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Evidence in support of veterinary involvement in antimicrobial stewardship training programs in the dairy industry: A preliminary study

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Abstract

The recent emergence of antimicrobial resistance has triggered initiatives aimed at conveying antimicrobial stewardship in human and veterinary medicine. The importance of effective education and training programs has been highlighted as a key area of expansion for championing judicious use of antimicrobial agents. In order to provide data that would aid in design of interventions encouraging prudent antimicrobial use, Illinois dairy farmers (n=20) were surveyed using a probability cluster sampling technique. Survey responses were analyzed and examined for significant trends based upon potential knowledge, attitudinal, and behavioral indices of antimicrobial stewardship. The key areas of training needs that were identified from the survey responses include appropriate antimicrobial selection, the use of protocols, improved on-farm record keeping, and understanding of the factors that constitute extra-label drug use. The results from this preliminary study highlight the need for additional antimicrobial stewardship training in this sector of the livestock industry, and may be used to guide veterinarians in developing producer-focused education and training programs aimed at encouraging best practices surrounding the practical antimicrobial stewardship necessary to foster high-health animal care systems.

Key words: antimicrobial stewardship, antibiotics, dairy, training

Résumé

L'émergence récente de la résistance antimicrobienne a motivé le développement d'initiatives dont le but est de promouvoir le principe de l'antibiogouvernance en médecine humaine et vétérinaire. Une éducation et des programmes de formation efficaces sont reconnues comme des éléments clés à mieux développer afin de promouvoir l'utilisation judicieuse des agents antimicrobiens. Dans le but de fournir des données qui aideraient à planifier des interventions encourageant l'utilisation judicieuse des antimicrobiens, des producteurs laitiers de l'Illinois (n = 20) ont été sondés avec une technique d'échantillonnage probabiliste en grappes. Les réponses du sondage ont été analysées pour détecter des tendances significatives en lien avec des indices de gérance des antimicrobiens basés sur les connaissances, les attitudes et le comportement. Parmi les secteurs clés de formation identifiés par le sondage on retrouve le choix approprié des antimicrobiens, l'utilisation de protocoles, une meilleure tenue des dossiers à la ferme et une compréhension des facteurs reliés à l'utilisation des médicaments en dérogation des directives de l'étiquette. Les résultats de cette étude préliminaire mettent en lumière le besoin d'une plus grande formation en gérance des antimicrobiens dans le secteur de la production bovine. Ces résultats pourront aussi être utilisés pour guider les vétérinaires dans le développement d'une éducation ciblant les producteurs et aussi de programmes de formation dont le but est d'encourager de meilleures pratiques dans le cadre d'une gérance concrète des antimicrobiens visant à favoriser des systèmes de soins d'animaux avec des normes élevées de santé.

Introduction

The benefits of antimicrobial use to animal health, well-being, and system efficiency are well established in modern intensive livestock production. However, the emergence of antimicrobial resistance is seen as an impending public health crisis, provoking numerous initiatives that encourage the prudent use of antimicrobials in both human and veterinary medicine.[1] Most of these initiatives recognize the multifactorial and complex ecology underlying the development of antimicrobial resistance, and have therefore recommended a multifaceted approach in developing risk reduction solutions.[4,10] Universally, these solutions highlight the need for

a collaborative approach that incorporates the expansion of regulatory policy and process, surveillance, research, and innovation at local, national, and international levels. The importance of effective education and training programs has been increasingly emphasized as a key area of expansion for improving antimicrobial stewardship at all levels. The benefit of effective education and training programs in other aspects of agricultural productivity and efficiency has been recognized for many years. In the US, formal and structured adult farmer education programs can be traced back to the Morrill Land Grant Act, with a strategic expansion of targeted training after the First and Second World Wars.[12] In the recent US National Action Plan for Combating Antibiotic-Resistant Bacteria, a specific milestone to implement educational outreach efforts for veterinarians and animal producers was described.[8] The objective of this preliminary study is to gather evidence on current attitudes and behaviors regarding antimicrobial use by Illinois dairy producers. It is anticipated that this information can be used to guide the future design of veterinarian-led, producer-focused, education and training programs aimed at advancing antimicrobial stewardship.

Antimicrobial stewardship encompasses a system of planning and implementing practices designed to appraise and improve the appropriate use of antimicrobials.[16] In livestock-based food production systems, antimicrobial stewardship is focused on providing a safe and affordable food product that assures and bolsters consumer confidence. The administration of antimicrobials, when needed, must be performed in accordance with Food and Drug Administration (FDA) regulations, ensuring that assigned time frames for withdrawal are followed.[2] In practical terms, regulatory compliance involves selection of an appropriate and approved antimicrobial for the relevant disease indication, administered at the correct dose, by the correct route, at the correct frequency, for the appropriate duration. While legally the use of antimicrobials in food producing animals requires veterinary oversight, the majority of decisions regarding antimicrobial administration have historically been made by lay farm workers.[8,13,14] Although there are numerous studies exploring the impact and effectiveness of antimicrobial stewardship programs in people,[4,6] there are only a few dairy programs that have been designed and implemented effectively.[3,9] These initiatives have highlighted several important areas of focus, including valid veterinary oversight, careful maintenance of complete records (drug lists and medical management), and the application of treatment protocols and standard operating procedures.[3,9]

Materials and Methods

To help identify areas of strengths and weaknesses in knowledge, attitude, behavior, and practice in antimicrobial usage, we undertook a study using a probability cluster survey of dairy producers (n=20) at the 2013 Illinois State Fair. The sampling frame was state fair attendance, and inclusion requirements were for the participants to be current Illinois-based dairy owners, or herd managers, on farms that shipped milk. There were no prerequisites for herd size, breed, conventional/organic status, or record-keeping system. No participant identifying or geographic information was collected. The study was entirely opinion-based, with no consultation of farm records, and no participation incentives. The trained survey administrators (n=6) were DVM students, hospital interns, researchers, or faculty from the University of Illinois College of Veterinary Medicine.

Participation consisted of a multi-question, in-person interview that characterized potential knowledge, attitudinal, and behavioral indices of antimicrobial stewardship (Table 1). These indices included 1) antimicrobial preference based on suspected disease, 2) the maintenance of treatment records, 3) the presence of diagnostic and treatment protocols for common diseases, 4) the level of active veterinary involvement, 5) understanding of the concept and consequences of extra-label drug use, and 6) familiarity with the concept of antimicrobial resistance. Data was aggregated and analyzed using an online survey-based data collection tool.[a] Since the data was descriptive, no statistical analysis was performed.

Results and Discussion

Participants were questioned on their first-line antimicrobial choices for 7 common dairy cattle diseases including respiratory disease (calf or adult), diarrhea (calf), mastitis, lameness/hoof problems (adult), uterine (metritis/retained placenta), and umbilical infections (calf). Overall the most common, systemically administered antimicrobials used by Illinois dairy producers (% of respondents in brackets) were penicillin (100%), oxytetracycline (74%), ampicillin (67%), ceftiofur hydrochloride (67%), and florfenicol (58%). The preferred antimicrobial varied according to the suspected diseased body system (Table 2; % of respondents in brackets); calf respiratory (florfenicol 50%), calf diarrhea (enrofloxacin 33%, penicillin 33%), adult lameness (ceftiofur hydrochloride 38%), uterine infection (oxytetracycline 38%), umbilical infections (penicillin 100%), and mastitis (penicillin 45%). The incidence of adult respiratory disease and umbilical infections were low, and so these categories were removed from further analyses.

Results of the preferential antimicrobial choices made by producers were further evaluated with a view to their compliance with FDA regulations (Table 3). Overall, the majority of antimicrobials (61%, 33/54) were used in an extra-label fashion. In fact, respiratory disease was the only category in which 100% of drug choices were fully compliant with FDA regulations. An additional, and more noteworthy, concern was that a striking proportion of treatment choices (13%, 7/54) would be classified as illegal, particularly in cases of calf diarrhea. Interestingly, current literature suggests that antimicrobial therapy is not even warranted in most cases of calf enteric disease.[15] While some of these suboptimal

practices are likely related to health illiteracy on the part of some of the producers, difficulties also arise from flaws in the pharmaceutical regulatory structure leading to a lack of approved therapies for some diseases. This means that veterinarians and producers are often required to make therapeutic decisions based on a very limited number of available products.

Additional insight regarding the high rate of regulatory non-compliance in this study population was provided by examining participant responses to questions regarding the concept of extra-label drug usage (ELDU). Many producers were uncertain regarding specific elements of definition for ELDU. Only 50% of respondents were able to identify the criteria that constitute drug label restrictions, and only a modest

Table 1. Summary of survey questions and response options.

Question	Response options
In the past 12 months, which of the following drugs have been used in your dairy herd (followed by list of available therapeutics)	Yes or No
Has your herd experienced any of the following conditions in the past 12 months? 1. Respiratory issues in calves 2. Respiratory issues in adult cattle 3. Diarrhea (scours) in calves 4. Lameness/foot problems in adult cattle 5. Uterine infection (metritis) or retained placenta 6. Umbilical infections in calves 7. Mastitis	Yes or No
If yes to any of the above questions, approximately how many animals have been affected and what two antibiotics have you most commonly used to treat each specified condition?	Open-ended
What type of record system do you maintain to track the use of antibiotics in your herd?	Select all that apply
Which of the following are included in your records	Select all that apply:
Do you have written protocols for diagnosing and treating common diseases?	Yes, No, or yes but they are implied and not written
How often is a veterinarian's advice sought before giving an antibiotic	Percentage
How often is the full recommended course of an antibiotic completed according to the label or veterinary orders?	Percentage
How are workers trained in the use of antibiotics?	Select all that apply
Who has the authority to initiate antibiotic treatment in an animal?	Select all that apply
What are your three most important sources of information regarding antibiotic use?	Select all that apply
Which of the following should be considered 'extra-label' use of an antibiotic	Select all that apply
When using an antibiotic off-label, how often do you obtain order or a prescription from your veterinarian	Percentage
How familiar are you with the concept of antibiotic resistance	Choose one of the following: 1. Never heard of it 2. Heard of it, but know nothing about it 3. Know a little about it 4. Know a lot about it

Table 2. Preferred antimicrobial treatment according to suspected affected body system. Numbers in brackets indicate the total percent of respondents who selected the antimicrobial treatment.

Affected body system	Preferred antimicrobial (% of respondents)
Calf respiratory	Florfenicol (50%)
Calf diarrhea	Enrofloxacin (33%); Penicillin (33%)
Adult lameness	Ceftiofur hydrochloride (38%)
Uterine infection	Oxytetracycline (38%)
Umbilical infection	Penicillin (100%)
Mastitis	Penicillin (45%)

Table 3. Relationship between antimicrobial choice and FDA regulations in Illinois dairy producers. Overall, the majority of antimicrobials (61%, 33/54) were used in an extra-label fashion. In addition, 13% (7/54) of antimicrobial selections would be classified as illegal, especially in cases of calf diarrhea.

	Number of producers using antimicrobials according to the manufacturer label		Number of producers administering prohibited antimicrobials	
	On label	Off label	Yes	No
Calf respiratory (n=12)	12	0	0	12
Calf scour (n=9)	2	7	3	6
Adult lameness (n=8)	3	5	1	7
Metritis (n=8)	4	4	1	7
Mastitis (n=17)	0	17	2	15

average percentage of participants (46%) could correctly identify specific elements of ELDU risk. Approximately 45% of respondents could not identify any example of practices that would constitute the extra-label use of antimicrobials. A sizeable proportion of the study population (95%) demonstrated a superficial recognition of the relationship of ELDU between meat and milk withholding. For instance, 65% of respondents indicated that they would use an antimicrobial labeled only for beef cattle in an adult dairy cow being sent to slaughter. This implies a significant misunderstanding of the term "dairy" and "beef" cow, particularly with regard to a regulatory definition.

While appropriate drug selection and administration are important aspects of antimicrobial stewardship, the maintenance of accurate medical records and the enactment of appropriate Standard Operating Procedures and protocols are also paramount,[3] particularly in avoiding milk and meat antimicrobial residue violations.[11] In this study population, only 15% of participants had written protocols for diagnosing disease, with another 25% stating that they had 'implied' protocols that were not written. Interestingly, 21% of the producers surveyed did not keep written records of drug use, and of those that maintained data, only 19% used a computerized system. This was similar to the totals reported in other midwest dairy studies.[17] Among producers who kept records, a large proportion were incomplete when compared to best practice.[2] While all of the respondents keeping records reported recording animal identification, treatment date, and name of drug used, a lower proportion recorded drug dose (67%), route of administration (13%), duration of therapy (40%), identity of the individual administering the drug (27%), and milk (40%) or meat (13%) withdrawal times. All of these are widely recognized as major risk factors in residue violations.[6,11]

It is interesting to consider how the absence of veterinary oversight may contribute to some of the suboptimal antimicrobial stewardship practices in this sector of the dairy industry. In this study, less than half of the producers (40%) sought regular veterinary input for antimicrobial selection. Only 25% of producers reported seeking veterinary advice on ELDU on every occasion, with 75% contravening FDA prohibitions by never obtaining prescription or veterinary guidance before administering an antimicrobial in an ELDU manner. Based on these results, future studies are warranted to determine if these results are representative and repeatable within a larger population of Illinois dairy producers.

Conclusion

Despite the limited sample size and frame, this survey highlights several areas where intervention could have significant impact on antimicrobial stewardship in Illinois dairy producers. These areas include appropriate antimicrobial treatment selection, the use of protocols and SOPs, improved on-farm record keeping, and an understanding of the factors that constitute extra-label drug use. Antimicrobial treatment records, cautious extra-label drug use, and adherence to consistent and legal treatment protocols are essential components of judicious antimicrobial use. Veterinarians are in an ideal position to assist their dairy clients in developing the type of effective and practical antimicrobial stewardship protocols necessary to foster high health animal care systems. This can be achieved by emphasizing management approaches that improve health, productivity and clinical outcomes, reduce the risk of drug residues, limit the selection of antimicrobial resistant bacterial strains, and increase compliance with regulatory mandates, while maximizing cost-benefits for the producer and confidence from the consumer.

Endnotes

[a]SurveyMonkey® Inc. Palo Alto, CA USA

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