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REVIEW

Examples and Suggestions for the Control of Paratuberculosis in European Cattle

Johannes Lorenz Khol*, Walter Baumgartner

Clinic for Ruminants, Department for Farm Animals and Veterinary Public Health, University of Veterinary Medicine Vienna, 1210 Vienna, Austria

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Abstract

Paratuberculosis, or Johne's disease (JD), is caused by *Mycobacterium avium* subspecies *paratuberculosis* (*MAP*), is found in ruminants worldwide and can cause considerable economic losses in cattle.

Control efforts and programs for JD in cattle are very diverse among European states, in Austria clinical JD is rated as a notifiable disease since 2006. The voluntary control programs established in many European countries, show different aims, measurements and acceptance.

Most control programs for JD are based on a test and cull strategy, combined with hygienic precautions. Unfortunately, the willingness to participate in such programs by farmers and veterinarians is limited due to high costs, intensive workload, long duration and limited success. To overcome this drawback and to harmonize the control of *MAP* in Europe, a basic program with defined minimum standards is suggested. This "minimal program" for the control of JD in cattle consists of 3 steps. Step 1 includes diagnostic evaluation of every case of diarrhea in adult cattle and culling of animals with clinical JD. Step 2 is the implementation of basic management measures, adapted to the potentials of the individual farm. Step 3 consists of regularly evaluation of the *MAP*-herd status with the focus on *MAP*-shedding animals.

This basic control program can be performed with reasonable costs and work load in most cattle herds and might serve as an international minimum standard for *MAP*-control in cattle. Such a program can also pose an incentive to decrease *MAP*-infections for those not willing to participate in more sophisticated control programs.

Key words: Cattle; Control Program; Europe; *Mycobacterium avium* subsp. *paratuberculosis*; Paratuberculosis

Introduction

Paratuberculosis, or Johne's disease (JD), is caused by *Mycobacterium avium* subspecies *paratuberculosis* (*MAP*), a slow growing and acid fast bacillus.[23] Although mainly considered as a

*Corresponding author: Johannes Lorenz Khol, Clinic for Ruminants, Department for Farm Animals and Veterinary Public Health, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria
Fax: +43-1-250775290. E-mail: Johannes.khol@vetmeduni.ac.at

disease of cattle, sheep and goats, *MAP* has a broad host range and can be found in many different species of wild and domestic ruminants.[14,19,20] The increased incidence of *MAP* and specific antibodies found in humans suffering from Morbus Crohn reported in some studies results in ongoing discussions about a possible link between the two diseases.[3]

The reported *MAP*-prevalence varies between European countries and reaches up to 84.7% of *MAP* positive dairy herds in parts of Germany.[7] Sweden is the only European state claiming freedom of the disease, but JD has also been reported sporadically.[9] An increase of *MAP* positive cattle herds from 6.97% in 1994–97 to 19.05% in 2002–03 has been shown in Austria.[2] A detailed review about the incidence of JD in Europe is given by Nielsen and Toft.[16]

Infections with *MAP* mostly take place soon after birth by oral ingestion of the organism with the most likely sources being fecal contamination of the calving unit and the udder. *MAP* can also be found in colostrum and milk of infected asymptomatic cows, serving as additional source of infection. Although calves are most susceptible to *MAP*-infections, adult cattle can become infected too.[25] Furthermore, about 25% of calves born to cattle with clinical signs of JD are already infected *in utero*. The first clinical signs of JD are usually not seen before 2 years of age but might be present at 1 year of age in herds with a high prevalence of JD.[6] Animals infected with *MAP* may shed high quantities of the organism in their feces, so called "super-shedders" were found to shed more than 1 million colony forming units (cfu) of *MAP* per gram of manure without showing clinical signs of JD.[26] The most important route of disease distribution is through purchase of asymptomatic infected animals, but transmission via semen, by embryo transfer and from free ranging ruminants has also been discussed.[10,12,18]

Infections with *MAP* in cattle can be divided into 4 stages: Stage 1 is called "silent infection", stage 2 "inapparent carrier adults", stage 3 "clinical disease" and stage 4 "advanced clinical disease.[6] Animals in stage 1 and 2 show no clinical signs of JD but cattle in stage 2 have a higher incidence of other diseases including infertility, mastitis and lameness as well as a reduction in milk yield.[15] Stage 3 and 4 are characterized by typical symptoms associated with JD such as chronic diarrhea and weight loss, despite normal appetite. Animals in stage 4 become weak, emaciated and suffer from chronic profuse diarrhea, leading to the death of the infected animal.[6]

While clinical cases of JD can often be diagnosed based on thorough clinical examination and history or necropsy findings, laboratory test have to be used if clinical symptoms are missing. Unfortunately, current laboratory tests for the diagnosis of JD show a low sensitivity and specificity in subclinically infected cattle.[5] The most commonly used laboratory tests are the fecal culture and PCR (Polymerase Chain Reaction) as direct methods and the Enzyme Linked Immunosorbent Assay (ELISA) as indirect method for the detection of *MAP*-specific antibodies.

JD is ranked as one of the most prevalent and costly diseases of dairy cattle today and is also affecting the beef cattle industry. Animals suffering from clinical JD (stage 3 and 4) only represent the "tip of the iceberg" of *MAP*-infections within a herd.[6] It has been estimated, that for every animal in stage 4 of *MAP*-infection, 1 to 2 animals in stage 3, 6 to 8 individuals in stage 2 and 12 to 25 cattle in stage 1 are present in a herd.[6] Economic losses of *MAP*-infections are difficult to calculate and include decreased milk production, reduced value at slaughter, costs for veterinary treatments and costs of control programs, as well as loss due to un- or underused production facilities.

Control of Johne's disease in Europe

Europe consists of 46 different countries with diverse agricultural structures and cattle population. Within the European Union 86,6 million cattle were counted in 2010[27] with an average herd size of 27 cattle, ranging between 202 (Cyprus) and 2,5 (Romania) animals per herd. These heterogeneous frame conditions for dairy and beef production as well as the differences in legislation and administration between the European countries lead to diverse control efforts and programs for *MAP* in cattle.

Some countries, such as Sweden, which are almost free of the disease, perform a rigorous mandatory control program with a stamping out policy. In most countries voluntary control programs for *MAP* are in action. These programs show different aims, levels of measurements and acceptance by the producers. In the following some examples for *MAP*-control programs in Europe are presented.

Sweden

Sweden has a cattle population of about 1.5 million animals[27] with very little import of live cattle per year. Since 1952 JD is notifiable in Sweden and the prevalence of the diseases is very low.[21] All suspected cases of JD in cattle are investigated by the responsible authority and since 2004 culture samples are taken from all adult cattle submitted for necropsy.[22] Furthermore live cattle imported to Sweden have to be sampled for *MAP* or the herd of origin has to be investigated.[9] In case a herd is detected as *MAP*-positive a stamping out policy, including extensive tracing of all contact herds, is applied. The affected premise has to be cleaned and disinfected and a holding period is applied on buildings, pastures and farmland.[22]

Norway

Norway has a cattle population of about 900,000 animals[27], an incidence of 10% of *MAP* positive farms has been reported.[16] In Norway a national surveillance and control program for JD was established in 1996. The active surveillance incudes all milk delivering cattle herds and beef herds receiving state support. Herds are randomly selected for fecal sampling of the 5 oldest cow of the herd.[8] Since 2000 clinical surveillance with special emphasize on animals with symptoms of JD, such as weight loss, diarrhea lasting more than 14 days and cattle that are over 4 years of age is performed. Confirmation of *MAP*-infection most often results in culling of the affected herd and compensation by the government.[8]

Austria

The Austrian cattle population consists of about 2 million[27] animals with a reported prevalence of 19% serological positive cattle herds in 2003.[2] Since 2006 clinical JD is notifable in Austria in cattle, sheep, goats and farmed deer.[11] Animals showing clinical signs of paratuberculosis have to be separated and tested for JD by blood (ELISA) and fecal (culture, PCR) sampling. Confirmed positive animals have to be culled within 3 days and the meat has to be disposed. Culled animals are compensated by the government and hygienic precautions to prevent further spreading of the disease have to be performed at the farm. If severe emaciation, possibly linked to JD, is noticed at slaughter, culling or in died animals, tissue samples are taken and tested for *MAP* by PCR.[11] The aim of this compulsory program is to reduce clinical JD, decrease the *MAP* shedding into the environment and thereby protect uninfected herd mates and farms. Additionally, the intake of *MAP* into the food chain shall be reduced by elimination of cattle with an advanced *MAP*-infection.

The Netherlands

Approximately 4 million cattle were counted in the Netherlands in 2010[27], about 54% of the cattle herds are considered *MAP*-positive.[16] In 2006 a new voluntary program for the control of JD was established in the Netherlands. This program is focused on milk quality and the reduction of the *MAP*-load in milk delivered to dairies.[1] Either all lactating cows are tested by milk ELISA, or cattle 3 years of age and older by serum ELISA at an interval of 24 months in participating farms. Positive results can be confirmed by fecal culture on request by the farmer.[24] The aim of the program is not to certify herds as *MAP*-free, participating herds are assigned “Status A”, B or C instead. Herds with no positive ELISA-result are assigned “Status A”, herds from which the positive animals have been removed achieve “Status B”, and herds with positive animals remaining in the herd are assigned “Status C”.[24] Since 2008 the initial round of testing within the program is paid by the Dutch Dairy Board, resulting in a participation of more than 80% of the Dutch dairy herds in the program. Mandatory participation and restriction of milk delivery for herds with “Status C” is considered after 2011.[1]

Denmark

The cattle population of Denmark consists of about 1,6 million cattle[27] with a prevalence of 55% *MAP*-positive herds[16] and 85% *MAP*-positive dairy herds.[1] A voluntary risk-based control program for JD was established in 2006 with the goal to reduce the *MAP*-prevalence in dairy cattle and the long-term goal of *MAP*-eradication.[1] The milk of all lactating cows of participating herds is tested 3 to 4 times per year by milk ELISA. Cows are categorized as high-risk animals if at least 1 of the last 3 milk ELISA tests is positive and as low risk animals if all ELISAs are negative.[17] High-risk animals require hygienic precautions to decrease exposure of calves to *MAP* contaminated colostrum, milk and feces. Furthermore, slaughtering of cows with repeated positive ELISA-results is recommended.[17] Beside the classification of high-risk and low-risk animals no status or infection level is assigned to the farms and participating farmers are informed that the program will last 6–8 years. Although all costs of the program have to be paid by the famer approximately 29% of the Danish dairy herds were participating in the program in 2009.[1]

Germany

A population of 12,7 million cattle was counted in Germany in 2010 (Eurostat). The reported seroprevalence of *MAP* varies between regions and reaches up to 84,7% seropositive dairy herds in some parts of the country.[7] Cases of JD in cattle have to be reported and are registered by the responsible state authorities but cause no consequences for the reported animals or herds. Guidelines for the control of JD have been released by the German Federal Ministry of Food, Agriculture and Consumer Protection in 2005.[28] These guidelines summarize suggestions for hygienic precautions and control programs for *MAP* with the aim to harmonize regional activities, reduce clinical cases and prevent further distribution of the disease. Beside these unaccommodating guidelines there do exist many regional voluntary control programs for JD in cattle including the federal states of Brandenburg, Lower Saxony, North Rhine-Westphalia, Saarland and Thuringia.

Discussion and suggestion of a minimal control program

Infections of cattle with *MAP* are difficult to control, have a great economic impact and will play an important role in cattle medicine in the future. Most control programs for JD are based on a test and cull strategy, combined with hygienic precautions, mainly focused to prevent new *MAP*-infections in calves and young livestock.[4] Unfortunately, the acceptance of such programs by farmers and veterinarians is limited due to high costs, intensive workload, long duration and the lack in sensitivity and specificity of laboratory tests, leading to limited success of the programs.

To overcome this lack and to harmonize the control of *MAP* in Europe a basic “minimal control program” with defined minimum standards should be considered. This suggested potential “minimal program” to control JD in cattle consists of 3 steps. Step 1 includes the consequent diagnostic evaluation of every case of diarrhea in adult cattle, followed by immediate culling of all animals with clinical JD. In step 2 basic management measures to prevent new infections within the herd are implemented. These hygienic measures can be chosen from already existing programs and publications.[25,28,29] Selection, adaptation and implementation of suitable and realizable precautions according to the possibilities (economy, time…) of the individual farm are most important at this stage. Only those hygienic precautions fully supported and backed by farmers, farm staff and veterinarians of the individual farm should be chosen to assure consequent realization and to avoid frustration. Step 3 consists of regularly evaluation of the *MAP*-herd status with the focus to detect *MAP*-shedding. This can for example be achieved in an easy and inexpensive way by the use of environmental fecal samples.[13]

This “minimal control program” can of course not replace more intensive “maximal programs” to control JD in cattle, but can be implemented with reasonable costs and work load in most cattle herds. The aim of such a program might be the reduction of clinical JD as well as to reduce the shedding of *MAP* into the environment. Thereby new infections within the herd and between herds might be reduced and the incidence of the bacterium in the food chain can be decreased. As an additional side effect, these simple measures might also help to reduce other diseases, to increase production efficiency and animal welfare. Furthermore, this program might serve as an introduction into the control of JD and can be intensified and extended at any time.

As trading of subclinically infected cattle is the most common route of disease transmission, efforts to control *MAP* in Europe should be coordinated on an international level. Although it might be very difficult or even impossible to eradicate *MAP* in infected farms, the reduction of new infections within infected cattle herds and the protection of uninfected farms can be achieved. To reach these goals, a pan European “minimal control program for JD in cattle”, based on the 3 steps presented above, should be considered. Such a cheap and easy to perform program might help to establish minimal standards for *MAP*-control in Europe and serve as an incentive to decrease *MAP*-infections for those not willing to participate in more sophisticated an expensive control programs.

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