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Paratuberculosis in Iceland: epidemiology and control measures, past and present

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Abstract

Paratuberculosis as well as the slow virus infections maedi/visna and jaagsiekte came to Iceland in 1933 when 20 sheep of the Karakul breed were imported from Halle, Germany. At least five of these sheep were subclinical carriers of paratuberculosis. Within 16 years paratuberculosis together with the other Karakul diseases (maedi/visna and jaagsiekte) almost ruined sheep farming, the main agricultural industry in Iceland. The first clinical case of paratuberculosis in sheep was confirmed in 1938, and in cattle in 1944. The first cattle cases of paratuberculosis appeared on farms where the disease had been prevalent in sheep for years. The virulence in cattle appeared to be considerably lower than in sheep. Extensive measures were used to control the spread of paratuberculosis in sheep. Hundreds of kilometres of fences were put up and used together with natural geographic borders to restrict the movement of sheep from infected areas. Serological and other immunological tests were also used to detect and dispose of infected individuals. These measures proved inadequate and the disease could not be eradicated. Culling and restocking of uninfected sheep in endemic areas eradicated maedi/visna and jaagsiekte but not paratuberculosis. Experiments showed that vaccination against paratuberculosis could reduce mortality in sheep by 94%. Vaccination of sheep in endemic areas has been compulsory in Iceland since 1966 and as a result losses have been reduced considerably. Today, serology is used to detect and control infection in cattle herds. Furthermore, serology is used to control vaccination of sheep and screen for infection in non-endemic areas. The complement fixation (CF) test for paratuberculosis has been used until now, but recently we have started comparing the CF test with the CSL absorbed ELISA test. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Iceland is a small island in the North Atlantic with 250,000 people and 480,000 sheep. The first Viking settlers came to Iceland from Norway in the 9th century, and brought their farm animals with them (Sigurdarson and Gunnarsson, 1983). The island is geographically isolated and the small primitive breed of hill sheep in Iceland had no contact with the outside world for centuries. They were healthy and there were few endemic infectious diseases in sheep in the country. As there was no immunological memory in the population to various pathogens, the import of new infectious diseases was likely to have catastrophic effects.

2. Introduction of paratuberculosis to Iceland

In 1933, 20 sheep of the Karakul breed were imported from Halle in Germany in order to improve the quality of the skin of the Icelandic sheep (Sigurdsson, 1954; Sigurdarson and Gunnarsson, 1983). The imported sheep appeared healthy and had certificates of good health control. After 2 months of quarantine, they were distributed to 14 farms in the main sheep farming areas.

The import of these 20 Karakul sheep had disastrous effects on sheep farming which was and still is the main farming industry in Iceland. Some of the imported sheep were inapparent carriers of slow infectious diseases which they introduced into the Icelandic sheep population (Sigurdsson, 1954; Palsson, 1962). These included paratuberculosis, maedi/visna and jaagsiekte, commonly called the “Karakul diseases” in Iceland. Although they transmitted infection to the Icelandic sheep population, the imported animals never showed any signs of these diseases (Palsson, 1962).

The first clinical case of paratuberculosis in sheep was diagnosed in 1938 or 5 years after the arrival of the sheep (Sigurdsson, 1954; Palsson, 1962). Paratuberculosis appeared in sheep on at least 5 out of the 14 original farms during the next few years. Gradually, the infection spread from these five original locales to surrounding farms, and over the next 18 years, 440 farms or 20–30% of the farms in the main sheep breeding areas were infected (Sigurdsson, 1954; Sigurdarson and Gunnarsson, 1983). About 7 years after the first clinical case appeared in sheep, paratuberculosis was observed in cattle, all of which came from farms with infected sheep (Gislason, 1956).

The Icelandic strain of *Mycobacterium avium* subsp. *paratuberculosis* appeared to be of a comparatively low virulence for cattle as infection had been prevalent in sheep for years on these farms before cattle showed any signs of infection. Production losses and mortality from paratuberculosis in cattle were moderate on most of the farms, although few farmers experienced high mortality (Sigurdarson and Gunnarsson, 1983). Paratuberculosis was confirmed in goats in 1969 and it is suspected that a reindeer may have been infected (Sigurdarson and Gunnarsson, 1983).

Farms in infected areas held about one fourth of the total sheep population in Iceland (Sigurdarson and Gunnarsson, 1983). The annual mortality of sheep during the epidemic averaged 8–9% in these areas and could approach 40% on individual farms (Palsson, 1962). It is estimated that the total losses during the epidemic were around 100,000 sheep (Palsson, 1962).

3. Control measures

Extensive measures were used to try to eradicate paratuberculosis and the other Karakul diseases in Icelandic sheep (Sigurdsson, 1954). The country was divided into infected and non-infected zones (Sigurdsson, 1954). Hundreds of kilometres of fences were put up and used together with natural barriers such as big rivers, glaciers and mountains to control the movement of sheep. Guards controlled the fences, animals crossing the lines were slaughtered, and the transport and sale of sheep between zones was prohibited (Palsson, 1962).

These measures alone did not help and in order to try to eradicate the Karakul diseases all sheep, a total of 102,000 in two of the main paratuberculosis areas were slaughtered and restocked with healthy uninfected sheep 1 year later (Sigurdsson, 1954). These measures eradicated maedi/visna and jaagsiekte in Iceland (Sigurdsson, 1954), but paratuberculosis reappeared a few years later (Sigurdsson, 1954). It is suspected that cattle remaining on the infected farms spread the infection to the new sheep.

Additional methods had to be used in order to control paratuberculosis. The only control measures available at the time were early diagnosis by skin tests and blood testing, culling of infected or suspected animals, and extensive zone control. These measures did not eradicate paratuberculosis, although the spread of the disease was delayed. However, mortality was still high on some farms and additional measures had to be taken.

4. Preventive measures

Extensive research by Dr. Bjorn Sigurdsson and co-workers led to the development of a paratuberculosis vaccine that is still used today (Sigurdsson and Tryggvadottir, 1949; Sigurdsson, 1952). Since it had not been possible to culture the Icelandic sheep strain, other strains were used in the vaccine (Palsson, 1962; Gunnarsson, 1979). The Icelandic vaccine or the so called Sigurdsson's vaccine consists of two heat killed bovine strains of the bacteria suspended in equal parts of olive oil and mineral oil (Sigurdsson and Tryggvadottir, 1949; Sigurdsson, 1952; Sigurdsson, 1954). Vaccination experiments began in sheep in 1950 and showed that vaccination could reduce mortality in sheep by about 90% (Palsson, 1962). Vaccination of sheep has been compulsory in infected areas since 1966 (Sigurdarson and Gunnarsson, 1983). Cattle, on the other hand, have never been vaccinated in Iceland.

Icelandic sheep graze freely on common highland pastures during the summer and are gathered collectively in the autumn. As vaccination produces local lesions at the site of infection and a nodule that can reduce the value of the carcass, only lambs intended for breeding are vaccinated in the autumn at the age of 4–6 months.

Today infection is kept under control by vaccinating breeding lambs in endemic areas, at the age of 4–6 months. In these areas, all adult sheep are examined in the slaughterhouse. Furthermore, part of the ileum is taken from all the sheep and sent to our institute for macroscopic inspection, microscopic examination of direct smears and/or histology.

Currently production losses from paratuberculosis are minimal. The disease has not been diagnosed in certain districts for >10 years and vaccination may even be stopped in these areas in the near future if it can be proven that the disease has been eradicated. Despite advances, we are still far away from eradicating paratuberculosis from Iceland.

Currently blood tests are done routinely on all rams and bulls used for insemination and on cattle that are to be sold or transported. The serologic test used is a “home made” complement fixation (CF) test that uses an antigen preparation made from infected intestinal mucosa (Sigurdsson, 1945; Sigurdsson, 1954; Gislason, 1956).

5. Comparison of serological tests

Lately, we have been running parallel testing on the CF test and the CFS absorbed ELISA test for cattle. To date, 578 samples from 46 farms have been tested. A total of 568 or 98.2% were negative in both tests, three were positive in both tests and seven were positive in either the CF test (5) or the ELISA test (2). A total of 98.7% of the samples gave same result in both tests. Unfortunately, we only had few positive samples, and the correlation between individual positive tests was not satisfying. On a herd basis, there was a reasonably good correlation where 44 out of 46 farms gave coherent results. Further testing is needed before we can draw any conclusions. In the near future serological tests for sheep will be compared in the same way.

6. The Icelandic history should stand out as a warning

Our history of paratuberculosis should stand out as a warning both to Iceland and other countries. The story could repeat itself in our country with any species of domestic animals which all have lived in isolation for centuries.

As an example, a major outbreak of an infectious disease in horses occurred in 1998, spreading rapidly throughout Iceland with 0.2% mortality (Bjornsdottir, 1998; Gunnarsson, 1998). The agent responsible appears to be an enterovirus and was apparently brought to the country either by people or equipment, as import of horses is totally prohibited in Iceland. Although this agent caused a major outbreak in Iceland, it may only cause a mild infection or even go unnoticed in other countries where immunological memory is present in the population.

The Icelandic story of paratuberculosis and the other Karakul diseases should stand out as a warning and reminder of the necessity to show the outmost caution when importing animals. This is important for the well being of our animals, for the farmers and the consumers as well.

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