**‘Ideal’ Versus ‘Real-World’: Application of Vignettes to Investigate Antibiotic Prescribing Decisions
by Farm Vets**

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Abstract

Antimicrobial resistance (AMR) represents a major threat to public and animal health, and inappropriate antimicrobial prescribing by doctors and vets is an important contributing factor to increasing rates of AMR. This study used vignettes, which are an under-utilised method in veterinary medicine research, to examine differences between farm vets’ ‘ideal’ antibiotic prescribing and their ‘real-world’ experiences of antibiotic prescribing. Vets attending the British Cattle Veterinary Association annual congress ($n = 16$) were presented with seven clinical scenarios relating to ailments in cattle and were asked to consider how likely they would be to prescribe antibiotics in each scenario, once in an ‘ideal, text-book’ situation, and once in a ‘real-world’ situation. Across all seven scenarios, participants reported being more likely to prescribe antibiotics in the ‘real-world’ situation compared to the ‘ideal, text-book’ situation. These results, based on the vignettes, support the hypothesis that farm vets’ everyday patterns of antibiotic prescribing are different from their ideals for antibiotic prescribing. It is recommended that further research is required to better understand how non-clinical factors influence vets’ prescribing decisions, in order to develop effective antimicrobial stewardship interventions that can help support vets to more frequently prescribe in line with stewardship ideals.

Introduction

Antimicrobial resistance (AMR) represents a profound threat to human and animal health (World Health Organisation (WHO) 2015) and food production will also be impacted by AMR (Bengtsson and Greko 2014). Solving the threats posed by AMR will require a collaborative, One Health approach that recognises that humans and other animals co-exist within one global ecosystem, and that learnings should be routinely shared between human and veterinary medicine (Gibbs 2014, Robinson and others 2016). Although AMR is a natural evolutionary process, increases in rates of resistance amongst microorganisms are driven partly by inappropriate antimicrobial prescribing by doctors, vets, and other prescribers (Hughes and others 2012, Trautfler and others 2014, Review on AMR 2015, Dyar and others 2016).

The antimicrobial prescribing decisions made by vets and doctors are not solely based on clinical information; these decisions are also influenced by a range of non-clinical factors including habit, emotions, and interactions with colleagues, clients, and patients (Gibbons and others 2013, Mattick and others 2014, Buller and others 2015, Higgins and others 2017, Smith and others 2018, Doidge and others 2019, Krockow and others 2019, Potthoff and others 2019). Time pressures and financial concerns also influence prescribers' treatment decisions (Mateus and others 2014, Hardefeldt and others 2018, King and others 2018, Golding and others 2019, Liu and others 2019). It seems likely, therefore, that non-clinical factors can act as barriers to appropriate, stewardship-aligned antimicrobial prescribing. Indeed, farm animal vets report that contextual factors relating to the farm and the farmer do prevent them from always prescribing antimicrobials in line with their own stewardship ideals (Golding and others 2019).

Despite this evidence of the impact of non-clinical influences on prescribing across both human and veterinary medicine, there is a difference in the current evidence base between the two disciplines. To date, much research has explored the impact of non-clinical factors on antimicrobial prescribing in human medicine (e.g. Tonkin-Crine and others 2011, Pinder and others 2015, Krockow and others 2019), with this extensive body of research now informing a range of stewardship interventions based on this understanding of non-clinical influences on prescribing behaviour (e.g. Hallsworth and others 2016, Tonkin-Crine and others 2017, Islam and others 2018). In contrast, there is a relative paucity of equivalent research in veterinary medicine, with recent rapid reviews highlighting that much of the existing veterinary research has been focused on patterns of antimicrobial prescribing and the influence of clinical factors on treatment decisions rather than on psychological and other non-clinical influences (Hockenhull and others 2017, Chambers and others 2020). There have been calls for more social science research to understand such influences on prescribing decisions in veterinary medicine (e.g. Buller and others 2015), and encouragingly, this

body of evidence is now growing. For example, recent publications have highlighted the influence of relationships between those vets or farmers prescribing and using antimicrobials and the key stakeholders they interact with (Bellet 2018, Hopman and others 2018, Smith and others 2018, Golding and others 2019), as well as the complexity of the system within which prescribing practices take place, with factors such as economics, concerns about competition, and local and national policies all influencing prescribing and usage of antimicrobials (Hardefeldt and others 2018, Hopman and others 2018, Begemann and others 2020, Redding and others 2020). This study aims to contribute to this growing body of evidence by using an experimental vignette methodology to examine vets' self-reported likelihood of prescribing antimicrobials in 'ideal' versus 'real-world' situations.

Vignette methodology. Experimental vignettes can be deployed in situations where a field-based experiment may be logistically or ethically challenging to conduct (Aguinis and Bradley 2014, Evans and others 2015). A vignette should have both experimental and control aspects; by only manipulating the experimental aspect of a vignette, researchers can ensure the vignettes have equivalence across different experimental conditions (Evans and others 2015). An acknowledged limitation of vignettes is the extent to which participants' responses accurately reflect their actual behaviour during clinical practice (Evans and others 2015) but there is reasonable evidence to support a correlation between participants' responses to vignettes and their actual behaviour (Peabody and others 2000, Veloski and others 2005, Evans and others 2015). Given this, experimental vignettes can potentially strike a balance between achieving sufficient internal validity so as to causally test the relationship between independent and dependent variables, whilst also maintaining some of the external validity that is more usually associated with field-based observational studies (which cannot address causation) (Aguinis and Bradley 2014, Evans and others 2015).

Vignettes have been widely used to explore different aspects of human medical consultations and decisions (e.g. Bachmann and others 2008, Saposnik and others 2016). At the time this study was conceived, vignettes appeared to be relatively under-utilised in veterinary research (e.g. Moore 2003, Collins and others 2009, Espetvedt and others 2013, Mateus and others 2014), although a number of recent studies suggest this may be changing (e.g. Magalhães-Sant'Ana and others 2016, White et al 2018, Goins and others 2019, Shalvey and others 2019). Within the context of AMR, however, only a handful of published studies in veterinary medicine have made use of vignettes (e.g. Espetvedt and others 2013, Mateus and others 2014, van Cleven and others 2018, Doidge and others 2019). For example, in one qualitative study, vignettes were used as a tool to prompt discussion with UK-based companion animal vets about their antimicrobial treatment

decisions (Mateus and others 2014). Another study in Belgium used vignettes to compare companion animal vets' compliance with antimicrobial prescribing guidelines; compliance varied between clinical scenarios and vets often prescribed second-choice treatments as their first-line option (van Cleven and others 2018). A third study explored the effects of psychosocial variables on vets' prescribing decisions when the farmer attended the vet practice to request antibiotics. This study found that antibiotic prescribing was influenced by factors such as habit, farmer relationship, and prescribing practices of other vets (Doidge and others 2019).

Within human medicine, however, vignette methodologies have been much more widely used. For example, systematic reviews have identified that vignettes have been used to investigate treatment and diagnostic decisions made by doctors and nurses across a variety of conditions including cancer, hypertension, and various infections (Bachmann and others 2008, Saposnik and others 2016). Vignettes have also been used within human medicine to explore GPs' decisions about first-line treatment recommendations for different conditions (Gardner and Ogden 2005) and to demonstrate that patients' beliefs about illness severity appear to differ according to the language used by GPs (Tayler and Ogden 2005, Tailor and Ogden 2009). Within the context of AMR, vignettes have been used to explore factors influencing antibiotic prescriptions for children with upper respiratory tract infections (Arnold and others 2005), to investigate GPs' management plans for sore throat and coughs (Llor and others 2017), and to examine hospital doctors' diagnostic and treatment decisions for skin infections, pneumonia, and bacteriuria (Livorsi and others 2016).

Aims and hypothesis. The aim of this within-participant study was to apply an experimental vignette methodology to examine potential differences in vets' antibiotic prescribing when they were asked to consider their own, everyday prescribing in comparison to 'ideal' prescribing, and to examine whether there would be variation in prescribing differences across different clinical scenarios. The study also sought to examine whether certain clinical scenarios were associated with a greater difference between ideal and real-world prescribing. Participants in this study were presented with seven vignettes that described clinical scenarios involving cattle and were asked to report their likely antibiotic prescribing behaviour in two situations: an 'ideal, text-book situation' and their 'real-world, day-to-day experience'. The experimental hypothesis was therefore: vets will report greater likelihood of prescribing antibiotics in the 'real-world' situations compared to the 'ideal, text-book' situations.

Materials and Methods

Study Design. This study used a paper-based survey to test within-participant differences in antimicrobial prescribing by farm vets across seven clinical scenarios in two conditions. Participants

were instructed to indicate how often they would use antibiotics in two versions of each of the seven clinical scenarios: 1) considering their own, day-to-day experience of prescribing (the ‘real-world’ situation) and 2) considering clinical information only, in an ideal, text-book situation (the ‘ideal’ situation).

Participants. Recruitment of a convenience sample of participants took place at the British Cattle Veterinary Association (BCVA) Annual Congress in October 2017, in Southport, UK. Delegates were approached in-person by two researchers (SG and HMM) during one afternoon of the congress and were asked if they would be willing to complete a short survey about prescribing. If they agreed, they were provided with the participant information sheet and the survey questions.

Measures.

Demographics. Participants were asked to provide their age, ethnicity, gender, and the year in which they qualified. They were also asked to state the counties in which they regularly worked, as well as the frequency with which they worked with various animals. None of these questions were mandatory.

The vignettes. Participants were presented with seven clinical scenarios that described cattle needing the attention of a vet; cattle were chosen for the vignettes as most farm vets in the UK will spend at least some of their time working with cattle and recruitment took place during a cattle conference. The scenarios were developed through consultation with a farm animal vet and Diplomate of the European College of Bovine Health Management, and scenarios were chosen to cover a range of clinical cases that would be commonly faced by farm vets. There was also expected to be some variation between vets across these scenarios, as in all cases selected, antimicrobials could potentially be prescribed, but may not be necessary.

The outcome measure was the likelihood of prescribing antibiotics in a given scenario. For each clinical scenario, participants were asked to respond twice about their prescribing; once for the ideal situation and once for the real-world situation. For the ideal situation, participants were asked: “Based strictly on clinical grounds, how often should you use antibiotics for each of these conditions in an ideal, ‘text-book’ scenario?”. For the real-world situation, participants were asked: “Based upon your day-to-day experience in clinical practice, how often do you use antibiotics for each of these conditions, in the ‘real-world’?”. Participants responded to both questions using a 5-point Likert scale: 1 (*never*), 2 (*occasionally*), 3 (*sometimes*), 4 (*often*), 5 (*always*). The text used for the scenarios presented to participants is reproduced in Table 1. After responding to the scenarios, participants were presented with a page for free-text responses with the following prompt: “If you have any other comments or thoughts about the questions or your answers, please do let us know here”.

Procedure. Individuals who agreed to participate were provided with five sheets of paper: the information sheet (which they could keep), the demographics questionnaire, the survey instructions, the clinical scenarios questionnaire, and the free-text box for comments. Participants were asked to state if any of the scenario wording was unclear or prompted questions. In order to minimise the chances of social desirability bias in participants' responses (where they might be reluctant to admit that their real-world prescribing differed from their ideal prescribing), the following instructions were provided to participants before they saw the clinical scenarios:

Some vets report that they sometimes make different decisions about antibiotic use depending on the situation they find themselves in. We are interested in understanding some of these differences in a bit more detail.

Overleaf are seven common scenarios experienced by vets who regularly attend to cattle.

Please read each of the below scenarios and think about the decision you might make in each scenario.

I would like you to think about each scenario (in the table overleaf) from two different perspectives:

1) Thinking about the last few months, based upon your own day-to-day experience in practice, think about how often you have used antibiotics in the 'real world'

2) Based solely on clinical grounds, thinking only about the animal's presentation, think about how often you should use antibiotics in an ideal, 'text-book' scenario

Don't worry if your actual practice is different from your 'ideal' - this is very common! We are really keen to know if there are some situations where vets find it easier to stick to their 'ideal' use of antibiotics, and other situations where vets are more likely to make a 'pragmatic' decision.

Participants were instructed to hand their surveys back to the researchers upon completion. The whole survey took no more than a few minutes for participants to complete.

Randomisation. To control for potential order effects, the order of presentation for the seven clinical scenarios was randomised across each printed survey. As participants had to respond twice to each scenario, the order of the response columns (for ideal and real-world prescribing) was also randomised. Random numbers were generated for this exercise using an online random number generator (Urbaniak and Plous 2015).

Data analysis. Due to the small sample size, Wilcoxon signed-rank tests were conducted to compare within-participant responses between ideal and real-world prescribing for each clinical scenario.

Ethics. Participants were advised that taking part was voluntary, and they could choose not to participate without providing a reason. Consent was presumed upon receipt of a completed survey and participants were provided with contact details for the research team. Participants were not recruited from a vulnerable or patient population and were not at significant risk during the study. The study was self-assessed by SG for ethical approval, in line with the University of Surrey's ethical review procedures.

Results

Participants were 16 vets (seven women, nine men); they all reported working in the UK (England, Wales, and Scotland) and spending at least some of their time working with cattle (see Table 2). The age range of participants was 26 to 45 years old (*mean* = 34.25, *standard deviation* = 6.07), and all described themselves as white. Participants reported being qualified for between 2 and 19 years (*mean* = 9.94, *standard deviation* = 5.51). For all but one of the clinical scenarios, the outcome measure (rates of antibiotic prescribing) was non-normally distributed for both the ideal and real-world situations; in most scenarios, the distribution of responses was positively skewed, with most participants in the ideal condition stating they would either *never* or *occasionally* prescribe antibiotics and most participants in the real-world condition stating they would *never*, *occasionally*, or *sometimes* prescribe antibiotics (see Figures 1 and 2).

Prescribing in ideal versus real-world situations. Across all seven clinical scenarios, participants reported using antibiotics more frequently in their day-to-day practice (the real-world situation) than they believed should be prescribed based solely on clinical information in an ideal, text-book (ideal) situation (see Table 3 and Figure 3). The differences in prescribing between the ideal and real-world conditions were tested using a series of Wilcoxon signed-rank tests, which were all statistically significant (see Table 3); these differences represented medium effects across five scenarios and large effects across two scenarios (dairy cow (drying off), $r = .52$ and dairy cow (IBR herd), $r = .52$). The experimental hypotheses were therefore retained: vets in this study did report greater use of antibiotics in real-world situations, compared to ideal situations, across seven different clinical scenarios.

Ranking the scenarios by level of prescribing identified that the highest level of prescribing in both ideal and real-world situations was reported for the dairy cow (drying off) scenario, and the lowest level of prescribing across both situations was reported for the dairy cow (lame) scenario (see Table 4). The largest mean difference in prescribing was seen in the dairy cow (IBR herd) scenario; this scenario ranked 5th highest for prescribing in the ideal situation but 2nd highest for prescribing in the real-world situation.

Discussion

This within-participant study sought to quantitatively assess whether farm vets' self-reported frequency of antibiotic prescribing in real-world situations differed from the level of antibiotic prescribing they believed should occur in ideal, text-book situations, when they were asked to think about their own prescribing in response to hypothetical clinical scenarios. The results identified that farm vets in this study consistently reported that they were more likely to prescribe antibiotics when asked to think about their own day-to-day experience of real-world situations compared to when they were asked to consider only clinical information in an ideal, text-book situation. This pattern of higher self-reported likelihood of prescribing in hypothetical real-world situations was identified across seven different clinical scenarios involving cattle and supports the hypothesis that farm vets are indeed influenced in their prescribing by contextual factors that they experience in their everyday prescribing practice. Across most scenarios, at least half of the participants reported that they would never or only occasionally prescribe antibiotics in the real-world; nonetheless, the frequency of these two responses was still lower across all seven scenarios in the hypothetical real-world scenarios compared to the ideal scenarios.

There was variation between the scenarios in terms of the amount of antibiotics vets reported they would likely prescribe, with participants being more likely to prescribe in some clinical scenarios than others, regardless of whether they were thinking about their ideal prescribing or their real-world prescribing (e.g. the dairy cow (drying off) scenario ranked highest for likelihood of prescribing across both conditions). This suggests a possible difference between the vignettes in terms of clinical factors, such as differing likelihood of bacterial infection or risk of complications. There was, however, also variation in the relative ranking of scenarios between the ideal and real-world conditions, with some scenarios resulting in greater differences in mean likelihood of prescribing than other scenarios between the ideal and real-world situations (e.g. the dairy cow (IBR herd) ranked fifth in the ideal condition but second in the real-world condition for likelihood of prescribing). This finding suggests that non-clinical factors may have a greater influence on prescribing for some clinical scenarios than for others, and that solutions for reducing inappropriate antibiotic prescribing may need to be tailored; what works for reducing inappropriate prescribing for one clinical presentation may not work for a different presentation. Of course, clinical factors may also have a greater influence on prescribing in some scenarios than others, especially where there is greater clinical uncertainty about the causal agent or a greater risk of negative clinical outcomes associated with not using antimicrobials; however, if vets only account for clinical factors in their prescribing decisions, then the relative ranking of likelihood of prescribing by participants in this

study should not in theory differ between the ideal and real-world situations. It seems likely that there is a complex interplay between the importance of clinical and non-clinical factors across different situations; for example, perhaps it is when there is greater clinical ambiguity that concerns about non-clinical factors, such as potential economic impacts or implications for vet-client relationships, loom larger in vets' prescribing decisions. Further research will be required to establish the circumstances in which clinical or non-clinical factors play a greater role in prescribing decisions, and whether this is related to clinical ambiguity.

Although these results are based on responses to hypothetical situations (vignettes), rather than observed behaviour, the results do support other findings from human and veterinary medicine that prescribers do not always base their antimicrobial prescribing decisions solely on clinical information (Trautfler and others 2014, Dekker and others 2015, Doidge and others 2019). Prescribers generally understand the need for antimicrobial stewardship (Buller and others 2015, Krockow and others 2019) but there is evidence that vets and doctors do not always prescribe in line with stewardship ideals (Trautfler and others 2014, Dekker and others 2015, Doidge and others 2019). For example, companion animal vets do not always follow prescribing guidelines (van Clevelen and others 2018) and GPs prescribe antimicrobials in a much higher proportion of cases than the 'ideal' level of prescribing indicated by guidelines and expert opinion (Pouwels and others 2018). Whilst inappropriate antimicrobial usage by farmers and the public are also important drivers of AMR (Laxminarayan and others 2013, WHO 2015, Chambers and others 2020), vets and doctors have the ability to influence multiple treatment decisions across different farms or in different patients, so it is important to understand the various factors that impact their prescribing decisions. Furthermore, in the UK at least, vets and doctors are important gatekeepers to antimicrobials, as these drugs are prescription-only medicines in both human and veterinary medicine; if vets or doctors refuse to prescribe, farmers or patients can only access antimicrobials illegally. Tackling AMR and developing effective antimicrobial stewardship interventions will therefore involve understanding what prevents prescribers from always prescribing in line with stewardship ideals.

Limitations. The most immediate limitation to this study is the small sample size, which is unlikely to be representative of the population sampled (delegates at the BCVA Annual Congress) and therefore findings should be interpreted cautiously with regards to potential generalisability. Additionally, small sample sizes are accompanied by the risk of potential false negatives; despite this, the sample appears to have been large enough to detect a within-participant effect, and the consistency of the direction of change in prescribing across all seven vignettes suggests these findings represent a real effect, at least amongst this set of participants. A second limitation is that, as with all self-report surveys, there is the risk that participants may have exhibited some social

desirability bias by providing answers about their ideal and real-world prescribing that they felt was aligned to what they 'should' do rather than what they 'actually' do. Despite this, as there is variation in the pattern of responses between the seven vignettes (such as different mean scores and different mean differences), this suggests that even if there was some level of social desirability bias in the responses, participants were still considering the specific clinical scenarios described in those vignettes and differentiating between the vignettes. Finally, it should also be acknowledged that those vets who attend the BCVA Annual Congress may not be representative of the wider population of UK cattle vets; for example, these vets may differ in terms of motivation to stay up-to-date with research developments, including best practice for antimicrobial prescribing, and these findings may therefore not be generalisable to all farm vets currently practicing across the UK.

Implications. Despite the small sample size, the findings of this study add to the overall picture of evidence that vets and other prescribers are influenced by the various non-clinical factors that they face when making their everyday prescribing decisions, and that their everyday patterns of antimicrobial prescribing differ from 'ideal' prescribing. Similar patterns of deviation from stewardship guidelines and ideal prescribing have been identified in companion animal vets, doctors, and paramedics (Livorsi and others 2016, Tafa and others 2017, Pouwels and others 2018, van Cleven et al., 2018). These deviations from stewardship guidelines represent an ongoing risk to human and animal health, in the form of inappropriate antimicrobial usage that could increase rates of AMR. Additional work is therefore required to find effective ways of supporting prescribers to more often prescribe in line with antimicrobial stewardship ideals.

As inappropriate antimicrobial prescribing by vets and doctors is at least partially driven by psychological, social, and environmental factors (Buller and others 2015, Krockow and others 2019), it is vital that there is a better understanding of how these contextual, non-clinical factors influence prescribing. Within human medicine, there is a reasonably large evidence base related to understanding these non-clinical factors (Tonkin-Crine and others 2011, Pinder and others 2015, Krockow and others 2019), and there is growing evidence about the effectiveness of interventions that target different non-clinical factors to change doctors' prescribing behaviour (Tonkin-Crine and others 2017). In contrast, the evidence base related to non-clinical influences on antimicrobial prescribing in veterinary medicine remains limited (Buller and others 2015, Hockenhull and others 2017, Chambers and others 2020). Further research is therefore required to develop current understanding of the various psychological, social, and environmental factors that push vets away from 'ideal' prescribing. It would be especially useful to understand which non-clinical factors have a greater or lesser influence on vets' prescribing decisions, as interventions can then be directed

towards those modifiable factors that are demonstrated to have the most important influence on rates of inappropriate prescribing in veterinary medicine.

AMR is widely acknowledged to be a One Health issue (Gibbs 2014, Robinson and others 2016), and developing effective stewardship interventions will require collaboration and knowledge exchange between different branches of veterinary medicine, as well as between human and veterinary medicine. Vets' prescribing was examined in this study using experimental vignettes, which are an established methodology within human medical research, but which are currently under-utilised within a veterinary medicine context. This study highlights that a One Health approach to tackling AMR does not just have to be focused on sharing findings from different domains, but can also involve adapting and applying methodological tools from one domain to another.

Conclusions. This study set out to explore whether farm vets' self-reported likelihood of antibiotic prescribing differed between ideal, text-book situations and real-world situations. In all seven scenarios presented in this study, farm vets reported higher levels of likely antibiotic prescribing in the hypothetical real-world situations than in the hypothetical ideal situations. The difference between ideal and real-world prescribing was greater for some clinical scenarios than others. Farm vets in this study were therefore aware their everyday antimicrobial prescribing is not in line with their prescribing ideals. Further research is required to better understand the impact of non-clinical factors on vets' prescribing decisions, in order to develop antimicrobial stewardship interventions that target influential and modifiable non-clinical factors.

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Table 1

Clinical Scenarios Presented to Participants

Scenario Reference	Clinical Scenario Presented to Participants
Dairy Cow (Abscess)	Dairy cow: well in herself, but melon-sized abscess on flank. No abnormalities on clinical exam. Abscess lanced, flushed with antiseptic solution, drains well. You advise farmer to flush twice daily for 5 days.
Dairy Cow (Lame)	Dairy cow: lame left hind due to white line disease. Corrective trim performed and pus drained successfully.
Dairy Cow (Endometritis)	Dairy cow: well in herself, but has endometritis (grade 2). No other abnormalities on clinical exam.
Dairy Cow (Drying Off)	Dairy cow: needs drying off. Her current somatic cell count is 210k. All previous SCC for this lactation have been between 180k and 240k. No case of clinical mastitis this lactation.
Dairy Cow (IBR Herd)	Dairy cow: Bright and alert, but nasal discharge and rectal temperature of 39.2°C. No other clinical abnormalities. Recent laboratory confirmation of IBR in herd (which was previously naïve).
Dairy Bull Calf (Nasal Discharge)	Dairy bull calf: 3 weeks old. Been through collection centre and arrived at rearing unit 2 days ago. Clear bilateral nasal discharge, otherwise normal on clinical exam.
Beef Calf (Castration)	Beef calf: 3 months old. Fit and well. Surgically castrated.

Note. Some abbreviations were included in the materials presented to participants; the text in this table is as presented to participants (although participants were not presented with the scenario reference label) 180k = 180,000 somatic cells per millilitre. 210k = 210,000 somatic cells per millilitre. 240k = 240,000 somatic cells per millilitre. Exam = examination. IBR = Infectious bovine rhinotracheitis. SCC = somatic cell count.

Table 2

Participants' Responses to "How Often Do You Look After the Following Animals?"

Species	Time Spent Working with Animals (n)			
	Often	Sometimes	Rarely	Never
Dairy Cattle	12	1	3	0
Beef Cattle	8	4	3	1
Sheep	7	3	3	3
Goats	0	7	4	5
Pigs	0	4	6	6
Poultry (Chickens)	1	1	6	8
Poultry (Other)*	1	0	4	10
Other Farm Animals*	0	3	4	7
Horses	1	2	3	10
Small Animals	2	2	1	11

Note. *Total does not equal 16 due to missing responses

Table 3

Mean Prescribing in Ideal and Real-World Situations (n = 16)

Clinical Scenario	Situation				Tests of Difference				
	Ideal		Real-World		Mean Diff.	<i>T</i>	<i>z</i>	<i>p</i>	<i>r</i>
	Mean (SD)	BCa 95% CI	Mean (SD)	BCa 95% CI					
Dairy Cow (IBR Herd)	1.69 (0.60)	1.50, 1.94	2.69 (1.08)	2.13, 3.19	1.00	86.50	2.96	.003	.52
Dairy Cow (Drying Off)	2.50 (1.46)	1.88, 3.13	3.31 (1.30)	2.79, 3.83	0.81	55.00	2.97	.003	.52
Dairy Bull Calf (Nasal Discharge)	1.75 (1.18)	1.31, 2.25	2.56 (1.09)	2.13, 3.00	0.81	36.00	2.57	.010	.45
Dairy Cow (Abscess)	1.50 (1.10)	1.06, 2.10	2.19 (1.33)	1.69, 2.75	0.69	36.00	2.64	.008	.47
Dairy Cow (Lame)	1.38 (0.62)	1.19, 1.56	2.06 (1.06)	1.63, 2.50	0.68	21.00	2.23	.026	.39
Dairy Cow (Endometritis)	2.00 (1.10)	1.50, 2.56	2.67 (1.23)*	2.08, 3.27	0.67	36.00	2.71	.007	.48
Beef Calf (Castration)	1.88 (1.36)	1.31, 2.50	2.38 (1.54)	1.81, 2.99	0.50	15.00	2.06	.039	.36

Note. *Mean based on data from 15 participants. BCa 95% CI = 95% bias-corrected and accelerated bootstrap confidence intervals. Diff. = Difference. SD = Standard deviation. Scenarios are listed in order of mean difference between situations.

Table 4

Ranking of Scenarios for Levels of Prescribing in Ideal and Real-World Situations (n = 16)

Clinical Scenario	Ranking		
	Real-World Situation (Mean)	Ideal Situation (Mean)	Ideal versus Real-World (Mean Difference)
Dairy Cow (Drying Off)	1st (3.31)	1st (2.50)	=2 nd (0.81)
Dairy Cow (IBR Herd)	2 nd (2.69)	5 th (1.69)	1st (1.00)
Dairy Cow (Endometritis)	3 rd (2.67)*	2 nd (2.00)	6 th (0.67)
Dairy Bull Calf (Nasal Discharge)	4 th (2.56)	4 th (1.75)	=2 nd (0.81)
Beef Calf (Castration)	5 th (2.38)	3 rd (1.88)	7 th (0.50)
Dairy Cow (Abscess)	6 th (2.19)	6 th (1.50)	4 th (0.69)
Dairy Cow (Lame)	7 th (2.06)	7 th (1.38)	5 th (0.68)

Note. *Mean based on data from 15 participants. Scenarios are listed in order of highest level of prescribing in real-world situation.

Figure 1. Participants' responses in ideal condition to "Based strictly on clinical grounds, how often should you use antibiotics for each of these conditions in an ideal, 'text-book' scenario?". Scenarios presented in ranked order (from lowest mean difference between conditions at the top to greatest mean difference between conditions at the bottom).

Figure 2. Participants' responses in real-world condition to "Based upon your day-to-day experience in clinical practice, how often do you use antibiotics for each of these conditions, in the 'real-world'?" . Scenarios presented in ranked order (from lowest mean difference between conditions at the top to greatest mean difference between conditions at the bottom)

Figure 3. Mean prescribing by condition for all clinical scenarios. Scenarios presented in ranked order (from lowest mean difference between conditions on left to greatest mean difference between conditions on right)