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Comparison of three injectable metaphylactic antimicrobial treatments administered at feedlot arrival for control of bovine respiratory disease in calf-fed Holstein steers

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Abstract

Three injectable metaphylactic antimicrobials were evaluated for efficacy against bovine respiratory disease (BRD) in calf-fed Holstein steers. Calves (N=3,605) weighing between 210 and 580 lb (95 and 263 kg) were enrolled in a complete random study design and administered either tulathromycin (TUL, 1.1 mL/100 lb [45.4 kg] of body weight [BW]), tildipirosin (TPR, 1.0 mL/100 lb [45.4 kg] BW), or gamithromycin (GAM, 1.8 mL/100 lb [45.4 kg] BW) at feedlot arrival. Body weight, health events, and carcass data were collected to assess differences among experimental groups for morbidity, mortality, treatment success, realizer rate, average daily gain (ADG), and carcass traits. An economic model was developed to compare the relative economic outcome associated with metaphylaxis using parameters describing morbidity, relapse, realizer, and mortality rates as well as the individual drug cost. No significant differences (P>0.05) were observed for ADG, first-pull morbidity rate, mortality rate, carcass weight, backfat, or marbling score due to metaphylaxis across experimental groups. Calves administered gamithromycin at processing had a significantly lower (P=0.01) realizer rate and realizer plus mortality rate, and higher (P=0.02) first-treatment success rate compared to calves administered tulathromycin. Health and performance outcomes did not differ between calves in the GAM and TPR groups; however, drug cost was lower in the GAM group. Compared to calves in the TUL group, the economic benefit of metaphylaxis was greater for calves in the GAM experimental group when considering drug cost and difference in relapse, realizer, and realizer plus mortality rates.

Key words: bovine respiratory disease, calf-fed Holstein, metaphylactic antimicrobials, feedlot morbidity, dairy calves

Introduction

The cost of prevention, treatment, and reduced performance from bovine respiratory disease (BRD) in feedlot cattle remains a primary source of economic loss for the cattle industry.[8,11] Previous studies have identified BRD as the primary cause of morbidity and mortality in a majority of feedlot cattle.[1,23,26] Metaphylactic antimicrobial administration during processing has the potential to target known infectious bacterial pathogens that may be present in calves entering the feedlot, as well as reducing the rate of future BRD morbidity by altering the relative makeup of microbial species in treated animals.[10] Uniform treatment of high-risk calves entering the feedlot with various antimicrobials has been shown to reduce morbidity, mortality, and overall cost to the feedlot operation.[13,17,21,24,25] Given the demonstrated efficacy, the net return of metaphylaxis for the purpose of animal health and performance has been estimated between $532 and $680 million per year to the US cattle feeding industry.[7]

Calf-fed Holsteins originating from the dairy industry represent a significant proportion of calves entering feedlots in various markets. These calves are often at higher risk of developing respiratory associated morbidity as a result of exposure to stressors and/or pathogens associated with the calf-ranch supply chain, as well as relatively lighter body weights at arrival into the feedlot.[18] Additional evaluation of preventative measures is needed in these high-risk populations and production environments to determine the effectiveness of the wide variety of commercially available injectable metaphylactic antimicrobial treatments marketed for reducing the prevalence and persistance of BRD morbidity. Tulathromycin[a], tildipirosin,[b] and gamithromycin[c] are 3 commercially available antimicrobials used for the control and treatment of BRD. Tulathromycin is labeled for treatment and control of pathogens including *Mannheimia haemolytica*, *Pasteurella multocida*, *Histophilus somni*, and *Mycoplasma bovis*.[3,9,12,22] Tildipirosin is labeled for treatment and control of *Mannheimia haemolytica*, *Pasteurella multocida*, and *Histophilus somni*. Gamithromycin is labeled for treatment of *Mannheimia haemolytica*, *Pasteurella multocida*, *Histophilus somni*, and *Mycoplasma bovis*, and for control of *Mannheimia haemolytica* and *Pasteurella multocida.* The USDA reported

that in 2017 approximately 18.4% of feedlots larger than 1,000 head administered tulathromycin, 5.1% administered gamithromycin, and 5.8% administered tildipirosin to cattle treated as a group, which suggests that a comparison of effectiveness is relevant to the industry.[23] The objective of this study was to compare morbidity, mortality, feedlot performance, and economics among calf-fed Holstein steers administered either tulathromycin, tildipirosin, or gamithromycin at feedlot arrival for control of BRD.

Materials and Methods

Experimental Design and Enrollment Procedure

A total of 3,605 calf-fed Holstein steers from multiple origins were enrolled in a complete random design study, with individual animal considered the experimental unit. Calves weighing between 210 and 580 lb (95 and 263 kg) were transported to a commercial feedlot in southwest Idaho and processed within 48 hours of arrival according to standard operating procedures. Animals were alternately assigned to experimental groups to evaluate the effect of metaphylaxis using tulathromycin (TUL; n=1136), tildipirosin (TPR; n=1139), or gamithromycin (GAM; n=1143) when administered at processing. Outcomes of interest included morbidity, mortality, treatment success, realizer rate, average daily gain (ADG), carcass traits, and modeled cost of metaphylaxis. All products were administered subcutaneously in the neck area according to label usage instructions: TUL 1.1 mL/100 lb (45.4 kg) of body weight (BW), TPR 1.0 mL/100 lb (45.4 kg) BW, and GAM 1.8 mL/100 lb (45.4 kg) BW. Chute order was used for random assignment of experimental group, with starting order chosen randomly by feedlot personnel blinded to the study design. Animals were identified by an electronic identification tag (EID), a visual identification tag, and administered an 8-way clostridial bacterin-toxoid,[d] a parenteral modified-live infectious bovine rhinotracheitis virus, bovine viral diarrhea virus (type 1 and 2), parainfluenza 3 virus, bovine respiratory syncytial virus + 5-way leptospirosis vaccine,[e] and implanted with trenbolone acetate and estradiol-17B[f] according to label usage instructions. Individual processing weights and rectal temperatures were also collected at the time of experimental group assignment. Calves were placed in pre-assigned pens at a stocking rate of 214 to 235 head per pen and offered *ad-libitum* access to feed and water consistent with commercial feedlot practices. Calves in all experimental groups were commingled within pens, which prevented measurement of the feed-to-gain ratio. Either potato by-products (processing or fry waste) or corn in various forms (flaked, high moisture, dried distillers grains) composed the primary energy source in the ration. No animal interventions beyond industry accepted diagnostic and therapeutic practices were utilized. A 7-d post-metaphylactic interval was observed during which animals in all 3 treatment groups were not eligible for BRD treatment.

Animals were re-implanted at an average of 126 days-on-feed (DOF) with trenbolone acetate and estradiol,[g] and administered the same combination parenteral modified-live viral 5-way leptospirosis vaccine[e] given at processing. Terminal implants were administered at an average of 253 DOF with trenbolone acetate and estradiol[h] and vaccinated against leptospirosis.[i] Individual animal weights (chute weights) were recorded at both re-implant events to assess ADG (lb/day) from processing to middle and terminal implants using the individual animal ID captured at processing for all animals enrolled in the study. A pencil shrink was not applied at re-implant to account for gut fill. Animals were harvested at an average of 363 DOF, and carcass traits were collected including hot carcass weight, fat thickness, ribeye area, and camera marbling score for 3,132 hd. All treatments, mortalities, processing and re-implant weights, and realizers were recorded using the EID assigned at processing within 1 of the 2 feedlot data collection software programs.[j,k]

Health Monitoring and Animal Care

Animals were monitored for morbidity or any signs of abnormality by trained pen riders at least once daily using the morbidity depression scoring system displayed in Table 1. Pen riders were blinded to the experimental status of the animals. Animals deemed eligible for treatment were removed from the pen and taken to the nearest hospital facility for diagnosis and treatment by trained feedlot personnel according to standard feedlot operating procedures. Animals with a rectal temperature ≥ 103.0 °F (39.4 °C) and a depression score > 1 were treated for BRD with florfenicol.[l] Due to insufficient product supply, florfenicol was replaced with a combination product containing florfenicol/flunixin meglumine[m] approximately 45 d into the study for first and second-treatment pulls. Treatment product administered to morbidities remained balanced among experimental groups both before and after the treatment protocol was amended. A 72 h post-treatment interval was observed following treatment for BRD before animals were returned to their home pen or deemed eligible for re-treatment. Calves that failed to respond to treatment after 3 treatments for BRD were classified as a realizer (chronic or poor-doing animals sold for salvage before their pen mates) and marketed where possible. Label pre-harvest withdrawal times were observed prior to marketing.

For the duration of the study all calves were under the supervision of a veterinarian and trained feedlot personnel.

Statistical Analysis

All response variables were analyzed using general and generalized linear mixed models for performance and health outcomes. Experimental group (TUL, TPR, GAM) was considered a fixed effect, lot was considered a random effect, and individual enrollment weight was considered a continuous covariate where appropriate. Harvest date was included as a

Table 1. Morbidity depression scoring system for cattle under observation for clinical signs of BRD.

Clinical Score Categories		
Clinical Score	**Severity**	**Observed Behavior**
0	Normal	•Bright, alert, responsive. •No abnormal clinical signs.
1	Mildly depressed	•May stand isolated with head down, ears drooping, but responsive to stimulation. •May have mild dyspnea with gauntness and nasal/ocular discharges.
2	Moderately depressed	•May remain recumbent or stand isolated with head down, depression obvious when stimulated. •May stumble if forced to trot. •Noticeable dyspnea with gauntness and nasal/ocular discharges.
3	Severely depressed / moribund	•May be recumbent and reluctant to rise or, if standing, is isolated and reluctant to move. When moving, ataxia, knuckling or swaying evident. Unable to stand, approaching death. •Head carried low with ears drooping. Eyes dull, possible excess salivation/lacrimation. •Pronounced dyspnea and gauntness. Mouth breathing. Nasal and ocular discharges.

fixed effect as not all cattle from the same lot were harvested on the same day. Continuous and binomial distributions were fit for performance and health outcomes, respectively. Tukey's HSD (honest significant difference) procedure was implemented to compare significance among individual effect levels while correcting for multiple comparisons.[n] Least squares means, 95% confidence intervals, and *P*-values (α=0.05 significance level) were reported for all variables.

Economic Comparison Model

An economic model was developed to assess the relative costs and returns associated with uniform antimicrobial metaphylaxis in relation to the morbidity, relapse, mortality, and realizer rates observed across experimental groups with significantly different morbidity outcomes. Constant means were assumed for feedlot arrival weight, ADG through the feeding period, morbidity rate, mortality rate, DOF to first morbidity treatment, DOF to realizer date, and DOF to mortality date. Differences between experimental groups were included for relapse rate and realizer rate following significant differences observed in the P-value of the experimental group comparison for TUL and GAM ($P<0.05$). The model was limited to a single re-treatment rate (relapse rate) since no significant differences were observed for second and third-pull retreatment rates. The drug cost of BRD treatment per 100 lb (45.4 kg) BW for each case or morbidity was assumed to be $2.50 (florfenicol and flunixin meglumine or florfenicol). The marketable value lost per 100 lb (45.4 kg) BW for each incidence of mortality was assumed to be $150, and realizers were marketed at $87 per 100 lb (45.4 kg) BW. Hospital costs were included as a flat fee of $5.00 per visit for materials and labor.

The relative cost of metaphylaxis for each experimental group was modeled as the sum of metaphylaxis drug cost, morbidity treatment cost, relapse (first re-treatment) cost, realizer cost, and mortality cost. Metaphylaxis cost was calculated using the product cost (tulathromycin, gamithromycin, or tildipirosin, $/100 lb [45.4 kg] BW) and feedlot arrival weight as:

$$Metaphylaxis\ cost = Product\ cost\ x \left(\frac{Feedlot\ arrival\ weight}{100}\right)$$

Relapse cost was calculated as:

$$Relapse\ cost = \left(Product\ cost\ x \left(\frac{Morbidity\ treatment\ weight}{100}\right) + Hospital\ cost\right) x\ Morbidity\ rate\ x\ Relapse\ rate$$

The cost of a realizer was calculated as:

$$Realizer\ cost\ (\$1.50\text{-}\$0.87)\ x\ Weight\ at\ realizer\ x\ Realizer\ rate$$

where

$$Weight\ at\ realizer = \left(3.37\ \frac{lb}{day}\ x\ DOF\ at\ realizer\right) + Enrollment\ weight$$

The cost of a mortality was calculated as:

$$Mortality\ cost\ (\$1.50)\ x\ Weight\ at\ mortality\ x\ Mortality\ rate$$

where

$$Weight\ at\ mortality = \left(3.37\ \frac{lb}{day}\ x\ DOF\ at\ mortality\right) + Enrollment\ weight$$

Weights at realizer status and mortality in the model were not a measured weight, but were calculated using the ADG from enrollment to first re-implant (Table 2). Alternatives to model the lost value of a mortality could include the purchase cost of the animal plus feed costs, the marketable

value at the time of death plus the feed cost, or the opportunity cost of the terminal projected marketable weight of the animal. Base economic assumptions and parameters for the full economic model are displayed in Tables 5 and 6.

Results and Discussion

Descriptive statistics including the mean, standard error of the mean, median, inter-quartile range, and range for production parameters and response variables are displayed in Table 2. Production parameters including arrival weights, lot size, implant protocols, ADG, DOF, and carcass traits are representative of normal standards and protocols for this feedlot. The overall morbidity rate (animals treated at least once) for BRD was 23.7% with a 5.4% realizer rate, and a mortality rate of 5.4%. The mean feedlot arrival weight observed at processing was 292.7 lb (132.8 kg), with a range of 210 to 580 lb (95 to 263 kg), which likely contributed to risk for BRD morbidity in this population. Previous studies have identified associations between risk of BRD morbidity and both arrival body weight and body weight shrink associated with transport and processing upon feedlot arrival.[6,15] Shrink associated with transport and processing was not measured in the current study, but has the potential to be a contributor to the observed morbidity rates.

Least-squares means and 95% CIs for all response variables are displayed in Table 3. Statistically significant differences due to experimental group were not observed for arrival body weight, arrival temperature, ADG to first or second implant, first pull rate, morbidity rate, mortality rate, carcass weight, fat thickness, or marbling score ($P>0.05$), but ribeye area was lower in the TUL group. Significant differences among experimental groups were observed for realizer rate ($P=0.01$). Calves in the GAM group had a lower ($P<0.05$) realizer rate (4.2%) compared to calves in the TUL group (6.9%), but did not differ from calves in the TPR group (5.2%). Morbidity rate was numerically highest in the TUL group (25.0%), but was not significantly different from the other 2 groups ($P=0.40$). Combined, the realizer plus mortality rate was significantly different among experimental groups ($P=0.01$). Calves in the TUL group had a higher ($P<0.05$) realizer plus mortality rate (13.2%) compared to those in the GAM group (8.6%); realizer plus mortality rate in calves in the TPR group (10.5%) was similar to both the GAM and TUL groups. The difference among experimental group means for total realizer plus mortality rate indicates significant economic outcomes are likely to result among metaphylaxis strategies.

In 2019, the USDA reported that 39.3% of feedlots greater than 1,000 head treated cattle as a group using an in-

Table 2. Descriptive statistics (mean, SEM [standard error of the mean], median, IQR [inter-quartile range], and range) for production parameters and response variables.

Variable	Mean	SEM	Median	IQR	Range
Lot size	227.87	1.61	228.00	223.00 – 234.00	214.00 – 235.00
Arrival weight, lb	292.66	0.59	290.00	270.00 – 315.00	210.00 – 580.00
Arrival temperature, °F	102.76	0.01	102.70	102.30 – 103.10	100.40 – 106.40
ADG first, lb*	3.37	0.01	3.42	3.12 – 3.69	1.02 – 4.62
First DOF†	126.34	0.09	128.00	123.00 – 130.00	110.00 – 145.00
ADG second, lb‡	3.56	0.01	3.58	3.38 – 3.78	2.07 – 4.48
Second DOF§	252.69	0.19	258.00	246.00 – 260.00	229.00 – 271.00
Total DOF	362.94	0.39	364.00	344.00 – 380.00	169.00 – 425.00
Morbidity rate, %‖	23.73	1.91	25.00	15.93 – 27.68	13.19 – 38.46
Retreatment rate, %¶	9.58	1.01	9.05	6.17 – 12.72	4.68 – 17.09
Realizer rate, %#	5.40	0.69	5.11	2.71 – 8.04	0.90 – 9.40
Mortality rate, %**	5.37	0.49	5.17	3.74 – 5.88	2.64 – 9.48
Hot carcass weight, lb	861.06	1.28	864.50	821.00 – 908.00	489.00 – 1111.00
Fat thickness, in	0.35	0.01	0.32	0.28 – 0.40	0.04 – 0.96
Ribeye area, in^2	12.10	0.03	12.10	11.2 – 13.0	6.2 – 17.4
Camera marbling score	426.94	1.71	406.00	366.00 – 471.00	193.00 – 853.00

* ADG (average daily gain) from arrival to first re-implant
† DOF (days-on-feed) from arrival to first re-implant
‡ ADG (average daily gain) from arrival to second re-implant
§ DOF (days-on-feed) from arrival to second re-implant
‖ Count of treated greater than or equal to 1 divided by lot size
¶ Count of treated more than once divided by lot size
# Count of realizers divided by lot size
** Count of mortalities divided by lot size

Table 3. LS (least square) means and 95% CI (confidence interval) for response variables for experimental groups administered tulathromycin, gamithromycin, or tildipirosin.

	TUL*		GAM*		TPR*		
Variable	**LS Mean†**	**95% CI**	**LS Mean**	**95% CI**	**LS Mean**	**95% CI**	*P*
Arrival weight, lb	292.90	279.82 – 305.98	292.37	279.29 – 305.45	293.43	280.35 – 306.51	0.62
Arrival temperature, °F	102.76	102.73 – 102.80	102.76	102.72 – 102.79	102.76	102.72 – 102.80	0.99
ADG first, lb‡	3.36	3.34 – 3.39	3.36	3.34 – 3.39	3.39	3.36 – 3.42	0.26
ADG second, lb§	3.56	3.54 – 3.58	3.57	3.55 – 3.59	3.56	3.54 – 3.58	0.53
Morbidity rate 1st pull, %	25.04	22.60 – 27.48	23.57	21.14 – 26.00	22.69	20.25 – 25.13	0.40
DOF 1ST morbidity‖	51.84	44.53 – 59.16	52.20	45.04 – 59.37	55.31	47.80 – 62.82	0.59
Realizer rate, %	6.92[a]	5.61 – 8.23	4.16[b]	2.85 – 5.47	5.15[ab]	3.84 – 6.46	0.01
DOF at realizer	133.01	115.89 – 150.14	166.71	142.15 – 191.27	139.70	119.11 – 160.29	0.06
Mortality rate, %	6.32	5.01 – 7.63	4.44	3.13 – 5.74	5.39	4.07 – 6.69	0.14
DOF at mortality	135.62	101.57 – 169.68	133.01	92.99 – 173.04	109.49	73.85 – 145.13	0.54
Realizer + Mortality, %	13.24[a]	11.45 – 15.04	8.60[b]	6.81 – 10.39	10.54[ab]	8.72 – 12.33	0.01
Hot carcass weight, lb	863.50	853.44 – 867.84	861.63	857.37 – 865.89	857.72	853.44 – 862.01	0.16
Fat thickness, in	0.32	0.29 – 0.34	0.32	0.30 – 0.34	0.32	0.30 – 0.34	0.23
Ribeye area, in	12.00[a]	11.74 – 12.27	12.17[b]	11.90 – 12.43	12.05[ab]	11.78 – 12.31	0.03
Camera marbling score	426.34	409.22 – 443.47	426.31	409.17 – 443.45	426.18	408.99 – 443.37	0.99

*TUL = tulathromycin, DRAXXIN, Zoetis Animal Health, Parsippany, NJ; GAM = gamithromycin, Zactran, Boehringer Ingelheim, Duluth, GA; TPR = tildipirosin, Zuprevo, Merck Animal Health, DeSoto, KS

† LS means not sharing the same superscript were determined to be statistically different at $P \leq 0.05$

‡ ADG (average daily gain) from arrival to first re-implant

§ ADG (average daily gain) from arrival to second re-implant

‖ DOF = days-on-feed.

jectable antimicrobial upon feedlot arrival.[23] This survey also reported that the majority of cattle were treated with either tulathromycin (18.4% of feedlots reported use), tilmicosin (10.0%), or tildipirosin (5.8%).[23] When considering breed type, dairy breeds or dairy crossbreds make up 11% of the total inventory of cattle placements in the US, which indicates a need for targeted studies of metaphylaxis use in these populations. Results of this study indicate the relative re-treatment and realizer rates could likely be improved for calves of dairy origin through the use of alternatives to tulathromycin, which is one of the most commonly administered antimicrobials.[23] It should be emphasized that the results of this study are specific to calf-fed dairy calves, which are region-specific subpopulations of the total feedlot inventory in the US.

Least-squares means and 95% CIs for morbidity outcomes based on treatment number are displayed in Table 4. Success and relapse rates were significantly different across experimental groups for the first respiratory treatment. First treatment success for TUL (46.9%) was lower ($P<0.05$) compared to GAM (58.9%), but similar to TPR (52.9%). First treatment relapse rate for TUL (46.6%) was higher ($P<0.05$) compared to GAM (36.9%), but did not differ from calves in the TPR group (39.9%). Realizer rate and case fatality rate were not different across groups for first-pull morbidity outcomes ($P>0.05$). Treatment success, relapse, realizer, and case fatality rate were also not different across experimental groups for second or third-pull morbidity outcomes ($P>0.05$). It is important to note that this study design commingled calves from all experimental groups in the same pen. This intentional study design could potentially have unmeasurable population wide effects on pen mates for each experimental group.

Additional studies investigating the effects of metaphylaxis strategies in dairy calves across different environments, ages, and breed types are needed due to the specific environmental challenges present in the dairy and dairy crossbred calf supply chain preceding feedlot placement. Approximately 80% of the feedlot placements for calves of a dairy breed occur below 700 lb (317 kg), where the opposite trend is observed for beef breeds, with placements below 700 lb (317 kg) representing only 37% of total feedlot placements.[23] Stanton et al observed that after treatment at post-weaning movement, dairy calves treated with tulathromycin were 0.5 times less likely to be treated for BRD compared to calves treated with oxytetracycline.[15] Timing of metaphylaxis also appears to have implications for the prevalence and persistence of BRD. Teixeira et al observed that metaphylaxis at 10 days of age or at 10 and 35 days of age with tildipirosin resulted in a lower likelihood of being affected with BRD and/or otitis.[20] However, no effect was observed for mortality rate. In contrast, Celestino et al observed a decrease in mortality rate when tildipirosin was administered for metaphylaxis within the first week of life and again 17 d later.[5] However, the overall morbidity rate of BRD was not reduced with metaphylaxis at this age.[5]

Fewer studies have looked at retreatment rates for BRD in dairy-specific populations following metaphylaxis. Lower likelihood of retreatment has been observed with the use of

Table 4. LS (least square) means and 95% CI (confidence interval) of treatment outcomes for first, second, and third morbidity treatments for experimental groups administered tulathromycin, gamithromycin, or tildipirosin.

	TUL*			GAM*			TPR*			
Morbidity 1st pull	**N**	**LS Mean†**	**95% CI**	**N**	**LS Mean**	**95% CI**	**N**	**LS Mean**	**95% CI**	**P**
Success, %	137	46.85[a]	40.90 – 52.80	167	58.85[b]	52.80 – 64.90	140	52.85[ab]	46.61 – 59.08	0.02
Relapse, %	137	46.55[a]	40.44 – 52.67	105	36.85[b]	30.64 – 43.06	106	39.93[ab]	35.55 – 46.33	0.05
Realizer, %	5	1.71	0.01 – 2.97	2	0.01	0.00 – 1.99	3	0.02	0.00 – 2.46	0.54
Case fatality, %	14	4.75	2.39 – 7.10	10	3.49	0.01 – 5.90	16	6.06	3.58 – 8.55	0.37
Morbidity 2nd pull										
Success, %	38	29.90	22.17 – 37.64	31	33.01	23.96 – 42.07	26	25.04	16.60 – 33.48	0.48
Relapse, %	80	60.67	51.73 – 69.61	53	54.89	44.69 – 65.09	71	68.39	58.47 – 78.30	0.15
Realizer, %	4	2.99	0.00 – 6.29	4	4.13	0.01 – 7.93	4	3.84	0.01 – 7.50	0.89
Case fatality, %	11	8.10	3.42 – 12.78	9	9.07	3.74 – 14.41	3	2.79	0.00 – 7.98	0.16
Morbidity 3rd pull										
Success, %	17	23.14	5.12 – 41.15	21	34.52	15.69 – 53.35	19	27.50	9.16 – 45.83	0.22
Relapse, %	2	2.51	0.00 – 6.50	3	5.82	1.03 – 10.61	1	1.58	0.00 – 5.82	0.37
Realizer, %	48	57.60	38.46 – 76.74	23	48.07	27.92 – 68.21	39	52.88	33.35 – 72.41	0.44
Case fatality, %	13	15.37	7.95 – 22.79	6	11.53	0.02 – 20.82	12	16.39	8.59 – 24.19	0.76

*TUL = tulathromycin, DRAXXIN, Zoetis Animal Health, Parsippany, NJ; GAM = gamithromycin, Zactran, Boehringer Ingelheim, Duluth, GA; TPR = tildipirosin, Zuprevo, Merck Animal Health, DeSoto, KS

†LS means not sharing the same superscript were determined to be statistically different at $P \leq 0.05$

tulathromycin as a therapeutic at the onset of BRD before 52 d of age compared to treatment with a placebo on commercial dairies.[4] In a review by Baptiste it was noted that the relative incidence of BRD in preweaning commercial dairy settings can be as high as 18.1%, with a mortality rate of 2.3%.[2] It is unclear how metaphylaxis in commercial and preweaning settings relate to metaphylaxis at feedlot arrival, but these studies may reveal information about breed-specific treatment response and how metaphylaxis at various ages affects future health. The majority of the available literature on the topic of metaphylaxis at feedlot arrival is specific to beef breeds where the metaphylactic drug of choice is typically tulathromycin.[23] It is important to emphasize that a lack of studies exist in the literature examining the use of antimicrobials and the unique challenges leading up to and following feedlot placement for dairy and dairy crossbred populations.

Assumed drug costs for all 3 products used for metaphylaxis are displayed in Table 5. Gamithromycin has a lower cost per 100 lb (45.4 kg) BW ($2.52) compared to tulathromycin and tildipirosin ($3.60 and $3.40, respectively), which results in a difference in the initial cost of metaphylaxis given at processing. These product prices were chosen to reflect published list prices with a moderate volume discount applied (approximately 5%) and may need to be modified based on purchasing power of specific cattle operations. Morbidity treatment costs in Table 6 were calculated using the individual observed weight at the time of treatment multiplied by the product cost (florfenicol or florfenicol and flunixin meglumine, $2.50/100 lb [45.4 kg] BW) plus a flat fee of $5.00 for hospital costs. Although there was a difference of $2.58/head cost of metaphylaxis, there were no significant differences between GAM and TPR for health and performance measures. For this reason the authors elected to compare only GAM and TUL groups in the economic analysis.

The full economic model showing the comparison between the TUL and GAM experimental groups is shown in Table 6. Realizer and 1st pull morbidity relapse rates were lower for calves in the GAM group compared to TUL. The TUL group had the highest cost in this model, with the highest portion of the cost resulting from realizers plus mortalities,

Table 5. Initial cost of metaphylaxis with tulathromycin, gamithromycin, or tildipirosin.

Variable	TUL*	GAM*	TPR*
Feedlot arrival weight, lb	293	293	293
Product cost, $/100 lb (45.4 kg) of body weight	3.60	2.52	3.40
Metaphylaxis cost, $/hd	10.55	7.38	9.96

*TUL = tulathromycin, DRAXXIN, Zoetis Animal Health, Parsippany, NJ; GAM = gamithromycin, Zactran, Boehringer Ingelheim, Duluth, GA; TPR = tildipirosin, Zuprevo, Merck Animal Health, DeSoto, KS

Table 6. Cost model comparison of metaphylaxis with tulathromycin or gamithromycin using costs and returns associated with morbidity, mortality, and realizer rates through the feeding period.

Variable	TUL*	GAM*
Feedlot arrival weight, lb	293	293
Product cost, $/100 lb (45.4 kg)	3.60	2.52
Morbidity rate, %	23.7	23.7
DOF at 1st morbidity†	54	54
Morbidity 1st treatment weight, lb	485.2	485.2
Relapse rate, %‡*	46.6	36.9
Realizer rate, %‡*	6.9	4.2
DOF at realizer	138	138
Weight at realizer, lb	758.06	758.06
Mortality rate, %	5.4	5.4
DOF at mortality	118	118
Weight at mortality, lb	690.66	690.66
Product cost at morbidity, $/100 lb (45.4 kg)	2.50	2.50
Hospital cost, $/hd	5.00	5.00
Value lost per mortality, $/hd	1035.99	1035.99
Value lost per realizer, $/hd	494.10	494.10
Metaphylaxis cost, $/hd	10.55	7.38
Morbidity cost $/hd	4.07	4.07
Relapse cost, $/hd	1.89	1.50
Realizer cost, $/hd	33.05	19.96
Mortality cost, $/hd	55.63	55.63
Total cost, $/hd	105.19	88.54

* TUL = tulathromycin, DRAXXIN, Zoetis Animal Health, Parsippany, NJ; GAM = gamithromycin, Zactran, Boehringer Ingelheim, Duluth, GA
† DOF = days-on-feed
‡ Indicates LS mean for each experimental group was used as model parameter where statistically significant differences were detected ($P<0.05$). Population-wide means were used where no significant difference was detected.

and the drug cost compared to the GAM experimental group. Overall, a $16.65 spread in the cost of metaphylaxis per head exists between the TUL and GAM groups with all parameters considered. Animal performance differences could impact the outcome of the observed economic model; however, results of this study did not demonstrate differences in ADG or carcass traits between experimental groups.[16,19] Additionally, the feed-to-gain ratio of experimental groups could not be measured in this study due to the commingled design where experimental groups were mixed within pen.

The effect of potential antimicrobial use at the calf grower operation prior to feedlot arrival should be considered. A potential hypothesis is that the use of antibiotics prior to feedlot arrival could impact the efficacy of antimicrobials administered as a metaphylactic in the present study, but the authors are not aware of any studies that support that hypothesis. Further research is needed to determine the effect of antimicrobials administered in the calf-ranch supply chain. Given that no negative control was included, it was not possible to evaluate the effect of metaphylaxis on performance outcomes. These results, however, do provide a practical model to estimate the relative economic outcome of different metaphylaxis strategies given differences in initial metaphylactic drug cost and relapse and realizer rates.

Conclusions

In this study, metaphylaxis at feedlot arrival with tulathromycin or gamithromycin led to different health and relative economic outcomes in calf-fed Holstein steers. However, there are additional variables including processing weight, geographical location, diet, background genetics, and cattle source to consider when interpreting these results. There were no significant differences among experimental groups observed for ADG, morbidity rate, mortality rate, carcass weight, backfat, or marbling score. Metaphylaxis with gamithromycin at processing resulted in a significantly lower realizer rate, combined realizer/mortality rate, and higher first treatment success rate compared to tulathromycin. When accounting for the metaphylactic drug cost at processing, first-pull treatment success, realizer rates, and realizer plus mortality rates, the relative cost as modeled in this study was lowest for calves in the gamithromycin experimental group compared to the tulathromycin experimental group. Although health and performance outcomes did not differ statistically between gamithromycin and tildipirosin groups, cost of metaphylaxis was lower in the gamithromycin group.

Endnotes

[a] Draxxin®, Zoetis Animal Health, Parsippany, NJ
[b] Zuprevo®, Merck Animal Health, Desoto, KS
[c] Zactran®, Boehringer Ingelheim Vetmedica, Duluth, GA
[d] Vision® 8, Merck Animal Health, Whitehouse Station, NJ
[e] Bovi-Shield Gold® FP™ 5 L5, Zoetis Animal Health, Parsippany, NJ
[f] Synovex Choice®, Zoetis Animal Health, Parsippany, NJ
[g] Revalor®-IS, Merck Animal Health, Whitehouse Station, NJ
[h] Revalor®-S, Merck Animal Health, Whitehouse Station, NJ
[i] Leptoferm-5®, Zoetis Animal Health, Parsippany, NJ
[j] CattleXpert, CattleXpert LLC, Elkhorn, NE
[k] CattleInfo, Simplot Livestock Co., Grand View, ID
[l] Nuflor® Injectable Solution, Merck Animal Health, Whitehouse Station, NJ
[m] Resflor Gold®, Merck Animal Health, Whitehouse Station, NJ
[n] JMP Inc., Cary, NC

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