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An Investigation into the Risk Factors Associated with Clinical Mastitis in Colorado Sheep

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Summary

A questionnaire was designed to assess the prevalence of mastitis and associated risk factors for Colorado sheep operations during the 1999 lambing season and was mailed to 829 producers in January 2000. Responses were received from 188 producers and the data from these questionnaires was analyzed using EpiInfo Version 6.04b. Prevalence was defined as the total number of reported mastitis cases in a given flock during the 1999 lambing season divided by the total number of ewes in that flock. The mean prevalence of mastitis among sheep from Colorado owners that responded was found to be approximately 6%. Of the 188 producers that responded, 80.3% represented farm flocks, 11.2% were herded range flocks, and 8.5% were fenced range flocks. The majority of producers (84%) lambing in sheltered pens, and of those producers, 83% used small pens which housed anywhere between 5 and 20 head. Producers reported that mastitis was most likely to occur in lambing sheds (40%), in a band (23%) and in small mixing pens (22%). Sixty-eight percent of the reported mastitis cases occurred in ewes three years of age or older with the highest prevalence of mastitis (35%) occurring in ewes that were five to six years of age. Trends were observed but the only statistically significant factors ($P < 0.05$) found in this study were lambing in April and the Corriedale breed. Confounding factors, including preventative husbandry and management procedures, may account for these results.

Key words: Sheep, Mastitis, Udder Health, Risk Factors, Prevention Strategies

Introduction

Mastitis, inflammation of the mammary

gland, is an infectious disease of lactating ewes that occurs in all sheep-producing countries (Jones and Watkins, 2000). Mastitis affects both the quantity and the quality of the ewe's milk and can result in significant economic loss, premature culling, and mortality. Most mastitis cases are caused by bacteria, such as *Staphylococcus aureus*, *Pasturella hemolytica*, *Escherichia coli*, and *Streptococcus* spp. (Jones and Watkins, 2000). The bacteria are found either in the environment or on the ewe, and enter through the teat end. Clinical signs of acute mastitis include an inflamed, painful, discolored udder that produces foul smelling milk with an abnormal appearance (Jones and Watkins, 2000). Additional symptoms include lameness and fever. The ewe may also isolate herself from the flock and refuse to let her lambs nurse (Jones and Watkins, 2000). Mastitis is typically diagnosed on the basis of clinical examination of the ewe and affected gland, or through laboratory culture of milk (Menzies and Ramanoon, 2001). Infected ewes can be treated symptomatically to control fever and to reduce inflammation, and intramammary or parenterally injected antibiotics may also be used.

Risk Factors associated with the development of mastitis are not as well defined in the ewe as they are in the cow. Suggested factors include teat and udder damage, poor anatomical udder conformation, fecal contamination of the teats, age of ewe, high stocking density, a dry period lasting longer than 60 days, poor sanitation, and other health management practices. (Menzies and Ramanoon, 2001 and Jones and Watkins, 2000). The objectives of this study were to estimate the prevalence of clinical mastitis in sheep flocks in Colorado and identify operation-level risk factors.

Materials and Methods

A questionnaire was designed to assess the prevalence of mastitis, as well as risk factors associated with mastitis, for selected Colorado sheep operations during the 1999 lambing season (Questionnaire available upon request from corresponding author). To define the study population, the Colorado Wool Growers Association (CWGA) was contacted in order to obtain a list of sheep producers in Colorado. In 1997, there were approximately 1,600 sheep operations in Colorado (Colorado Agricultural Statistics Service, 2001), 51% of which were on the CWGA list. In January 2000, these 829 producers received the mailed questionnaire. Due to budget constraints, a reminder letter was sent in February 2000 to only 100 randomly selected producers who were non-respondents to the first questionnaire. Once the questionnaires were returned, the data were entered into a database (Approach, Lotus SmartSuite; Cambridge, Massachusetts).

To evaluate flock characteristics, descriptive statistics and frequency distributions were calculated using EpiInfo Version 6.04b (EpiInfo; Centers for Disease Control, Atlanta, Georgia and World Health Organization, Geneva, Switzerland). In order to assess whether management factors might be different between high and low

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prevalence flocks, prevalence was defined as the total number of producer-reported cases of mastitis during the 1999 lambing season divided by the total number of ewes in the flock in 1999. The overall mean prevalence of mastitis was 5.9%. Flocks that were one or more standard deviation above the overall mean prevalence were categorized as high prevalence flocks, and flocks that were less than one standard deviation above the overall mean prevalence were categorized as low prevalence flocks. These high and low prevalence flocks were compared using univariate analyses.

Pearson's chi-square test was used to compare dichotomous variables, and one-way analysis of variance was used to compare the means of continuous variables. Additionally, odds ratios were calculated (95% confidence intervals), and all statistical tests were considered significant at $P < 0.05$. The odds ratios were achieved by calculating the risk of the unaffected population divided by the affected population.

Results and Discussion

One hundred eighty-eight producers participated in the study. Of these, 151 (80.3%) represented farm flocks, 21 (11.2%) represented herded range flocks, and 16 (8.5%) represented fenced range flocks. The mean number of ewes per flock was 358 (range, 2 to 10,000 ewes), and the mean number of rams per flock was 13 (range, 0 to 350 rams). The average farm flock had 60 ewes and 3 rams, and the average range flock had 1,567 ewes and 52 rams.

The number of lambs born to a ewe has been suggested to contribute to the incidence of mastitis due to the udder damage caused by frequent and rough suckling of lambs (Jones and Watkins, 2000). This study found during the 1999 lambing season in Colorado, 58% of ewes had twins and 7% had triplets.

Shearing may facilitate the spread of mastitis pathogens from affected to non-affected ewes. One hundred twenty-one operations (64.0%) had ewes sheared before the 1999 lambing season, and this occurred on average 27 days before lambing. Of the operations that sheared before the last lambing season, 113 (96.6%) reported that they

used the same shearing crew each year and 103 (89.6%) stated that they used a crew that is used by other producers in their area.

The location of lambing has been suggested as a risk factor for mastitis. Both indoor and outdoor lambing systems, if not managed properly, can potentially enhance the opportunity for mastitis to occur. Indoor lambing systems lend themselves to the potential for fecal contamination of the udder if clean bedding is not maintained at all times; while outdoor lambing systems may expose ewes to cold, wet weather and the potential for wind chill and cold stress to the udder (Jones and Watkins, 2000). During the 1999 Colorado lambing season, 84% of operations reported that their ewes lambed in pens with shelter. Alternatively, 6.4% of operations reported that their ewes lambed in pens without shelter, and 6.4% lambed on the range. The majority of producers (145/174 [83.3%]) used small mixing pens (defined as pens holding 5 to 20 head) for lambing, and 25.7% (45/175) of operations reported that ewes lambed in large mixing pens (defined as pens holding 50 to 100 head). When asked where ewes were most likely to experience mastitis, 40% of producers stated that it occurred in a lambing shed, 23% reported that it occurred in a small mixing pen, 15% said it occurred in a large mixing pen, and 22% were reported to occur in a band. Eighty-two percent of producers reported that they cleaned pens (removed manure and bedding) during last lambing season. However, only 38% of these operations applied a disinfectant after cleaning. In addition, ewes and their lambs remained in the lambing pen between 38 and 82 hours before being moved elsewhere. The typical lambing season in Colorado runs from January to May. The majority of producers (92/175 [52.6%]) reported that some ewes lambed in March, while 4% reported to have ewes lamb in December and 2.3% had ewes lamb in June.

There is a positive correlation between the prevalence of mastitis and ewe age (Menzies and Ramanoon, 2001). As a result, the overall age distribution of ewes during the 1999 lambing season was compared with the age distribution of ewes with mastitis. Ewe lambs (lambing at one year of age) made up 12.5% of flocks, however only represented 2.5% of reported cases of mas-

titis. Yearlings (ewes lambing at about two years of age) made up 12% of flocks, but accounted for only 9.4% of mastitis cases. Ewes three to four years of age made up the largest age group (36%) and they represented 31% of the reported cases of mastitis. The second largest age group, five to six years, made up 24.9% of flocks, and accounted for the majority of the mastitis cases (35%). Finally, ewes seven and older made up 8% of flocks, however, accounted for over 14% of reported mastitis cases.

Diagnosis is often made by clinical examination of the ewe and gland as well as milk culture (Menzies and Ramanoon, 2001). Producers in Colorado most commonly diagnose mastitis by palpating the udder (53%). Starving lambs is the next most commonly used sign for arriving at a diagnosis (50%), followed by discolored milk (42%), discolored udder (39%), lameness (34%), sloughing udder (19%) and death (16%). Only one percent of producers reported that they submitted milk samples to a laboratory to confirm the mastitis diagnosis. Six percent of ewes diagnosed with mastitis were diagnosed after weaning, and this diagnosis was made, on average, 22 days after weaning. Seventy-seven (40.7%) of producers reported that they palpated each ewe's udder after weaning, and 78% of producers culled ewes that had palpable evidence of mastitis.

Analysis of the data collected during this study concluded that only two factors were found to be statistically significant ($P < 0.05$), lambing during the month of April and the breed Corriedale. Operations that had ewes that lambed in April ($P = 0.05$, Odds Ratio = 0.39) and May ($P = 0.01$, Odds Ratio = 0.00) were less likely to experience mastitis in their flock. In addition, operations with Corriedales were seven times more likely to have a high prevalence of mastitis ($P = 0.003$, Odds Ratio = 6.90). Confounding factors, including preventative husbandry and management procedures, may account for the above described associations.

Conclusions

Currently, there are no well-established methods of prevention for mastitis in ewes, however, a greater understanding of the known risk factors and predisposing causes

of mastitis in sheep could lead to appropriate operation management strategies. Mastitis should be looked for more closely in older ewes. Over 68% of mastitis cases occurred in ewes that were three years or older, and ewes that were five to six years of age had the highest prevalence of mastitis (35%). The udders, teats, and milk of lactating ewes should be monitored routinely to avoid lamb starvation. Early recognition, segregation, and culling of affected ewes so as to minimize the spread of infection should also be implemented. In flocks with a high incidence of mastitis, teat ends should be examined routinely and any lesions that are identified should be treated in an attempt to prevent infection (Jones and Watkins, 2000).

Genetic resistance to mastitis in sheep has been suggested (Menziés and Ramanóon, 2001). For that reason, just as genetic selection against the development of mastitis would be valuable; an assessment of the genetic makeup of flocks with an elevated incidence of mastitis may also be warranted.

The environment in which the sheep live should also be closely evaluated as environmental *Streptococcus* spp. and coliforms including *Escherichia coli* are known etiologic agents (Menziés and Ramanóon, 2001). Approximately 40% of mastitis cases were identified while the ewes were in lambing pens. Fecal contamination of the udder is prevalent in indoor lambing systems and can be reduced by regular cleaning and disinfecting or by moving ewes and their lambs outdoors as soon as possible (Jones and Watkins, 2000). Lambing pens should also be cleaned and disinfected at the end of each lambing season, and should remain unoccupied until the next lambing season. In addition, operations that had ewes that lambed in April and May were less likely to experience mastitis in their flock, thus lambing later in the spring may help prevent mastitis in ewes.

Literature Cited

- Jones, J. E. T., and G. H. Watkins. 2000. Mastitis and contagious agalactia. In: W.B. Martin and I. D. Aitken (Ed.) Diseases of Sheep. Pp. 75-80. Oxford; Malden, Massachusetts: Blackwell Science.
- Menziés, P. I., and S. Z. Ramanóon. 2001. Mastitis of sheep and goats. In: R. A. Smith and D. C. Van Metre (Ed.) The Veterinary clinics of North America, Food Animal Practice, Update on Small Ruminant Medicine. 17:333-358. Philadelphia, Pennsylvania: W. B. Saunders Company.
- Colorado Agricultural Statistics Service. 2001. Colorado Agricultural Statistics, Annual Report 2000-2001, Colorado Department of Agriculture. P. 5. Lakewood, Colorado: Colorado Agricultural Statistics Service.