

# Tuberculosis: an emerging zoonosis

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Tuberculosis (TB) caused by *Mycobacterium tuberculosis* is primarily a disease of humans who are considered the primary reservoir host for this pathogen. It is an ancient disease, with descriptions dating back thousands of years. It is currently estimated that one-third of the global human population is infected,<sup>1</sup> and TB accounts for millions of deaths annually.

### *Mycobacterium tuberculosis* in animals

Humans have had a very close association with animals for millennia, utilising them for food, labour, transport, clothing, companionship, disability assistance, recreation, sport, religious and cultural icons, security, entertainment and research and in rescue, rehabilitation and conservation efforts. It is inevitable then that as a result of this close association, transmission of pathogens from humans to animals and *vice versa* will occur. *M. tuberculosis* infections have been reported in a wide range of animal species including: elephants,<sup>2-6</sup> non-human primates,<sup>3,5,7</sup> rhinoceroses,<sup>6</sup> tapir,<sup>7</sup> various non-domestic ungulates,<sup>6,7</sup> seals,<sup>3,5</sup> various non-domestic carnivores,<sup>5</sup> dogs,<sup>8,9</sup> cats,<sup>9</sup> guinea pigs,<sup>10</sup> rabbits,<sup>10</sup> cattle<sup>11</sup> and birds.<sup>3,5,12</sup> Susceptibility to infection with *M. tuberculosis* varies significantly between animal taxonomic groups, with species such as old world monkeys, lesser apes, elephants, hamsters and guinea pigs being highly susceptible; great apes, new world monkeys, canids, seals, tapir, rhinoceroses, pigs, rats and mice are moderately susceptible; and prosimians, felids, equids, ungulates, rabbits, birds and reptiles have low susceptibility.<sup>3</sup> The susceptibility for many species is unknown. Animals are generally considered to acquire infection from humans with active TB, however animal-to-animal transmission also occurs, including between different species.<sup>6</sup>

Historically, zoonotic TB has been associated with *M. bovis*, however the incidence has declined significantly with the control and eradication of *M. bovis* in many countries and the advent of the pasteurisation of milk.<sup>13</sup> It is now emerging that animals are a potential source of *M. tuberculosis* infection for humans, and it is becoming an important occupational and public health concern. Although the relative incidence is low, there are now several reports of transmission of *M. tuberculosis* from animals to humans.<sup>5,6,9,14-17</sup> In the majority of these cases

infection occurred in humans that had a close and/or prolonged association with the infected animal/s, most commonly through occupational exposure.

### Risk factors for animal-to-human transmission

Many of the risk factors identified for contracting TB from a human with active TB are equally applicable to acquiring infection from an animal. These include: the number of bacilli being actively shed; total time of exposure; droplet size; persistence of aerosols through insufficient ventilation; and immune status.<sup>13</sup> Additional risks associated with working with animals include: proximity to an infected animal; aerosol-generating practices (such as the use of high pressure hosing when cleaning); conducting clinical veterinary procedures such as trunk washes in elephants; conducting necropsies on an infected animal; being an elephant trainer/keeper; and inconsistent or improper use of N95 masks when working with known or potentially infected animals.<sup>6</sup> Generally, however, it is concluded that humans must be in close proximity to, and have more than incidental contact with, an infected animal to be at risk of infection.<sup>13,14</sup>

### Case studies of animal-to-human transmission

A number of recent case studies provide examples of zoonotic *M. tuberculosis* infections. One report documents the infection of veterinary personnel during the clinical and pathological examination of a dog with unexpected disseminated TB. Contact investigation among the owners and veterinary personnel indicated that the index dog did not infect humans during its lifetime. However, all three pathologists performing the necropsy on the dog later returned positive results. Infection was most likely due to inhalation of aerosols created by using an electric saw to open the brain cavity.<sup>9</sup>

Tuberculosis caused by *M. tuberculosis* is emerging as an important disease of Asian elephants (*Elephas maximus*).<sup>2-6</sup> There have been numerous reports of transmission of *M. tuberculosis* from elephants to humans.<sup>5,6,14-17</sup> TB was diagnosed in two Asian elephants, three Rocky Mountain goats (*Oreamnos americanus*) and one black rhinoceros (*Diceros bicornis*) in the Los Angeles Zoo. Tuberculin skin test conversions were associated with working with the elephants and attending an elephant necropsy.<sup>6</sup> Five employees working at an elephant refuge in Tennessee had tuberculin skin test conversions linked to the presence of an infected elephant at the refuge. Risk of conversion was increased for elephant caregivers and administrative personnel working

in the barn housing the elephant or in offices connected to the barn. Indirect exposure to aerosolised organisms and delayed and inadequate infection control practices likely contributed to transmission.<sup>16</sup> After the death of three elephants at an exotic animal farm in Illinois due to TB and the diagnosis in a fourth live elephant, 22 caregivers at the farm were screened for TB; 11 caregivers had positive tuberculin skin test reactions, one of whom was diagnosed with active TB. Genotyping demonstrated that the isolates from the four elephants and the caregiver with active TB were the same.<sup>15</sup> After the diagnosis of TB in an Asian elephant and a chimpanzee (*Pan troglodytes*) in an Australian zoo, over 145 staff and volunteers were screened and completed a detailed questionnaire to assess exposure risk. There was no evidence of risk to people who did not work with the elephants.<sup>18,19</sup>

### Conclusion

People should be aware of the risk of contracting TB from animals where there is a risk of animal exposure to *M. tuberculosis*, particularly with susceptible species and in regions of the world where the incidence of TB in the human population is high. Animal industries and professions (e.g. zoological institutions, the veterinary profession and wildlife rescue and rehabilitation centres) should have occupational health programs that include personnel education, adequate infection control practices, appropriate use of personal protective equipment, TB screening programs for susceptible species, regular screening of employees working with these species and pre-employment screening to establish baseline exposure for TB.

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