

# **Review of the risk of Japanese encephalitis in horses from approved countries – final report**

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### **Acknowledgement of Country**

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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# Summary

Prompted by the detection of Japanese encephalitis virus (JEV) on the Australian mainland in 2022, the Department of Agriculture, Fisheries and Forestry has conducted a review of horse import policy relevant to JEV risk management. The purpose of the review was to determine whether the risk posed by JEV has changed since the completion of the *Import risk analysis report for horses from approved countries: Final report* (the Horse IRA), released in March 2010 and the *Import risk analysis report for horses from approved countries: Final policy review* (the Horse Review), released in August 2013.

This policy review considers relevant new scientific information, and relevant changes in Australia's status, industry practices and operational practicalities.

This risk review recommends removing the current risk management measures for JEV in horses exported to Australia from approved countries. This policy review replaces the former JEV chapters in the Horse IRA and the Horse Review.

# 1 Background

Japanese encephalitis (JE) is a viral disease caused by infection with Japanese encephalitis virus (JEV). The virus is transmitted by mosquito vectors. JEV can cause encephalitis in equids (horses and donkeys) and humans, and reproductive problems (abortion and stillbirths) in pigs (WOAH Manual, 2021). International experience suggests pigs and wading birds (such as bitterns, egrets and herons) are the primary amplifying hosts for JEV. Other mammalian species can become infected but are not considered significant in the epidemiology of the disease (Brown, 2008). Horses and humans are dead-end hosts that produce insufficient viraemia for onwards transmission of the virus (Gould et al, 1964).

JEV is present throughout Asia, Papua New Guinea and south-eastern Russia (AHA, 2020). In 1995, the first human case of JE in Australia was detected in the Torres Strait islands. Serological testing confirmed the presence of JEV antibodies in dogs, horses and pigs in the area (Geering et al, 1995). The first reported case of JE on the Australian mainland occurred in a human in the Cape York region during 1998 (van den Hurk et al, 2006). Evidence of JEV was detected in most years in the Torres Strait and sporadically in Cape York (van den Hurk et al, 2006). In 2021, a change to the expected distribution of JEV in Australia was observed, with a human case detected in the Tiwi Islands, Northern Territory (Northern Territory Government, 2021). Retrospective diagnosis in 2022 also identified JEV was present in a piggery near Townsville, Queensland, in 2021. In 2022, a JE outbreak occurred in Australia, in which JE was confirmed in humans, domestic pigs and one alpaca (Government of South Australia, 2022). JEV was also detected in feral pigs across northern Australia in 2022.

Detections have occurred in Queensland, New South Wales, South Australia, Victoria, and the Northern Territory, associated with a pattern of high rainfall and warmer temperatures (Yakob et al, 2022).

To date, there have been no confirmed clinical cases of JE in horses in Australia, but there was serological evidence of JEV exposure in horses on mainland Australia consistent with the 2022 outbreak.

JE is a nationally notifiable disease in Australia and is a World Organisation for Animal Health (WOAH) listed disease.

## 2 Technical information

### 2.1 Taxonomy

JEV is a single-stranded ribonucleic acid (RNA) virus that is a member of the Flavivirus genus. JEV exhibits serological cross-reactivity with several related viruses which can lead to false positive results when using serological diagnostic methods (WOAH Manual, 2021). Cross-reactivity occurs with Murray Valley encephalitis virus and Kunjin virus (a subtype of West Nile virus) which are endemic in Australia (Morita et al, 2015).

There are five genotypes (GI-GV) of JEV, all belonging to a single serotype (Gubler et al, 2007). Each genotype has a different distribution pattern. These distribution patterns have changed significantly in recent years (Gao et al, 2019). Since 1990, GI has replaced GIII as the dominant genotype present in Asia, while GIII has been displaced to more temperate regions of Asia including Russia (Gao et al, 2019) and has exhibited long-distance geographic displacement from endemic areas with detections in Italy (Preziuso et al, 2018) and Angola (Simon-Loriere et al 2017). GII occurs in tropical regions of Asia, recorded primarily in Malaysia, and was also present in far northern Australia in the late 1990's before being displaced by GI. GV was isolated in Malaysia in 1952 but remained silent until its re-emergence in Tibet, China in 2009 (Li et al, 2011) and the Republic of South Korea in 2010 (Takhampunya et al 2011). Prior to 2017, genotype GIV had limited distribution and was found only in Indonesia (Mackenzie et al, 2022). This changed when, GIV was detected in Australia in 2021, associated with a human case of JE in the Tiwi Islands (Waller et al, 2022). In early 2022, an outbreak of JEV occurred on pig farms in New South Wales, Victoria and Queensland. The virus detected in infected piggeries was identified as the GIV and is recognised as the genotype currently circulating in Australia (Howard-Jones et al, 2022, Mackenzie and Williams, 2022).

### 2.2 Agent properties

JEV is not stable within the environment. The virus is susceptible to ultraviolet light, gamma irradiation, high heat, acidic pH and a variety of detergents, disinfectants and solvents (AHA, 2020). These include 70% ethanol, 2% glutaraldehyde, 3-8% formaldehyde, 1% sodium hypochlorite, iodine and phenols (CFSPH, 2016).

### 2.3 Epidemiology

JEV is transmitted via mosquito vectors from the genus *Culex*. *Culex annulirostris* is the primary vector for JEV in Australia (Mackenzie et al, 2022). *Culex gelidus* has also been associated with the transmission of JEV in northern Australia (Yakob et al, 2022). Other genera have also been shown to harbour the virus but their role in transmission remains unconfirmed (CFSPH, 2016). Vertical transmission can occur in mosquitoes (Brown, 2008).

JEV has a wide vertebrate host range, although, only a few species develop clinical disease and/or contribute to onwards transmission (Mansfield et al, 2017). Wading birds and pigs act as amplifying hosts for the virus due to the high viraemic load they display during infection (Brown, 2008). Clinical disease has not been recorded in wild birds associated with JEV infection, while infection of pigs may result in reproductive disease in sows and boars, and neurological disease in piglets (Morita et al, 2015).

Horses and humans are susceptible to infection after being bitten by an infected mosquito, although they do not commonly develop clinical signs. In humans, 1% of those infected may develop clinical JE (Mulvey et al, 2021). Because of low titres and short duration of viraemia, humans and horses do not transmit viruses to biting mosquitoes and are considered as dead-end hosts (WOAH, 2022).

Cases of JE are associated with environmental conditions (high rainfall and warm temperatures) favourable to mosquitoes and the presence of amplifying host species. In endemic regions, JEV can circulate continuously in tropical areas where it may spike during the wet season, while JE cases most often occur in late summer to early autumn in temperate areas (Brown, 2008). The recent geographic expansion of JEV into and within Australia is not yet understood but may have been facilitated by climatic conditions favourable for mosquito populations and an abundance of temporary wetlands supporting the movement and distribution of JEV-infected wading birds (Yakob et al, 2022). Dispersal of mosquito vectors by weather events is also a possibility. High animal density in intensive farming operations and exposure to mosquito vectors is associated with the spillover and rapid amplification of JEV in domestic pigs in Australia (Yakob et al, 2022). Increasing serological and virus isolation data indicates that feral pigs are a major vertebrate host for JEV in Australia (Mackenzie et al, 2022, Mackenzie and Williams, 2022).

Clinical signs

The incubation period in equids is generally 8–10 days (CFSPH, 2016), although some reports have shown incubation periods of 4–14 days (Burns & Matumoto, 1949; Gould et al, 1964).

Most infected horses are not clinically affected with JEV. The morbidity rate of JEV is 1-1.4% in horses (WOAH Technical Disease Card, 2019). Clinical signs in horses may include transient, lethargic, or hyperexcitable forms of JE. The transient form of JE is characterised by pyrexia lasting up to three days, accompanied by anorexia, stupor, impaired locomotion, and congested or icteric mucous membranes, followed by recovery (Geering et al, 1995). In the lethargic form, neurological signs accompany fluctuating pyrexia and recovery occurs within a week. The hyperexcitable form is the most severe and is characterised by marked pyrexia, aimless wandering, violent and abnormal behaviour, blindness, profuse sweating, muscle tremors, collapse and death within one to two days (Brown, 2008; CFSPH, 2016).

## **2.4 Pathology**

There are no pathognomonic lesions for JEV in horses.

## **2.5 Diagnosis**

The definitive diagnosis of JE in horses depends on virus isolation from sick or dead horses, and clinical signs (WOAH Manual, 2021). Virus isolation can be difficult due to viral instability (Lian et al. 2002, WOAH Manual, 2021) and a brief viraemic period (AHA, 2020). In Australia, Hendra virus must be excluded before diagnostic samples for JEV are collected as both diseases can present with similar clinical signs.

Serological tests to detect JEV antibodies are virus neutralisation (VN), haemagglutination inhibition (HI), complement fixation (CF) and enzyme-linked immunosorbent assay (ELISA). Diagnosis is based on paired sera collected from the suspect horse at least 14 days apart showing a significant titre rise (WOAH Manual, 2021). These tests can be unreliable and false

positive results can occur due to cross-reaction with other flaviviruses of the JEV sero-complex (WOAH Manual, 2021).

False positive results to JEV on serology can occur in horses imported into Australia that have been vaccinated against JEV or West Nile Virus (Hirota, 2009).

## 2.6 Vaccination

Inactivated vaccines are used to protect horses against JEV in Asia. Horses must undergo two vaccinations at least one month apart, followed by annual boosters to reduce the risk of JE (Lam et al, 2005).

Vaccination does not guarantee protection from JE in horses. A case of hyperexcitable JE was reported in a gelding in Hong Kong that had been vaccinated against JEV (Lam et al, 2005).

No JEV vaccine is currently approved in Australia for general use in horses.

## 2.7 Current biosecurity measures

The current biosecurity measures for horses exported to Australia from approved countries where JEV is circulating are:

*For 60 days immediately before export the horse has been continuously resident and free of quarantine restriction in a country where no clinical, epidemiological or other evidence of Japanese encephalitis has occurred during the previous 12 months.*

**OR**

*The horse has been held in pre-export quarantine for at least 21 days immediately before export. During this time the horse has been isolated from animals not of equivalent health status **AND** during pre-export quarantine the horse has been stabled in insect-screened stables. The horse has been treated with an insect repellent for protection from biting insects before leaving the stables.*

**OR**

*Within 12 months before export, but not during pre-export quarantine, the horse has been vaccinated against Japanese encephalitis using an approved vaccine according to the manufacturer's recommendations.*



### 3 Risk assessment

The department recommends removing biosecurity conditions related to JEV in horses exported to Australia from approved countries for the following reasons:

- Horses are dead-end hosts for JEV, so even if infected they do not represent a significant risk for onward transmission.
  - Vectors are required for disease transmission, but horses do not produce viraemia in levels high enough to infect vectors.
  - There is no evidence of horse-to-horse or horse-to-human transmission.
- Horses commonly do not present with clinical signs.
  - Morbidity and mortality rates in horses are low – 1-1.4% and 5-15% respectively (WOAH Technical Disease Card, 2019).
  - In clinical cases (transient or lethargic forms of JEV), illness resolves within a week and no long-term health impacts have been reported.
  - No confirmed cases of JE have been diagnosed in horses in Australia despite the virus being widespread in 2022 (however, serological evidence of exposure has been identified).
- Existing non-specific import conditions for horses are likely to identify and exclude the import of clinical cases of JE.
  - Health examination of all horses 24 hrs prior to export for evidence of infectious or contagious disease.
  - Monitoring that all horses remain free from evidence of infectious or contagious disease during pre-export quarantine.
- Australia is not free from JEV.
  - A widespread outbreak of JEV occurred in 2022, with virus identified in Queensland, New South Wales, Victoria, South Australia and the Northern Territory.
- While the epidemiology of JEV in Australia is yet to be fully understood, it is not considered practicable to eradicate JEV from Australia due to detections across a wide geographical area, transmission by mosquito vectors and the likelihood of wildlife and feral pig reservoirs in which transmission could persist.

## 4 Conclusion

Based on this review, the department recommends that the current biosecurity conditions for horses from approved countries exported to Australia be updated to remove all risk management measures specific to JEV. Horses are dead-end hosts for JEV and do not represent a significant risk for onward transmission. Additionally, JEV is present within Australia. Hence, we consider that measures are no longer required to maintain Australia's appropriate level of protection (ALOP).

Due to the potential for a clinical case during post-entry quarantine to result in disease investigations that could delay the release of all horses in the post-entry quarantine facility and disrupt entry of subsequent consignments, the department strongly recommends vaccination against JE for horses from countries where JEV is endemic. Vaccination for JEV within 12 months before export, but not during pre-export quarantine, using an approved vaccine in the country of export, according to the manufacturer's recommendations is likely to give the best protection against clinical cases occurring during post-entry quarantine.

# Glossary

<b>Term</b>	<b>Definition</b>
appropriate level of protection (ALOP) for Australia	The <i>Biosecurity Act 2015</i> defines the appropriate level of protection (or ALOP) for Australia as a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to very low, but not to zero.
approved countries	Countries, including jurisdictions and territories that are approved to directly export horses to Australia
biosecurity	The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents to protect human, animal or plant health or life, and the environment
biosecurity measures	The <i>Biosecurity Act 2015</i> defines biosecurity measures as measures to manage any of the following: biosecurity risk, the risk of contagion of a listed human disease, the risk of listed human diseases entering, emerging, establishing themselves or spreading in Australian territory, and biosecurity emergencies and human biosecurity emergencies.
biosecurity risk	The <i>Biosecurity Act 2015</i> refers to biosecurity risk as the likelihood of a disease or pest entering, establishing or spreading in Australian territory, and the potential for the disease or pest causing harm to human, animal or plant health, the environment, economic or community activities.
DAFF	The Department of Agriculture, Fisheries and Forestry
ELISA	Enzyme-linked immunosorbent assay
HI	Haemagglutination inhibition test
Horse IRA	<i>Import risk analysis report for horses from approved countries: Final report</i> - released in March 2010
Horse review	<i>Import risk analysis report for horses from approved countries: Final policy review</i> - released in August 2013
JE	Japanese encephalitis
JEV	Japanese encephalitis virus
risk analysis	Refers to the technical or scientific process for assessing the level of biosecurity risk associated with the goods, or the class of goods, and if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or class of goods to a level that achieves the ALOP for Australia
VN	Virus neutralisation test
WHO	World Health Organization
WOAH	World Organisation for Animal Health, previously abbreviated to the OIE
WOAH Code	WOAH Terrestrial Animal Health Code
WOAH Manual	WOAH Manual of Diagnostic Tests and Vaccines for Terrestrial Animals
WTO	World Trade Organization
zoonotic disease	Disease that is transmittable to humans from animals

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