Antimicrobial Usage in Bovine Veterinary Medicine in Washington State

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science in Environmental Health Sciences

University of Washington

2024

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Program Authorized to Offer Degree:

Environmental and Occupational Health Sciences

University of Washington

Abstract

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To support Washington (WA) state bovine veterinarians in antimicrobial stewardship, we surveyed and interviewed bovine veterinarians regarding antimicrobial prescription practices. From February 2023 to February 2024, we surveyed and interviewed active, licensed WA state bovine veterinarians. Survey questions covered demographics, perceptions, and clinical cases. Responses were analyzed by a clinical veterinary microbiologist. Interviews discussed herd health management, prescription practices, and explored survey trends. A systematic qualitative analysis of interviews was performed. We analyzed 14 survey responses, one group conversation (20 veterinarians), and two in-depth interviews. Respondents identified owner/producer compliance and prescription of broad-spectrum antibiotics as factors contributing to antimicrobial resistance within veterinary medicine. Over half of respondents reported using personally developed guidelines. Respondents chose the most appropriate treatment option in 66% of cases. Participants often selected empiric antimicrobials for respiratory cases but chose diagnostic tests and non-antimicrobial treatments for mastitis and diarrhea cases. Veterinarians

interviewed clarified that they do not culture for respiratory pathogens because culture results are not clinically actionable and there are limited legal antibiotic drug choices available in food animal medicine. These results highlight stewardship opportunities in bovine medicine, including the need for resources to clarify regulatory status, clinical indications, and appropriate usage of critically important antibiotics. Limited clinically actionable diagnostic data for bovine respiratory disease emerged as a significant barrier to antibiotic stewardship. Our results emphasize the need for resources to support bovine veterinarians in antimicrobial stewardship, particularly regarding regulatory compliance, clinical treatment indications, and stewardship principles. More research studies on effective antimicrobial treatment approaches for bovine respiratory conditions are needed.

Introduction

Ensuring food security, as per the World Health Organization's definition—characterized by the provision of adequate, safe, and nutritious food to meet nutritional, cultural, and socio-economic needs—has emerged as a formidable challenge in the 21st century.[1] The complexity of this challenge is expected to intensify in the years ahead, as the global population is predicted to increase 50% from 2000 to 2050, totaling 9.5 billion.[2] To meet the needs of a population of 9.5 billion, the Food and Agriculture Organization estimates that global food production must increase by a total of 70%.[2] Of key importance to food security, animal sourced foods (ASF) are a nutritionally and culturally important part of the global diet.[3,4] Along with population growth, rising incomes and cultural changes in the global south are expected to drive increased ASF demand and production over the next decade.[2] For these reasons, efficient and effective animal agricultural systems are vital to ensuring food security in the future.

As animal agriculture has intensified to meet this growing demand for ASF, the use of antibiotics has become a critical tool. From treating disease and preventing infections to promoting growth, antibiotics have long been a cornerstone of modern farming practices.[5] However, their effectiveness is now jeopardized by the emergence of antibiotic resistant bacteria capable of causing infections which threaten both food animal health and food system security. Antibiotic resistance was first documented in antibiotic-treated food animals in 1951[6] and has since been observed globally in both high- and low-income countries [7–9] In animals, antibiotic resistant organisms have been found in both commensal bacteria and pathogens, posing a risk to food safety and animal health.[7,8,10]

Although antibiotic resistance occurs in bacteria naturally, it is widely accepted that use and misuse of antibiotics in both human medicine and veterinary care and animal agriculture has rapidly increased the spread of antibiotic resistant microorganisms.[11,12] Further, geographic studies have shown positive correlations between locations with high rates of antibiotic use and antibiotic resistant bacteria in food animals.[13] As antimicrobials are an important and commonly used tool in animal agriculture,[5,14] antimicrobial stewardship is imperative to reduce the spread of resistance and maintain the utility of antibiotics for ensuring animal health and food system security.

Antimicrobial stewardship is defined by the Centers for Disease Control as the "effort to measure and improve how antibiotics are prescribed by clinicians and used by patients".[15] Ideally, antimicrobial stewardship practices should be a One Health collaborative effort, where responsibility and innovation are shared across human medicine, small animal veterinary medicine, and large animal veterinary medicine and the persistence of antimicrobial resistance in the environment is also considered.[14] Within the context of One Health, stewardship in animal agriculture is an important piece of this multifaceted, collaborative effort. Further, previous research in large animal veterinary practice suggests that despite obstacles, integrating antimicrobial stewardship principles into routine veterinary practice is feasible due to the organized structure and disease prevention focus of large-scale food animal operations.[16] Disease prevention strategies, through preventing illness altogether, can reduce the need for antimicrobial use.[17]

Recent regulatory efforts have aimed to promote antimicrobial stewardship in animal agriculture. The U.S. Food and Drug Administration (FDA) Veterinary Feed Directive (VFD), a part of the Animal Drug Availability Act of 1996, mandates licensed veterinarian supervision for administering drugs in animal agriculture.[18] This also necessitates a valid veterinary-client-patient relationship (VCPR) for VFDs.[18] In Washington State, legislation from 2016 requires an in-person VCPR with one designated veterinarian.[19] Additionally, FDA's 2021 guidance for industry (GFI) #263 mandated that medically important antibiotics are now available only with a valid veterinary prescription.[20,21] Overall, these regulatory changes reflect a commitment to combating antimicrobial resistance at both national and state levels.

In addition to regulatory efforts, supporting veterinarians to optimize antibiotic use, improving diagnostic testing, and increasing research efforts have been suggested as ways to improve stewardship.[14,22,23] Researching the stewardship knowledge, attitudes, and practices of large animal veterinarians can reveal barriers and opportunities for improvement. For instance, a survey of 157 large animal veterinarians in the United States revealed that while 99.3% of veterinarians would recommend antimicrobial drug (AMD) treatment for ill animals, there was variation in responses to scenarios involving use of antimicrobials in large animal herd settings.[24] The study also highlighted the influence of client pressure on AMD prescribing, the role of owner and producer compliance in contributing to AMR, and the effectiveness of environmental modifications in disease prevention to mitigate AMR.[24] Similarly, a survey involving both small

and large animal veterinarians in Kentucky found that veterinarians working in facilities with prescription policies were less likely to overprescribe compared to those in facilities without such policies, emphasizing the importance of prescription policies for stewardship.[25] Survey data thus serves as an effective tool in informing AMR stewardship efforts.

While surveys offer valuable insights, qualitative interview data provide unique perspectives not captured by surveys alone. For example, interviews with dairy veterinarians in New York State revealed beliefs that improving herd health management could reduce antibiotic usage and that limited antibiotic choices pose a barrier to stewardship. Additionally, the interviews suggested leveraging consumer beliefs to reduce antibiotic usage.[26] At the same time, reliance on interview data alone has potential for individual biases.[27] For this reason, combining interview and survey data in a mixed method fashion offers a robust approach to gaining comprehensive insights into the perspectives and behaviors of bovine veterinarians.

Few studies on veterinarians have integrated both interview and survey data, and few have specifically focused on dairy farms in Washington state. Washington ranks 10th in total milk production among the US states.[28] Additionally, dairy products are the state's 2nd largest agricultural commodity. Given the state's crucial position in food security and economic stability, there is a critical need for such research.[28] Furthermore, with approximately 480 dairy farms and 262,000 dairy cows in Washington, there are ample opportunities for implementing enhanced stewardship initiatives.[28]

In this study, we utilize survey and data from bovine veterinarians in Washington state to explore knowledge, attitudes, and practices regarding antimicrobial usage. Specifically, our objectives are to characterize antibiotic prescription patterns, understand factors impacting prescription and use of diagnostics, and identify barriers to stewardship. Understanding prescription and stewardship patterns in WA state can inform public health programs and improve resources to support bovine veterinarians in stewardship efforts.

Methods

Survey distribution and design

This study was reviewed by the University of Washington Human Subjects Division and deemed exempt (STUDY00016886). A copy of the survey as shown to participants can be found

in the supporting information. The survey was predominantly distributed at three significant outreach events. These events included a conference and two veterinary continuing education events which were strategically selected to ensure broad geographical coverage across the state. Additionally, the survey was disseminated statewide between February 8, 2023, and February 2, 2024, via various channels including communications from the Washington State Veterinary Medical Association (WVSMA), the Washington State University Veterinary School, the King County Veterinarian Updates email list, and several social media outlets.

The survey was designed collaboratively with researchers at the University of Washington, Washington State University, and the Washington Animal Disease Diagnostic Laboratory (WADDL). It was anonymous, and participants self-selected to participate through a pre-screening and consent form. All bovine veterinarians currently practicing in Washington State were eligible to participate.

Survey questions included demographic information, factors influencing prescription practices, and clinical scenarios. For the clinical scenarios, veterinarians were asked to select treatment for a sick animal or group of animals. For specific examples of clinical scenarios, please see **Table 4** in the Results Section. These scenarios were customized based on the species the respondents reported treating and included both feedlot cattle and dairy cows. If the respondent opted to perform culture and susceptibility testing, follow-up questions were presented which involved interpreting culture and susceptibility results.

Survey analysis

Data were collected in REDCap and imported into R (version 4.1.1) for cleaning and analysis. All incomplete, duplicate, and ineligible entries were removed. Ineligible responses consisted of surveys of veterinarians who were retired, or veterinarians who did not treat any dairy cattle or feedlot cattle. After data processing, 14 responses remained. Data summary tables were generated using R packages including dyplr (1.1.1) and flextable.

For scenario questions, treatments were classified as appropriate or not appropriate based on guidance from a board-certified veterinary microbiologist (CB). Responses were considered not appropriate if they did not comply with current regulation, were not effective against the specific illness, or involved antibiotics classified as critically important for human health by the World Health Organization when not needed.[29]

Group Conversations and Interviews

In addition to the survey, group conversations and interviews were conducted to obtain a more detailed understanding of prescription practices and AMR perspectives among veterinarians. First, a group conversation was facilitated at a conference in Washington on September 22-24, 2023, to formulate research questions and determine the scope of formal focus groups. Approximately 20 large animal veterinarians were present for the group conversation and 8 contributed to the discussion. Further, informal discussions with bovine veterinarians at a conference and continuing education events helped inform the interview instrument. Additionally, the survey responses informed the interview script, prompting veterinarians to elaborate on survey reported trends.

Interview participants were recruited through the previously described survey; Those who took the survey and indicated that they would be interested in answering further questions were contacted. Two of 10 contacts agreed to participate in interviews, which were held virtually in March 2024.

The interviews were led by a Washington State veterinarian and included six main sections: 1) Study overview, 2) Farm interactions and experiences, including frequency of interaction and individuals involved, 3) Herd health management, including communication of protocols to farm workers and the process for identification of sick animals, 4) Elaboration of treatment choices selected by surveyed veterinarians, 5) How to best support veterinarians in their stewardship efforts, and 6) Resources available for combatting antimicrobial resistance (AMR).

Group Conversation and Interview Analysis

Audio recordings from the group conversation and focus groups were transcribed into text using Otter AI (Version 3.48.0-240415 - 6525f8af)[30] and quality control was performed to ensure accuracy. This text underwent analysis using coding methods reported in Braun & Clarke (2008). These transcripts were carefully reviewed to form initial ideas, and a list of codes was developed pertaining to the group discussions and research questions. Data were then coded based on recurring features in a systematic process, with collation by each code. Some phrases were cross-referenced across multiple categories, while others were excluded. These codes were

then organized into thematic categories aligned with research objectives, patterns, and initial goals. Thematic categories were named and defined clearly. Representative quotes and examples were selected for each theme to illustrate the findings. This systematic approach ensured comprehensive coverage of important themes and maintained focus on the initial research questions.

Results

Surveys

Demographics

Of 14 total respondents, most veterinarians (64.3%) reported having attended veterinary school in Washington State, while others attended veterinary school in California (21.4%), Oklahoma (1%), and Minnesota (1%) (**Table 1**). In terms of years of experience, the largest group was those who had more than 20 years of experience (35.7%). Most veterinarians (85.7%) were large animal veterinarians, whereas 2 (14.3%) were mixed animal veterinarians that treated some bovine species. Regarding species treated, 92.9% treated commercial dairy cows and 21.4% treated feedlot cattle. In terms of practice roles, most veterinarians (64.3%) were practice owners, while the remaining veterinarians (35.7%) were associates in a group practice. Finally, almost all veterinarians (92.9%) reported working in the private practice sector, with the remaining veterinarians working for an an animal agricultural industry entity.

Table 1. Demographic Information for Respondents of Completed and Eligible Surveys (N = 14).

State of Veterinary School Attended	**% Responses (N)**
California	21.4 (3)
Washington	64.3 (9)
Oklahoma	7.1 (1)
Minnesota	7.1 (1)
Years of Clinical Experience	
Less than 5 years	28.6 (4)
5-10 years	28.6 (4)
11-15 years	0 (0)
16-20 years	7.1 (1)
More than 20 years	35.7 (5)

Class of Veterinarian	
Mixed	14.3 (2)
Large	85.7 (12)
Species Treated[1]	
Commercial Dairy	92.9 (13)
Commercial Feedlot	21.4 (3)
Practice Role[2]	
Owner	64.3 (9)
Associate	35.7 (5)
Sector[3]	
Private Practice	92.9 (13)
Industry	7.1 (1)
Academic	0 (0)

[1] No respondents selected that they treated commercial poultry, wildlife, or "other".
[2] No respondents selected that their practice role was locum or "other".
[3] No respondents worked in corporate practice, government, or academic sectors

Factors influencing AMR

When asked about their perception of the major factors influencing AMR in general, 92.9% of veterinarians agreed that antibiotic use in human medicine is a contributing factor (**Table 2**). Within veterinary medicine, many respondents selected owner/producer compliance (78.6%), client expectations (71.4%), prescription of broad-spectrum antibiotics (71.4%) and veterinary medicine prescription practices (64.3%) as factors that contribute to AMR.

Table 2. Factors influencing AMR and Education/Resources

Factors that contribute to AMR in general	**% Responses (N)**
Use in human medicine	92.9 (13)
Use in small animal medicine	50 (7)
Use in food animal medicine	64.3 (9)
Environmental pressure	42.9 (6)
Random genetic mutations	57.1 (8)
Other	0 (0)
Factors that contribute to AMR in veterinary medicine	**% Responses (N)**
Owner/producer compliance	78.6 (11)
Veterinary medicine prescription practices	64.3 (9)
Client expectations	71.4 (10)
Prescription of broad-spectrum antibiotics	71.4 (10)
Financial constraints	42.9 (6)
Restrictions of owner (for ex – time available to administer treatment)	57.1 (8)
Antimicrobial drugs available on site	50 (7)
Lack of veterinary education on antimicrobial use and stewardship	42.9 (6)

Educational and Stewardship

Respondents indicated that for continuing education on antimicrobial resistance (AMR), the most utilized resources are in-person sessions (85.7%), online courses (78.6%), and journal articles (71.4%) (**Table 3**). Additionally, most veterinarians (78.6%) rely on organizational antibiotic use guidelines (such as those provided by AVMA, AAHA, and ISCAID). However, 57.1% of respondents also employ personally developed guidelines for antibiotic use. No respondents reported using hospital-specific guidelines.

Table 3. Resources for continuing education on AMR and Antibiotic guidelines used by WA state dairy veterinarians

Resources for AMR Continuing Education	**% Responses (N)**
In-person continuing education conference	85.7 (12)
Online continuing education conference	78.6 (11)
Journal articles	71.4 (10)
ISCAID or similar recommendations	0 (0)
Veterinary teaching hospitals/infectious disease specialists	42.9 (6)
Diagnostic labs	57.1 (8)
Textbooks	28.6 (4)
Pharmaceutical representatives	14.3 (2)
Antibiotic use guidelines used	**% Responses (N)**
Organizational antibiotic use guidelines (i.e., AVMA, AAHA, ISCAID)	78.6 (11)
Hospital-specific antibiotic use guidelines	0 (0)
Personally developed antibiotic use guidelines	57.1 (8)
I generally do not refer to antibiotic use guidelines during my practice.	7.1 (1)
Other[1]	7.1 (1)

1. The National Dairy Farmers Assuring Responsible Management (FARM) Program

Clinical Scenario Question Responses

In response to clinical scenario questions where veterinarians selected a treatment plan for sick animals, veterinarian participants' responses varied widely (**Table 4**). Overall, respondents chose the most appropriate (as determined by the study veterinary microbiologist) treatment option 66% of the time. In feedlot cattle scenarios, respondents chose the most appropriate response 67% of the time for the Hereford calf with acute respiratory signs, 67% for the Angus heifer with acute respiratory signs, and 100% for the Angus steer with acute respiratory signs (**Table 4**). However, in response to the follow-up question regarding preventative treatments for the steers, only 67% of respondents chose to implement prophylaxis for incoming cows. For dairy cow scenarios, 100% of respondents identified the most

appropriate response for the group of heifers with high calf mortality, 38% of the time for the heifer with acute diarrhea and fever, 88% of the time for the group of heifers with acute respiratory signs, and 50% of the time for the Jersey cow with mastitis.

Table 4. Summary of Results for Small Animal and Mixed Animal Scenario Questions

Case	Case description	Test results (If diagnostic testing was selected) and follow up questions	% treatment appropriate[1]	% treatment not preferred
Hereford calf with acute respiratory signs	In a backgrounding yard, a recently weaned Hereford calf newly arrived to the premise is showing signs of lethargy, soft/moist cough and isolation from the group. Physical exam reveals a fever of 105F, increased cranioventral lungs sounds and a decreased rumen fill. The calf has not received vaccines prior to shipment.	N/A	67 (2/3)	33 (1/3)
Angus heifer with acute respiratory signs	You are presented with an angus heifer that was moved to the sick pen after signs of lethargy, isolation and coughing were noted. Examination reveals dehydration, lethargy, increased respiratory rate, increased cranioventral lung sounds and a fever of 105F. The heifer was vaccinated at birth with intranasal PI3/IBR MLV and systemically at 2 weeks with a IBR/PI3/BRSV/BVD-MLV, and was recently transported from a calf ranch to the dairy shortly after weaning.	A deep nasopharyngeal swab was obtained and bacterial culture and testing for respiratory viruses via PCR was performed. *Salmonella dublin* was isolated on culture with no viral agents detected.	67 (2/3)	33 (1/3)
Angus steer with acute respiratory signs	An angus steer is showing symptoms such lethargy, soft cough and isolation from the herd housed in a feedlot. The group (pen) comes from three different direct sources and the animals entered the operation at around the same time. Of the fifty animals originally housed in the pen, 20% are showing signs of respiratory disease.	Which of these interventions would you recommend? Prophylaxis of incoming calves onto premise (2/3), Individual animal treatment based on clinical signs (2/3), Metaphylaxis of in-contact calves in the same pen as the affected calf (1/3)	100 (3/3)	0 (0/3)

Group of heifers with high calf mortality	A group of Holstein heifers of weaning age are to be moved from hutches to a grow barn. This calf source consistently has some management issues with colostrum administration at birth, and the facilities are minimally adequate. The calves on this farm have 15% mortality due to respiratory disease.	N/A	33 (1/3)	67 (2/3)
Heifer with acute diarrhea and fever	You are presented with a Holstein heifer that was moved to the sick pen after signs of lethargy, isolation and diarrhea were noted. Exam reveals dehydration, depression, increased respiratory rate, fecal staining of hind legs and a fever of 105F. This calf was vaccinated at birth with intranasal PI3/IBR MLV and vaccinated systemically at 2 weeks with a IBR/PI3/BRSV/BVD-MLV.	A fecal sample was obtained and bacterial culture and a screen for viruses via PCR performed. *Salmonella typhimurium* was identified, and the animal is also positive for bovine coronavirus.	100 (5/5)	0 (0/5)
Group of heifers with acute respiratory signs	You are presented with 50 heifers that were recently weaned and co-mingled. Five animals are showing similar signs of respiratory disease, including lethargy, isolation, coughing, dehydration, increased respiratory rate and increased cranioventral lung sounds, and a fever of 105F. There have been two dead, which necropsies have been performed on. One necropsy revealed fibrinous pneumonia while the other showed effusive pleuritis.	*Histophilus somni* and *Mycoplasma bovis* are identified on culture and no viruses are detected from the lungs of two affected animals. No viruses were detected.	38 (3/8)	62 (5/8)
Jersey cow with mastitis	A 4 year old Jersey cow that is 90 days in milk presents with a 30% drop in production. Her front left quarter is firm, painful, and hot to the touch. She is bright, alert and responsive, and has a temperature of 103 F and a heart rate of 95 bpm.	A sample of milk is cultured and *E. coli* is identified	88 (7/8)	12 (1/8)

[1]The percent appropriate treatment represents the appropriateness of answers to the initial scenario-based questions. For the prescription of antimicrobials, both preferred and unpreferred, the percentage of prescriptions is calculated based on the selection of the antimicrobial treatment plan for the initial scenario-based questions and subsequent branching logic questions. Appropriate treatment was decided through consult with a board-certified veterinary microbiologist (CB) and is based on whether responses are clinically indicated, stewardship appropriate, and in compliance with current legislation.

In group scenarios, veterinarians chose to screen cattle and treat only symptomatic individuals 87% of the time, while opting to treat all cattle only 13% of the time. Non-antimicrobial treatments were not selected by veterinarians in group scenarios (**Table 5**).

Table 5. Treatment choices selected by respondents for scenarios with groups of animals

Species	Illness	All cattle treated	Symptomatic cattle treated	Non-antimicrobial treatments
Feedlot	Respiratory	33% (1)	67% (2)	0% (0)
Dairy	Respiratory	0% (0)	100% (5)	0% (0)
Dairy	Respiratory	12.5% (1)	87.5% (7)	0% (0)

A trend emerged in which veterinarians were more likely to use diagnostic testing or recommend non-antimicrobial interventions for individual cases of mastitis and diarrhea in dairy settings, in contrast to scenarios involving respiratory illnesses in dairy groups or feedlot environments (**Figure 1**). This variation could stem from factors such as the nature of the illness or specific setting. To gain further insights, additional information was sought from dairy veterinarians during interviews.

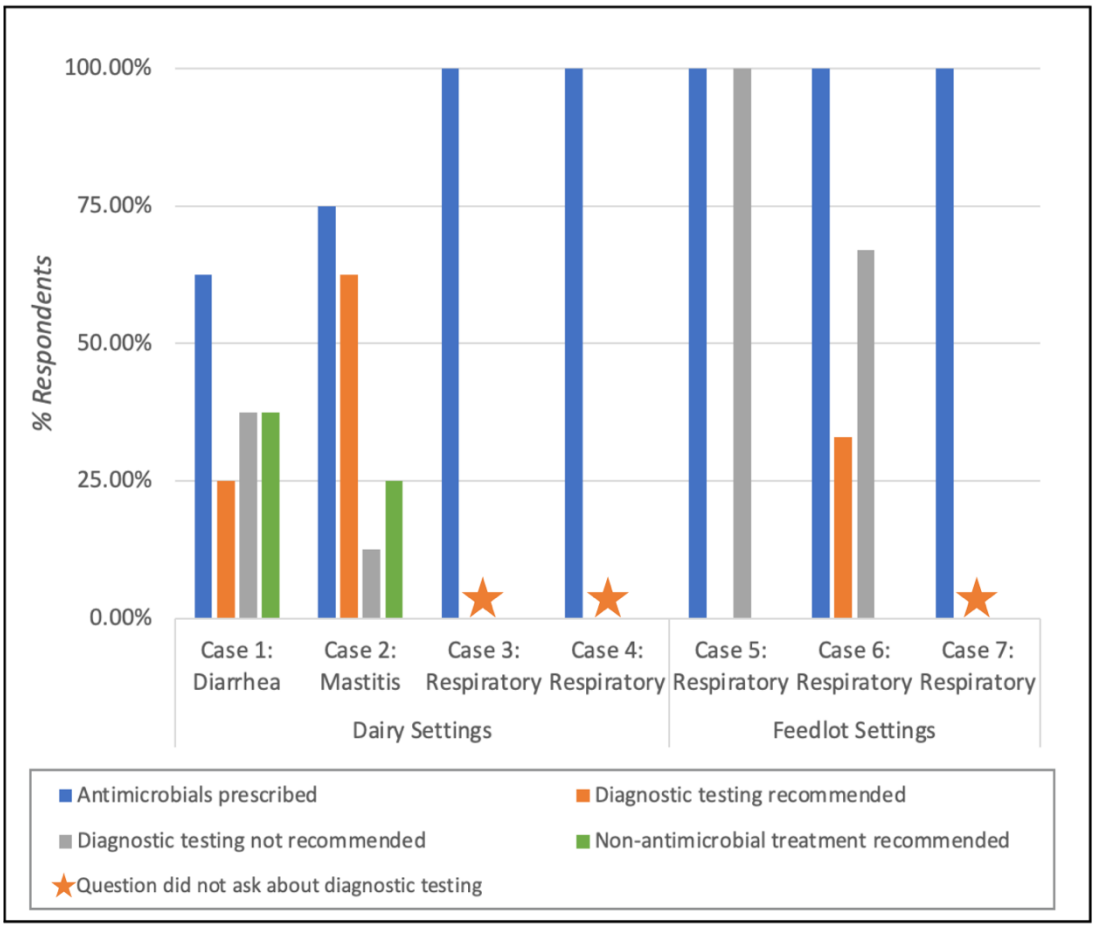

Figure 1. Diagnostic testing and treatment choices trends for mastitis, diarrhea, and respiratory illness cases in dairy and feedlot species

Regarding antibiotic usage, veterinarians most frequently administered tulathromycin, accounting for 41% of prescriptions (**Table 6**). Overall, broad-spectrum antibiotics constituted 58.6% of drug choices. Enrofloxacin accounted for 10% of drug choices. Broad-spectrum third generation cephalosporins represented 13% of drug choices, including for cases where cephalosporins were not clinically indicated.

Table 6. Antimicrobial choices by dairy veterinarians

Antimicrobial drug	**% used[1]**
Tulathromycin	41 (12/29)
Ceftiofur hydrochloride	13 (4/29)
Enrofloxacin	10 (3/29)
Florfenicol	10 (3/29)

Tetracycline	10 (3/29)
Ceftiofur	7 (2/29)
Cephapirin sodium	7 (2/29)

1. Includes all scenarios and follow-ups. For example, if a veterinarian selected to do empiric therapy and wait for diagnostic testing, but changed their answer after diagnostic testing, both antimicrobials are included.

Group Conversations

In the formative group conversation held with large animal veterinary participants, when making decisions regarding antibiotic prescriptions, participants stated they use several resources, including FARAD,[31] Ohio State recommendations,[32] and their own personally developed guidelines. When prompted for suggestions regarding new resources, they shared that targeting producers and farm workers with educational efforts could yield significant benefits. They emphasized that providing more support for farm herd health workers administering antibiotics could improve antibiotic stewardship, and that offering resources for producers could enhance client receptivity.

In terms of identifying barriers to stewardship, the veterinarians highlighted the pressure to prescribe as a major obstacle. They noted that if a producer disagrees with their clinical decisions, they may seek a new veterinarian. Moreover, veterinarian participants expressed a preference for more preventative approaches. For instance, one veterinarian remarked, “When I see a group of sick animals, it’s like, why are we here? ...how can we prevent this from happening again.” However, when advocating for preventative measures, veterinarian participants report experiencing hesitancy from producers. For example, one participant stated, “I've been getting a lot of pushback on [preventative approaches] … [the producers ask] why aren't we getting these [antibiotics].”

Furthermore, the veterinarians emphasized that cost is a significant barrier, particularly concerning ordering of culture and susceptibility testing. Additionally, respondents noted that “the economic bottom line” is the priority for farmers, so they allocate resources to where they perceive the most value and impact.

Interviews

Interviewees were both dairy veterinarians, and no feedlot veterinarians were interviewed. Interview themes were determined to fall into three main categories: 1) herd health systems, 2) stewardship and barriers to stewardship, and 3) resources to develop for stewardship

Herd health systems

Regarding herd health systems, veterinarians highlighted the collaborative nature of herd health management**,** which involves individuals from all levels of farm management. Interviewees revealed that they interact frequently with personnel including owners, managers, feeders, animal caretakers, nutritionists, and partnering entities, occurring on a weekly or biweekly basis. These engagements involve report development, hands-on check-ins, sick animal evaluations, and various other activities. When prompted about treatment protocol development, interviewees described a "*team effort*" involving the veterinarian, animal caregivers, herd managers, and owners. This process involves assessing ongoing situations, effective treatments, and logistical feasibility. Further underscoring this collaboration, multiple farm employees assume responsibility for identifying and diagnosing animal diseases. Milkers, for instance, undergo regular training in mastitis detection through milk examination, an integral expectation of their role. Additionally, animal caretakers involved in feeding, tending, and moving animals routinely flag issues, while designated personnel perform daily surveillance of cows. Veterinarians expressed admiration for the efficiency and accuracy exhibited by farm workers in disease identification. Cumulatively, these insights affirm that herd health is a collaborative endeavor, drawing upon the expertise and experience of diverse stakeholders across various management levels.

Further, veterinarians pointed out the importance of building relationships with farm employees as a cornerstone of successful herd health management. Veterinarians emphasized that animal care workers become proficient at identifying diseases through years of experience working alongside various veterinarians or senior employees. Additionally, the veterinarians interviewed actively contribute to this knowledge by seizing every opportunity to teach farm workers more about cow health. For instance, one veterinarian stated, "*I try and just take like any learning opportunity that comes up, if I see something different on a cow... I'll just kind of talk with the guys about it at that moment to and then over time, that builds up to a lot of information."* Further, veterinarian participants shared that they try to make weekly visits to farms to engage with animal care employees to nurture these relationships. This proactive engagement ensures that farm workers are comfortable communicating directly with veterinarians, rather than deviating from established protocols if they encounter issues.

Interviewees reported that many farms have robust structures and data management systems to manage herd health. According to the veterinarians interviewed, most dairy farms participate in the National Farm Program, specifically the Farmers Assuring Responsible Management (FARM) program, where having treatment and vaccination and biosecurity protocols is mandatory. This adherence to established protocols provides a strong foundational structure for farms to implement best data management practices. Furthermore, veterinarians highlighted the existence of larger federal or national structures that support the dissemination of best practices in herd health management. Veterinarians interviewed reported that farms have robust documentation systems in place, with treatment records being meticulously documented electronically. Additionally, farms leverage SCR collars, collars which monitor real-time health data on cows, further enhancing their data management capabilities. Further, interviewees report that veterinarians and farm workers both maintain institutional memory which is essential to managing herd health. In summary, the interviews revealed that herd health management is collaborative, relationship building is essential, and robust structures and data management systems exist on farms.

Stewardship and barriers to stewardship

A lack of research on best practices for treating respiratory diseases in dairy cows and calves emerged as a significant barrier to antibiotic stewardship. For instance, we asked interviewees to elaborate on a trend discovered in the survey where veterinarians were more likely to opt for culture and susceptibility testing and non-antimicrobial approaches for mastitis and diarrhea cases but chose empiric therapies for respiratory disease cases (Table 6). Interviewed veterinarians explained that there is more comprehensive research available for treating mastitis and diarrhea compared to respiratory diseases. One veterinarian explained:

"[For mastitis], diagnostics can give us feedback about management more, and particularly, identifying contagious mastitis pathogens, and [self]-curing." Another veterinarian highlighted this disparity, noting that "With mastitis, we know that if we get a Gram-negative culture, she will probably self-cure. So we have this knowledge that many of these cows don't actually need that antibiotic. And I don't think we have that same knowledge when it comes to pneumonia." Furthermore, veterinarians shared that research has demonstrated the efficacy of non-

antimicrobial treatments such as fluid therapy for gastrointestinal diseases like acute diarrhea, as it is often not bacterial in nature.

Further, veterinarians interviewed share that the largest **barrier to culture and susceptibility testing is that respiratory cultures are often not actionable** due to a lack of reliable data and lack of possible drug choices. In explaining why they rarely opted for culture and susceptibility tests, one veterinarian explained "I don't know if this result will actually change anything that we're doing. And I have done it and it has never really changed anything that we're doing... I don't tend to recommend it on farms." Another veterinarian concurred, particularly for respiratory cultures, stating "I find pneumonia diagnostics to be completely not useful, because you pretty much always find the same few things, but none of them really seem to explain the problem."

We also prompted veterinarians to elaborate on a trend identified in the survey results, wherein veterinarians showed a preference for antimicrobial treatments over non-antimicrobial treatments, including vaccines (Table 6). Veterinarians explained that while a standard set of vaccines constitutes core components on farms, **most vaccinations do not address the diseases for which antibiotics are commonly used**. For instance, diseases like mastitis, lameness, and pneumonia, which constitute a significant portion of interviewed veterinarians' antibiotic use, often do not have effective vaccines available, although veterinarians may still use them. As one veterinarian expressed, "I don't know how much worse it would be if we didn't vaccinate, but we still have a lot of pneumonia, even with vaccines." The lack of effective vaccines highlights another research gap, particularly for respiratory pathogens. A veterinarian emphasized this, stating:

"I don't know if [vaccines are ineffective] it's because there's other pathogens out there now that just we don't know, aren't really finding new pathogens, or new variants, or I don't know what it is, but or it's just that it's all more management based and not really have nothing to do with the pathogens. But it's a frustrating thing… We can't really vaccinate for most of the stuff that we deal with."

Not surprisingly, when considering the aforementioned barriers, dairy veterinarians reported prioritizing prevention over antibiotic selection due to limited drug choices and

insufficient research on their effectiveness. One veterinarian echoed this sentiment, stating, "The main thing we focus on all the time is prevention. So anytime there's [an issue] we're going to go back to what are the management factors that are that are causing that, more so than what drugs [to] use. “

Avenues to address barriers

When discussing how to improve support for veterinarians in antimicrobial stewardship, veterinarians reiterated the necessity for **increased research into respiratory pathogens in cows and calves**. As one veterinarian emphasized,

“[It would be useful to have] more research into those kinds of things… looking for new problems in calves. Are we sure there's not any more pathogens causing pneumonia? What if we did some more deliberate antimicrobial susceptibility surveillance studies with nasal pharyngeal swabs in a certain population? So it could tell us something about what medicines we should be using first or second, or third?... I think there's just kind of the lack of that in calves, especially where I think a lot of antibiotics are used a lot more than we want.”

When asked about the resources they presently utilize or would find helpful, veterinarians mentioned that they read research papers on new drugs and meta-reviews when available, but due to the limited availability of new knowledge, they do not access resources frequently. In addition, interviewees expressed that they would find it beneficial to have a resource that provides insights into trends in antibiotic resistance specific to their region.

Furthermore, veterinarians interviewed suggested the development of resources tailored to farm herd health workers. Some suggestions included posters or flyers providing information on diagnosing conditions that may or may not require antibiotics, such as acute diarrhea, and emphasizing the importance of non-antimicrobial treatments such as fluids over antibiotics in certain cases. In addition, veterinarians suggested a resource for farm workers explaining antimicrobial spectrum and tissue penetration of different drugs to better understand why certain drug choices are recommended for specific conditions. In summary, veterinarians highlighted the need for accessible and informative resources, both for themselves and for farm workers, to support effective antimicrobial stewardship practices.

Discussion

Various not preferred treatment options were observed. Some respondents some treatments, such as antimicrobial drugs for acute diarrhea caused by *E. coli,* were chosen despite being clinically unnecessary.[3334] Further, some treatment choices did not align with stewardship guidelines. For example, third-generation cephalosporins were often prescribed for mastitis cases, which contradicts established guidelines for critically important antibiotics.[29] However, cephalosporins remain one of the most commonly used antibiotics in the dairy industry because they have no milk withdrawal time and are easy-to-use injectables.[35] For this scenario, discontinuing treatment is the most appropriate choice, as studies have shown that mastitis caused by Gram-negative bacteria often self-cures.[36] Given that mastitis cases has been reported to contribute to as much as 75% of antibiotic use on dairy farms,[37] improving communication delivery of this information may help reduce antibiotic use. Further, while 71.4% of participants agreed that use of broad-spectrum antibiotics is a driver of AMR in veterinary medicine, such use constituted 56.8% of drug choices by participants. This conflict in perspectives and behaviors has been previously observed and may reflect a conflict for veterinarians in in balancing stewardship goals with animal welfare concerns.[38]

In addition to antimicrobial drug choice, some management choices for antibiotic use were considered not preferred by the veterinarians. In a scenario involving respiratory conditions in Angus steers, two-thirds of respondents favored prophylaxis for incoming calves, while one-third opted for metaphylaxis of calves in-contact with the affected calf. In feedlot settings, prophylaxis is often used in high-risk environmental conditions, such as crowded spaces.[22,39] Notably, both metaphylaxis and prophylaxis involve significant antibiotic usage and have demonstrated varying efficacy across different scenarios, as evidenced by a systematic review and metanalysis of 169 clinical trials in feedlot cattle.[40] Importantly, while these management practices are permissible in the US, they are heavily restricted in the European Union under Regulation 2019/6.[41]

Across all treatment choices, we observed a survey trend where veterinarians selected diagnostic testing and non-antimicrobial treatments in cases of diarrhea and mastitis but relied on empiric antibiotic treatments for respiratory disease cases. During interviews, veterinarians highlighted that while actionable clinical data are available for mastitis and diarrhea in dairy

cows, significant research gaps exist regarding effective bovine respiratory treatments.[42] Coupled with the limited selection of legal antibiotics for treating bovine respiratory diseases, diagnostic test results are not highly actionable for dairy veterinarians. Although veterinarians interviewed discussed mainly upper respiratory sampling, lower respiratory sampling is difficult to perform and still may not provide useful information for treatment. Further research in clinical microbiology for respiratory diseases in bovine species is needed, including a better understanding of specific pathogens, effectiveness of antimicrobial drugs, and actionable interpretations of diagnostic test results. Additionally, interviewees explained why vaccines were not commonly chosen by survey participants as an alternative to antimicrobials; While a standard set of vaccinations is routinely administered, they are not particularly efficacious for conditions which constitute most antibiotic use on dairy farms, such as mastitis and pneumonia. Moreover, evidence regarding the effectiveness of such vaccines is both limited and conflicting.[43,44] Supporting research on efficacious vaccines, evidence-based treatments, etiological agents of disease, and preventative strategies would bolster bovine veternary stewardship. Emerging zoonotic pathogens (e.g., highly pathogenic avian influenza) exemplify the need for basic science research in bovine infectious diseases.[45]

Considering these findings, veterinarians may benefit from the establishment of more accessible antimicrobial prescription guidelines. While 78.6% of surveyed veterinarians adhere to organizational guidelines, 57.1% also rely on personally developed guidelines, indicating potential gaps in comprehensiveness and accessibility of existing resources. This is a concern, as studies have found that overprescription tends to be more prevalent among veterinarians practicing in facilities lacking standardized prescription policies.[25] To improve support for food animal veterinarians, future guidelines and resources should prioritize providing readily accessible information on legal compliance, the clinical efficacy of antibiotics for common cattle illnesses, and the classification of antibiotics as critically important. In addition, accessible resources on milk withdrawal times for certain antibiotics may be helpful. Existing resources on withdrawal times can be challenging to navigate. When drugs are used off-label, they do not have specified withdrawal times, and veterinarians must intuitively decide when it is safe to resume milk production. Therefore, it is essential to streamline access to this information to ensure proper drug use and adherence to withdrawal periods.

Further, such guidelines must extend beyond veterinarians to involve all farm stakeholders, including owners and farmworkers. Our survey findings highlight the significant influence of owner/producer compliance and client expectations on antimicrobial use, aligning with similar studies.[38] Additional investigation is necessary to understand the specific factors contributing to owner compliance challenges. For instance, studies have shown a disparity between stewardship intentions and actual antimicrobial use behaviors among dairy farmers,[46,47] suggesting the need for targeted support. Additionally, fostering collaborative relationships between veterinarians and farmers may be an avenue to stewardship.[48] Moreover, interviewees expressed the need for resources aimed at producers and farmworkers, underscoring the importance of broader stewardship efforts involving all stakeholders.

Finally, due to the limited actionability and perceived reliability of diagnostic test results and the constrained range of legal antibiotic options, preventive management strategies emerge as a promising focal point for stewardship efforts in bovine medicine. While further research is needed, emphasizing prevention strategies to curtail antibiotic usage could offer a more immediate avenue for stewardship in bovine veterinary medicine. Moreover, focusing stewardship programs on prevention may be particularly promising because veterinary participants in both group conversations and interviews emphasized their focus on prevention and management rather than antimicrobial use or choice. Focusing on prevention aligns well with the need to address emerging pathogens, such as highly pathogenic avian influenza, where efficacious vaccinations and preventive measures can significantly reduce the spread of the disease.[45]

A limitation of our study is the sample size: 14 bovine veterinarians were surveyed, approximately 20 large animal veterinarians participated in the group conversation, and 2 dairy veterinarians were interviewed. However, State dairy stakeholders confirmed that this sample represents 75-100% of all registered bovine veterinarians in Washington State, strengthening the validity of our findings. Moreover, our findings may be subject to selection bias, as individuals with a stronger interest in AMR might have been more likely to participate in the survey, discussions, and interviews. Additionally, some individuals may not have responded due to a lack of awareness about the survey, potentially biasing our results.

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Supporting Information

Table 6. Diagnostic testing and treatment choices trends for mastitis, diarrhea, and respiratory illness cases in dairy and feedlot species

Species	Situation	Illness	Diagnostic testing recommended	Diagnostic testing not recommended	Non-antimicrobial treatment recommended	Antimicrobials prescribed
Dairy	Individual	Diarrhea	25% (2)	37.5% (3)	37.5% (3)	62.5% (5)
		Mastitis	62.5% (5)	12.5% (1)	25% (2)	75% (6)
	Group	Respiratory	N/A[1]	N/A[1]	0% (0)	100% (5)
		Respiratory	N/A[1]	N/A[1]	0% (0)	100% (8)
Feedlot	Individual	Respiratory	0% (0)	100% (3)	0% (0)	100% (3)
		Respiratory	33% (1)	67% (2)	0% (0)	100% (3)

	Group	Respiratory	N/A[1]	N/A[1]	0% (0)	100% (3)

1. Follow up questions on diagnostic testing were not a part of this scenario.

Consent

Consent Form for "Evaluating Antimicrobial Usage Practices in Small and Large Animal Veterinary Medicine" Participants:

Consent form for the "Evaluating Antimicrobial Usage Practices in Small and Large Animal Veterinary Medicine" study

You are invited to participate in a survey to evaluate veterinarian prescription practices in Washington State. This study is a collaboration between the Washington Integrated Food Safety Center of Excellence (CoE) and Washington Animal Disease Diagnostic Laboratory (WADDL).

You will be asked to complete a short survey comprised of demographic questions, opinion based questions and 2-3 scenario based questions regarding your veterinary work. This survey should take 10-15 minutes.

Your decision to participate in this study is completely voluntary and you have the right to stop your participation at any time without penalty.

Data Confidentiality: You will be assigned a confidential study number that will be used to analyze your survey. If you participate in the raffle or opt in to hear about future studies, we will separate your contact information from your responses prior to analysis. We will securely retain this information in order to contact you about the raffle or future studies.

Risks, and Benefits: There is a minimal risk of a loss of data confidentiality. Extra care will be taken to ensure that your answers are secure and kept separate from any identifying information.

Benefits to participants: There are minimal benefits to the participants, but the results of the study may be helpful for the veterinary community.

Contact Information: If you have any questions about this project, you may contact PI Erica Fuhrmeister at efuhrm@uw.edu or Vickie Ramirez at +1(206)-685-2654 (ramirezv@uw.edu).

Do wish to participate in this study and proceed to the survey?

◯ Yes ◯ No

Thank you for your interest in this study. Please feel free to contact us at 206-685-2654 if you have any questions or think you may wish to participate in the future.

Information/Screening

Please read through the information below to learn more about this study.

Evaluating antimicrobial usage practices large animal veterinary medicine:

Washington Integrated Food Safety Center of Excellence (CoE) and Washington Animal Disease Diagnostic Laboratory (WADDL) are conducting a survey to evaluate veterinarian prescription practices in Washington State. We will be collecting surveys from large veterinarians currently providing care in Washington State.

What does this study involve? The one-time survey should take approximately 10-15 minutes and will comprise 2-3 scenario based questions, demographic questions and opinion based questions. Responses will be kept confidential and participation in the survey is voluntary.

Who is eligible to participate?Any large animal veterinarian currently practicing in Washington State is eligible to participate.

What are the benefits for participating?The results of this study will be used to inform the creation of best practice recommendations to be used in the veterinary community.

Will there be compensation for my time?Your name will be entered in a raffle to receive a $25 tango gift card. We will ask for your email address at the conclusion of the survey which will only be used for the purpose of sending you a gift card, should you win. You may also opt in to receiving follow up information, including a summary of our findings from the survey.

For additional information or questions contact Dr. Erica Fuhrmeister at efuhrm@uw.edu.

Click "Next" to see if you are eligible to participate in this study.

These questions are designed to see if you are eligible to participate in this study.

Are you actively practicing veterinary medicine in Washington State?

- ◯ Yes, I am actively practicing veterinary medicine in Washington State
- ◯ I am actively practicing veterinary medicine but in another state
- ◯ I am a retired Washington State veterinarian
- ◯ I am not a licensed veterinarian

How did you hear about this study?

- ◯ Through WSVMA
- ◯ From a colleague
- ◯ Through social media
- ◯ Other

If other, please describe:

_____

Eligibility status:

You are eligible to participate in this survey. Please click "Submit" if you wish to continue to the e-consent form. If you prefer to do the consent and survey over the phone with a member of the study team, please call us at 206-685-2654.

We're sorry, we are currently only collecting information from practicing veterinarians in Washington state and you do not meet the eligibility criteria for this study. Thank you for your time and feel free to contact the study team at 206-685-2654 if you have any questions.

Survey

We will start this survey about your veterinary clinic experience and type(s) of care you provide.

Date the survey was started

_____
(MM-DD-YYYY)

How many years of veterinary clinical practice experience do you have?

◯ Less than 5 years
◯ 5-10 years
◯ 11-15 years
◯ 16-20 years
◯ More than 20 years

What year did you graduate from veterinary school? (Please answer in a 4-digit year, e.g. 1996)

_____

What veterinary school did you attend?

_____

What best describes your current employment setting?

◯ Mixed Animal Veterinary
◯ Large Animal Veterinary

What is your practice role?

◯ Owner
◯ Associate
◯ Locum
◯ Other

If other, what is your role?

_____

What species do you accept for treatment? (Select all that apply)

☐ Backyard livestock/hobby farm species (For example but not limited to: chickens, goats, sheep)
☐ Commercial poultry farms
☐ Commercial dairy cattle
☐ Commercial feedlot cattle
☐ Pocket/exotic pets
☐ Wildlife
☐ Other

If other species, what species?

_____

What sector of veterinary medicine are you currently employed? (Select all that apply)

☐ Private Practice
☐ Corporate Practice
☐ Government
☐ Industry
☐ Academia
☐ Other

If other sector, what sector?

_____

This next section asks your opinion about antibiotic resistance.

In your opinion, which of the following contributes to antibiotic resistant infections in people? (Select all that apply)

- ☐ Antibiotic use in human medicine
- ☐ Antibiotic use in small animal veterinary medicine
- ☐ Antibiotic use in food animal veterinary medicine
- ☐ Environmental pressure
- ☐ Random genetic mutations
- ☐ Other

If other, what else do you think contributes to antibiotic resistant infections in people?

_____

Which of the following factors in veterinary medicine do you believe may play a role in antibiotic resistance? (Select all that apply)

- ☐ Owner/producer compliance
- ☐ Veterinary medicine prescription practices
- ☐ Client expectations
- ☐ Prescription of broad spectrum antimicrobial drugs for treatment
- ☐ Financial constraints
- ☐ Restrictions of owner (For example: time available to administer treatment, etc)
- ☐ Antimicrobial drugs available on site
- ☐ Lack of veterinary education on antimicrobial use and stewardship

Where might you seek continuing education pertaining to antimicrobial use, resistance and/or stewardship? (Select all that apply)

- ☐ In-person continuing education conference
- ☐ Online continuing education conference
- ☐ Journal articles
- ☐ ISCAID or similar recommendations
- ☐ Veterinary teaching hospitals/infectious disease specialists
- ☐ Diagnostic labs
- ☐ Textbooks
- ☐ Pharmaceutical representatives
- ☐ Other

What other place might you seek education?

_____

Have you ever prescribed or administered any of the following antibiotics (Select all that apply)?

- ☐ Imipenem, meropenem, ertapenem, doripenem
- ☐ Linezolid
- ☐ Oral Polymyxin B
- ☐ Mupirocin
- ☐ Injectable aminoglycoside in cattle
- ☐ Vancomycin
- ☐ Ciprofloxacin
- ☐ No, I have NOT prescribed or administered any of these antibiotics

Which veterinary antibiotic use guidelines do you typically refer to? (Select all that apply)

- ☐ Organizational antibiotic use guidelines (i.e., AVMA, AAHA, ISCAID)
- ☐ Hospital-specific antibiotic use guidelines
- ☐ Personally developed antibiotic use guidelines
- ☐ I generally do not refer to antibiotic use guidelines during my practice.
- ☐ Other

What other veterinary antibiotic guidelines do you use?

_____

Do the following factors influence how you prescribe antibiotics? Please rate your level of agreement with the following statements:

Client expectations of receiving antibiotics influence the way I prescribe antimicrobials.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree
Client ability to medicate influences the way I prescribe antimicrobials.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree
Client finances influence the way I prescribe antimicrobials.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree
When prescribing antimicrobials, the stock of readily available antimicrobials (e.g. the formulary of my in-clinic pharmacy, availability from pharmaceutical company) impacts which antibiotic I decide to prescribe.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree
Preference for certain antibiotics impacts which antimicrobial I select to prescribe.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree
Consideration of antimicrobial resistance influences the manner in which I prescribe antimicrobials.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree
Training that I have received in veterinary school influences the manner in which I prescribe antimicrobials.	◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neither Agree nor Disagree ◯ Somewhat Agree ◯ Strongly Agree

This next section includes short vignettes asking how you would treat an animal with specific signs.

In a backgrounding yard, a recently weaned Hereford calf newly arrived to the premise is showing signs of lethargy, soft/moist cough and isolation from the group. Physical exam reveals a fever of 105F, increased cranioventral lungs sounds and a decreased rumen fill. The calf has not received vaccines prior to shipment. Given this information, what treatment would you recommend for this calf?

- ◯ Empiric antimicrobial therapy without submitting samples for diagnostic testing
- ◯ Empiric antimicrobial drugs while awaiting results from diagnostic lab
- ◯ I may prescribe antimicrobial drugs once diagnostic test results are complete
- ◯ Non-antimicrobial treatments (For example: Non-steroid antiinflammatories, corticosteroids, behavioral modifications, diet)

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A deep nasopharyngeal swab was performed, and Mannheimia haemolytica was isolated on culture and also tested positive for Bovine parainfluenza virus-3. The calf is not responding as expected to the originally prescribed treatment. Given this information, would you change the antimicrobial treatment prescribed?

- ◯ Yes
- ◯ Stop antimicrobial treatment
- ◯ No

What would you change to?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A deep nasopharyngeal swab or BAL culture was performed, and Mannheimia haemolytica was isolated on culture and also tested positive for Bovine parainfluenza virus-3. The calf is not responding as expected to the originally prescribed treatment. Given this information, what antimicrobial treatment, if any, would you prescribe?

- ◯ None
- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

For the above scenario, would you contact the state veterinary office?

- ◯ Yes
- ◯ No

You are presented with an angus heifer that was moved to the sick pen after signs of lethargy, isolation and coughing were noted. Examination reveals dehydration, lethargy, increased respiratory rate, increased cranioventral lung sounds and a fever of 105F. The heifer was vaccinated at birth with intranasal PI3/IBR MLV and systemically at 2 weeks with a IBR/PI3/BRSV/BVD-MLV, and was recently transported from a calf ranch to the dairy shortly after weaning. Given this information, what treatment would you recommend for this calf?

- ◯ Empiric antimicrobial therapy without submitting samples for diagnostic testing
- ◯ Empiric antimicrobial drugs while awaiting results from diagnostic lab
- ◯ Antimicrobial drugs once diagnostic test results are complete
- ◯ Non-antimicrobial treatments (For example: Non-steroid antiinflammatories, corticosteroids, behavioral modifications, diet)

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A deep nasopharyngeal swab was obtained and bacterial culture and testing for respiratory viruses via PCR was performed. Salmonella Dublin was isolated on culture with no viral agents detected. Given this information, would you change the antimicrobial treatment prescribed?

- ◯ Yes
- ◯ Stop antimicrobial treatment
- ◯ No

What would you change to?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A deep nasopharyngeal swab was obtained and bacterial culture; and a screen testing for respiratory viruses via PCR was performed. Results showed isolation of Salmonella Dublin was isolated on culture with no viral agents detected. Given this information, what antimicrobial treatment, if any, would you prescribe?

- ◯ None
- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

For the above scenario, would you contact the state veterinary office?

- ◯ Yes
- ◯ No

An angus steer is showing symptoms such lethargy, soft cough and isolation from the herd housed in a feedlot. The group (pen) comes from three different direct sources and the animals entered the operation at around the same time. Of the fifty animals originally housed in the pen, 20% are showing signs of respiratory disease. Given this information, what treatment would you recommend for the cattle in this group?

- ◯ Empiric antimicrobial therapy to only cattle showing symptoms
- ◯ Empiric antimicrobial therapy for all cattle
- ◯ Evaluate the health of all cattle in a chute and administer antibiotics to those showing symptoms
- ◯ Non-antimicrobial treatments (intensify monitoring, nutritional supplements, vaccination, etc)
- ◯ No treatment

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

Given the situation described above, which of the following interventions would you recommend? (Select all that apply)

- ☐ Prophylaxis of incoming calves onto premise
- ☐ Individual animal treatment based on clinical signs
- ☐ Metaphylaxis of in-contact calves in the same pen as the affected calf.

For the above scenario, would you contact the state veterinary office?

- ◯ Yes
- ◯ No

A group of holstein heifers of weaning age are to be moved from hutches to a grow barn. This calf source consistently has some management issues with colostrum administration at birth, and the facilities are minimally adequate. The calves on this farm have 15% mortality due to respiratory disease. Which of the following interventions do you recommend to prevent bacterial disease in this group at the dairy?

- ◯ Empiric antimicrobial therapy to only cattle showing symptoms
- ◯ Empiric antimicrobial therapy for all cattle
- ◯ Non-antimicrobial treatments (For example: nutritional support, vaccination, allowing rest and acclimatization time, etc)
- ◯ No treatment

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

For the above scenario, would you contact the state veterinary office?

- ◯ Yes
- ◯ No

You are presented with a holstein heifer that was moved to the sick pen after signs of lethargy, isolation and diarrhea were noted. Exam reveals dehydration, depression, increased respiratory rate, fecal staining of hind legs and a fever of 105F. This calf was vaccinated at birth with intranasal PI3/IBR MLV and vaccinated systemically at 2 weeks with a IBR/PI3/BRSV/BVD-MLV. Given this information, what treatment would you recommend for this calf?

- ◯ Empiric antimicrobial therapy without submitting samples for diagnostic testing
- ◯ Empiric antimicrobial drugs while awaiting results from diagnostic lab
- ◯ Antimicrobial drugs once diagnostic test results are complete
- ◯ Non-antimicrobial treatments (For example: Non-steroid antiinflammatories, corticosteroids, behavioral modifications, diet)
- ◯ I do not treat this type of animal

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A fecal sample was obtained and bacterial culture and a screen for viruses via PCR performed. Salmonella Typhimurium was identified, and the animal is also positive for bovine coronavirus. Given this information, would you change the antimicrobial treatment prescribed?

- ◯ Yes
- ◯ Stop antimicrobial treatment
- ◯ No

What would you change to?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A fecal sample was obtained and bacterial culture and a screen for viruses via PCR performed. Salmonella Typhimurium was identified, and the animal is also positive for bovine coronavirus. Given this information, what antimicrobial, if any, would you prescribe?	◯ None ◯ Ampicillin ◯ Bacitracin ◯ Ceftiofur ◯ Danofloxacin ◯ Enrofloxacin ◯ Florfenicol ◯ Gamithromycin ◯ Gentamicin ◯ Lincomycin ◯ Neomycin ◯ Penicillin ◯ Pradofloxacin ◯ Spectinomycin ◯ Sulfadimethoxine ◯ Tetracycline ◯ Tiamulin ◯ Tildipirosin ◯ Tilmicosin ◯ Trimethoprim/sulfamethoxazole ◯ Tulathromycin ◯ Tylosin tartrate ◯ Virginiamycin
For the above scenario, would you contact the state veterinary office?	◯ Yes ◯ No
You are presented with 50 heifers that were recently weaned and co-mingled. Five animals are showing similar signs of respiratory disease, including lethargy, isolation, coughing, dehydration, increased respiratory rate and increased cranioventral lung sounds, and a fever of 105F. There have been two dead, which necropsies have been performed on. One necropsy revealed fibrinous pneumonia while the other showed effusive pleuritis. Given this information, which of the following intervention is your group treatment of choice?	◯ Empiric antimicrobial therapy to only cattle showing symptoms ◯ Empiric antimicrobial therapy for all cattle ◯ Non-antimicrobial treatments (For example: Evaluate the health of all cattle in a chute, nutritional support, vaccination, etc) ◯ No treatment

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

Histophilus somni and Mycoplasma bovis are identified on culture and no viruses are detected from the lungs of two affected animals. No viruses were detected. Given this information, would you change the initial treatment prescribed?

- ◯ Start antimicrobial treatment
- ◯ Change antimicrobial drug prescribed
- ◯ Stop antimicrobial treatment
- ◯ Start non-antimicrobial treatments
- ◯ No changes to treatment plan

What antimicrobial would you prescribe?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

For the above scenario, would you contact the state veterinary office?

- ◯ Yes
- ◯ No

A 4 year old Jersey cow that is 90 days in milk presents with a 30% drop in production. Her front left quarter is firm, painful, and hot to the touch. She is bright, alert and responsive, and has a temperature of 103 F and a heart rate of 95 bpm. Given this information, which of the following intervention would you pursue?

- ◯ Empiric antimicrobial therapy without submitting samples for diagnostic testing
- ◯ Empiric antimicrobial drugs while awaiting results from diagnostic lab
- ◯ Antimicrobial drugs once diagnostic test results are complete
- ◯ Non-antimicrobial treatment options (For example: Non-steroid antiinflammatories, corticosteroids, behavioral modifications, diet)

What antimicrobial drug would you prescribe for treatment?

- ◯ Amoxicillin Trihydrate
- ◯ Ceftiofur Hydrochloride
- ◯ Ceftiofur Sodium
- ◯ Cephapirin Sodium
- ◯ Cloxacillin Benzathine or Sodium
- ◯ Erythromycin
- ◯ Hetacillin Potassium
- ◯ Novobiocin Sodium
- ◯ Penicillin G Procaine
- ◯ Penicillin G Procaine and Dihydrostreptomycin
- ◯ Penicillin G Procaine and Novobiocin Sodium
- ◯ Pirlimycin Hydrochloride
- ◯ Other

If you chose other, what antimicrobial drug would you prescribe?

_____

What antimicrobial drug would you prescribe for treatment?

- ◯ Amoxicillin Trihydrate
- ◯ Ceftiofur Hydrochloride
- ◯ Ceftiofur Sodium
- ◯ Cephapirin Sodium
- ◯ Cloxacillin Benzathine or Sodium
- ◯ Erythromycin
- ◯ Hetacillin Potassium
- ◯ Novobiocin Sodium
- ◯ Penicillin G Procaine
- ◯ Penicillin G Procaine and Dihydrostreptomycin
- ◯ Penicillin G Procaine and Novobiocin Sodium
- ◯ Pirlimycin Hydrochloride
- ◯ Other

If you chose other, what antimicrobial drug would you prescribe?

_____

A sample of milk is cultured and E. coli is identified. Given this information, would you change the antimicrobial treatment prescribed?

- ◯ Yes
- ◯ Stop antimicrobial treatment
- ◯ No

What would you change to?	◯ Amoxicillin Trihydrate ◯ Ceftiofur Hydrochloride ◯ Ceftiofur Sodium ◯ Cephapirin Sodium ◯ Cloxacillin Benzathine or Sodium ◯ Erythromycin ◯ Hetacillin Potassium ◯ Novobiocin Sodium ◯ Penicillin G Procaine ◯ Penicillin G Procaine and Dihydrostreptomycin ◯ Penicillin G Procaine and Novobiocin Sodium ◯ Pirlimycin Hydrochloride ◯ Other
If you chose other, what antimicrobial drug would you prescribe?	_____
A sample of milk is cultured and E. coli is identified. Given this information, if any, antimicrobial treatment would you prescribe?	◯ None ◯ Amoxicillin Trihydrate ◯ Ceftiofur Hydrochloride ◯ Ceftiofur Sodium ◯ Cephapirin Sodium ◯ Cloxacillin Benzathine or Sodium ◯ Erythromycin ◯ Hetacillin Potassium ◯ Novobiocin Sodium ◯ Penicillin G Procaine ◯ Penicillin G Procaine and Dihydrostreptomycin ◯ Penicillin G Procaine and Novobiocin Sodium ◯ Pirlimycin Hydrochloride ◯ Other
If you chose other, what antimicrobial drug would you prescribe?	_____
For the above scenario, would you contact the state veterinary office?	◯ Yes ◯ No
A 20,000 bird commercial poultry farm (5,000 birds per barn) reports a 20% mortality in chicks with clinical signs including sudden death, respiratory distress and lethargy in one barn. Recently, there was a change in source for the breeder flock. Given this information, which treatment do you recommend?	◯ Administer antimicrobial therapy to all poultry on premises ◯ Administer antimicrobial therapy to affected poultry barns only ◯ Non-antimicrobial treatments (intensify monitoring, nutritional supplements, vaccination, etc) ◯ No treatment

What antimicrobial drug would you prescribe for treatment?	◯ Amoxicillin ◯ Bacitracin ◯ Bambermycin ◯ Ceftiofur ◯ Chlortetracycline ◯ Enrofloxacin ◯ Erythromycin ◯ Flavophospholipol ◯ Florfenicol ◯ Gentamicin ◯ Lincomycin ◯ Neomycin ◯ Novobiocin ◯ Oxytetracycline ◯ Penicillin ◯ Spectinomycin ◯ Streptomycin ◯ Sulfadimethoxine ◯ Sulphathiazole ◯ Tetracycline ◯ Trimethoprim/sulfamethoxazole ◯ Tylosin tartrate ◯ Virginiamycin
A culture of the liver and air sac was performed on four affected chicks, and results showed isolation of E. coli. Given this information, would you change the treatment prescribed?	◯ Start antimicrobial treatment ◯ Change antimicrobial drug prescribed ◯ Stop antimicrobial treatment ◯ Start non-antimicrobial treatments ◯ No changes to treatment plan
What antimicrobial would you use to treat these animals?	◯ Amoxicillin ◯ Bacitracin ◯ Bambermycin ◯ Ceftiofur ◯ Chlortetracycline ◯ Enrofloxacin ◯ Erythromycin ◯ Flavophospholipol ◯ Florfenicol ◯ Gentamicin ◯ Lincomycin ◯ Neomycin ◯ Novobiocin ◯ Oxytetracycline ◯ Penicillin ◯ Spectinomycin ◯ Streptomycin ◯ Sulfadimethoxine ◯ Sulphathiazole ◯ Tetracycline ◯ Trimethoprim/sulfamethoxazole ◯ Tylosin tartrate ◯ Virginiamycin
For the above scenario, would you contact the state veterinary office?	◯ Yes ◯ No

When working with commercial or large animals, who do you communicate instructions to for administering antimicrobials to the patient(s)?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I communicate antimicrobial treatment plan directly to the farm or premise owner	◯	◯	◯	◯	◯
I communicate antimicrobial treatment plan to a veterinary assistant/technician, who communicates this to individuals carrying out treatment.	◯	◯	◯	◯	◯
I communicate antimicrobial treatment plan to the farm or premise manager.	◯	◯	◯	◯	◯
I communicate antimicrobial treatment plan to a farm hand, who is employed by animal owner and provides care to animal.	◯	◯	◯	◯	◯

The owner of a backyard chicken enclosure has just received 8 new chicks in the mail, and has introduced them to the flock. Since then, some adult birds in the flock are showing respiratory symptoms, including wheezing, discharge from eyes and nose, lethargy and decreased appetite. Given this information, which treatment do you recommend?

- ◯ Empiric antimicrobial therapy without submitting samples for diagnostic testing
- ◯ Empiric antimicrobial drugs while awaiting results from diagnostic lab
- ◯ Antimicrobial drugs once diagnostic test results are complete
- ◯ Non-antimicrobial treatment options (For example: quarantine symptomatic individuals, cull)
- ◯ I do not treat this species

For this situation given, would you treat:

- ◯ Symptomatic adult birds
- ◯ All adult birds
- ◯ All birds in the flock (adults and chicks)

What antimicrobial drug would you prescribe for treatment?

- ◯ Amoxicillin
- ◯ Bacitracin
- ◯ Bambermycin
- ◯ Ceftiofur
- ◯ Chlortetracycline
- ◯ Enrofloxacin
- ◯ Erythromycin
- ◯ Flavophospholipol
- ◯ Florfenicol
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Novobiocin
- ◯ Oxytetracycline
- ◯ Penicillin
- ◯ Spectinomycin
- ◯ Streptomycin
- ◯ Sulphathiazole
- ◯ Tetracycline
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tylosin tartrate
- ◯ Virginiamycin

What antimicrobial drug would you prescribe for treatment?

- ◯ Amoxicillin
- ◯ Bacitracin
- ◯ Bambermycin
- ◯ Ceftiofur
- ◯ Chlortetracycline
- ◯ Enrofloxacin
- ◯ Erythromycin
- ◯ Flavophospholipol
- ◯ Florfenicol
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Novobiocin
- ◯ Oxytetracycline
- ◯ Penicillin
- ◯ Spectinomycin
- ◯ Streptomycin
- ◯ Sulphathiazole
- ◯ Tetracycline
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A tracheal swab was taken to identify bacterial and/or viral pathogens. Results showed a positive PCR for Mycoplasma gallisepticum. Given this information, would you change the antimicrobial treatment prescribed?

- ◯ Yes
- ◯ Stop antimicrobial treatment
- ◯ No

What would you change to?

- ◯ Amoxicillin
- ◯ Bacitracin
- ◯ Bambermycin
- ◯ Ceftiofur
- ◯ Chlortetracycline
- ◯ Enrofloxacin
- ◯ Erythromycin
- ◯ Flavophospholipol
- ◯ Florfenicol
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Novobiocin
- ◯ Oxytetracycline
- ◯ Penicillin
- ◯ Spectinomycin
- ◯ Streptomycin
- ◯ Sulphathiazole
- ◯ Tetracycline
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A tracheal swab was taken to identify bacterial and/or viral pathogens. Results showed a positive PCR for Mycoplasma gallisepticum. Given this information, what antimicrobial treatment, if any, would you prescribe?	◯ None ◯ Amoxicillin ◯ Bacitracin ◯ Bambermycin ◯ Ceftiofur ◯ Chlortetracycline ◯ Enrofloxacin ◯ Erythromycin ◯ Flavophospholipol ◯ Florfenicol ◯ Gentamicin ◯ Lincomycin ◯ Neomycin ◯ Novobiocin ◯ Oxytetracycline ◯ Penicillin ◯ Spectinomycin ◯ Streptomycin ◯ Sulphathiazole ◯ Tetracycline ◯ Trimethoprim/sulfamethoxazole ◯ Tylosin tartrate ◯ Virginiamycin
For the above scenario, would you contact the state veterinary office?	◯ Yes ◯ No
In a backyard farm setting, a goat presents with a submandibular abscess. The owner of the backyard farm is concerned about caseous lymphadenitis (Corynebacterium pseudotuberculosis, CL), and is inquiring about treatment for this, as well as methods to control the spread to the rest of the herd. Given this information, which treatment do you recommend?	◯ Empiric antimicrobial therapy without submitting samples for diagnostic testing ◯ Empiric antimicrobial drugs while awaiting results from diagnostic lab ◯ Antimicrobial drugs once diagnostic test results are complete ◯ Non-antimicrobial treatments (For example: quarantine symptomatic individuals, drain abscess, remove lymph nodes, cull) ◯ I do not treat this species
For the above scenario, which animals in the backyard farm would be treated?	◯ Treat symptomatic goat only ◯ Treat all goats in the herd ◯ Treat all animals on the farm

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

What antimicrobial drug would you prescribe for treatment?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A culture of the abscess material or exudate was performed, and results showed isolation of Staphylococcus aureus. Given this information, would you change the antimicrobial treatment prescribed?

- ◯ Yes
- ◯ Stop antimicrobial treatment
- ◯ No

What would you change to?

- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

A culture of the abscess material or exudate was performed, and results showed isolation of Staphylococcus aureus. Given this information, what antimicrobial treatment, if any, would you prescribe?

- ◯ None
- ◯ Ampicillin
- ◯ Bacitracin
- ◯ Ceftiofur
- ◯ Danofloxacin
- ◯ Enrofloxacin
- ◯ Florfenicol
- ◯ Gamithromycin
- ◯ Gentamicin
- ◯ Lincomycin
- ◯ Neomycin
- ◯ Penicillin
- ◯ Pradofloxacin
- ◯ Spectinomycin
- ◯ Sulfadimethoxine
- ◯ Tetracycline
- ◯ Tiamulin
- ◯ Tildipirosin
- ◯ Tilmicosin
- ◯ Trimethoprim/sulfamethoxazole
- ◯ Tulathromycin
- ◯ Tylosin tartrate
- ◯ Virginiamycin

For the above scenario, would you contact the state veterinary office?

- ◯ Yes
- ◯ No

When working with backyard animals, who do you communicate instructions to for administering antimicrobials to the patient(s)?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

I communicate antimicrobial treatment plan directly to backyard farm or animal owner.	○	○	○	○	○
I communicate antimicrobial treatment plan to the production manager of farm where animal resides.	○	○	○	○	○
I communicate antimicrobial treatment plan to a veterinary assistant/technician, who communicates this to individuals carrying out treatment.	○	○	○	○	○
I communicate antimicrobial treatment plan to animal care staff.	○	○	○	○	○
I communicate antimicrobial treatment plan to another person not directly involved in treatment plan of the animal.	○	○	○	○	○

You are almost done with the survey, just one very long question, and two very short questions left!

This is a very long list, but please select all the antimicrobials that you have NOT heard of, or are unfamiliar with.

- ☐ Amikacin
- ☐ Amoxicillin
- ☐ Amoxicillin Trihydrate
- ☐ Amoxicillin/Clavulanic Acid
- ☐ Ampicillin
- ☐ Bacitracin
- ☐ Bambermycin
- ☐ Cefazolin
- ☐ Cefovecin
- ☐ Cefpodoxime
- ☐ Ceftazidime
- ☐ Ceftiofur
- ☐ Ceftiofur Hydrochloride
- ☐ Ceftiofur Sodium
- ☐ Cephalexin
- ☐ Cephalothin
- ☐ Cephapirin Sodium
- ☐ Chloramphenicol
- ☐ Chlortetracycline
- ☐ Clarithromycin
- ☐ Clindamycin
- ☐ Cloxacillin Benzathine or Sodium
- ☐ Danofloxacin
- ☐ Doripenem
- ☐ Doxycycline
- ☐ Enrofloxacin
- ☐ Ertapenem
- ☐ Erythromycin
- ☐ Flavophospholipol
- ☐ Florfenicol
- ☐ Gamithromycin
- ☐ Gentamicin
- ☐ Hetacillin Potassium
- ☐ Imipenem
- ☐ Imipenim
- ☐ Lincomycin
- ☐ Linezolid
- ☐ Marbofloxacin
- ☐ Meropenem
- ☐ Minocycline
- ☐ Mupirocin
- ☐ Neomycin
- ☐ Nitrofurantoin
- ☐ Novobiocin
- ☐ Novobiocin Sodium
- ☐ Orbifloxacin
- ☐ Oxacillin
- ☐ Oxytetracycline
- ☐ Penicillin
- ☐ Penicillin G Procaine
- ☐ Penicillin G Procaine and Dihydrostreptomycin
- ☐ Penicillin G Procaine and Novobiocin Sodium
- ☐ Piperacillin/tazobactam
- ☐ Pirlimycin Hydrochloride
- ☐ Pradofloxacin
- ☐ Rifampin
- ☐ Spectinomycin
- ☐ Streptomycin
- ☐ Sulfadimethoxine
- ☐ Sulphadimethoxine
- ☐ Sulphathiazole
- ☐ Tetracycline
- ☐ Tiamulin
- ☐ Tildipirosin
- ☐ Tilmicosin
- ☐ Trimethoprim/sulfamethoxazole
- ☐ Tulathromycin
- ☐ Tylosin tartrate
- ☐ Vancomycin

☐ Virginiamycin

Thank you for your time! Just two final questions.

For participating in this study, we would like to compensate you for your time by putting your name into a raffle to win a $25 gift card. Would you like your name added to the raffle?

◯ Yes
◯ No

Please provide your email to notify you if you are a raffle winner.

_____

Would you be interested in hearing about future studies and the results of this survey? Future studies would be strictly related to the veterinary field (e.g., occupational health, one health, AMR)

◯ Yes
◯ No

Please provide your email to connect with you about future studies.

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