

Barriers to and enablers of implementing antimicrobial stewardship programs in veterinary practices

Laura Y. Hardefeldt^{1,2}  | J. R. Gilkerson¹ | H. Billman-Jacobe^{1,2} |
M. A. Stevenson¹ | K. Thursky² | K. E. Bailey^{1,2} | G. F. Browning^{1,2}

¹Department of Veterinary and Agricultural Biosciences, Asia-Pacific Centre for Animal Health, Melbourne Veterinary School, University of Melbourne, Parkville, Victoria, Australia

²National Centre for Antimicrobial Stewardship, Peter Doherty Institute, Grattan St, Carlton, Victoria, Australia

Correspondence

Laura Hardefeldt, Asia-Pacific Centre for Animal Health, Department of Veterinary Biosciences, Melbourne Veterinary School, Faculty of Veterinary & Agricultural Sciences, University of Melbourne, Parkville, VIC 3010, Australia.

Email: Laura.Hardefeldt@unimelb.edu.au

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Background: Antimicrobial stewardship (AMS) programs are yet to be widely implemented in veterinary practice and medical programs are unlikely to be directly applicable to veterinary settings.

Objective: To gain an in-depth understanding of the factors that influence effective AMS in veterinary practices in Australia.

Methods: A concurrent explanatory mixed methods design was used. The quantitative phase of the study consisted of an online questionnaire to assess veterinarians' attitudes to antimicrobial resistance (AMR) and antimicrobial use in animals, and the extent to which AMS currently is implemented (knowingly or unknowingly). The qualitative phase used semi-structured interviews to gain an understanding of the barriers to and enablers of AMS in veterinary practices. Data were collected and entered into NVivo v.11, openly coded and analyzed according to mixed methods data analysis principles.

Results: Companion animal, equine, and bovine veterinarians participated in the study. Veterinary practices rarely had antimicrobial prescribing policies. The key barriers were a lack of AMS governance structures, client expectations and competition between practices, cost of microbiological testing, and lack of access to education, training and AMS resources. The enablers were concern for the role of veterinary antimicrobial use in development of AMR in humans, a sense of pride in the service provided, and preparedness to change prescribing practices.

Conclusion and Clinical Importance: Our study can guide development and establishment of AMS programs in veterinary practices by defining the major issues that influence the prescribing behavior of veterinarians.

KEYWORDS

antibiotics, antimicrobial resistance, guidelines, policy

Abbreviations: AMR, antimicrobial resistance; AMS, antimicrobial stewardship; MDR, multidrug resistance.

The work for this project was performed at the University of Melbourne and in veterinary practices around Australia. This paper has not been presented at any meetings.

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1 | INTRODUCTION

Antimicrobial resistance (AMR) is a global health emergency. Use of antimicrobials in animals has been implicated in the emergence of AMR in bacterial populations, with undesirable consequences for both human and animal health.^{1,2} Antimicrobial stewardship (AMS) programs are widely implemented in human hospitals worldwide and have been

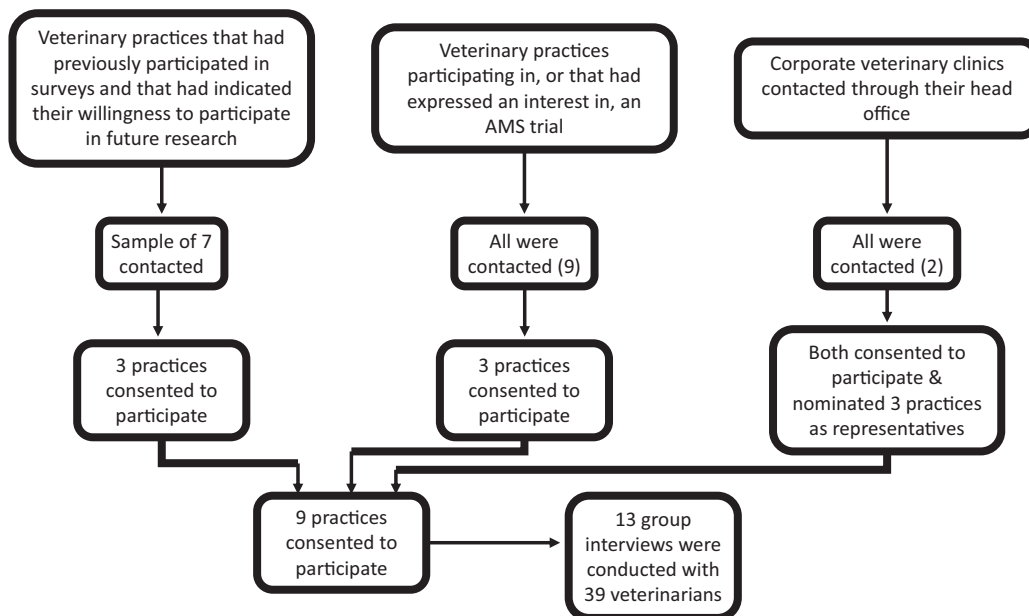


FIGURE 1 Qualitative study logistics

shown to improve clinical outcomes for patients whereas limiting the emergence and spread of AMR.³ Global⁴ and national⁵ strategies for tackling AMR have called for improved AMS in veterinary practices, but no formal reports have described the outcomes of AMS programs that have been implemented in veterinary practices to date.

Medical strategies for AMS are unlikely to be directly applicable to veterinary medicine, in part because of differences in the availability of human and financial resources for the diagnosis and treatment of individual animals, geographical spread, and limited tools supporting AMS in the veterinary sector. Most veterinary practices in Australia employ fewer than five veterinarians (87% in 2000) and the average profit margin is 16%.⁶ Importantly, this profit is inclusive of profit derived from dispensing of pharmaceutical agents. The veterinary profession will need to develop strategies for AMS that are innovative and appropriate to the size, variability, and resource availability of the majority of veterinary practices. Our aim was to gain an in-depth understanding of the factors that influence AMS in Australian veterinary practices.

2 | MATERIALS AND METHODS

Ours was a cross-sectional study to assess veterinarians' attitudes to AMR and antimicrobial use in animals in Australia. A concurrent explanatory mixed methods design was used, in which a preliminary quantitative process contributed to a principally qualitative study.^{7,8} The quantitative phase consisted of an online questionnaire to assess veterinarians' attitudes to AMR and antimicrobial use in animals, and the extent to which AMS currently is implemented (knowingly or unknowingly) in their practice. The qualitative phase consisted of semistructured interviews to understand the barriers to and enablers of AMS in veterinary practices in Australia. This design allowed a study of specific aspects of AMS, with exploration of the original themes in a range of veterinary practice types, with triangulation of the findings to ensure consistency.

2.1 | Quantitative

An on-line questionnaire was developed with both open and closed questions (questionnaire available as Supporting Information) asking veterinarians to provide details of their attitudes to AMR and antimicrobial use in animals and the extent to which AMS currently is implemented (knowingly or unknowingly) in their area of practice. The questionnaire was sent to practices participating in the qualitative survey. Announcements were made using social media, and responses were requested at the Australian Veterinary Association Conference (Melbourne, June 2017) between February and June 2017. Sample size calculations were performed to determine the number of respondents required to make appropriate inferences from the survey. To be 95% certain that our estimate of the population prevalence of veterinarians using a given class of antimicrobial was within 7.5% of the true population prevalence, 168 completed surveys were required (10,000 veterinarians were estimated to be practicing in Australia at the time of the survey). The entire questionnaire took about 10 minutes to complete, encompassed 4 question areas with a maximum of 36 questions in total. The questionnaire was trialled with four general practitioners unaffiliated with the research team, and modified iteratively to improve clarity, face validity, and content validity. Descriptive statistics were used to summarize participants' data.

2.2 | Qualitative

A qualitative approach involving semistructured interviews with veterinarians was employed. Interview themes were developed using the COM-B framework.⁹ A purposive sample approach was used to select participants to ensure inclusion of a diverse range of clinical practice (Figure 1). Participants were recruited until a diverse range of practice type and data saturation was reached on thematic analysis.

The semistructured interview guide was informed by a literature review and findings from previous surveys and was piloted with 2

veterinarians. Three key areas were addressed: attitudes to and experiences of AMR, current AMS processes, and needs for and barriers to proposed components of AMS programs. Between March and June 2017, face-to-face interviews were conducted at the veterinary clinics involved. Informed consent was provided and the interviews were audio recorded with the participants' consent. The interviews lasted, on average, 45–60 minutes and were conducted by 1 author (L.Y. Hardefeldt).

Interviews were audiotaped, transcribed, entered into NVivo version 11 (NVivo version 11, QSR International Pty Ltd), and openly coded and analyzed by 1 researcher (L.Y. Hardefeldt) using qualitative data analysis principles^{10–13} and thematic analysis.¹⁴ A second researcher (G.F. Browning) independently analyzed 2 of the transcripts to ensure reliability. Identified inconsistencies in the codes were discussed and the themes generated were agreed upon. The code structure was developed using an inductive approach. Special attention was paid to any notable variation between veterinarians from metropolitan and rural areas, and those in companion animal-only practice versus those in equine or cattle practice (with or without a companion animal component), and between practice owners or directors and employees.

2.3 | Ethical clearance

This research was approved by the University of Melbourne Faculty of Veterinary and Agricultural Sciences Human Ethics Advisory Group under Approval No. 1648135.1.

3 | RESULTS

On-line questionnaire responses, totaling 184, were received. The demographics of the respondents are presented in Table 1. Veterinary practices were recruited for focus group interviews until data saturation was reached on thematic analysis, which occurred after interview 7, and continued to ensure consistency across a diverse range of practice. Thirteen interviews were conducted (Figure 1). Information on participants recruited for the interviews is presented in Table 1 and is similar to the survey respondents and the national workforce, where data exists. A coding tree was designed (Supporting Information Table S1) and, based on emerging themes, the enablers of and barriers to AMS in veterinary practices were explored. We found no discernible difference in experiences between rural and metropolitan practices, or between practice owners and employees. Differences were found between veterinarians working in companion animal only practices and those in practices serving a clientele that owned horses or cattle. The key findings are summarized in Table 2.

3.1 | Key themes identified

3.1.1 | Perceptions of AMR

Multidrug resistant pathogens (MDR) were rarely encountered by survey respondents (88% [162/184] reported encountering MDR pathogens less frequently than monthly or never). The most commonly encountered MDR pathogens were extended spectrum beta-lactamase producing Gram-negative organisms, methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus pseudintermedius*

TABLE 1 Demographics of survey respondents and interview participants compared with national veterinary workforce

Characteristic	Survey respondents N (%)	Interview participants N (%)	Australian veterinary workforce ^{6,30} %
Sex			
Male	62 (36)	10 (26)	39
Female	111 (64)	29 (74)	61
Location			
Capital city	76 (42)	19 (49)	50
Other	105 (58)	20 (51)	50
Years in practice			
0–5	40 (23)	11 (28)	NA
6–15	63 (36)	19 (49)	NA
>15	73 (41)	9 (23)	NA
Position in practice			
Owner/director	NA	11 (28)	NA
Associate	NA	28 (72)	NA
Type of practice			
Companion animal only	92 (51)	20 (51)	NA
Equine or Bovine	87 (49)	19 (49)	NA
+/- companion animal			

Abbreviation: NA, not available.

(54, 32, and 21% of the 159 respondents who reported culturing MDR pathogens, respectively). Similarly, AMR was encountered infrequently by most focus group participants, with only some reporting frequently dealing with MDR infections. Many reported they felt that the medical profession, and in particular medical general practitioners, were most responsible for AMR in humans in Australia. However, veterinarians frequently reported feeling partly responsible for AMR in human medicine and often were concerned about that contribution. For example:

I'm worried about my influence, if I'm causing it. And then I guess I do know people that have had elective procedures that have developed resistance. So I don't want to add to it.

In addition, a wide range of opinions was encountered about the relevance of the effect of antimicrobial use in different species on the risk of AMR in humans. Over 50% (94/184) of respondents to the questionnaire indicated that veterinary antimicrobial use had a moderate contribution to overall AMR, but over 60% (111/184) indicated that their own antimicrobial use made only a minimal contribution to AMR (Figure 2). The focus group interviews gave greater depth of understanding to this issue. Although most companion animal veterinarians admitted to the overuse of antimicrobials, they thought that antimicrobial use in the dairy and intensive animal industries was most to blame, whereas veterinarians treating dairy cattle attributed most of the risk to the intensive animal industries. For example:

I think statistically it's got to be the human doctors. And we are only a small percentage of prescribers, particularly

TABLE 2 Summary of major barriers and enablers for implementing AMS programs in veterinary practices

Major barriers	Major enablers
Client expectations and competition between practices	Concern for human health
Cost of microbiological testing	Pride in service provided
Lack of access to education and training	Low level of resistance encountered
Lack of AMS governance structures	Preparedness to change prescribing practices
Lack of independent guidelines for antimicrobial use	Frequent use of low cost diagnostic tests
Hierarchical structure of many practices	Low use of most critically important antimicrobial agents

small animals. And then there's also, there's the growing concern about the production animals and the use of that, but I think that's coming well into focus now as well.

Because I think the chance that small animal drugs getting into the human food chain, or antibiotic resistance chain, are much less than food production.

Some veterinarians treating horses and cattle felt that antimicrobial use in those species was contributing to AMR to some degree. For example:

We do prescribe a lot of antimicrobials, particularly to dairy cows. So that's got to contribute somewhere, I would have thought.

Some participants felt that there were limited detrimental effects of antimicrobial use in animals. For example:

Lots of vets don't have any fear of antibiotics, they kind of figure, well, if I'm going to give the patient something, then antibiotics would be it.

Fear of AMR affecting the ability to effectively treat clinical veterinary patients in the future was expressed, as was the potential for dispensing rights of veterinarians being removed as a result of perceived irresponsible use by veterinarians.

Use of critically important antimicrobials¹⁵ varied among classes of drugs (Figure 3). Use of 3rd generation cephalosporins was most common (88/184, 48% of respondents indicating at least weekly use), whereas use of fluoroquinolones (43/183, 23%) and other critically important antimicrobials was less common (31/183, 17% of respondents indicating at least weekly use). Most veterinarians who responded to the questionnaire strongly disagreed that profit made from the sale of antimicrobials influenced their decision to prescribe (72% strongly disagreed, 23% disagreed, 4% neither agreed nor disagreed, and 1% agreed, of 172 respondents). Consistent with this response, only 35% (64/184) of respondents were aware of the amounts of antimicrobials sold by the practice.

3.1.2 | Client expectations of antimicrobial treatment

There was uniformity among participants that clients presenting animals to veterinarians expected some form of treatment from them, often antimicrobials. A subset of clients demanded antimicrobials,

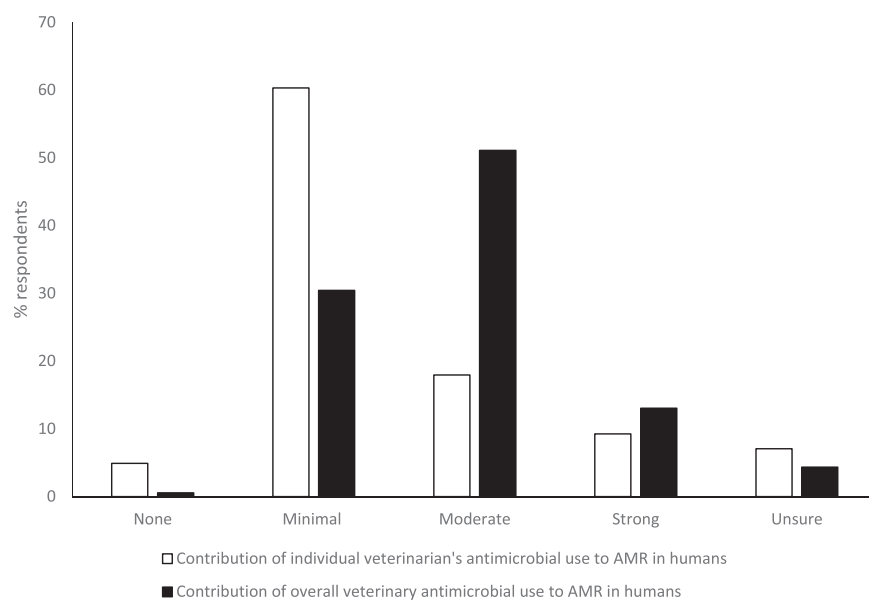


FIGURE 2 Proportions of survey respondents indicating how much antimicrobial use by individuals, and by the profession, contributes to the overall burden of AMR

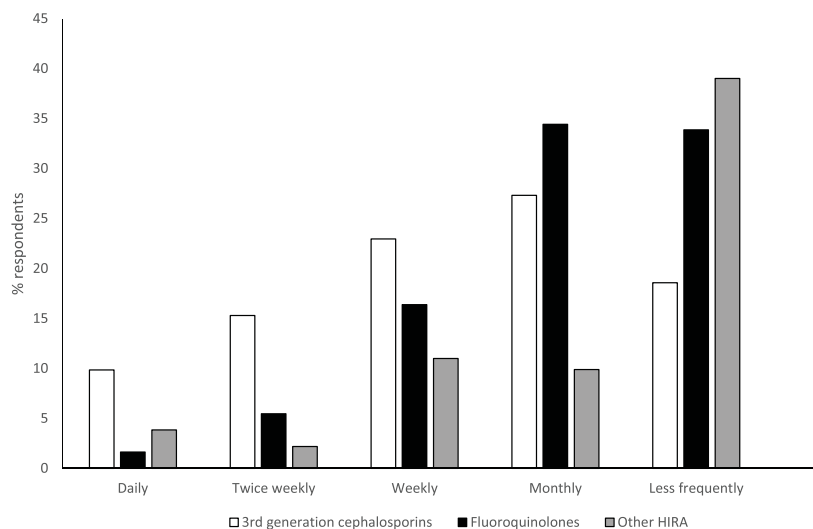


FIGURE 3 Frequency of use of antimicrobials with a high-importance rating. HIRA; high-importance rating antimicrobials

sometimes without a formal consultation. Most reported that these expectations had a subsequent impact on their prescribing practice, although some felt that it did not influence their therapeutic choices. Antimicrobial dispensing to bona fide clients without formal consultation was not reported in companion animal practice, but was commonly reported in horse and cattle practice. It was deduced that antimicrobials were given without a formal consultation for 3 reasons. Firstly, veterinarians feel pressured to “keep clients happy” because of competition among practices and fear that clients would consult a new practice if they were not pleased with the service they received. This concern was equally common in equine and cattle practice, where clients often have many animals and can contribute proportionately more to the practice’s profitability than an individual companion animal client with only 1 animal. For example:

Because you have to provide a business and you have to keep the clients happy. That’s that difference between us and the medical profession. They still get paid at the end of the day. But if we don’t have clients, we don’t get paid or have a job. So at some point you do have to keep them happy.

The second reason was that some clients felt they were capable of diagnosing common diseases and were not willing to pay for a veterinary consultation for routine disease management, and that veterinarians felt that they were unable to examine every animal requiring antimicrobial treatment. However, participants often conceded that the treatment they advise was different from the client’s first preference and that, in many cases, the antimicrobials were not used in accordance with the advice given, or with the label, and that consultation with clients usually led to more appropriate treatment. For example:

But obviously, you’re not going out to see every case

Finally, veterinarians often reported that, because of long work days and lack of time, it was easier to dispense antimicrobials than to spend time convincing clients that the antimicrobials were not necessary or that a veterinary consultation was required. For example:

At the end of a long day, it’s hard to deal with that stuff

3.1.3 | Costs associated with diagnostic testing

The factors that influenced the decision to perform culture and susceptibility testing were consistent among the questionnaire respondents: persistent or recurrent infections were the most common reason (74% of respondents [137/184]), whereas cost constraints of the client (34% of respondents [62/184]), location of the disease (30% of respondents [56/184]), severe infections (27% of respondents [50/184]), and atypical findings on in-house cytology (18% of respondents [33/184]) also were reported. Diagnostic tests of low cost, such as cytology, were unanimously used by focus group participants in companion animal practice, but less so in horse and cattle practice. Most focus group participants reported that the costs of diagnostic testing, and particularly culture and sensitivity testing, led to overuse of antimicrobials in their practice. Such overuse occurred when a treatment trial with antimicrobials replaced the use of diagnostic tests to investigate the presence of an infection, or when the cost constraints of the client prevented diagnostic testing but the veterinarian feared the consequences that a failure to treat an unlikely infection may have for the health of the animal. For example:

because of the unwillingness of people to necessarily take diagnostic steps. And so it’s often offered as a, well, we can trial antibiotics and see if it gets better.

but there is this fear of what if I neglect to treat something that I should have treated?

TABLE 3 Summary of recommendations to facilitate the establishment of AMS programs in veterinary practices

Observed gap	Recommendations
Veterinary AMS legislation	Require veterinary practices to have AMS policies Restrict antimicrobial sales that occur without formal consultation
Education & training	Develop online courses and training on AMS targeted at veterinary practitioners (may contribute to continuing education requirements) Provide courses and training on AMS processes to specialists
Resources	Develop a means of easily monitoring antimicrobial use and resistance in veterinary practice Develop therapeutic guidelines for antimicrobial use in animals Make available examples and templates for AMS policies and procedures, including templates for on-farm use of antimicrobials

Others felt that they were not under-utilizing diagnostic testing because of the costs of these tests. For example:

I think if it's necessary I'd do it, but I just don't think it's necessary most times.

3.1.4 | Lack of resources

Antimicrobial prescribing policies and AMS policies were uncommon, with only 15% (27/184) of survey respondents indicating that their practice had either of these documents (70% did not have either document, 15% were unsure). For respondents who had access to antimicrobial prescribing policies, 44% (10/23) commented that the policy document had been created in the past year. None of the focus group participants was practicing in a clinic that had a formal antimicrobial use policy. Guidelines were used by only 28% (51/184) of respondents to the questionnaire, with the most commonly used being the Australasian Infectious Disease Advisory Panel guidelines¹⁶ (45% [23/51]) and the British Small Animal Veterinary Association guidelines¹⁷ (20% [10/51]). Many focus group participants had access to guidelines, but skepticism was expressed about the involvement of a pharmaceutical company in the production of the antimicrobial use guidelines currently available for companion animals.¹⁶ For example:

I sort of think that it's tainted information. Good information that you have to try and sort of filter a little bit. It would be really nice to have a guideline that wasn't sponsored by someone who had something to earn.

Specialist veterinarians, in either internal medicine or surgery, were primarily consulted for advice on clinical cases when colleagues or employers were either not available or were unsure, although rarely for advice on which antimicrobial was most appropriate. However, frequently participants reported relying on personal experience when deciding on antimicrobial treatment and recently graduated veterinarians reported relying on the experience of colleagues. For example:

I still use a little bit of what I thought I knew but it's more attractive to use what everyone else here has done and their protocols

Antimicrobial stewardship policies were strongly supported by the respondents to the survey, with 89% (163/184) reporting that they felt their practice should have an AMS policy to improve responsible prescribing (40% [65/163]), decrease AMR in animals (16% [26/163]), decrease AMR in humans (15% [26/163]) or because it represents best practice (10% [17/163]). Common reasons for not having AMS policies in veterinary practice were a misunderstanding of AMS (25% [5/20]), being in solo practice (25% [5/20]) or because they already had low rates of antimicrobial prescribing (25% [5/20]). The most commonly selected factors limiting AMS in practice were pressure from clients, practice culture, client finances, and lack of continuing veterinary education (24%, 19%, 19% and 11% of 97 respondents, respectively). Exposure to some form of education about AMS or appropriate antimicrobial prescribing was reported by 45% (82/184) of respondents, with Australian Veterinary Association national conferences or division meetings reported to be the most frequent source of education (27% [22/82]), followed by self-directed education (23% [19/82]) and webinars or podcasts (16% [13/82]). Additional education was strongly supported by survey respondents (176/183, 96%), and willingness to change prescribing habits based on additional education also frequently was indicated (169/175, 97%).

4 | DISCUSSION

To the authors' knowledge, ours is the first study of the enablers of and barriers to AMS in veterinary practice although several studies have examined attitudes and knowledge about AMR and the impact of antibiotic use.^{18–20} Our results show that 89% of the veterinarians who responded to the questionnaire self-reported that they would support AMS programs in their practices and that limiting factors commonly involve pressure from clients to dispense antimicrobials. This finding is in contrast to a survey of factors influencing prescribing in European veterinarians, where owner demands were among the least important factors.²⁰ However, the interviews indicated that pressure from clients is just 1 of the factors driving prescribing, and that the situation is complex, with a multitude of contributing influences reflecting the competitive nature of veterinary practice and underlying client-related socioeconomic and situational factors. Instituting AMS

programs in veterinary practices is critical, but regulation requiring such programs may be required to overcome the most important barriers of commercial competition among practices and pressure from clients to dispense antimicrobials, often without formal consultation. Antimicrobial stewardship programs have been widely implemented in human medicine, with key goals of improving and sustaining appropriate antimicrobial prescribing.^{21–24} However, AMS program implementation is not only a challenge facing veterinarians in Australia. Additional challenges remain in promoting sustainable antimicrobial use in human medicine, requiring behavioral change interventions.²⁵ In addition, evidence from human medicine indicates that interventions that focus on behavioral change can improve antimicrobial prescribing.^{3,25–27}

Behavior can be understood to result from interactions among capability, opportunity and motivation⁹ and, although the framework has not been specifically assessed for its appropriateness for AMS interventions, it forms a useful platform to interrogate the enablers and barriers in this population of veterinarians. Capability is the physical and psychological skill to institute AMS programs. Although awareness of AMS as a movement was widespread, still some veterinarians were unsure what AMS represented, which in itself is a psychological barrier. In addition, lack of education that would enable AMS and costs associated with culture and susceptibility testing frequently were identified as barriers by participants in both parts of our study. These factors represent barriers to AMS capability.

The second part of the framework is opportunity, which encompasses the physical resources and social support needed to institute AMS programs. Formal AMS programs have yet to be instituted in Australian veterinary practices, and many of the constituents of these programs are yet to be developed in Australia. At the time the questionnaire was administered, guidelines for antimicrobial use were only available for companion animal practice, and skepticism about the reliability of these guidelines was commonly mentioned in the interviews because of the involvement of a pharmaceutical company in their production. In addition, no education campaign currently targets AMS or appropriate antimicrobial use in Australia. These factors all represent physical barriers to the opportunity for behavioral change. The high levels of interest and support for AMS identified in our study suggest that substantial social opportunity exists for AMS.

Motivation is the final part of the framework for behavioral change. Motivation can be reflective, based on one's conception of self or higher priorities, or automatic, involving emotions and impulses that arise from associative learning or innate dispositions. Participants in both parts of our project exhibited reflective motivation in favor of AMS, as has been found in veterinarians in the United Kingdom.²⁸ Few participants reported frequently culturing MDR pathogens, but most felt that the profession had a responsibility to address inappropriate antimicrobial use. Most veterinarians were cognizant of the potential role that veterinary antimicrobial prescribing could play in the development of AMR and most also felt that overuse of antimicrobials was common in veterinary medicine. Pressure from clients, fear of negative commercial outcomes, and perceptions that individual contributions to AMR were low

adversely affected motivation, as also has been found in general medical practitioners in Australia.²⁹

Several features of our study may have influenced the results. Enrollment bias may occur with such surveys because respondents are self-selected. However, respondent demographics were broadly representative of the Australian veterinary profession. In addition, recruitment for the interviews was predominately from practices that expressed an interest in AMS. This factor may have biased the results towards those practitioners who were more likely to have an interest in AMS and more awareness of recommended prescribing practices.

Establishment of formalized AMS programs has been identified as a key strategy for addressing AMR in Australia's National AMR implementation strategy⁵ and is critical in providing veterinarians with the knowledge and tools necessary to decrease inappropriate prescribing of antimicrobials in animals. The Australian state and territory veterinary boards should coordinate with government, professional bodies, and academic institutions examining the topic, to require AMS in veterinary practices. Our study has provided insights into the barriers and enablers for AMS in Australian veterinary practices (Table 2) and has suggested a number of measures that may support the establishment of veterinary AMS programs in Australia (Table 3).

CONFLICT OF INTEREST DECLARATION

The Authors declare that they have no conflict of interest with the contents of this article.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Authors declare no IACUC or other approval was needed.

ORCID

Laura Y. Hardefeldt  <http://orcid.org/0000-0001-5780-7567>

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Author/s:

Hardefeldt, LY; Gilkerson, JR; Billman-Jacobe, H; Stevenson, MA; Thursky, K; Bailey, KE; Browning, GF

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