DIAGNOSIS OF HELMINTH INFECTIONS IN CATTLE: WERE WE WRONG IN THE PAST?

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1. INTRODUCTION

Helminth infections are ubiquitous and remain a constraint to the efficient raising of cattle on pasture. Helminth infections of cattle are mainly caused by:

- the gastrointestinal (GI) nematodes *Ostertagia ostertagi*, *Cooperia oncophora*, *Haemonchus* spp. and to a lesser extent by other genera such as *Trichostrongylus*, *Oesophagostomum*, *Bunostomum* and *Nematodirus*,
- lungworms (*Dictyocaulus viviparus*), and,
- liver flukes (*Fasciola* spp.).

The current control strategies, based on anthelmintic use have resulted in a dramatic decrease in cases of clinical parasitism, especially of parasitic gastroenteritis and fasciolosis. For both infections, these programmes have proven to be very efficient to control clinical infections. In contrast, outbreaks of infections with lungworms seem to increase because drug-based preventive measures are more problematical to apply.

Nowadays cattle producers treat their whole herd at regular intervals, rather to maximise production than to avoid disease. However, these treatments mostly don’t consider the basic epidemiological information needed for an optimal strategic control or don’t assess the economic benefits of the treatments. The main worries about regular whole-herd treatments are:

- drug residues in animal products and the environment,
- the high costs of anthelmintic treatments (~ € 1 billion/year in the EU) and veterinary consultation,
- reduced development of natural immunity against nematodes; and most of all,

- the rapidly increasing incidence of anthelmintic resistance, a serious problem in small ruminants that is now also increasing in cattle.

To avoid these problems, a radical move from uncontrolled anthelmintic treatments of herds/animals to treatment of only those herds/animals that require it, is essential.

A key problem remains, however, to identify those herds/individual animals requiring treatment, especially those herds/animals, that apparently are healthy but are producing less than the norm. Conventional diagnosis of nematode infection is laborious and expensive, and often not informative in providing a decision on whether to treat an animal/herd or not. In the past too much emphasis was given on estimation of parasite numbers, rarely on the effects of parasites on host production. Morbidity due to parasitic infections not only depends on the intensity of infection but also on the immunity status, genetic background, nutritional level and stress of the host and on intercurrent diseases. Moreover, it is often overlooked that one of the general properties of the relationship between helminth parasitism and production loss in cattle is that the relationship is very non-linear (Smith, 1997). Therefore, it is important, for identifying animals that require treatment, to develop indicators that detect both parasite levels *and* sequelae of these parasite infection on production traits.

The objective of the present short review is to discuss:

- the factors contributing to morbidity in helminth infections of cattle,
- the limitations of the existing conventional diagnostic techniques, and,
- innovative parameters for identification of animals/herds requiring treatment.

2. FACTORS CONTRIBUTING TO MORBIDITY

To assess the impact of helminth infections on livestock productivity, the actual and preventable losses due to morbidity, and production indicators (e.g. milk production, calving rate, growth rate) need to be estimated from well-structured studies. Accurate assessments of the economic losses (the main justification for controlling parasites) from helminth infections are, however, hampered by several factors:

- incomplete information on the exact interplay between levels of infection in relation to the production of the animals,

- geographical variation in importance of productive indices,

- breed variation in resilience and resistance to infection,

- the complex interplay with levels of nutrition, immunity, age and concurrent infection with other parasites and infectious agents.

It is apparent that the severity of pathology resulting from a certain worm burden does vary between hosts. While factors such as age, nutrition and immunity are likely to be responsible for much of these variations, the host genetic effects may well be a determining factor (Gasbarre *et al.* 2001).

Our lack of understanding of the complex play of the factors involved in production losses undermines our ability to represent these losses as a simple function of some index of parasitism. Even if various indices of parasitism may be correlated with production losses it may be expected that these correlations exist only at particular times in the infection cycle (Smith, 1997). Atwill *et* *al.* (1995) using a mixed logistic regression for analyzing diseases data obtained from groups of animals, indicated that about 50% of the total variance on the logit scale for the probability of disease was attributable to unmeasured or unmeasurable group-level factors.

3. THE LIMITATIONS OF CONVENTIONAL DIAGNOSTIC TECHNIQUES

Conventional diagnosis of helminth infection is often not informative in providing a decision on whether to treat or not (Eysker & Ploeger, 2000).

In first grazing season (FGS) calves, a minority of susceptible animals is shedding high numbers of GI nematode eggs, causing most of the pasture contamination with infective larvae. Treatment of these calves early in the grazing season could protect the whole herd against GI nematode-related production losses. Although the susceptibility of calves to GI nematode infection is genetically determined (Gasbarre *et al.* 1990), no genetic markers are currently available to identify these animals. Faecal egg counts early in the FGS may be used as a phenotypic marker for resistance against GI nematodes (Leighton *et al.* 1989). In Western Europe, the peak egg output occurs around two months after turnout (Shaw *et al.* 1997, 1998). To identify the calves that excrete high numbers of worm eggs, all calves should be tested at that time. A major disadvantage of faecal egg counts is the absence of a threshold value between ‘high’ faecal egg counts, resulting in high infection levels with reduced weight gains later in the FGS, and ‘low’ faecal egg counts that will result in low infection levels without production losses (Vercruysse and Claerebout, 2001). Any tentative to determine a threshold based on low and high faecal egg counts need also to consider the nematode species involved e.g. high counts due to *Cooperia* may be of less importance compared to low egg counts due to *Ostertagia*. The absence of a threshold value limits the use of faecal egg counts as a diagnostic tool for preventive treatment of FGS calves. Faecal egg output in adult animals (second grazing season or older) is generally low and faecal egg counts are considered to be a poor indicator of infection level in adult cattle (Michel, 1968; Gross *et al.* 1999). No relationship between treatment response and infection level could be demonstrated using faecal egg counts as a parameter of infection (Michel *et al.* 1982; O’ Farrell *et al.* 1986).

Lungworm infections can easily be detected in a cattle herd. A clinical diagnosis of husk can be confirmed by detection of larvae in the faeces (Baermann method) or *Dictyocaulus*-specific antibodies in serum. When the Baermann technique is correctly applied the method is considered to be very sensitive for the diagnosis of patent primary lungworm infections from 3.5-4 weeks after infection onwards (Eysker, 1997). Not all animals of an infected herd excrete larvae and therefore it is important that the number of samples taken to examine is as large as possible, especially for older animals (Eysker *et al.* 1994). Antibody-detection tests are also highly sensitive and specific (Vercruysse & Claerebout, 2001) and several tests are commercially available. However, a quantitative relationship between serum antibody levels or faecal larval counts and production losses in naturally infected cattle has not been demonstrated. Consequently, no threshold values are available to distinguish between herds or animals that should be treated or not (Vercruysse & Claerebout, 2001).

Diagnosis of clinical fasciolosis is often more difficult, because of the lack of typical symptoms. If fasciolosis is suspected based on production losses combined with a history of grazing on wet pastures, the diagnosis can be confirmed by detecting *Fasciola* eggs in the faeces or *Fasciola*-specific antibodies in serum/milk. Although faecal examination has a high specificity, its sensitivity is believed to be low, due to the long pre-patent period, intermittent egg excretion and overdispersion of the fluke population (Vercruysse & Claerebout, 2001). Serological assays with ~~a~~ high specificities and sensitivities are commercially available. However, these assays have been designed as qualitative tests for the detection of *Fasciola*, rather than quantitative tests to estimate the level of infection, and therefore a threshold level for production-based treatment has not been determined.

From the above it should be clear that to determine an economic threshold treatment vs non-treatment remains difficult for helminth infections in cattle. The reason for this, however, is not a lack of sensitivity or specificity of the available diagnostic techniques, but a lack of studies to determine quantitative relationships between diagnostic test results and morbidity.

4. TOWARDS HEALTH MONITORING

Cattle production in the EU, and especially dairy production, continues to follow a trend towards increased intensification on a smaller number of larger, more specialised production units. Adaptation of parasitological control strategies from the current treatment programmes which don't assess the economic losses to targeted treatments, requires the development of parasitological morbidity indicators that should ideally fulfil the following criteria:

- samples for analysis should be cheap and easy to collect,
- provide information on the parasite-associated economic losses,
- provide information on the losses that are recoverable through treatment,
- provide information on the immunity status of the animal.

4.1 Sample collection

Herd health monitoring has become an essential part of cattle breeding, requiring samplings at regular intervals. For cost-effectiveness and animal welfare reasons, animal handling to collect samples should be restricted to the minimum or sample collection should be based on non-invasive methods.

For FSG calves sampling during the pasture season may be difficult. Therefore, serum sampling at housing has been recommended for GI nematodes to assess the infection levels of the previous pasture season and to improve, if needed, control programmes the following year.

In adult dairy cattle, most suitable would be diagnostics applied on milk samples. Bulk tank milk samples are collected several times in a month for milk quality assessments. If the herds are registered in a milk production-recording programme, individual milk samples are collected at monthly intervals. Here also the housing period may well be a recommended period of sampling.

In beef cattle, frequent handling of the animals can be avoided by diagnostic tests on serum samples collected for established surveillance programmes (e.g. brucellosis) or by indicators based on automated weight recordings. The collection of a serum sample at a minimum number of occasions per year for the monitoring of different infectious diseases requires an integrated approach by different animal health workers.

4.2 Information on the presence of parasite infection and its effect on productivity

Until now, most diagnostic techniques have been developed to detect the presence of the parasite and/or to quantify the infection. However, this may be irrelevant when the detected infection does not cause any production loss. For instance, in some cases liver fluke infections may not have a negative effect on milk yield, depending on the combined action of amount of exposure to the parasite and the host's immunity and feeding status. Instead of identifying the infected animals, we should identify the animals that suffer economical losses.

In FGS calves, a very useful parameter to measure GI nematode-associated morbidity is the serum pepsinogen level. This parameter is a direct indicator of the clinical damage caused by the abomasal worm *O. ostertagi*. When determined at housing, it is an excellent tool to evaluate the exposure to GI nematode infection and thus to evaluate the effectiveness of any control programme (Dorny *et al.* 1999). In addition, negative correlations have been established between the serum pepsinogen level determined at housing and the growth performance of calves during the housing period (Ploeger *et al.* 1990a).

In adult cattle, the most promising technique to measure parasite induced morbidity is the determination of parasite-specific antibody levels. Antibody levels are considered to be a reflection of the amount of exposure of the animal to the parasite. It was demonstrated that there exist significant negative relationships between the *Ostertagia*-specific antibody level in bulk tank milk with milk yield and hazard of conception (Sanchez *et al.* 2002; Charlier *et al.* 2005). Also, increased antibody levels against *Fasciola* have been associated with lower average annual milk yield and an increased inter-calving interval (Charlier *et al.* 2006).

Both milk antibody level and serum pepsinogen determination are until now mainly applied at the herd level. For individual based treatments, we could develop these techniques further on the individual level or instead of measuring indicators of parasitism, we could measure productivity and restrict treatment to the underperforming animals. Previously, infection parameters could explain around 20% of the variation in growth performance between herds (Ploeger *et al.* 1990b). There are studies underway that evaluate the usefulness of parameters such as weight gain during the grazing season and body condition score. New technologies such as automated weight recordings and digital image systems based on laser scanning technology may offer new perspectives in the use of these parameters.

4.3 Information on the losses that are recoverable

It is not because a parasite has been identified to cause a decreased productivity, that these losses may all be recoverable through control of the infection (Perry & Randolph, 1999). Treatment costs, extra feeding costs through increased appetite, re-infection after treatment and unrecoverable physical damage may all contribute that a part of the costs are not recoverable through treatment. Ross *et al.* (1970) found a drop in milk yield associated with fasciolosis of 14%, of which 8% was recoverable through treatment. Therefore, indicators should not only be evaluated by investigating their associations with production parameters, but it is necessary to evaluate their value in predicting the increase in production after control of the infection.

4.4 Information on the immunity status of the animal

It is often observed that only a small proportion (± 25%) of the animals harbour a high worm burden, while the other animals harbour a low worm burden (Agneessens *et al.* 2000). It has been demonstrated that this infection pattern is strongly influenced by the host genetics (Gasbarre *et al.* 1990). This pattern strongly suggests that effective control strategies can be based on targeting drug administration to the small percentage of susceptible animals (Gasbarre *et al.* 2001). This approach requires the identification of genetic markers that can be used to identify the susceptible animals. However to our knowledge, some promising genetic markers have until now only been identified in sheep (Beh *et al.* 2002) and not in cattle (Sonstegard & Gasbarre, 2001). It is thus not expected that cost-effective tests, based on identifying genetic markers will be available in the near future.

5. SUMMARY

Currently, producers treat their whole herd at regular intervals to control parasites without considering the basic epidemiological information needed for an optimal strategic control or assessing their economic losses from infection with helminths. A key problem is to identify those individual animals/herds requiring therapeutic treatment. Conventional diagnosis of helminth infection is laborious and expensive, and often not informative in providing a decision on whether to treat or not. Recently, there has been good progress in the development of diagnostic biomarkers for some helminth infections in cattle, e.i. GI nematodes and liver fluke.

6. KEY WORDS

Cattle, helminths, diagnosis, control.

7. RESUME

Actuellement, le contrôle des helminthoses chez les bovins est basé sur le traitement anthelminthique de la totalité du troupeau à intervalles réguliers. En général, l’éleveur traite son troupeau sans tenir compte, ni de l’information épidémiologique nécessaire pour un contrôle stratégique optimal, ni des pertes économiques éventuellement engendrées par l’helminthose. L’identification des troupeaux ou des animaux pour qui un traitement thérapeutique pourrait être bénéfique est particulièrement difficile. Le diagnostic conventionnel des helminthoses est laborieux et cher, et n’offre en général pas de réponse claire sur la décision de traiter ou non. Il y a eu récemment des progrès dans le développement de biomarqueurs pour quelques infestations parasitaires chez le bétail, entre autres pour les nématodes gastro-intestinaux et pour la douve.

8. MOTS CLES

Bovins, helminthes, diagnostic, contrôle.

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