Equine helminth infections: control by selective chemotherapy

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Summary
A programme of selective anthelmintic therapy was used in a herd of 31 horses. Faecal egg counts were done during the months of September, November, January, March, May and the following September. Horses with ≥100 eggs per gram (epg) were treated with ivermectin, and those with <100 epg were not treated. The criteria for adequate internal parasite control in the herd was a median herd faecal egg count of ≤100 epg. Effectiveness of selective therapy was assessed by faecal egg count after nine months of treatment and was determined to be adequate when a median herd egg count of 0 epg was obtained. However, on returning from pasture the following September, median herd egg count had risen to 325 epg. A statistically significant correlation was seen in the paired September faecal egg counts of the horses that had September faecal egg count for the following September. Initial September faecal egg count was related to the number of anthelmintic treatments required during the period of selective therapy, whereas age of horse was not. We propose that faecal egg counts be incorporated into strategic anthelmintic programmes as an economical tool for identifying and targeting herd members predisposed to shedding elevated numbers of helminth eggs.

Introduction
EQUINE gastrointestinal helminths (Strongylus, Parascaris, Strongyloides, Oxyurus and Anoplocephala) are important parasites warranting control. The major pathogens of adult horses are the large and small strongyles (Herd 1986). Traditional control has consisted of the rotational use of anthelmintics at six to eight week intervals (Drudge and Lyons 1966; Scoggins and DiPietro 1986). Recently, this control strategy has been questioned based on findings of increased helminth resistance to chemotherapy agents (Drudge and Tolliver 1981; Herd, Miller and Gabel 1981; French and Klei 1983; Herd 1986 and 1987; Reinemeyer and Henton 1987) and on epidemiologic grounds (Herd and Willardson 1985; Herd, Willardson and Gabel 1985; Craig and Courtney 1986; Herd 1986). The primary goal of anthelmintic therapy is to prevent environmental contamination by parasite eggs shed in the faeces of infected animals (Drudge and Lyons 1986; Herd 1986; Herd 1987; Georgi 1990). The treatment of horses with subclinical parasitic infections in an effort to prevent the development of clinical signs associated with severe infection also may be a secondary goal (Herd 1986; Ullinger 1989). Studies on man (Anderson and May 1982; Schad and Anderson 1985) and sheep (Dineen and Donald 1965; McKenna 1987) have revealed that certain individuals in a population are predisposed to parasitic infection by as yet undefined genetic, ecological or behavioural factors, and serve as reservoirs of infection. These studies suggest that the identification and selective treatment of predisposed individuals may provide a useful strategy for controlling parasitism in a population (Anderson and May 1982; Schad and Anderson 1985).

A herd of 31 horses stabled nine months of the year with access to pasture during three summer months was treated historically with anthelmintics at eight week intervals. We designed a programme of selective anthelmintic therapy based on faecal egg counts to determine a) if the proportion and nature of individuals in the herd that served as a reservoir for environmental contamination (by maintaining elevated faecal egg counts) could be identified economically using faecal examinations, b) if selective anthelmintic therapy for horses with faecal egg counts ≥100 epg could provide adequate parasite control in the population and c) if horse age or initial faecal egg count are associated with the frequency of anthelmintic therapy during the year of the selective programme.

Materials and methods
Horses were members of the Cornell University Polo string and aged three to 19 years (mean, 11.29 ± 4.4). The string consisted of 18 geldings and 13 mares of predominantly Thoroughbred and Quarter Horse breeding. Horses were brought in from pasture during September and were housed until late May in a tie-stall barn. Following the conclusion of their athletic season in late May, horses were returned to pasture. Horses were housed in tie-stall barns from September to May and pasture grazed during June, July and August in consecutive years of the study. At pasture, horses were inaccessible to study or anthelmintic treatment.

During the period of tie-stall barn housing, horses were allowed overnight exercise in the polo arena twice weekly where they were fed from the dirt floor. Manure was removed from the facility daily. Qualitative and quantitative faecal egg counts were done during the months of September, November, January, March, May and September by the Cornell-McMaster dilution egg counting technique as described by Georgi (1990) for a total of 186 samples. Concentration egg counts were performed on 147 samples with ≥100 epg by the Cornell-McMaster technique, between the months of September and May, to supplement the results obtained by the McMaster technique, which is inherently less reliable at low levels of parasitic infection (Georgi 1990). Horses with ≥100 epg of faeces at any sampling were given 0.2 mg/kg ivermectin orally; horses with <100 epg were not treated. The cutoff point of <100 epg of faeces was determined subjectively as being indicative of an insignificantly low level of parasitic infection and agrees with cutoffs used by other investigators (Herd 1986; Reinemeyer and Henton 1987; Ullinger 1989).

Statistical analysis
Statistical Analysis Systems (1985) was used in data summary and analysis. Spearman's correlation coefficient was used to compare...
faecal egg count results from Cornell-McMaster and concentration techniques. Following correlation, all subsequent analysis and data presentation was carried out using Cornell-McMaster faecal egg count results. Fisher's exact test was used to compare the proportion of horses with <100 and ≥100 epg during the initial September and following May samplings and during the initial September and following September samplings. Kendall correlation coefficient was used to determine whether paired faecal egg counts of individual horses obtained during the initial September sampling, prior to the initiation of selective chemotherapy, varied in concordance or discordance with those obtained the following September. Fisher exact test was used to determine 1) if horse age was related to the total of anthelmintic treatments needed during the study period and 2) if the faecal egg count for the initial September was related to the number of subsequent anthelmintic treatments needed.

Results

Population analysis

There was a strong correlation between faecal egg counts obtained using the Cornell-McMaster and concentration techniques. Correlation coefficients ranged from 0.86 to 0.93, with P<0.0001, for 147 paired samples obtained during the five samplings studied.

The median faecal egg count of 31 horses on selective anthelmintic therapy is presented in Figure 1. The herd median epg was elevated above the 100 epg cutoff point during the initial September sampling and during the following September sampling. During the months the horses were stabled, median herd faecal egg counts remained below 100 epg.

Initial September and following May faecal egg counts were analysed to test whether there were differences in the proportion of horses with <100 and ≥100 epg. Initial September counts revealed 10 horses with <100 epg and 21 with ≥100 epg. In May, following eight months of selective anthelmintic therapy, 26 had <100 epg and five had ≥100 epg. Significant (P=0.00008) differences were seen with more horses having elevated faecal egg counts during the initial September sampling as compared to the following May. However, after horses returned from pasture the following September, 12 had <100 epg and 19 had ≥100 epg, which was not significantly different from initial September results.

Individual analysis

Individual faecal egg counts obtained at the beginning of the selective chemotherapy trial were plotted against those obtained a year later, in an effort to determine if horses initially identified as shedders of high or low numbers of faecal eggs remained as such (Fig 2). Paired faecal egg counts for 31 horses on selective chemotherapy were highly correlated (Kendall's tau = 0.43511; P<0.001) from initial to subsequent September samplings. In other words, horses with high faecal egg counts initially were likely to have high counts the following September, and horses with low counts initially were likely to have low counts the following September.

Horses were classified by age (younger or older than the mean of 11 years) and number of anthelmintic treatments required during the study year. A relationship was not observed between age and number of treatments required under the selective anthelmintic program. The initial September faecal egg count of <100 or ≥100 epg was tested to determine if it was related to the number of anthelmintic treatments given after September. Ten horses had initial counts <100 epg: eight of these either did not require treatment or required treatment once, whereas two required treatment two or three times during the study year. In contrast, 21 horses had initial counts ≥100 epg: five did not require treatment or required treatment once, whereas 16 required treatment two or three times. Therefore, initial faecal egg count was significantly related (P=0.005) to the number of subsequent anthelmintic treatments needed by horses having low counts requiring less frequent treatment and horses with high counts requiring more frequent treatment. This relationship is depicted in Figure 3, which shows the median faecal egg counts of horses requiring 0, 1, 2, 3 or 4 anthelmintic treatments during the study year. Interestingly, the median faecal egg counts of the five horses that did not require treatment during the study year remained 0 throughout.

Economic analysis

The year prior to the present study, the 31 horses were given oral ivermectin paste at eight week intervals, which cost $1,923.24 (186 treatments). Selective anthelmintic therapy of horses with faecal egg counts ≥100 epg resulted in drug costs of $703.12 (68 treatments).
The $1,220.12 difference in drug costs was applied toward McMaster faecal examinations, which were performed economically under private practice conditions (Herd 1986) and cost $372.00.

**Discussion**

Parasites exist among their hosts in a highly aggregated fashion with few individuals harbouring the majority of parasites (Dineen and Donald 1965; Crofton 1971; Anderson and May 1982; Schad and Anderson 1985; Herd 1987; McKenna 1987). Faecal egg counts have been correlated to adult worm burden in man (Schad and Anderson 1985) and sheep (Dineen and Donald 1965).

Definitive work relating equine faecal egg counts to worm burdens has not been published to our knowledge, although frequent references to a lack of correlation are made (Herd 1986; 1987). Clearly, faecal egg counts cannot be used to indicate the presence of immature, migrating or hypobiotic parasites, all of which are frequent occurrences in equine helminth infections (Ogbourne 1971). In addition, faecal egg counts are not indicative of parasite infections in which eggs are not shed in the faeces (Oxystomum). The use of faecal egg counts in this study was restricted to identifying horses that, by shedding increased numbers of eggs, serve as a reservoir of infection for the herd. In this way, faecal egg counts also were used to assess the efficacy of selective anthelmintic therapy in the group of 31 horses.

The goal of selective anthelmintic therapy was to keep the mean faecal egg count of the herd below 100 epg. This goal was achieved with selective therapy during the nine months the horses were stabled, with median faecal egg counts in the herd of 0, 100, 0 and 0 epg during the months of November, January, March and May, respectively (Fig. 1). It was not an objective of the study to determine the effect of leaving the horses untreated.

Following three months at pasture without anthelmintic therapy, the median herd egg count rose to 225 epg. This was an unexpected phenomenon given the increased exposure of the herd to parasitic larvae (Herd and Willardson 1985), the three-month absence of anthelmintic therapy and the reported seasonal fecundity of strongyles (Ogbourne 1971). Interestingly, the faecal egg counts of individual horses were highly correlated during the sequential September samplings (Kendall's tau correlation coefficient 0.435; P<0.001; Fig 2). Thus, faecal egg counts obtained during the initial September were predictive of faecal egg counts obtained the following September. In addition, horses' initial faecal egg count was related to the number of subsequent treatments needed under the selective anthelmintic programme. These findings suggest that individual horses in a herd may demonstrate predisposition to parasitic infection. Possible mechanisms contributing to predisposition to parasitic infection in the horse may be similar to genetic and/or behavioural mechanisms hypothesised in other species (Dineen and Donald 1965; Anderson and May 1982; Schad and Anderson 1985).

In this study, equine faecal egg counts provided an economical and useful tool for identifying herd members who were predisposed to shedding elevated numbers of helminth eggs and thus served as a source for herd exposure. Recommendations for evaluating the effectiveness of anthelmintic programmes that employ faecal egg counts obtained from herd subsamples or done on combined faecal samples from several individuals in the herd are not designed to identify the small proportion of herd members predisposed to shed elevated numbers of helminth eggs. We propose that total herd faecal egg counts be used to identify, and target for supplemental anthelmintic therapy, herd members predisposed to shedding elevated numbers of helminth eggs and that this strategy be integrated with strategic anthelmintic programmes and sound pasture management to improve equine parasitic control.

**Acknowledgements**

The authors thank B. Tankersley and J. Descanio for their assistance with the investigation; W. Brashier for secretarial assistance; C. Rosenthal for assistance with the statistical analysis and members of the Ambulatory Clinic at the New York State College of Veterinary Medicine for their encouragement, financial support and assistance in the preparation of the manuscript.

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**Received for publication: 10.7.90**

**Accepted: 14.9.90**