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Comparison of tulathromycin, tildipirosin, and tilmicosin for control of bovine respiratory disease in steers purchased from auction markets and fed in a Texas feedlot

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Abstract

Crossbred steers (n=1,370) purchased from auction markets in Texas were received into a commercial feedlot near Hereford, Texas. Steers were recently weaned and considered at high risk of developing bovine respiratory disease (BRD). Upon arrival, steers were randomly assigned (within arrival blocks) to 1 of 3 treatment groups that received: 1) tilmicosin (TLM; 4.5 mg/lb (10.0 mg/kg)), 2) tildipirosin (TLD; 1.82 mg/lb (4.0 mg/kg)), or 3) tulathromycin (TUL; 1.14 mg/lb (2.5 mg/kg)). Steers were penned by treatment into 36 pens with 12 pens per treatment. Data were analyzed with linear mixed models for a randomized complete block design. Steers administered TUL had significantly lower BRD morbidity than both TLD and TLM ($P < 0.01$) treatments, and TLD had lower BRD morbidity than TLM ($P < 0.05$). Cattle receiving TUL also had a lower percentage of chronic illness than both TLD and TLM treatments ($P < 0.05$). Steers in the TUL treatment group had lower BRD and overall mortality at closeout than TLD ($P < 0.05$), but the TLM-treated steers did not differ from the other groups. Deads-in average daily gain was 0.55 lb (0.25 kg) greater in TUL-treated steers than steers administered TLM, and 0.56 lb (0.25 kg) greater than steers receiving TLD ($P < 0.05$). Cattle receiving TUL had 1.33 lb (0.6 kg) lower deads-in feed-to-gain ratio at closeout than those receiving TLM, and 1.51 lb (0.68 kg) lower than those receiving TLD ($P < 0.05$). During the first 30 days-on-feed, TUL-treated steers had greater daily dry-matter intake compared with TLD-treated steers ($P < 0.01$), but no other differences among treatment groups. By closeout, there were no differences in cumulative mean dry-matter intake between treatment groups. Overall, TUL treatment on arrival resulted in improved health and performance as compared to TLM and TLD treatments.

Key words: BRD, bovine, respiratory, tulathromycin, tildipirosin, tilmicosin

Résumé

Des bouvillons de race croisée (n=1,370) obtenus d'un encan du Texas ont été placés dans un parc d'engraissement commercial près de Hereford au Texas. Ces bouvillons sevrés depuis peu étaient considérés à haut risque de développer le complexe respiratoire bovin. À leur arrivée, les bouvillons ont été alloués de façon aléatoire (à l'intérieur de blocs d'arrivée) à un traitement afin de recevoir soit de la tilmicosine (TLM; 4.5 mg/lb (10.0 mg/kg)), soit de la tildipirosine (TLD; 1.82 mg/lb (4.0 mg/kg)) ou soit de la tulathromycine (TUL; 1.14 mg/lb (2.5 mg/kg)). Les bouvillons dans un enclos recevaient le même traitement et il y avait 36 enclos au total (soit 12 par traitement). Les données ont été analysées avec des modèles linéaires mixtes avec un plan avec blocs aléatoires complets. La morbidité reliée au complexe respiratoire bovin était significativement moins élevée pour le traitement TUL que pour le traitement TLD et le traitement TLM ($P < 0.01$) et moins élevée pour le traitement TLD que pour le traitement TLM ($P < 0.05$). Le pourcentage de maladie chronique était significativement moins élevé pour le traitement TUL que pour le traitement TLD et le traitement TLM ($P < 0.05$). Il y avait moins de mortalité reliée au complexe respiratoire bovin et de mortalité en générale à la fin de l'engraissement pour le traitement TUL que pour le traitement TLD ($P < 0.05$) alors qu'il n'y avait pas de différence à ce niveau entre le traitement TLM et les deux autres traitements. Le gain moyen quotidien (avec les morts) pour le traitement TUL était plus élevé que pour le traitement TLM par 0.55 lb (0.25 kg) et que pour le traitement TLD par 0.56 lb (0.25 kg) ($P < 0.05$). L'indice de conversion alimentaire (avec les morts) à la fin de l'engraissement était moins élevé pour le traitement TUL que pour le traitement TLM par 1.33 lb (0.6 kg)

et que pour le traitement TLD par 1.51 lb (0.68 kg) ($P < 0.05$). Durant les premiers 30 jours d'engraissement, la consommation journalière de matière sèche était significativement plus élevée pour le traitement TUL que pour le traitement TLD ($P < 0.01$) alors qu'il n'y avait pas d'autres différences entre les traitements. La moyenne de la consommation cumulative de matière sèche n'était pas différente entre les traitements à la fin de l'engraissement. Dans l'ensemble, le traitement TUL à l'arrivée a permis d'améliorer la santé et la performance par rapport aux traitements TLM et TLD.

Introduction

On-arrival antibiotic treatment of feeder cattle at high risk of developing bovine respiratory disease (BRD) is a common intervention applied in feedlots located on the High Plains in the United States (US) when receiving young calves considered to have a naïve immune system. A 2011 survey of feedlots in the US conducted by the National Animal Health Monitoring System estimated that 21.3% of all incoming cattle received some type of on-arrival treatment, which was increased from the 2001 survey estimate of 10.4%.[8] There are a number of options available to veterinarians and producers in the US with label claims "for the control of bovine respiratory disease", including the recently approved tildipirosin. The same survey showed that the most common antimicrobials used in feedlots were tilmicosin (46.0 ± 8.2%), tulathromycin (29.5 ± 7.9%), and ceftiofur (13.8 ± 3.4%).

In 2014, Tennant et al reported that both tilmicosin and tulathromycin used as on-arrival treatment to control BRD resulted in significantly lower BRD morbidity and mortality as well as significantly higher average daily gains at harvest as compared to negative controls.[7] In the same study, treatment with tulathromycin resulted in significantly lower BRD morbidity than tilmicosin. In 2016, Miller and co-workers reported that on-arrival treatment with tulathromycin resulted in significantly greater average daily gain (ADG) and lower BRD morbidity than treatment with gamithromycin or tilmicosin.[3]

The objective of this experiment was to evaluate 3 different antimicrobials for control of BRD in feeder steers considered at high risk of developing BRD soon after arrival. Variables measured included subsequent morbidity, mortality, treatment response, ADG, and feed-to-gain (F:G) ratios. While initial morbidity and mortality are generally measured to determine efficacy of an on-arrival program, long-term growth and performance are also very important in determining the bottom-line effectiveness of a health management program.

Materials and Methods

Cattle

Crossbred steers (n=1,370) with an average weight of 626 lb (285.4 kg) (range 466 to 795 lb; 212 to 361 kg) were purchased from auction markets in central, southern, and eastern Texas by a single order-buying company. Steers were shipped by truck to a commercial feedlot located near Hereford, Texas and arrived between September 24, 2012 and October 12, 2012. Each truckload was kept separate upon arrival until randomization and administration of treatments was complete. Any animal deemed to be suffering from any illness, lameness or other condition that would adversely affect the outcomes of the study was removed and treated according to the standard feedlot protocol. A total of 18 truckloads of steers were received for the study with an average of 76 head per load (range 58 to 79). The steers were primarily Angus and/or Charolais breeds with less than 25% *Bos indicus* influence. Each load was in transit from the order-buying facility to the feedlot for approximately 8 to 10 hours. Weight shrinkage from pay-weight to off-truck weight at the feedlot averaged 3.8% (range 2.98% to 4.77%).

Processing

Following a rest period of at least 4 hours with ad libitum water and hay available, cattle were processed according to the feedlot's standard arrival processing protocol with the exception of the experimental treatments. Standard arrival processing included the following:

- individual visual identification ear tag;
- individual radio frequency identification tag;
- modified-live infectious bovine rhinotracheitis virus and bovine viral diarrhea virus vaccine[a] (2 mL) administered subcutaneously (SC) in left neck;
- *Clostridium chauvoei-septicum-novyi-sordellii-perfringens* types C and D bacterin-toxoid[b] (2 mL) administered SC in right neck;
- doramectin[c] (1 mL/110 lb (50 kg)) of body weight administered SC in left neck;
- trenbolone acetate (80 mg) and estradiol (16 mg) implant[d] administered SC in left ear;
- individual body weights were collected for purposes of calculating treatment dosages.

This pen-level study was performed as a randomized complete block design with each of the 3 treatments (tilmicosin, tildipirosin, tulathromycin) replicated twice within each block. Pen (within block) was the experimental unit. Within-arrival group (block) was made up of 3 truckloads of cattle, and cattle were randomly assigned, while in the chute, to 1 of 6 pens. Of those 6 pens, 2 pens were assigned to each treatment, 1 with a shed and 1 without a shed. Randomization was generated with SAS Release 9.2.[e]

The experimental treatments were as follows: 1) tilmicosin[f] (TLM; 4.5 mg/lb (10.0 mg/kg)), 2) tildipirosin[g] (TLD; 1.82 mg/lb (4.0 mg/kg)), or 3) tulathromycin[h] (TUL; 1.14 mg/lb (2.5 mg/kg)). All treatment injections were given SC in the lateral aspect of the right neck. Following processing and randomization procedures, each pen was weighed collectively on scales certified for trade by the state of Texas. The same scales were used to weigh each pen at re-implant

and at closeout prior to shipment. Weights obtained on these scales were used for measurements of weight gain.

Pens

Temporary receiving pens were of sufficient size to accommodate an entire truckload of cattle. Cattle were housed in these pens after off-loading until processing. Once processed and randomized to treatment, cattle were moved to the respective study pens. Open air, dirt-floor feedlot pens were used for the study, measuring 250 feet (76.2 meters) in depth and 45 feet (13.7 m) in width. A concrete feed bunk spanned the 45-feet (13.7 m) width of the pen with a 10-feet (3 m) wide concrete apron along the inside of the feed bunk to provide solid footing for the cattle when eating. Study pens held between 35 and 40 head, and were arranged in side-by-side fashion. Pens used for the study had feed bunks located on the west side of the pen and were all in the same alley. Half of the pens used for the study had a shed located on the north fence that had an 8-feet (2.4 m) tall by 70-feet (21.3 m) long windbreak constructed of highway guard rail that began 16 feet (4.9 m) behind the feed bunk and continued to the water tank. A shade was also provided in these same pens that was congruent with the windbreak and continued over the end of the water tank, making its total length 80 feet (24.4 m). The shades were 14 feet (4.3 m) wide and 10 feet (3 m) high on the south edge and 8 feet (2.4 m) on the north edge. Pens were served with hospital facilities of appropriate size to accommodate animal handling and treatment. The hospital is equipped with sorting facilities, hydraulic chute, and scales.

Animal health

Since each of the on-arrival treatments had differing pharmacokinetics, different post-metaphylaxis intervals (PMI) were used for the treatments. The PMI, the time period between when the calves received their on-arrival treatment and when they became eligible for retreatment, was as follows: 1) TLM = 3 days; 2) TLD = 10 days; and 3) TUL = 10 days.

All animals were observed daily throughout the entire study by experienced pen riders. Any animal observed to be abnormal was recorded by the pen rider and assigned a clinical appearance score (CAS) based on the following schedule:

0 = no BRD clinical signs. Calf is bright, alert, and responsive when approached. "0's" were not recorded unless the animal was noted to have a non-BRD malady.

1 = mild BRD. Calf shows signs typical of BRD until approached; calf brightens, moves readily, and appears normal when approached. Calf may be mildly depressed and a small amount of nasal and/or ocular discharge may be present.

2 = moderate BRD. Calf is showing obvious signs of BRD; when approached, calf does not brighten up and moves slowly and/or reluctantly. Calf is moderately depressed and may exhibit dyspnea, considerable nasal and/or ocular discharge, and coughing.

3 = severe BRD. Calf is showing severe signs of BRD; when approached calf stumbles or moves only with extreme prodding. Calf is severely depressed and may be anorexic and coughing with copious nasal discharge.

4 = calf is moribund (recumbent and not able or willing to rise or go to feed or water).

All pen riders, feeders or others making observations during the study were masked to treatments throughout the entire study. Masked individuals were not present during treatment administration, and they were never informed of what the study entailed. Since there were differences in PMI between treatments, the pen riders were given a list of pens with the dates that each pen was eligible to be pulled. As a point of discussion, it is possible that the pen riders were able to ascertain that the 3-day PMI pens may have been TLM; however, they were informed that the study could be related to vaccine or other possible differences.

Once the respective PMI had passed and a steer was observed to have a CAS ≥ 2, it was taken to the hospital for evaluation. The rectal temperature of calves pulled to the hospital was recorded, but was not used as part of the case definition. The treatment regimen used to treat steers deemed sick with BRD was as follows:

- first BRD treatment: ceftiofur crystalline free acid[i] (3 mg/lb (6.6 mg/kg)) given SC at the base of the left ear with a 7-day post-treatment interval (PTI);
- second BRD treatment: ceftiofur crystalline free acid[i] (3 mg/lb (6.6 mg/kg)) given SC at the base of the right ear with a 7-day PTI;
- third BRD treatment: danofloxacin[j] (3.63 mg/lb (8 mg/kg)) given SC on the lateral aspect of the left neck.

Steers were returned to their home pen after their first and second BRD treatments. Following the third BRD treatment, affected cattle were placed in a recovery pen with other study animals that also had received 3 BRD treatments; these cattle were never returned to their home pen. Cattle that died in these pens were recorded; however, none of the feed or head days were used in calculations of performance data. All cattle that died during the study were examined by necropsy to determine the cause of death. Necropsy examinations were conducted by experienced feedlot personnel or the attending veterinarian.

On day 71 ± 4, cattle were weighed and administered a growth promotant implant containing trenbolone acetate (120 mg) and estradiol (24 mg)[k] along with a modified-live IBRV vaccine.[l] Re-implant and re-vaccination procedures were conducted on all 6 pens within each block on the same day. Both individual and collective pen weights were obtained at this time.

At the completion of the study, all 6 pens within each block were harvested on the same day; all study pens were harvested at the same abattoir facility. Collective pen weights were obtained for each pen prior to shipment.

Measurements and calculations

The following formulas were used for calculation of ADG, average daily dry-matter intake (DMI), and F:G:

Deads-in:

$$\text{ADG} = \frac{(\text{closeout total pen weight} - 4\% \text{ shrink}) - (\text{initial total pen weight})}{\text{total head days of pen}}$$

$$\text{DMI} = \frac{(\text{total dry matter feed delivered for defined period})}{\text{total head days of pen}}$$

$$\text{F:G} = \frac{(\text{total dry matter feed intake of pen for defined period}}{(\text{closeout total pen weight} - 4\% \text{ shrink}) - (\text{initial total pen weight})}$$

Deads-out:

$$\text{ADG} = \frac{(\text{average closeout weight/hd for pen}) - (\text{average initial weight/hd for pen})}{\text{number of days-on-feed}}$$

$$\text{F:G} = \frac{\text{average daily DMI}}{\text{ADG}}$$

Head days were measured only on the number of cattle in the home pen. Hospital pens were not used unless the calf suffered from an illness other than BRD or if a calf received 3 BRD treatments, in which case it was retained in the hospital pen. Feed and head days were not included for cattle removed from the home pens.

Statistical analysis

This pen-level study was performed as a randomized complete block design with each of the 3 treatments (TLM, TLD, TUL) replicated twice within each block and pen (within block) as the experimental unit. The data were analyzed using an intent-to-treat approach.

General and generalized linear mixed models, for continuous and categorical response variables respectively, were used for all analysis using the Glimmix procedure in SAS[e] (ver. 9.4). Final models included fixed effects of treatment group and a random effect (intercept) for block in order to account for the design structure (i.e., lack of independence among pens within blocks). The potential for an interaction between treatment group and whether or not a pen had a shed available was investigated for all primary outcome variables by including fixed effects of treatment X shed, treatment, and shed; when no significant interactions were observed, the shed variables were removed. For repeated measures analyses of daily DMI data, effects of treatment, time, and the treatment by time interaction were evaluated, and an autoregressive covariance structure was used to account for the correlation of multiple observations on the same pen (within blocks) over time. Model-adjusted means and standard errors of the means are reported for all outcomes (back-transformed to the original scale for generalized models). When overall treatment effects tended to be significant ($P \leq 0.10$) pairwise comparisons were made, and significant differences were indicated when P values were ≤ 0.05.

Results and Discussion

Steers were harvested between April 11 and April 25, 2013; all cattle within each block were harvested on the same day. The number of head allocated per pen and average weight at allocation did not differ among treatment groups (Table 1). However, there were more steers per pen at re-implant time in the TUL group compared to the TLM and TLD groups (Table 1), which was also reflected by significantly lower mortality and lower chronicity in TUL-treated steers (Table 2). Similarly, Rooney and colleagues reported increased treatment success in steers treated on-arrival with tulathromycin compared to steers treated on-arrival with tilmicosin.[5]

Across all blocks, re-implant day ranged between 68 and 75 DOF, with an average of 71.8 d; all cattle within a block were re-implanted on the same day. Treatment group means for bodyweight (BW), ADG, and F:G at re-implant time are shown in Table 1. At re-implant, the TLD- and TUL-cattle were heavier (14.3 and 11.5 lb (6.5 and 5.2 kg), respectively) as compared to the TLM group (Table 1). Average daily gain (deads in) through re-implant was 1.24 and 1.33 lb (0.56 and 0.60 kg) greater (P values < 0.05) in the TUL group compared to either the TLM and TLD groups, respectively (Table 1). Average daily gain in TLD and TUL cattle on a deads-out basis was at least 0.16 lb (0.073 kg) greater than the TLM group (P values < 0.05; Table 1). There was no treatment effect on 71-d cumulative DMI or F:G (Table 1); however, daily DMI during the first 30 DOF differed significantly ($P = 0.02$) by treatment group (Figure 1). There was no evidence of a treatment-by-time interaction, but daily DMI did differ significantly over time (DOF) as expected ($P < 0.01$). Mean daily DMI during the first 30 DOF for the TUL group (12.69 lb (5.76 kg)/hd/d) was higher ($P < 0.01$) than the mean for the TLD group (11.85 lb (5.38 kg)/hd/d). However, the mean DMI for the TLM group (12.28 lb (5.57 kg)/hd/d) did not differ from the means of either the TUL ($P = 0.15$) or TLD ($P = 0.13$) groups.

Health outcomes by treatment group at re-implant time are shown in Table 2. Cumulative BRD morbidity (first treatment) was different among groups ($P < 0.01$), with the TUL group cattle having fewer BRD events than the TLD and TLM groups. Cattle administered TUL on arrival had 26.6% BRD morbidity while the TLM and TLD groups had 50.4 and 40.9% BRD morbidity, respectively. Although re-treatment risk showed the same numerical trend, there were no differences among treatment groups. The mean percent of BRD chronics (treated for BRD ≥ 3 times) was lower (P values < 0.05) for steers in the TUL group than both TLM and TLD groups (2.17 vs 10.58 and 8.71, respectively; Table 2).

There was an overall treatment effect on BRD mortality at re-implant, with the pairwise comparisons indicating that TUL-treated cattle had lower (P values < 0.05) BRD mortality

Table 1. Model-adjusted means* (SEM) for allocation and re-implant performance by treatment group†, and *P* values for assessing the overall treatment effects.

Item	TLM	TLD	TUL	(SEM)	*P* value
Number of steers (pens) allocated	458	456	456	(12)	-
Mean number allocated per pen	38.17	38.00	38.00	(0.65)	0.42
Initial body weight, lb	607.9	610.4	606.7	(3.52)	0.67
Mean head per pen at re-implant	33.25[a]	32.33[a]	36.58[b]	(0.98)	< 0.01
Re-implant body weight, lb	866.8[a]	881.1[b]	878.3[b]	(6.81)	0.04
Re-implant deads-in ADG, lb	2.07[a]	1.98[a]	3.31[b]	(0.24)	< 0.01
Re-implant deads-out ADG, lb	3.60[a]	3.76[b]	3.78[b]	(0.08)	0.05
Re-implant dry matter intake, lb/hd	15.80	15.63	16.54	(0.40)	0.24
Re-implant F:G deads-in, lb	10.09	5.84	5.04	(2.32)	0.26
Re-implant F:G deads-out, lb	4.40	4.18	4.38	(0.13)	0.43

*From statistical analyses that account for the lack of independence among pens within blocks
†TLM, TLD, TUL = tilmicosin (Micotil®), tildipirosin (Zuprevo®), and tulathromycin (Draxxin®), respectively
[a,b]Means with different superscript letters, within rows, differ significantly ($P \leq 0.05$) by pairwise comparisons

Table 2. Model-adjusted means* (SEM) for health data at re-implant by treatment group†, and *P* values for overall effect of treatment.

Item	TLM	TLD	TUL	*P* value
BRD morbidity, %	50.43[a] (3.56)	40.93[b] (3.47)	26.58[c] (2.95)	< 0.01
BRD re-treatment risk‡, %	42.09 (5.12)	37.09 (5.18)	28.95 (5.37)	0.21
Chronics#, %	10.58[a] (1.95)	8.71[a] (1.72)	2.17[b] (0.74)	< 0.01
BRD mortality, %	3.86[a] (1.22)	4.04[a] (1.27)	1.45[b] (0.64)	0.09
Overall mortality, %	4.70[a] (1.35)	5.09[a] (1.43)	1.46[b] (0.63)	0.03

*From statistical analyses that account for the lack of independence among pens within blocks
†TLM, TLD, TUL = tilmicosin (Micotil®), tildipirosin (Zuprevo®), and tulathromycin (Draxxin®), respectively
‡Percent of BRD cases that were retreated
#Percent of cattle that were treated 3 times for BRD
[a,b]Means with different superscript letters, within rows, differ significantly ($P \leq 0.05$) by pairwise comparisons

(1.45%) than both the TLM (3.86%) and TLD (4.04%) groups (Table 2). Overall mortality was also lower (*P* values < 0.05) for the TUL group (1.46%) as compared to the TLM (4.70%) and TLD (5.09%) groups (Table 2).

By closeout, 563 of all 1,370 (41.09%) steers were treated for BRD, and 38.01% were retreated for BRD (214 of 563). Mean BRD morbidity differed ($P < 0.01$) among treatment groups, with fewer TUL steers treated for BRD than those in the TLM and TLD groups (28.7 vs 52.0 and 42.2%), respectively (Table 3). Re-treatment risk followed a similar numerical trend, but treatments did not differ (Table 3). Steers treated with TUL on arrival had fewer (*P* values < 0.05) chronics (2.8%) than did steers administered TLM (11.7%) or TLD (8.9%); however, the percent chronics did not differ between the TLM and TLD steers (Table 3).

A total of 71 steers died (5.18%), with 58 (4.23%) dying of BRD. The mean percent BRD mortality and overall mortality at closeout were lower (*P* values < 0.05) for TUL than for TLD cattle (Table 3). TUL-treated steers had 1.86% BRD mortality and an overall mortality of 2.49%, while TLD steers had a BRD mortality of 5.98% and an overall mortality of 7.08%. Mortality in TLM-treated steers did not differ from the other 2 groups. In a study by Bartram et al,[1] dairy calves were experimentally challenged with *Mycoplasma bovis*. Calves showing clinical signs of BRD were randomly assigned to either tulathromycin or tildipirosin treatment protocols. Following a 14-day period, tulathromycin-treated calves had lower mortality and increased body weight gain compared to calves treated with tildipirosin.

Live performance through close-out is shown in Table 4. The total mean DOF for all pens in the study was 197 d (range 195 to 199), and mean live out-weight was 1,264 lb (573 kg). Mean final live bodyweight did not differ by treatment group (Table 4). Due to differences in overall mortality and chronicity, mean number of cattle harvested per pen was higher (*P* values < 0.05) for TUL-treated steers than in other treatment groups (Tables 3 and 4). TUL-treated steers also gained more on a deads-in basis than those in the other groups ($P < 0.01$; Table 4). At closeout, ADG by TUL-cattle (deads-in basis) was 0.55 and 0.56 lb (0.249 and 0.254 kg)/day more than the TLM or TLD steers (*P* values < 0.05; Table 4). Mean DMI and deads-out F:G did not differ among treat-

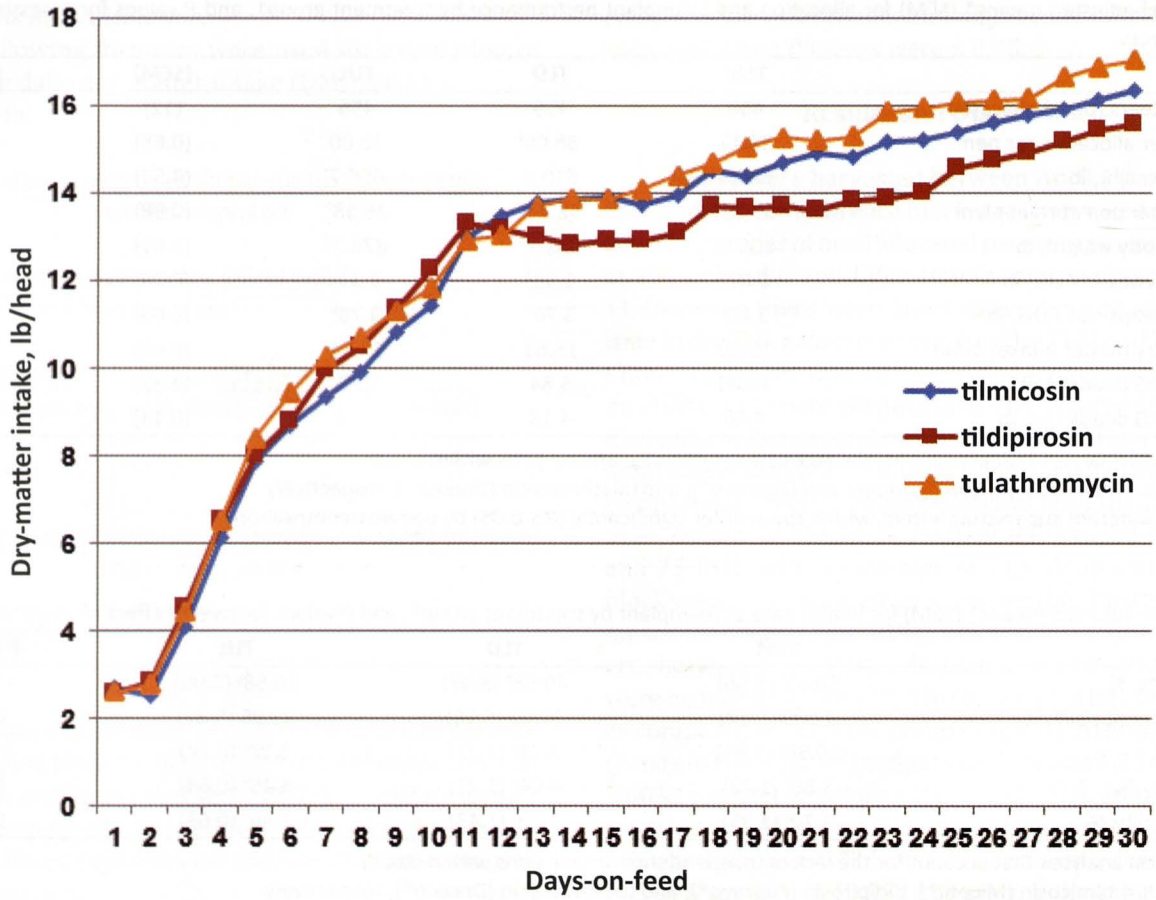

Figure 1. Model-adjusted means* for daily dry-matter intake per head by days-on-feed (DOF) for each treatment group**, indicating the significant mean effect of treatment during the first 30 DOF.
*From statistical analyses that account for repeated measures and the lack of independence among pens within blocks
**tilmicosin = Micotil®, tildipirosin = Zuprevo®, tulathromycin = Draxxin®

Table 3. Model-adjusted means* (SEM) for health data at closeout by treatment group†, and *P* values for overall effect of treatment.

Item	TLM	TLD	TUL	*P* value
BRD morbidity, %	51.97[a] (3.75)	42.21[b] (3.68)	28.70[c] (3.21)	< 0.01
BRD re-treatment risk‡, %	42.98 (5.04)	38.32 (5.14)	29.59 (5.24)	0.15
Chronics#, %	11.66[a] (2.09)	8.90[a] (1.76)	2.80[b] (0.86)	< 0.01
BRD mortality, %	4.12[a,b] (1.23)	5.98[a] (1.60)	1.86[b] (0.72)	0.03
Overall mortality, %	5.20[a,b] (1.37)	7.08[a] (1.70)	2.49[b] (0.85)	0.03

*From statistical analyses that account for the lack of independence among pens within blocks
†TLM, TLD, TUL = tilmicosin (Micotil®), tildipirosin (Zuprevo®), and tulathromycin (Draxxin®), respectively
‡Percent of BRD cases that were re-treated
#Percent of steers that were treated 3 times for BRD
[a,b,c]Means with different superscript letters, within rows, differ significantly ($P \leq 0.05$) by pairwise comparisons

ment groups (Table 4). However, on a deads-in basis F:G was at least 1.33 lb (0.60 kg) better for TUL steers than for the other 2 treatments (Table 4).

Carcass data are shown in Table 5. A total of 1,199 head were harvested; however, due to demands made by the abattoir facility, no outside personnel were allowed access to the facility for carcass data collection, thus carcass data were provided by the abattoir employees. Problems with identification of carcasses resulted in only receiving limited carcass data on 1,097 head, with an overall average hot carcass weight (HCW) of 806 lb (366 kg) across all treatments. Quality grade and USDA yield grade information were only available on 1,094 head. Seventy-one head died during the study, which accounts for 1,270 head. The remaining 100

Table 4. Model-adjusted means* (SEM) for final live performance through closeout by treatment group†, and *P* values for assessing the overall treatment effects.

Item	TLM	TLD	TUL	(SEM)	*P* value
No./pen harvested	32.42[a]	31.75[a]	36.08[b]	(1.01)	< 0.01
Final live body weight, lb	1,257.8	1,268.6	1,265.9	(7.22)	0.42
Deads-in ADG, lb	2.57[a]	2.56[a]	3.12[b]	(0.12)	< 0.01
Deads-out ADG, lb	3.30	3.34	3.35	(0.03)	0.41
Dry matter intake/head, lb	18.66	18.83	19.00	(0.47)	0.88
F:G deads-in	7.43[a]	7.61[a]	6.10[b]	(0.35)	< 0.01
F:G deads-out	5.66	5.64	5.67	(0.15)	0.98

*From statistical analyses that account for the lack of independence among pens within blocks
†TLM, TLD, TUL = tilmicosin (Micotil®), tildipirosin (Zuprevo®), and tulathromycin (Draxxin®), respectively
[a,b]Means with different superscript letters, within rows, differ significantly ($P \leq 0.05$) by pairwise comparisons

Table 5. Carcass performance data at harvest by treatment group*, and *P* values for assessing the overall treatment effects.

Item	TLM	TLD	TUL	*P* value
No. carcass data (number allocated)	367 (458)	349 (456)	381 (456)	
Mean hot carcass weight (SEM)†, lb	800.65 (4.81)	809.94 (4.88)	809.30 (4.78)	0.33
Grade, count (% of treatment group)				0.12
Choice	133 (36.54)	101 (28.94)	127 (33.33)	
Select	213 (58.52)	215 (61.60)	231 (60.63)	
No-roll	18 (4.95)	33 (9.46)	23 (6.04)	
USDA Yield Grade, count (% of treatment group)				0.82
1	51 (14.01)	49 (14.04)	49 (12.86)	
2	147 (40.38)	137 (39.26)	165 (43.31)	
3	129 (35.44)	113 (32.38)	127 (33.33)	
4	34 (9.34)	43 (12.32)	39 (10.24)	
5	3 (0.82)	7 (2.01)	1 (0.26)	

*TLM, TLD, TUL = tilmicosin (Micotil®), tildipirosin (Zuprevo®), and tulathromycin (Draxxin®), respectively
†From statistical analyses that account for the lack of independence among pens within blocks

head were cattle considered BRD chronics that survived, but were harvested at a later date. Unfortunately, individual carcass weights and carcass data on these cattle could not be collected. Quality and yield grade distributions, as well as HCW means, were not different among treatments (Table 5). Similarly, Skogerboe et al reported no difference in carcass characteristics of heifers and steers treated on arrival with either tulathromycin or tilmicosin.[6]

Booker and associates reported similar results when comparing tulathromycin with tilmicosin at a western Canadian feedlot, showing tulathromycin administered on-arrival resulted in lower BRD morbidity, chronics, and mortality, as well as improved ADG as compared to cattle treated on arrival with tilmicosin.[2] Nickell et al reported in a smaller study that tulathromycin given on-arrival also resulted in lower BRD morbidity, chronics, and mortality along with improvements in ADG, DMI, and F:G as compared to cattle administered tilmicosin.[4] In 2013 Van Donkersgoed and Merrill reported that cattle treated with tildipirosin on-arrival had lower BRD morbidity than steers treated with tilmicosin; however, no other significant differences were observed.[9]

Conclusion

Results of this study are in agreement with other studies comparing tulathromycin and tilmicosin administered on arrival, and provided new insight to comparisons with tildipirosin. In this study, high-risk steers administered tulathromycin during arrival-processing had lower BRD morbidity, BRD chronics, BRD mortality, and overall mortality at re-implant (71 ± 4 d post-treatment) than steers receiving tilmicosin or tildipirosin at arrival. Although BRD mortality and overall mortality for tilmicosin-treated cattle did not differ significantly from the other 2 groups at closeout (197 ± 3 d), in general, differences in health outcomes at closeout were similar to those at re-implant. In addition, steers treated with tulathromycin had higher deads-in ADG and lower deads-in F:G at closeout than steers treated with tilmicosin or tildipirosin.

Endnotes

[a]Bovi-Shield Gold® IBR-BVD, Zoetis Animal Health, Florham Park, NJ

[b]Ultrachoice® 7, Zoetis Animal Health, Florham Park, NJ
[c]Dectomax® Injectable, Zoetis Animal Health, Florham Park, NJ
[d]Component® TE-IS, Elanco Animal Health, Indianapolis, IN
[e]SAS Institute, Cary, NC
[f]Micotil® 300, Elanco Animal Health, Indianapolis, IN
[g]Zuprevo™ 18%, Merck Animal Health, Madison, NJ
[h]Draxxin® Injectable Solution, Zoetis Animal Health, Florham Park, NJ
[i]Excede® Sterile Suspension, Zoetis Animal Health, Florham Park, NJ
[j]Advocin®, Zoetis Animal Health, Florham Park, NJ
[k]Component® TE-S, Elanco Animal Health, Indianapolis, IN
[l]Bovi-Shield® IBR, Zoetis Animal Health, Florham Park, NJ

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