Proceedings of the New Zealand Grassland Association 55: 199-202 (1993)

Bovine tuberculosis - the New Zealand problem

G.W. de LISLE
AgResearch, Wallaceville Animal Research Centre. Upper Hutt, New Zealand

Abstract

Control strategies based on the slaughter of cattle identified as infected by skin testing have been successful in eradicating bovine tuberculosis from several countries. In contrast, identical control methods have not achieved eradication in New Zealand. The reason for the persistence of tuberculosis in New Zealand is the presence of a wildlife reservoir of infection. While possums are the principal wildlife reservoir of bovine tuberculosis, feral pigs and wild deer may also be a source of infection for domestic animals. Current control programmes in which possums are poisoned are successful in reducing but not eliminating the spread of infection to cattle and farmed deer. The development of vaccines and the biological control of possums is the focus of active research in New Zealand. These are long-term research projects that will take many years before they can be sufficiently developed to be used to eradicate bovine tuberculosis from this country.

Keywords: bovine tuberculosis, cattle, farmed deer, *Mycobacterium bovis*, possums

Introduction

In the early 1900s bovine tuberculosis caused by *Mycobacterium bovis* was widespread in cattle throughout the world (Francis 1947). In cattle it was a major cause of economic loss due to clinical disease and was responsible for many cases of tuberculosis in humans, especially children. *Mycobacterium bovis can* produce a disease in humans indistinguishable from that caused by *Mycobacterium tuberculosis*, the more common cause of tuberculosis in humans. Pasteurisation of milk together with the control of tuberculosis in cattle was responsible in most western countries for eliminating *M. bovis* as a major cause of disease in humans.

Before the Second World War several countries had made considerable progress in controlling bovine tuberculosis. The successful control programmes were based upon the slaughter of infected cattle identified by skin testing. In addition, extensive use was made of abattoir surveillance and tracing of diseased animals back to the farm of origin, *M. bovis* has now been totally eradicated in Cuba, Finland, Iceland, Norway and Sweden using this approach. The tuberculin skin test, which has a sensitivity of only 70%, has been a central component of all the successful eradication programmes. This sensitivity is more than sufficient to enable the eradication of *M. bovis,* as the infection usually spreads very slowly through herds. The high specificity of skin testing, especially the comparative skin test (>99%), resulted in the slaughter of relatively few uninfected animals because of false positive reactions,

Bovine tuberculosis in New Zealand

Tuberculosis has been recognised as a problem in New Zealand cattle for over 100 years. In 1893 it was made a notifiable disease, affected animals being condemned on clinical grounds. During the next 50 years several initiatives were taken to control bovine tuberculosis. The tuberculin skin test was successfully used to control tuberculosis in herds supplying milk to some smaller towns such as Masterton, Dannevirke and Wairoa. Nationally, however, tuberculosis was still a major clinical problem. From 1935 to 1944 field condemnations of cattle for tuberculosis averaged about 7000 per year. A national voluntary tuberculosis control scheme using tuberculin skin testing was started for town milk supply cattle in 1945 (Laing 1955). Compulsory testing of dairy and beef cattle began in 1961 and 1971 respectively (Anon. 1986). Initially the scheme was very successful. By 1976 79% of the 38 500 herds under test had been accredited. However, the incidence of tuberculosis did not uniformly decline in all areas under test. In the Buller County of the West Coast of the South Island many herds either remained infected or were reinfected despite frequent skin testing.

Tuberculosis in possums

In 1967, *M. bovis* was isolated for the first time from possums (Ekdahl *et al. 1971).* These possums came from Westport and had generalised tuberculosis. A feature of these cases was the "vast number of organisms present and these were discharging either via suppurating sinuses or the respiratory system". While Ekdahl *et al.* (1971) did not recognise the full significance of this finding, they did mention the possibility that possums and pigs might be a reservoir

of infection for domestic animals. By the mid 1970s there was a growing body of epidemiological evidence that tuberculosis was spreading from possums to cattle. The most compelling evidence was the finding that tuberculosis could be eradicated from cattle only after possums in the same area had been poisoned.

The tuberculosis control scheme was adapted by considering the presence of wildlife reservoirs of *M. bovis.* To facilitate management of bovine tuberculosis, New Zealand was divided into Endemic and Non-endemic areas. The Endemic areas (5) have wildlife reservoirs of *M. bovis* that are too extensive to be eradicated with current technology. The Endemic areas cover approximately 20% of New Zealand's land area and contain 76% of the infected herds (Livingstone 1992). The Non-endemic areas are largely free of bovine tuberculosis. A minor component of the Non-endemic areas is the "Special Tb Investigation Areas" (STIA) which contain a wildlife reservoir of infection. There are 13 STIAs where it is considered possible to eradicate tuberculosis from these areas.

Tuberculosis in farmed deer

Mycobucterium bovis was first isolated from a wild deer in New Zealand in 1970. Subsequently, large numbers of tuberculous wild deer were identified in game packing houses (de Lisle & Havill 1985). The year 1970 also marked the start of deer farming in New Zealand. Many of the deer farms were established with captured wild deer, some of which were infected *with M. bovis. The* first case of *M. bovis* in farmed deer was recorded in 1978. By the early 1980s tuberculosis had become a major problem in farmed deer. There were added complications because no tests had been developed to diagnose tuberculosis in deer. A voluntary tuberculosis control scheme was introduced for deer in 1985 but it was not made compulsory until 1990 (Carter 1992). The spread of infection from farmed deer to other animals, especially possums, highlighted the need for a comprehensive tuberculosis control programme that included all host species of *M. bovis.*

Tuberculosis in wildlife other than possums

Mycobacterium bovis has been isolated from wild deer, feral pigs, wild ferrets, feral goats, feral cats, possums and a rabbit in New Zealand. Apart from possums, there is little direct evidence to suggest that these different wildlife hosts are a source of infection for domestic animals. A high prevalence of infection with *M. bovis* has been observed in feral pigs from Central Otago. In many areas of Central Otage where infected pigs have been found, the density of possums was low. This observation has led to the hypothesis that tuberculosis may be cycling within the feral pig population. In addition, the incidence of tuberculosis in cattle and farmed deer in Central Otago has raised the possibility of spread of infection from feral pigs to domestic animals. The role of pigs as a source of M. *bovis* for other animals is controversial. The epidemiological evidence indicates that animal to animal spread rarely occurs in Australian feral pigs or New Zealand domestic pigs.

The recent finding of *M.* bovis-infected wild ferrets in seven geographically distinct areas of New Zealand has highlighted another potentially important wildlife reservoir of infection. One area where infected ferrets have been found is in Central Otago.

DNA fingerprinting

Restriction endonuclease analysis, a form of DNA fingerprinting, has been used extensively to study the epidemiology of bovine tuberculosis in New Zealand (de Lisle *et* al. 1991). Early investigations using DNA fingerprinting demonstrated that strains of *M. bovis* from possums which had identical fingerprints came from adjacent localities. Subsequent studies examined *M. bovis* isolates present in farmed and non-farmed animals from the same locality. These studies revealed that the types of M. *bovis* found in possums are also found in cattle and farmed deer. The results are consistent with a cycle of infection between farmed and non-farmed species from the same locality. No evidence has been obtained to indicate that any of the different types of *M. bovis* have a host species preference.

DNA fingerprinting has been used to investigate outbreaks of *M. bovis.* For example, the transition of the Mackenzie Basin from an area free of infection to one of endemic tuberculosis has been examined using DNA fingerprinting. A diversity of different types of *M. bovis* was found in farmed and non-farmed animals from the Mackenzie Basin. The results were consistent with at least two different introductions of infection into this area. DNA fingerprinting also helped identify the possible location of the origins of these introductions. Identical DNA types of *M. bovis* in farmed and non-farmed animals demonstrated that the Mackenzie Basin had become an area of endemic bovine tuberculosis with a wildlife reservoir of infection.

Current bovine tuberculosis control strategies

The policies and standards of the Tuberculosis Eradication Scheme are defined by the Ministry of

Agriculture and Fisheries in consultation with the Animal Health Board. The mission of this scheme is "To eradicate bovine tuberculosis from New Zealand" (Isbister 1993).

The objectives of the five-year strategic plan of the Animal Health Board are:

1. In endemic areas to reduce the percentage of movement of controlled herds (deer and cattle combined) by 30-50% and the number of reactors by 50-70%.
2. To reduce the percentage of movement of controlled herds in the non-endemic areas to 0.2% (i.e., the internationally recognised level for official freedom from tuberculosis).
3. To prevent the establishment of new endemic areas and expansion of existing endemic areas into farmland free of feral/wild tuberculosis vectors.
4. To encourage individual farmers to take greater responsibility for the control of tuberculosis within their herds.

Achieving these objectives will rely heavily on control of possums through the use of 1080 poison. The Animal Health Board realises that to achieve the goal of eradication of bovine tuberculosis requires new control procedures. An integral part of the Animal Health Board's strategy of total eradication is the funding of a comprehensive research programme.

Future prospects for the eradication of bovine tuberculosis from New Zealand

Mycobacterium bovis-infected wildlife are now found in approximately 28% of New Zealand. Elimination of this reservoir of infection by poisoning or traditional trapping methods is not affordable or feasible. Therefore, new methods are required to achieve the goal of eradication of ***M. bovis*** from domestic livestock in New Zealand. Two new approaches, tuberculosis vaccines and the biological control of possums, are now the focus of active research programmes. There is an continuing controversy over the use of BCG, a live ***M. bovis*** vaccine, for the control of tuberculosis in humans. In some trials levels of protection of up to 80% were observed. This contrasts markedly with the absence of protection observed in the extensive trial carried out in southern India. Advances in genetic engineering have resulted in a huge increase in the knowledge of mycobacteria and the immunological responses associated with tuberculosis. Opportunities are now available to produce a new generation of vaccines that could be used to help control bovine tuberculosis in New Zealand.

The concept of biological control of possums is to introduce into the population an "agent" or "vaccine" which would lead to decrease in possum numbers. Significant reductions in possum numbers would result in elimination of ***M. bovis*** from this wildlife reservoir. One approach is to use a virus to disseminate a species-specific agent of contraception (Tyndale-Biscoe 1991). For contraception, the agent would act to induce an immune response which would interfere with reproduction. While the concept of biological control is relatively simple, there are some extremely difficult scientific and ethical problems to overcome. Not only does the concept of biological control have to be demonstrated to be feasible in the possum, it also has to be shown to be 100% safe. Any possible effects of a biological control agent on a non-target species, especially domestic animals or humans, would be completely unacceptable.

There are major scientific problems to overcome to produce an effective tuberculosis vaccine or an agent for the biological control of possums. Both approaches require long-term research programmes that must include a large investment in basic as well as applied research. Given the unique nature of the bovine tuberculosis problem in New Zealand, the majority of the research will have to be done in this country.

REFERENCES

Anon. 1968. History of Tb control schemes. ***Surveillance 13 (3): 4-l.***

Carter, C.E. 1992. Control of tuberculosis in the New Zealand deer industry. Proceedings of the Bovine Epidemiology Workshop, Townsville, Australia. l-8.

de Lisle, G.W.; Havill, P.F. 1985. Mycobacteria isolated from deer in New Zealand from 1970-1983. New ***Zealand veterinary journal 33:*** 138-140.

de Lisle, G.W.; Wards, B.J.; Collins, D.M. 1991. DNA typing of mycobacteria. Symposium on Tuberculosis. Publication No. 132. Veterinary Continuing Education, Massey University. 137-142.

Ekdahl, M.O.; Smith, B.L.; Money, D.F.L. 1970. Tuberculosis in some wild and feral animals in New Zealand. New ***Zealand veterinary journal 18: 44-45.***

Francis, J. 1947. Bovine Tuberculosis. London, Staples Press Limited.

Isbister, R.J. 1993. The Animal Health Board's Five Year Strategic Plan. Proceedings of the Great Lake Pest Summit. 36.

Laing, A.D.M.G. 1955. The history and progress of the town milk supply tuberculin testing scheme. New ***Zealand veterinary journal 3:*** 138-143.

Livingstone, P.G. 1992. Bovine tuberculosis in New

Zealand – Past, present and future. Proceedings of the Bovine Epidemiology Workshop, Townsville, Australia. l-l 6.

Tyndale-Biscoe, C.H. 1991. The concept of viral vectored immunocontraception for possum control in New Zealand. Symposium on Tuberculosis. Publication No. 132. Veterinary Continuing Education, Massey University. 271-290.

■