Letters

Decision trees on the web – a parasite compendium

Harm W. Ploeger, Deborah C.K. van Doorn, E. Rolf Nijsse and Maarten Eysker

Department of Infectious Diseases and Immunology, Division of Clinical Infectiology, Faculty of Veterinary Medicine, Utrecht University, P.O. Box 80.165, 3508 TD Utrecht, The Netherlands

Drug resistance is a major and continuously increasing problem throughout the world. Current discussions on how to deal with this focus on the different usage of anthelmintics, the development of new drugs and alternatives, such as forages rich in condensed tannins or vaccines. Pasture-management strategies are also included in the list of alternative strategies (see, for example, http://wormboss.com.au) but are often considered difficult to implement. In the Netherlands, parasite-control decision trees are developed that integrate grazing management for several farm animal species, which can also be used for teaching.

On a worldwide basis, humans and animals provide shelter for a wide variety of parasite species. Some of these parasites are pathogenic, whereas others are relatively benign. In grazing animals, parasite control aims at preventing illness and welfare problems and minimizing economic losses of parasitic infections. This does not necessarily require that infection is minimized. Excessive antiparasitic treatments could not only preclude development of immunity against parasites, with the probable consequence that at least yearly treatments become a necessity [1], but could also inadvertently contribute to decreased immunity against species that were not the primary target of the treatments. The latter inadvertent effect is illustrated by the increase in lungworm outbreaks in adult dairy cows since the 1990s [2,3]. However, low-level nematode infection would hardly affect the growth of replacement stock, although it does trigger the development of some immunity [4,5]. In addition, treatments are not always applied at appropriate times and the excessive use of drugs commonly occurs [6,7]. Clearly, there is a need for a more rational use of antiparasitics and this becomes more pertinent with the ever-increasing problem of drug resistance. Yet, discussions remain focused strongly on how to continue using existing drugs [8,9], with alternative measures considered supplemental to using those drugs. However, grazing management is in its own right a serious means to control many of the important parasites of farm animals and, in fact, offers one of the most powerful and sustainable tools (see, for example, Refs [10–12]).

Integrating grazing management and parasite control demands a lot from the management skills of farmers. Several factors need to be considered in designing a parasite-control strategy that best fits the needs of a specific farm. (i) Animals are usually infected with a variety of parasite species, each having their own life-cycle characteristics. (ii) Current anthelmintics are broad-spectrum, being effective against different life-cycle stages and against different species, including species with entirely different epidemiology. This implies that treatment aimed at one species could be effective against another species but at an inappropriate time. (iii) Parasites are hard to eradicate on a population level, even if one could assume that the whole parasite population is subjected to a highly effective antiparasitic. In the Netherlands, for example, this applies for *Haemonchus contortus*, which resides almost completely in the ewes at the time of lambing during spring. (iv) Drug resistance develops most rapidly under conditions of low refugia when highly effective compounds are used [7,13]. (v) Antiparasitics with a similar mode of action can also have different properties. For example, macrocyclic lactones might have different periods of residual activity, which needs to be considered in grazing management.

Obviously, farmers and veterinary practitioners will be assisted greatly with an easy-to-use decision tree that integrates parasite control into daily management routine. The most important feature of such a decision tree is that it first and foremost takes account of past, actual and planned grazing management on a farm and how this influences parasite epidemiology. Only if this does not suffice to keep infection below acceptable limits, does the decision tree recommend additional measures. Box 1 briefly explains a web-based decision tree for nematode infections in dairy cattle. Similar trees have been developed for horse and sheep parasites. A major advantage of this approach is that

Box 1. A decision tree for the control of gastrointestinal and lung nematode infection in cattle

After opening the site www.parasietenwijzer.nl (choose English), clicking *Farm animals*, then *Cattle*, then *Gastrointestinal nematodes (GIN) and Lungworm*, the opening pages of the decision tree unfold, explaining its purpose and how it works. Following *Start*, one enters the actual tree. The user is guided through a series of questions about how the replacement stock is grazed. Clearly, calves grazing only one paddock the entire grazing season need a different parasite-control strategy (some form of early-season treatment) than calves moved monthly to another paddock not yet grazed by other cattle in the same year (no anthelmintics required). By following the tree, the user gets advice, which contains recommendations on monitoring and the additional action required to keep infection within acceptable limits. This way, neither disease nor serious production losses will occur, while the opportunity to develop (some level of) naturally acquired resistance remains. Both GIN and lungworm can be controlled by a form of rotational grazing, although what is effective against one is not against the other. Therefore, the tree first considers GIN, because this enables the greatest flexibility for farmers. It then considers what is needed to control lungworm. The tree includes fact sheets on life-cycle and epidemiology, monitoring infection and available antiparasitics. Although the decision tree has been developed for use in the Netherlands, it can be used easily in other countries with similar climate and farm-management practices. Alternatively, the decision tree can be adapted to fit local conditions.

Corresponding author: Otti, O. (oliver.otti@env.ethz.ch).

the use of an antiparasitic really becomes supplemental, leading to the best choice of antiparasitic used at the best time possible, given the situation at hand. Farmers can also compare several grazing-management scenarios and then select one that requires no or the least supplemental treatments while still being practical.

Another aspect concerns knowledge-transfer efficiency. Two decades ago it was concluded that Dutch dairy farmers used anthelmintics excessively. Despite communicating this to farmers and veterinarians, drug use increased [6]. Apparently, we need to improve how we transfer knowledge to end-users so that the message arrives and results in the appropriate action. A decision tree on the internet (Box 1) might be perfectly suited for this. It can be accessed whenever and as often as required, it is not lost as easily as a paper-version, it can be updated regularly and it offers the opportunity for more direct feedback between end-user and expert. Moreover, recent experiences in teaching indicate that it offers great opportunities to educate future veterinary practitioners, showing how parasite control really is an integrative part of modern farm management.

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