

A randomized trial comparing effects of respiratory disease metaphylaxis with gamithromycin or ceftiofur crystalline free acid on the health, performance, and economic return of auction market-derived stocker calves backgrounded on Missouri pastures

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Abstract

The objective was to compare gamithromycin (GAM) and ceftiofur crystalline free acid (CCFA) metaphylaxis for controlling bovine respiratory disease (BRD) impacts in auction market-derived steers. Steers (n=240; initial BW = 537.54 ± 60.61 lb [243.82 ± 27.49 kg]) were randomly allocated to 16 pastures randomized to the 2 treatment groups. Caretakers and data analyst were masked to treatments. Data were analyzed using linear models with means (± standard errors of means) reported. Following metaphylaxis, 16 steers (GAM, n=3; CCFA, n=13) required treatment for BRD. Mean BRD morbidity was higher ($P=0.03$) in the CCFA group (10.83 ± 2.84%) compared to the GAM group (2.50 ± 1.43%). Four steers in each group died or were removed from the 59-day trial due to non-BRD health reasons. Average daily gain in steers finishing the study was greater ($P=0.03$) in GAM (2.90 ± 0.09 lb [1.32 ± 0.04 kg]) vs CCFA (2.57 ± 0.09 lb [1.17 ± 0.04 kg]) steers. Mean net return per head for steers finishing the study was greater ($P\leq 0.01$) for GAM (\$22.34 ± 6.75) vs CCFA (-\$6.67 ± 6.75). Overall, steers administered GAM metaphylaxis had lower morbidity, increased weight gain, and increased net revenue, compared to those given CCFA.

Key words: bovine, BRD, ceftiofur crystalline free acid, gamithromycin, respiratory disease

Résumé

L'objectif était de comparer l'effet de la gamithromycine (GAM) et du ceftiofur sous forme d'acide libre cristallin (CALC) dans le traitement en métaphylaxie du complexe respiratoire bovin (CRB) chez des bouvillons d'encan pour

le marché. Des bouvillons (n = 240; poids initial = 537.54 ± 60.61 lb [243.83 ± 27.49 kg]) ont été alloués aléatoirement dans 16 pâturages et divisés au hasard en deux groupes de traitement. Les employés du parc et les analystes de données ne connaissaient pas les groupes de traitement. Les données ont été analysées avec des modèles linéaires et on rapporte les moyennes (± l'erreur type). Suivant le traitement en métaphylaxie, 16 bouvillons (n = 3 pour GAM et n = 13 pour CALC) ont nécessité un traitement pour le CRB. La morbidité moyenne était plus élevée ($P = 0.03$) dans le groupe CALC (10.83 ± 2.84%) que dans le groupe GAM (2.50 ± 1.43%). Durant l'essai de 59 jours, il y a eu quatre cas de mortalité ou de retrait dans chaque groupe qui n'étaient pas reliés au CRB. Le gain moyen quotidien chez les bouvillons terminant l'étude était plus élevé ($P = 0.03$) dans le groupe GAM (2.90 ± 0.09 lb [1.31 ± 0.04 kg]) que dans le groupe CALC (2.57 ± 0.09 lb [1.17 ± 0.04 kg]). Le revenu net moyen par tête pour les bouvillons finissants était plus élevé ($P \leq 0.01$) dans le groupe GAM (\$22.34 ± 6.75) que dans le groupe CALC (-\$6.67 ± 6.75). Dans l'ensemble, les bouvillons qui recevaient le traitement en métaphylaxie avec GAM avaient une morbidité moindre, un plus grand gain de poids et généraient plus de revenu net que ceux qui recevaient CALC.

Introduction

With estimated costs exceeding \$4 billion annually due to investments in prevention and treatment, as well as economic losses due to mortality and decreased productivity, bovine respiratory disease (BRD) is considered the most economically devastating disease facing the beef industry.¹² Although there are management strategies and products, both biological and pharmaceutical, to aid in the prevention

and control of BRD, the beef industry structure in North America poses a challenge for overcoming BRD due to potential animal stresses and pathogen challenges.²³ The complex interaction of various bacterial and viral pathogens, as well as host, environmental, nutritional and management factors, creates inherent challenges for managing the BRD complex in a feeder cattle production environment.^{11,17}

Diagnosis of BRD is often subjective, and accuracy can vary among observers. In addition, cattle are effective at concealing signs of illness.¹⁷ For the common approach of using clinical observations for diagnosing BRD, White and Renter estimated diagnostic sensitivity and specificity to be 61.8% and 62.8%, respectively.²⁹ With these known shortcomings in BRD diagnosis and potential for high risk of disease, metaphylaxis is an advantageous tool used to mitigate BRD in potentially high-risk populations. Metaphylaxis can decrease the potential for disease, and the subsequent severity and impacts, by treating the entire high-risk cohort at a single time point prior to the onset of illness (e.g., on arrival to stocker or feedlot facility).^{14,17}

Metaphylaxis has been demonstrated to be efficacious in reducing the impacts of BRD in feedlot cattle.^{1,3,16,18,19,24} However, there are limited data comparing the impact of different antimicrobials administered metaphylactically in stocker calves.^{2,21} The objective of this study was to compare the field efficacy of 2 antimicrobials, gamithromycin and ceftiofur crystalline free acid, administered for BRD metaphylaxis in naturally exposed, potentially high-risk, beef stocker calves backgrounded in pastures over a 59-day period. Protocol-defined primary outcomes of interest for comparisons among treatment groups included standard health and performance measures, as well as mean financial return per head estimated using a partial-budget approach.

Materials and Methods

Study Design and Cattle Population

The study was designed as a double-blinded, positive control, clinical efficacy trial using a balanced randomized design with pasture as the experimental unit. The number of pastures (and animals within pasture) was optimized to detect a 10% difference in first-treatment BRD morbidity, assuming that positive control group morbidity would be 20%. The level of significance (type 1 error) was set at a more liberal value of $P \leq 0.10$ due to limitations in the number of pastures available, and power was set at 80%. This study population was to represent a cohort of 450 to 650 lb (205 to 295 kg) auction market-derived beef stocker calves (steers) that were considered at a high risk of developing BRD. In October 2017, cross-bred beef steers were purchased from a livestock auction in southwest Missouri. The health histories of these steers were unknown. Steers were shipped in 3 truckloads to the research facility approximately 3.5 hours from the auction facility.

Processing and Treatment Allocation

Upon arrival to the facility, all steers were commingled in a holding area for approximately 24 hours prior to processing. Prior to study enrollment and processing, steers were observed for any abnormalities; only steers with no observable clinical disease were enrolled. Steers were not screened for bovine viral diarrhea virus or other pathogens prior to enrollment. At processing, steers ($n=240$) received unique numbered tags in each ear, were individually weighed, and the following products (administered per label and dosed, if applicable, according to individual body weight): *Clostridium chauvoei-septicum-novyisordellii-perfringens* Types C & D bacterin-toxoid^a (2 mL) administered subcutaneously (SC) in right neck (front of shoulder); modified-live bovine rhinotracheitis-virus diarrhea-parainfluenza 3-respiratory syncytial virus vaccine with *Mannheimia haemolytica* toxoid^b (2 mL) administered SC in left neck (front of shoulder); oxfendazole oral suspension^c (1 mL/110 lb [50 kg] body weight) administered orally via drench applicator; eprinomectin (5 mg/mL) pour on^d (1 mL/22 lb [10 kg] body weight) externally applied with pour-on applicator; trenbolone acetate (40 mg) and estradiol (8 mg) implant^e administered SC in the backside of the left ear using an implant gun.

Immediately following the standard arrival processing protocol, steers were allocated and administered 1 of 2 antimicrobials given as metaphylaxis for BRD prior to leaving the chute: gamithromycin^f (GAM; 150 mg/mL, 2 mL/110 lb [50 kg] body weight) administered SC in left neck (front of shoulder), or ceftiofur crystalline free acid^g (CCFA; 200 mg/mL, 1.5 mL/100 lb [45.5 kg] body weight) administered SC in the middle third or base of posterior aspect of the right ear.

Prior to study initiation, pastures ($n=16$; experimental unit) were allocated to treatment by randomly assigning the first pasture to a treatment group and systematically assigning every other pasture to an alternate treatment group until all 16 pastures were assigned a treatment group. When calves were enrolled, the first 15 steers through the chute were randomly allocated to 1 of the 16 pastures and, consequently, to their pre-assigned treatment group. The same allocation order was used for each subsequent group of 15 steers through the chute until all enrolled calves were allocated to a pasture. Therefore, 120 steers were randomized to 8 pastures for each treatment group, and each pasture housed 15 steers. All random numbers were generated in Microsoft Excel using the RAND function. Following enrollment in the study (day 0), the only additional processing was to collect individual body weights on study days 30 and 59. In the event steers were removed from the study prematurely, weights were to be obtained prior to removal if possible.

Housing and Feeding

Steers were housed in approximately 54 x 54 ft (16.5 x 16.5 m) grass lots attached to the assigned study pasture for 5 days following processing and metaphylactic treat-

ment to allow for ease of observation and to acclimate the calves. Beginning on study day 6, calves had access to approximately 20-acre pastures joined to each of the grass lots. Each study pasture was equipped with at least 1 feed bunk and 1 waterer. Calves had *ad libitum* access to mixed grass hay, water, and minerals^h throughout the trial; additionally, calves were supplemented once daily with a creep feed ration at approximately 1% of the total body weight per pasture. Approximately halfway through the trial (day 31), calves in each pasture received 90.2 lb (41 kg) of a grain ration daily for the remainder of the study to optimize feeding logistics at the facility. Steers were housed and maintained on pasture for the duration of the trial.

Animal Health

Prior to initiation of the study, the Boehringer Ingelheim Institutional Animal Care and Use Committee approved the care and use of cattle in this study as defined by the protocol. Steers were observed for clinical signs associated with BRD by trained personnel, who were masked to treatment allocation, twice daily from allocation (day 0) to day 13 and then once daily from day 14 until completion of the study on day 59. The clinical assessment included observations of the following clinical signs: 1) increased respiratory rate, 2) depression, 3) nasal or ocular discharge, 4) cough, and 5) gait abnormalities. Based on these observations, steers were assigned a clinical assessment score (CAS) using a modified DART scoring system as follows:^{22,30} 0 = no signs associated with BRD were present, 1 = mild presentation of 1 or 2 signs, 2 = mild presentation of more than 2 signs or severe presentation of 1 or 2 signs, 3 = severe presentation of more than 2 signs, 4 = very severe presentation of several signs.

The post-metaphylaxis interval (PMI), defined as the period of time between metaphylaxis and when calves were eligible for further treatment, was designated as 8 days for both treatment groups. Steers were first treated with a single dose of florfenicol (300 mg/mL)ⁱ administered per label (6 mL/100 lb [45.4 kg]) SC in the neck if: 1) assigned a CAS of 1 or 2 and had a rectal temperature $\geq 104^{\circ}\text{F}$ (40°C), or 2) assigned a CAS of 3 or 4 regardless of rectal temperature. Following the PMI, steers assigned a CAS of 1 or 2 that had a rectal temperature of $\leq 104^{\circ}\text{F}$ (40°C) were returned to their home pasture without BRD treatment. The post-treatment interval for florfenicol was designated as 4 days. However, if after 2 days following treatment with florfenicol a steer was assigned a severity score 3 or 4, then it could be administered a second BRD treatment. The second BRD treatment was a single dose of enrofloxacinⁱ (100 mg/mL) administered SC and dosed per label (4.5 mL/100 lb [45.4 kg] body weight). If calves did not respond after treatment with enrofloxacin they were to be pulled for further evaluation of respiratory disease and removed from the study if deemed chronic or unable to perform. Calves that exhibited illness with clinical signs not consistent with BRD were to be evaluated and treated appropriately by the attending veterinarian. The

attending veterinarian was masked to treatment group and thus granted clinical discretion in all instances to deliver appropriate care.

Measurements and Calculations

The performance and clinical outcome variables of interest were average daily body weight gain (ADG), and BRD treatment morbidity, treatment success, mortality, and case fatality. All analyses were conducted at the pasture-level. The outcome variables were calculated (for each pasture) using the following general formulas:

$$\text{ADG (deads-out)} = \frac{\text{mean cattle weight at end} - \text{mean initial total cattle weight}}{\text{number (no.) days on trial}}$$

$$\text{ADG (deads-in)} = \frac{\text{total cattle weight at end} - \text{initial total cattle weight}}{\text{no. head days on trial}}$$

$$\text{BRD morbidity} = \frac{\text{no. calves treated for BRD during trial period}}{\text{no. calves allocated to pasture}}$$

$$\text{Treatment success} = \frac{\text{no. BRD treated calves that were not retreated, BRD dead or chronic}}{\text{no. calves treated for BRD during the trial period}}$$

$$\text{BRD mortality} = \frac{\text{no. calves dead from BRD during trial period}}{\text{no. calves allocated to pasture}}$$

$$\text{Overall mortality} = \frac{\text{no. calves dead regardless of cause}}{\text{no. calves allocated to pasture}}$$

$$\text{Case fatality} = \frac{\text{no. calves treated for BRD that died of BRD}}{\text{no. calves treated for BRD}}$$

Economic Assessment

The study protocol called for a comprehensive partial budget analysis, where standardized prices were used for all costs and revenues, and a corresponding net revenue was calculated for each pasture (experimental unit). Labor that was applied equally to all pasture groups; facilities, equipment, and other fixed costs were not included. A standardized purchase price for all study cattle ($n=240$) of \$161.08 per hundred-weight (\$/cwt [45.4 kg]) was used, based on an average of USDA Agriculture Marketing Service (AMS) reports for 500 to 550 lb (227 to 250 kg), medium- to large-frame steers sold in Missouri between September 15 and October 15, 2017.²⁵ Product costs were estimated from an online distributor²⁸ for the following processing supplies and products: numbered ear tags, *Clostridium chauvoei-septicum-novyi-sordellii-perfringens* Types C & D bacterin-toxoid, modified-live bovine rhinotracheitis-virus diarrhea-parainfluenza 3-respiratory syncytial virus vaccine with *Mannheimia haemolytica* toxoid, oxfendazole oral suspension, eprinomectin pour-on, trenbolone acetate and estradiol implant, gamithromycin (GAM), ceftiofur (CCFA), florfenicol, and enrofloxacin. Additional standardized input costs included: a chute processing charge including product-delivery equipment and consumables such as needles, syringes, and implant guns (\$2.00/head), grain cost (\$219.65/ton; Twillman Feed Service), hay (\$96.00/ton)²⁷ and mineral supplementation (\$28.00/50 lb [22.7 kg]),ⁱ pasture lease costs (\$10.50/head/month),¹⁵ pull and temperature charge for animals identified as sick (\$3.00/head), and a mortality disposal fee (\$25.00). The value for

individual animals that were removed prior to the study-end for illness or lameness were assumed to be valued based on an average discount of 30% of the standardized purchase price.⁴ A standardized sale price for cattle finishing the study of \$140.86/cwt (45.4 kg) was an average price from USDA AMS reports for 650 to 700 lb (295 to 318 kg), medium- to large-frame steers sold in Missouri between November 15 and December 15, 2017.²⁶ Associated total costs and revenues per pasture were calculated using the standardized prices indicated above, multiplied by pasture-level study measurements including weight and/or number of head per pasture, and then a total net return per pasture was expressed on a per-head enrolled basis (deads-in). In addition, a similar analysis, utilizing the same cost and revenue values, was performed with a dataset that excluded cattle that died or were removed during the study period (deads-out) since all deaths and removals were attributed to non-BRD causes. Net return values, on a per-head basis, for each pasture were used for statistical analysis as described below.

Statistical Analysis

General and generalized linear models were used for all analyses. Data were coded so the data analyst (DR) was blinded during analysis. Data were formatted for pasture-level analyses. Models were fitted using binomial (e.g. health events) or normal (e.g. body weight, net return) distributions, Kenward-Roger degrees of freedom and Newton-Raphson and Ridging optimization procedures (Proc GLIMMIX SAS 9.3). Fixed effects included the treatment structure. Treatment group means and standard errors of the means (back-transformed to the original scale for generalized models) are reported. Per protocol, treatment effects were considered significant when *P* values were ≤ 0.10 .

Results

Two hundred-forty steers, body weights ranging between 389.4 and 717.2 lb (176.6 to 325.3 kg) at allocation,

were included in the study. Average cattle body weight at allocation, per pasture, was 537.5 lb (244.5 kg) and ranged from 504.5 to 572.1 lb (229.3 to 260.1 kg). At allocation, there was no evidence that treatment groups differed significantly with respect to day 0 body weight (Table 1). Means and standard errors of the means by treatment group are reported in Table 1 for allocation and performance variables.

Most of the allocated steers finished the 59-day study period (232 of 240 allocated); 8 died or were removed from the trial prematurely due to health reasons (GAM, n=4; CCFA, n=4). The 2 mortalities, both in the GAM group, were attributed to non-BRD causes. One steer, found dead on study day 8, had a history of lameness and persistent diarrhea, and gross necropsy diagnosis was enterotoxemia. The other death occurred while the animal was being moved from pasture for evaluation and treatment. The diagnosis at necropsy was central nervous system disorder or cardiac failure; lung tissues were sent to the University of Missouri Veterinary Medical Diagnostic Laboratory where culture and PCR results were found to be negative for all major bacterial (*Pasteurella* spp, *Mannheimia haemolytica*, *Histophilus somni*) and viral (parainfluenza type-3 virus, bovine respiratory syncytial virus, bovine viral diarrhea virus, and infectious bovine rhinotracheitis) BRD pathogens, respectively. Of the 6 steers removed (GAM, n=2; CCFA, n=4) from the study, 4 were due to lameness and 2 were due to persistent diarrhea. One steer, removed on day 14 for persistent diarrhea, depression, and anorexia, was sent to the University of Missouri Veterinary Medical Diagnostic Laboratory, euthanized and necropsied; postmortem diagnosis was bovine viral diarrhea confirmed by PCR. Diagnostics were not performed on any other animals.

On study day 30, weights were collected from 234 calves (GAM, n=116; CCFA, n=118). The day 30 body weights for GAM and CCFA treatment groups were 632.07 lb (286.70 kg) and 612.02 lb (277.61 kg), respectively (*P*=0.20). Including all steers on trial, from study days 0 to 30, ADG was 2.46 lb (1.12 kg) and 2.17 lb (0.98 kg) for the GAM and CCFA groups, respectively (*P*=0.41). However, in steers that finished the

Table 1. Body weight and average daily weight gain (ADG) means (standard errors of the means) by treatment group for high-risk stocker steers administered metaphylaxis with gamithromycin (GAM) or ceftiofur crystalline free acid (CCFA) for control of bovine respiratory disease.

Item	GAM [†]	CCFA [†]	<i>P</i> -value
Day 0 weight, lb	537.90 (7.08)	537.19 (7.08)	0.94
Day 30 weight [‡] , lb	632.07 (10.57)	612.02 (10.57)	0.20
Day 59 weight [‡] , lb	708.79 (9.83)	689.39 (9.83)	0.18
ADG day 0-30, lb (deads-out [¶])	3.14 (0.20)	2.49 (0.20)	0.04
ADG day 0-59, lb (deads-out [¶])	2.90 (0.09)	2.57 (0.09)	0.03
ADG day 0-30, lb (deads-in [‡])	2.46 (0.24)	2.17 (0.24)	0.41
ADG day 0-59, lb (deads-in [‡])	2.55 (0.13)	2.23 (0.13)	0.11

[†]Sixteen pastures were randomly allocated to GAM (n=8) and CCFA (n=8), and 240 steers were randomized to treatment (GAM, n=120; CCFA, n=120), yielding 15 steers per pasture.

[‡]Includes only the calves that were available for weight measures on days 30 and 59 (removals and dead cattle excluded)

[¶]Includes only the weights of calves that finished the study, excluding deaths and removals due to non-BRD reasons

[‡]Includes all calves available for weight measures including deaths and removals due to non-BRD reasons

study, excluding non-BRD removals and deaths from study days 0 to 30, ADG was 3.14 lb (1.42 kg) and 2.49 lb (1.13 kg), for the GAM and CCFA groups, respectively ($P=0.04$). The final body weights (day 59) obtained included 232 calves (GAM, $n=116$; CCFA, $n=116$) and were 708.79 lb (321.50 kg) and 689.39 lb (312.70 kg) for the GAM and CCFA groups, respectively ($P=0.18$). From study days 0 to 59, including all steers enrolled to the study, ADG was 2.55 lb (1.16 kg) and 2.23 lb (1.01 kg) for the GAM and CCFA groups, respectively ($P=0.11$). Excluding removals and deaths due to non-BRD illness, the GAM group significantly outgained the CCFA group throughout the study; ADG was 2.90 lb (1.32 kg) and 2.57 lb (1.17 kg), for GAM and CCFA groups respectively ($P=0.03$). Body weight means did not vary significantly between treatment groups on days 0, 30, and 59 (Table 1).

Treatment group means for health and economic outcome variables are reported in Table 2. Sixteen total steers (GAM, $n=3$; CCFA, $n=13$) were given an initial treatment (florfenicol) for BRD; no BRD treatments were given after day 28 of the trial. The 3 steers in the GAM group received CAS of 1 ($n=1$) or 2 ($n=2$), and the 13 steers in the CCFA group received a CAS of 1 ($n=5$) or 2 ($n=8$); no calves received a CAS of 3 or 4. However, 6 febrile steers with clinical signs of respiratory disease were treated within the PMI period (3 each on study days 5 and 6) based on the clinical discretion of the masked veterinarian (GAM, $n=1$; CCFA, $n=5$). In steers treated for BRD, rectal temperatures for the GAM and CCFA groups ranged from 104.3 to 104.5°F (40.2 to 40.3°C), and 104.1 to 107.1°F (40.1 to 41.7°C), respectively. First-treatment (BRD) morbidity was significantly different among groups, with the mean for the CCFA group approximately 4-fold higher than the mean for the GAM group (Table 2). All calves treated for BRD recovered after the initial treatment; therefore, no

calves were treated twice for BRD during the trial period, and treatment success and case fatality were numerically equal for both groups.

Overall mean net return per head, including removals and deaths unrelated to BRD, for steers in the GAM ($\$2.07 \pm 6.83$) and CCFA ($-\15.70 ± 6.83) groups were significantly different ($P=0.09$). Mean net return per head for steers that finished the study (excluding deaths and removals due to non-BRD reasons) was significantly higher ($P \leq 0.01$) for GAM ($\$22.34 \pm 6.75$) vs CCFA ($-\6.67 ± 6.75) steers (Table 2).

Discussion

Results from this randomized trial of auction market-derived feeder steers backgrounded on pasture demonstrated differences in health, performance, and economic outcomes between steers given metaphylaxis with gamithromycin and ceftiofur crystalline free acid for the control of BRD. Overall, BRD clinical morbidity was lower than expected, and the relatively few cattle that died or were removed were all attributed to non-BRD causes. Although BRD incidence following metaphylaxis was relatively low, it was significantly lower for the GAM steers compared to steers administered CCFA. Despite relatively low clinical morbidity, ADG in steers that finished the study was significantly greater for the GAM steers than those given CCFA, perhaps reflecting impacts of metaphylaxis on subclinical disease. The net economic return per head allocated to the study, which captures costs due to both health and performance, was greater for cattle given GAM vs those given CCFA, whether calculated on a “deads-in” or “deads-out” basis.

Relatively few cattle were observed with clinical BRD in this study, despite selecting a study population that was

Table 2. Health and economic outcome means (standard errors of the means) by treatment group for high-risk stocker steers administered metaphylaxis with gamithromycin (GAM) or ceftiofur crystalline free acid (CCFA) for control of bovine respiratory disease.

Item	GAM [†]	CCFA [†]	P-value
First BRD treatment morbidity [‡] , %	2.50 (1.43)	10.83 (2.84)	0.03
Second BRD treatment morbidity, %	0	0	-
First treatment success, %	100	100	-
BRD death loss, %	0	0	-
BRD case fatality, %	0	0	-
Overall death loss [‡] , %	1.67 (1.17)	0 (0)	0.97
Non-BRD removals [‡] , %	1.67 (1.17)	3.33 (1.64)	0.43
Net return [‡] (deads-out [‡]), \$	22.34 (6.75)	-6.67 (6.75)	0.01
Net return [‡] (deads-in [*]), \$	2.07 (6.83)	-15.70 (6.83)	0.09

[†]Sixteen pastures were randomly allocated to GAM ($n=8$) and CCFA ($n=8$), and 240 steers were randomized to treatment (GAM, $n=120$; CCFA, $n=120$), yielding 15 steers per pasture.

[‡]Calves treated with florfenicol (Nuflor[®], Merck Animal Health, Madison, NJ)

[‡]Died of causes other than BRD (total = 2); 1 due to enterotoxemia, 1 due to central nervous system disorder or cardiac failure

[‡]Removed for causes other than BRD (total = 6); 4 due to lameness, 2 due to persistent diarrhea.

[‡]Net return was estimated for each pasture using standardized prices for all variable costs and revenues, fixed costs were not included.

[‡]Includes net return only for the calves that finished the study, excluding deaths and removals due to non-BRD reasons

^{*}Includes net return on all calves on trial including deaths and removals due to non-BRD reasons

deemed to be high-risk for BRD and appropriate for receiving metaphylaxis upon arrival to a stocker facility. Ives and Richeson defined high-risk calves as light-weight, recently weaned, highly commingled or of auction-market origin, subjected to long transport time, and have an unknown health history.¹⁴ The population of 240 mixed-breed beef steers for this study ranged in body weight from 389.4 to 717.2 lb (176.6 to 325.3 kg), were commingled, were purchased from a livestock auction in southwest Missouri, were transported approximately 3.5 hours to the study facility, and had unknown health histories. While these study animals had known risk factors of BRD, the observed BRD morbidity and mortality following metaphylaxis were lower than expected. One of the health management challenges in this type of feeder cattle population is the uncertainty and variability in observed vs predicted BRD risks, which results in metaphylaxis often being an effective risk management tool.^{14,17} It is plausible that the relatively low BRD morbidity observed in this study could be due to decreased stressors or between-animal contact rates in pasture cattle compared to more intensively reared cattle in feedlot environments.^{9,17} It is also worth noting that both of these 2 antimicrobials, GAM and CCFA, may have been efficacious in reducing BRD, but in this study, that cannot be determined without a negative control group for comparison.

In this trial, 16 steers were treated for BRD within the first 28 days following metaphylaxis, which is consistent with Buhman et al who reported that approximately 91% of calves with BRD were diagnosed within the first 27 days after arrival.⁷ Health and performance outcomes in this study were observed over a 59-day study period, which is a relatively common backgrounding period in the industry, and beyond the time frame when most cases of BRD occur.¹⁰ The protocol-defined PMI for this trial was 8 days, which would have inherently skewed the time distribution of initial BRD treatments and potentially impacted measures of severity or first-treatment success. There were 6 febrile steers with clinical signs of BRD that were treated within the PMI at the clinical discretion of the attending veterinarian. The impact of those treatments relative to PMI and the distribution and severity of clinical disease within the population is unknown; however, by effectively masking the clinician to metaphylaxis groups, there would be no bias as to comparisons of observed outcomes between treatment groups.

There are relatively limited published data regarding effects of metaphylaxis for BRD in stocker cattle.^{2,21} However, metaphylaxis with GAM has been shown to reduce BRD morbidity in feedlot cattle, as compared to untreated animals or animals receiving other antimicrobials including oxytetracycline, tulathromycin, tilmicosin, and CCFA.^{2,3,16,18,19} Metaphylaxis with CCFA in feedlot and stocker cattle has been compared to tilmicosin, but there have been conflicting results in terms of relative efficacy.^{5,21} In a recent meta-analysis, the estimated odds of BRD morbidity were lower for GAM than CCFA metaphylaxis (odds ratio = 0.73, 95% credibility interval [0.29-1.55]) from day 1 to day 60; however, there was

only 1 direct comparison between GAM and CCFA.¹ Amrine et al directly compared GAM and CCFA in a study population comprised of both feedlot and stocker calves in multiple sites located in Missouri and Oklahoma.² Although that direct comparison of GAM and CCFA included a mixed population of calves in both feedlot and stocker production systems, the overall results observed in that study were consistent with what was observed in the present study.² They reported that calves administered metaphylaxis with GAM gained significantly more weight and resulted in fewer animals pulled for treatment than calves receiving CCFA for metaphylaxis.² In the study reported here, the significant difference in ADG for steers finishing the study was relatively substantial given the relatively low clinical burden of BRD in this study population.

To the authors' knowledge this is the first reported partial budget analysis directly comparing economic impacts of GAM and CCFA metaphylaxis. The partial budget approach for the economic analysis was defined *a priori* in the protocol, but given the lack of previously published data it was unknown whether a difference between the groups would be observed. However, given the observed differences in clinical morbidity, and weight gains in particular, it is perhaps not unexpected that economic differences were demonstrated. It has been well-established that BRD impacts performance, and subsequently net returns, in feedlot cattle.^{6,8,13,20} However, performance data relating to metaphylaxis for BRD in a stocker system are relatively sparse.² The economic differences observed in this study were relatively substantial and statistically significant, whether calculated on a dead-in or dead-out basis, and even though the magnitude of the estimated returns differed among the 2 approaches (as expected), both were consistent in that mean differences favored the group receiving GAM metaphylaxis.

Conclusions

This randomized trial was unique in that it directly compared health, performance, and economic impacts of metaphylaxis with gamithromycin and ceftiofur crystalline free acid for control of BRD in auction market-derived stocker calves backgrounded for approximately 2 months on pasture. Even with relatively low overall BRD morbidity, GAM steers had significantly lower clinical morbidity than CCFA steers. In addition, after excluding the few steers that died or were removed due to non-BRD reasons, steers receiving metaphylaxis with GAM significantly outperformed CCFA steers with respect to ADG over the entire study period. There was no evidence of significant differences in other health outcomes, but across the whole study population there were no deaths or removals attributed to BRD, and all steers with clinical BRD recovered after first treatment. The overall estimated net economic return per head was better for steers given GAM compared to CCFA, whether removals and deaths unrelated to BRD were included in the analysis or not. Overall, steers in this study that were administered metaphylaxis with GAM

had improved health, weight gain, and economic return as compared to those administered CCFA.

Endnotes

- ^a Alpha-7[®], Boehringer Ingelheim, St. Joseph, MO
^b PYRAMID[®] 5 + Presponse[®] SQ, Boehringer Ingelheim, St. Joseph, MO
^c Synanthic[®] Suspension 22.5% Bovine Dewormer, Boehringer Ingelheim, St. Joseph, MO
^d Ivomec[®] Eprinex[®] Pour-On, Boehringer Ingelheim, Duluth, GA
^e Revalor[®]-G, Merck Animal Health, Madison, NJ
^f Zactran[®], Boehringer Ingelheim, Duluth, GA
^g Excede[®], Zoetis Animal Health, Kalamazoo, MI
^h AMPT-A 54229[™], ADM Animal Nutrition, Quincy, IL
ⁱ Nufloor[®], Merck Animal Health, Madison, NJ
^j Baytril[®] 100, Bayer, Shawnee, KS

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