Wildlife Health Australia

Hendra virus and Australian wildlife

Fact sheet

Introductory statement

Hendra virus (HeV) causes a potentially fatal disease of horses and humans. HeV emerged in 1994 and cases to date have been limited to Queensland (Qld) and New South Wales (NSW), where annual incidents are now reported. Flying-foxes are the natural reservoir of the virus. Horses are infected directly from flying-foxes or via their urine, body fluids or excretions. All human cases have resulted from direct contact with infected horses. Evidence of infection has been seen in two dogs that were in contact with infected horses. HeV has attracted international interest as one of a group of diseases of humans and domestic animals that has emerged from bats since the 1990s. HeV does not cause evident clinical disease in flying-foxes and direct transmission to humans from bats has not been demonstrated. Ongoing work is required to understand the ecology and factors driving emergence of this disease.

Aetiology

HeV is a RNA virus belonging to the family *Paramyxoviridae*, genus *Henipavirus*.

Natural hosts

There are four species of flying-fox on mainland Australia:

- *Pteropus alecto* black flying-fox
- Pteropus *conspicillatus* spectacled flying-fox
- *Pteropus scapulatus* little red flying-fox
- *Pteropus poliocephalus* grey-headed flying-fox

While serologic evidence of HeV infection has been found in all four species (Field 2005), more recent research suggests that two species, the black flying-fox and spectacled flying-fox, are the primary reservoir hosts (Field et al. 2011; Smith et al. 2014; Edson et al. 2015; Goldspink et al. 2015). The impact of HeV infection on flying-fox populations is presumed to be minimal.

Other hosts

Clinical disease due to natural HeV infection has only been observed in horses and humans. No significant age or sex predilection has been determined in these species.

An extensive search for the natural host of HeV was undertaken in the locations where the first equine cases were identified, with over 1200 individual animals tested. Other than flying-foxes, no evidence of HeV infection was found in a wide range of domestic and wild mammals (including insectivorous bats), birds, reptiles, amphibians and insects (Halpin et al. 1996; Field et al. 2001; Field 2005). Serological surveys of horses (Ward et al. 1996) and other domestic animals, including cattle, dogs, cats and poultry were negative. A serosurvey of 128 wildlife carers who handled bats (humans likely to have been exposed to the virus) was also negative (Selvey et al. 1996).

In experimental studies, HeV has been shown to infect horses, ferrets, pigs, cats (including cat to horse transmission), African green monkeys (*Chlorocebus sabaeus*), guinea pigs and hamsters (Westbury et al. 1995; Westbury et al. 1996; Williamson et al. 1998; Williamson et al. 2000; Li et al. 2010).

There has been one recorded case of HeV infection in a domestic dog in Qld in 2011, confirmed by PCR, and one reported case of seroconversion (NSW, July 2013); in both cases the dogs were living on properties where equine cases of HeV occurred (Williamson 2011; Kirkland et al. 2015; Queensland Government 2015). Experimental infection of dogs with HeV shows they can be reliably infected and that they may pose a potential transmission risk to humans (Middleton et al. 2017). It is strongly recommended that sick horses are isolated from other horses, people and pets (including dogs and cats) until veterinary opinion can be obtained.

World distribution

HeV cases have only been reported from Australia. However, serological evidence of HeV infection has been reported in six species of flying-foxes from Papua New Guinea: bare-backed fruit bats (*Dobsonia andersoni* and *D. magna*), Admiralty flying-fox (*Pteropus admiralitatum*), Bismark masked flying-fox (*P. capistratus*), small or variable flying-fox (*P. hypomelanus*) and great flying-fox (*P. neohibernicus*) (Halpin et al. 1999; Breed et al. 2013). It is possible that these reports reflect cross-neutralisation with Nipah virus or an unidentified henipavirus.

Related henipaviruses have been found in bats in Asia, China and Africa (Hayman et al. 2008; Li et al. 2008; Peel et al. 2012), and it is probable that more will be found with ongoing surveillance. The most notable of these related viruses is Nipah virus, which has caused mortalities in animals and humans in Malaysia (Yob et al. 2001) and Bangladesh (Hsu et al. 2004) [see also WHA EXOTIC fact sheet on Nipah virus].

Occurrences in Australia

Fifty-six events involving disease in horses have been reported to May 2017, involving more than 98 confirmed or possible cases in horses (Business Queensland 2017). Three of these events have also involved disease in humans (Murray et al. 1995; O'Sullivan et al. 1997; Playford et al. 2010). Prior to 2011, 14 equine HeV incidents involving seven human cases (of which four were fatal) were recorded (Field et al. 2012). See also Epidemiology.

A novel henipavirus, Cedar virus, has been isolated from flying-fox urine in Qld (Marsh et al. 2012). In 2013, another novel henipavirus was detected in grey-headed flying-foxes in Adelaide, SA, during routine diagnostic testing of individuals that died suddenly, putatively from heat stress. The virus is most closely related to HeV and potentially represents a new species in the Henipavirus genus (Primary Industries and Regions 2013; Wang et al. 2016). The clinical significance of these novel viruses is largely unknown.

Epidemiology

Serological evidence of HeV exposure has been reported from flying-foxes from WA, NT, Qld and NSW (Field 2005). Black and spectacled flying-foxes appear to be the primary reservoir hosts for HeV and the source of HeV infection in horses (Smith et al. 2014; Field et al. 2015a; Goldspink et al. 2015; Martin et al. 2016). There is evidence that infections occur sporadically in flying-foxes across Australia (Breed et al. 2011; Field et al. 2011). Latent infection with recrudescence may be an important epidemiological factor in infection in flying-foxes (Edson et al. 2015).

Flying-fox urine is believed to be the most important route of excretion of HeV (Field et al. 2011; Edson et al. 2015). Transmission between flying-foxes likely involves direct contact with urine of conspecifics (Edson et al. 2015). Viral infection and shedding fluctuates (Field et al. 2001), with a short viraemic period and small numbers of flying-foxes actively infected at one time (Edson et al. 2015). Viral transmission between bats appears efficient; seroprevalence is high and widely distributed in flying-fox colonies (Breed et al. 2011).

HeV spillover from flying-foxes to horses likely has complex causality involving multiple host and environmental factors. Paddock-housed horses are most at risk and are likely exposed when they stand underneath fruiting or flowering shade trees in which flying-foxes are feeding or roosting, or have recently visited (Field et al. 2007). The most likely pathway of transmission is when infectious urine, body fluids or excretions of flying-foxes come into contact with a horse's mucous membranes (Williamson et al. 1998; Halpin et al. 2000; Field 2005; Field et al. 2015b). This may putatively occur directly or indirectly, the latter via contaminated pasture, feed or water (Field et al. 2012; Edson et al. 2015; Field et al. 2015b; Martin et al. 2015).

The incubation period for horses is believed to be 5-16 days (Murray et al. 1995; Baldock et al. 1996). The reported incubation period in humans is similar (Playford et al. 2010) or possibly longer (up to 21 days) (Queensland Health 2011). Horses may be able to shed virus for 2 days prior to the onset of clinical signs (Middleton 2009a).

Close contact between horses, or between horse and human, appears necessary for spread of infection (Williamson et al. 1998; Middleton 2009b). Viral loads in acutely infected horses are usually very high (Kirkland et al. 2015) but horse to human transmission is considered to be inefficient. Procedures undertaken by affected veterinarians and assistants (including endoscopy of the respiratory tract and necropsy) may have significantly increased their exposure to the virus. There is no evidence of spread of HeV from flying-foxes to any species other than horses and no evidence of human-to-human spread. Other mammals, including dogs, may become infected following exposure to viraemic horses. There is a potential risk of transmission from infected dogs to humans (Middleton et al. 2017). While there is evidence of recrudescence of HeV infection in humans, experimental studies indicate that virus persistence in convalescent animals is not likely to be a risk for transmission to humans (Middleton 2016).

Multiple hot spots of HeV infection in horses are found along the east coast of Australia from far north Qld to the mid north coast of NSW, with the largest hot spot extending from southern Qld to northern NSW (Smith

et al. 2014). The geographic spread of HeV outbreaks in horses falls entirely within the geographic range of *P. alecto* and most events usually occur in winter, in the southernmost part of the distribution of *P. alecto* (McFarlane et al. 2011; Field et al. 2015a; Martin et al. 2016). The winter seasonality of equine HeV cases is mirrored by a strong seasonality in HeV excretion in pooled flying-fox urine samples (Field et al. 2015a). Excreted HeV may have increased survival at cooler temperatures (Scanlan et al. 2015).

Clinical signs

Flying-fox - no clinical signs have been observed in wild or experimentally infected flying-foxes (Williamson et al. 1998; Williamson et al. 2000; Goldspink et al. 2015).

Horse - acute onset of clinical signs; pyrexia, increased heart rate, dyspnoea (sometimes with frothy nasal discharge) and rapid progression to death associated with either respiratory or neurological signs. Colic and acute death have also been reported (Ball et al. 2014). Morbidity may be up to 100% [based on results of experimental direct inoculation of horses, with all four horses developing clinical signs] (Williamson et al. 1998). The case fatality rate in horses has been estimated at 90%; it is known that some experimentally infected horses can survive (Williamson et al. 1998). In the 1994 outbreak in the Brisbane suburb of Hendra, seven out of twenty horses survived the initial infection and seroconverted before being euthanased (Murray et al. 1995). In the 2008 Redlands outbreak, one horse survived for 42 days after clinical signs abated before being euthanased (Field et al. 2010).

Human - pyrexia, neurological or respiratory signs and symptoms (O'Sullivan et al. 1997; Mahalingam et al. 2012). Of seven reported human cases, four have resulted in death (Queensland Health 2011).

Diagnosis

If HeV is suspected in horses, notify your local animal health authority immediately using the **Emergency Animal Disease Watch Hotline 1800 675 888**. There is a legal obligation to notify. Investigation will be undertaken by jurisdictional biosecurity officers.

HeV is a notifiable human disease in Qld and NSW. Suspected cases in humans should be reported, investigated and treated as a matter of urgency. Contact a local doctor, emergency centre or the nearest Public Health Unit. Queenslanders may contact the Qld Health 24-hour hotline on **13 HEALTH (13 43 25 84**).

HeV has been detected in a range of tissues and fluids from flying-foxes including urine, serum, spleen, kidney, uterine fluid, foetal tissues, saliva, lung, liver and urogenital, nasal, oral and rectal swabs (Halpin et al. 2000; Edson et al. 2015; Goldspink et al. 2015). Spleen and urine appear to carry the highest viral loads in infected flying-foxes (Edson et al. 2015; Goldspink et al. 2015).

Clinical pathology

Flying-fox – Haematologic and biochemical values for HeV positive individuals fall within normal reference ranges, however studies show HeV positive black flying-foxes had significantly higher lymphocytes, ALP, urine protein and significantly lower neutrophils and plasma triglycerides. There were also nonsignificant trends toward higher mean lymphocyte counts, erythrocyte mean cell volume, urinary pH, lower mean platelet counts, and plasma potassium levels in Hendra virus–positive animals (McMichael et al. 2017).

Horse and human - non-specific changes indicative of pyrexia, respiratory and or neurological signs.

Pathology

Flying-fox - no gross lesions. Mild vasculitis has been observed in the lung, spleen, meninges, kidney and heart on histology in some cases of experimental infection (Williamson et al. 1998; Williamson et al. 2000; Middleton 2009a).

Horse - generalised vasculitis of small blood vessels and lymphatics.

Differential diagnoses

Flying-fox - N/A

Horses and humans - Other causes of pyrexia, respiratory or neurological disease.

Laboratory diagnostic specimens and laboratory procedures

HeV is a Physical Containment Level 4 (PC4) pathogen. Samples should only be collected when the risk of human exposure can be adequately managed. Necropsy of diseased animals may be very high risk and is not required for diagnosis of the disease in horses. Full necropsy of suspect or confirmed cases and virus culture should only be conducted under high-security conditions. Diagnostic tests for HeV include virus isolation, the detection of nucleic acids or serology (OIE 2014).

Flying-fox - testing of individual flying-foxes should not be used for the purpose of assessing risk following contact between a flying-fox and another animal. Risk assessment for these situations should be conducted on a case-by-case basis using the circumstances alone. For research purposes, testing may be performed by serology or PCR of urine - either collected individually or pooled from under roost trees (Field et al. 2011; Edson et al. 2015). A detailed information document 'Hendra Virus Testing in Individual Flying-foxes at Necropsy' has been produced by the WHA Bat Health Focus Group (http://www.wildlifehealthaustralia.com.au/ProgramsProjects/BatHealthFocusGroup.aspx) (WHA 2015).

Horses - see Qld "Guidelines for veterinarians handling potential HeV infection in horses" https://www.daf.qld.gov.au/__data/assets/pdf_file/0009/97713/2355-guidelines-for-veterinarians-sept-2013.pdf and NSW "Hendra virus information for vets" http://www.dpi.nsw.gov.au/agriculture/livestock/horses/health/general/hendra-virus/vets for sampling, packaging and transport requirements.

Treatment

Treatment of flying-foxes is neither appropriate nor necessary as infection is sub-clinical. Information on options for human treatment is available through the Qld and NSW Departments of Health. Human monoclonal antibody targeting the viral G glycoprotein has shown some promise as a post-exposure treatment (Mahalingam et al. 2012; Broder et al. 2013).

Equine cases and canine cases were formerly euthanased to prevent risk of further disease transmission. Research has now established there is no evidence that recovered horses shed infectious virus and previous government policy regarding euthanasia of seropositive, recovered horses was reviewed in 2016. Compulsory euthanasia of recovered horses is no longer mandatory. Management of seropositive non-vaccinated horses is at the discretion of the state Chief Veterinary Officer (Animal Health Australia 2016; Middleton 2016; AVA 2017).

Prevention and control

Prevention of the infection in horses and humans is aided by use of vaccination in horses, limiting exposure of horses and their feed to flying-fox contamination, and by use of appropriate personal protective equipment, particularly when dealing with sick horses and undertaking post mortem examination of suspect horse cases. Post mortem examination is believed to carry the greatest risk (Marsh et al. 2011) and some potential transmission risk exists prior to the onset of clinical signs in horses.

Refer to guidelines:

Veterinarians: https://www.business.qld.gov.au/industry/service-industries/veterinary-surgeons/guidelines-hendra (Qld) and http://www.dpi.nsw.gov.au/agriculture/livestock/horses/health/general/hendra-virus/vets (NSW)

Horse owners: https://www.business.qld.gov.au/industry/agriculture/animal-management/horses/hendra-virus-owners (Qld) and http://www.dpi.nsw.gov.au/agriculture/livestock/horses/health/general/hendra-virus (NSW).

A vaccine based on the G glycoprotein of HeV, Equivac HeV, is available for use in horses https://www.zoetis.com.au/product-class/equivac-hev.aspx.

See the guidelines above, and AUSVETPLAN Response Policy Briefs (Animal Health Australia 2016) for information on decontamination procedures. Specific testing of disinfectants against HeV has not been conducted, however HeV is a member of Category A viruses, with a lipid envelope and these category of viruses are usually inactivated by soaps, detergents and many disinfectants (QDAFF 2013).

Surveillance and management

The AUSVETPLAN Response Policy Brief for Hendra virus infection (Animal Health Australia 2016) details the national response policy for eradication of HeV infection in terrestrial animals. HeV is not an OIE listed disease.

Statistics

Wildlife disease surveillance in Australia is coordinated by Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. Please contact admin@wildlifehealthaustralia.com.au.

Research

Many knowledge gaps exist in our understanding of HeV. Key work has been undertaken on:

- Ecology of HeV in Australian flying-foxes (including field transmission between bats and horses), risk mapping and prediction by Biosecurity Qld and university research groups.
- Immunology and genomics of fruit bats, henipavirus transmission and pathophysiology by CSIRO Australian Animal Health Laboratories.

Drivers of disease emergence are an important area of study. In 2011 significant public funding established a Joint Government Hendra Virus Taskforce, which funded 20 projects for HeV research, development and extension activities https://rirdc.infoservices.com.au/items/16-001 (National Hendra Virus Research Program 2016).

Human health implications

HeV causes serious neurological disease in humans with a high fatality rate. All human cases have resulted from direct contact with infected horses, who in turn have been infected directly or indirectly by flying foxes. HeV is a notifiable human disease in Qld and NSW and is covered by a national guideline: http://www.health.gov.au/internet/main/publishing.nsf/content/0E7D7BF4F17C1A96CA257BF0001CBF10/$File/Hendra-virus-SoNG.pdf (CDNA 2016). The Qld and NSW Departments of Health produce HeV fact sheets (www.health.qld.gov.au/communicablediseases/hendra-fastfacts.aspx and www.health.nsw.gov.au/Infectious/factsheets/Pages/Hendra_virus.aspx).

Conclusion

The ecology of HeV is not fully understood. Whilst current research suggests complex multifactorial factors influence the spillover of HeV from flying-foxes to horses, more work is required on many aspects of HeV ecology, including factors influencing viral excretion in reservoir hosts and viral transmission between flying-foxes and horses. Although flying-foxes are known to play an important ecological role (Fujita and Tuttle 1991; Kunz et al. 2011; Kasso and Balakrishnan 2013), their presence near human habitation often causes conflict. Australian flying-foxes numbers are likely to continue to increase in urban and peri-urban areas, due partly to more abundant and seasonally reliable (irrigated) native and alternative food sources in these areas (Hall and Richards 2000) and limitations in secure food and roost resources outside these areas (Eby and Lunney 2002; Roberts et al. 2011).

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Additional resources

In addition to the web sites provided in the fact sheet see:

Hendra Virus news updates provided by Queensland Department of Agriculture, Fisheries and Forestry (QDAFF) http://www.daff.qld.gov.au/

Compendium of findings from the National Hendra Virus Research Program https://rirdc.infoservices.com.au/items/16-001

The Action Plan for Australian Bats – Australian Government Department of Sustainability, Environment, Water, Population and Communities http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/index.html

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To provide feedback on this fact sheet

We are interested in hearing from anyone with information on this condition in Australia, including laboratory reports, historical datasets or survey results that could be added to the National Wildlife Health Information System. If you can help, please contact us at admin@wildlifehealthaustralia.com.au.

Wildlife Health Australia would be very grateful for any feedback on this fact sheet. Please provide detailed comments or suggestions to admin@wildlifehealthaustralia.com.au. We would also like to hear from you if you have a particular area of expertise and would like to produce a fact sheet (or sheets) for the network (or update current sheets). A small amount of funding is available to facilitate this.

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