The effect of tilmicosin administered to ewes prior to lambing on incidence of clinical mastitis and subsequent lamb performance

Ann Croft, Todd Duffield, Paula Menzies, Ken Leslie, Randy Bagg, Paul Dick

Abstract — The effect of tilmicosin on the incidence of clinical mastitis and subsequent lamb performance was studied in 9 sheep flocks in Ontario. Ewes were treated randomly with either tilmicosin or placebo approximately one month prior to lambing. Outcome was assessed by comparing rates of clinical mastitis, palpable udder abnormalities, and preweaning (50-day) lamb weights between the 2 treatment groups, while controlling for other important variables. Lambs raised by multiparous ewes treated with tilmicosin were significantly heavier than lambs from placebo-treated multiparous ewes at 50 days. Lambs from tilmicosin-treated ewes were on average 0.52 kg heavier than lambs in the placebo group. There was no difference between treatment groups in the weight of lambs from first parity ewes. Tilmicosin treatment resulted in a 43% decrease in palpable udder abnormalities. Incidence of clinical mastitis did not differ between experimental groups. The administration of tilmicosin prelambing, at the time of routine clostridial disease vaccination, may be a beneficial and convenient way to reduce mastitis infection and improve the preweaning gain of lambs.

Résumé — Influence de la tilmicosine administrée à des brebis avant l'agnelage sur l'incidence de la mammite clinique et sur les rendements subséquents des agneaux. L'influence de la tilmicosine sur l'incidence de la mammite chronique et le rendement subséquent des agneaux ont été étudiés chez 9 troupeaux de moutons de l'Ontario. Les brebis ont été traitées au hasard avec de la tilmicosine ou un placebo, environ un mois avant l'agnelage. Les résultats ont été évalués en comparant les taux de mammite clinique, les anormalités mammaires palpables et le poids des agneaux avant le sevrage (50 jours) entre les 2 groupes expérimentaux tout en maîtrisant d'autres variables importantes. À 50 jours, les agneaux élevés par les brebis multipares traitées à la tilmicosine étaient significativement plus lourds que les agneaux des multipares ayant reçu un placebo. Les agneaux des brebis traités à la tilmicosine pesaient en moyenne 0,52 kg de plus que ceux du groupe placebo. Il n'y avait pas de différence entre les 2 groupes expérimentaux dans le poids des agneaux provenant de brebis primipares. Le traitement à la tilmicosine s'est traduit par une baisse de 43 % des anormalités palpables du pis. L'incidence des mammites cliniques n'a pas varié entre les groupes expérimentaux. L'administration de tilmicosine avant l'agnelage, au moment de la vaccination de routine contre les infections à *Clostridium*, peut être un moyen efficace et pratique de réduire les infections du pis et d'accroître le poids des agneaux en présevrage.

(Traduit par docteur André Blouin)

Can Vet J 2000;41:306–311

Introduction

Mastitis is an economically important disease for sheep producers, due to premature culling of ewes with udder abnormalities and reduced lamb performance (1–3). Prevalence of subclinical mastitis ranges from 4% to 50% in lactating ewes (4), with infection by coagulase-negative staphylococci being the most common. *Pasteurella haemolytica* and *Staphylococcus aureus* are the most common isolates from clinical mastitis cases (4). Mastitis has an adverse effect on milk production. One study found that ewes with mastitis produced 19.7% less milk than did uninfected ewes (5). In another study, ewes experimentally infected with a coagulase-negative staphylococcus (*S. simulans*) produced 22.8% to 37.3% less milk than did the non-infected control animals, depending on time of inoculation (6). In the same study, lambs from the infected ewes had significantly poorer growth and consumed 4.1 kg of creep feed, while lambs from the control ewes consumed 3.2 kg of creep feed (6). In the 2nd year of a 3-year study, lambs from infected ewes had a 10% decrease in average daily gain as compared with lambs nursing uninfected ewes (2). Intake of creep feed was limited in that 2nd year due to the physical form and palatability of the feed. However, in the 1st and 3rd years of the study, adequate creep feed intake may have overcome the effects of intramammary infection (2). In a recent study, somatic cell count (SCC) had a significant effect on average

Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, Ontario N1G 2W1 (Croft, Duffield, Menzies, Leslie); Provel, a Division of Eli Lilly Canada Inc., Research Park Centre, 150 Research Lane, Suite 120, Guelph, Ontario N1G 4T2 (Bagg, Dick).

Address correspondence to Dr. Todd Duffield.

Reprints are not available.

This project was generously supported by Provel, a division of Eli Lilly Canada Inc.

Table 1. Descriptive flock characteristics, ewe enrolment, lambs born, and lambs completing trial

Flock	Location in Ontario	Breed	Lambing system	No. ewes treated	No. ewes lambed	No. lambs born	No. lambs 50-day weight	Bottle-fed lambs		No. lambs on trial
								50-day weight	No 50-day weight	
A	Eastern	NCC, Hampshire	annual	47	36	69	58	0	0	58
B	Southwestern	Suffolk	annual	34	20	33	27	4	1	23
C	Eastern	Polled Dorset, Oxford	annual	27	27	40	33	2	0	31
D	Southwestern	Suffolk	annual	63	49	78	75	0	0	75
E	South central	Rideau Arcott	accelerated	250	236	536	430	0	0	430
F	Northern	Large crossbreds	annual	79	78	186	160	15	9	145
G	South central	Rideau Arcott	accelerated	73	71	142	133	0	0	133
H	Southwestern	Rideau, Poly, crossbreds	accelerated	280	218	461	401	62	21	339
I	Eastern	Horned Dorset, Suffolk	annual	55	52	85	68	5	0	63
Totals				908	787	1630	1385	88	31	1297

NCC — North Country Cheviot; Poly — Polypay

50-day weights of lambs (7). Independent of culture status, each increase of 100 000 cells/mL in SCC decreased the 50-day lamb weights by 0.24 kg. For ewes infected with a major pathogen, a decrease in 50-day lamb weights by 0.36 kg was observed for every 100 000 cells/mL increase in SCC (7). For ewes infected with any pathogen, the decrease in weight was 0.21 kg for every 100 000 cells/mL increase in SCC (7). This study determined that inflammation in the udder was a better indicator for changes in lamb growth than were milk culture results (7).

Various treatments of ovine mastitis have been studied. Intramammary therapy with spiramycin and neomycin (8) and cephapirin benzathine (1,3) administered at weaning have resulted in significant cure rates for existing infections and prevented new infections. Also, treatment with spiramycin and neomycin significantly reduced the SCC after lambing (8). Intramuscular (IM) injection of benzathine penicillin resulted in similar positive effects compared with treatment with intramammary cephapirin benzathine (3). Another study showed that a prophylactic IM injection of penicillin at weaning was effective both for reducing incidence of mastitis, as well as reducing the loss of milk production capacity (5).

Tilmicosin recently received label approval in Canada for the treatment of pneumonia in lambs. This macrolide antibiotic is known to concentrate in the mammary gland and is effective against both *Pasteurella* spp. and *Staphylococcus* spp. Other therapeutic regimens for the treatment and prevention of mastitis in the dry period have not been well adopted by the sheep industry, due to inconvenience and the length of the dry period. A subcutaneous (SC) injection of tilmicosin 1 mo prior to the first date of the expected lambing season, at the time of clostridial vaccination, could be a readily adopted management procedure in the sheep industry.

Given these properties of tilmicosin and the significance of mastitis on lamb growth, it was hypothesized that there would be a positive response to tilmicosin treatment, as evidenced by a decrease in clinical mastitis and improved lamb performance. Furthermore, a decrease in premature culling of ewes might be expected, due to improved udder health. These treatment effects would provide sufficient economic gain to support adoption by the sheep industry. The objectives of this project were to study the effect of tilmicosin treatment prior to lambing on the incidence of clinical mastitis during lactation and palpable abnormalities of the mammary glands, and to measure the effect of tilmicosin treatment prior to lambing on lamb 50-day weights.

Materials and methods

Study flocks and experimental animals

Nine sheep flocks in Ontario were used. The winter and spring lambing groups were included, and both annual and accelerated lambing systems (more than one lambing per year) were involved in the trial. Table 1 shows descriptive characteristics of the flocks, ewe enrolment, and lamb information. A total of 908 ewes were included. Both primiparous ewe lambs and multiparous ewes were enrolled on the experiment.

Enrolment and treatment protocol

Ewes were enrolled in the study at the time of clostridial vaccination or shearing, approximately 1 mo prior to lambing. Ewes were treated with either tilmicosin (Micotil, 300 mg/mL, Provel, a Division of Eli Lilly Canada, Guelph, Ontario) or a placebo. Individual treatment vials, needles, and syringes were provided to the producers; they were identified only by flock name and vial number. A repeating random order of tilmicosin and placebo vial numbers was generated, and the vials were numbered sequentially, allowing treatment to be randomly allocated to the ewes. The dosage of tilmicosin is 10 mg/kg bodyweight (BW) (or 1.5 mL/100 lbs BW). Most animals received between 2.6 mL and 3.4 mL of solution, as determined by the producer. The placebo solution was prepared by aseptically mixing 25% propylene glycol (Propylene Glycol U.S.P., Fisher Chemicals, Don Mills, Ontario) and 75% sterile water in 100-mL bottles. A light yellow color was achieved by adding 300 mg of oxytetracycline (Liquamycin-LP, 100 mg/mL, Pfizer, London, Ontario) to each 100-mL bottle of placebo solution. This resulted in both tilmicosin and placebo vials being yellow in color, ensuring that the producers were blinded to the treatment being given.

This study was conducted under an experimental studies certificate (ESC) authorized by the Bureau of Veterinary Drugs. The requirements for this ESC stated that ewes should be treated with tilmicosin at least 28 d prior to lambing and these treated animals could not be

Table 2. Method to establish "total mastitis" based on udder scores at treatment and weaning and clinical mastitis

Udder score at treatment[a]	Clinical Mastitis[b]	Udder score at weaning[a]	Total Mastitis[c]
0	0	0	0
1	0	1 (same side)	0
2	0	2	0
1	0	0	0
2	0	0	0
any[d]	1	any	1
0	0	1	1
0	0	2	1
1	0	2	1
1	0	1 (other side)	1

[a]At the time of treatment and weaning, the udder of each ewe was scored by palpation according to the scale: 0 — normal on both sides; 1 — abnormal on one side; 2 — abnormal on both sides

[b]Throughout the duration of the study, ewes were observed for illness. The occurrence of clinical mastitis was recorded as: 0 — did not occur; 1 — did occur

[c]A category of Total Mastitis was established to include ewes that had changes in udder score between treatment and weaning, but no reported case of clinical mastitis. This category also included ewes with clinical mastitis. The occurrence of Total Mastitis was coded as: 0 — not present; 1 — present

[d]any — an udder score of 0 or 1 or 2

slaughtered for food less than 28 d posttreatment. In Canada, use of tilmicosin in sheep is currently approved only for the treatment of pneumonia in lambs weighing greater than 15 kg. Use of tilmicosin in ewes prior to lambing to reduce udder inflammation constitutes an extra label application of this product.

The ewe tag identification (ID), vial number, and volume administered were recorded on supplied treatment forms. The solution was injected SC, either behind the elbow in the region of the axilla, between the shoulders on the back, or on the neck. The udder was palpated at this time and assessed as normal or abnormal.

Outcome data collection

Lamb weight

Lambs were raised under conditions normally practised for each flock, with some lambs fostered onto other ewes or bottle fed. The producer weighed the lambs at 50 d, according to the Sheep Flock Improvement Program (SFIP) requirements (lambs between 28 and 69 d of age). Lamb data were collected from SFIP reports, since most producers routinely submit their lamb weights to the SFIP, making this a convenient method of collecting lamb weights.

Clinical mastitis

Ewes were monitored for clinical mastitis by the owners at lambing and through lactation. Clinical mastitis cases were treated, as necessary, by the producer and recorded.

Udder abnormalities

Udder scoring was done by each producer at the time of enrolment. The assessment was either normal or abnormal for each udder half on palpation. An udder score of 0 was given if normal on both sides; a score of 1, if abnormal on one side; and a score of 2, if abnormal on both sides. Flocks A, C, F, and I had the udders scored again at weaning. Flock G had recorded abnormal udders at weaning, so that ewes with no score at weaning were considered to be normal.

Producer udder scores were used to establish a category of mammary infection that included ewes with udder changes between treatment and weaning without a reported case of clinical mastitis, as well as ewes with clinical mastitis. This category was called "Total Mastitis." Table 2 shows the method of determining total mastitis scores. A score of 0 was given if the ewe had no changes in the udder from the time of treatment to weaning. A score of 0 was also given if the udder was abnormal at treatment time and normal at weaning, since the status of mastitis was unknown, although these animals could be potential cures. A score of 1 was given if the ewe had a reported case of clinical mastitis, or if there was a change towards abnormal for the udder score.

Milk samples

Flocks B, D, and F had composite milk samples collected at lambing. Each teat was cleansed with alcohol swabs, and milk was collected as soon after lambing as possible. Alcohol swabs and milk vials were provided to the producer. The samples were labeled with the ewe identification and flock, and placed in the freezer. After all the lambings were complete, the samples were collected and sent to the University of Guelph, where they were kept frozen at −20°C until cultured. A total of 109 of a possible 176 milk samples were collected. The samples were thawed at room temperature and cultured in 2 batches on blood and MacConkey agars.

Data management

The data were managed by using a spreadsheet program and a database (Microsoft Excel, Microsoft Access, Microsoft Corporation, Seattle, Washington, USA). Spreadsheets were developed for both the lamb and ewe data. Lamb data included information on lamb ID, sex, breed, birthdate, sire, dam, "born as" multiple, "raised as" multiple, 50-day weight, date weighed, age at 50-day weight, and disposal code. "Born as" and "raised as" refer to lambs being born or raised as singles, twins, triplets, etc. Lambs were included in the data set if their dam was enrolled on the study, if they were raised by an enrolled ewe, and if they had a 50-day weight. Foster lambs were also included, with the foster ewe recorded as their dam. Bottle fed lambs were not included on the trial.

Ewe data included information on ewe ID, flock, accelerated or annual lambing system, vial number, treatment, dose (mL), age of ewe, breed of ewe, treatment date, number of days from treatment to lambing, and udder score information. Lambing date, number of lambs born, number of lambs on the trial, outcome of the lamb(s), milk sample collected, and culling or death of the ewe were also included in the ewe data set. Ewes were included in the data set if they were treated and lambed. Ewes that lambed but whose lambs died before the 50-day weight were also included, as well as ewes that died after lambing. A separate milk culture spreadsheet included ewe ID, flock, vial number, treatment, organism, and number of colonies.

Statistical analysis

For the lamb data, differences between treatment groups for 50-day weights were evaluated by analysis of variance by using the mixed procedure in SAS (SAS Institute, Cary, North Carolina, USA). Variables considered for each model included lamb and flock level factors related to lamb weight differences. The model considered the fixed effects of lamb sex, breed, raised as, clinical mastitis, total mastitis, accelerated/annual lambing system, days from treatment to lambing, age of lamb at 50-day weight, age of ewe, and udder score at treatment. Flock and ewe ID were included as random effects to account for any correlation between lambs raised by the same ewe, and for ewes within the same flock. A backward stepwise elimination procedure was used to test significant fixed effects by using a cut-off of $P \leq 0.05$. All possible 2-way interactions with treatment were tested with the significant variables that were remaining. The final model included the variables breed, raised as, sex of lamb, age of lamb at 50-day weight, and udder score at treatment. Age of ewe was removed, since the analysis was stratified by young and old ewes.

The mammary gland data were divided into clinical mastitis, abnormal udders, and total mastitis. Clinical mastitis included only the recorded cases of mastitis. Abnormal udders included only the changes recorded in the udder, excluding clinical mastitis cases. Total mastitis included both abnormal udders and the clinical cases. All mastitis outcomes were screened by using 2 by 2 tables to test the effect of treatment on udder health. Any variables that were significant ($P \leq 0.05$) were then included in the logistic regression analysis. Logistic models were built with mastitis as the binary outcome and treatment as the binary variable of interest. Dummy variables for breed were created for the Rideau and Suffolk breeds, and for crossbreds, with all other breeds forming the base group. Dummy variables for udder score at treatment were created for abnormal on one side and abnormal on both sides, with normal udders forming the base group. Age of ewe, accelerated/annual lambing system, breed of ewe, udder score at treatment, and flock were included in the regression model as potential confounding or explanatory variables. Each model was built by using a backward stepwise elimination procedure, with $P < 0.05$ as the cut-off. All logistic regression models were then submitted to final logistic analysis by using the generalized estimation equation (GEE) to control for disease clustering by flock (9).

Relative to the milk culture data, differences between treatment groups for organism and number of colonies were assessed by using simple tables. Since the results appeared virtually identical between treatments, no further analysis was conducted.

Results

Seven hundred and eighty-seven ewes and 1297 lambs were enrolled in the project. Of the 908 ewes that were treated, 787 ewes lambed, producing 1630 lambs. Table 1 shows the ewe enrolment and lamb information. Of the 245 lambs with no 50-day weights, 141 were mortalities and 104 lambs did not have a recorded weight. This may be an underestimate of the mortality numbers, since producers were not specifically requested to record this information.

Among a range of breeds included in the study, Rideau Arcotts and crossbreds were the most common. There was even distribution of lamb by breed, by sex, and across treatment groups. There were 560 male lambs, 667 female lambs, and 70 wether lambs. Flock F was the only flock upon which early castration was practised and that had wether lambs on the study. The distribution of lambs "raised as" ranged from singles to quintuplets, with 67% of lambs raised as twins and 16% raised as triplets. The 50-day lamb weight data were normally distributed for both treatment groups. On a raw basis, the average weight of the tilmicosin-treated lambs (19.71 kg) was slightly more than the placebo-treated lambs (19.58 kg). The age of lambs at the time when 50-day weight was measured ranged from 28 to 69 d, with most between 46 and 66 d of age at weighing, with a 53.5 d average.

Breed of ewe was evenly distributed across treatment groups, with an average ewe age of 3.8 y. There were 393 tilmicosin-treated ewes with an average age of 3.75 y, and 394 placebo-treated ewes with an average age of 3.85 y. Singles, twins, and triplets were raised by 25%, 57%, and 9% of ewes, respectively.

Lamb data

The model to test treatment effect on 50-day weight included breed of lamb, raised as, sex of lamb, age of ewe, age of lamb at 50-day weight, and udder score at treatment. The significance level for the treatment effect was $P = 0.056$. The least squares means of 50-day weights for lambs from tilmicosin-treated and placebo-treated ewes were 20.05 kg and 19.62 kg, respectively. In the final model, the ewes were divided by age, since it was reasoned that primiparous ewes were unlikely to have an existing intramammary infection. Although parity information was not available, the ewes were classified as young, if 1 y of age (105 ewes), or old, if > 1 y of age (619 ewes). However, some of the 2-year-old ewes were possibly lambing for the first time. The results of this final model are presented in Table 3 and Table 4. There was a significant ($P = 0.034$) effect of treatment with tilmicosin prior to lambing in the older ewes. There was a +0.52 kg/lamb advantage at 50 d with tilmicosin treatment in older ewes after controlling for the effects of flock, breed, raised as, sex of lamb, age of lamb at 50-day weight, and udder score at treatment. However, the 105 young ewes showed no significant effect of tilmicosin treatment.

Ewe data

The mastitis data were divided into clinical mastitis, abnormal udders, and total mastitis. The incidence of each category by treatment is presented in Table 5. The logistic regression model used to evaluate each mastitis category included the variables, treatment, age of ewe, accelerated or annual lambing system, breed class, and udder score at treatment. The P values and odds ratios for the effect of tilmicosin treatment in each mastitis category are shown in Table 6. Clustering

Table 3. Final lamb weight model stratified by ewe age

Type of variable	Variable	*P* value	
		Ewes = 1 y old	Ewes > 1 y old
Fixed effects	Treatment	0.4950	0.0343
	Breed of lamb	0.9872	0.0001
	Raised as	0.0001	0.0001
	Sex of lamb	0.0010	0.0001
	Age of lamb at 50-day weight	0.0001	0.0001
	Udder score at treatment	0.1679	0.0204
Random effects	Ewe	0.1886	0.0001
	Flock	0.6487	0.1379

Table 4. Least squares means for lamb 50-day weights by treatment group (ewes > 1 y old)

Treatment	Least squares means[a]	Standard error
Tilmicosin	20.39	0.734
Placebo	19.87	0.738

[a]Significant at $P < 0.05$

of mastitis by flock was controlled in the final GEE model.

Composite milk samples from 109 ewes were submitted and cultured, with 13 samples (12%) contaminated, 70 samples (65%) that showed coagulase-negative *Staphylococcus* spp. and 16 samples (15%) that had no growth. Gram-positive organisms, *Escherichia coli*, and other streptococci (not *S. agalactiae*) made up the remainder of the cultures (8%). For each organism, there were no differences in numbers of colony forming units between the 2 treatment groups. Based on these culture results, no further analysis was conducted on the milk culture data.

Discussion

There was a significant positive effect of tilmicosin treatment prior to lambing on the 50-day weight of lambs from ewes older than 1 y. Since mastitis is an economically important disease of sheep, causing premature culling of ewes and reduced lamb performance, this effect is of great interest when studying control strategies for ovine mastitis. By administering the treatment prior to lambing, the effect was aimed at reducing existing inflammation in the udder. Therefore, it is reasonable to expect that the treatment would have a greater impact in multiparous ewes than in primiparous ewes, since ewe lambs are less likely to have been exposed to meaningful risk factors for a mastitis infection prior to their first lambing. In our study, the raw lamb weights were normally distributed for both treatment groups, with the mean weight of the lambs in the tilmicosin group being greater than in the placebo group. In the initial analysis, the lamb weights calculated by using least squares means were greater in the tilmicosin group, and the difference was close to being significant ($P = 0.056$). When the lamb data were then divided by ewe age into lambs born from 1-year-old ewes and lambs born from ewes > 1 y old, a significant treatment effect of + 0.52 kg/lamb was found ($P = 0.034$). The age division was chosen because parity information was unavailable, but the goal was to stratify the ewes into primiparous and multiparous groups.

Table 5. Incidence of mastitis by treatment

Mastitis	Tilmicosin ($n = 393$)	Placebo ($n = 394$)	Total ($n = 787$)
Abnormal udder	16 (4.1)	24 (6.1)	40 (5.1)
Clinical	14 (3.6)	14 (3.6)	28 (3.6)
Total	30 (7.6)	38 (9.6)	68 (8.6)

The numbers in parentheses represent the percent incidence

Table 6. *P* values and odds ratios for logistic regression model for mastitis data

Mastitis	*P* value	Odds ratio	95% Confidence interval	
			Low	High
Abnormal udder	0.03	0.57	0.39	0.83
Clinical	0.94	0.98	0.12	7.49
Total	0.08	0.75	0.54	1.04

The positive effect on lamb weight supports the work done by Ramanoon (7), who found that for each increase of 100 000 cells/mL in SCC, there was an associated decrease in 50-day lamb weights, ranging from 0.21 kg to 0.36 kg, depending on the type of infection. Other studies have identified both reduced growth and reduced feed efficiency in lambs that nursed ewes having mammary gland infections (2,6).

Although the results from previous studies are based on culture results, SCC, or other tests as measures of mastitis infection, our study only utilized udder palpation, observed clinical cases, and selected culture results for determination of mastitis infection. Udder palpation is a highly subjective observation, with many different interpretations, and is directly affected by producer diligence. Also, clinical cases may be missed by the producer, causing an underestimation of mastitis infection. However, producers frequently make management decisions based on udder palpation and observed clinical cases. Thus, these detection methods were utilized in this field trial. It is important to note that even with the underestimates and the highly subjective observations of mastitis infection, a significant difference in rates of udder abnormalities between tilmicosin- and placebo-treated ewes was found. This is further evidence that the difference in lamb weights between treatment groups was related to udder condition.

The difference of 0.52 kg BW between the tilmicosin and placebo lambs needs to be assessed for its practical and economic significance. Depending on the value of slaughter lambs, an increase of 0.5 kg BW at 50-day weight may be economically significant at market time. Recent lamb prices in Ontario ranged from $240/cwt (1 cwt = 45.36 kg) for new crop lambs to $122/cwt for heavy lambs (Ontario Livestock Exchange data, winter 1998). This would translate to a value ranging from $2.77 to $1.41 for the 0.52 kg gain. Treatment costs will vary depending on the cost of the antibiotic to the producer, syringe and needle costs, and cost attributed to labor. The adoption of this treatment program needs to be assessed on a flock basis, depending on

the prevalence of mastitis in the flock, the number of lambs raised per ewe treated and the lamb market, creep feed intake, and premature culling. Measurement of creep feed intake or ewe culling rates were not possible in the this trial.

The incidence of total mastitis in the ewes enrolled on the field trial was found to be 8.6%. Abnormal udders accounted for 5.1% and clinical cases for 3.6%. This range is consistent with the literature, where rates of subclinical and clinical mastitis range widely from 4% to 50% in lactating ewes (2–4).

Tilmicosin treatment was found to significantly reduce the incidence of abnormal udders at weaning. The odds ratio of 0.57 (range 0.39–0.83) indicates that ewes treated with tilmicosin are 43% less likely to have an abnormal udder. This is an underestimate of abnormal udders, since not all flocks scored the udders at weaning. Since the significance values for clinical and total mastitis were not significant, no conclusions regarding the odds ratios can be reached.

Many sheep flocks routinely cull animals due to abnormal udders. This field trial was not designed to collect information on culling; thus, a comparison between culling rates and reasons for culling between tilmicosin- and placebo-treated ewes was not possible. This would be a very interesting aspect to consider in future studies of control measures for ovine mastitis.

Since the results of the culture data were virtually identical when considered by treatment group, no further analysis was done on the data. However, it is interesting to note that the most common isolate was a coagulase-negative staphylococcus (65%), which is consistent with previous research (4). In future trials, it would be useful to differentiate the species in isolates of coagulase-negative staphylococci in order to determine differences in pathogenicity.

In this study, conducted under many different management regimes, administration of tilmicosin to multiparous ewes approximately 1 mo prior to commencement of lambing had a beneficial effect on 50-day lamb weights, regardless of age or sex of the lamb. Tilmicosin also reduced the incidence of abnormal udders present at weaning by either curing existing infections or preventing new ones. It may be economically beneficial to sheep producers to routinely treat ewes in late gestation with tilmicosin, depending on the level of mastitis in the flock, the cost of treatment, and the value of the lamb market.

Acknowledgments

We thank all the producers for their excellent cooperation and effort in making their flocks available for this trial. We also thank the people involved with the Sheep Flock Improvement Program for their help in data collection and management and Anna Bashiri of the Ontario Veterinary College for conducting the milk cultures.

CVJ

References

1. Hueston WD, Boner GJ, Baertsche SL. Intramammary antibiotic treatment at the end of lactation for prophylaxis and treatment of intramammary infections in ewes. J Am Vet Med Assoc 1989;194:1041–1044.
2. Ahmad G, Timms LL, Morrical DG, Brackelberg PO. Dynamics and significance of ovine subclinical intramammary infections and their effects on lamb performance. Sheep Res J 1992;8:25–29.
3. Ahmad G, Timms LL, Morrical DG, Brackelberg PO. Ovine subclinical mastitis: Efficacy of dry treatment as a therapeutic and prophylactic measure. Sheep Res J 1992;8:30–33.
4. Kirk JH, Glenn JS. Mastitis in ewes. Compend Contin Educ Pract Vet 1996;18:582–591.
5. McCarthy FD, Lyndsey JB, Gore MT, Notter DR. Incidence and control of subclinical mastitis in intensively managed ewes. J Anim Sci 1988;66:2715–2721.
6. Fthenakis GC, Jones JET. The effect of experimentally induced subclinical mastitis on milk yield of ewes and on the growth of lambs. Br Vet J 1990;146:43–49.
7. Ramanoon SZ. Ovine intramammary infection in an accelerated lambing system [MSc Thesis]. Guelph, Ontario. Univ of Guelph, 1997.
8. Longo F, Beguin JC, Monsallier G, Delas P, Consalvi PJ. Efficacy of spiramycin and neomycin combination in the control of cell counts and udder pathogens in the dry ewe. Proc Int Symp "Somatic cells and milk of small ruminants," Bella, Italy, September 25–27, 1993. 1996:49–52.
9. Karim M, Zeger S. GEE: A SAS Macro for longitudinal data analysis. Technical Report 674. Baltimore: John Hopkins University. 1988.