Producer attitudes and practices related to antimicrobial use in beef cattle in Tennessee

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RUMINANTS

Objective—To evaluate knowledge, attitudes, and management practices involving antimicrobial use among Tennessee beef producers.

Design—Mail survey.

Sample Population—A population-based, stratified random sample of 3,000 beef producers across the state.

Procedures—Questionnaires were mailed to beef producers. Questions focused on producer practices related to education, biosecurity, veterinary use, and the purchase and use of antimicrobials. Operation types were categorized as either cow-calf only or multiple operation type (MOT). Associations between various factors and antimicrobial use were evaluated by use of multivariable logistic regression, with the outcome variable being any antimicrobial use (injectable or by mouth) in the past year.

Results—Of 3,000 questionnaires mailed, 1,042 (34.7%) were returned. A significantly higher proportion of producers with MOTs reported giving antimicrobials by mouth or by injection than did producers with cow-calf only operations. In addition, higher proportions of producers with MOTs than producers with cow-calf only operations reported treating with macrolides, florfenicol, ceftiofur, and aminoglycosides. In the multivariable analysis, herd size > 50 cattle, participation in Beef Quality Assurance or master beef producer certification programs, quarantining of newly purchased animals, use of written instructions for treating disease, and observation of withdrawal times were associated with a higher likelihood of antimicrobial use.

Conclusions and Clinical Relevance—Results suggested that producers who engaged in more progressive farming practices were also more likely to use antimicrobials. Incorporating training on judicious antimicrobial use into educational programs would likely increase awareness of best management practices regarding antimicrobial use. (*J Am Vet Med Assoc* 2010;237:1292–1298)

Antimicrobial use practices in food-producing animals and the potential for deleterious effects such as widespread antimicrobial resistance have been the subject of increased attention in recent years. However, objective data, including assessments of the use of various antimicrobial classes, are limited.[1–5] In the United States, aminoglycosides, β-lactam antimicrobials, macrolides, sulfonamides, and tetracyclines are readily available to livestock producers without a prescription.

Conventional beef production in the United States can be divided into 3 stages: cow-calf, backgrounding-stocking, and feedlot operations. Cow-calf producers raise cattle for up to a year, after which they are sold to other beef cattle operations. Backgrounding-stocking operations include cattle operations that purchase young animals (about 6 to 10 months old) and feed them until they achieve the desired weight to be moved to a feedlot. Cattle are typically placed in feedlots when they are 12 to 18 months of age and remain there for 4 to 6 months until they are purchased when they reach the appropriate weight for meat production. The intensity of management during each stage of beef cattle production varies. Cow-calf management is a relatively low-intensity production modality, and reported estimates of morbidity rates for breeding cows are low. For instance, in 1996 the NAHMS estimated that ≤ 0.5% of breeding female cattle had respiratory disease, diarrhea,

Abbreviations

BQA	Beef Quality Assurance
CI	Confidence interval
MOT	Multiple operation type
NAHMS	National Animal Health Monitoring Systems
OR	Odds ratio
TTAR	Tennessee Team on Antimicrobial Resistance

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mastitis, retained placenta, or uterine infection.[6] Thus, indications for antimicrobial use in adult breeding animals in cow-calf operations appear to be limited. For all US beef operations, an estimated 4.5% of the 2005 calf crop died; the highest percentages of nonpredator deaths were attributed to respiratory disease and calving problems.[7]

Stocker calves may come from multiple sources and often are transported long distances before they reach the feedlot. Morbidity rates of 40% to 50%[8] have been reported for newly received feedlot calves. In addition, a NAHMS report for 1999[9] estimated that 14.4% of feedlot cattle developed respiratory disease. Widespread preventive or therapeutic use of antimicrobials, including administration in feed or water or via injection, is a common practice when commingling cattle from multiple sources.[9] In a feedlot setting, these practices are used to minimize formation of liver abscesses, increase average daily weight gain, and treat respiratory disease.[9]

It has been suggested that educational efforts focused on judicious use of antimicrobials can encourage livestock producers to appropriately target antimicrobial treatment in livestock populations.[10–12] However, little is known about current knowledge of or attitudes toward antimicrobial use among beef producers. In 2009, Tennessee ranked ninth in the United States in beef cow inventory,[13] with most beef cattle operations being small (1 to 49 cattle) cow-calf operations.[14] The objective of the study reported here was to evaluate knowledge, attitudes, and management practices involving antimicrobial use among Tennessee beef producers so that continued educational efforts focusing on judicious antimicrobial use might be appropriately designed.

Materials and Methods

Survey development and administration—Data for the present study were collected as part of a TTAR mail survey. The TTAR is a coalition of veterinarians, extension agents, scientists, producers, and individuals from the Tennessee Department of Agriculture, the University of Tennessee, the Tennessee Cattlemen's Association, and the Tennessee Department of Health that develops and promotes best-use practices. Epidemiologists from the Tennessee Department of Health and individuals from the National Agricultural Statistics Service worked together to develop the initial survey instrument, which was reviewed by TTAR members, large animal veterinarians, and beef extension agents (10 people). The survey was then pilot tested among 6 cattlemen attending the 2006 Tennessee Cattlemen's Association convention.

The final survey[a] was mailed in November 2007 to a population-based, stratified random sample of 3,000 beef producers throughout Tennessee. A second mailing was sent to nonrespondents in February 2008. In collaboration with the Tennessee Cattlemen's Association and the Tennessee Farmer's Cooperative, announcements regarding the survey and encouraging participation were placed in trade journals. The sample was selected from 4 strata (1 to 49 cattle, 50 to 149 cattle, 150 to 249 cattle, and ≥ 250 cattle) proportional in size to the herd size distribution for the population of beef producers in the state. In accordance with National Agricultural Statistics Service protocol, producer responses were assigned numeric codes, so researchers had no access to the names of or contact information for survey participants. Questions focused on producer knowledge, attitudes, practices, and needs related to agricultural education, biosecurity, veterinary consultation, and the purchase and use of antimicrobials. Specifically, producers were asked about where antimicrobials were purchased (veterinarian, cooperative, mail order, Internet, or other), antimicrobial use practices, veterinary consultation for sick cattle, use of bacterial culture results for selection of antimicrobials, observation of withdrawal times, and record-keeping practices. Antimicrobial categories included examples of the most common brand names. Additional questions on management practices such as quarantine provisions for new and sick cattle, parasite control, membership in producer groups, and completion of beef industry–related training programs such as BQA or master beef producer certification were included. Producers were asked to rate their agreement with statements on the efficacy of antimicrobials, concerns about antimicrobial-resistant bacteria in food, antimicrobial residues in food, and prudent antimicrobial use. The collection period for responses was November 1, 2007, through April 11, 2008.

Statistical analysis—Responses were weighted proportionally to likelihood of selection for participation in the study, and weights were adjusted within herd size strata according to proportion of nonrespondents. Data were analyzed with a statistical software package suitable for complex survey designs.[b] Operation types were categorized as cow-calf only or MOT. Opinion statements with options for strongly agree, agree, neutral, disagree, and strongly disagree were dichotomized for analysis (ie, in agreement vs not in agreement); neutral responses were grouped with not in agreement responses.

Antimicrobials listed in the questionnaire were grouped by class as tetracyclines, β-lactam antimicrobials, sulfonamides, macrolides, florfenicol, lincomycin, ceftiofur, fluoroquinolones, aminoglycosides, and aminocyclitols. An additional dichotomous variable was created for whether any antimicrobials had been given, either by injection or by mouth, in the past year.

Associations between various factors and antimicrobial use were evaluated. Factors associated ($P < 0.25$) with antimicrobial use in univariate analyses were examined for collinearity by means of a variable clustering procedure[c] with a maximum eigenvalue of 0.9. Subsequently, a single variable from each cluster was included in a multivariable logistic regression model with the outcome variable being any antimicrobial use (by injection or by mouth) in the past year. A stepwise backward-elimination approach was used until all variables remaining in the model were significantly ($P < 0.05$) associated with the outcome.

To assess the fit of each model, sensitivity and specificity of the model-predicted outcomes were assessed by treating the observed status as the gold standard. A probability cut point of ≥ 0.5 was used for predicted out-

come; samples for which the predicted probability that they were positive was ≥ 50% were classified as positive.

Results

A total of 1,042 (34.7%) of the survey questionnaires were returned. Data were entered and validated by Tennessee Department of Health personnel. Of the respondents, 82% (n = 850) had cattle operations; the remaining 18% no longer had cattle. Seventy-six percent (650) of all cattle operations were classified as cow-calf only, and 24% (200) were classified as MOTs. There were minor variations in response rate among questions; responses to opinion questions were missing more often than were responses to questions regarding operation practices. Slightly higher proportions of producers who had MOTs agreed with questionnaire statements about decreased on-farm antimicrobial efficacy, the importance of antimicrobial-resistant bacteria or antimicrobial residues in food, and the importance of prudent antimicrobial use in the beef industry for consumer confidence, compared with proportions of producers who had cow-calf only operations (**Table 1**). Approximately a third of all producers (34%) reported using bacterial culture to determine the cause of disease, and approximately a third (31.5%) reported using results of susceptibility testing to choose the appropriate antimicrobial. Use of antimicrobial-related record keeping was reported by less than half (39.4%) of producers. Approximately three-fourths (77.3%) of producers reported purchasing antimicrobials from a cooperative; just over half (51.1%) of producers reported purchasing antimicrobials from a veterinarian.

Observation of withdrawal times was the reported norm, with 82.2% of producers responding that guidelines for withdrawal times were followed. Reported mass treatment for disease prevention was relatively uncommon (13.2%), even among MOT operations (23.0%; **Table 2**).

For both operation types, the antimicrobials most commonly administered, by mouth or by injection, during the year prior to survey response were tetracyclines (37.6%), β-lactam antimicrobials (33.2%), sulfonamides (8.9%), macrolides (9.1%), and florfenicol

Table 1—Opinions of Tennessee beef producers regarding antimicrobials; producers are classified on the basis of operation type.

		Percentage of producers				
Statement	**Operation type**	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Antimicrobials work less effectively than in the past (n = 747)						
	Cow-calf only	1.1	15.0	64.2	17.9	1.7
	MOT	4.2	20.8	42.4	30.2	2.4
Antimicrobial-resistant bacteria in food are an important problem (n = 761)						
	Cow-calf only	17.5	44.0	34.6	3.5	0.4
	MOT	21.3	49.9	25.4	3.4	0.0
Antimicrobial residues in food are an important problem (n = 762)						
	Cow-calf only	18.9	45.5	31.6	3.7	0.2
	MOT	21.9	49.4	26.4	2.3	0.0
Prudent antimicrobial use in the beef industry is important for consumer confidence (n = 753)						
	Cow-calf only	23.2	49.1	24.9	2.1	0.8
	MOT	25.2	56.9	14.9	3.0	0.0

Data were obtained from questionnaires mailed to a population-based, stratified random sample of 3,000 beef producers throughout Tennessee in November 2007, with a second mailing in February 2008 to nonrespondents. Responses were weighted. Values in parentheses represent number of respondents; surveys were returned by 650 producers with cow-calf operations and 200 producers with MOTs.

Table 2—Antimicrobial use and management practices of Tennessee beef producers classified on the basis of operation type.

	Percentage of producers			
Practice	**MOT**	**Cow-calf only**	**All producers**	***P* value**
Used bacterial culture to determine cause of disease (n = 822)	40.7	32.0	34.0	0.03
Used bacterial culture to choose appropriate antimicrobials (n = 821)	34.6	30.6	31.5	0.30
Consulted with a veterinarian for cattle with respiratory illness or pneumonia (n = 835)	73.2	74.4	74.1	0.73
Consulted with a veterinarian for cattle with diarrhea (n = 830)	43.9	45.4	45.1	0.71
Kept records of antimicrobial purchases (n = 826)	51.8	35.5	39.4	< 0.01
Kept records of antimicrobial use (n = 823)	41.8	29.2	32.2	< 0.01
Purchased antimicrobials from a veterinarian (n = 850)	57.6	49.0	51.1	0.03
Purchased antimicrobials from cooperative (n = 850)	73.0	78.6	77.3	0.11
Purchased antimicrobials from Internet sites (n = 850)	5.9	3.7	4.2	0.16
Observed withdrawal times (n = 811)	86.6	80.8	82.2	0.07
Treated with antimicrobials at dosages higher than the label instructed (n = 823)	17.3	12.4	13.5	0.08
Gave antimicrobials as mass treatment for disease prevention within the past year (n = 823)	23.0	10.2	13.2	< 0.01
Gave antimicrobials for growth promotion (n = 829)	3.1	1.9	2.2	0.29

P values represent comparison between MOT operations and cow-calf only operations.

(12.5%; **Table 3**). Use of ceftiofur, fluoroquinolones, aminoglycosides, aminocyclitols, and lincomycin was reported by < 5% of producers.

A significantly ($P < 0.01$) higher proportion of producers with MOTs reported giving antimicrobials by mouth or by injection in the past year than did producers with cow-calf only operations. In addition, higher proportions reported treating with macrolides ($P < 0.01$), florfenicol ($P < 0.01$), ceftiofur ($P = 0.04$), and aminoglycosides ($P = 0.01$). There were no significant differences in the proportions of producers with MOTs versus producers with cow-calf only operations that reported use of fluoroquinolones, tetracyclines, β-lactam antimicrobials, lincomycin, or aminocyclitols (Table 3).

Tetracyclines were the antimicrobials most commonly reported as being used as feed additives on both MOTs and cow-calf operations (**Table 4**). Overall, a significantly ($P < 0.01$) higher proportion of producers with MOTs than producers with cow-calf only operations reported using feed additive antimicrobials in the year prior to the survey. Specific antimicrobials that were reportedly used as feed additives by higher proportions of producers with MOTs included β-lactam antibiotics ($P < 0.01$) and sulfonamides ($P < 0.01$). There were no significant differences in the reported use of tetracyclines, macrolides, and aminoglycosides as feed additives between producers with MOTs and producers with cow-calf only operations.

Variables associated ($P < 0.25$) with antimicrobial use in the past year in univariate analyses were herd size (OR for herds with > 50 cattle vs 1 to 50 cattle, 3.4; 95% CI, 2.2 to 4.7; $P < 0.01$), operation type (OR for MOT vs cow-calf only, 1.3; 95% CI, 1.1 to 1.5; $P < 0.01$), BQA or master beef producer certification (OR for certification vs no certification, 3.0; 95% CI, 2.2 to 4.2; $P < 0.01$), interest in cattle health education programs (OR for interest vs no interest, 1.8; 95% CI, 1.3 to 2.5; $P < 0.01$), opinion on whether antimicrobials work less effectively than in the past (OR for in agreement vs not in agreement, 1.6; 95% CI, 1.1 to 2.5; $P = 0.02$), opinion on whether antimicrobial-resistant bacteria in food are an important problem (OR for in agreement vs not in agreement, 1.2; 95% CI, 0.9 to 1.7; $P = 0.17$), opinion on whether prudent antimicrobial use in the beef industry is important for consumer confidence (OR for in agreement vs not in agreement, 1.8; 95% CI, 1.3 to 2.5; $P < 0.01$), whether newly purchased animals were quarantined (OR for quarantined vs not quarantined, 2.2; 95% CI, 1.7 to 3.0; $P < 0.01$), whether sick cows were separated from healthy cows (OR for separated vs not separated, 1.8; 95% CI, 1.3 to 2.6; $P < 0.01$), whether growth-promoting implants were used in steer calves (OR for used vs not used, 3.1; 95% CI, 1.9 to 5.1; $P < 0.01$), whether measures for controlling external parasites were used (OR for used vs not used, 3.2; 95% CI, 1.6 to 6.2; $P < 0.01$), whether the producer had written instructions for treating disease (OR for yes vs no, 2.7; 95% CI, 1.8 to 3.9; $P < 0.01$), whether the producer employed additional workers involved in treating disease (OR for yes vs no, 1.3; 95% CI, 0.9 to 2.0; $P = 0.14$), whether records of antimicrobial purchases were kept (OR for yes vs no, 1.8; 95% CI, 1.3 to 2.4; $P < 0.01$), whether antimicrobial withholding times were observed (OR for yes vs no, 3.4; 95% CI, 2.3 to 5.1; $P < 0.01$), whether bacterial culture was used to determine the cause of disease (OR for yes vs no, 1.5; 95% CI, 1.1 to 2.0; $P = 0.02$), and whether antimicrobial susceptibility testing was performed to choose an appropriate antimicrobial (OR for yes vs no, 1.7; 95% CI, 1.3 to 2.4; $P < 0.01$). These variables were all included in the initial cluster analysis.

Table 3—Percentages of Tennessee beef producers who had administered antimicrobials by mouth or by injection during the past year; producers are classified on the basis of operation type.

	Percentage of producers			
Antimicrobial class	**MOT**	**Cow-calf only**	**All producers**	***P* value**
Tetracyclines	41.8	36.3	37.6	0.16
β-Lactam antimicrobials	37.8	31.7	33.2	0.11
Florfenicol	18.9	10.4	12.5	< 0.01
Macrolides	14.5	7.4	9.1	< 0.01
Sulfonamides	12.5	7.8	8.9	0.04
Fluoroquinolones	6.3	3.6	4.1	0.07
Ceftiofur	6.0	3.1	3.8	0.04
Aminoglycosides	5.6	2.1	2.9	0.01
Lincomycin	1.7	1.7	1.7	0.99
Aminocyclitols	1.4	1.3	1.3	0.93
Any antimicrobial	64.5	53.7	56.3	< 0.01

Table 4—Percentages of Tennessee beef producers who had administered antimicrobials as feed additives in the past year; producers are classified on the basis of operation type.

	Percentage of producers			
Antimicrobial class	**MOT**	**Cow-calf only**	**All producers**	***P* value**
Tetracyclines	18.8	14.6	15.6	0.16
Sulfonamides	7.9	2.1	3.5	< 0.01
β-Lactam antimicrobials	5.8	2.0	2.9	< 0.01
Macrolides	1.6	0.9	1.0	0.41
Aminoglycosides	1.5	0.7	0.9	0.30
Any antimicrobial	28.9	18.2	20.8	< 0.01

Variables that were not associated with antimicrobial use in the past year in univariate analyses included region of Tennessee (OR for middle vs west, 0.9 [95% CI, 0.6 to 1.4]; OR for east vs west, 0.9 [95% CI, 0.6 to 1.4]; overall $P = 0.89$), opinion on whether antimicrobial residues in food are an important problem (OR for in agreement vs not in agreement, 0.8; 95% CI, 0.6 to 1.1; $P = 0.26$), whether cattle were tested for diseases before arrival (OR for yes vs no, 1.0; 95% CI, 0.7 to 1.6; $P = 0.93$), whether antimicrobials were given for growth promotion (OR for yes vs no, 1.6; 95% CI, 0.6 to 4.3; $P = 0.37$), whether producers were able to keep pests away from cattle feed (OR for yes vs no, 0.9; 95% CI, 0.7 to 1.3; $P = 0.74$), and whether veterinarians were used when cattle had respiratory disease or diarrhea (OR for yes vs no, 1.0; 95% CI, 0.7 to 1.4; $P = 0.99$).

Variables that were grouped together in the cluster analysis included quarantine of newly purchased animals and separation of sick cows from healthy cows (cluster 1); whether bacterial culture was used to determine the cause of disease and whether susceptibility testing was performed to choose the appropriate antimicrobial (cluster 2); opinions on whether antimicrobials work less effectively than in the past, whether antimicrobial-resistant bacteria in food are an important problem, and whether prudent antimicrobial use in the beef industry is important for consumer confidence (cluster 3); herd size, operation type, and whether the producer used growth-promoting implants in steer calves (cluster 4); whether the producer had written instructions for treating disease and whether records of antimicrobial purchases were kept (cluster 5); and BQA or master beef producer certification and interest in cattle health education programs (cluster 6). Clusters 7 to 9 had 1 variable each and consisted of whether the producer employed additional workers involved in treating disease (cluster 7), whether the producer used measures for controlling external parasites (cluster 8), and whether antimicrobial withholding times were observed (cluster 9).

Several factors were found in the multivariable analysis to be associated with a greater likelihood of antimicrobial use in the past year **(Table 5)**. These included herd size > 50 cattle, participation in BQA training or master beef producer certification, whether producers quarantined newly purchased animals, whether producers used written instructions for treating disease, and whether withdrawal times were observed. The sensitivity of the model was 87.7%; the specificity was 22.8%. Interactions were deemed not to be biologically plausible.

Discussion

Most (56.3%) Tennessee beef cattle operations in the present survey reported having used antimicrobials in the past year. Producers with MOTs were significantly more likely than producers with cow-calf only operations to have administered antimicrobials by mouth or by injection in the past year and were significantly more likely to have used macrolides, florfenicol, ceftiofur, and aminoglycosides. In the multivariable analysis, having a herd size > 50 cattle, participation in the BQA or master beef producer certification program, quarantine of newly purchased animals, use of written instructions for treating disease, and observation of withdrawal times were associated with a greater likelihood of antimicrobial use in the past. The response rate (1,042/3,000 [34.7%]) for the survey was good, most likely because of prior notification by and cooperation with the Tennessee Cattlemen's Association. In the 1999 NAHMS feedlot study,[9] 1 or more cattle on 41.7% of feedlots were administered an injectable antimicrobial to prevent shipping fever, and 83.2% of feedlots used some type of antimicrobial in feed or water. National estimates of antimicrobial use for cow-calf operations were not available for comparison. Livestock antimicrobial use estimates are limited, and additional data are needed.[15,16] The operation-level descriptive estimates of antimicrobial use obtained in the present study are the first that we are aware of that are specific for Tennessee beef cattle operations.

In the present study, a slightly higher proportion of producers who had MOTs agreed with the survey statement that antimicrobials worked less effectively than in the past. We believe that this was important given the various stresses backgrounding and stocker calves are subjected to and the reportedly higher likelihood of antimicrobial use among producers with MOTs. Stress can result in increased susceptibility to disease and may encourage greater use of certain classes of antimicrobials for these type of operations, compared with cow-calf only operations.

Response bias can be an issue with any survey. To assess whether our responses might be applicable to operations outside Tennessee, we compared our data with data from the NAHMS beef study,[17] which was administered in 24 states representing 87.8% of the US beef cow

Table 5—Results of multivariable logistic regression analysis of factors associated with antimicrobial use by Tennessee beef producers.

Variable	Categories	OR	95% CI	*P* value
Herd size (No. of cattle)	1–50	Referent	NA	NA
	> 50	2.4	1.6–3.8	< 0.01
BQA or master beef producer certification	Yes	1.7	1.2–2.5	< 0.01
	No	Referent	NA	NA
Quarantined newly purchased animals	Yes	1.6	1.1–2.2	< 0.01
	No	Referent	NA	NA
Had written instructions for treating disease	Yes	1.9	1.3–3.0	< 0.01
	No	Referent	NA	NA
Observed antimicrobial withholding times	Yes	2.1	1.4–3.5	< 0.01
	No	Referent	NA	NA

NA = Not applicable.

inventory and 79.6% of cow-calf herds. Responses for these 2 studies appeared to be fairly comparable. For example, the NAHMS study[17] found that 11.9% of operations had used growth-promoting implants in calves during the previous 12 months, whereas the present study found that 11.7% of producers in Tennessee had used growth-promoting implants in steer calves in the past year.

According to a previous study,[9] the antimicrobials most commonly used in feed or water to promote growth and prevent disease in feedlot cattle in the United States are tylosin, chlortetracycline, and oxytetracycline. In a study[18] of *Salmonella* and *Escherichia coli* isolates obtained from beef carcasses at a feedlot and a commercial abattoir, approximately 97% of *Salmonella* isolates were resistant to at least 1 antimicrobial, with most of these resistant to sulfamethoxazole, and 80.3% of *E coli* isolates were resistant to at least 1 antimicrobial. In the present study, tetracyclines were the most commonly reported antimicrobial class administered as a feed additive. In addition, 77.3% of producers reported obtaining antimicrobials from a cooperative, and 4.2% reported obtaining antimicrobials via the Internet. The widespread availability of over-the-counter and feed supplement antimicrobials is an important consideration in future efforts regarding judicious antimicrobial use. Just 51.1% of producers reported obtaining antimicrobials from a veterinarian. Producer education efforts on the part of veterinarians serve to enhance judicious use. Although increased antimicrobial use is linked to increased resistance, resistance patterns are likely to vary by dose, class, and antimicrobial mechanism of action. Further study is needed to develop appropriate use practices for livestock.

In the multivariable analysis in the present study, herd size was significantly associated with the likelihood of antimicrobial use during the previous year among beef operations in Tennessee. The fact that herd size and operation type were grouped together in the cluster analysis suggested that both herd size and operation type played a role in the likelihood of antimicrobial use. Because beef operations in Tennessee were predominantly cow-calf only, it is likely that the higher within-cluster association of herd size with antimicrobial use, versus operation type, was related to the small number of backgrounder and feeder operations in the state. Other studies[9,19] have demonstrated that herd size is likely to be associated with intensity of management and that the proportion of producers who consider their herd to be a primary source of income tends to increase as herd size increases.[20]

In the present study, we found that participation in BQA training or master beef producer certification, quarantining of newly purchased animals, having written instructions for treating sick cattle, and observing withdrawal times were associated with a higher likelihood of having used antimicrobials in the past year. It is plausible that producers who incorporated these progressive farming practices were also more likely to adopt other best management practices with regard to antimicrobial use. Both the BQA and master beef producer certification programs provide producers with education regarding judicious antimicrobial use. In a recent USDA NAHMS survey[17] of beef cattle producers, 41% of producers who attended BQA training already followed BQA guidelines regarding antimicrobial selection and use, and another 22% changed to BQA-suggested practices after training. Beef quality assurance programs should continue to be used to deliver judicious antimicrobial use training. Methods to reach producers not involved in BQA programs should be explored.

Antimicrobials are important for human and animal health. In the present study, antimicrobials were commonly used and readily accessible to Tennessee beef producers via a variety of routes. Educational efforts focused on practical, cost-effective, and labor-effective alternatives to antimicrobial use, such as an increased focus on biosecurity, vaccination, and low-stress handling of livestock and decreased stocking density to minimize disease transmission, should be emphasized when possible. Industry education programs and consultation with veterinarians regarding effective and judicious use practices may prolong the effectiveness and availability of antimicrobials.

a. Copies of the questionnaire are available from the corresponding author on request.
b. SAS, version 9.1, SAS Institute Inc, Cary, NC.
c. PROC VARCLUS, SAS, version 9.1, SAS Institute Inc, Cary, NC.

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From this month's *AJVR*

Performance of a commercially available in-clinic ELISA for the detection of antibodies against *Anaplasma phagocytophilum*, *Ehrlichia canis*, and *Borrelia burgdorferi* and *Dirofilaria immitis* antigen in dogs

Ramaswamy Chandrashekar et al

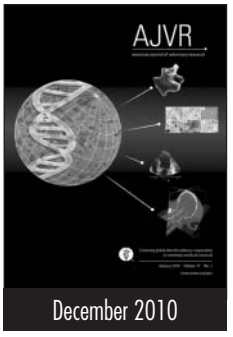
Objective—To evaluate the sensitivity and specificity of a commercially available in-clinic ELISA for detection of diseases in dogs.

Sample Population—846 serum samples obtained from dogs.

Procedures—Samples were evaluated via the in-clinic ELISA to detect antibodies against *Anaplasma phagocytophilum*, *Ehrlichia canis*, and *Borrelia burgdorferi* and *Dirofilaria immitis* (heartworm) antigen. True infection or immunologic status of samples was assessed by use of results of necropsy, an antigen assay for *D immitis*, and immunofluorescence assay or western blot analysis for antibodies against *B burgdorferi*, *E canis*, and *A phagocytophilum*.

Results—Sensitivity and specificity of the in-clinic ELISA for detection of heartworm antigen (99.2% and 100%, respectively), antibodies against *B burgdorferi* (98.8% and 100%, respectively), and antibodies against *E canis* (96.2% and 100%, respectively) were similar to results for a similar commercial test. In samples obtained from dogs in the northeast and upper Midwest of the United States, sensitivity and specificity of the in-clinic ELISA for antibodies against *Anaplasma* spp were 99.1% and 100%, respectively, compared with results for an immunofluorescence assay. Samples from 2 dogs experimentally infected with NY18 strain of *A phagocytophilum* were tested by use of the in-clinic ELISA, and antibodies against *A phagocytophilum* were detected by 8 days after inoculation. Antibodies against *Anaplasma platys* in experimentally infected dogs cross-reacted with the *A phagocytophilum* analyte. Coinfections were identified in several of the canine serum samples.

Conclusions and Clinical Relevance—The commercially available in-clinic ELISA could be used by veterinarians to screen dogs for heartworm infection and for exposure to tick-borne pathogens. (*Am J Vet Res* 2010;71:1443–1450)



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