know any antibiotics that are prohibited to use in livestock? (Ans-Yes) | Yes   | 197            | 94.71          |
|                                                                           | No         | 10             | 4.81           |
|                                                                           | Blank      | 1              | 0.48           |
| 8. Antibiotics can be used to cure infections caused by bacteria (Ans -True) | TRUE     | 205            | 98.56          |
|                                                                           | FALSE      | 2              | 0.96           |
|                                                                           | Blank      | 1              | 0.48           |
| 9. Antibiotics can be used to cure infections caused by viruses (Ans -False) | TRUE     | 15             | 7.21           |
|                                                                           | FALSE      | 190            | 91.35          |
|                                                                           | Blank      | 3              | 1.44           |
| 10. Do you think the use of antibiotics will speed up the recovery of cold, cough, and other diseases caused by the common flu virus? (Ans -No) | Yes | 70            | 33.65          |
|                                                                           | No         | 138            | 66.35          |
| 11. Do you think frequent prescription of antibiotics will decrease their efficacy? (Ans -Yes) | Yes | 203            | 97.60          |
|                                                                           | No         | 4              | 1.92           |
12. Do you think antibiotics should be used for disease prevention? (Ans - No)

|   | Yes | No |
|---|-----|----|
|   | 18  | 8.65 |

13. Do you think antibiotic drug residues and drug resistance will occur when antibiotics are not used prudently? (Ans - Yes)

|   | Yes | No |
|---|-----|----|
|   | 188 | 90.38 |

14. Do you think biosecurity and improved hygiene can reduce the use of antibiotics? (Ans - Yes)

|   | Yes | No |
|---|-----|----|
|   | 208 | 100.00 |

Table 3. Relationship between veterinarian’s knowledge on antibiotic use/resistance to age groups

| Knowledge Statements | Univariate analysis |
|----------------------|--------------------|
|                      | Age groups         | P value |
|                      | 25-30=1 | 31-35=2 | >36 |
| 1. Do you know ‘antimicrobial’? (Ans-Yes)  | |
| Yes                  | 109 (100) | 86 (100) | 13 (100) |
| No                   |           |         |         |
| 2. Are you familiar with the concept of antibiotics? (Ans-Yes) | |
| Yes                  | 109 (100) | 85 (98.88) | 13 (100) |
| No                   | 0         | 1 (0.12) | 0 |
| 3. Do you think that antibiotic is different from antimicrobials? (Ans-Yes) | |
| Yes                  | 88 (80.73) | 70 (81.40) | 11 (84.62) |
| No                   | 20 (18.35) | 14 (16.28) | 02 (15.38) |
| Blank/No Answer      | 01 (0.92) | 02 (0.23) | 0 |
| 4. Do you know about antibiotic withdrawal period? (Ans-Yes) | |
| Yes                  | 108 (99.08) | 85 (98.84) | 13 (100) |
| No                   | 01 (0.92) | 01 (0.16) | 0 |
| 5. Do you know about antibiotic susceptibility testing? (Ans-Yes) | |
| Yes                  | 101 (92.66) | 82 (95.35) | 10 (76.92) |
| No                   | 08 (07.34) | 03 (03.49) | 03 (06.73) |
| Blank/No Answer      | 0         | 01 (0.16) | 0 |
| 6. Do you know about antibiotic resistance? (Ans-Yes) | |
| Yes                  | 109 (100) | 86 (100) | 13 (100) |
| No                   |           |         |         |
| 7. Do you know any antibiotics that are prohibited to use in livestock? (Ans-Yes) | |
| Yes                  | 105 (96.33) | 80 (93.02) | 12 (92.31) |
| No                   | 04 (03.67) | 05 (06.98) | 01 (07.69) |
| Blank/No Answer      | 0         | 01 (0.16) | 0 |
| 8. Antibiotics can be used to cure infections caused by bacteria (Ans - True) | |
| True                 | 107 (98.17) | 85 (98.84) | 13 (100) |
| False                | 02 (01.83) | 00 | 0 |
| Blank/No Answer      | 0         | 01 (0.16) | 0 |
| 9. Antibiotics can be used to cure infections caused by virus (Ans - False) | |
| True                 | 09 (08.26) | 06 (06.98) | 0 |
| False                | 98 (89.91) | 79 (91.86) | 13 (100) |
| Blank/No Answer      | 0         | 01 (0.16) | 0 |
| 10. Do you think the use of antibiotics will speed up recovery of cold, cough and other diseases caused by common flu virus? (Ans-No) | |
| Yes                  | 42 (38.53) | 25 (29.07) | 03 (23.08) |
| No                   | 67 (61.47) | 61 (70.93) | 10 (76.92) |

11. Do you think frequent prescribe of antibiotics will decrease the efficacy of drug? (Ans-Yes)
|   | Yes          | No          | Blank       |
|---|--------------|-------------|-------------|
| 12. Do you think antibiotic should be used for disease prevention? (Ans-No) | 107 (98.17) | 83 (96.51) | 13 (100) |
| 13. Do you think antibiotic drug residues and drug resistance will occur when antibiotics are not used prudently? (Ans-Yes) | 08 (07.34) | 07 (08.14) | 03 (23.08) |
| 14. Do you think biosecurity and improved hygiene can reduce the use of antibiotics? (Ans-Yes) | 104 (95.41) | 75 (87.21) | 09 (69.23) |

**Attitude towards antibiotic use and resistance**

Out of the 208 participants, 207 opinioned that only veterinarians are eligible to prescribe drugs for animals (Table 4). Moreover, nearly all agreed that antibiotic abuse is prevalent in veterinary practices in Bangladesh. Practitioners also had a positive attitude towards vaccination for the purpose of preventing diseases and for reducing the use of antibiotics in animals. Most practitioners (99.04%) felt that national guideline on rational antibiotic use is necessary and 87.02% believed a local antimicrobial guideline would be more useful than an international one. Around 80% disagreed with adding antibiotics with feed/water as a growth promoter in poultry and livestock. Regarding the major reasons of antibiotic resistance, irrational use of antibiotics was identified as the primary cause by 94.71%, followed by over-the-counter use, low dose, low-quality antibiotics, and waste disposal of antibiotics (Fig 1). Besides, the attitude towards antibiotics use and resistance among different aged group vets were varied especially in middle aged vets (31-35 years). The lack of exposure and training regarding antibiotics in middle aged vets has impacts on attitude regarding antibiotics and resistance. Importantly, all vets group showed indifference attitude if individual or animal could not be treated with antibiotics.
Besides, almost all practitioners agreed that vaccination could reduce the use of antibiotics and resistance (Table 5).

**Table 4. Practitioner’s attitude towards antibiotic use and resistance**

| Questions                                                                 | Number (n) | Percentage (%) |
|---------------------------------------------------------------------------|------------|----------------|
| 1. In your opinion, only veterinarians are eligible to prescribe drugs for animals | Yes: 207 | 99.52          |
|                                                                           | No: 1      | 0.48           |
| 2. At present, there is abuse of antibiotics                              | Yes: 205  | 98.56          |
|                                                                           | No: 3      | 1.44           |
| 3. Antibiotic resistance affects you and your family’s health             | Agree: 206| 99.04          |
|                                                                           | Disagree: 0| 0.00           |
|                                                                           | Neutral: 2 | 0.96           |
| 4. When a disease in an individual can't be treated with antibiotics, how serious do you think it could be? | Very serious: 119 | 57.21          |
|                                                                           | Serious: 55 | 25.48          |
|                                                                           | Less serious: 11 | 5.29          |
|                                                                           | Not serious at all: 24 | 11.54         |
|                                                                           | Blank: 1   | 0.48           |
| 5. When a disease in an animal cannot be treated with antibiotics, how serious do you think it could be? | Very serious: 114 | 54.81          |
|                                                                           | Serious: 60 | 28.85          |
|                                                                           | Less serious: 10 | 4.81          |
|                                                                           | Not serious at all: 22 | 10.58         |
|                                                                           | Blank: 2   | 0.96           |
| 6. Do you think vaccination can prevent disease?                          | Yes: 207  | 99.52          |
|                                                                           | No: 1      | 0.48           |
| 7. Do you think vaccination can reduce the use of antibiotics?            | Yes: 203  | 97.60          |
|                                                                           | No: 5      | 2.40           |
| 8. Is it necessary to establish a law on “Rational use of antibiotics” at the national level? | Yes: 206  | 99.04          |
|                                                                           | No: 2      | 0.96           |
| 9. A local antimicrobial guideline would be more useful than an international one | Yes: 181  | 87.02          |
|                                                                           | No: 26     | 12.50          |
|                                                                           | Blank: 1   | 0.48           |
| 10. It is important to add antibiotics with feed/water as a growth promoter in livestock | Agree: 10 | 4.81           |
|                                                                           | Disagree: 165 | 79.33         |
|                                                                           | Neutral: 32 | 15.38          |
|                                                                           | Blank: 1   | 0.48           |
| 11. Inappropriate use or half course of antibiotics leads to antibiotic resistance | Agree: 203 | 97.60          |
|                                                                           | Disagree: 1 | 0.48          |
|                                                                           | Neutral: 3 | 1.44           |
|                                                                           | Blank: 1   | 0.48           |
| 12. An appropriate withdrawal period is needed before selling to avoid antibiotic residue in food animals? | Agree: 205 | 98.56          |
|                                                                           | Disagree: 0 | 0.00           |
|                                                                           | Neutral: 2 | 0.96           |
|                                                                           | Blank: 1   | 0.48           |
| 14. Have you ever attended any training/conference/seminar/workshop on antimicrobial resistance? | Yes: 127  | 61.06          |
|                                                                           | No: 81     | 38.94          |
### Fig 1. Major reasons of AMR indicated by the veterinarians

### Table 5. Relationship between veterinarian’s attitude on antibiotic use/resistance and age groups

| Attitude Statements                                                                 | Univariate analysis | Age group | P value |
|-------------------------------------------------------------------------------------|---------------------|-----------|---------|
| 1. In your opinion, only veterinarians are eligible for drugs prescriptions for animals? |                     | 25-30=1   | 31-35=2 | >36     |
| Yes                                                                                 |                     | 108 (99.08) | 86 (100) | 13 (100) | 0.634 |
| No                                                                                  |                     | 01 (0.92)   | 00       | 0        | 0.634 |
| 2. At present, there is abuse of antibiotics                                         |                     | 107 (98.17) | 85 (98.84) | 13 (100) | 0.837 |
| Yes                                                                                 |                     | 02 (01.83)  | 01 (01.16) | 0        | 0.837 |
| No                                                                                  |                     | 01 (0.92)   | 01 (01.16) | 0        | 0.837 |
| 3. Antibiotic resistance affects you and your family’s health                        |                     | 108 (99.08) | 85 (98.84) | 13 (100) | 0.921 |
| Agree                                                                               |                     | 00         | 00       | 0        | 0.921 |
| Disagree                                                                            |                     | 00         | 00       | 0        | 0.921 |
| Neutral                                                                             |                     | 00         | 00       | 0        | 0.921 |
| 4. When a disease in individual can’t be treated with antibiotics, how serious do you think it could be? |                     | 105 (96.33) | 85 (98.84) | 13 (100) | 0.443 |
| Very serious                                                                        |                     | 64 (58.72)  | 44 (51.16) | 06 (46.15) | 0.177 |
| Serious                                                                             |                     | 28 (25.69)  | 29 (33.72) | 03 (23.08) | 0.177 |
| Not serious                                                                         |                     | 08 (07.34)  | 02 (02.33) | 0        | 0.177 |
| Not serious at all                                                                  |                     | 08 (07.34)  | 10 (11.63) | 04 (30.77) | 0.177 |
| Blank                                                                               |                     | 01 (0.92)   | 01 (01.16) | 0        | 0.177 |
| 5. When a disease in animal cannot be treated with antibiotics, how serious do you think it could be? |                     | 107 (95.33) | 85 (98.84) | 13 (100) | 0.654 |
| Very serious                                                                        |                     | 67 (61.47)  | 46 (53.49) | 06 (46.15) | 0.654 |
| Serious                                                                             |                     | 24 (22.02)  | 26 (30.23) | 03 (23.08) | 0.654 |
| Not serious                                                                         |                     | 09 (08.26)  | 02 (02.33) | 0        | 0.654 |
| Not serious at all                                                                  |                     | 08 (07.34)  | 12 (13.95) | 04 (30.77) | 0.654 |
| Blank                                                                               |                     | 01 (0.92)   | 00       | 0        | 0.654 |
| 6. Do you think vaccination can prevent disease?                                     |                     | 107 (98.17) | 86 (100)  | 13 (100) | 0.443 |
| Yes                                                                                 |                     | 105 (96.33) | 85 (98.84) | 13 (100) | 0.443 |
| No                                                                                  |                     | 04 (03.67)  | 01 (01.16) | 0        | 0.443 |
| 7. Do you think vaccination can reduce the uses of antibiotics?                      |                     | 107 (98.17) | 86 (100)  | 13 (100) | 0.443 |
| Yes                                                                                 |                     | 105 (96.33) | 85 (98.84) | 13 (100) | 0.443 |
| No                                                                                  |                     | 04 (03.67)  | 01 (01.16) | 0        | 0.443 |
| 8. Is it necessary to establish a law on “Rational use of antibiotics” at the national level? |                     | 107 (98.17) | 86 (100)  | 13 (100) | 0.443 |
| Yes                                                                                 |                     | 105 (96.33) | 85 (98.84) | 13 (100) | 0.443 |
| No                                                                                  |                     | 04 (03.67)  | 01 (01.16) | 0        | 0.443 |
| 9. A local antimicrobial guideline would be more useful than international one        |                     | 91 (83.49)  | 79 (91.86) | 11 (84.62) | 0.0001 |
| Yes                                                                                 |                     | 17 (15.60)  | 07 (08.14) | 02 (15.38) | 0.0001 |
| No                                                                                  |                     | 01 (0.92)   | 00       | 0        | 0.0001 |
| 10. It is important to add antibiotic with feed/water as growth promoter in livestock |                     | 108 (99.08) | 85 (98.84) | 10 (76.92) | 0.134 |
| Agree                                                                               |                     | 02 (01.83)  | 08 (09.30) | 0        | 0.134 |
| Disagree                                                                            |                     | 00         | 00       | 0        | 0.134 |
| Neutral                                                                             |                     | 00         | 00       | 0        | 0.134 |
| 11. Inappropriate use or half course of antibiotics leads to antibiotic resistance   |                     | 108 (99.08) | 85 (98.84) | 10 (76.92) | 0.134 |
| Agree                                                                               |                     | 02 (01.83)  | 08 (09.30) | 0        | 0.134 |
| Disagree                                                                            |                     | 00         | 00       | 0        | 0.134 |
| Neutral                                                                             |                     | 00         | 00       | 0        | 0.134 |
| 12. An appropriate withdrawal period is needed before selling to avoid antibiotic residue in food animal | | | | |
| Agree                                                                               |                     | 107 (98.17) | 86 (100)  | 13 (100) | 0.443 |
| Disagree                                                                            |                     | 00         | 00       | 0        | 0.443 |
| Neutral                                                                             |                     | 00         | 00       | 0        | 0.443 |
| 13. Have you ever attended any training/conference/seminar/workshop on antimicrobial resistance? |                     | 69 (63.30)  | 49 (56.98) | 09 (69.23) | 0.549 |
| Yes                                                                                 |                     | 40 (36.70)  | 37 (43.02) | 04 (30.77) | 0.549 |
| No                                                                                  |                     | 00         | 00       | 0        | 0.549 |
The practice of the veterinarians regarding antibiotic prescribing

The majority (70.19%) of the veterinarians reported that they sometimes prescribe antibiotics over the phone or without examining the animals (Table 6). Also, only 9.1% of the practitioners always or often recommend antimicrobial susceptibility testing before prescribing an antibiotic agents. Half of the participants prefer broad-spectrum antibiotics while the other half prefer narrow-spectrum antibiotics. Results also show that antibiotics constitute a large percentage of daily prescribed drugs. Moreover, combined antibiotic therapy is also preferred to single therapy by about 65% of the practitioners, and old generation antibiotics are preferred to new generation antibiotics by most (63.46%) as a first-line treatment. Some practitioners (25.96%) reported prescribing antibiotics without determining the bodyweight of the animals. Most practitioners (74.52) do not mention the antibiotic withdrawal period in the prescriptions. When exploring the factors considered by the vets while prescribing antibiotics, the severity of the disease was found to be the most important factor (Fig 2). The vets also considered other factors such as availability of an antibiotic in the local market, culture sensitivity test report, economic status of the owner, and owners’ demand for antibiotics. There was no significant variation in relation with practitioners age and antibiotic practices. But, young veterinarians were more concerned regarding drug choice, antibiotic susceptibility testing, resistance patterns with compared to middle aged vets where experienced vets group showed same level of expertise (Table 7).
### Table 6. Practice of veterinary practitioner’s regarding antibiotic and resistance

| Questions                                                                 | Number (n) | Percentage (%) |
|---------------------------------------------------------------------------|------------|----------------|
| 1. Do you prescribe antibiotics over phone or without seeing/examining animals? |            |                |
| Often/Always                                                              | 6          | 2.88           |
| Sometimes                                                                 | 146        | 70.19          |
| Never/rarely                                                              | 56         | 26.92          |
| 2. Do you have facilities in your area to test antimicrobial sensitivity? |            |                |
| Yes                                                                       | 93         | 44.71          |
| No                                                                        | 115        | 55.29          |
| 3. How often on a first visit to a farm you suggest antimicrobial susceptibility testing if you suspect a bacterial infection is present? |            |                |
| Often/Always                                                              | 19         | 9.13           |
| Sometimes                                                                 | 104        | 50.00          |
| Never/rarely                                                              | 85         | 40.87          |
| 4. How often do you carry out antimicrobial susceptibility testing, when a pathogen has not responded to the first antibiotic used? |            |                |
| Often/Always                                                              | 41         | 19.71          |
| Sometimes                                                                 | 111        | 53.37          |
| Never/rarely                                                              | 56         | 26.92          |
| 5. How often do you encounter a poor clinical response to an antimicrobial used? |            |                |
| Often/Always                                                              | 19         | 9.13           |
| Sometimes                                                                 | 170        | 81.73          |
| Never/rarely                                                              | 17         | 8.17           |
| Blank                                                                     | 2          | 0.96           |
| 6. How commonly do you feel that poor clinical response may be due to antimicrobial resistance? |            |                |
| Often/Always                                                              | 76         | 36.54          |
| Sometimes                                                                 | 124        | 59.62          |
| Never/rarely                                                              | 7          | 3.37           |
| Blank                                                                     | 1          | 0.48           |
| 7. How many times have you had to change an antimicrobial agent because of resistance confirmed on antimicrobial susceptibility testing? |            |                |
| Often/Always                                                              | 50         | 24.04          |
| Sometimes                                                                 | 118        | 56.73          |
| Never/rarely                                                              | 39         | 18.75          |
| Blank                                                                     | 1          | 0.48           |
| 9. Which spectrum of antibiotics do you prefer most?                       |            |                |
| Broad spectrum                                                            | 104        | 50.00          |
| Narrow spectrum                                                           | 104        | 50.00          |
| 10. What percentage of your daily prescriptions has antibiotics?           |            |                |
| <20                                                                       | 54         | 25.96          |
| 20% to 40%                                                                | 95         | 45.67          |
| 40% to 60%                                                                | 59         | 28.37          |
| Above 60%                                                                 | 0          | 0.00           |
| 11. Do you mention withdrawal period in the prescription?                 |            |                |
| Yes                                                                       | 53         | 25.48          |
| No                                                                        | 155        | 74.52          |
| 12. Do you suggest keeping drug register of animals?                       |            |                |
| Yes                                                                       | 155        | 74.52          |
| No                                                                        | 52         | 25.00          |
| Blank                                                                     | 1          | 0.48           |
| 13. Do you prefer combine antibiotics to ensure therapeutic success?        |            |                |
| Yes                                                                       | 135        | 64.90          |
| No                                                                        | 73         | 35.10          |
| 14. Do you administer antibiotics to animals without determining their body weight properly? |            |                |
| Yes                                                                       | 54         | 25.96          |
| No                                                                        | 153        | 73.56          |
| Blank                                                                     | 1          | 0.48           |
| 15. Do you consider whether an infection is self-limiting before prescribing antibiotics? |            |                |
| Yes                                                                       | 162        | 77.88          |
| No                                                                        | 44         | 21.15          |
| Blank                                                                     | 2          | 0.96           |
| 16. As the first line of treatment, do you choose new generation antibiotics rather than older generations like penicillin? |            |                |
| Yes                                                                       | 76         | 36.54          |
| No                                                                        | 132        | 63.46          |
| 17. Do you consult with other veterinarian/other educational resources when in doubt of a drug’s mechanism of action? |            |                |
| Yes                                                                       | 199        | 95.67          |
### Fig 2. Factors considered by veterinarians while prescribing antibiotics

### Table 7. Relationship between veterinarian’s practice on antibiotic use leads to antibiotic resistance and age groups

| Practice Statements                                      | Univariate analysis | Age groups | P value |
|---------------------------------------------------------|---------------------|------------|---------|
| 1. Do you prescribe antibiotics over phone or without seeing/examining animals? |                     | 25-30=1    | 31-35=2 | >36     |
| Often/Always                                            | 05 (04.59)          | 01 (01.16) | 01 (01.16) | 0       |
| Sometimes                                               | 70 (64.22)          | 67 (77.91) | 09 (69.23) | 0.231   |
| Never/rarely                                            | 34 (31.19)          | 18 (20.93) | 04 (30.77) |         |
| 2. Do you have facilities in your area to test antimicrobial sensitivity? |                     | 25-30=1    | 31-35=2 | >36     |
| Yes                                                     | 46 (42.20)          | 43 (50.00) | 04 (30.77) | 0.321   |
| No                                                      | 63 (57.80)          | 43 (50.00) | 09 (69.23) |         |
| 3. How often on a first visit to a farm you suggest antimicrobial susceptibility testing if you suspect a bacterial infection is present? |                     | 25-30=1    | 31-35=2 | >36     |
| Often/Always                                            | 08 (07.34)          | 10 (11.63) | 01 (07.69) | 0.854   |
| Sometimes                                               | 57 (52.29)          | 41 (47.67) | 06 (46.15) |         |
| Never/rarely                                            | 44 (40.37)          | 35 (40.70) | 06 (46.15) |         |
| 4. How often do you suggest antimicrobial susceptibility testing, when a pathogen has not responded to the first antibiotic used? |                     | 25-30=1    | 31-35=2 | >36     |
| Often/Always                                            | 25 (22.94)          | 14 (16.28) | 02 (15.38) | 0.492   |
| Sometimes                                               | 60 (55.05)          | 44 (51.16) | 07 (53.85) |         |
| Never/rarely                                            | 24 (22.02)          | 28 (32.56) | 04 (30.77) |         |
| 5. How often do you encounter a poor clinical response to an antimicrobial used? |                     | 25-30=1    | 31-35=2 | >36     |
| Often/Always                                            | 14 (12.84)          | 05 (05.81) | 01 (01.16) | 0.185   |
| Sometimes                                               | 82 (75.23)          | 75 (87.21) | 13 (100) |         |
| Never/rarely                                            | 11 (10.09)          | 06 (06.98) | 01 (07.69) |         |
| Blank                                                   | 02 (01.83)          | 00 (00.00) | 01 (01.16) |         |
| 6. How commonly do you feel that poor clinical response may be due to antimicrobial resistance? |                     | 25-30=1    | 31-35=2 | >36     |
| Often/Always                                            | 48 (44.04)          | 24 (27.91) | 04 (30.77) | 0.118   |
| Sometimes                                               | 56 (51.38)          | 60 (69.77) | 08 (61.54) |         |
| Never/rarely                                            | 05 (04.59)          | 01 (01.16) | 01 (07.69) |         |
| Blank                                                   | 01 (01.16)          | 01 (01.16) | 01 (01.16) |         |
| 7. How often have you had to change an antimicrobial agent because of resistance confirmed on antimicrobial susceptibility testing? |                     | 25-30=1    | 31-35=2 | >36     |
| Often/Always                                            | 23 (21.10)          | 23 (26.74) | 04 (30.77) | 0.839   |
| Sometimes                                               | 65 (59.63)          | 46 (53.49) | 07 (53.85) |         |
| Never/rarely                                            | 21 (19.27)          | 16 (18.60) | 02 (15.38) |         |
| Blank                                                   | 01 (01.16)          | 01 (01.16) | 01 (01.16) |         |
| 8. What are the factor/factors you consider for prescribing antibiotics? |                     |            |         |         |
| Severity of the disease                                 | 53                  | 32.00      | 6       |
| Culture sensitivity test report                          | 5                   | 4.00       | 2       |
| Economic status of the owner                             | 1                   |            |         |
| Availability at the local market                        | 3                   |            |         |
| Owner’s demand, Severity of the disease, Availability at the local market | 1               |            |         |
| Severity of the disease, Culture sensitivity test report | 9                   | 4.00       |         |
| Severity of the disease, Availability at the local market, Culture sensitivity test report | 10               | 6.00       |         |
| Severity of the disease, Availability at the local market | 4                   | 11.00      |         |
| Economic status of the owner, Severity of the disease    | 5                   | 2.00       |         |
| Economic status of the owner, Severity of the disease, Availability at the local market, Culture sensitivity test report | 8 | 8.00 | 1 |
| Economic status of the owner, Severity of the disease, Availability at the local market | 7 | 11.00 | 1 |
| Availability at the local market, Culture sensitivity test report | 1.00 |
| Economic status of the owner, Availability at the local market | 1 |
| Economic status of the owner, Severity of the disease, Culture sensitivity test report | 1.00 |
| Owner’s demand, Economic status of the owner, Severity of the disease | 1 |
| Owner’s demand, Economic status of the owner, Severity of the disease, Availability at the local market | 2 |
| Owner’s demand, Economic status of the owner, Severity of the disease, Availability at the local market, Culture sensitivity test report | 2.00 |

| Owner’s demand, Economic status of the owner, Severity of the disease, Availability at the local market, Culture sensitivity test report | 0.059 |
| --- | --- |
| 9. Which spectrum of antibiotics do you prefer most? |  |
| Broad spectrum | 55 (50.46) | 41 (47.67) | 08 (61.54) |
| Narrow spectrum | 54 (49.54) | 45 (52.33) | 05 (38.46) |
| 10. What percentage of your daily prescriptions has antibiotics? |  |
| <20 | 29 (26.61) | 21 (24.42) | 04 (30.77) |
| 20% to 40% | 48 (44.04) | 41 (47.67) | 06 (46.15) |
| 40% to 60% | 32 (29.36) | 24 (27.91) | 03 (23.08) |
| Above 60% | 0 | 0.00 | 0 |
| 11. Do you mention withdrawal period in the prescription? |  |
| Yes | 35 (32.11) | 16 (18.60) | 02 (15.38) |
| No | 74 (67.89) | 70 (81.40) | 11 (84.62) |
| 12. Do you suggest keeping drug register of animals? |  |
| Yes | 83 (76.15) | 65 (75.58) | 07 (53.85) |
| No | 26 (23.85) | 21 (24.42) | 05 (38.46) |
| Blank | 0 | 0.00 | 0 |
| 13. Do you prefer combine antibiotics to ensure therapeutic success? |  |
| Yes | 70 (64.22) | 57 (66.28) | 08 (61.54) |
| No | 39 (35.78) | 29 (33.72) | 05 (38.46) |
| 14. Do you administer antibiotics to animals without determining their body weight properly? |  |
| Yes | 28 (25.69) | 22 (25.58) | 04 (30.77) |
| No | 80 (73.39) | 64 (74.42) | 09 (69.23) |
| Blank | 0 | 0.00 | 0 |
| 15. Do you consider whether an infection is self-limiting before prescribing antibiotics? |  |
| Yes | 93 (85.32) | 59 (68.60) | 10 (76.92) |
| No | 16 (14.68) | 25 (29.07) | 03 (23.08) |
| Blank | 0 | 02 (02.33) | 0 |
| 16. As the first line of treatment, do you choose new generation antibiotics rather than older generations like penicillin? |  |
| Yes | 34 (31.19) | 36 (41.86) | 06 (46.15) |
| No | 75 (68.81) | 50 (58.14) | 07 (53.85) |
| 17. Do you consult with other veterinarian/other educational resources when in doubt of a drug’s mechanism of action? |  |
| Yes | 104 (94.41) | 83 (96.51) | 12 (92.31) |
| No | 05 (04.59) | 03 (03.49) | 01 (07.69) |
| 18. Do you suggest clients to vaccinate their animals against preventable diseases? |  |
| Yes | 108 (99.08) | 86 (100) | 11 (84.62) |
| No | 01 (0.92) | 0.00 | 02 (15.38) |

### Discussion

The present study explored the knowledge, attitude, and practice of the Bangladeshi veterinary practitioners regarding antibiotic use and resistance. It was found that some vets had gaps in knowledge in certain crucial concepts, for example, many practitioners considered antibiotics
and antimicrobials to be the same. Failure to differentiate between antimicrobials and antibiotics and their roles can be a major reason for inappropriate antibiotic prescribing such as prescribing antibiotics for viral infections. Another surprising finding was that although most knew that antibiotics cannot cure viral infections, one-third of the vets believed antibiotics would speed up cold, cough, or other viral infections. However, there is no evidence that antibiotics can cure viral infections or speed up recovery of viral infections such as common cold [22,23].

Nearly all veterinarians were aware of antibiotic withdrawal period and considered it important to maintain an appropriate withdrawal period prior to selling animals treated with antibiotics in order to avoid antibiotic residues in animals. However paradoxically, while prescribing antibiotics, only one out of four practitioners mentioned the withdrawal period in the prescriptions. This may happen probably because practitioners do not have the knowledge of the withdrawal periods of the specific antibiotics they prescribe, or because they think the farmers will not understand or follow instructions related to withdrawal periods anyway. Studies have shown that most Bangladeshi farmers do not have knowledge on antibiotic withdrawal period [10,11]. Non adherence to the required withdrawal periods may result in the presence of residual antibiotics in food animal products [24]. Antibiotic residues can be toxic to humans as well as may contribute to the development of AMR [24,25].

Prescribing antibiotics based on the results of susceptibility testing is recommended to make sure that the prescribed regimen is effective against the infection. However, in this study, such practice was not often followed by the practitioners even after the initial treatment failed. This can partially be explained by the fact that most areas of Bangladesh did not have any facility to test antimicrobial sensitivity, as reported by the veterinarians. The absence of susceptibility data can also promote combined antibiotic therapy since the vets may want to prescribe more than
one drug for maximizing the chance of therapeutic success with the hope that if one drug is found ineffective, the others will work. A study of the veterinary surgeons of the United Kingdom also reported similar findings where the surgeons only occasionally carried out susceptibility testing [26].

The use of antibiotics for disease prevention of animals by farmers and poultry dealers have been reported in Bangladesh [8], although such practices are not recommended [14]. Most veterinarians in this study do not consider the use of antimicrobials for disease prevention. Instead, the participants have shown a very positive attitude towards vaccination for both infection prevention and lowering the use of antibiotics. Given the fact that about half of the most significant animal diseases are of viral origins [27], vaccination can be very effective and efficient in lowering the occurrences of infectious diseases in animals and will subsequently confer financial gains to the farmers as well as help to minimize unnecessary use of antibiotics. Vaccines have also been recommended for infection prevention by WHO [14].

Participants were knowledgeable about antibiotic resistance, its causes, and its consequences. However, unless such knowledge is translated into practice, no real benefit will be achieved. We have identified a number of inappropriate practices by the veterinarians including excessive antibiotic prescribing, prescribing antibiotics over the phone without examining animals, not relying on susceptibility testing, not mentioning antibiotic withdrawal period in prescription, etc.

This survey revealed the varied difference in knowledge, attitude and practice of antibiotics use among different aged group of veterinarians in Bangladesh. It was not conclusively established the variation of predefined questions answer with the different aged group of vets. From this study it revealed that old aged vets with higher training or field based training have a higher knowledge of appropriate use of antibiotics and AMR. The difference has observed among vets
aged groups that possibly could have the link to work experiences over time. To understand the perceptions and barriers, further investigation is required to appropriate use of antibiotics in livestock and in poultry among the vets subpopulation. It would help the policy makers and academicians to ensure proper training and impart practical field based knowledge of appropriate use of antibiotics and AMR to the vets students, young vets and all level aged groups of vets.

Another major problem is Bangladeshi farmers rely more upon village doctors, traditional healers and drug sellers and consider government veterinarians as the last resort for seeking health services for their livestock [9]. This trend needs to change and qualified veterinarians should be the primary source of advice in order to promote rational antibiotic use. Veterinarians should also play an active role in dispelling misconceptions of the farmers surrounding antibiotics, and themselves should adopt the appropriate practices. The government should focus on implementing the laws pertaining to judicious use of antibiotics, as well as recruiting more qualified veterinarians so that farmers can have easy access to them.

Limitations

A few limitations were witnessed during conduct the current study. The number of participants in the survey was low that may be due to several factors such as unwillingness to participate or lack of internet accessibility. Sometimes respondents may have declined to share information they considered inappropriate or mistaken, resulting in an under-reporting of certain aspects on antibiotics and AMR knowledge and practices. The study could not meet the exact proportional number of respondents with anticipated geographic locations due to freedom of choice of the respondents.
Conclusion

The study findings suggest policy guidelines and advocacy to the public and private veterinarians in improving prudent use of antibiotics. Antimicrobial stewardship program in the public and private veterinary hospitals are needed to be initiated to promote the rational use of antibiotics. Improved knowledge and awareness of the veterinarians through continuous education and training can enhance the rational use of antibiotics. Dissemination of regularly updated national antibiotic use guidelines in food animals, understanding the role of good biosecurity and vaccination practices in disease prevention, including antimicrobial susceptibility testing at affordable costs with easy accessibility are the significant factors that need attention to combat the rising AMR in veterinary sector in Bangladesh.

Disclosure of potential conflicts of interest

The authors declare that they have no conflict of interest.

Supporting Information

S1 Text. Questionnaire for KAP survey on antibiotics and AMR.
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Severity of the disease: 92.79%
Availability at the local market: 39.42%
Culture sensitivity test report: 30.29%
Economic status of the owner: 27.40%
Owner's demand: 5.29%