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WHY YOU SHOULDN'T HAVE SLEPT THROUGH PARASITOLOGY - IMPACTS ON MILK PRODUCTION

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Introduction

This series of 2 papers examines the implications of infection with internal parasites in adult dairy cattle and new diagnostic tests for these parasites. The new data presented are largely the results of research conducted by 2 graduate students at the Atlantic Veterinary College – Dr. Ane Nødtvedt and Dr. Javier Sanchez. For more detailed information on these projects will be presented in peer-reviewed journals, over the coming year.

In the mid 1990s, a group of researchers at the Atlantic Veterinary College began to re-examine the role of internal parasites, particularly Ostertagia, in adult dairy cattle. The majority of the researchers had graduated from veterinary school in the 1970s or 1980s. At that time, there was controversy over the importance of gastrointestinal nematodes (GIN) in adult, lactating dairy cattle. The general conclusion, and the information that filtered into the veterinary curriculum of the day, was that GIN have minimal or no significance to mature animals. Internal parasites were considered to be important only in replacement heifers, during their first year on pasture. These conclusions were reached largely based on 2 factors. First, the shedding of eggs by adult animals, when measured by the same criteria as calves or heifers (eggs per gram), was minimal. This was taken as evidence that the more mature animals mounted an effective immune response and eliminated the organisms. Secondly, and perhaps more importantly, animals that were treated for GIN, with the available treatment regimes of the day, failed to show consistent responses to therapy.

Our group began to question the conclusions for a number of reasons. Evidence had been gathered that the first factor was based on false logic. Examinations of the abomasums from adult dairy cattle often showed a large number of mature and fecund parasites.[1, 2] The dry matter intake of adult cattle, particularly when lactating is very high, relative to younger animals. The low number of eggs per gram was more a function of the dilution of eggs in massive quantities of fecal material than a reflection of low parasite burdens. A second reason to revisit the conclusions was because of the development of a new generation of macrocyclic lactones and in particular the development of a formulation with no milk withhold, Eprinex-Ivomec®. Finally, new diagnostic technologies, with the potential to be cheaper and more reflective of parasite burden were being developed.[3]

Ostertagia review

Ostertagia ostertagi is a small reddish brown abomasal parasite. They are the most important internal worms of cattle in temperate zones. Adult Ostertagia are approximately 1 cm long and, as a result, can easily be missed on routine post mortem examination of the abomasum, unless they are extremely numerous.[4]

The life cycle of Ostertagia is direct, there is no intermediate host and no migration occurs inside the cow. Eggs are shed in the feces and develop into the L3 stage (infective) in the cow dung. While in the dung, they gain nourishment by feeding on bacteria. From shedding of egg to L3 takes approximately 2 w, depending on environmental conditions. When conditions are appropriate, the larva migrate onto blades of grass (accumulate in water droplets), where they are ingested. When the larva molt from L2 to L3, they retain the L2 cuticle as a protective sheath. This sheath is removed in the rumen, before they enter the abomasum. The pre-patent period, the time from when they enter the abomasums and burrow into the gastric glands until they emerge as adults and begin to shed eggs is about 3 w. Arrested development or hypobiosis can develop based on the favorability of conditions for development larval stages in the environment. When hypobiosis takes place, it happens in the L4 stage and can last for up to 6 months. [5]

Ostertagia infection can manifest in a variety of ways. Type I Ostertagiosis is the clinical manifestation of primary infection with ostertagia. It is observed most frequently in young animals having their first season of pasture exposure. Signs include weight loss, diarrhea and dehydration. Young animals are exposed to waves of larva over the summer, based on generation time of the organism and environmental conditions. The first wave, due to overwintering parasites and re-emergence of hypobiotic organisms, occurs in spring. Waves tend to peak in August depending on local conditions. [4]

A syndrome known as Type II Ostertagiosis occurs when a large number of arrested L4 larva develop into L5 and emerge from the gastric glands at the same time. This can cause massive disruption in the gastric mucosa and reduced appetite, diarrhea dehydration and hypoalbuminemia. This rare manifestation of Ostertagia infection occurs in late winter or spring. [6]

With modern anthelmintic treatments and a better knowledge of parasite life cycle and control points, clinical disease is now uncommon. As with other disease syndromes (eg mastitis and ketosis), despite programs that address clinical disease, there may remain potential for productivity gains through the management of subclinical disease. The reports have been conflicting as to the subclinical impact of Ostertagia. It is clear that adult animal do become infected with Ostertagia, however these burdens are light when FEC is used as the yardstick. Measuring worms in the abomasum does not correspond well with FEC and are likely a better, albeit impractical, measure of worm burden.[1,2] In the absence of a good and practical diagnostic test, response to therapy has been taken as the most practical measure of parasite burden. In 1999, Gross et al. examined reports of more than 80 clinical trials and concluded there was a 0.63 kg/day, benefit to therapy. [7] Other researchers have concluded that there is insufficient evidence to recommend treatment and called for more research to clarify the debate, particularly in a North American context. [8]

Research at the Atlantic Veterinary College

In the late 1990s, our group conducted studies in Atlantic Canada [9,10] and collaborated with others in Eastern Canada,[11] which indicated that nematode infections are widespread among dairy cows in these regions. The studies employed a novel Ostertagia ELISA (discussed in the companion paper) and suggested that worm burden were having a detrimental effect on milk production.

Armed with these data, our group set out to examine the epidemiology of Ostertagia, through a longitudinal study of parasite burdens and, via a clinical trial, to evaluate the impact of treatment at calving with Ivomec- Eprinex® on milk production, as a surrogate measure of pre-treatment infection status. The remainder of this paper reports the results of these evaluations.

Herd selection

Thirty-eight dairy farms were selected for the epidemiological study based on proximity to the 4 Canadian veterinary colleges. The farms were located in Prince Edward Island (PEI) (n=14), Quebec (n=14) Ontario (n=5) and Saskatchewan (n=5). Only the PEI and Quebec (28) were part of the clinical trial. All herds participated in a milk-recording program, had some exposure to pasture and had not used broad-spectrum endectocides in the milking cows in the 6 months prior to the onset of the trial.

Epidemiological Study

Fecal egg counts were performed on samples collected rectally from the eight randomly selected cows per herd (4 first calf heifers and 4 2+ calf cows). Cows from PEI and Quebec were sampled approximately monthly, whereas the Ontario and Saskatchewan animals were sampled quarterly, through the one-year period of the trial. Larval cultures were performed on a separate subgroup of cows but are not discussed here. Information on the use of pasture and other management factors was collected using a standard in-person interview questionnaire at all participating farms. The number of nematode eggs per 5 grams of feces was determined for individual cows using a modified Wisconsin sugar flotation technique. [12]

Appropriate statistical analysis were used to control for the both the effects of the distribution of the data (skewed), herds effects and the clustering of observations by cow due to repeated samples. Factors including season, region, lactation-group and different management practices (questionnaire) were tested.

A total of 315 cows were included in the epidemiological part of the study. Raw FEC results were reported as eggs per 5 grams of feces (ep5g). The range of egg counts was from 0 to 419 ep5g. In 46% of the samples no eggs were present. In the model, second lactation and older animals were approximately 4.5 times more likely to have a zero count than animals in their first lactation. Additionally, both season and region were significant variables, with winter yielded lower expected FECs than all the other seasons and Quebec herds having lower expected FEC numbers than herds from PEI (the baseline). Mechanical spreading of manure on pastures used by heifers resulted in lower expected FEC in the lactating cows, while mechanical spreading of manure on pastures used by lactating cows had the opposite effect. This effect may be the result of greater exposure in heifers providing some level of immunity in mature animals. Overall, if lactating cows (versus only dry cows) were on pasture the expected number of nematode eggs was increased compared to non-pastured animals.

The egg counts in PEI and Quebec rise as early as April or May, even though the animals were not let out on pasture until late May or early June in 2000. This observed spring rise happens before any possible re-exposure could have occurred and can be attributed to maturing hypobiotic L4 larva.

Clinical Trial

The study was a double blind randomized clinical trial. As they calved, cows were randomly allocated to treatment with eprinomectin pour-on solution or placebo within blocks of 10. A total of 942 cows were included in the clinical trial (PEI n=662, Quebec n=280). Despite the equal herd numbers and similarity in herds size, there are more PEI cows because the study lasted for a full year in PEI and only six months in Quebec. No difference in previous lactation milk production was found between the placebo (8831.7 kg per cow) and the treated group (8832.4 kg per cow). Milk production was monitored for 6 herd tests after treatment.

Ivomec-Eprinex® treated animals gave significantly more milk in the first six individual test day models than placebo treated animals. The average increase in milk production for animals in the treated group was estimated at 0.94 kg/day. There was a trend towards a greater effect of the treatment in animals from 1st or 2nd lactation compared to the 3rd lactation and older animals.

Fecal egg output was available from 172 of the cows that calved on the clinical trial. The number of ep5g obtained form the animals ranged from 0-419. The mean was 9.2, median 1.0 and standard deviation 30.0. These numbers are low relative to other studies, which reported 15 to 25 ep5g.[11,13,14] Despite these lower GIN egg outputs, the production effect was higher than the overall median effect reported by Gross et al. of 0.63 kg/day across all study types. This greater effect could be due to the use of one of a new generation of anthelmintics, or also to changes in management and improved genetic potential for milk production through the past decades.[7] This result also supports the observation of low correlation between worm burden, FEC and production response in adult cattle.[1,2,13]

A common feature of subclinical parasite infections in ruminants is a decrease in voluntary feed intake.[15,16] It can be hypothesized that negative energy balance in the transition cow is further influenced by decreased appetite caused by abomasal nematodes. Studies that examine the impact of parasite burden and transition cow energy status should be conducted to assess this effect.

While the interaction between treatment and calving season was not significant there may not have been sufficient power to detect effects during the summer. Power may have been a factor in the inability of the production model to detect a significant interaction between anthelmintic treatment and parity group in this dataset as well, even though the trend was towards a better response in first and second lactation animals compared to older cows. Abattoir studies have shown similar worm burdens across age groups in culled dairy cattle,[1,2] so there is reason to assume that the actual number of parasites present in animals from the three groups would be comparable.

Reinemeyer suggests that the production response following anthelmintic treatment is highly variable between animals within a herd and that a test identifying animals that potentially respond to treatment is lacking.[8] While the results from the current study showed that a large group of animals responded positively to treatment, both herd management and individual cow factors were important. Using a diagnostic tool to discern which herds or animals would respond favourably to therapy would be beneficial. The second in this series of papers discusses the development of such a tool. In the absence of such a commercially available test, it should be noted that the increase in test day milk yields shown in this study occurred across various management schemes, degrees of pasture exposure and two geographic locations.

Overall conclusions

Fecal egg counts in the study were low and varied with season, lactation group and herd management. If lactating animals were exposed to pasture there was significantly higher FEC. The clinical trial showed an increase in daily milk production of 0.94 kg/day in Ivomec-Eprinex ® treated cows over controls. This response was evident across calving seasons, age groups and provinces.

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