Proc. Fifth Bienn. Symp. North.
Wild Sheep and Goat Council 1986

LONG-TERM EFFECT OF FENBENDAZOLE ON LUNGWORM INFECTIONS IN TRANSPLANTED BIGHORN SHEEP

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ABSTRACT

The use of fenbendazole (Panacur) in transplanted bighorns to reduce parasite-related stresses associated with shipping and prevent contamination of ranges was tested in two experiments. In the first trial, 27 sheep from the Sun River Game Range were drenched with fenbendazole before they were moved to the Brandon Butte area of the Missouri Breaks in northeastern Montana. Twenty-nine untreated animals from the same holding pen were released simultaneously in the Chimney Butte area about 75 miles to the west. Both ranges are similar in terms of grazing potential and terrain. Neither area had resident bighorn populations, although both had been inhabited historically by Ovis canadensis auduboni.

Fecal lungworm larval counts in the two transplanted herds were compared over a six-year period. Results indicated that the level of larval output in the untreated sheep remained two- to three-fold higher than in the treated herd, except for one year midway in the study when counts tended to equalize.

In the second experiment, alfalfa pellets containing 0.5% fenbendazole were fed free-choice to two bighorn ewes moved from the Sun River Game Range to the Montana State University Veterinary Research Laboratory. Both animals were shedding low to moderate numbers of lungworm larvae and various gastrointestinal nematode ova prior to treatment. After exposure to medicated pellets for two days, normal feeding was resumed. The effect on parasite levels was monitored by comparing periodic fecal larval counts over an eight-week period and again after one year. Results indicated that passage of larval lungworms decreased to barely detectable levels by day 7 and ceased completely by day 21 post-treatment. Both ewes remained negative through day 58, but subsequently resumed low-level excretion of larvae. Both sheep were completely cleared of gastrointestinal nematodes by the free-choice regimen used.

INTRODUCTION

The role of protostrongylid lungworms (*Protostrongylus stilesi, P. rushi*) as contributors to chronic or subacute respiratory disease problems in Rocky Mountain bighorn sheep (*Ovis c. canadensis*) has been recognized for many years (Marsh, 1938; Buechner, 1960; Forrester, 1971). Although disagreement exists over the relative importance of the various microbial pathogens in field outbreaks of pneumonia, lungworms appear to be one of the constant stressors associated with lack of productivity and/or increased mortality in free-ranging bighorn populations (Spraker et al., 1984). As a result, efforts to develop effective control measures for *Protostrongylus* infections have received continuing emphasis. Recent development of a new "generation" of antiparasitic drugs for use in domestic livestock has made available a variety of new compounds having potential activity against lungworms in wild sheep (Enigk and Dey-Hazra, 1976; Kelly et al., 1975). Schmidt et al. (1979) reported greatly increased lamb survival when bighorn ewes were treated to control lungworms. They reported that while treatment with fenbendazole (Panacur^{R}) was not as effective as cambendazole in reducing lamb mortality, fenbendazole had the advantage of killing adult lungworms, which left sheep parasite-free for a longer time. Since the sheep in the transplant study were being transplanted onto ranges that had not had resident bighorn populations since the early 1900's, it afforded an opportunity to evaluate the use of fenbendazole for lungworm control prior to relocation, in an attempt to maintain lungworm-free ranges. In a second study, the objective was to test the palatability and effectiveness of a pelleted formulation of fenbendazole when fed free-choice to penned bighorns naturally infected with lungworms and various gastrointestinal nematodes.

METHODS

TRANSPLANT STUDY

The Missouri Breaks consist of steep, eroding drainages of the Missouri River in east-central Montana. Average annual precipitation in the area is approximately 12 in. Most soils are clay derived from Bearpaw shale. Many ridges and buttes in the area where sheep were transplanted are capped with sandstone, providing small cliffs and broken rock faces.

Vegetation consists of a highly dissected mosaic of prairie and timber. The ridge tops and surrounding plateau are dominated mainly by big sagebrush, western wheatgrass, and bluebunch wheatgrass. Most slopes are dominated by ponderosa pine or Rocky Mountain juniper with grass or shrub understories. Some steep northfacing slopes are dominated by Douglas fir. Many steep, xeric slopes are barren except for very sparse stands of greasewood and longleaf sagebrush. A more detailed description of the vegetation was published by Mackie (1970).

Fifty-six Rocky Mountain bighorn sheep were live-trapped on the Sun River Game Range, Lewis and Clark County, MT, by personnel of the Montana Department of Fish, Wildlife and Parks in March, 1980. Twenty-nine animals from this group were relocated in the Chimney Butte area of the Missouri Breaks north of Winifred, Fergus County, by the Bureau of Land Management. The 27 remaining sheep were given a single dose of fenbendazole suspension at the rate of approximately 5 mg drug/kg body weight, prorated as follows: adults, 30 ml; yearlings, 20 ml; lambs, 10 ml. Baseline lungworm larval counts for both groups were calculated from pellets collected in the common holding pen used by the sheep prior to relocation. Penicillin was administered intramuscularly as a preventive agent to suppress bacterial respiratory infections (Blunt and Thorne, personal communication, 1980). The treated sheep were released the following day at Brandon Butte on the C.M. Russell National Wildlife Refuge south of Malta, Phillips County, Montana. The two release sites were approximately 75 miles apart and on opposite sides of the Missouri River.

Lungworm larval output in the two herds was monitored from fecal samples collected annually, usually in August or September. Lungworm surveillance continued from 1980 to 1985 except for one year (1984) when no samples were taken. Ten to 12 pellet groups were collected from both herds at each sampling interval. They were air-dried in paper sacks and sent to the Veterinary Research Lab. at Montana State University for analysis. The standard Baermann test was used to obtain quantitative counts of Protostrongylus larvae per gram of feces.

Another herd, the result of a 1958 transplant, occupies the Two Calf Creek area of the C.M. Russell National Wildlife Refuge. This area is approximately 20 miles east of the Chimney Butte control herd. Pellet samples were also collected from this herd during the same period for evidence of fluctuations in lungworm prevalence and intensity in an established bighorn herd exposed to habitat and climatic conditions similar to the test herds.

PENNED SHEEP STUDY

Two mature bighorn ewes live-trapped at the Sun River Game Range were moved to the Montana State University Veterinary Research Lab. Following confirmation of active lungworm infections in both animals with the Baermann technique, a commercial feed preparation containing 0.5% fenbendazole on a pelleted alfalfa carrier was fed over a 30-hour period in lieu of hay. Two and one-half pounds of pellets were administered to permit a desired drug intake of 5 mg/kg body weight, the dose used for domestic ruminants. Feed consumption was monitored periodically to estimate the palatability of the mixture and to measure the approximate rate of drug intake. Observations were made during initial exposure of the ewes to medicated pellets to evaluate their response to the preparation. The sensitivity of lungworms to the levels of fenbendazole ingested via free-choice feeding was measured by periodic fecal examinations during the two-month

period post-treatment and again approximately 15 months later. The response of gastrointestinal nematodes to the medicated ration also was noted as an additional indication of the efficacy of the test formulation.

RESULTS

TRANSPLANT STUDY

No adverse effects of treatment or negative impacts due to relocation were observed in either group of sheep at the time of release. Animals released in the Chimney Butte area separated into several groups and colonized a 10- to 15-mile area, including one group that crossed the Missouri River. Two groups in the release area were sampled for this study. The sheep released at Brandon Butte were basically in two groups; the group that was sampled is located on Brandon and Mickey Buttes. The other group is located approximately 12 miles NE of the release site.

Lungworm prevalence data in the treated and control herds are summarized in Table 1.

Table 1. Long-term effect of fenbendazole on protostrongylid larval output by bighorn sheep moved to clean ranges.

Herd	Date Sampled					
	March 1980	July 1980	1981	1982	1983	1985
Chimney Butte (control)	126 lpg (100%+)	*	30 lpg (100%+)	43 lpg (87%+)	27 lpg (90%+)	79 lpg (85%+)
Brandon Butte[1] (treated)	126 lpg (100%+)	47 lpg (6%+)	16 lpg (55%+)	14 lpg (92%+)	41 lpg (100%+)	36 lpg (100%+)
Two Calf[2] (established herd on adjoining range	*	13 lpg (94%+)	*	10 lpg (82%+)	8 lpg (90%+)	4 lpg (91%+)

[1]Treated with fenbendazole drench following March fecal examination.
[2]Data included for purposes of comparison
*No samples available
Numbers in parentheses = percentage of sampled animals positive for *Protostrongylus*

PENNED SHEEP STUDY

The effect of feeding fenbendazole-medicated pellets on *Protostrongylus* larval output in bighorn sheep in shown in Table 2.

Table 2. Responses of protostrongylid lungworm infections in bighorn sheep to treatment with fenbendazole-medicated pellets*

Sheep No.	Day post-treatment -45	-18	7	14	21	30	44	58	478
A 1661	92	278	0.4	0.2	0	0	0	0	39
G 986	101	6	0.6	0.1	0	0	0	0	0.4

*Expressed as larvae/gm. feces

Both animals were shedding low to moderate numbers of lungworm larvae (6-278 larvae/gm feces) and various gastrointestinal nematode ova prior to treatment. By day 7 post-medication, larval counts in feces were reduced 98.8% to 99.8%. Low level excretion of lungworm larvae continued through day 14 but ceased completely by the 21st day after treatment. Both ewes remained negative through day 58 but subsequently resumed low-level larval production. Both sheep apparently were completely cleared of gastrointestinal nematodes, including Marshallagia marshalli and Nematodirus sp. which were present in moderate numbers in both animals. No evidence was seen of side effects resulting from the levels of drug ingested during the 30-hour treatment period, or at any time during the post-treatment observation period.

DISCUSSION

Schmidt et al. (loc. cit.) reported no recurrence of lungworm larval excretion in bighorn sheep up to six months after treatment with two doses of fenbendazole. Their interpretation was that both larval and adult lungworms had been killed. In the present field study, 47% of the sheep were passing Protostrongylus larvae within five months after a single drench with fenbendazole. Residual infections apparently persisted in some animals in spite of an overall reduction of 95% in larval output following one treatment. These sheep were transplanted onto historic Audubon bighorn range that had not had resident sheep since the turn of the century. Hence, although the objective of complete parasite clearance was not accomplished, the level of range contamination was reduced significantly. Additional benefits in terms of increased vigor of the relocated herd may also have resulted from the overall reduction of total worm burdens.

Productivity data for the transplanted sheep are available only from incidental air and ground observations by agency personnel. They indicate that little difference exists between the two test herds. Lamb-ewe ratios tend to be slightly higher in the control group, ranging from 50 to 60%. Actual counts have been slightly higher in the treated herd, which consisted of 82 animals in 1985.

Additional data (Huschle and Worley, unpublished) on parasite patterns in sheep on dry prairie ranges have been collected from the Two Calf herd, which occupies an area on the C.M. Russell National Wildlife Range approximately 20 miles east of the Chimney Butte control herd. Lungworm prevalence and intensity in this herd, the result of a 1958 transplant, have consistently been the lowest in the state, averaging about nine larvae/gm. of feces. Lungworm larval output in the Brandon Butte sheep has increased following medication to a higher level than the Two Calf sheep and is approaching that of the control herd. One factor contributing to this trend may be the somewhat higher concentrations of the Brandon Butte sheep in comparison with the control herd. The decrease in lungworm output observed in the control herd to a level similar to the Two Calf herd may indicate that transmission of protostrongylid lungworms is severely limited on dry prairie ranges due to a probable scarcity of snail intermediate hosts. For this reason, benefits from reducing or eliminating lungworms probably would be minimal under the circumstances.

Use of a pelleted fenbendazole ration in a free-choice regimen was designed to test the palatability and rate of consumption by bighorns under controlled conditions. Although there are obvious differences between a confinement setting and field use of the material, the rate of feed intake was adequate to achieve the desired drug intake in about 30 hours. The response in the test ewes suggested that sufficient drug was ingested during this time interval to reduce lungworm levels significantly and completely eliminate gastrointestinal worm infections with Marshallagia and Nematodirus. However, complete eradication of lungworms was not accomplished with the short-term feeding schedule tested. The inability to eliminate all adult lungworms was predictable in view of the partial effect reported by Schmidt et al. (1979) with the use of a single dose of fenbendazole fed in apple pomace.

Rate of feed consumption as indicated by observations at two- to four-hour intervals suggested that some exploratory "testing" of the medicated ration occurred within two hoursafter the initial feeding. One ewe ate continuously for three to four minutes after tentatively nibbling at the material. An estimated one-third of the total ration was eaten during the first 18 hours. By 24 hours, 50 to 60% had been consumed. Approximately 30 hours was required for the full fenbendazole dose to be eaten. The composition of the commercial preparation apparently was sufficiently palatable to the sheep that it was not necessary to "precondition" them to a pelleted formulation or withhold feed to induce them to eat. On the other hand, lack of access to other feed in a confinement situation such as this may indicate that administration of the material in the field is more likely to be successful during the winter range period when alternative feed sources are not readily available.

The practical advantage of a commercial anthelmintic preparation that is not dependent on the availability of apple

pomace and does not require additional formulating are considerable. Further evaluation of fenbendazole-medicated pellets administered over a longer period or at two or more separate feedings, is needed to determine the ultimate usefulness of the compound in parasite control programs for bighorn sheep.

ACKNOWLEDGEMENTS

The cooperation of the Montana Department of Fish, Wildlife and Parks and the Bureau of Land Management in trapping and transporting the sheep used in this study is gratefully acknowledged. Doug Ayers assisted with field work and compiled observations made by BLM personnel. Floyd M. Seesee and M.C. Sterner provided technical assistance in both field and laboratory aspects of the project. Drs. R.K. Muser and G.H. Myers of American Hoechst Corporation furnished the medication used in the feeding experiment. Published as journal series No. J-1850, Montana Agricultural Experiment Station.

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QUESTIONS AND ANSWERS

Bill Samuel, Alberta: This statement in the abstract, where you reduce the larval lungworm counts to barely detectable levels, reminds me of the young lady who came home and told her father on a Saturday night that she had a problem but not a big problem because she was just a wee bit pregnant. So, I'd like to ask, and anybody can answer, have we now decided that we should treat during transplant just to reduce the larval levels to give the transplanted sheep a better start even though treatment doesn't eradicate anything?

Gary Huschle: That is what possibly could have happened if we would have had severe winter in the first year or two, but that didn't occur.

Samuel: Then the second question is, were there significant differences between your treated and your controlled herds over the years with the lungworm larvae per gram? In the different years are they statistically different? They look pretty close to me.

Huschle: We didn't run a statistical analysis on it. In the first three years I believe they would be. You're looking at only half the animals being infected on the treated group and all 100% still infected on the control group.

Peter Davidson, BC: I've treated with Fenbendazole and have managed to reduce levels down to barely detectible levels, and had the odd sheep with high levels still transplanted probably because it was missed. I generally tried to treat three times at the sites using Schmidt's method with fermented ethyl mash. What we found is the levels, well most of the sheep had 0 levels, the odd had low levels, like Bill was saying barely detectable, but within 4 - 6 months we were back up to normal levels on the source herd, 600-800 larvae per gram which is on very poor winter range. On the transplanted herd we were up around 30 larvae per gram, anywhere from 5 - 30 larvae per gram. So we didn't stop the problem. We just changed level of infestation. The other big difference was the lamb survival did dramatically increase in the source herd, we probably increased the lamb survival by 30-45%. That's judging by pretreatment lamb survival over a period of years vs. post treatment over a period of 2 - 3 years. We did find a very similar experience to Schmidt down in Colorado.

Wayne Winter, South Dakota: I was wondering if you or anybody else in the room ever attempted to offer pelletized hay to sheep that were not captive free choice. In Custer State Park, we'd have to do that. We didn't get very good acceptance to it, but we had used alfalfa hay without apple mash and got excellent acceptance of that. I was just wondering if anyone tried to offer free choice to Montana sheep.

(Comment from back of room)

Winter: That was our experience. We couldn't get them to take it very readily and we had a lot better luck with our regular alfalfa hay.

(Comment from back of room)

Winter: We had used that for a number of years, but we felt we didn't have to mess with the mash anymore. They took plain alfalfa hay just as readily as they did alfalfa hay with mash. We just decided to discontinue using the mash.