Deworming programs for horses: are we doing more harm than good ?

Andrew S. Peregrine, BVMS, PhD, DVM, Diplomate EVPC, MRCVS
Department of Pathobiology, Ontario Veterinary College, University of Guelph,
Guelph, Ontario N1G 2W1

For approximately the last 30 years horses have traditionally been dewormed at regular intervals throughout the year, typically every 6 to 8 weeks. In foals, such regimens have been used to control *Parascaris equorum*. In mature animals, interval treatment regimens were primarily designed to control *Strongylus vulgaris*. However, subsequent to the introduction of ivermectin in the 1980s, *S. vulgaris* became an uncommon infection of horses - largely because, unlike earlier drugs, ivermectin eliminated both adult and immature stages of *S. vulgaris*. In contrast, cyathostomes (small strongyles) have become increasingly important as a cause of morbidity and mortality in horses, and today are considered the primary reason for deworming animals that spend time at pasture (Love et al., 1999). Horses become infected with cyathostomes by ingesting infective larvae in pasture. Thereafter, the parasites invade the wall of the large intestine and, over a period of weeks to months, encyst and increase in size. Eventually the parasites break out into the lumen of the large intestine where they mature and produce strongyle eggs. The change in importance of cyathostomes over the last 20 years is thought to have occurred because none of the currently licensed anthelmintics, except moxidectin, have activity at standard dosages against immature stages encysted in the wall of the large intestine. In addition, cyathostomes have been particularly adept at developing anthelmintic resistance (see below). Because this resistance appears to have arisen in association with excessive and inappropriate use of dewormers, there is increasingly a need for veterinarians to look critically at the deworming programs used by clients so that problems with anthelmintic resistance do not worsen.

How common is anthelmintic resistance ? In order to fully answer this question it is important to appreciate that all the drugs licensed in Canada for treatment of nematode infections in horses belong to just three chemical classes (see Table 1). Since drugs in the same class have the same mechanism of action, if parasites develop resistance to one drug they generally develop resistance simultaneously to all drugs in the same chemical class.

Table 1. Drugs licensed in Canada for treatment of nematode infections in horses

Dewormer chemical class	Compound	Commercial name
benzimidazole	fenbendazole	Panacur/Safe-Guard
	oxibendazole	Anthelcide EQ
	oxfendazole	Benzelmin
tetrahydropyrimidine	pyrantel	Strongid/Exodus
macrocyclic lactone	ivermectin	Eqvalan/Panomec
	moxidectin	Quest

Anthelmintic resistance in cyathostomes. The gold standard for evaluation of the anthelmintic susceptibility of cyathostome infections is the Fecal Egg Count Reduction Test (FECRT; see below). Over the last 30 years there have been multiple reports from across North America of cyathostome infections in horses that are resistant to benzimidazoles. In recent work, the FECRT was carried out on 44 horse farms, representing various breeds, in Georgia, South Carolina, Florida, Kentucky and Louisiana. Resistance to fenbendazole was found on 98% of the farms. Furthermore, the authors concluded that single dose treatment with fenbendazole is ineffective against cyathostome infections on almost all farms in the southern USA (Kaplan et al., 2004). In light of the high prevalence of resistance to benzimidazoles around the world (Lyons et al., 1999; Kaplan, 2002), and the large movement of horses around North America, it is highly likely that a large proportion of farms in Canada have benzimidazole-resistant cyathostomes. Anecdotal evidence suggests that this is the case.

Since 1991, pyrantel-resistant cyathostomes have been described in southern parts of the USA (Chapman et al., 1996; Woods et al., 1998). In the aforementioned study by Kaplan et al. (2004), pyrantel resistance was detected on 41% of the farms investigated in the southeastern USA. Resistance to pyrantel has also been demonstrated in Ontario (Slocombe and De Gannes, 1998). It should be noted that the prevalence of pyrantel resistance observed in North America is significantly higher than other parts of the world, and appears to be associated with daily feeding of low-dose pyrantel as this treatment regimen is not licensed in other parts of the world (Kaplan et al., 2004).

Resistance to macrocyclic lactones has yet to be described in cyathostomes. However, since resistance to ivermectin is becoming a significant problem associated with gastrointestinal nematodes of both small ruminants and cattle it is considered inevitable that resistance to macrocyclic lactones will develop in cyathostomes (Lloyd and Soulsby, 1998; Sangster, 1999).

In summary, benzimidazole resistance in cyathostomes is now a common occurrence in North America. Secondly, the prevalence of resistance to pyrantel appears to be increasing rapidly. And thirdly, of particular concern, many farms in the southeastern USA now have cyathostomes that are resistant to both benzimidazoles and pyrantel (Kaplan et al., 2004). At present, the clinical significance of this resistance is unclear. However, the increasing annual incidence of cases of acute larval cyathostominosis, an enteropathy associated with synchronous emergence of large numbers of cyathostomes from the wall of the large intestine (Lyons et al., 2000), is thought to be associated with anthelmintic resistance (Tarigo-Martinie et al., 2001; Peregrine et al., 2002).

Anthelmintic resistance in roundworms. For many years it was considered unlikely that drug resistance would develop in *P. equorum*. However, very recently, work on a large Thoroughbred farm on the east side of Toronto identified *P. equorum* infections in foals that were resistant to ivermectin (Hearn and Peregrine, 2003). As with the aforementioned studies on cyathostomes, this resistance was primarily demonstrated with the FECRT. However, over the last two years a number of foals have presented to the OVC from across Ontario with ascarid impactions despite regular deworming with ivermectin. It would therefore appear that ivermectin-resistant *P. equorum* occur on multiple farms in the province and that the resistance is now of clinical significance.

Designing a deworming program. Since it is unlikely that new anthelmintic classes of drugs will be introduced in the near future, it is increasingly important to use parasite control programs that decrease the rate of selection of anthelmintic resistance. When designing such a program it should be recognized that the most important risk factor for development of anthelmintic resistance is frequent treatment of all animals. As a result, the primary objectives for a deworming program should be to decrease the number of anthelmintic treatments AND to decrease environmental contamination with parasites. In order to achieve these objectives, the following are guidelines for control of cyathostomes:

1. ***Use strategic deworming treatments based on the parasite's epidemiology.*** This varies with the geographic location of an animal. However, since cyathostomes are acquired by horses at pasture, animals only need deworming while at pasture. It should also be recognized that the viability of cyathostome larvae is greatly reduced once minimum daily temperatures decrease below 0^{o}C (Baudena et al., 2000). Thus, a typical horse that lives year round in Ontario does not require anthelmintic treatments during the winter months. However, if an animal moves south during the winter, into the central/southern USA, additional deworming treatments may be required if the animal spends time at pasture.
2. ***Use inter-treatment intervals that are based on a drug's efficacy.*** The time interval between dewormer treatments should reflect the expected time following treatment that a horse's feces will remain negative for strongyle eggs, i.e. the "egg reappearance time". This interval varies amongst dewormers as some anthelmintic drugs only remove adult parasites while others remove both adults and immature parasites. Reasonable estimates for the egg reappearance time of different dewormers, in the absence of anthelmintic resistance, are as follows:
   - benzimidazoles = 4-5 weeks
   - pyrantel = 4-5 weeks
   - ivermectin = 6-8 weeks
   - moxidectin = 12 weeks

   When selecting a treatment interval one should not use a duration that is shorter than these figures. Ideally, an interval should be used that is as long as possible – fecal egg counts (FEC) for a representative group of animals will enable one to determine whether an interval is too long. Keeping FECs zero or near zero all the time is not sustainable and is likely to increase the rate of selection for anthelmintic resistance (Kaplan et al., 2004).
3. ***Carry out regular monitoring of anthelmintic efficacy.*** In light of the increasing problems with anthelmintic resistance, it is not sound to assume that dewormers are controlling parasite infections in any age group of animals without monitoring the efficacy of dewormers. Annual monitoring of efficacy should therefore be a part of all health management programs (Tarigo-Martinie et al., 2001) and in Ontario should be carried out with a FECRT during the summer months. In order to obtain representative information for a farm, fecal samples should be collected from 8-12 horses on the day of treatment and analysed to determine the number of parasite eggs per gram (epg) of feces (ideally the group of animals should include 4-6 horses with fecal egg counts ≥100 epg). Ten to fourteen days following the day of treatment a second fecal sample should be collected from the same horses and examined in a similar manner. The percentage reduction in fecal egg count (FECRT%) should then be calculated for each animal as follows:

   FECRT% = (pre-treatment epg – post-treatment epg / pre-treatment epg) x 100

   For example, if the pre-treatment epg = 200 and the post-treatment epg = 100:

   FECRT% = (200 – 100 / 200) x 100 = 50%

The mean FECRT% for all the horses should then be determined and interpreted as follows:

- for benzimidazoles and pyrantel – values less than 80% = indicative of resistance
- for macrocyclic lactones – values less than 98% = indicative of resistance (Briggs et al., 2004)

4. ***Ensure correct dose of anthelmintic is administered.*** Since under dosing is a risk factor for development of anthelmintic resistance, owners should be encouraged to use tape measures to obtain individual horse body weights, and to dose accordingly.
5. ***Rotate anthelmintic class on an annual basis.*** The practice of using different anthelmintics for each treatment ("rapid rotation") has not been shown to slow the development of anthelmintic resistance (Uhlinger and Kristula, 1992). Furthermore, such programs may select for resistance to more than one drug at the same time (Herd et al., 1981), and may mask the clinical impact of a drug with poor efficacy to the extent that one is unaware of a resistance problem (Kaplan et al., 2004). It is therefore recommended that a slow rotation program should be used in which one anthelmintic class is used for an entire year. A different class is then used the following year. Depending on the drug class being used this may not control tapeworms or bots. Thus, inclusion of drugs for these parasites at the appropriate time of the year is considered acceptable. N.B. If resistance to an anthelmintic class has been demonstrated on a farm that class of drugs should not be included in the slow rotation program for at least 5 years.
6. ***All horses on a farm should be on the same deworming program***. The use of different anthelmintic classes in different horses living on the same farm is equivalent to using a fast rotation program.
7. ***New arrivals***. Anthelmintic resistance most commonly establishes on a farm with the arrival of a new animal that is infected with drug-resistant parasites. For cyathostome control, if a farm does not have resistance to both benzimidazoles and pyrantel in these parasites:
   (a) short-term additions (i.e. visiting the farm for <6 weeks) should be treated with ivermectin on arrival as the egg reappearance time for this drug is 6-8 weeks.
   (b) long-term additions (i.e. on the farm for >6 weeks) should be treated with moxidectin on arrival as this drug has significant larvicidal activity.
   For control of roundworms, all visiting foals should be treated with a double dose of fenbendazole daily for 5 days (Briggs et al., 2004).
8. ***Targeted treatment ?*** Within any group of horses only a minority of animals harbour the majority of the parasites. Thus, since strongyle fecal egg counts <200 epg do not appear to be associated with significant morbidity, and today these eggs are almost entirely produced by cyathostomes, an increasing number of veterinary parasitologists are suggesting that one only needs to treat horses with high fecal egg counts (e.g. >200 epg). Such targeted treatment regimens are dependent on fecal examinations being carried out on all horses every 4-8 weeks and typically are associated with a substantial (>50%) reduction in the total amount of anthelmintics used on a farm. Although the cost of fecal monitoring is greatly increased, targeted treatment can be economically viable and has been used to control multi-drug resistant cyathostomes (Little et al., 2003).
9. ***Sound pasture management***. Attention to the environment in which horses are kept is just as important for parasite control as the use of anthelmintic drugs. For example, picking up manure from pasture twice a week (daily when rainfall may lead to the distribution of feces) has been shown to control strongyle infections just as effectively as anthelmintic compounds. Other pasture management tools that can be used to reduce the environmental burden of

parasites, and therefore decrease the reliance on anthelmintic drugs, include:

- *Stocking density* – High stocking rates should be avoided. One horse per two acres is an ideal maximum; higher stocking densities require an increasing reliance on the use of anthelmintic compounds.
- *Pasture rotation* – If adequate grazing is available, pastures should be rotated.
- *Pasture rotation with other animal species* – Rotation of pasture with cattle, sheep or goats can be beneficial as important horse parasites are not infective for these species and vice versa.
- *Clean pasture* – While freezing winter conditions kill the majority of cyathostome larvae on pasture, some larvae are able to overwinter outdoors and represent a source of infection for early grazing horses. However, as temperatures rise in the spring these parasites burn up their metabolic reserves and die off. Thus, since cyathostome larvae that have overwintered on Ontario pasture have generally all died by the end of June, pasture can be considered clean of parasites from July onwards if not grazed on earlier in the year.
- *Adolescent horses* – Young animals are more susceptible to gastrointestinal parasites than older horses and have the potential for high fecal egg counts prior to the development of immunity. Such animals should therefore be given the cleanest pasture available and not grazed with other age groups. In addition, the pasture they have used should be assumed to be heavily contaminated with parasites after their withdrawal.

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