The Prevalence of Strongyles in Stabled and Pastured Horses in Vermont and Efficacy of Anthelmintic Programs in These Horses

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KEY WORDS: equine strongyles, anthelmintic programs, stabled horses, pastured horses, cyathostomes, Vermont

ABSTRACT

Equine strongyle populations were studied on 5 farms in central Vermont in 2002. Fecal egg counts were used to estimate the prevalence of strongyle infections in horses that are permanently stabled with minimal access to grazing as compared with counts for horses on pasture year round. Egg counts for these horses were compared with counts for horses kept on pasture year round. Anthelmintic efficacy of various treatment programs against equine strongyles also was investigated by examination of fecal samples at intervals after treatment. Statistical analysis of the egg count data indicated there was no significant difference in fecal egg counts between stabled horses that had been treated 50 days earlier with fenbendazole and horses that grazed on pasture that had not been treated for parasites in more than 7 months. Further analysis indicated there was a significant ($P = 0.0016$) difference in egg counts between the stabled horses treated with fenbendazole and horses treated with ivermectin that grazed on pasture. The study demonstrated that horses that are primarily stabled do have substantial strongyle burdens. Ivermectin was effective in the reduction of worm burdens in these horses.

INTRODUCTION

Cyathostomes are presently considered one of the leading pathogenic agents in horses. They can number over tens of thousands and are very prolific.[1] If left untreated, cyathostomes can be fatal.[2]

Cyathostome eggs are passed in the horse's feces,[3] and infective third-stage lar-

vae are typically ingested by the horse while grazing in contaminated pasture.[4,5] However, many horses in racehorse parks, stables, and other equine facilities have very limited access to grazing. The present study was performed to investigate the prevalence of cyathostomes in permanently stabled horses fed hay and commercial ration with sporadic access to pasture as compared with the prevalence in pastured horses. An additional objective was also to evaluate field anthelmintic efficacy of programs used at the farms studied. The level of parasite contamination in paddocks or pastures was not evaluated at any farm.

MATERIALS AND METHODS

Study Sites and Test Animals

A Morgan horse farm in Middlebury, VT, designated Farm A, was selected for collection of fecal samples from stabled horses. All adult horses (10 mares and 9 stallions) had been maintained in stables since they were 2 years of age. From weaning to 1 year of age, foals born on the farm were free to graze on pasture and received monthly treatments with fenbendazole. Yearlings were housed in paddocks by sex and were treated 5 times annually with ivermectin (bimonthly) and also received 1 annual treatment with fenbendazole, for a total of 6 anthelmintic treatments annually. All horses 2 years of age and older were kept in stables with minimal turnout and received a regular anthelmintic treatment every 2 months, rotating fenbendazole, ivermectin, and pyrantel pamoate.

The horses on Farm A were each fed a pelleted concentrate (approximately 2.7 kg per horse) and 4.5 to 6.8 kg of grass hay daily plus a multivitamin supplement. Water was available ad libitum. Five or 6 days each week, the horses were individually exercised by longeing in an indoor arena for 20 minutes. Two or 3 times a week, the horses were turned out individually in a dirt paddock (13 × 18 m) for approximately 1 hour. During the summer, horses were given access to a grass paddock (13 × 68 m) for 1 hour approximately 3 times monthly.

Horses at 4 other equine farms also were studied for management, fecal egg counts, and anthelmintic programs. All horses on these farms had access to pasture and were adults (2 years of age or older). Farm B, located in a mountainous area of Lincoln, VT, had 5 mares, including 2 Icelandic horses, 1 Shetland pony, 1 Welsh cross pony, and 1 quarter horse. This farm was situated at a higher elevation (approximately 680 m higher) than any of the other farms studied. Horses were fed hay and grain as well as a vitamin B supplement and were on an anthelmintic rotation of ivermectin, pyrantel pamoate, and fenbendazole every 3 months. The farm had a riding ring (36 × 54 m) and 4 grass fields (three 2-acre fields and one 5-acre field). Horses were primarily turned out in the riding ring and 5-acre field in the winter months (November through February) and grazed in the 2-acre fields for the remaining months. Manure was removed from the riding ring 4 times monthly from April through June when accumulation of feces and mud was greatest. There were usually 2 horses grazing per acre at any given time.

Farm C was in East Middlebury, VT, and had 5 stallions and 9 mares, including 3 thoroughbreds, and 1 each of Arabian, Morgan, quarter horse, Welsh, Morgan/thoroughbred cross, Appaloosa/Welsh cross, Connemara/Welsh cross, thoroughbred/quarter horse cross, thoroughbred/Clydesdale cross, Arabian/Percheron cross, and Morgan/Welsh cross. These animals received hay and grain daily and were maintained on a fast rotation of fenbendazole, pyrantel pamoate, and ivermectin (or moxidectin) every 6 to 11 weeks. With the exception of moxidectin, which was administered directly by oral dosing, the anthelmintics were given by mixing the product in a bran mash in the feed bin of each horse. Pyrantel tartrate daily was administered in the feed year round; therefore, there were periods of time when horses

were receiving more than 1 treatment. However, horses that had received pyrantel tartrate in this study had not received an additional anthelmintic in more than 2 months before initiation of this study, with the exception of 1 horse. Horses grazed on four 5-acre and one 2-acre fields. The pastures were scraped with a tractor twice a year, and the grass was turned over 4 times a year.

Farm D, located in Bridport, VT, had 12 stallions and 9 mares, including 4 quarter horses, 2 paints, 3 Arabians, 3 Appaloosas, 2 Connemaras, 2 mixed-breed ponies, 2 thoroughbreds, 1 Percheron, 1 Arabian/Morgan cross, and 1 Morgan. All horses on this farm were rotated between pasture and paddock. Twenty of these horses on Farm D were on a fast rotation of ivermectin, pyrantel pamoate, and fenbendazole every 6 to 8 weeks, and 1 horse received pyrantel tartrate daily.

Farm E, also located in Bridport, VT, had 7 stallions, including 2 Arabian/pinto cross, 2 quarter horses, 1 pinto/quarter horse cross, 1 Connemara, and 1 Appaloosa. Hay as well as calcium, phosphorus, and free choice trace mineral salts were fed to all horses. Ivermectin and pyrantel pamoate were rotated 2 to 4 times a year. Horses grazed on a 1-acre pasture, and manure was removed from the pasture twice a year.

Fecal Samples

Fecal samples were not routinely collected and evaluated for estimating worm burdens at any of the farms before the study was initiated. Furthermore, pretreatment fecal egg counts were not possible at these farms because all horses were on an anthelmintic at the initiation of this study. On Farm A, individual fecal samples were collected from the 19 adult Morgan horses on September 27, 2002. The freshest fecal material identified in each stall was collected. Samples collected were less than 1 day old. The horses had been treated with fenbendazole 50 days before fecal collection for this study. Following the initial examination at this farm, horses were treated with ivermectin on November 12, 2002, and fecal samples were collected a second time on November 25, 2002.

Individual fecal samples were collected from the stalls on the other 4 farms. Fecal material was collected no later than 3 hours after a horse had defecated. Samples were collected from Farm B on October 2, 2002. Horses there had received pyrantel pamoate 43 days before fecal collection. Samples from 14 horses on Farm C were collected September 28, 2002. Eight of the horses had been treated with pyrantel tartrate daily, 4 had been treated with fenbendazole 27 days before fecal collection, and 1 had been treated with ivermectin 58 days before fecal collection. One horse had received pyrantel tartrate daily as well as a 5-day dosing with fenbendazole. The final day of treatment for that horse was 1 week before fecal collection. Samples were collected on Farm D on September 27, 2002. Twenty of the horses on Farm D had been treated with ivermectin 56 days before the study and 1 received pyrantel tartrate daily. Seven horses were sampled on Farm E on September 28, 2002. Horses on this farm had not been treated with an anthelmintic in more than 7 months.

Analysis

Each sample was collected in a plastic bag, which was placed in a trash bag, packed in a cardboard box filled with ice packs, and shipped to Magnolia, KY, through postal mail. Samples were analyzed by a contracted parasitologist to determine strongylid fecal egg counts using the modified Wisconsin centrifugal flotation technique, and the number of eggs per gram (EPG) in each sample was recorded.[6] The counts were transformed to the natural logarithm of the (count + 1) to calculate geometric means. Geometric mean fecal egg counts were compared among farms and among stabled horses that were treated, grazing horses that were treated, and horses on pasture that were wormed infrequently. Data among farms were compared by 1-way analysis of variance using Microsoft Excel 2002 statistical functions. If a significant ($P < 0.05$)

Table 1. Fecal Strongyle Egg Count Data from Stabled and Pastured Horses on Farms in Vermont

				Fecal Egg Count (EPG)*	
Farm	**No. of Horses**	**Management**	**No. Passing Eggs**	**Geometric Mean**	**Range**
A	19	Stabled, with limited turnout	11	8.37[a]	0–253
B	5	Pastured at all times	1	0.90[b,c]	0–12
C	14	Pastured at all times	5	2.58[a,b,c]	0–144
D	21	Pastured at all times	2	0.28[b]	0–92
E	7	Pastured at all times	5	11.26[a,c,d]	0–254
Pooled Data Comparisons					
A	19	Stabled, with limited turnout	11	8.37[a]	0–253
B,C,D	40	Pastured at all times	8	0.90[b]	0–144
E	7	Pastured at all times	5	11.26[a]	0–254

*Determined by modified Wisconsin double centrifugation method.
Means having no superscript letters in common are significantly different ($P < .05$), as determined by Student's *t*-test.
EPG = eggs per gram of feces.

among-farms factor was found, individual farms were compared using a 2-tailed Student's *t*-test. Differences between farms were significant when $P < 0.05$.

RESULTS

Egg count data for horses at each farm are shown in Table 1. There was a significant ($P = 0.0036$) farm effect detected. Initial counts at Farm A ranged from 0 to 253 EPG, and 11 of the 19 horses were passing strongyle eggs in the feces. At second collection, following administration of ivermectin approximately 2 weeks earlier, all horses were negative for strongyle eggs. Counts for individual horses on Farm B ranged from 0 to 12 EPG; only 1 of the 5 horses was passing strongyle eggs. On Farm C, counts ranged from 0 to 144 EPG, with 5 of the 14 horses positive for strongyle eggs. Two of the 21 horses on Farm D were passing strongyle eggs; counts ranged from 0 to 92 EPG. Five of the 7 horses on Farm E were positive for strongyle eggs, and individual counts ranged from 0 to 254 EPG.

Individual comparisons between farms indicated the geometric mean fecal egg count on Farm A (in September) was significantly ($P < 0.04$) higher than those on either Farm B or D. The geometric mean count at Farm A was statistically similar to that for Farms C and E. The geometric mean for horses sampled on Farm E was significantly ($P = 0.04$) higher than the mean for Farm D.

When counts were pooled by management and worming program, the mean count for stabled horses (Farm A) was significantly ($P = 0.0089$) greater than the mean for horses on pasture that were dewormed on a regular basis (Farms B, C, and D), but was not significantly different from the mean for horses at Farm E that were infrequently dewormed (Table 1).

DISCUSSION

On Farm A, strongyle-type eggs were present in the feces of 11 of 19 horses that spent the majority of their time in stalls and had virtually no exposure to grazing on pasture. Five of the 19 horses on that farm had fecal egg counts greater than 50 EPG. This level of infection was unexpected for horses maintained primarily in stalls with very little access to pastures. The mechanism of strongyle transmission in stalls on Farm A is unclear from the limited data available in this study. Gibson[7] and Herd[8] reported that it is unlikely strongyle larvae can survive in stalls because housing conditions and management would be unfavorable for eggs to develop to the infective stage. Herd indicated that shedding of large numbers of strongyles in stalls is a consequence of previous grazing on pasture.[8] Because strongyles can reach maturity in the intes-

tine as long as 2 years after horses leave pasture,[7,9] horses on Farm A could have picked up infective larvae during their grazing period in the summer and then shed strongyle eggs in the stalls. This delay in maturation is evident of arrested development, in which development is halted and strongyle larvae stay dormant in the mucosa of the large intestine.[3,7] It has been speculated that arrest is terminated after anthelmintic treatment, whereby mature worms in the lumen of the large intestine are killed, causing dormant larvae to leave the mucosa and mature in the lumen to replace the adult worms that were removed.[7,9] This would explain the ineffectiveness of fenbendazole on Farm A. Only one dose of fenbendazole was given, which would have only targeted adult worms in the intestine. To control for the larvae in the mucosal tissue, 5 consecutive days of fenbendazole treatment is needed.[10] Therefore, the worm burdens present in horses on Farm A might have been a consequence of predominately arrested larvae.

Despite the absence of grass in the outside paddock accessed by the horses on Farm A 2 or 3 times weekly and the diligent maintenance of the area, several different horses use the paddock, and there is potential for the persistence of pre-infective and infective stage larvae in this area. Remnant feces left in the environment can potentially provide enough moisture to harbor pre-infective and infective larvae. Ogbourne[11] found that almost all larvae had developed into the second stage by the time feces had dried completely. Second-stage larvae were able to survive in dry feces and then continue development to the infective stage with rain. Infective larvae have been reported to survive in feces for 8 to 32 weeks.[4]

Contrary to the findings of Herd and Gibson, Langrova[12] reported that strongyle larvae might be able to persist in stables, including on the floor of the stall, under the water bucket, on the walls, and in the feed troughs. Eggs can develop to the infective stage in as little as 2 days.[13] Although stalls would be presumed to lack the necessary levels of moisture needed for eggs to survive and hatch to the infective stage,[14] urine and water buckets could contribute enough moisture to allow the eggs to mature. Langrova[12] found that the majority of infective larvae in horse stalls were under the water buckets. Although stalls were cleaned every morning at the farm, horses nibbling in these areas might have ingested surviving larvae on the walls or on the floor. Optimal temperatures in the spring and summer between 20° C and 25° C would favor hatching and development to the infective stage, and the life cycle would be completed with egg-laying in the fall.[15]

Farm B was situated at an elevation 680 m higher than any of the other farms studied. Therefore, the frost period for this farm was approximately 3 weeks longer than for the other farms. This may have resulted in a lower worm burden than was detected at the other farms examined. Fewer worms would be able to propagate during this longer freezing period. However, with only 5 horses sampled on this farm, the results may not be accurately representative of the worming program or the management situation, and results must be interpreted with caution.

The spectrum and duration of efficacy of the anthelmintic used to treat the horses at these farms could also be a factor in the appearance of eggs in the feces of the horses evaluated in the study. There was no significant difference between the geometric mean for horses on Farm A that had been treated 50 days previously with fenbendazole and those on farm E that had not been treated for parasites in 7 months and grazed on pasture. Label recommendations for fenbendazole in horses advise to retreat horses at 6- to 8-week intervals.[10] Therefore, it is likely that either re-infection had occurred in horses on Farm A since the previous fenbendazole treatment or the worm burden was the result of arrested larvae.

It is also possible that the regular use of fenbendazole at Farm A may have reduced its effectiveness against cyathostomes.[2,16]

Testing for resistance in these parasite populations was not performed for this study, however. Horses on Farm D, which had been treated with ivermectin most recently (56 days before fecal sampling), had a significantly ($P = 0.0016$) lower worm population than did horses on Farm A. Fenbendazole also was used on a regular basis on Farm D, but the timing of fecal sampling in the study did not permit an evaluation of its efficacy or duration of activity in preventing passage of strongyle eggs in the feces of grazing horses.

The efficacy of ivermectin was evident in this study. On Farm D, cyathostome eggs were detected in only 1 of 20 horses sampled in late September (when egg-laying would be prevalent) following treatment with ivermectin 56 days earlier. The horse that was positive exceeded the weight limit of the drug, thereby reducing the drug's effectiveness. Furthermore, on Farm A, the horses from the study were treated with ivermectin on November 12, 2002, and fecal samples were collected on November 25, 2002. At that sampling, no strongyle eggs were identified in any sample from the farm.

Thus, the control of strongyle worm levels is not only important for horses grazing on pasture, but also in horses that are stabled. Results of this study suggest that the use of ivermectin in these horses was associated with a longer suppression of cyathostome egg passage than was achieved with fenbendazole.

ACKNOWLEDGMENTS

The authors thank Gilbert Myers, PhD, Magnolia, KY, for his assistance with the laboratory analysis of fecal samples and his insight during the progression of this study; Marcia Collaer, PhD, Middlebury College, for her statistical assistance; and Middlebury College Senior Work Fund for their financial support. Finally, we express our gratitude to all horse owners who participated in this study.

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