Eliminating bovine tuberculosis from Australia

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***Mycobacterium bovis*, the causative organism of bovine tuberculosis (TB), has a worldwide distribution. Australia, like most developed countries, recognised the zoonotic risk of bovine TB, and embarked on state control programs to minimise the incidence of disease in cattle in the 1960s and a national campaign to eradicate the disease in 1970. Veterinarians, physicians and many other different disciplines worked cooperatively in Australia to understand and solve the problem; perhaps a very early example of the One Health concept in action.**

Mycobacterium bovis belongs in the *Mycobacterium tuberculosis* complex, a closely related group of organisms that causes tuberculosis (TB) in humans and other mammals. The traditional members of the complex are *M. tuberculosis, M. africanum, M. bovis* (and *M. bovis* BCG) and *M. microti. M. tuberculosis* and *M. africanum* primarily affect humans and *M. microti* is mainly associated with TB disease of voles.

It is well known that *M. bovis* has the widest host range of any of the *M. tuberculosis* complex species[1]. The list of animals susceptible to *M. bovis* is extensive, including domesticated animals such as cattle, farmed buffalo, goats, various species of deer, sheep and pigs, as well as a variety of free-living and captive wildlife species that may be maintenance, spillover or end hosts for *M. bovis*[2]. The 44 recorded wild animal hosts of *M. bovis,* or a closely related variant, include not only ruminants such as buffalo (three spp.) and deer, antelope and goats (11 spp.), but also large and small carnivores from cats to lions (seven spp.), omnivores such as bears and pigs (three spp.), primates (two spp.), mustelids such as badgers (*Meles meles*) and ferrets (four spp.), rabbits and hares (two spp.), some other small mammals (four spp.), seals and dolphins (seven spp.), and even a marsupial, the Australian brushtail possum (*Trichosurus vulpecula*). Another 17 species have been recorded as hosts in captivity, including six additional primates, and two species of rhinoceros.

In Australia in the 1930s, 25% of the cases of TB in children were due to *M. bovis*[3], caused mainly by ingestion of infected cow's milk. Following the implementation of pasteurisation in the mid-1950s and a successful bovine TB eradication campaign, Australia was declared free of TB according to international standards in 1997 (the last case of animal *M. bovis* was recorded in 2002). A significant feature of the campaign was the involvement of industry, which worked in partnership with government to fund and make policy decisions. Eradication was underpinned by

a test and slaughter program but included a number of novel interventions such as age culling, tracking of residual animals on Crown and private land using radio collars, strategic use of depopulation, an enhanced abattoir monitoring program. Research funded by government and industry provided new knowledge to assist policy decisions. Buffalo were recognised as a maintenance host for *M. bovis* and were included in the test and slaughter program from the early 1980s, when attention was focused on northern Australia. *M. bovis* also infected feral pigs but these were confirmed as spillover hosts. Incidental cases of *M. bovis* were confirmed in deer and a goat but neither of these presented a risk to the eradication program.

Despite the success of the program, an average of five cases per year of human infection (range 2–25) caused by *M. bovis* were recorded from 1975 to 2004[4] and 2–5 cases were recorded up to 2010. During 1975–1994, *M. bovis* infection was recorded in cattle workers and three cases were recorded in laboratory workers; however, the majority of cases resulted from reactivation of previous infection or were in people infected prior to arrival in Australia. Considerable concern has been raised about the increased risk of *M. bovis* causing TB in developing countries with a high HIV/AIDS burden such as South Africa and SE Asia[5], but this has not yet been recognised as a significant problem.

Wildlife species such as badgers, brushtail possums, white-tailed deer (*Odocoileus virginianus*), bison (*Bison bison*) and African buffalo (*Syncerus caffer*) are maintenance hosts for *M. bovis* and may be reservoirs for infection of both domestic animals and other wildlife species. In particular, the badger, possum and buffalo have caused almost insurmountable difficulties for conventional control and eradication programs in Great Britain and Ireland, New Zealand and South Africa respectively. Australia was fortunate it didn't have a wildlife maintenance host other than imported water buffalo. The inclusion of buffalo in the test and slaughter campaign, along with large-scale depopulation of feral buffalo contributed to Australia's success in eradication of bovine TB from its cattle herds.

Organisms once considered "garden variety", *M. bovis* isolated from goats, antelopes and seals have been further characterised as new members within the *M. tuberculosis* complex, evolving from an *M. tuberculosis*-like ancestor. For example, TB in Spanish goats, originally considered to have been caused by *M. bovis,* is now recognised as being caused by a particular clone of the *M. tuberculosis* complex known as *M. caprae*[6] and TB in seals and sea lions is now known to be caused by a new species called *M. pinnipedii*[7], which is also known to be zoonotic[8]. The presence of *M. pinnipedii* in seals, sea lions, and more recently a bottlenose dolphin (unpublished data) remain a risk for humans, and information sharing and cooperation between wildlife specialists, veterinarians and physicians is required to minimise exposure and infection in wildlife species and humans who work with them.

References

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Biography

Debby Cousins is currently a Director in Biosecurity Victoria, Department of Primary Industries. Dr Cousins did her PhD on *Mycobacterium bovis* diagnostics and molecular epidemiology at UWA, and she led the Australian and OIE reference laboratories for bovine tuberculosis for over 20 years.