

Comparison of perceptions and concerns of antimicrobial resistance between veterinary and medical health professionals

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Received June 16, 2023

Accepted September 24, 2023

doi.org/10.2460/ajvr.23.06.0121

OBJECTIVE

To understand the comparative concerns and perceptions of veterinary and medical health professionals regarding antimicrobial resistance (AMR) and its effects on their clinical practices.

SAMPLE

17 Doctors of medicine and veterinary medicine and 1 nurse practitioner were interviewed to collect qualitative-based data regarding their clinical experience with AMR.

METHODS

The interviews from the health professionals were transcribed and thematically coded to reveal 3 overarching themes and 7 corresponding subthemes.

RESULTS

Both veterinary and human medical health professionals share concerns about antimicrobial resistance, specifically regarding the development of “superbugs” and increased difficulty in treating disease. However, there were some unique differences in the clinical effects of AMR between the professions in relation to client demand and satisfaction, ability to track/test trends, and approaches to therapy. Both professions also discussed the possible one-health implications of AMR and its transmission.

CLINICAL RELEVANCE

There are several barriers to veterinarians that prevent them from using best-practice methods with antimicrobials that were not shared with human medical personnel, who can use antibiotic stewardship principles and readily access necessary testing. However, many veterinarians possessed a unique one-health-based understanding of how antimicrobial resistance can affect the wider community across species and globally that many human medical professionals had not previously considered. This demonstrates an increased need for one-health understanding within human medical professionals and a need for veterinarians to have access to necessary tools to comply with stewardship guidelines, such as culture and sensitivity testing and antibiograms, to have the ability to limit their contribution to antibiotic resistance.

Keywords: antimicrobial resistance, one health, veterinary medicine, qualitative, human medicine

Antimicrobial resistance is a concern that threatens the public health of individuals in the US and globally. The CDC estimates there are over 2.8 million antimicrobial-resistant infections each year in the US alone, resulting in over 35,000 deaths.¹ Globally, there were almost 5 million deaths associated with antimicrobial resistance in 2019.¹ In the veterinary field, resistant bacteria of methicillin-resistant *Staphylococcus*, *Pseudomonas*, and *Campylobacter jejuni* affect companion animals, while cattle in the US

fight infections such as bovine respiratory disease and keratoconjunctivitis, which are developing resistance to different antibiotics leading to difficult treatment with an economic impact.² Antimicrobial resistance is an active problem at the interface of the medical and veterinary industries.¹ Antimicrobial resistance poses a significant threat to human lives, animal health, and food security, making it a pressing concern for society.

Research to mitigate antimicrobial resistance has taken many forms, ranging from developing

new antimicrobials to primary disease prevention. Antimicrobial resistance demands a multisectoral approach due to its effects on several industries and professions. One health promotes human health by understanding the connections between animals and humans, as well as their shared environment, providing insights into facing zoonoses, vector-borne diseases, food safety, and environmental concerns.³ One health has also been proposed as an approach to antimicrobial resistance,³⁻⁵ as it fosters a collaborative approach led by professionals from various fields, including healthcare workers, veterinarians, ecologists, and others, who strive to promote health by acknowledging the interdependent relationship between humans, animals, and the environment.³ Given that antimicrobial resistance is a one-health concern, an effective solution must be devised through collaboration between medical and veterinary professionals and members of the public, especially those in contact with animals or their environment.³

Collaboration between the medical fields and veterinary professionals could allow for a multisectoral solution to be developed in response to antimicrobial resistance. A lack of communication between medical and veterinary fields^{6,7} has impeded the realization of this interdisciplinary approach. A collaborative effort against antimicrobial resistance has been encouraged by WHO, which is working with the United Nations' Food and Agriculture Organization and the World Organisation for Animal Health to develop a one-health-based approach.⁸

Formative studies⁹⁻¹¹ have assessed prescribing habits and the perceptions of vets and medical professionals toward antimicrobial resistance. However, this extant literature has not fully assessed the perceptions and barriers of antimicrobial resistance mitigation of healthcare workers and veterinarians within the US. As a first step, comparing the views and needs of these 2 professions can inform future research geared toward the development of a multisectoral and collaborative approach that is required to combat antimicrobial resistance.

Methods

Participants, individuals trained and licensed as a doctor of veterinary medicine (DVM), doctor of medicine (MD), doctor of osteopathic medicine, nurse practitioner (NP), or physician's assistant and practicing in the US, were recruited through posting on professional listservs, by emailing individual clinics and hospitals, and through social media (eg, Facebook, Twitter). Individuals first completed a screening survey to determine eligibility. A Qualtrics survey collected responses from June 2022 to August 2022 to gather demographic and practice information. In total, 40 practitioners accessed the screening survey, with 3 screeners being incomplete and 1 considered ineligible due to being located outside of the US.

Eligible participants were asked to participate in a semistructured qualitative interview, leading to 18 individuals scheduling an interview while others did not respond to the scheduling attempt. The

interviews (n = 18) were conducted from July 2022 to September 2022 through an online medium. The purpose of the interviews was to collect in-depth information on the perceptions of interdisciplinary collaboration and concerns regarding antimicrobial resistance. The interview was estimated to take approximately 30 minutes. Those who completed an interview received a \$30 Amazon gift card. All protocols were approved by the IRB of the participating institution.

Measures

Demographic questions included age, zip code, and profession while practice information questions included practice setting and type. Further information about antibiotic prescribing frequencies was collected during the initial stages of the interview.

Interview guide

To gain a deeper understanding of participants' experiences and perceptions, a semistructured interview guide was designed to elicit narratives regarding (1) concerns related to antibiotic resistance, eg, what concerns do you have regarding antibiotic resistance in your profession?; and (2) the impact on professional practice, eg, how does this concern affect your practice?

Data analysis

The interview audio was digitally recorded, transcribed, and reviewed for accuracy against the recordings. The resulting data were analyzed using a qualitative grounded theory approach to inductively identify and interpret concepts and themes that emerged from the interview transcripts.¹² This analysis was performed through independent coding by 2 members of the research team. The members would regularly check their coding to ensure accuracy and agreement. Whenever necessary, descriptive analyses were conducted using SPSS statistical software (version 26).

Demographics

The demographics of the sample (n = 18) are presented (**Table 1**). Participants ranged in age from 26 to 48 years (mean = 35.278), and the majority (n = 11) were a DVM. Practice settings varied for both DVMs and MD/NPs, with the majority (n = 8) of DVMs engaged in small animal practice whereas almost all (n = 6) of MD/NPs either practiced internal medicine or internal medicine/pediatrics. Of those interviewed, half of the veterinarians prescribed 6 times or more each day. This is in stark contrast to the healthcare providers who were more prone to prescribe 5 times or less each day (n = 6; see **Table 2**).

Results

Overarching theme 1: shared concerns about prescription practices and effects

Individuals within both professions shared concerns about prescription practices and their effects on antimicrobial resistance. Some veterinarians

Table 1—Sample demographics (n = 18).

	n	Minimum	Maximum	Mean
Age		26	48	35.278
Profession				
MD	6			
NP	1			
DVM	11			
Veterinary practice setting				
Small animal practice	8			
Mixed animal practice	2			
Other	1			
MD/NP practice setting				
Internal medicine	3			
Internal medicine and pediatrics	3			
Other	1			
Practice location				
Urban	7			
Suburban	10			
Rural	1			
Veterinary practice site				
California	2			
Georgia	2			
Idaho	1			
Illinois	1			
New York	1			
Pennsylvania	2			
Virginia	1			
Texas	1			
MD/NP practice site				
Indiana	6			
Oregon	1			

DVM = Doctor of veterinary medicine. MD = Doctor of medicine. NP = Nurse practitioner.

discussed the generational differences in prescribing behavior and how many of them felt they were fighting older, outdated prescription practices. Veterinarians also shared the concerns of medical doctors using antibiotics inappropriately, while they, as vets, had limited options due to availability or legal regulations for livestock management but may face blame for resistance. Healthcare providers also discussed concern for the development of antibiotic resistance overall and the contribution of overprescribing or unnecessary prescriptions. These concerns often developed into specific concerns about the development of “superbugs” or facing difficulty in treating diseases due to antimicrobial resistance (**Supplementary Table S1**).

Subtheme 1: development of superbugs—Both veterinarians and medical professionals in human

medicine demonstrated concern for the development of superbugs. For example, both discussed concerns about the potential impact of superbugs at the individual level (eg, life-threatening or sustained infections, side effects). Medical doctors also discussed the longer term impact on larger communities, specifically affecting their considerations when prescribing antibiotics, as well as the increased prevalence of superbugs due to increased levels of resistance. Specific superbugs that were discussed by participants included methicillin-resistant *Staphylococcus aureus* and resistant *Pseudomonas*.

Subtheme 2: increased difficulty in treating—Participants noted increased frustration in their day-to-day practice as treatment paradigms shift due to increased antibiotic resistance. Members of both professions indicated the need to prescribe stronger antibiotics or develop “creative” treatment plans while managing side effects from the stronger medications and/or recurring infections.

Overarching theme 2: clinical discrepancies between the professions

While the professions shared broad concerns relating to antibiotic resistance, there were some unique differences that the professions faced within their respective clinical practices. These differences were reflected in their concerns about working with clients, testing, and approach to antibiotic therapy (**Supplementary Table S2**).

Subtheme 1: client patient demand vs compliance—While both professions wanted to ensure their patients’ health through antibiotic treatment, there were differences in the frustrations faced by the professions as brought to them by clients. Some of the human medical professionals discussed the need for compliance from their human patients in finishing the antibiotic regimen. Veterinarians also demonstrated concerns about compliance regarding clients not giving their pets the full length of the prescription or human patients not completing their antibiotic course. In addition, the veterinarians discussed not completing antibiotic cultures as a frustration in client compliance. Veterinarians also discussed the frequency in which clients would expect an antibiotic to be provided to them without a physical exam or culture or in scenarios where an antibiotic would be unnecessary. Client demand for an antibiotic prescription was primarily a challenge faced by veterinarians.

Subtheme 2: ability to track/test trends—Veterinarians and human medical professionals differed in their ability to track and test (eg, bacterial cultures, antibiograms, etc) trends in antibiotic

Table 2—Frequency of antibiotic prescription.

	n	Not often, 1 time/day	1-5 times/ day	6-9 times/ day	Up to 10 or more times/day
MD/NP	7	1	5	0	1
DVM	10*	1	4	2	3

*One DVM was unable to provide value.

resistance, although both professions agreed it was necessary and allowed for better understanding and prescription practices of antibiotics. One MD pointed out the availability of antibiograms and guidelines for local resistance trends within their clinics/hospitals. In contrast, veterinarians discussed frustration with their inability to track local trends or impact on antibiotic resistance due to limited or conflicting information. One veterinarian noted the potential availability of swab testing for veterinary clinics that are members of the American Animal Hospital Association but then discussed how it was only a recommendation seldom followed by the limited members of this group. Other veterinarians further discussed the inability to do cultures due to the prohibitive cost or client compliance.

Subtheme 3: stewardship vs empirical therapy—Both professions expressed the need for proper use of antibiotics; however, differences arose in their methods of judicious prescription of antibiotic therapy. Human medical professionals often discussed the need for proper stewardship of antibiotics as a core principle of the profession, focusing on choosing the narrowest antibiotic possible. Veterinarians regarded their prescription practices as based on empirical therapy. Often regarded as educated guesses, veterinarians discussed how their therapy selections were based on the limited available information and consequently the hope of a positive outcome. The difference in these 2 approaches can be found in the confidence in the prescriptions based on the availability of information on antibiotic history, local trends, culture results, and the reinforcement of stewardship as a key principle of human prescription practice.

Overarching theme 3: one-health implications

There were elements of one health present throughout many of the interviews, specifically in relation to transmission and the effects of antibiotic resistance on different fields (**Supplementary Table S3**).

Subtheme 1: zoonotic transmission—Almost half of the human medical professionals interviewed mentioned concern for the transmission of antibiotic resistance between animals, humans, and/or the environment. Two specifically mentioned concerns about the development of antibiotic resistance in humans due to antibiotic use in agriculture and livestock. Many of the human medical professionals mentioned how they were not particularly knowledgeable about the use of antibiotics or antimicrobial resistance outside of their fields. Veterinarians also discussed concern for zoonotic transmission of antibiotic resistance.

Subtheme 2: global transmission—Veterinarians readily acknowledged the potential for transfer of resistance or other diseases from animals to humans, either from pet to owner or involving livestock/poultry. Some veterinarians discussed concern for

the global effect of antimicrobial resistance and its spread across the world.

Discussion

The objective of this study was to investigate how veterinarians and medical personnel perceive antimicrobial resistance and its effects on their practice. While previous studies^{13,14} separately conducted on these 2 groups had identified concerns regarding the misuse of antibiotics and its consequences within their respective fields, this study unearthed unique insights by examining and contrasting the discrepancies in their apprehensions.

Several concerns stemmed from differences in clinical capabilities relating to antimicrobial resistance, with one of the distinctions being the contrasting needs of clients. Doctors tended to be concerned with patient compliance rather than patient satisfaction compared to the veterinarians, who were also more focused on how to handle clients who were accustomed to readily receiving antibiotics in unnecessary cases. However, a previous study¹¹ showed that patient expectation for antibiotics is a factor in prescribing behavior for doctors as well. There was also a difference in the ability to track or test trends in antibiotic resistance. One participating doctor mentioned the use of antibiograms and local guidelines to follow antibiotic resistance. In contrast, veterinarians expressed frustration with their inability to perform cultures on their patients or monitor antibiotic resistance trends. Previous findings¹⁵ have demonstrated that the cost of culture and sensitivity testing is a factor that contributes to antibiotic overuse within veterinarian practices. The final clinical difference appeared in the approach to antibiotic therapy. Doctors stressed the importance of stewardship and choosing the narrowest antibiotic available. Initially, doctors may rely on empirical therapy, relying on infection site, history, and known resistance patterns, while waiting for testing results to guide definitive therapy.¹⁶ The veterinary participants appear to lack this advantage of definitive therapy, discussing how they had to rely on empirical therapy and choose an antibiotic based on their best-educated guess due to a lack of testing ability. This is consistent with previous work¹⁷ that found that veterinarians chose their antibiotics based on empirical strategies rather than using antibiotic sensitivity testing. These challenges faced by veterinarians demonstrate barriers that prevent veterinarians from following best practices regarding antimicrobial use. The AVMA has provided key principles to drive antimicrobial stewardship within the veterinary industry. Within these principles is a discussion of using alternatives to antibiotic drugs and using an evidence-based approach before antimicrobial drug use.¹⁸ The ability of veterinarians to follow these guidelines is challenged due to client expectations for antibiotics and the lack of testing availability, which would allow veterinarians to abide by stewardship guidelines.

Providers from both fields are aware that their practices affect antibiotic resistance. However, their

ability to limit their contribution to antimicrobial resistance is hindered by the availability of testing and the demands of clients. Veterinarians must determine how to satisfy their client's want for treatment while doctors and nurse practitioners must work to gain client compliance when finishing their antibiotic regimens. This highlights a need for increased availability of testing for the veterinary field, including increasing access to local antibiotic resistance trends as well as patient-specific culturing. Testing availability is often prohibitive by cost to the client, which could be mitigated with increased use of pet insurance to cover the high prices incurred by laboratories for these tests. These results also highlight the knowledge gap possessed by medical doctors and nurse practitioners on antibiotic use outside of their field. Many acknowledged that they had not considered how antibiotics were used outside of human medicine. This relates to a lack of knowledge or engagement in one health by human medical professionals.¹⁹ Increasing the knowledge of medical professionals of one health may also allow for increased knowledge of the use of antibiotics within veterinary medicine and their effect on the environment.

Both human medical sectors and veterinary medicine play a role in mitigating antimicrobial resistance. Due to its multisectoral nature, AMR requires a collaborative approach. This collaborative need has been addressed on an international level with the Global Health Security Initiative, which promotes control of AMR through a global and multisectoral collaboration involving human medical professionals, public health professionals, animal health professionals, and those in environmental protection.²⁰ At an academic level, previous work²¹ has found that medical and veterinary students also believe that AMR requires a collaborative response and that both professions should be involved in educating patients and the public. In the future, this collaborative approach to antimicrobial resistance mitigation could be applied to various current barriers. Knowledge could be exchanged between the fields to allow for increased understanding of the use of antimicrobials in other sectors. The veterinary field could also benefit from the expertise of the human medical field to approach possible testing and tracking techniques for resistance trends. It is also possible that both fields could be involved in patient and client education to promote the public's compliance with antibiotic prescription and understand situations where an antibiotic is unnecessary. This education could encourage pet owners to purchase pet insurance, allowing for increased affordability of culture testing, which would allow veterinarians to transition from empirical therapy to a more focused approach following stewardship guidelines.

There are some limitations to this study. First, as a formative qualitative study, we sought to better understand the perspectives of veterinarians and medical doctors; however, our findings may not be representative of the larger fields. As such, further research is warranted. Second, the perspectives expressed during these interviews were limited to

those who were willing to participate in the study. Moreover, most medical professionals worked in internal medicine within a single state, so the views of the wider profession may not have been captured. While our participants in human internal medicine did experience frustration with antibiotic resistance, it is important to note that practitioners in other specialties, such as pediatricians or general practitioners, also work with antibiotics and may have unique experiences with resistance that were not captured in this study. Among our veterinary participants, a majority were small animal practitioners. As such, those who are large animal practitioners may have different experiences that are not reflected in these results. Within our study, we did not assess the individual rationale for the use of antimicrobials and their classifications, which have been used comparatively across both human and veterinary medicine. Further research is necessary to identify specific classifications of antimicrobials that are perceived to be used across both fields and to which resistance presents a public health threat to both veterinary medicine and human medicine.

Our findings highlight the frustrations faced by healthcare providers and veterinarians as they combat antimicrobial resistance within their practices. This common struggle has led to the development of similar concerns between the professions, but the 2 fields battle different barriers in their attempts to mitigate their contribution to antibiotic resistance.

Further research is necessary to understand the perspectives of a wider range of practitioners and different types of veterinarians, including a better understanding of stewardship guidelines in veterinary practices.

Acknowledgments

None reported.

Disclosures

The authors have nothing to disclose. No AI-assisted technologies were used in the generation of this manuscript.

Funding

This study was funded by the Department of Public Health at the authors' institution.

References

1. What exactly is antibiotic resistance? Centers for Disease Control and Prevention. October 5, 2022. Accessed April 21, 2023. <https://www.cdc.gov/drugresistance/about.html>
2. Antimicrobial-resistant pathogens affecting animal health. American Veterinary Medical Association. Accessed August 5, 2023. <https://www.avma.org/resources-tools/one-health/antimicrobial-use-and-antimicrobial-resistance/antimicrobial-resistant-pathogens-affecting-animal-health>
3. One health basics. One health. Centers for Disease Control and Prevention. November 8, 2022. Accessed May 21, 2023. <https://www.cdc.gov/onehealth/basics/index.html>

4. Robinson TP, Bu DP, Carrique-Mas J, et al. Antibiotic resistance is the quintessential one health issue. *Trans R Soc Trop Med Hyg.* 2016;110(7):377–380. doi:10.1093/trstmh/trw048
5. Haworth-Brockman M, Saxinger LM, Miazga-Rodriguez M, Wierzbowski A, Otto SJG. One health evaluation of antimicrobial use and resistance surveillance: a novel tool for evaluating integrated, one health antimicrobial resistance and antimicrobial use surveillance programs. *Front Public Health.* 2021;9:693703. doi:10.3389/fpubh.2021.693703
6. Hill WA, Petty GC, Erwin PC, Souza MJ. A survey of Tennessee veterinarian and physician attitudes, knowledge, and practices regarding zoonoses prevention among animal owners with HIV infection or AIDS. *J Am Vet Med Assoc.* 2012;240(12):1432–1440. doi:10.2460/javma.240.12.1432
7. Grant S, Olsen CW. Preventing zoonotic diseases in immunocompromised persons: the role of physicians and veterinarians. *Emerg Infect Dis.* 1999;5(1):159–163. doi:10.3201/eid0501.990121
8. Antimicrobial resistance. World Health Organization. November 17, 2021. Accessed March 10, 2022. <https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance>
9. Taylor DD, Martin JN, Morley PS, Belk KE, White AE, Walter EJS. Survey of production animal veterinarians' prescription practices, factors influencing antimicrobial drug use, and perceptions of and attitudes toward antimicrobial resistance. *J Am Vet Med Assoc.* 2020;257(1):87–96. doi:10.2460/javma.257.1.87
10. Abbo L, Sinkowitz-Cochran R, Smith L, et al. Faculty and resident physicians' attitudes, perceptions, and knowledge about antimicrobial use and resistance. *Infect Control Hosp Epidemiol.* 2011;32(7):714–718. doi:10.1086/660761
11. Sanchez GV, Roberts RM, Albert AP, Johnson DD, Hicks LA. Effects of knowledge, attitudes, and practices of primary care providers on antibiotic selection, United States. *Emerg Infect Dis.* 2014;20(12):2041–2047. doi:10.3201/eid2012.140331
12. Corbin J, Strauss A. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* 3rd ed. Sage Publications, Inc; 2008. doi:10.4135/9781452230153
13. Padda H, Wemette M, Safi AG, et al. New York State dairy veterinarians' perceptions of antibiotic use and resistance: a qualitative interview study. *Prev Vet Med.* 2021;194:105428. doi:10.1016/j.prevetmed.2021.105428
14. Zetts RM, Stoesz A, Garcia AM, et al. Primary care physicians' attitudes and perceptions towards antibiotic resistance and outpatient antibiotic stewardship in the USA: a qualitative study. *BMJ Open.* 2020;10(7):e034983. doi:10.1136/bmjopen-2019-034983
15. Hardefeldt LY, Gilkerson JR, Billman-Jacobe H, et al. Barriers to and enablers of implementing antimicrobial stewardship programs in veterinary practices. *J Vet Intern Med.* 2018;32(3):1092–1099. doi:10.1111/jvim.15083
16. Leekha S, Terrell CL, Edson RS. General principles of antimicrobial therapy. *Mayo Clin Proc.* 2011;86(2):156–167. doi:10.4065/mcp.2010.0639
17. De Briyne N, Atkinson J, Pokludová L, Borriello SP, Price S. Factors influencing antibiotic prescribing habits and use of sensitivity testing amongst veterinarians in Europe. *Vet Rec.* 2013;173(19):475–475. doi:10.1136/vr.101454
18. Antimicrobial stewardship definition and core principles. American Veterinary Medical Association. Accessed May 20, 2023. <https://www.avma.org/resources-tools/avma-policies/antimicrobial-stewardship-definition-and-core-principles>
19. Natterson-Horowitz B. A physician's view of one health: challenges and opportunities. *Vet Sci.* 2015;2(1):23–25. doi:10.3390/vetsci2010023
20. Ferri M, Ranucci E, Romagnoli P, Giaccone V. Antimicrobial resistance: a global emerging threat to public health systems. *Crit Rev Food Sci Nutr.* 2017;57(13):2857–2876. doi:10.1080/10408398.2015.1077192
21. Primeau CA, McWhirter JE, Carson C, McEwen SA, Parmley EJ. Exploring medical and veterinary student perceptions and communication preferences related to antimicrobial resistance in Ontario, Canada using qualitative methods. *BMC Public Health.* 2023;23(1):483. doi:10.1186/s12889-023-15193-x

Supplementary Materials

Supplementary materials are posted online at the journal website: avmajournals.avma.org