These Ain't Your Father's Parasites: Dewormer Resistance and New Strategies for Parasite Control in Horses

Ray M. Kaplan, DVM, PhD, DEVPC

Department of Infectious Diseases
College of Veterinary Medicine
University of Georgia
Athens, Georgia 30602

Summary

Most veterinarians continue to recommend anthelmintic (dewormer) treatment programs for horses that are based on knowledge and concepts that are more than 40 years old. However, recent studies demonstrate that resistance and multiple-drug resistance in equine parasites is extremely common, but few horse owners or veterinarians take this into account when making treatment decisions. Parasites are highly over-dispersed in hosts, such that a small percentage of hosts (20%) harbor most (80%) of the parasites. The common practices of recommending the same treatment program for all horses despite great differences in parasite burdens, of recommending frequent preventive treatment of all horses without any indication of parasitic disease or knowing what species of parasites are present, of recommending the use of drugs without knowledge of their efficacy, of failing to perform fecal egg count surveillance and of failing to determine if treatments are effective, are all incompatible with achieving optimal and sustainable parasite control. Consequently, it is necessary that attitudes and approaches for parasite control in horses undergo a complete overhaul, and that both horse owners and veterinarians become educated in these important issues.

Introduction

The introduction of benzimidazole (BZ) anthelmintics (dewormers) led to a revolution in equine in parasite control (Drudge and Lyons 1966). With these new tools came new recommendations; horse owners were advised to deworm all horses every 8 weeks. These recommendations were widely adopted, resulting in a dramatic reduction in morbidity and mortality from parasitic disease. For the first time ever it was possible to truly control equine parasites, leading to significant improvements in equine health and performance. By the 1970's and 80'new dewormers became available and rotation between drugs became a common practice. Unfortunately, parasites have risen to the chemical challenge. Anthelmintic resistant small strongyles (small strongyles) now are highly prevalent and even where drugs still are effective, the egg reappearance period (ERP) following treatment has become significantly shorter. Today most horse owners continue to follow recommendations that are based on knowledge that is more than 40 years old and frequently use dewormers that have become totally ineffective due to the presence of drug-resistant parasites. Furthermore, the strict adherence to outdated approaches has produced a mentality of fear – horse owners deworm frequently because they think they have to, and because they fear what might happen if they do not. But the truth is that most adult horses will remain quite healthy with much fewer treatments, and this is the reason why parasite drug resistance usually goes unnoticed for long periods. Therefore, it is important for horse owners and veterinarians to become educated in the latest knowledge on parasite biology so that parasite control practices can be modernized to meet the new issues and problems we now face.

A shift in emphasis: the downfall of *Strongylus vulgaris* (large strongyle bloodworm) and the rise of small strongyles (small strongyles)

Prior to the introduction and strategic use of benzimidazole (BZ) anthelmintics, it is estimated that 90% of colics were due to migrating arterial stages of the large strongyle parasite *Strongylus vulgaris* (Drudge and Lyons 1977). However, the excellent efficacy of modern dewormers has markedly decreased the prevalence of this parasite, and the once common affliction of colic due to this parasite has become a rare occurrence in managed horses (Lyons, Tolliver et al. 1999). By the early 1980's it was recognized that small strongyles frequently accounted for virtually 100% of the strongyle worm egg output of grazing horses. This major change in species prevalence has caused an important shift in the relative importance of these nematodes; small strongyles are now recognized as the principal parasitic pathogen of horses (Love, Murphy et al. 1999). Contributing to the pathogenic potential of these parasites is the problem of drug resistance which is now reaching alarming levels. Disease symptoms in horses infected with small strongyles range from no measureable effect, to a mild subclinical alteration in gastrointestinal function, to a life-threatening disease known as larval cyathostomosis, characterized by severe weight loss, chronic diarrhea, and edema. It is important to understand that it is the larval worms that come out of the intestinal wall (mucosa) that are the most damaging stage of the infection. The adult worms, which with few exceptions are the stages killed by dewormer treatments cause very little damage to the horse. So in order to optimize horse health, it is necessary to prevent new infections. Consequently, we aim to kill adult worms with our treatments, but it is actually the prevention of egg shedding that does most for horse health and overall worm control because by doing this we reduce numbers of infective larvae on pasture and subsequent infections in the grazing horse.

Anthelmintic Resistance: a growing threat to parasite control and equine health

Currently used parasite control programs are almost completely dependent upon the intensive use of dewormers. Presently there are three major chemical classes of dewormers used to control nematode parasites in horses: benzimidazoles (fenbendazole – Safeguard®, Panacur®, oxfendazole -- Benzelmin®, oxibendazole – Anthelcide EQ®), tetrahydropyrimidines (pyrantel salts – Strongid®, others), and avermectin/milbemycins (ivermectin -- Eqvalan®, Equimetrin®, Zimectrin®, others; and moxidectin – Quest®; note that avermectin/milbemycins are also referred to as macrocyclic lactones). Of these three drug classes, resistance to BZ is the most prevalent and widespread, with reports of resistance from over 21 countries. Reports of resistance to pyrantel are less common, but the true prevalence of resistance in most of the world is unknown. In 2001-2002, a large multi-state study was performed to determine the prevalence of resistance on horse farms in the southern United States (Kaplan, Klei et al. 2004). 1274 horses on 44 large stables in Georgia, South Carolina, Florida, Kentucky, and Louisiana were tested in this study. The fecal egg count reduction test (FECRT) was performed on each farm using 4 different dewormers: fenbendazole, oxibendazole, pyrantel pamoate and ivermectin. Resistance testing was only done for the small strongyles. Using fairly conservative criteria that were chosen to minimize the chance that a farm would be designated as having resistant worms if resistance was not present, the percent of farms found to harbor resistant worms were as follows: 97.7% for fenbendazole, 0%, for ivermectin, 53.5% for oxibendazole and 40.5% for pyrantel pamoate. In terms of actual reductions in fecal egg counts (FEC), the mean percent reductions for all farms were 24.8% for fenbendazole, 99.9% for ivermectin, 73.8% for oxibendazole and 78.6% for pyrantel pamoate. With the exception of ivermectin, these values are far below the levels needed for effective worm control. Interestingly, statistical analysis between states for each treatment revealed that in almost all instances there were no statistical differences in results between states.

The prevalences of resistance to fenbendazole, oxibendazole, and pyrantel pamoate found in this study were far greater than in any previously published report. Furthermore, results from all 5 southern states were remarkably similar despite major differences in the types of farms and in physical geography. This suggests that drug resistance in small strongyles is highly prevalent throughout the entire southern United States and probably nationwide. These results indicate the following: (1) that drug resistance in small strongyles is much more common than is commonly recognized, (2) that the problem of anthelmintic resistance in small strongyles is worsening, and (3) anthelmintic resistance may be more severe in the United States than elsewhere in the world. It is interesting to note that the high prevalence of resistance to pyrantel pamoate found in this study has not been detected in studies performed outside the United States. Many parasitologists have suspected that low-dose daily feeding of pyrantel may lead to resistance. Because the United States and Canada are the only countries in which daily feeding of low-dose pyrantel tartrate is practiced, one must wonder whether this mode of administration is having a major impact on the selection for resistance to pyrantel.

The results of this study indicate that a serious situation is emerging for small strongyle control in horses. More than 40% of all farms tested had small strongyle populations that are resistant to fenbendazole (FBZ), oxibendazole (OBZ) and pyrantel pamoate (PP), meaning that on almost half of all farms, only a single drug class (avermectin/milbemycin) that has been in use for 25 years remains effective. However, in the past 3 years there have been reports out of the United Kingdom, Australia and Brazil indicating the presence of avermectin/milbemycin (AM) -resistant small strongyles. AM-resistant small strongyles have not yet been reported in the US, but recently a report from the University of Kentucky indicates reduced activity of ivermectin which is suggestive of early resistance (Lyons, Tolliver et al. 2008). These reports are not surprising – what is surprising is how long it took before resistance developed. AM resistance is extremely common and widespread in closely related parasites of sheep and goats; in the southeastern US the prevalence of ivermectin resistance in *Haemonchus contortus* (barber pole worm) is approximately 90%. Reports of AM resistance in parasites of cattle also are becoming increasingly common. Furthermore, numerous reports suggest that AM resistance is quite common in roundworms (*Parascaris equorum*) of horses, which is the most important parasite of foals.

Given the fact that resistance to ivermectin and moxidectin in the small strongyles may already be present in Kentucky, the appropriate solution to the problem of drug resistance is not to simply use more ivermectin and moxidectin because these drugs continue to be effective against small strongyles. Testing should be done on each farm to determine which drugs work and which do not. Since OBZ is considerably more effective than FBZ, OBZ should be used in all instances in place of FBZ for single dose usage. An alternative to AM anthelmintics may be using drug combinations of OBZ and PP. We recently completed a study to investigate whether combined use of OBZ and PP would produce clinically significant increases in efficacy as compared to the use of these drugs individually. On 10 of the 12 farms the combination treatment was highly effective in reducing FEC compared to the drugs used singly (Kaplan, Menigo et al. 2005). These data suggest that on most farms using OBZ and PP in combination results in clinically significant increases in efficacy, and produces a very high level of FECR. Overall, based on these results, routine use of OBZ and PP in combination may be considered when the drugs are not highly effective individually. This may be especially important when treating foals since ivermectin and moxidectin resistance appears to be increasingly common in roundworms (*Parascaris equorum*). However, as always, the effectiveness of these drugs needs to be evaluated before relying upon them, and then monitored by periodic surveillance of FEC pre and post treatment.

These resistance issues need to be appreciated in the context of what can be expected in the future with regard to development and marketing of new dewormers (meaning completely new drug classes, not just new products of existing classes). The great cost associated with the development of new drugs has greatly reduced investment into discovery and development of new dewormers. Of promise is discovery of a new dewormer recently announced by Novartis, but it is unlikely that an equine product will be marketed in the near future, and it is possible that it may never be marketed for horses. Also of relevance is the fact that any new dewormer products are almost certain to be much more expensive that current products. Therefore, as we diagnose AM resistance with increasing frequency, options for control with dewormers will be quite limited as there will likely be a delay of many years before any new drugs are available. The increasingly high prevalence of anthelmintic-resistant small strongyles must therefore be taken into account when designing worm control programs for horses. It is strongly recommended that prior to using a BZ drug or pyrantel on a horse farm that a FECRT be conducted to rule out the presence of drug-resistant worms on that property. Furthermore, ivermectin resistance could appear at any time.

How can we achieve optimal and sustainable worm control?

Strategies to decelerate further development of drug resistance thereby extending the lifetime of currently effective dewormers should be implemented whenever possible. This goal can best be achieved by treating the right horse with the right drug at the right time. Recipe-based treatment programs based solely on the calendar without regard to the medical needs of individual horses, the biology of the parasites, or whether the drug is actually effective against the target parasites can no longer be justified or recommended. An *evidence-based approach* where the biology of the target parasites and the effectiveness of drugs are considered, and each horse is viewed as an individual patient with individual medical needs must be adopted. To develop such a programs we must combine the following: (1) epidemiological principles of nematode control; (2) determine which drugs are effective on each farm; (3) use the correct drug for the correct parasite at the correct time of the year; (4) determine which horses require less or more frequent treatment by performing FEC; and (5) evaluate the overall success of the worm control program by monitoring the FEC of all horses on the property at regular intervals. Implementation of such programs will only be possible if veterinarians take a central and active role so it is important that horse owners are willing to pay for these services.

In the course of my studies investigating anthelmintic resistance, I have met many horse owners who refuse to adjust their normal deworming routine even when shown results of FEC that are negative. This attitude commonly held by horse owners stems partly from the belief that all worms are bad and that no worms should be tolerated in a horse. This attitude is also influenced by the widely held notion that all horses are highly susceptible to worms and therefore all horses should be treated the same. However, both of these notions are completely false. Horses evolved with their intestinal worms and small numbers of most worms do not cause any significant health impairment, but rather help to stimulate immunity that serves to protect the horse from the establishment of a more serious worm burden. In fact, small strongyles rarely cause severe disease. Unless parasite control fails miserably, most horses will not show symptoms of disease. Furthermore, small numbers of eggs shed by untreated horses are critical for slowing the development of anthelmintic resistance (details below). Finally, all horses are not the same. Parasite burdens are highly aggregated in hosts, meaning that about 20-30% of horses harbor about 80% of all the worms. On many farms this distribution is skewed even further. Thus, some horses carry extremely high worm burdens (even when treated frequently with dewormers) while other horses have strong immunity and are infected with few worms (Figure 1).

In recent years, parasitologists have come to view the most important factor affecting the rate of development of anthelmintic resistance as the proportion of drug-selected to unselected parasites in a population (Sangster 1999; Van Wyk 2001). This unselected portion of the population, called refugia, provide a pool of genes susceptible to anthelmintics, thus diluting the frequency of resistant genes. As the relative size of the refugia increases, the rate of evolution towards resistance decreases. Therefore, it is likely that, by serendipity, the lack of efficacy of ivermectin against encysted mucosal small strongyle larvae has helped to preserve its efficacy. These mucosal larvae, which are usually present in far greater numbers than the adult stages, provide a large refugia when ivermectin is administered to a horse.

Successful nematode parasite control, while maintaining limited refugia, is only possible if routine FECs are performed to identify those horses that require treatment and those that do not. Although this recommendation is contrary to the treat-all-animals paradigm that often has been taught in the past, it is highly compatible with the host-parasite dynamics of small strongyles. In our recent study on anthelmintic resistance, most farms deliberately delayed scheduled dewormer treatments (for purposes of the study), and farm data were only included if sufficient horses were passing adequate numbers of small strongyle eggs, a condition met by only 44 of 62 (71%) farms. Nevertheless, we still found that > 33% of all horses on these 44 farms had a FEC < 20 eggs per gram (EPG) and on some farms this value exceeded 50% (see Figure 1).

In that study we used a very sensitive method for determining FEC, which improved the precision of our measurement. In contrast, the more commonly used McMaster method, which is the technique I currently recommend for clinical use, has a minimum sensitivity of 25 EPG. By use of the McMaster method, all of these horses would theoretically have had negative results on fecal examinations. This skewed distribution of FECs, combined with high degrees of anthelmintic resistance and frequent deworming, suggests that parasite control is being neglected severely in some horses, whereas many other horses are being treated much more frequently than necessary. Leaving horses with low FECs untreated will have little impact on overall strongyle control, but the small numbers of eggs shed will greatly dilute the contribution to pasture contamination made by treated horses that may be shedding eggs produced by drug-selected (and/or resistant) worms. Such an approach will succeed in reducing selection pressure for resistance while improving overall parasite control. Because this will require a fresh view toward parasite control as well as diagnostic capabilities, the only way this treatment scheme can be successful is by having veterinarians once again take an active and leading role in designing and monitoring the effectiveness of parasite control programs.

Costs of performing FEC must be viewed as a necessary expense for maintaining optimal horse health. Owners must be warned against embracing the mistaken notion that since the price of a tube of dewormer is the same or less than the price of a FEC that it is cheaper to just go ahead and treat. Millions of tubes of dewormer are being administered to horses every year that are killing very few parasites either because there are very few worms in the horse to kill, or because the drug is ineffective as a result of resistance. Furthermore, there are future costs to over-treating in the form of worsening drug resistance. So not only do current practices of over-treating horses waste money and promote drug resistance, but by not monitoring the success of the program using FEC, there is no way to know how successful the program actually is. In the early years of the modern age of anthelmintics (1960's and 1970's), passage of a nasogastric tube was required for administration of dewormers to horses. Consequently, deworming of horses was almost an exclusive activity of veterinarians. However, over the past few decades, the ready availability of safe, effective, inexpensive, and easily administered dewormers to has led to an important decrease in veterinary involvement in parasite control. This trend must change -- veterinarians need to become more involved in developing and monitoring parasite control programs, because the growing problem of anthelmintic resistance only will worsen in the future. This can only happen if horse owners appreciate the value of such services and provide a market demand for these services.

Which parasites are important and which should be targeted in a control program?

Small strongyles (small strongyles) are considered the principal parasitic pathogens of adult horses, but tapeworms (*Anoplocephala perfoliata*), bots (*Gasterophilus* spp), and large strongyles (*Strongylus vulgaris*, *S. edentatus*, and *S. equinus*) are also considered to be significant pathogens and worthy of specific targeting in a worm control program. As mentioned previously, the large strongyles, particularly *S. vulgaris* are now quite rare in managed horses and require only once or twice (depending on climate) yearly strategic treatments to keep them that way. Other less common and less important parasites such as stomach spirurid worms (*Draschia, Habronema*), pinworms (*Oxyuris equi*), *Onchocerca*, *Trichostrongylus axei, Dictyocaulus arnfeldi, and Strongyloides westeri* are expected to be controlled by default in a properly designed program which takes into account the main group of parasites that are targeted. If any of these "lesser" parasites are diagnosed, they should be treated on a case by case basis. It is important to note that in areas of the US where suppressive treatment of horses has not been commonly practiced over the past few decades, such as in the desert southwest, some of these parasites of "lesser importance" such as *Habronema* and *Draschia* remain quite common and important. In foals, the same parasites listed above for adult horses are also important, but added to this list is the roundworm, *Parascaris equorum*, which is considered to be the most important parasite of foals.

When should anthelmintic treatments be given and what criteria should be used to make treatment decisions?

When a treatment is given is just as important as which drug is used. Reasons for this include the following: (1) virtually all of the parasites listed above are transmitted seasonally (2) each parasite has a different life cycle, and host interaction (3) larval rather than adult stages are most pathogenic for both the large and small strongyles; and (4) the different dewormers have differing spectra of activity against the different worms and in many cases against different stages of the same worms. With this in mind, it becomes obvious that treatments evenly spaced throughout the year simply do make any biological or medical sense. Optimal and rational worm control demands that the most appropriate drug be administered at the most appropriate time. In the large majority of situations, all of the important parasites of adult horses listed above except small strongyles can be satisfactorily controlled with only 2 – 3 treatments each year. In many horses, 2 - 3 treatments each year will also be sufficient for controlling small strongyles, but other horses will require several more treatments.

The timing and frequency of treatments must be based on a large number of factors among which are: the time of year, the parasite species being targeted by treatment, the age of the horse, the level of immunity of a particular horse to small strongyles (as revealed by FEC), and which drugs were used previously and when they were used. Ultimately, treatments should be worked into a logical program that addresses all the parasites of concern, without trying to address each parasite individually.

Tapeworms: In Kentucky, post-mortem surveys indicated that tapeworms are transmitted to horses predominantly in the summer and fall; however, it is not clear whether tapeworm transmission in Florida follows this same pattern. Also, there is no consensus on how often horses need to be treated for tapeworms. One properly timed treatment per year likely is enough under most circumstances, but there is little data to support the need for more or less frequent treatments. Nevertheless, a single treatment in the late fall/early winter +/- a second treatment in the spring may be advised. It is quite possible that this recommendation could change if more data is published on the epidemiology of tapeworm transmission in Florida. Of course, if tapeworms are diagnosed as a clinical problem on a farm, then treatment every 4 months would be advisable until the problem is under control.

Bots: In northern Florida, bots are transmitted predominantly in the fall, with a small peak in early summer. It is recommended to treat for bots in January, as in most years a hard frost will have occurred, thus greatly reducing bot activity. A second treatment in early autumn may be needed in some years or on some properties. However, in general, years of ivermectin and moxidectin treatments have greatly reduced the magnitude of bot activity, thus bots are not as big a concern as they once were. In reality, bots are more of an aesthetic problem than a medical problem.

Small strongyles: When considering the treatment interval for control of small strongyles (which is typically the primary target of worm control in adult horses), a number of factors must be considered, but foremost among these is the fact that each drug has a different egg reappearance period (ERP). Small strongyles encyst in the intestinal wall as part of their normal life cycle. Single-dose dewormers have no activity against these stages (with the exception of moxidectin) and only kill the worms in the lumen of the large intestine (mostly adult worms with some mature larvae). Following treatment with a dewormer, larvae encysted in the intestinal wall come out and fairly rapidly repopulate the intestinal lumen and begin shedding eggs in the feces. Frequently used every 8-week rotational treatment strategies will fail to achieve optimal control because the ERP of BZ drugs and pyrantel is only about 4 weeks (assuming the drugs were effective in the first place which is often not the case). If used at 8-week intervals, significant pasture contamination (from the high egg shedding horses) will occur between treatments ensuring that horses are always ingesting numerous parasite larvae from pasture. The ERP of ivermectin is approximately 8 weeks and moxidectin is 12-16 weeks. Thus, treating 8 weeks after moxidectin will be a useless endeavor – there will be virtually no worms to kill. [Note that these ERPs continue to shorten, so one can no longer assume they will see the usual historic intervals. In fact ERP of 4 weeks are being reported for ivermectin, thus it is worth doing periodic surveillance to check]

Before one can understand why particular recommendations for worm control make sense, he or she must understand what the objective of the control program actually is. It is an interesting exercise to ask horse owners, "Why should you control parasites?" Most will offer a response that includes some reference to improved health or enhanced performance. But the answers differ if one refines the question and asks, "What are you specifically trying to do when you give a dewormer?" The most frequent answer is, "To kill worms". However, killing worms per se is NOT the objective of a parasite control program. This is especially true for small strongyles, which exert the majority of their pathogenic effects BEFORE they are susceptible to many dewormers. An important fact that is often overlooked or is simply not appreciated but is extremely important to remember is that the *encysted larval small strongyle worms in the intestinal wall are most pathogenic to the horse* (and the worst of these effects is when the larvae emerge to repopulate the lumen)*; and ivermectin, pyrantel pamoate, and BZ (single dose) only kill adult worms.* Only moxidectin and a double-dose 5-day regimen of FBZ (if no high-level resistance to FBZ) will kill the encysted larvae. In contrast, the adult worms in the intestinal lumen that are shedding the eggs are much less damaging than the immature encysted forms.

The true objective of a worm control program is to optimize the health of horses --- NOT to kill all worms. Small numbers of small strongyle worms cause little harm and treating low level infections can actually cause more harm to the horse than not treating. With this in mind, the real goal of the worm control program for horses is preventing contamination of the environment with the eggs of the target parasites. For small strongyles, the direct source of infection is larvae on pasture, and those larvae develop from eggs deposited by grazing horses. Once strongyle eggs turn into infective larvae, the only factors that can diminish the risk of future infections are hot weather, time, and keeping horses off the pasture. The only practical way to decrease future infection is by limiting the passage of worm eggs by killing female worms before they reproduce. So that's what we aim for with small strongyle control recommendations: limiting the passage of large numbers of strongyle eggs onto pasture. To accomplish this goal, treatments must be administered at concentrated intervals for limited "high transmission" times of the year. At times of the year when survival and/or development of small strongyle eggs and larvae on pasture is minimal (summer in south, winter in north), there is little reason to treat with a non-larvicidal product.

Because the hot summer weather of Florida precludes any significant cyathostome transmission, treatments should be started around October 01 and continued until March or April. Treatments can be stopped in March or April because if the recommendations listed below are followed, minimal pasture contamination with parasite eggs has occurred for 6-7 months. Therefore, few worms will be available to infect the horses, and by the time pastures might once again start to be contaminated with significant numbers of eggs and larvae (after the ERP of the last treatment in spring expires), environmental conditions will prevent their development and/or survival.

Back to selective treatment -- how do you decide if a horse should be treated or not? There is no absolute cutoff in FEC that can be used to determine whether a horse needs treatment or not. This will change on the basis of season, stocking rates, age of horse, overall health of horse, and tolerance of the owner. In response to the question "At what FEC value should you deworm a horse?", 7 equine parasitologists gave answers ranging from 200 to 500 EPG (Uhlinger 1993). FECs do not directly correlate with luminal worm burdens, but it is very unlikely that horses with FEC less than 200 EPG will be suffering ill effects from those infections. Another way to examine this issue is to segregate horses into 3 categories based upon their strongyle contaminative potential. The contaminative potential of a horse can be determined by examining a fecal sample collected approximately four to eight weeks after the expiration of the ERP for the last effective dewormer it received. Depending upon the last drug used, this may require a break in scheduled deworming treatments if horses are treated at regular intervals year round (something I do not recommend). The best time to do this would be the late winter/early spring since there is unlikely to be any negative consequence of not treating, and in fact I do not recommend treating over the winter. Since the relative magnitude of contamination (as measured directly by FEC) is a repeatable characteristic of individual animals, horses can be classified as low, moderate or high egg shedders. In herds that have not been dewormed recently, certain horses (approximately 20-30% of the herd) have high egg counts, another proportion will have low egg counts (30-50%), and the remainder cluster around the average. Adult horses with egg counts <200 EPG are classified as Low Contaminators/Shedders, and those with EPGs >500 EPG are classified as High Contaminators/Shedders. The remainder of horses, with EPGs >200 to <500 EPG, are classified as Moderate Contaminators/Shedders.

Given this information what is a rational worm control program? Worm control programs are best viewed as a yearly cycle starting at the time of year when worm transmission to horses changes from negligible to probable. In Florida, this is in late summer/early autumn as temperatures begin to drop. Intestinal strongyles of horses simply do not survive and develop on pasture to any significant level during the hot summers in the Florida (or elsewhere in the South for that matter). The goals of the program laid out here are to: keep FEC low thereby reducing future worm transmission, kill all important parasites at the correct time of the year, and reduce the development of drug resistance. Please keep in mind that this is just one of many possible programs and there is room for differences of opinion among parasitologists and veterinarians. Ultimately, each farm (with veterinary guidance) should develop its own program tailored to the needs of the farm. The take home message must be that there is no such thing as a one size fits all program. But that does not mean that whatever one decides to do is OK -- there are many programs that are clearly poor, because they do not take into account the factors discussed in this paper.