EXOTIC - Rabies in wildlife

Fact Sheet

October 2024

Key points

- Rabies virus is **not found** in Australia.
- Rabies is an invariably fatal neurological disease, generally transmitted by the bite of a rabid (clinically infected) animal. Post-exposure treatment can save human lives.
- Rabies can infect all warm-blooded animals, including wildlife, domestic animals and humans.
- Rabies is a nationally notifiable disease; you must notify animal health authorities if you suspect an animal has rabies (see *Surveillance and management* below).
- Rabies is moving east along the Indonesian island chain and ongoing vigilance is required. The introduction of rabies to Australia would have a significant impact on public health, wildlife and animal health.

Aetiology

Rabies is caused by infection with a genotype of single stranded RNA viruses within the genus *Lyssavirus,* family *Rhabdoviridae* [1, 2]. There are at least 17 recognised, closely related lyssavirus species that are distinct from the "classical" rabies genotype. One closely related lyssavirus is Australian Bat Lyssavirus [3]. See the Ausvetplan *Response Strategy for lyssavirus*, table 2.1 for details of other clinically important lyssaviruses found globally [1]. Classical rabies virus (genotype 1), which is **not** present in Australia, can be further divided into variants or biotypes [1]. A rabies virus biotype is adapted to a single maintenance-host species; other species may also be infected by the virus biotype (spill-over hosts), but these species may be inefficient as vectors or may not be numerous enough to maintain a cycle.

One Health implications

Wildlife and the environment: overseas, many wildlife species are maintenance hosts for rabies virus. In 2015, there were over 5,500 cases of animal rabies reported in the USA, 92% of these from wildlife [4]. Many more cases may go unreported.

Domestic animals: any warm-blooded species may become infected with rabies. Domestic and stray dogs are considered the most important maintenance hosts for rabies in many areas of Africa and Asia. Most other domestic animal species are spillover hosts, and while they may become infected, they are unlikely to spread the virus further.

Humans: rabies is a significant zoonosis that causes incurable neurological disease [2]. In humans, 99% of rabies infections are due to bites from infected dogs, and a high proportion of cases occur in children in Africa and Asia [5]. An estimated 40,000-100,000 human deaths are caused by rabies

each year worldwide; in addition, millions of persons, undergo post exposure treatment [2, 5]. Human infections are not important in the epidemiology of rabies.

Natural hosts

Any warm-blooded animal, including humans, may become infected with the rabies virus and develop neurological disease. Although birds have been known to develop antibodies, rabies is not considered a disease of birds [6]. The maintenance hosts of rabies virus are usually members of the orders Carnivora (carnivores) and Chiroptera (bats). Maintenance hosts are generally more susceptible to rabies, shed a larger amount of virus and follow a more predictable disease course than non-maintenance species. In some areas of the world, wildlife species have become important for maintenance of the disease. This includes the red fox and raccoon dog in Europe; striped skunks, raccoons, red and grey foxes, and coyotes in North America; side-striped and black-backed jackals, various mongoose species (particularly the yellow mongooses) and bat-eared foxes in southern Africa; the Arctic fox in the northern polar areas. Cape fur seals (*Arctocephalus pusillus pusillus*) have recently become a spillover host of rabies in South Africa, with resultant spread to dogs (and risk to humans) through bites from infected animals [7].

Other mammal species may be accidental hosts, capable of transmitting disease but with no epidemiological significance in maintaining rabies epidemics. Accidental hosts include humans, other primates, horses, cattle, pigs and sheep.

In developing countries, domestic dogs are the primary vector of rabies in urban cycles [8].

The susceptibility of Australian native animals is unknown. Monotremes (echidna, platypus), marsupials (kangaroos, wombats, possums etc.) are considered to be at very low risk for natural virus infection, in part due to their lower body temperatures, which may inhibit viral replication. Cetaceans (whales and dolphins) are also considered to very low risk for natural infection, due to their lack of exposure to land mammals. A North American marsupial, the Virginian opossum (*Didelphis virginianus*) is thought to be relatively resistant to experimental infection [9]. Although cases of natural infection in opossums are not common, there have been reports of rabies in the USA [10] and South America [11] with further evidence of exposure to the virus in other opossums [12]. The relative infrequency of reports of rabies in marsupials in South America, despite the numbers and diversity of this taxon, helps to support the hypothesis of their relative resistance to natural infection [9].

For other lyssaviruses, only select hosts can carry each of these viruses. Each lyssavirus is particular to a specific geographic area. Bats are known to be the maintenance host for almost all identified lyssaviruses [1].

World distribution

Rabies occurs in much of the world. Rabies is endemic in wildlife in North America and Europe (with the exception of UK and Ireland). In Latin America, Africa and Asia, rabies is primarily a disease of urban areas arising from stray dogs [1]. Countries free of rabies include Japan, Singapore, New Zealand, Papua New Guinea and Australia. Rabies appears to be moving east along the Indonesian

island chain. In recent years, there have been outbreaks of rabies on a number of the Indonesian islands including Bali, Flores, Pulau Larat and Kisar; previously, these islands had been considered rabies free. Detailed country information can be found at www.woah.org/en/disease/rabies.

Occurrence in Australia

Classical rabies virus is **not** present in Australia. Another *Lyssavirus*, Australian bat lyssavirus (ABLV) is found in Australian bat populations (see WHA Fact Sheet "*Australian bat lyssavirus*").

Rabies was the likely cause of a disease outbreak reported in Tasmania in 1867. It was confined to an area around Hobart and involved several dogs, a pig and a child, but was eradicated [13]. Two cases of rabies were diagnosed; one in 1987 and the other in 1990. Both cases were in children that had been infected with the disease in other countries prior to entering Australia. These cases demonstrated a prolonged incubation period of at least several months.

Epidemiology

The incubation period for rabies in animals and humans can be highly variable. It is generally 3–8 weeks but can vary from 2 days to 6 months or longer. Factors that influence the length of incubation are the virus strain involved, viral dose, proximity of the animal bite to the central nervous system and the amount of sensory innervation to the affected location [1].

The virus is shed in saliva of the infected animals from the time of onset of clinical signs. Virus shedding has been reported up to 13 days before appearance of clinical signs.

Almost all infected hosts die from rabies infection. Recovery from infection has been recorded, rarely, in foxes and bats. It is generally accepted that there is no carrier or latent state for rabies.

Rabies is mainly transmitted through contamination of fresh wounds with infective saliva, generally through the bite of a rabid animal or sometimes by licking of cuts or abrasions in skin or mucous membranes.

Within a geographic region, the rate of transmission is mainly influenced by the population density of susceptible (non-vaccinated) host species.

Outbreaks of rabies may occur and generally last for several months. They are locally explosive in the maintenance species and cause a rapid decrease in host population.

Rabies virus is comparatively fragile and does not survive for long periods outside the host. The virus is inactivated by heat, and is susceptible to ultraviolet light, lipid solvents (soapy water, ether, chloroform, acetone), 45–75% ethanol, quaternary ammonium compounds (e.g. 0.2% cetrimide) and 5–7% iodine preparations [1]. Contamination of the air in bat caves with rabies virus is recognised, but the risk of acquiring rabies through inhalation is considered extremely low [14].

Clinical signs

Clinical signs in affected wildlife can be variable and subtle. A common and important feature of rabid wildlife is a change in behaviour including a loss of fear, ataxia, subsequent aggression towards other animals and people. Wild animals will often lose their natural caution around humans. Animals may wander into urban areas and into buildings. These behavioural changes may result in an increased risk of contact with the rabid animal, for humans, domestic animals and other wildlife. Abnormal appetite (pica) and unusual vocalisation, which is often incessant, and in dogs may manifest as a low coarse howl, are notable signs. Excitation is often seen and may present as ceaseless running over long distances, with or without snapping at nearby objects, animals or people. A rabid fox may charge at and bite passing people, animals and even vehicles. Paralysis, paresis and, in the terminal stages, coma occur. Animals may progress rapidly between different clinical signs and there have been occasional reports of death with few prior signs.

Secondary signs may include unkempt coat, dehydration, red eyes, salivation, poor body condition and signs of trauma, due to neurological deficits. Dilated pupils, loss of the corneal reflex and squinting may be observed.

Diagnosis

In endemic countries, diagnosis is often made on clinical signs, however laboratory tests are required for definitive diagnosis. Samples from suspect cases in Australia should be submitted to the state or territory government veterinary laboratory, from which they will be sent to the Australian Centre for Disease Prevention Laboratory.

Diagnostic tests include fluorescent antibody test (the preferred initial test), RT-PCR and sequencing, immunohistochemistry, viral isolation in neuroblastoma cell cultures or viral isolation in mice.

Laboratory diagnostic specimens

Whole brain should be collected from dead animals or those euthanased during any stage of the disease. Fresh brain is required for all tests except immunohistochemistry, for which formalin-fixed brain is used. Samples of the head or animal carcass must be chilled and not damaged. Samples of lung, liver and stomach contents should be collected for differential toxicological investigations [1].

Pathology

There are no consistent gross lesions in animals that die of rabies [1]. Lesions secondary to neurologic deficits may include dehydration, loss of condition, lesions due to trauma, such as broken teeth from chewing and biting inappropriate objects and unusual stomach or oral contents including soil and plant material in carnivorous species.

Microscopically, significant lesions occur in the central nervous system and cranial and spinal ganglia [1]. Perivascular cuffing, focal and diffuse gliosis, neuronal degeneration and intracytoplasmic inclusion bodies can be seen. Occasionally, intracytoplasmic inclusion bodies may also be located in glial, ganglion, salivary gland, adrenal medulla and retinal cells.

Histopathological lesions are not pathognomonic for rabies and laboratory testing is required for confirmation.

Differential diagnoses

In wildlife, differential diagnoses for rabies include any disease that can produce neurological signs. Other viral infections of the CNS, bacteria such as *Listeria monocytogenes*, and fungal disease such as cryptococcosis should be considered. Other differentials include protozoa (*Toxoplasma* and *Babesia*) and toxicity including 1080, lead and other heavy metals, organophosphates and urea.

Treatment, prevention and control

The is no effective treatment for rabies once clinical signs have developed.

In areas of the world where dog-mediated rabies occurs, mass vaccination of dogs is the most cost-effective strategy for preventing rabies in people. Culling free roaming dogs is not effective in controlling rabies [14]. In Indonesia, despite 70% of dogs in East Flores being culled, rabies was neither contained nor eliminated and spread across the entire island. At the time vaccination was not used [15].

Advice regarding human health implications of rabies should be sought from the local public health department. **Pre- and post-exposure prophylaxis are available for rabies exposure in humans, and are life-saving.** More information on rabies can be found at the Australian Government Department of Health website (see www.health.gov.au/resources/publications/rabies-and-other-lyssavirus-cdna-national-guidelines-for-public-health-units).

Introduction of rabies into Australia is considered most likely to occur via (illegal) entry of a dog sub-clinically infected with dog-adapted virus, that then comes in contact with, and spreads rabies virus to wild dogs/ dingoes or community dogs [16]. Rabies is a nationally-notifiable disease and Australia has very good processes for the identification and management of rabies should it enter the country. Timely detection of the incursion would be key to successful elimination of the virus and prevention of human exposure. Incursion is considered most likely to occur in the northern regions of Australia [16]. The lack of veterinary services in remote areas of northern Australia has been identified as a potential barrier to reporting and detection of rabies (or other exotic diseases) in dogs [17].

Australia has an abundant variety and widespread population of potential wild maintenance species, such as the European red fox, feral cat, wild dogs and the dingo [1]. The density estimates from Australian studies indicate fox densities are well above those found in many parts of Europe and North America where fox rabies has been endemic [18].

Oral rabies vaccination has been delivered to wildlife overseas via an edible bait system, using attenuated strain vaccines. The vaccine produces an immunising infection through the oral and pharyngeal route. The efficacy of these vaccines is dependent, in part, on the willingness of wildlife species to accept the bait and the absorption rates of the vaccines via the oropharyngeal mucosa.

A ‘trap-vaccinate-release’ method has also been used to vaccinate wildlife overseas. This involves capturing live wildlife and administering a vaccine injection prior to releasing the individual. This can be time consuming and expensive but may be more suitable than oral vaccination strategies due to poor bait uptake and risks of using bait in areas inhabited with people [1].

Australia’s planned approach to control and prevention, in the event of a rabies incursion, is summarised in the AUSVETPLAN *Response Strategy for lyssavirus* [1] (https://animalhealthaustralia.com.au/ausvetplan). Response would be primarily directed towards minimising and preventing human exposure to rabies infections and preventing its establishment in urban areas. The approach would focus on identification of the strain (and its preferred host) and vaccination of the host species through where possible [19], with a goal of eradication.

Research

Further work is required, within a One Health framework, to better understand how to promote a culture of awareness and reporting of ill-health in dogs, particularly in remote communities of northern Australia [17]. There is limited information on the potential risk of infection, and onward transmission, in many of Australia’s native mammal species. Other key preparedness activities include modelling of potential dog and fox rabies spread, incorporating the movement and ecological parameters of the many different dog (as well as fox) populations throughout the country. This would require an accurate understanding of dog population dynamics and interactions [20], including contact rates in and around human populations, as well as with other wildlife and domestic animal species [16].

Surveillance and management

Rabies is a nationally notifiable disease (see www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/animal/notifiable). By law you must notify animal health authorities in your jurisdiction if you know or suspect that an animal has a notifiable pest or disease. Refer to advice in your jurisdiction (www.agriculture.gov.au/biosecurity-trade/pests-diseases-weeds/animal/state-notifiable) and on outbreak.gov.au on how to report.

The threat to Australia from rabies is taken very seriously by Australian governments. The AUSVETPLAN *Response Strategy for lyssavirus* [1] and the rabies Series of National Guidelines (SoNG) are regularly reviewed and updated [21].

Australia’s animal health and wildlife health surveillance systems include consideration of rabies as part of general surveillance activities, including surveillance of wildlife for rabies. Monitoring of wildlife should include careful observation of animals behaving abnormally and testing for the presence of rabies in animals showing neurological signs.

Wildlife Health Australia administers Australia’s general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations

and individuals. Targeted surveillance data is also collected by WHA. See the WHA website for more information https://wildlifehealthaustralia.com.au/Our-Work/Surveillance and https://wildlifehealthaustralia.com.au/Our-Work/Surveillance/eWHIS-Wildlife-Health-Information-System.

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Wildlife Health Australia recognises the Traditional Custodians of Country throughout Australia. We respectfully acknowledge Aboriginal and Torres Strait Islander peoples' continuing connection to land, sea, wildlife and community. We pay our respects to them and their cultures, and to their Elders past and present.

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