Environmental epidemiology of bovine tuberculosis in pastured cattle and deer herds

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Abstract: In present days most of European countries are free from bovine tuberculosis. In the last century test-and-slaughter method of eradication was the only by which the present situation has been reached. Nowadays epidemiologists can't reach further results because of sylvatic reservoir of the bovine tuberculosis. The interdisciplinary research of this disease began in England where Eurasian badger (*Meles meles*) proved to be the most important reservoir of the disease. In our study we examined two cattle and a red deer farm proved to be infected with Mycobacterium caprae in the same region of Hungary. We collected data about husbandry systems of the farms and about the environment for determining the risk of unwanted events occurring. Our results suggest that strict recordkeeping, good management practice, fencing system and herd size are the most important factors in the epidemiology of bovine tuberculosis in pastured herds in a highly infected forest environment.

Introduction

Bovine tuberculosis is one of the most important animal health problems of pastured herds in many regions of Europe. Since the last two decades the research carried out in connection with natural reservoir of bovine tuberculosis has got more important in the maintenance of freedom from the disease. (7)

The reservoir research in Europe began in England in the 1970s as the connection between the infection of badgers and cattle was confirmed. (4) Since then an interdisciplinary approach has been applied by epidemiologists as the results of ecology, population biology, geology, meteorology, mathematics, statistics and of course veterinary epidemiology has been used in planning strategy against bovine tuberculosis. In England Eurasian badger (*Meles meles*) proved to be the most important reservoir but either red (*Cervus elaphus*) and fallow deer (*Dama dama*) were found to be infected in some area of the UK. (4, 9)

In continental Europe the European badger hasn't got such importance in the epidemiology of bovine tuberculosis. The European studies suggest that wild boar is the most important reservoir of the disease but in some areas red and fallow deer can also play an important role in the epidemiology. In the course of the research it was found that dense wildlife population and intensive hunting management were predisposing factors to make the disease endemic in an area. (8, 13)

Areas with the above-mentioned predisposing factors are risky for grassland based animal husbandry. But as the environmental requirements of intensive wildlife (especially large game species) management and pasturing animal keeping are very similar so these areas are mostly the best for grassland and pasture management. For this reason environmental epidemiology and risk assessment is applied in Europe to prevent tuberculosis infection of herds managed in endemic area. (1, 7)

Risk assessment can be conducted in a qualitative or a quantitative manner. A qualitative assessment presents data in a logical way and aims at summing up the risk in words using terms like "negligible", "low", "moderate" and "high" without allocating exact numerical values to probabilities, costs and consequences. Quantitative risk assessment uses the tools of mathematics, statistics and computing and is suitable for modelling epidemics. (10)

Materials and methods

In our study first we analysed the environment of three (2 cattle, 1 deer) farms in the view of spread the bovine tuberculosis. Then we used the qualitative risk assessment as we analysed the steps of the technology of the three farms, identified hazardous steps, assessed the probability and the consequence of hazards and made recommendations to prevent risk. In the assessment we used the above-mentioned terms without exact numerical values.

Study area

Our research was carried out in the Region of Zselic. This is a highly forested area of South Tarnsdanubia. The climate is sub-Mediterranean, sub-Atlantic so in contrast with the other parts of Hungary the summer is less hot and less dry, the winter is mild, and the rainfall is more frequent all the year round. Soil type is clayed brown forest soil with high iron content and low pH. These conditions are favourable for mycobacteria surviving in the environment.

The habitat has got a varied structure and contains a wide range of natural and agricultural plant community so it can support game populations. The bottle-neck factor in the habitat is the relative lack of surface water which makes the habitat overpopulated in dry periods of the year. Few watering places appeal a lot of animals in a wide range of species.

The big game population of the area is very dense and intensively managed. There are seven game parks on an almost 1200 km^2 area. The waste materials of hunting are not rendered in accordance with professional rules and law. After big hunting bags a lot of risk materials remain in the forests availably for wild boars. This is why wild boars are infected with *M. caprae*. The prevalence of infection is more than 20 %. (3) In red deer the infection prevalence was found to be 5.88 %. (2)

Study farms

All three farms are in the same valley of the Zselic about 3km far from each other. Animals are pastured in a year-round grazing system. Every farm has got natural watercourse with source outside the farm. All are confirmed to be infected within a period of two years. The deer farm is fenced around with a 2.4m height wire fence. At the beginning of the study around the two cattle farms were electric fences only.

Cattle-farm 'A'

This farm holds a Limousine herd with 450 cows, 8-10 breeding bulls and offspring. The animals are kept in 5 groups. The owner and the stockmen are not professionals. The production and animal health records are kept at the headquarter office of the owner's firm far from the farm. Data which should be the base of the records are collected by the stockmen. The management of the herd is not good. Winter nutrition and spring condition of the cows are very weak. The lack of professional education of the management made the eradication very hard. It lasted 20 months.

The method of the eradication programme was test-and-slaughter. We examined every individuals elder than 6 weeks by single intradermal tuberculin test (SITT) in accordance with the European Council Directive 64/432/EEC in every 42 days and slaughtered all animals which had got 2mm or greater sized skin test response. All culled animals' lymph nodes and all tuberculosis-like lesions were sent to the national bovine tuberculosis reference laboratory for culture. With this method we found four culture (*M. caprae*) positive animals. In the course of diagnostic slaughtering we found serious signs of paratuberculosis in many animals culled as reactors. These findings were confirmed by the reference laboratory.

After the first year of the eradication programme the owner decided and began to fence round the farm with 1.2m height wire fence which can fence wild boars off but can be jumped across by red deer.

Cattle-farm 'B'

This farm holds a Charolais herd with 50 cows, 1 breeding bull and offspring. The animals are kept in two groups: calved and pregnant cows. The owner is not but the stockmen are professionals. The records collected by professional personnel are kept on the farm. The farm management, nutrition, animal health programme are excellent. The eradication programme was the same as on Farm 'A' and lasted for 10 months. Only one animal were confirmed to be infected with *M. caprae*. The culture positive lesion was a small abscess in the cow's retropharyngeal lymph node. Signs of paratuberculosis were found at culling and infection was confirmed too.

After half a year of eradication effort the owner began to fence the farm round with 2.4m height wire fence and ended the work within a month. This is a good tool for fencing also deer species off the farm.

Deer-farm

This farm holds 220 red deer hinds, 14 stags and offspring. The animals are kept in smaller (20-30 hinds) groups in the summer and in bigger (40-60 hinds) ones in the winter. The nutrition is well-managed, every husbandry action is planned, and record-keeping is strict and can be traced back for decades. The farm management has got special profession in deer farming. This farm couldn't have been eradicated yet.

Only the hinds and youngsters can be tested by SITT twice a year, in the period from November to February and in July-August. Stags can be tested only in February when they haven't got hard antlers. After the confirmation of infection in every year one-three animals prove to be infected by laboratory confirmation. Paratuberculosis was also found and confirmed in this herd.

The base of this deer herd originates from different part of Hungary. In the early history of the herd there was bovine tuberculosis which 'disappeared' more than a decade ago.

Results

Analysing the environmental data we can declare that Zselic Region of Hungary is a bovine tuberculosis high risk area because of the following reasons. The climatic and geographic factors can help mycobateria to survive in the environment so the time when shed bacteria is able to infect a new host is much longer than in a dryer, warmer climate with intensive ultraviolet radiation (e. g. in the lack of forest cover) or in another type of soil. The dense big game population which is bothered by intensive hunting management and sometimes concentrated by scarcity of water is at epidemiologic risk largely. The confirmed bovine tuberculosis infection of wild boar and red deer gives special importance to these species and highlights the incorrect waste management of hunters.

Analysing the relevant epidemiologic data of the three farms the main differences can be summarized in Table 1.

Point of view	Cattle-farm A	Cattle-farm B	Deer-farm
Species	cattle	cattle	red deer
Herd size	450	50	220
Group size	80-110	20-30	20-30/40-60
Management	weak	very good	very good
Stockmanship	weak	very good	good
Nutrition	wrong	right	right
Data collection and record-keeping	wrong	right	right
Frequency of skin-testing until freedom from BTB	42 days	42 days	6 months
Prevalence of infection at the beginning of the eradication	<1 %	1-2 %	<1 %
Duration of the eradication programme	20 months	10 months	not ended yet
Height of the round fence	1.2m	2.4m	2.4m
Paratuberculosis infection	yes	yes	yes

Table 1: Epidemiologic data of study farms

Discussion

Our results suggest that successful grassland based animal husbandry can be run on in a bovine tuberculosis high risk area if the animal keeper takes into consideration the results of epidemiologic risk assessment and applied effective prevention programme.

In our study we found that good animal keeping practice and appropriate nutrition have got great importance. Considering that the tuberculosis in many species e. g. in humans is an indicator disease of well-being this is not surprising. And the same holds true of herd size and stocking density. It is very possible that every species has got an 'ideal' herd size which is not advisable to exceed. As either in humans the tuberculosis epidemics began when the population settled down and began to increase and got dense. (6, 12, 13)

Animal health records are also very important in chronic diseases' management. On the deer-farm the record-keeping is excellent and this is why we could trace back in the past and found the early tuberculosis epidemic out. On Cattle-farm A unreliable record-keeping made the eradication so hard as it lasted for 20 months and it was possible that the first animals hadn't been found at the first testing after infection as contrasted with Cattle-farm B. In herds where either paratuberculosis infection worsens the diagnostic ability of skin test the correct data collection and record-keeping for years are essential to find infected animals as soon as possible.

Frequency of tuberculin testing is also a very important factor of eradication. It is clear that 6 months interval is not enough to reach the freedom from bovine tuberculosis because the possibility that a new host gets infected and begins to shed bacteria is at least moderate. It is very necessary to increase the frequency of testing if the aim is freedom from the disease. Because of the biologic cycle of red deer species in an extensive game farm system more frequent testing is impossible. This is why we recommend that high quality breeding animals should be kept in an intensive, small-grouped system where individual treatment and record-keeping and more frequent tuberculin testing can be carried out. The 6 months interval with good animal keeping practice are enough just to keep the prevalence low. (13)

Fences round the farms can keep big game out. The longer time data of the deer-farm suggest that an adequately high fence is able to isolate the domesticated herd from wildlife correctly. It is possible that the studied deer-farms' epidemic is independent from the environments' one and correctly managed by husbandry tools as the average prevalence on the deer-farm is lower than the prevalence of red deer population in the environment and lower than experienced on New Zealand and Irish deer-farms. (5, 11)

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