In the first days of chemical anthelmintics, veterinarians were intimately involved with equine parasite control programs. The drugs available were toxic and large volume, and often had to be administered as a drench or a bolus using nasogastric intubation. However, deaths from large strongyle infestation, previously the leading cause of colic deaths in horse, plummeted to near zero. However, as anthelmintic compounds became safer, easy to administer, and available over-the-counter, the veterinarian’s role in parasite control became diminished. As cases of obvious parasitism in adult horses became rare, veterinarians showed varied interest in changing or challenging what had become the dominant paradigm in equine deworming: worm every horse every 8 weeks, and rotate dewormer products each treatment.

Unfortunately, although this regimen has proved to be effective against large strongyles, it has resulted in extensive resistance. As seen in small ruminants, where there are now farms with worms resistant to 100% of known de-wormers, resistance in equine parasites is increasing rapidly. Furthermore, as horses are regularly sold, transported, and boarded at multiple barns during a lifetime, resistant strains have the opportunity to spread much more rapidly. In the Southeastern US, a study of farms had small strongyles that were resistant to multiple drugs:

- Strongid (pyrantel pamoate) 40.5% farms showing resistant parasites
- Anthelcide (oxibendazole): 53.5% farms showing resistant parasites
- Panacur (fenbendazole): 97.7% farms showing resistant parasites
- Zimectrin (ivermectin): 0% farms showing resistant parasites
- Quest (moxidectin): 0% farms showing resistant parasites

In addition, due to the declining importance of human parasite infection in developed (rich) countries, the drive to produce novel categories of anthelmintics is almost nil. The last new drug to reach the market was moxidectin (Quest®), and there is only one new drug in the pipeline. Its approval is years away, and it is likely to be considerably more extensive than current compounds.

As the frontline in equine health care, veterinarians have an important role in preventing the spread of resistant organisms. This task is somewhat easier in the case of antibacterial drugs, as the majority are available by prescription only. However, as anthelmintics are predominantly purchased from horse owners from feed stores and catalogs, the veterinarian and his/her expertise is frequently bypassed. Without legislation to restrict these drugs to sale by prescription only, education is our only tool to slow or reverse the spread of resistance.

The following material has been used at New Bolton Center for horse owners as a 50 minute Power Point lecture. For maximum effect, it is titled:

“Global Worming”: What you can do to prevent de-wormer meltdown in the 21st century

Our Goal:
- Prevent and treat parasite-related disease
- Prevent further resistance from developing

10 steps you can take to prevent de-wormer meltdown

Step #1: Acknowledge the problem
- De-wormer resistance has already happened.
- There is only one class of de-wormer that is still uniformly effective: avermectins
- Once we have avermectin resistance, we’re out of drugs.

Step #2: Start performing Fecal Egg Counts
- Make the diagnosis!
- Perform a fecal egg count on a sample of horses
- Shows number of eggs per gram of manure.
- ONLY evaluates number of adults, not harmful larvae.
- Tells you who needs to be de-wormed
- Tells you if your de-wormer worked

Step #3: Understand Natural Immunity
• De-worm smart, not hard:
• Some horses have very good natural immunity against worms, will never get fecal eggs counts above 150 epg
• FEC ~2 months after the last de-worming:
  o Low contaminators: less than 150 epg
  o Moderate contaminators: 150-500 epg
  o High contaminators: over 500 epg
• **20% of horses produce 80% of the eggs**

Step #3: Save the refugia!
• “Resistance is futile!”
• Refugia: parasite populations that are “hiding” from anthelminthic selection pressure
  o Refugia saves genetic variability that maintains drug sensitivity
• “Where do I find this refugia of which you speak?”
  o By only deworming the high shedders
  o By not removing all the encysted larvae

[animations of the effects of de-wormers on resistance patterns and the effect of refugia]

Step #5: Pick the right drug
• De-worm smart, not hard:
• Adult strongyle
  o Prevent pasture contamination
  o Pyrantel pamoate, oxibendazole, fenbendazole, ivermectin
• Encysted strongyle larvae
  o Treat strongyle-related disease
  o Moxidectin, double-dose FBZ x 5 days
  o Moxidectin safer!
• Tapeworms
  o Prevent colic
  o Autumn
  o Praziquantel, pyrantel tartrate (daily Strongid)
• Bots
  o Autumn
  o Ivermectin, moxidectin
• Fenbendazole, oxibendazole, pyrantal pamoate only kill the less dangerous adults. Ivermectin gets some un-encysted larvae
• Why give them? To prevent egg contamination of your pasture
  o #1 goal of a good de-worming program

Step #6: Use the correct dosing interval
• De-worming every eight weeks?
  o De-wormers suppress egg production for different amounts of time:
  o Quest (moxidectin): 12 weeks
  o Zimectrin (ivermectin): 4-8 weeks
  o Anthelcide (oxibendazole): 4 weeks
  o Panacur (fenbendazole): 4 weeks
  o Strongid (pyrantel pamoate): 4 weeks

Step #7: Re-consider rotation de-worming
• Many farms already have major resistance problems
  o Quick rotation encourages more resistance
• Two choices:
  o Only use drugs that work on your farm
  o Use avermectins only

Step #8: Use seasonal de-worming
• Only L3 larva is infectious
• Takes 3-5 days from egg to L3
• L3 killed by cold and very hot weather
• SO…
  o No need to de-worm in mid-winter, mid/summer in PA?
Saves $$$
Better for the environment
Decreases worm resistance

**Step # 9: Reduce larval numbers**
- Remember, it takes 3 days from egg to L3
  - Pick up manure every 3-5 days
  - Do not drag fields that are occupied
  - Drag in the heat of the summer?

**Step # 10: Educate your friends!**
- The _bad_ old days
  - No good de-wormers
  - A lot of fatal colics
- The _good_ old days
  - New effective drugs, great control
  - “Recipe”/calendar approach very effective
- The present time
  - Burgeoning resistance\(^3\), no new drugs
  - New threats necessitate better diagnostics, more individualized programs

This presentation is freely available to referring veterinarians for their own use, with appropriate credit. Please contact Rose Nolen-Walston (rnolenw@vet.upenn.edu) for copies of this lecture.

**References.**