

# Japanese encephalitis

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### DISEASE WATCH HOTLINE: 1800 675 888

The Disease Watch Hotline is a toll-free telephone number that connects callers to the relevant State or Territory officer to report concerns about any potential emergency disease situation. Anyone suspecting an emergency disease outbreak should use this number to get immediate advice and assistance.

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Pig in covered pen.





# 1

# Introduction

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## 1.1 This manual

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### 1.1.1 Purpose

As part of AUSVETPLAN (the Australian Veterinary Emergency Plan), this response strategy contains the nationally agreed approach for the response to an incident – or suspected incident – of Japanese encephalitis (JE) in Australia. It has been developed to ensure that a fast, efficient and effective response can be implemented consistently across Australia with minimal delay.

### 1.1.2 Scope

This response strategy covers JE caused by JE virus.

This response strategy provides information about:

- the disease ([Section 2](#))
- the implications for Australia (potential pathways of introduction, expected impacts and critical factors for a response) ([Section 3](#))
- the agreed default policy and guidelines for agencies and organisations involved in a response to an outbreak ([Section 4](#))
- declared areas and premises ([Section 5](#))
- quarantine and movement controls ([Section 6](#))
- how to establish proof of freedom ([Section 7](#)).

The key features of JE are described in the **Japanese encephalitis Fact Sheet** (under development).

### 1.1.3 Development

The strategies in this document for the diagnosis and management of an outbreak of JE are based on risk assessment and are informed by the recommendations in the World Organisation for Animal Health (OIE) *Terrestrial animal health code* (Chapter 8.10) and the OIE *Manual of diagnostic tests and vaccines for terrestrial animals* (Chapter 3.1.10). The strategies and policy guidelines are for emergency situations, and are not applicable to policies for imported animals or animal products.

This manual has been produced in accordance with the procedures described in the **AUSVETPLAN Overview**, and in consultation with Australian national, state and territory governments; the relevant livestock industries; nongovernment agencies; and public health authorities, where relevant.

In this manual, text placed in square brackets [xxx] indicates that that aspect of the manual remains contentious or is under development; such text is not part of the official manual. The issues will be worked on by experts and relevant text included at a future date.

## 1.2 Other documentation

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This response strategy should be read and implemented in conjunction with:

- other AUSVETPLAN documents, including the operational, enterprise and management manuals; and any relevant guidance and resource documents. The complete series of manuals is available on the Animal Health Australia website<sup>1</sup>
- relevant nationally agreed standard operating procedures (NASOPs).<sup>2</sup> These procedures complement AUSVETPLAN and describe in detail specific actions undertaken during a response to an incident. NASOPs have been developed for use by jurisdictions during responses to emergency animal disease (EAD) incidents and emergencies
- relevant jurisdictional or industry policies, response plans, standard operating procedures and work instructions
- relevant Commonwealth and jurisdictional legislation, and legal agreements (such as the Emergency Animal Disease Response Agreement,<sup>3</sup> where applicable).

## 1.3 Training resources

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### 1.3.1 EAD preparedness and response arrangements in Australia

The EAD Foundation Online course<sup>4</sup> provides livestock producers, veterinarians, veterinary students, government personnel and emergency workers with foundation knowledge for further training in EAD preparedness and response in Australia.

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1 [www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents](http://www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents)

2 [www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/nationally-agreed-standard-operating-procedures](http://www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/nationally-agreed-standard-operating-procedures)

3 [www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement](http://www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement)

4 [www.animalhealthaustralia.com.au/emergency-animal-disease-training-program](http://www.animalhealthaustralia.com.au/emergency-animal-disease-training-program)



# 2

# Nature of the disease

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Japanese encephalitis (JE) is an acute mosquito-borne viral disease that can cause abortion and mummified fetuses, as well as fever and encephalitis, in susceptible species. Disease occurs most commonly in pigs, horses and humans.

## 2.1 Aetiology

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JE is caused by infection with JE virus (JEV), which is a member of the *Flavivirus* genus of the family *Flaviviridae*. JEV is part of a serological complex known as the JE serogroup.

There is one serotype of JEV and five reported genotypes. Substantial strain variation has been reported among JEV isolates, in both antigenic composition and virulence of the isolates for laboratory animals, but the epidemiological and practical significance of these variations is uncertain.

A number of antigenically related members of the JE serogroup occur in Australia, which may cause serological cross-reactions with JEV and complicate the initial diagnosis (see [Section 2.5.4](#)).

### OIE listing

JE is a World Organisation for Animal Health (OIE)–listed disease.<sup>5</sup>

## 2.2 Susceptible species

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Evidence of exposure to JEV and/or infection has been detected in a wide range of animal species, including waterbirds, pigs, equids (horses and donkeys), cattle, sheep, goats, water buffalo, chickens, ducks, dogs, cats, monkeys, raccoons, rodents, insectivorous bats, flying foxes, snakes, lizards and frogs (Peiris et al 1993, Mall et al 1995, Hanna et al 1996, Koh et al 2006, Cui et al 2008, Ohno et al 2009, van den Hurk et al 2009, Ariel 2011, Spickler 2016, EFSA AHAW Panel 2017, Mansfield et al 2017, Kumar et al 2018).

Few species are thought to play a significant role in the natural transmission of JEV – most commonly waterbirds and pigs (see [Section 2.4.2](#)). As well, few species show clinical signs of disease – most commonly equids, pigs and humans (see [Section 2.5.1](#)).

The susceptibility of Australian native mammals and marsupials is uncertain. Limited studies have shown that some species of macropods and possums are susceptible to infection (see [Section 2.4.2](#); Daniels et al, unpublished information cited in Mackenzie et al 2002).

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<sup>5</sup> OIE-listed diseases are diseases with the potential for international spread, significant mortality or morbidity within the susceptible species, and/or potential for zoonotic spread to humans. OIE member countries that have been free from a notifiable disease are obliged to notify the OIE within 24 hours of confirming the presence of the disease.

## Zoonotic potential

JE is zoonotic. Humans are incidental hosts, but JE in humans may cause severe and often fatal encephalitis.

## 2.3 World distribution

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### Distribution outside Australia

The current range of the virus includes many parts of Asia, Papua New Guinea (PNG) and southeastern Russia.

JEV has expanded its traditional boundaries significantly during the past four decades. This has been attributed in part to increased deforestation and irrigated agricultural production, which have favoured the expansion of vector habitats (Mackenzie et al 1998). Other factors may include an increase in pig breeding in Asia and the establishment of large, modern pig farms (Umenai et al 1985).

More information on the reported world distribution of JEV is available from the OIE World Animal Health Information Database website.<sup>6</sup>

### Occurrence in Australia

Human cases of JE were reported from Badu Island in Torres Strait in 1995 (Hanna et al 1996). Serological testing confirmed the presence of antibody in dogs, pigs, horses and humans on Badu and other islands in the area. Another single human case occurred on Badu Island in 1998 (Hanna et al 1999). Serological evidence of seasonal JEV activity is detected in animals in Torres Strait each year (AHA 2019).

On the Australian mainland, a human case was reported from the Mitchell River area of western Cape York in 1998. Serological evidence of pig infection was detected in the Mitchell River area and in the Northern Peninsula area of Cape York at that time, but there was no further evidence of human infections in residents of nearby communities, and JEV did not establish a transmission cycle (Hanna et al 1999). Periodically, overseas-acquired human cases of JE are detected; however, there have been no reports of associated viral transmission in Australia.

## 2.4 Epidemiology

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### 2.4.1 Incubation period

There is limited information on the incubation period of JE in animals.

In pigs and waterbirds, viraemia, which is associated with a febrile response, can commence as soon as 24 hours after inoculation of virus (Maeda et al 1978, Sasaki et al 1982, Boyle et al 1983).

In horses, reported incubation periods from experimental infection range from 4 to 14 days (Burns & Matumoto 1949, Gould et al 1964).

Artificial hibernation studies in bats have shown that extended incubation periods are possible. For example, bats inoculated and held at 10 °C for 107 days all developed viraemia after being warmed to room temperature (Burke & Leake 1988).

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<sup>6</sup> [www.oie.int/wahis\\_2/public/wahid.php/Diseaseinformation/diseasehome](http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/diseasehome)



White egret on horse.

The extrinsic incubation period (the period between infection of a vector and its ability to transmit the agent to susceptible vertebrate hosts) is discussed in [Section 2.4.2](#).

## Humans

The incubation period of JE in humans is variable; it typically ranges from 4 to 14 days (WHO 2019).

## OIE incubation period

For the purposes of the OIE *Terrestrial animal health code*, the incubation period<sup>7</sup> for JE is 21 days.

## 2.4.2 Persistence of agent and modes of transmission

### General properties

JEV is relatively unstable and is susceptible to:

- ultraviolet light and gamma irradiation (Spickler 2016)
- heat – at 50 °C, 50% of its infectivity is lost in 10 minutes; it is inactivated after 30 minutes at 56 °C (Monath & Heinz 1996)
- acidic pH – the virus is labile below pH 6.0 and has optimal stability at pH 8.0 (Nawa 1996, Parsonson 1997, Joo & Chu 1999)
- 70% ethanol, 2% glutaraldehyde, 3–8% formaldehyde, 1% sodium hypochlorite, iodine, phenol iodophors and organic solvents/detergents (Spickler 2016).

<sup>7</sup> In the OIE *Terrestrial animal health code*, 'incubation period' means the longest period that elapses between the introduction of the pathogenic agent into the animal and the occurrence of the first clinical signs of the disease.

## Environment (including windborne spread)

JEV does not survive well in the environment (Wang et al 2009, as cited in EFSA AHAW Panel 2017), and environmental contamination is not considered important in its transmission. Windborne spread is not reported.

## Live animals

The primary mechanism of spread of JEV between hosts is by bites from infected mosquito vectors. Transmission is believed to be maintained in mosquito–waterbird or mosquito–waterbird–pig cycles.

Waterbirds, particularly birds of the family Ardeidae (wading birds), such as herons and egrets, are the main natural reservoirs of JEV and are important amplifying hosts. Viraemia commences within 1–2 days of infection, reaching levels sufficient to infect vectors that last 3–5 days (Scherer et al 1959, Boyle et al 1983).

Pigs (feral and domestic) develop high levels of viraemia (Burke & Leake 1988) and are also major amplifiers of the virus. Viraemia can commence as soon as 24 hours after inoculation and may persist for up to 6 days. However, it appears that sufficient viraemia to infect mosquitoes is unlikely to be present after 4 days in individual pigs (Maeda et al 1978, Sasaki et al 1982, Ricklin et al 2016a). Outbreaks in naive pig populations typically consist of two amplification cycles, with approximately 20% of pigs infected in the first cycle. In the second cycle, approximately 1–2 weeks later, most remaining naive pigs become infected (EFSA AHAW Panel 2017).

Vector-free transmission between pigs has been demonstrated but is thought to play a less important role in outbreaks than mosquito-borne transmission:

- In one study, experimentally infected pigs shed JEV in oronasal secretions (for 5–6 days), and others were very susceptible to oronasal infection (Ricklin et al 2016b). A separate study found that JEV in aerosols had a half-life of less than 30 minutes at 24 °C, and that other species (mice, hamsters and squirrel monkeys) may also be susceptible to aerosol infection (Larson et al 1980).
- JEV has been detected in semen collected from experimentally infected boars (Habu et al 1977, Ogasa et al 1977). Infection of gilts by artificial insemination with semen containing JEV has been documented (Habu 1991).
- JEV may also be transmitted to pig fetuses transplacentally (Morimoto et al 1972, Habu et al 1977).
- Viral RNA has been detected in the urine from one experimentally infected pig but, apart from via oronasal secretions and semen, JEV is not known to be transmitted in the secreta or excreta of infected animals (Burke & Leake 1988).

Other species (including young ducklings and chicks, insectivorous bats, flying foxes and possums) are mooted to act as reservoir hosts, but their role in the natural epidemiology of JE is yet to be elucidated:

- One study found that ducklings (*Anas platyrhynchos*) or chicks (*Gallus gallus*) that were infected before 6 weeks of age may develop a viraemia of sufficient magnitude to enable them to function as reservoir hosts and thus play a role in the transmission cycle (Cleaton et al 2014). Peak viraemias in both species declined as the age at infection increased from 2 to 42 days.
- Bats may be infected after consumption of infected mosquitoes (La Motte 1958).
- For both insectivorous bats and flying foxes, the possibility of extended incubation periods (see Section 2.4.1) may have implications for the overwintering of JEV in some endemic areas (Doi et al 1983; see 'Other relevant considerations', below).

- Infected flying foxes may develop prolonged viraemia (up to 9 days) following infection (Bannerjee et al 1979). They have been shown to transmit JEV to other flying foxes and chickens (Banerjee et al 1984), and naive mosquitoes, in some cases despite lacking detectable viraemia (van den Hurk et al 2009).
- In unpublished studies, experimentally infected brush-tailed possums (*Trichosurus vulpecula*) developed and maintained high levels of viraemia for 48–72 hours, whereas macropods developed only low-level viraemia (Daniels et al, unpublished results cited in Mackenzie et al 2002).

Although they may be severely clinically affected, horses are considered dead-end hosts that do not develop viraemia of sufficient titre to infect mosquitoes. Experimental chick-to-horse, horse-to-chick and horse-to-horse transmission of JEV has been demonstrated. However, only low-titre viraemia, which persisted for 2–6 days, was detected (Gould et al 1964).

A wide range of other species (including cattle, sheep, goats, dogs, sparrow, pigeons, chickens and ducks over 6 weeks of age, water buffalo, rodents, reptiles, amphibians and macropods) are considered susceptible to infection but are also believed to be dead-end hosts that do not contribute to disease transmission (Mackenzie et al 1998, Daniels et al 2002, Shimoda et al 2011).

### Other animal products and byproducts

Other than pig semen and embryos (see above), animal products and byproducts are not considered important in the natural transmission of JEV. However, blood-based products and tissues for transplantation from viraemic animals may potentially pose a transmission risk to recipient animals and humans.

Ricklin et al (2016a) demonstrated that virus does not persist in thymus, liver, kidney, bone marrow or skeletal muscle of pigs for much longer than viraemia.

Mann et al (2018) systematically reviewed published literature for evidence of flavivirus transmission in breastmilk and found no evidence of JEV in human breastmilk or of JEV transmission via breastfeeding. Given the similar pathogenesis of JE in people and livestock (pigs – Ricklin et al 2016a), it is likely that there is no transmission of JEV in the milk of livestock.

### People

Transmission to humans is usually by a bite from an infected mosquito. Rarely, transplacental transmission (Chaturvedi et al 1980), laboratory-acquired infections – including aerosol transmission (Steffen 1987, Fischer et al 2010, OIE 2019) – and transmission via blood and organ transplantation (Plesner 2004) have been described in humans (Karthikeyan et al 2017).

Humans are not considered to be significant in the epidemiology of the disease. The viraemic period in humans is uncertain, but viraemia is not usually demonstrable when clinical signs have become evident. As in horses, it is believed that the low-titre viraemia that develops in humans is insufficient to infect mosquitoes (Rosen 1986).

### Arthropod vectors

#### Species

JEV is transmitted by mosquito vectors in the *Culex*, *Aedes* and *Anopheles* genera. Species of mosquito that are locally important as vectors in certain regions of Southeast Asia include *C. tritaeniorhynchus*, *C. vishnui*, *C. gelidus*, *C. fuscocephala*, *Anopheles vagus* and *Anopheles annularis*.

The vector competence of *C. annulirostris* and other Australian *Culex* species has been confirmed experimentally (van den Hurk et al 2003). Field studies have shown that *C. annulirostris*, a



*Culex gelidus* © Copyright CSIRO Australia 2021. Australian Insect Families, <http://anic.ento.csiro.au/insectfamilies>

morphologically and ecologically similar mosquito to *C. tritaeniorhynchus*, has been the primary vector of JEV in the Torres Strait islands (Mackenzie et al 2002). *C. annulirostris* has been implicated in the transmission of JEV in the Western Province of PNG and in Guam. JEV has also been isolated from *C. gelidus* (van den Hurk et al 2001, cited in Mackenzie et al 2002) and *Ochlerotatus vigilax* in Torres Strait (Johansen et al 2001, cited in Mackenzie et al 2002). *C. gelidus* is now believed to be widely established in northern Australia (Whelan et al 2001).

JEV has been isolated from *Culicoides* midges in China, but the significance of this finding is unclear (Spickler 2016).

### Transmission

The virus multiplies in the female mosquito (particularly the salivary glands and reproductive organs) during an extrinsic incubation period. This period is highly dependent on temperature, being significantly longer (around 3 weeks, or longer) below 20 °C (Burke & Leake 1988). The extrinsic incubation period can also be affected by virus dose (a longer period with a lower dose) and vector species (Burke & Leake 1988).

Following the extrinsic incubation period, virus in salivary glands is available to infect another host during a blood meal by the female mosquito. Female mosquitoes seek a blood meal soon after mating to assist the development of eggs. The preferred source of blood meal can vary widely between mosquito species and in different situations.

After taking a blood meal, the female searches for a secluded resting spot where the meal can be digested and the ovaries can develop the eggs. JEV is known to survive for extended periods in mosquito eggs and has been isolated from adult mosquitoes reared from field-collected larvae (Mackenzie et al 2006, cited in Karthikeyan et al 2017). Transovarial transmission has been demonstrated in laboratory studies of *Aedes albopictus* and *A. togoi* (Rosen et al 1978), but further studies are needed to assess the epidemiological significance of transovarial transmission in natural cycles.



Infected adult mosquitoes usually remain infected for life. The lifespan of mosquitoes is affected by a range of factors, such as temperature, rainfall, wind, availability of hosts and humidity. In general, the survival rate beyond about 4 weeks is very low.

### Host preferences

The major *Culex* vectors of JEV bite during the night, particularly in the period shortly after sunset and in the early morning (between midnight and 4 am). They prefer animals to humans for obtaining blood meals. Host animal preference may vary between vector species (Mackenzie et al 1998).

*C. annulirostris* is reported to feed mostly on wallabies and other macropods, with birds accounting for less than 10% of blood meals in one study (van den Hurk et al 2003). However, high rates of pig feeding are observed when greater numbers of pigs are available. Other studies have suggested that *C. annulirostris* preferentially feeds on cattle when they are available (Kay et al 1979, cited in Hanna et al 1999).

### Dispersal

Long-distance dispersal of *C. annulirostris*, the vector species identified in Torres Strait, has been reported under suitable moisture and wind speed conditions.

Studies in New South Wales recorded a mean local dispersal of 0.8–2.2 km per day for *C. annulirostris*. The maximum daily dispersal was reported as 10 km (Bryan et al 1992).

*C. annulirostris* has been collected at heights up to 310 m, and has an estimated flight range of 594–648 km (Kay & Farrow 2000). Wind-blown introduction by infected mosquitoes has been proposed as the method of introduction of JEV to Cape York Peninsula (Ritchie & Rochester 2001).

### Vector lineages

*C. annulirostris* is widespread in Australia, being prevalent in the Murray–Darling drainage basin in Queensland, New South Wales, Victoria and South Australia, and in many parts of coastal northern and eastern Australia. However, one study has proposed that mosquito lineages may affect competence for JEV transmission and so influence the distribution of disease. Hemmerter et al (2007) investigated *C. annulirostris* lineages in Australia and the southwest Pacific. They found five geographically restricted divergent lineages: two in mainland Australia, one confined to Solomon Islands, and two distributed within PNG and the Torres Strait islands (with the southern limit defined as the top of Cape York Peninsula). The southern limit of the PNG lineages coincided exactly with the known limit of JEV activity in Australia. This may explain why JEV has not become established on mainland Australia, where some lineages of *C. annulirostris* are widespread.

The potential significance of the different *C. annulirostris* lineages for the distribution of JEV in Australia may be mitigated by the existence of other competent vector species in Australia, such as *C. gelidus* (see 'Species', above).

### Other relevant considerations

#### Overwintering

The mechanisms by which JEV survives periods of cold temperatures (overwintering) and drought have been reviewed by Rosen (1986), Burke and Leake (1988), Vaughn and Hoke (1992), and Mackenzie et al (1998). Transovarial transmission of JEV in vectors has been demonstrated experimentally (Rosen et al 1978), and the virus has been isolated from adult mosquitoes reared from field-collected larvae (Rosen 1986). Seasonal reintroduction of JEV by infected migratory birds or by windblown virus-



infected mosquitoes may occur (Ritchie & Rochester 2001). Survival of the virus in hibernating reptiles or microbats has also been considered (Sulkin et al 1966, Hayashi 1976, Doi et al 1983). Vector-free transmission between pigs by direct contact may also contribute to overwintering of JEV (Ricklin et al 2016b).

### 2.4.3 Factors influencing transmission

The local rate of transmission of JEV depends on a complex interaction between vectors, the virus and hosts. Influencing factors (eg vector feeding preferences and mobility, host differences) are discussed in [Section 2.4.2](#).

In temperate endemic areas, infection builds up in waterbirds and then in pigs in late spring and early summer, spilling over to humans and horses in summer and autumn (Buescher & Scherer 1959). In tropical areas, JEV circulates more or less continuously between mosquitoes, birds and pigs. It has been proposed that high rainfall will lead to an increase in mosquito populations (Buescher & Scherer 1959); however, this may not occur in areas where torrential rains wash away developing mosquito larvae.

## 2.5 Diagnostic criteria

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### 2.5.1 Clinical signs

#### Animals

Most infections with JEV are asymptomatic. Clinical disease in animals is most commonly associated with pigs and equids; reports of disease in other species are rare.

JE is associated with reproductive failure in pigs, with 50–70% losses reported in affected populations. Pregnant sows and gilts may abort, produce mummified or malformed fetuses, or give birth to stillborn or weak piglets at term. Central nervous system (CNS) signs such as tremors and convulsions, indicative of encephalitis, are occasionally seen in pigs up to 6 months of age (EFSA AHAW Panel 2017). JE can also cause sterility in boars (Joo & Chu 1999); this is most commonly temporary but may be permanent if the boar is severely affected (Spickler 2016).

Horses are the equid most commonly affected, although disease is also reported in donkeys (OIE 2013). Disease in most symptomatic horses is mild, with recovery after 2–3 days. In these cases, affected horses have transient fever, anorexia, lethargy, and congested and jaundiced mucous membranes. Some infected horses develop encephalitis. This may be mild, with the same clinical signs described above accompanied by neurological signs such as difficulty swallowing, ataxia, incoordination and transient neck rigidity. Most of these horses recover within a week. When more severe encephalitis occurs, horses may be hyperexcitable, with high fever, aimless wandering, violent and ‘demented’ behaviour, profuse sweating, muscle tremors and occasional blindness. Some horses with severe encephalitis recover, but many collapse and die within 1–2 days (Spickler 2016).

Nonspecific disease (fever, decreased appetite and depression) and encephalitis have been reported in cattle (Katayama et al 2013, Kako et al 2014, Karthikeyan et al 2017). In one experimental study, young ducklings (*Anas platyrhynchos*) and chicks (*Gallus gallus*) demonstrated reduced weight gain, and ducklings exposed at 10 days of age or less showed overt clinical signs of disease (Cleaton et al 2014).

## Humans

Most infections in humans are asymptomatic. Mild forms of disease may occur as a febrile illness with headache and aseptic meningitis. In children, in particular, the initial presentation may be gastrointestinal disease (WHO 2015). This may progress to an acute neurological illness, characterised by headache, fever, convulsions, focal neurological signs and depressed level of consciousness (Solomon et al 2000, cited in ATAGI 2018). When encephalitis is present, the case-fatality rate is 20–30 % (Heymann 2015), and there is a high prevalence of neurological sequelae (up to 50%) in those who survive the acute illness. Less commonly, the disease may present as an acute flaccid paralysis.

### 2.5.2 Pathology

#### Gross lesions

There are no characteristic gross lesions in animals or aborted fetuses. Aborted or stillborn porcine fetuses may show lesions involving fluid retention in body cavities, congestion of lymph nodes, varying degrees of hypoplasia of tissues of the CNS, and focal necrosis of the liver and spleen (Joo & Chu 1999).

Estimation of the gestational age at which mummified porcine fetuses died could be useful to identify the likely time of exposure of pregnant sows and gilts to JEV.

#### Microscopic lesions

JE causes a panencephalitis. There is diffuse nonsuppurative meningoencephalomyelitis with neuronophagia, focal gliosis, perivascular cuffing, and parenchymal infiltration with inflammatory cells (Ricklin et al 2016a). Death of Purkinje cells in the cerebellum is pronounced. There are no inclusion bodies.

#### Pathogenesis

The pathogenesis of JEV is incompletely understood. After infection from the bite of an infected mosquito, JEV is believed to first replicate in the skin before being transported to local lymph nodes. It is theorised that, following haematogenous spread, the virus crosses the blood–brain barrier via endothelial cells of the cerebral capillaries and replicates in the neurons (Mackenzie et al 1998, Solomon & Vaughn 2002, Karthikeyan et al 2017). An alternative theory for the pathogenesis of JEV in pigs is that virus can cross the olfactory mucosa, where there is no blood–brain barrier. Park et al (2018) found evidence to support this theory following experimental infection of pigs.

### 2.5.3 Differential diagnosis

JE should be suspected in disease outbreaks:

- in pigs characterised by abortions, fetal malformations, fetal mummification or stillbirths; nervous signs in neonates; and (rarely) encephalitis in pigs to 6 months of age
- in horses characterised by fever, jaundice and neurological signs.

Geographic and temporal clustering of such disease in pigs or horses, particularly in a region at risk of JEV incursion, should lead to a high index of suspicion. Accompanying febrile and/or neurological disease in humans would also raise suspicion of JE.

Laboratory confirmation of diagnosis is required.

Diseases and conditions that should be considered in the differential diagnosis include the following:

### **Pigs**

- African swine fever
- Aujeszky's disease (pseudorabies)
- bovine virus diarrhoea (CNS signs are rare; congenital malformations are seen experimentally)
- classical swine fever
- congenital tremors (eg due to atypical porcine pestivirus)
- encephalomyocarditis virus infection
- erysipelas
- haemagglutinating encephalomyelitis
- infection with La Piedad Michoacan virus (Mexican blue eye paramyxovirus)
- influenza A viruses in swine
- leptospirosis
- Menangle virus infection
- myxovirus parainfluenza 1 virus infection
- Nipah virus infection
- porcine myocarditis syndrome (pestivirus)
- porcine parvovirus infection
- porcine polioencephalomyelitis (either Talfan or porcine teschovirus)
- porcine reproductive and respiratory disease.

Of these, only classical swine fever, Menangle virus infection and influenza A viruses in swine induce congenital malformations, which would be expected with JE.

### **Horses**

- arsenic poisoning
- Australian bat lyssavirus
- Murray Valley encephalitis
- Borna disease
- botulism
- equine encephalosis
- equine herpesvirus 1 infection (neurological form)
- equine infectious anaemia
- equine viral encephalomyelitis
- Hendra virus infection
- hepatic encephalopathy (eg *Crotalaria* plant poisoning or post-vaccinal hepatitis)
- *Indigofera* plant poisoning
- rabies
- tetanus
- West Nile virus infection.



Pig litter consisting of five large (full-term) stillborn fetuses and two small, mummified fetuses. Photo credit: Dr. K. Kawashima, Central Livestock Hygiene Service Center, Saitama pref., Japan and CFSPH, Iowa State.

## 2.5.4 Laboratory tests

### Specimens required

Postmortem specimens should be collected from animals with encephalitis killed in the acute stage of the disease or from animals that have been dead for less than 12 hours.

The brain should be removed aseptically, and brain tissue specimens (including cortex, midbrain and brainstem) and cerebrospinal fluid (CSF) collected into sterile containers.

A full range of tissues (including brain, aborted fetuses, spleen, liver, kidney, lung, heart) should be collected into neutral buffered formalin for histopathology to rule out other diseases in the differential diagnosis.

Blood samples should be collected in heparin and for serum. At least 20 mL of serum on clotted blood should be collected from each of several animals in the convalescent stage of the disease and/or from cohorts. Ideally, serum should be separated from the clot before shipment, to prevent haemolysis. Both clot and serum should be submitted.

If possible and practical, a minimum of 5 mL of CSF could be collected into suitable sterile containers from the lumbosacral space in standing horses or from the atlanto-occipital space in recumbent horses.

Any potentially infected materials must be handled using containment level 3 procedures to prevent the risk of human infection. Humans may be infected by direct contact of infectious material with broken skin or mucous membranes, accidental parenteral inoculation or aerosol. Diagnosticians collecting samples should also take the appropriate precautions. The OIE recommends that at-risk field veterinarians and laboratory workers should be vaccinated (OIE Terrestrial Manual 2016).

## Transport of specimens

Specimens should be submitted in accordance with agreed state or territory protocols. Specimens should initially be forwarded to the state or territory laboratory for appropriate analysis, and assessment of whether further analysis will be required by the CSIRO Australian Centre for Disease Preparedness (CSIRO-ACDP), Geelong.

If the state or territory laboratory deems it necessary, duplicate samples of the specimens should be forwarded to CSIRO-ACDP for emergency disease testing, after the necessary clearance has been obtained from the chief veterinary officer (CVO) of the state or territory of the suspect case, and after the CVOs of Victoria and Australia have been informed about the case and the transport of the specimens to Geelong (for the first case). Sample packaging and consignment for delivery to CSIRO-ACDP should be coordinated by the relevant state or territory laboratory.

For further information, see the **AUSVETPLAN management manual *Laboratory preparedness***.

## Laboratory diagnosis

### Virus identification

Definitive diagnosis of JE in horses depends on isolation of the causal virus. Isolation of the virus should be consistent with the observed clinical signs and epidemiological considerations.

JEV isolates are prepared by inoculation of susceptible cell cultures with homogenates prepared from tissue specimens, heparinised whole blood or blood clots. Viral isolates are subjected to enzyme-linked immunosorbent assay (ELISA) or haemagglutination inhibition (HI) tests to confirm whether the virus is a *Flavivirus*, and to serum neutralisation or polymerase chain reaction (PCR) tests to specifically identify JEV.

The isolation rate of virus from diseased or dead horses is usually very low, which may be due to the brevity of the viraemic period, instability of the virus under certain environmental conditions, and the presence of antibody in infected animals.

Alternatively, virus may be detected directly by PCR in postmortem tissues, blood or serum, and in mosquitoes. Viral antigen has been demonstrated in the CNS of fatal cases by immunohistochemistry.

### Serology

Serological tests are useful to determine the prevalence of infection in an animal population and the geographical distribution of the virus. When using serological tests for diagnosis in individual horses, it should be remembered that horses may have been inapparently infected with the virus some time ago or may have been immunised with a vaccine.

Determination by serology of a recent infection requires demonstration of a fourfold rise in the titre of JEV-specific antibody within paired sera collected in the acute and convalescent phases, and taken at least 14 days apart.

Serological tests suffer from a lack of specificity, with considerable serological cross-reaction among viruses of the *Flavivirus* genus. These occur even among the various serogroups. For example, the HI test will give cross-reactions between JEV and the dengue viruses. Within the JE serogroup, Australia has five endemic viruses: Murray Valley encephalitis (MVE), Kunjin (subtype of West Nile virus), Alfuy, Kokobera and Stratford. It is not known to what extent cross-reactions may occur between antibody to JEV infection and antibody in response to infections with these related Australian viruses, particularly in situations where multiple infections have occurred. Hence,

Table 2.1 Laboratory tests currently available at CSIRO-ACDP for the diagnosis of JE

| Test  | Specimen required   | Test detects   | Time taken to obtain result |
|---|---|--|-----------------------------|
| <b>Agent detection</b>                          |   |  |                             |
| qPCR  | Fresh tissue (especially CNS and porcine fetuses)                   | Viral RNA  | 4–6 hours                   |
| Histopathology                                  | Formalin-fixed tissues (especially CNS and aborted fetuses)         | Microscopic changes  | 2 days                      |
| Immunohistochemistry                            | Formalin-fixed or fresh tissue (especially CNS and porcine fetuses) | Viral antigens in tissue   | 3 days                      |
| <b>Agent characterisation</b>                   |   |  |                             |
| Virus isolation and identification <sup>a</sup> | Whole blood, CNS tissue, CSF  | Virus  | 2–3 weeks                   |
| PCR and sequencing                              | Whole blood, fresh tissue   | Viral RNA  | 2–3 days                    |
| <b>Serology</b>                                 |   |  |                             |
| Flavivirus C-ELISA                              | Serum   | Group-reactive antibodies to flaviviruses  | 1 day                       |
| Serum neutralisation test                       | Serum   | Neutralising antibody to specific flaviviruses (JEV, MVE, KUN)   | 1 week                      |
| JEV, MVE and KUN specific C-ELISAs, as a panel  | Serum   | Antibody specific to each flavivirus – on the basis of pattern of reactivity in the tests <sup>b</sup> | 2 days                      |
| IgM C-ELISA <sup>c</sup>                        | Serum, CSF  | JEV IgM antibody   | 1 day                       |

C-ELISA = competitive enzyme-linked immunosorbent assay; CNS = central nervous system; CSF = cerebrospinal fluid;

a Isolates subjected to ELISA or HI tests to identify the virus as a flavivirus, and serum neutralisation or PCR to confirm the virus as JEV

b Does not reliably differentiate between antibodies to JEV and MVE in all situations

c Test of choice for rapid diagnosis of infected humans

Source: Information supplied by the then Australian Animal Health Laboratory, 2011 [refer to CSIRO-ACDP for the most up-to-date information]

determination of specificity for JEV antibody is currently based on comparison of results using JEV, MVE and KUN antigens. Tests performed 2–4 weeks after an initial test, to detect rising titres, may help clarify the principal infecting virus. Currently, the definitive test of highest specificity is the serum neutralisation test.

A presumptive diagnosis of recent infection could be made by detection of virus-specific immunoglobulin M (IgM) in serum. If only one serum sample is available from an animal, the results should be validated by collection of further samples to confirm infection at a site or in an area.

## CSIRO-ACDP tests

The diagnostic tests currently available at CSIRO-ACDP are shown in [Table 2.1](#). The testing algorithm used by CSIRO-ACDP is shown in Figure 2.1.

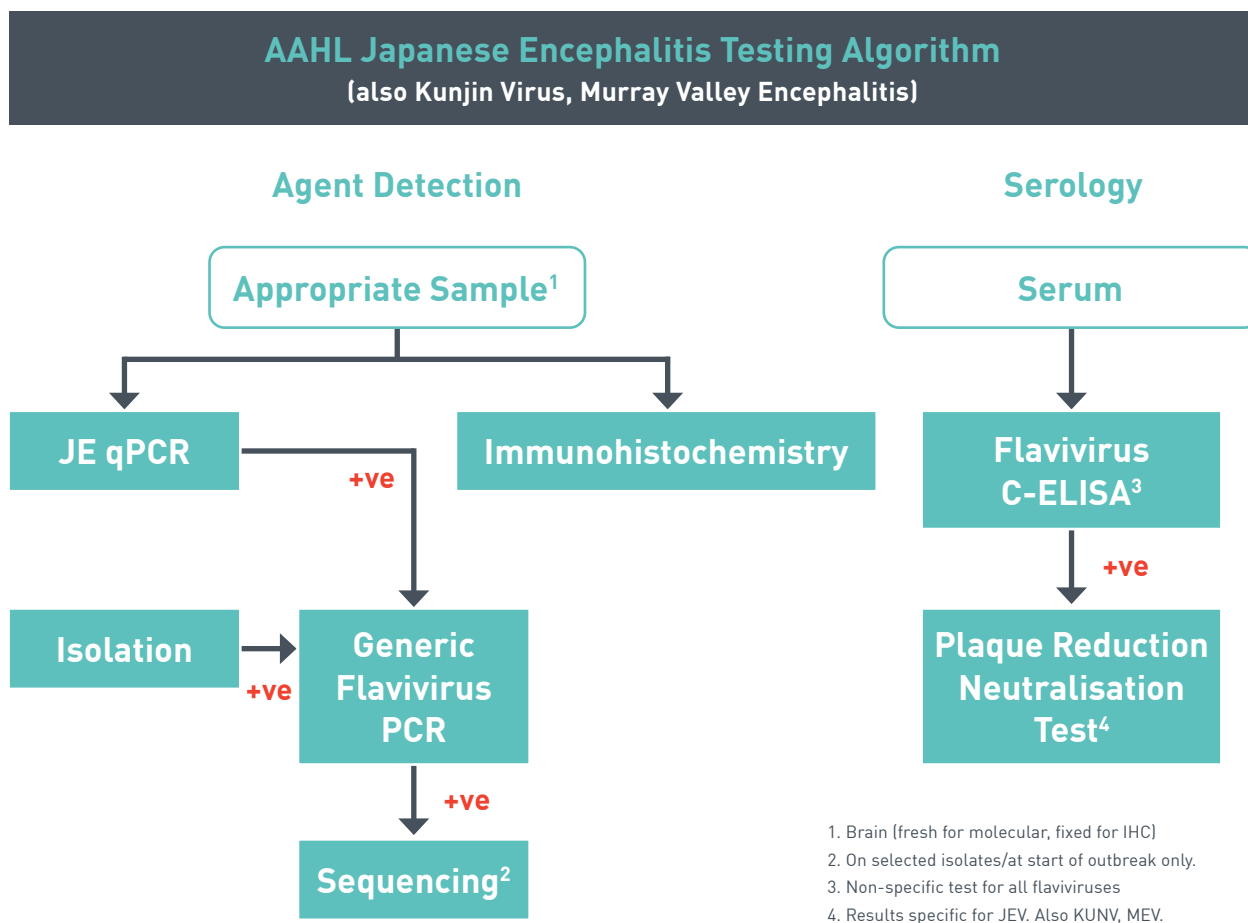


Figure 2.1 The current approach to diagnostic testing at CSIRO-ACDP

## 2.6 Resistance and immunity

JEV infects a very wide range of animal species without causing disease, and there are probably few species in endemic countries that are innately resistant to infection.

Passive immunity in pigs is transferred from dam to offspring in colostrum and lasts up to 4 months (Khan et al 2014). However, the dam needs to have a sufficient level of antibody, produced by previous infection with the virus or by vaccination with a live attenuated virus vaccine. Inactivated virus vaccines do not usually produce a sufficient level of antibody to provide protective antibody in colostrum.

Initial antibody response to infection usually appears within a week. Nonimmune horses imported into endemic areas seroconvert within 6–12 months of residence and become immune (Hale & Witherington 1954). Antibody levels are boosted by repeated exposure to JEV in subsequent years (Konishi et al 2004).

It has been suggested that a natural equivalent to vaccination may occur when susceptible hosts are exposed to other flaviviruses in the JE serogroup. Preliminary studies with Australian members of the JE serogroup have indicated that prior infection of pigs with Murray Valley encephalitis (MVE) virus or West Nile virus (Kunjin) suppresses development of a JEV viraemia on experimental challenge (Williams et al 2001). However, JEV became established in PNG despite the endemic presence of MVE virus.



## 2.7 Vaccination

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### Pigs

In countries where the disease is endemic, inactivated (killed) and attenuated (live) virus vaccines for pigs are available. The attenuated vaccine is reported to be more efficacious against natural challenge than an inactivated vaccine (Ueba et al 1978, Sasaki et al 1982).

Vaccination of pigs will have no effect on the natural transmission of the virus within the sylvatic (mosquito–waterbird) cycle. It is rarely used routinely in commercial pig populations because of its expense, the interference of maternal antibodies with the response to vaccination in pigs under 4 months of age, and the short lifespan (and high turnover) of grower pigs. However, it may reduce clinical disease and reproductive losses in pigs (Daniels et al 2002); vaccination of breeding stock 2–3 weeks before the start of the mosquito season has been recommended (Chu & Joo 1992). Vaccination can also be effective in suppressing viraemia in pigs, as an aid to reducing human infection where good vaccine coverage of the pig population is feasible (CSIRO 2002). An ongoing pig vaccination program has been in place in South Korea for the past 30 years (Nah et al 2015).

### Horses

Inactivated vaccines are commonly used in Asia to vaccinate at-risk horses (Lam et al 2005) and have been effective in reducing the incidence of clinical disease in many countries. For maximum protection, the primary course of vaccination should be completed before the season of peak mosquito activity. Apart from an occasional transient local reaction at the site of injection, no side effects have been reported (Ellis et al 2000).

An attenuated live vaccine has also been used in China and South Korea (Kwon et al 1978, cited in Ellis et al 2000).

### Humans

Effective JE vaccines for use in people are available. The *Australian immunisation handbook* (ATAGI 2018) provides recommendations on vaccination of humans.

## 2.8 Treatment of infected animals

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There is no specific treatment for viral encephalitis in horses or other livestock, and therapy is primarily supportive.

Treatment of horses and other livestock with the antiparasitic drug ivermectin may disrupt virus transmission and reduce the likelihood of infection. Effects on mosquitoes (death and reduced egg production) fed on blood containing various concentrations of ivermectin have been observed (Tesh & Guzman 1990). These authors suggested that the widespread use of ivermectin in veterinary and human medicine may have an unrecognised effect on mosquito populations.

## 2.9 Control overseas

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In endemic areas, control in animal populations is used to support public health initiatives, and to limit disease in livestock and protect high-value animals (eg stud and racing horses). The primary means of control are use of vaccination, awareness raising and vector control (as appropriate).

# 3

## Implications for Australia

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### 3.1 Potential pathways of introduction

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Japanese encephalitis virus (JEV) could be introduced from a nearby endemic country (such as Papua New Guinea) or could spread further south from Torres Strait to the Australian mainland in three main ways:

- movement of infected waterbirds
- dispersal of infective mosquitoes by wind
- movement by humans of viraemic pigs.

Animal movement within Torres Strait is controlled, and few animals move south from the Thursday Island group of islands. However, control over the movements of wild waterbirds and mosquitoes is not feasible.

Potential vector species (such as *Culex annulirostris*) are present in many parts of Australia. Australia also has significant populations of susceptible host animal species, including amplifying host species such as waterbirds and pigs (domestic and feral).

### 3.2 Social and economic effects

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The socioeconomic consequences of Japanese encephalitis (JE) occurring in Australia would result mainly from its public health importance. The death of people from JE, combined with the ongoing need for vaccination, may have a significant social effect.

Social impacts of an outbreak may also arise from loss of livelihood, loss of animals, uncertainty around future earnings and the stigma associated with disease. There will also be concerns about the welfare of affected animal populations and the humaneness of the response measures applied. These factors may affect the mental health of individuals and lead to a loss of community cohesion in areas with a heavy reliance on pig production, and on the performance and recreational horse industries.

Economic losses are expected in the pig production, horse (performance and recreational) and associated industries. Losses would arise from mortalities; production losses; and the costs of supportive and preventive treatment (including vaccination), and other control measures.

Greater losses and disruption may be experienced if vaccines (human and animal) are unavailable or their availability is delayed.

The widespread use of insecticides to control mosquito vectors may raise environmental and public health concerns. Environmental concerns may also be raised if Australian native fauna become diseased.



Cattle egrets on cow's back in Australian paddock.

### 3.3 Critical factors for an Australian response

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The critical factors for a response to JE in Australia include the following:

- A wide range of species may be infected by JEV; most are asymptotically infected.
- Waterbirds and mosquitoes are natural reservoirs of JEV.
- Waterbirds and pigs are known amplifying hosts.
- A range of other species have been proposed as amplifying hosts, including young chicks and ducks, reptiles, possums, insectivorous bats and flying foxes; however, their role in the field epidemiology of JE is unclear.
- Transmission is usually by mosquito bite; however, transmission by direct contact, semen and embryos has been reported in pigs.
- Disease is most commonly associated with pigs and equids (horses and donkeys). Rarely, disease has been reported in cattle, and young chicks and ducks.
- JE is zoonotic; most infections in humans are asymptomatic, but fatal encephalitis can occur.
- People and equids are considered dead-end hosts.
- JE is not a food safety concern.
- The potential role of Australian wildlife species in the epidemiology of JE is not known.
- Vaccines are available to prevent clinical disease in humans, pigs and horses.
- Vaccination does not eliminate natural transmission of JEV.
- Animal vaccines against JEV are not available in Australia.
- Potential vector species (eg *Culex annulirostris*) are present in Australia.
- Pig production systems are prone to rapid overcrowding if output is disrupted (eg by restrictions on animal movements for disease control purposes), with negative effects on animal welfare.

# 4

# Policy and rationale

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## 4.1 Introduction

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### 4.1.1 Summary of policy

The default policy is to control Japanese encephalitis (JE) in domestic animal populations to support public health agencies and programs, and the pig and horse industries. Implementation of this policy will be supported by a range of strategies, including:

- *coordination and cooperation* with public health responses
- *early recognition* and laboratory confirmation of cases
- *establishment of declared areas* to facilitate outbreak management
- *movement controls* over pigs, pig semen and embryos, and other potential amplifying hosts in declared areas, to minimise the spread of infection
- an *epidemiological assessment* to inform decisions on appropriate control measures, and to establish the potential role of mosquito vectors and reservoir host species in the transmission of JE virus (JEV) in Australia
- *tracing and surveillance* in domestic and wild animals (including, as necessary, in feral pigs), and potential mosquito vector species, to determine the source and extent of infection, and subsequently to provide proof of freedom from the disease
- *mosquito management* in selected areas (eg around piggeries)
- *management of wild animal* reservoir species, if warranted
- a *public awareness campaign* to inform the public, encourage rapid reporting of suspected cases, and facilitate cooperation from industry and the community.

Vaccination and stamping out are not likely to be used to control an outbreak of JE (see [Sections 4.3.8](#) and [4.3.11](#), respectively).

### 4.1.2 Case definition

For the purpose of this manual, a case of JE is defined as laboratory-confirmed current infection in a susceptible animal, with or without clinical signs.

[Sections 2.2](#) and [2.5.4](#) provide information on susceptible species and laboratory confirmation of infection, respectively.

## Notes:

- AUSVETPLAN case definitions guide when a response to an emergency animal disease (EAD) incident should be undertaken. AUSVETPLAN case definitions do not determine when international reporting of an EAD incident is required.
- Positive serology in the absence of genome or antigen does not constitute a case, but may warrant further investigation to determine whether there is evidence of infection.
- At the time of an outbreak, revised or subsequent case definitions may be developed (with the agreement of the Consultative Committee on Emergency Animal Diseases – CCEAD).

### 4.1.3 Cost-sharing arrangement

In Australia, JE is included as a category 1 EAD in the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses (EAD Response Agreement).<sup>8</sup> When cost sharing of the eligible response costs of an incident is agreed, category 1 diseases are those for which costs will be shared 100% by government and 0% by industry.

### 4.1.4 Criteria for proof of freedom

The World Organisation for Animal Health (OIE) provides general guidance for demonstrating proof of freedom from EADs in Chapter 1.6 of its *Terrestrial animal health code*.<sup>9</sup> The OIE does not provide JE-specific guidelines for demonstrating proof of freedom.

Guidance on surveillance to provide evidence for proof of freedom is provided in [Sections 4.3.3 and 7](#).

### 4.1.5 Governance

Governance arrangements for the response to EADs are outlined in the **AUSVETPLAN Overview**.

Information on the responsibilities of a state coordination centre and local control centre is available in the **AUSVETPLAN management manual *Control centres management Manual (Parts 1 and 2)***.

#### Disease-specific governance issues

As JE is zoonotic, close collaboration between animal health and public health agencies will be required. The chief veterinary officer in the affected state or territory has responsibility for managing animal health risks and instituting animal health control action within that jurisdiction. The chief health officer of the affected state or territory has responsibility for managing public health risks and instituting public health control action within that jurisdiction. Government environment agencies may also be involved if wild animals are involved in the disease incident.

Where transmission is occurring in remote areas, inclusion of the Liaison – Other Agencies function (in state coordination centres and local control centres) is strongly recommended to facilitate community liaison, help ensure that control measures applied are appropriate to the context of the outbreak, and facilitate community support for implementation of the measures.

<sup>8</sup> Information about the EAD Response Agreement can be found at [www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement](http://www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement)

<sup>9</sup> [www.oie.int/international-standard-setting/terrestrial-code/access-online](http://www.oie.int/international-standard-setting/terrestrial-code/access-online)

## 4.2 Public health implications

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Work health and safety (WHS) legislation in Australia requires businesses and workers to, as far as reasonably practicable, ensure the health and safety of themselves and others. Jurisdictional WHS authorities should be consulted on individual jurisdictional legislative requirements.

Measures to manage the risks of JE include:

- providing information, training, instruction or supervision to protect people from JE risks, including on decontamination of reusable equipment, mosquito control and use of personal protective equipment (PPE)
- ensuring that people at high risk of exposure have current JE immunity (see 'Vaccination of people', below)
- providing suitable PPE and ensuring that PPE is worn by those at risk (see [Section 4.3.5](#)).

JEV infection in humans is a notifiable disease in all states and territories in Australia.

Further instructions about the public health management of JE, including management of cases of JE, should be obtained from state or territory public health authorities.

Biosafety level 3 precautions and practices are recommended for laboratory investigators working with JEV (see [Section 2.5.4](#)).

### 4.2.1 Vaccination of people

The *Australian immunisation handbook* (ATAGI 2018) provides information on the availability and use of JE vaccines in humans.

During an outbreak, primary vaccination of humans will confer protection from clinical disease but will not influence the epidemic spread of JEV. Human vaccination programs will be determined and managed by public health authorities.

### 4.2.2 Managing potential exposures

People potentially exposed to JEV should be referred to their medical practitioner or their local public health authority.

### 4.2.3 Food safety

The World Health Organization does not describe JE as a food safety concern (WHO 2015).

## 4.3 Control and eradication policy

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The occurrence of JE in animals in Australia will be managed to minimise the effects on humans, animals and trade. The strategies used will need to be adapted to the circumstances, taking into consideration the occurrence of, or potential for, human cases and the effect on domestic animal populations. In the initial response, tracing, surveillance and epidemiological assessment will be important for guiding decisions on the feasibility of eradication.

Incursions into new areas may fail to establish, depending on the ecosystem; these will be managed to minimise negative effects and limit the likelihood of establishment.





Exclusion fence along boundary of Australian property intended to keep out wild dogs and feral pigs.

If JEV becomes established in an area, eradication will not be feasible and long-term control programs may need to be developed (see [Section 4.4](#)).

### 4.3.1 Epidemiological assessment

Epidemiological investigation or assessment draws on multiple sources of information to build understanding of the disease and how it is behaving in an outbreak. This helps inform response decision making.

In the initial response to JE, the key objectives for an epidemiological assessment will be to identify:

- the spatial distribution of infected and free domestic and wild animal populations
- the vectors involved and their distribution
- the source of infection
- pathways of spread and their relative priority
- the likely extent of spread and size of the outbreak, using modelling, where available
- risk factors for the presence of infection and susceptibility to disease.

Epidemiological assessment, and tracing and surveillance activities (see [Section 4.3.3](#)) in an EAD response are interrelated activities. Early findings from tracing and surveillance will be inputs into the initial epidemiological assessment. The outcomes of the initial epidemiological assessment will then guide decisions on subsequent tracing and surveillance priorities.



The outcomes of the epidemiological assessment will also be used initially to determine the feasibility of eradication versus long-term control and so guide the selection of appropriate response measures.

Ongoing epidemiological assessment is important for any EAD response to aid evaluation of the continued effectiveness and value of response measures, and assessment of the progress of disease control measures. Ongoing epidemiological assessment will consider the outcomes of tracing and surveillance activities, and will contribute evidence to support any later claims of disease freedom.

### 4.3.2 Quarantine and movement controls

See Section 5 for information on the use of declared areas and premises, and Section 6 for details of recommended movement controls.

#### Quarantine

Quarantine will be immediately imposed on all infected premises (IPs) holding pigs (as known amplifying hosts).

Decisions on placing the following premises in quarantine should be based on risk assessment:

- IPs holding other animals known or mooted to act as amplifying hosts (eg waterbirds, insectivorous bats, flying foxes, possums, reptiles – see [Section 2.4.2](#))
- IPs holding dead-end hosts (eg horses – see [Section 2.4.2](#))
- dangerous contact premises (DCPs)
- suspect premises (SPs)
- trace premises (TPs).

The risk assessment should take into consideration:

- the number, species and age of animals present, and the role of these species in the epidemiology of JE
- the potential presence and nature of other contaminated materials
- the ongoing risk of JEV transmission on and from the premises (including the risk to public health)
- the need for additional disease control measures on the premises to control JE.

The presence of dead-end hosts alone (whether infected or not) would not be sufficient to warrant placing a premises under quarantine.

When imposed, quarantine will remain in place until disease control measures on the premises have been completed and the ongoing risk of disease has been assessed (see [Section 5.4](#) for guidance on reclassifying premises).

#### Movement controls

[Section 6.2](#) provides details of recommended movement controls for live pigs, domestic chickens and ducks under 8 weeks of age, and pig semen and in vivo-derived embryos. Movements of livestock transport vehicles and equipment in declared areas will be controlled to prevent inadvertent spread of mosquito vectors.

### 4.3.3 Tracing and surveillance

Guidance on tracing and surveillance can be found in the **AUSVETPLAN guidance document *Tracing and surveillance***.

#### Tracing

Tracing personnel will need to have a good knowledge of different pig enterprises in the jurisdiction, and their typical movement and trading patterns, or have access to other personnel who have this knowledge (eg through the Specialist Advice – Livestock Industry function). This knowledge will help focus tracing activities to identify the highest-risk animals and locations.

Rapid trace-back and trace-forward of high-risk animals and items from IPs may help identify the source of infection, and the location of potentially infected animals and contaminated items. This will contribute to defining the extent of disease spread.

It is important to estimate the date when JEV is likely to have been introduced onto each IP, from which forward and back tracing will be undertaken. In the initial stages of an outbreak, an estimated date of introduction to a premises may not yet have been determined, or the epidemiological investigation may be inconclusive. In this case, tracing should include movements on or off the IP for at least 21 days before the first appearance of clinical signs and up to the time that the premises was designated an IP.

Tracing should include live pigs (highest priority), and pig semen and embryos. Tracing should include consideration of vector involvement, and contact of animals with waterbirds and feral pigs.

Tracing of other animals that may potentially act as amplifying hosts should be undertaken, where relevant. This would include human-assisted movements of waterbirds, insectivorous bats, flying foxes, possums and reptiles (eg as part of zoological collections), and of domestic chickens and ducks under 8 weeks of age.

Tracing the movements of livestock transport vehicles is a low priority.

Back tracing of the movements of dead-end hosts (such as horses) may be warranted if disease occurs in a dead-end host outside the known area of transmission (to help determine the potential source of infection). Forward tracing of these animals will enable monitoring of their health and welfare, but is not expected to contribute to understanding of the epidemiology of the outbreak.

The epidemiological investigation on an IP will further guide prioritisation.

#### Surveillance

Surveillance in a JE outbreak will initially aim to:

- rapidly identify new cases
- determine the extent of spread (including in wild animal populations, where appropriate)
- identify potential vector species involved in the outbreak and their distribution
- identify the source of infection
- provide data to inform risk analyses and selection of appropriate control measures.

The surveillance aims will be achieved by prioritising surveillance:

- of premises found to be epidemiologically linked to the index premises (identified through tracing) to determine whether they may be infected

- of premises containing infected animals that have not been identified through tracing, for further investigation and testing
- of wild animal populations in areas surrounding known IPs, as appropriate
- of potential vector populations.

Field surveillance should be prioritised based on risk, taking into account the likelihood that subclinical infection may be present, the likelihood of further disease transmission and the consequences for disease control.

See [Section 7](#) for further details on surveillance procedures and prioritisation, and their contribution to providing evidence to support any subsequent declarations of disease freedom.

### 4.3.4 Zoning and compartmentalisation for international trade

#### General considerations

Where it is not possible to establish and maintain disease freedom for the entire country, establishing and maintaining disease-free subpopulations, through zoning and/or compartmentalisation,<sup>10</sup> may be considered.

In the case of a limited disease outbreak, a containment zone<sup>11</sup> may be established around the areas where the outbreak is occurring, with the purpose of maintaining the disease-free status of the rest of the country outside the containment zone.

All zoning applications would need to be prepared by the Australian Government in conjunction with the relevant jurisdiction(s) and agreed to by the CCEAD. Compartmentalisation applications would require input from the relevant industries. Recognition of both zones and compartments must be negotiated between the Australian Government and individual overseas trading partners. Zoning and compartmentalisation would require considerable resources that could otherwise be used to control an outbreak. Careful consideration will need to be given to prioritising these activities, because the resulting competition for resources could delay the quick eradication of the disease and recognition of disease freedom.

Agreements between trading partners take time to develop, consider and finalise, because of the need to provide detailed information on activities such as biosecurity, surveillance, traceability and diagnostics to support the approach that is developed. An importing country will need assurance that its animal health status is not compromised if it imports from an established disease-free zone in Australia. Trading partners may not accept a zoning or compartmentalisation proposal, regardless of the information provided. Eradication of disease may be achieved before zoning or compartmentalisation applications are finalised.

The OIE general guidelines for zoning and compartmentalisation are in Chapter 4.4 of the OIE Terrestrial Code.

### 4.3.5 Biosafety and biosecurity for personnel

Exposure to JEV poses a risk to response personnel. Potential routes of exposure for response

<sup>10</sup> With zoning, disease-free subpopulations are defined primarily on a geographical basis. With compartmentalisation, disease-free subpopulations are defined primarily by management practices [such as the biosecurity plan and surveillance practices of enterprises or groups of enterprises].

<sup>11</sup> The OIE defines a 'containment zone' as an infected zone within a previously free country or zone, which includes all suspected or confirmed cases that are epidemiologically linked and where movement control, biosecurity and sanitary measures are applied to prevent the spread of, and to eradicate, the infection or infestation. The then Australian Government Department of Agriculture and Water Resources commissioned a report on what would be required for the establishment of containment zones in Australia. This report is available at [www.ausvet.com.au/tools-resources](http://www.ausvet.com.au/tools-resources).

personnel include bites from mosquito vectors and exposure to infectious materials (eg via needlestick injuries, aerosols or broken mucous membranes during postmortem, surveillance or laboratory activities).

To minimise the risk of JEV infection, all people who work with potentially infected animals, work in areas in which infected vectors may be present or handle JEV should have current JE vaccination and wear appropriate PPE. The PPE should be chosen based on the assessed level of risk, the task and the animal species. Appropriate PPE for field personnel may include:

- gloves
- long pants, long-sleeved shirt and insect repellent (to limit mosquito bites)
- water-resistant dressings to cover cuts and abrasions
- safety eyewear or face shield to protect the face and mucous membranes from contact with oral and nasal discharges from pigs
- respirator or face mask to prevent aerosol transmission (eg during postmortem examination and collection of samples)
- enclosed footwear.

Hand hygiene should be undertaken after removing PPE.

Laboratory workers should use biosafety level 3 precautions (see [Section 2.5.4](#)).

### 4.3.6 Biosecurity for equipment

JEV is not transmitted by most fomites, but equipment contaminated with blood from viraemic animals (eg needles, postmortem equipment) may pose a risk to the health of response personnel (eg through needlestick injuries). Disposable equipment contaminated with blood should be disposed of in a biosecure manner. Reusable equipment contaminated with blood should be decontaminated (see [Section 4.3.13](#)).

Although there are no additional JE-specific recommendations, the maintenance of general biosecurity measures is recommended in all EAD responses.

### 4.3.7 Animal welfare

Guidance on managing livestock welfare can be found in the **AUSVETPLAN operational manual *Livestock welfare and management***.

Imposition of movement controls on live animals on premises with intensive livestock production (such as piggeries) may result in development of animal welfare issues due to overcrowding within 2 weeks, depending on the production system in use (Garner et al 2012). Careful management will be required to avoid or mitigate the welfare issues – for example, by considering use of maintenance feed rations to slow growth rates (where possible), providing access to temporary housing on-site, ensuring rapid destocking (where a stamping-out policy is being implemented), or ensuring that biosecure transport to an approved abattoir is readily available (where appropriate). If the latter option is not available, culling of overcrowded animals on the premises may need to be considered.

Animal welfare issues may also arise if movement controls are applied to chicken and duck hatcheries.

Given the impacts of JE on horses (and, rarely, on cattle), close monitoring and careful management of animal welfare on affected premises will be required.

### 4.3.8 Vaccination

#### General considerations

No JE vaccines for animals are registered in Australia. Significant initial difficulties in sourcing large quantities of JE vaccine are likely, given the limited production by international vaccine manufacturers, and the legislative requirements for the importation and use of vaccines in Australia. These challenges are likely to preclude the vaccination of pigs and horses in a response.

Importation of JE vaccines is subject to the issuing of import permit(s) by the Australian Government Department of Agriculture, Water and the Environment. Supply and use of the vaccine in Australia will require an emergency permit and consent to import from the Australian Pesticides and Veterinary Medicines Authority. Importation, distribution, use and disposal of a vaccine that is a genetically modified organism must also be licensed by the Office of the Gene Technology Regulator, or permitted under an Emergency Dealing Determination by the minister responsible for gene technology, or other relevant and appropriate processes.

Vaccination would have to be approved by the National Management Group (NMG), based on the recommendation of the CCEAD.

#### Specific considerations

Vaccination of pigs is not routinely recommended for control of JE in an outbreak situation. However, it may slow the spread of virus and reduce the risk to human populations where human and pig populations have a significant interface. It may also reduce production losses in pig populations.

If an appropriate vaccine for horses is available in an outbreak, voluntary vaccination of horses in and near transmission areas may be encouraged to limit disease and improve animal welfare outcomes. Such vaccination will not influence the epidemic spread of JEV; consequently, horse owners will be responsible for the costs of vaccination.

Clinical disease in other domestic livestock species is rare, and vaccination is not warranted.

Vaccines for birds (including chickens and ducks) and wildlife are not available.

### 4.3.9 Treatment of infected animals

There is no effective treatment for JE in susceptible species.

#### 4.3.10 Treatment of animal products and byproducts

Most animal products and byproducts are not implicated in the spread of JEV, and their treatment is unnecessary.

Blood-based products or tissues for transplantation from potentially viraemic animals may require treatment to inactivate JEV. The treatment required will depend on the product and its proposed end use, and will need to be determined on a case-by-case basis. Where no suitable treatment is identified, these products should not be used and should be disposed of instead.

#### 4.3.11 Destruction of animals

Destruction plans should be developed for each premises on which animals may be destroyed. Guidance on destruction methods can be found in the **AUSVETPLAN operational manual *Destruction of animals***.



Eastern great egret hunting in water.

Stamping out pig populations will not eliminate JEV because the virus is maintained in mosquito–waterbird transmission cycles. It is therefore not likely to be an appropriate or necessary part of the control program in all circumstances. However, it may be considered:

- if a defined pig population is involved and stamping out the population will support eradication
- to limit amplification of the virus and:
  - assist with limiting transmission to susceptible human populations where pig populations are located close to human populations
  - assist with limiting transmission to other pig populations in areas of high pig density.

Horses and other animals suffering severe clinical disease may need to be destroyed on animal welfare grounds, but not for disease control purposes.

#### 4.3.12 Disposal of animals, and animal products and byproducts

Disposal plans should be developed for each quarantined premises. Guidance on disposal options and methods can be found in the **AUSVETPLAN operational manual *Disposal***.

There are no special requirements for disposal of carcasses or other materials from IPs.

#### 4.3.13 Decontamination

Decontamination plans should be developed for each premises to be decontaminated. General guidance on decontamination can be found in the **AUSVETPLAN operational manual *Decontamination***.

JEV is unstable in the environment, and most fomites are not implicated in natural transmission of the virus. Nondisposable equipment that is contaminated with blood from potentially viraemic animals should be decontaminated to prevent any risk of transmission to people (eg through needlestick injury). Decontamination of equipment and housing on affected pig premises is recommended to prevent transmission via oronasal secretions. On other premises, no decontamination precautions, other than normal hygienic measures, are necessary.

JEV is susceptible to detergents and certain common disinfectants (such as 1% sodium hypochlorite, iodine and iodophors) – see [Section 2.4.2](#).

#### 4.3.14 Wild animal management

Guidance on disease control measures in wild animal populations can be found in the **AUSVETPLAN *Wild animal response strategy***.

Waterbirds and feral pigs act as reservoirs for JEV. A potential role as amplifying hosts and reservoir species has also been mooted for certain wildlife species, including possums, flying foxes and reptiles (see [Section 2.4.2](#)), but their role in the natural epidemiology of JEV has not been elucidated.

If JEV is spreading through a region, surveillance of feral pig populations will be required. The ability of other wild animals to become infected – and potentially act as amplifying hosts or reservoir species – should be determined, to provide epidemiological information to support response decision making. Wild animal experts should be engaged in the planning of monitoring and surveillance programs (and, if required, control programs) in wild animals. Depending on the location of the outbreak, engagement with remote community members to report any abnormalities observed during time spent on-country may assist with this surveillance (although many species may be asymptotically infected).

Control of virus spread is unlikely to be achieved by attempting control of wild animal populations. However, strategic control of feral pigs near centres of human population or populations of domestic pigs may need to be undertaken to reduce the risk of disease.

#### 4.3.15 Vector management

##### Surveillance

With input from an entomologist, a vector monitoring program should be implemented to identify the range of mosquito species that can transmit infection. The mosquito vector species implicated will determine the potential extent of spread of JEV within Australia, and the control measures to be used (as mosquito behaviour varies with species).

A range of collection techniques, including carbon dioxide-baited light traps, truck traps and larval sampling, are used by state and territory health departments for vector surveillance. An adequate number of carbon dioxide-baited light traps should be available at short notice. Collections should be stored in a suitable condition for later sorting and identification.

Insect collections can be subjected to conventional virus isolation procedures, but these are expensive, logistically difficult and too time-consuming to be used for routine surveillance. Successful virus-specific surveillance of large pools of mosquitoes is becoming more feasible using PCR technology. Although the specificity of virus isolation and PCR is high, the sensitivity of these techniques is inadequate for routine use. Sensitivity can be improved by increasing the density of traps, where the risk justifies the cost.

In risk areas, insects collected under sentinel programs for other diseases should also be tested for JEV. Currently available mosquito monitoring systems could be augmented by establishing additional monitoring sites. Information obtained from serological monitoring of sentinel animals will indicate whether virus isolation from, or PCR testing of, mosquitoes is necessary.

##### Vector control measures

Control of widespread mosquito vector species will be challenging. Expert advice from an entomologist should be obtained to guide the development of a targeted mosquito control program



to limit transmission. In development of a control program, it should be recognised that viraemia in many host species is believed to be insufficient to infect mosquitoes, and that many species may be asymptotically infected. The potential human health and environmental effects of widespread insecticide use should also be considered.

## **Pigs**

Early detection of infection in a piggery near a town or city could be followed by mosquito control measures over an area to suppress infected mosquito populations that might enter the town or city. Currently, some local health authorities practise vector control for Murray Valley encephalitis and Ross River virus infections in areas within a 10 km radius of townships. Piggeries within such areas would need to apply vector controls.

## **Horses**

In an outbreak situation, horse owners should reduce the risk of exposure of their horses to mosquitoes, where possible.

Specific advice may vary with the mosquito vector species implicated and their ecology. Mosquito control measures that might be of some benefit, derived from American experience in the control of West Nile virus, include:

- housing horses in mosquito-screened stables during peak periods of mosquito activity (between dusk and dawn)
- screening stable windows with PVC mesh impregnated with 0.25% (mass/volume) cypermethrin; this should be reapplied weekly by soaking removable screens or painting nonremovable screens
- turning off lights inside stables at night
- using fluorescent lights, which do not attract mosquitoes in stables
- placing incandescent bulbs around the stable perimeter to attract mosquitoes away from horses
- using fogging, fans and automatic overhead misting systems to eliminate mosquitoes in stables
- treating horses with topical repellents
- spraying stable walls with residual insecticides such as fenvalerate, deltamethrin or permethrin
- using physical barriers – for example, rugging and hooding horses in lightweight permethrin-treated material (if climatically appropriate)
- using mosquito-repellent collars and leg bands
- eliminating mosquito breeding sites on the premises
- eliminating mosquito breeding sites immediately adjacent to horse enterprises; this may reduce the risk of infection for the enterprise, but a community-wide effort using larvicides and adulticides may be needed to have any real effect on mosquito populations.

## **Humans**

Because JEV is spread by mosquitoes, vector control is an important measure to control infection of humans. Appropriate (long-sleeved, full-length) clothing and the use of insect repellents will help reduce human infection rates.

In the event of an outbreak, any decisions to conduct broadscale vector control in towns and cities will be made by local, and state or territory health authorities. Decisions will be based on information obtained from surveillance systems tracking the spread of virus infection and vector populations.

### 4.3.16 Public awareness and media

Guidance on managing public information can be found in the *Biosecurity incident public information manual*.<sup>12</sup>

Public awareness and industry engagement will support a cohesive response. The communications strategy should include mechanisms for raising awareness in owners of pigs and horses. It should include strategies for communication with petting zoos; school farms; urban and peri-urban pig owners, and smaller commercial piggeries (that may not be engaged with the industry peak body, for example); riding stables; recreational horse groups; racing organisations; and so on.

Key topics to be covered in public information messaging will include advice on:

- the modes of transmission of JEV between animals, and between animals and humans
- the safety of food and other products derived from animals
- mosquito control, and preventing mosquito bites of animals and humans
- preventing human infection through vaccination
- seeking medical advice if human exposure is suspected
- signs of disease in animals and how to report suspected infection in animals
- where to find more information on the response and the control measures being used
- the benefits of vaccination (if available) in horses, and how vaccine may be obtained.

National coordination of public information and engagement messaging in the event of a JE incident in Australia may occur through:

- activation of the National Biosecurity Emergency Communication Network<sup>13</sup> to coordinate animal health information, and liaise with public health and environmental agencies
- activation of the National Health Emergency Media Response Network to coordinate public health information, and liaise with animal health and environmental agencies.

The Australian Government Department of Health will produce and manage public and media messages (including appropriate public health warnings) about the human health aspects of the incident.

### 4.3.17 Other strategies

Other control strategies may need to be considered, depending on the context of the incident.

Enhanced biosecurity (particularly vector control and measures to prevent contact with feral pigs) is encouraged on all premises with pigs. The *National farm biosecurity manual for pork production*<sup>14</sup> provides guidelines for pig producers on both routine and high-risk biosecurity procedures. The **AUSVETPLAN enterprise manual for the pig industry** provides additional detail on the biosecurity and other response measures that may be used on pig premises in an EAD response.

### 4.3.18 Stand-down

Stand-down of the response will occur once JE has been controlled or eradicated, when control or eradication is no longer considered feasible or practicable, or when the NMG formally declares the outbreak over.

<sup>12</sup> [www.animalhealthaustralia.com.au/news/new-biosecurity-incident-public-information-manual-now-available](http://www.animalhealthaustralia.com.au/news/new-biosecurity-incident-public-information-manual-now-available)

<sup>13</sup> Previously known as the Primary Industries National Communication Network (NCN). More information is available at [www.outbreak.gov.au/about/biosecurity-incident-national-communication-network](http://www.outbreak.gov.au/about/biosecurity-incident-national-communication-network).

<sup>14</sup> [www.farmbiosecurity.com.au/toolkit/plans-manuals](http://www.farmbiosecurity.com.au/toolkit/plans-manuals)

### Additional information

Additional information on the stand-down of EAD responses can be found in the **AUSVETPLAN management manual *Control centres management (Part 1)***.

## 4.4 Other control and eradication options

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If control and eradication of JE using the strategies outlined above is not feasible, a long-term control program may need to be developed through consultation between Australian governments (including public health agencies) and the pig and horse industries. The involvement of other industries (eg chicken and duck industries, zoos) may also be warranted, depending on the circumstances (particularly the location) of the incident.

## 4.5 Funding and compensation

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### General considerations

Details of the cost-sharing arrangements can be found in the EAD Response Agreement.<sup>15</sup> Details of the approach to valuation of, and compensation for, livestock and property in disease responses can be found in the **AUSVETPLAN operational manual *Valuation and compensation***.

# 5

## Guidelines for classifying declared areas and premises

### 5.1 Declared areas

Detailed guidelines for declared areas are provided in the **AUSVETPLAN guidance document *Declared areas and premises classifications***.

Figure 5.1 illustrates the recommended minimum distances between the boundaries of an infected premises (IP), the transmission area (TA), the restricted area (RA) and the control area (CA) during the initial response.

| IP, SP, TP, DCP or DCPF | Transmission area | Restricted area | Control area  | Outside area |
|-------------------------|-------------------|-----------------|---------------|--------------|
|                         | Minimum 50km      | Minimum 100km   | Minimum 250km |              |

Figure 5.1 Recommended minimum distances between the boundaries of an infected premises, the restricted area and the control area

#### 5.1.1 Restricted area (RA)

For Japanese encephalitis (JE), an RA will be declared to encompass any TAs identified (see [Section 5.2](#)). The boundary of the RA should be at least 100 kilometres from the boundary of the TA and informed by risk assessment. This risk assessment should consider:

- the factors used to determine the boundaries of the TA (see [Section 5.2](#))
- the location of key elements in industry supply chains (eg abattoirs, artificial breeding centres)
- the impacts on the industry of disease control measures applied in the RA compared with the expected benefits of disease control
- resources available to implement disease control, taking into account the expected rate of spread of JE virus (JEV).

#### 5.1.2 Control area (CA)

The boundary of the CA should be at least 250 kilometres from the boundary of the RAs within it. It will be informed by risk assessment, taking into consideration the factors used to inform the size of the RA. Based on risk assessment, the CA may need to be much larger – initially, possibly as large as the state or territory in which the incident occurs. As a general principle, to facilitate control of the disease, it will be preferable to start with a larger CA and subsequently reduce its size when appropriate.

## 5.2 Other areas

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### Transmission area (TA)

A TA should include all likely infected vectors in the area surrounding known areas of transmission. The TA will include IPs and, where possible, all suspect premises (SPs), trace premises (TPs), dangerous contact premises (DCPs) and dangerous contact processing facilities (DCPFs).

The boundaries of the TA should be at least 50 kilometres from the nearest IP, SP, TP, DCP or DCPF. They will be informed by an assessment of:

- the known distribution of infection (informed by detection of disease, seroconversion of susceptible animals, trapping and testing of vectors, and any other confirmation of active transmission of JEV)
- the length of time infection is thought to have been present in the area, and therefore where subclinical infection may be present (noting the World Organisation for Animal Health (OIE) incubation period for JEV of up to 21 days)
- the likely vector species, and their distribution and expected dispersal (eg as informed by prevailing weather conditions and geographical features)
- the location and distribution of any population of susceptible animals (including wild animals) in the area, and patterns of livestock movements
- the accuracy of available information.

## 5.3 Declared premises

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Detailed guidelines for declaring premises status are provided in the **AUSVETPLAN guidance document *Declared areas and premises classifications***.

### 5.3.1 Premises status classifications

For JE, the premises classifications to be used are:

- infected premises (IP)
- suspect premises (SP)
- trace premises (TP)
- dangerous contact premises (DCP)
- dangerous contact processing facility (DCPF)
- approved processing facility (APF)
- approved disposal site (ADS)
- premises of relevance (POR)
- resolved premises (RP)
- unknown status premises (UP)
- zero susceptible species premises (ZP).

### 5.3.2 Qualifiers

The following qualifying categories may be added to a property status:

- Assessed negative (AN)
- Vaccinated (VN).

### 5.3.3 Other disease-specific classifications

Not applicable.

## 5.4 Resolving premises and reclassifying declared areas

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### 5.4.1 Resolving premises

For the purposes of this manual, unless otherwise stated, the recommended minimum quarantine period is 42 days from the introduction of infection to the premises (to allow sufficient levels of immunity to develop in all susceptible animals on the premises). For piggeries, a high level of immunity should be demonstrated (eg through testing) before controls on movements are lifted.

### 5.4.2 Reclassifying declared areas

Detailed guidelines for reclassifying previously declared areas are provided in the **AUSVETPLAN guidance document *Declared areas and premises classifications***.

For JE, the key principles for reclassifying a declared area to one of a lower risk status include the following:

- The area should be epidemiologically distinct from other declared areas.
- All TPs and SPs have been investigated and reclassified. Predetermined disease control activities and risk assessment have been completed on all IPs, DCPs, DCPFs and vaccinated ARPs in the area, and they have been reclassified as RPs.
- All tracing and surveillance associated with control of the disease have been completed satisfactorily, with no evidence or suspicion of infection in the area.
- A minimum period of 42 days<sup>16</sup> has elapsed since all IPs, DCPs and DCPFs in the area were reclassified as RPs.
- An approved surveillance program has confirmed no evidence of infection in the area.
- Vector monitoring and absence-of-transmission studies indicate that vectors are not actively involved in the transmission of infection.

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<sup>16</sup> The minimum period uses, or is based on, the disease-specific incubation period defined by the OIE – two incubation periods is a common guideline.



# 6

# Movement controls

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## 6.1 Principles

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General principles for movement controls for managing emergency animal diseases are provided in the **AUSVETPLAN guidance document *Movement controls*** [under development].

Key considerations for movement controls for managing Japanese encephalitis (JE) are as follows:

- Transmission of JE virus (JEV) occurs primarily through bites from infected mosquito vectors.
- Pigs are important amplifying hosts for JEV, and transmission can occur through direct contact between infected and susceptible pigs.
- Transmission through pig semen and embryos has also been reported.
- A number of other species may act, or are mooted to act, as amplifying hosts (eg waterbirds, insectivorous bats, flying foxes, possums, reptiles, chickens and ducks under 8 weeks of age). These animals, especially if present in sufficient numbers, may have a role in the local epidemiology of JE.
- Horses and other livestock are considered dead-end hosts and do not develop viraemia substantial enough to infect insect vectors.
- Fomites are not significant in the transmission of JEV; however
  - contaminated items that may pose a risk of traumatic injury and transmission to people should be cleaned
  - infected vectors may be inadvertently moved to new areas through the transport of livestock or empty livestock transport vehicles.

## 6.2 Recommended movement controls

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General permits (GPs) and special permits (SpPs) may not be available until the relevant chief veterinary officer gives approval for movements, and this approval may not be given in the early stages of a response.

SpPs are used for higher-risk movements. They require formal application and individual risk assessment by the relevant government veterinarian or gazetted inspector of stock. An SpP may only be issued if the assessed risk can be managed by the application of acceptable mitigation measures.



Movement of piglets between properties on a truck.

### 6.2.1 Live susceptible animals

#### All species

For animals being transported, compliance with all jurisdictional legislation and the *Australian animal welfare standards for the land transport of livestock*<sup>17</sup> is required. This includes ensuring that the animals are fit to load.<sup>18</sup>

#### Pigs

Pigs are known amplifying hosts (capable of infecting insect vectors), and their movement presents a high risk. Where pig movements are permitted, they should be managed in a way that minimises the chance of infection spreading to new areas – for example, timing dispatch at periods when mosquito activity is low.

#### Live pigs, unless being sent for slaughter

Movements of live pigs, unless being sent for slaughter being moved:

- off quarantined premises (infected premises – IPs, dangerous contact premises – DCPs, suspect premises – SPs, and trace premises – TPs) are prohibited, because these are high-risk premises and it will be difficult to have confidence that the population is not viraemic at the time of the movement
- onto quarantined premises (IPs, DCPs, SPs and TPs) are prohibited, because facilitating an increase in the number of susceptible hosts in the restricted area (RA) is not consistent with the objectives of disease control

<sup>17</sup> [www.animalwelfarestandards.net.au](http://www.animalwelfarestandards.net.au)

<sup>18</sup> Guidelines on whether animals are fit to load are produced by Meat & Livestock Australia (MLA) and are available free of charge by registering on the MLA website: [www.mla.com.au/meat-safety-and-traceability/red-meat-integrity-system/red-meat-integrity-systems-newsletter/is-your-livestock-fit-to-load](http://www.mla.com.au/meat-safety-and-traceability/red-meat-integrity-system/red-meat-integrity-systems-newsletter/is-your-livestock-fit-to-load).

- off at-risk premises (ARPs) in the RA are prohibited, because pigs are amplifying hosts and can develop viraemia within 24 hours of infection, without showing clinical signs; it will be difficult to have confidence that the population is not viraemic at the time of movement, given that they are in a high-risk area (RA)
- onto ARPs in the RA are prohibited, because facilitating an increase in the number of susceptible hosts in the RA is not consistent with the objectives of disease control
- off premises of relevance (PORs) in the control area (CA) are prohibited except under GPa (see Table 6.1); this requires attestation (and therefore some confidence) that pigs (potentially from what are now quarantined premises, or other premises within the RA) have not been introduced to the source premises in the previous 42 days.

Emergency permits may be considered if movements that are otherwise prohibited are warranted on welfare grounds (see [Section 6.2.18](#)).

Table 6.1 shows the requirements for movement of live pigs from premises other than IPs, DCPs, SPs and TPs, unless being sent for slaughter.

**Table 6.1 Recommended movement controls for live susceptible animals not being sent to slaughter (other than from IPs, DCPs, SPs and TPs)**

| To →<br>From ↓ | RA         | CA                           | OA                           |
|----------------|------------|------------------------------|------------------------------|
| RA             | Prohibited | Prohibited                   | Prohibited                   |
| CA             | Prohibited | Prohibited, except under GPa | Prohibited, except under GPa |
| OA             | Prohibited | Allowed                      | Allowed                      |

CA = control area; GP = general permit; OA = outside area; RA = restricted area

### Notes for Table 6.1

GPa conditions

- No evidence of clinical disease in animals being moved.
- Owner declaration that the pigs were born on the property or resident on the property for the consecutive 42 days immediately before the movement.
- All pigs moving are individually identified and specified on the permit for traceability and other purposes.
- The permit accompanies the pigs during movement, and the person responsible for the pigs retains a copy of the permit, consistent with the legal requirements of the jurisdiction.
- Any pigs that develop clinical signs during the 42 days following movement are immediately reported to a government veterinary officer.
- Pigs are not permitted to move again for 42 days (ie they must remain resident at the destination for a minimum of 42 days) unless going for direct slaughter (pigs going to slaughter may be subject to separate permit conditions).

## Live pigs being sent for slaughter

Movements of live pigs being sent for slaughter:

- off quarantined premises (IPs, DCPs, SPs and TP) are prohibited, because these are high-risk premises and it will be difficult to have confidence that the animals are not viraemic at the time of the movement
- off ARPs in the RA are prohibited except under SpP to an approved processing facility (APF) in the same RA – or to an APF in another RA, CA or outside area (OA) (subject to additional risk assessment, and only if there is no suitable APF in the same RA). Although not known to be infected, these animals originate in a high-risk area (RA). Transit across a CA or the OA to an APF in another RA is considered a potential risk for transmission of JEV and is prohibited except following risk assessment and the application of any necessary additional precautions
- off PORs in the CA or premises in the OA and onto APFs in the RA are prohibited except under SpP where no suitable processing facility is available in the CA or OA
- off PORs in the CA to processing facilities in the CA or OA are prohibited except under GPb (see Table 6.2); this requires attestation (and therefore some confidence) that pigs (potentially from what are now quarantined premises, or other premises within the RA) have not been introduced to the source premises in the previous 42 days.

Emergency permits may be considered if movements that are otherwise prohibited are warranted on welfare grounds (see [Section 6.2.18](#)).

Table 6.2 describes the requirements for movements of live pigs being sent for slaughter from premises other than IPs, DCPs, SPs and TP.

**Table 6.2 Recommended movement controls for live pigs (other than from IPs, DCPs, SPs and TP) being sent for slaughter**

| To →   | RA                            | CA                            | OA                            |
|--------|-------------------------------|-------------------------------|-------------------------------|
| From ↓ |                               |                               |                               |
| RA     | Prohibited, except under SpP1 | Prohibited, except under SpP2 | Prohibited, except under SpP2 |
| CA     | Prohibited, except under SpP1 | Prohibited, except under GPb  | Prohibited, except under SpP2 |
| OA     | Prohibited, except under SpP1 | Allowed                       | Allowed                       |

CA = control area; GP = general permit; OA = outside area; RA = restricted area; SpP = special permit

### Notes for Table 6.2

SpP1 conditions

- No evidence of clinical disease in pigs being moved.
- For movements originating in the RA:
  - Appropriate vector control is implemented to stop adult competent vectors travelling with the pigs.

- The livestock transport vehicle is cleaned and treated for vectors before and after use.
- Movement is directly to an agreed APF within the same RA.
- For movements originating in the CA or OA:
  - Movement is only permitted if there is no suitable APF in the CA or OA.
  - The livestock transport vehicle is cleaned and treated for vectors after use.
- Pigs are slaughtered within 24 hours.
- All pigs moving are individually identified and specified on the permit for traceability and other purposes.
- The permit accompanies the livestock during movement, and the person responsible for the livestock retains a copy of the permit, consistent with the legal requirements of the jurisdiction.

#### SpP2 conditions

- Only if there is no suitable APF in the RA of origin.
- Includes at least the conditions for SpP1.
- Subject to additional risk assessment; may include additional conditions to address risks of movement into or through the CA and OA.

#### GPb conditions

- No evidence of clinical disease in pigs being moved.
- Owner declaration that the pigs were born on the property, or resident on the property for the consecutive 42 days immediately before movement.
- All pigs moving are individually identified and specified on the permit for traceability and other purposes.
- Movement is directly to an abattoir.
- Pigs are slaughtered within 24 hours.
- The permit accompanies the pigs during movement, and the person responsible for the pigs retains a copy of the permit, consistent with the legal requirements of the jurisdiction.

### Dead-end hosts

Movements of other animal species that are susceptible to infection but considered dead-end hosts (eg horses, cattle, sheep, goats – see [Section 2.4.2](#)) should not be restricted for disease control purposes.

### Other known or potential amplifying hosts

Movement (by people) of other animals known or mooted to act as amplifying hosts (eg waterbirds, insectivorous bats, flying foxes, possums, reptiles) is uncommon but may occur for zoos and similar establishments. Movements of young chicks and ducks (under 8 weeks of age) may also pose a risk of transmission.

Proposed movements of these animals from premises in declared areas (RAs or CAs) should be subject to risk assessment, on a case-by-case basis. The risk assessment should take into consideration the likelihood that the animals may be viraemic at the time of the proposed movement, the potential for onward transmission and the consequences for disease control.

## 6.2.2 Carcasses

No restrictions apply to movement of carcasses because JEV is not transmitted via carcasses.

## 6.2.3 Semen and embryos from live susceptible animals

### Pig semen and embryos

Movement of pig semen and embryos off and onto quarantined premises (IPs, DCPs, SPs and TP) is prohibited.

Table 6.3 shows the requirements for movement of pig semen and embryos from other premises.

Movements of pig semen and embryos:

- off quarantined premises (IPs, DCPs, SPs and TP) are prohibited, because these are high-risk premises and it will be difficult to have confidence that the population is truly uninfected at the time of collection
- onto quarantined premises (IPs, DCPs, SPs and TP) are prohibited, because facilitating an increase in the number of susceptible hosts in the RA is not consistent with the objectives of disease control
- off ARPs in the RA are prohibited, because pigs are amplifying hosts and can develop viraemia within 24 hours of infection, without showing clinical signs; it will be difficult to have confidence that the population is truly uninfected at the time of collection, given that the pigs are in a high-risk area (RA)
- onto ARPs in the RA are prohibited, because facilitating an increase in the number of susceptible hosts in the RA is not consistent with the objectives of disease control
- off PORs in the CA are prohibited except under GPc (see Table 6.3); this requires attestation (and therefore some confidence) that pigs (potentially from what are now quarantined premises, or other premises within the RA) have not been introduced to the source premises in the previous 60 days.

Movements of pig semen and embryos that are otherwise prohibited may be considered, on a case-by-case basis and subject to risk assessment, if there is evidence that the semen or embryos were collected before the start of the outbreak, and have been handled and stored in a manner that would preclude contamination after collection.

**Table 6.3 Recommended movement controls for pig semen and embryos (other than from IPs, DCPs, SPs and TP)**

| To →<br>From ↓ | RA         | CA                           | OA                           |
|----------------|------------|------------------------------|------------------------------|
| RA (ARPs)      | Prohibited | Prohibited                   | Prohibited                   |
| CA(PORs)       | Prohibited | Prohibited, except under GPc | Prohibited, except under GPc |
| OA             | Prohibited | Allowed                      | Allowed                      |

ARP = at-risk premises; CA = control area; GP = general permit; OA = outside area; POR = premises of relevance; RA = restricted area



## Notes for Table 6.3

GPc conditions:

- Owner declaration that no pigs have been introduced to the property during the 42 days before collection of the semen or embryos.
- Evidence of an operational biosecurity manual, including maintenance of biosecurity procedures.
- Absence of clinical signs before and on the day of collection, and since that time.

Semen and embryos from other susceptible animals

- The use of semen and embryos from other animals known or mooted to act as amplifying hosts (eg waterbirds, insectivorous bats, flying foxes, possums, reptiles) is uncommon. Proposed movements of their semen and embryos from premises in declared areas (RAs or CAs) should be subject to risk assessment, on a case-by-case basis. The risk assessment should take into consideration the likelihood that the animals were viraemic at the time the semen or embryos were collected, the way in which the semen and embryos have been handled and stored (including the potential for any contamination with JEV post-collection), and the location of the intended recipient premises and animals.

### 6.2.4 Meat and meat products

Meat and meat products are not subject to movement restrictions.

### 6.2.5 Milk and dairy products

Milk and dairy products are not subject to movement restrictions.

### 6.2.6 Eggs and egg products

Eggs and egg products are not subject to movement restrictions.

### 6.2.7 Hides, skin, wool and other fibres

Hides, skin, wool and other fibres are not subject to movement restrictions.

### 6.2.8 Other animal byproducts

Movement of other animal byproducts (including blood-based products and tissues for transplantation) will need to be considered on a case-by-case basis, informed by risk assessment. The risk assessment should consider the likelihood that the byproduct may be infectious, the potential for exposure of susceptible animals or people, and the consequences of any such exposure. Factors that may inform the risk assessment include the origin of the byproduct, any processing undertaken or planned, and the proposed end use of the byproduct.

### 6.2.9 Waste products and effluent

Movement of waste products and effluent off premises with susceptible animals is not restricted.

### 6.2.10 Vehicles, including empty livestock transport vehicles, and associated equipment

Conditions for the movement of vehicles used to move pigs from premises in the RA are included in [Section 6.2.1](#).

Livestock transport vehicles (including empty vehicles) and equipment used with livestock should be cleaned and treated for vectors before moving off premises in the RA. Cleaning and treating for vectors involves removing manure before and after each load, then cleaning and treating with an appropriate insecticide that is effective against vectors. For details of appropriate insecticide treatments, refer to the **AUSVETPLAN operational manual *Decontamination***.

For movements of other vehicles from premises in the RA, care should be taken to avoid the concurrent transport of infected vectors.

No restrictions apply to movements of empty livestock transport vehicles and associated equipment off premises in the CA or OA, or to movements of vehicles not involved in the transport of livestock.

### 6.2.11 Nonsusceptible animals

Evidence of seroconversion to JEV has been found in a broad range of species, suggesting that most, if not all, species may be susceptible to infection. Movement controls for species that are reported to develop sufficient viraemia to be a source of infection are provided in [Section 6.2.1](#).

For movements of other animals, care must be taken to avoid the concurrent transport of infected vectors (see [Section 6.2.10](#)), but no other restrictions should apply.

### 6.2.12 People

No restrictions apply to the movement of people. [Section 4.3.5](#) provides guidance on the use of personal protective equipment for people at high risk of JEV exposure.

Care must be taken to avoid the transport of infected vectors with any movement of people off premises in the RA (see also [Section 6.2.10](#)).

### 6.2.13 Specimens

Specimens should be collected, packed and transported according to [Section 2.5.4](#).

### 6.2.14 Crops, grains, hay, silage and mixed feeds

No restrictions apply to the movements of grains, hay, silage and mixed feeds.

The movement of fresh crops from quarantined premises should be subject to risk assessment, on a case-by-case basis, taking into consideration the potential presence of infected vectors, the proposed destination and use of the crops, any vector control applied and any further processing that may occur.

### 6.2.15 Equipment, including personal items

Equipment that is contaminated with blood from infected, or potentially infected, animals on IPs, DCPs, SPs and TP should be cleaned before leaving the premises, or disposed of in a biosecure manner (eg through normal biohazard waste management). Although transmission of JEV by fomites is not usual, cleaning (or disposing of) such contaminated equipment minimises the likelihood of inadvertent exposure of people through needlestick or similar injury.



Chickens at country show on display for judging.

### 6.2.16 Sales, shows and other events

All sales, shows and other events (eg petting zoos) in the RA involving the congregation of pigs, or other animals known or mooted to act as amplifying hosts (waterbirds, chickens and ducks under 8 weeks of age, insectivorous bats, flying foxes, possums and reptiles) are prohibited. The conduct of these events in the CA will be under permit and subject to risk assessment on a case-by-case basis.

### 6.2.17 Stock routes and rights of way

The use by pigs of stock routes and rights of way in the RA is prohibited. The use by pigs of stock routes and rights of way in the CA will be under permit and subject to risk assessment on a case-by-case basis.

### 6.2.18 Animal movements for emergency (including welfare) reasons

Movements of animals that are otherwise prohibited may be considered on a case-by-case basis (informed by risk assessment) for emergency (including welfare) reasons. Examples are movements for emergency veterinary treatment and movements to different premises under the same ownership to manage feed availability. If allowed, such movements will be under SpP.

### 6.2.19 Other movements

Movements of other risk materials will need to be considered on a case-by-case basis, informed by risk assessment.

# 7

# Surveillance and proof of freedom

## 7.1 Surveillance

The key objectives and priorities for surveillance in response to an outbreak of Japanese encephalitis (JE) are outlined in [Section 4.3.3](#).

### 7.1.1 Specific considerations

Specific considerations for surveillance that are relevant for JE include the following:

- Existing surveillance programs for other diseases may contribute to surveillance for JE. Such programs include:
  - arbovirus and vector surveillance carried out under the National Arbovirus Monitoring Program; additional sampling for existing sentinel herds may be undertaken, or additional sentinel herds may be recruited
  - public health vector monitoring programs
  - structured surveillance schemes, in some states, which may provide sera for retrospective analysis.
- Public health surveillance for JE will be undertaken jointly by national, and state and territory public health authorities. Relevant data will be published in the fortnightly publication *Communicable Diseases Intelligence*.<sup>19</sup>
- Surveillance of potential (mosquito) vector species will be required (see [Section 4.3.15](#)).
- Surveillance of wild animal populations (eg feral pigs, known and potential wild animal reservoirs) may also be required to inform understanding of the distribution of infection (see [Section 4.3.14](#)).
- Most infected animals do not show clinical signs.
- The viraemic period in domestic animals is short, which may limit the opportunity for virus isolation.
- Serological surveillance may be useful in delimiting the extent of the incursion. However, cross-reactions with endemic flaviviruses may make interpretation of serological findings more difficult.

### 7.1.2 Premises surveillance

#### Domestic animals

##### Surveillance on suspect premises (SPs)

Any suspect cases of clinical disease in domestic animals must be investigated to establish the distribution of infection. Identification and isolation of virus should be attempted from suitable cases.

<sup>19</sup> [www.health.gov.au/cdi](http://www.health.gov.au/cdi)



Species of biting midges are monitoring using a network of light traps, NAMP.

Serology can also be conducted on sick animals and cohorts, with resampling 2 weeks later to confirm recent seroconversion to Japanese encephalitis virus (JEV).

#### **Surveillance on premises with epidemiological links to the outbreak (dangerous contact premises – DCPs, and trace premises – TPs)**

Animals should be examined for clinical signs of infection. Where clinical signs are present, surveillance as for SPs should be undertaken.

If there are no animals showing clinical signs of JE, serological surveillance should be undertaken to identify evidence of exposure to JEV.

#### **Surveillance on at-risk premises (ARPs) and premises of relevance (PORs)**

Surveillance on ARPs and PORs may provide early warning of JEV activity. The following discussion draws on a review by Ellis et al (2000).

In nonimmune horses, daily monitoring of rectal temperature may indicate virus activity. However, clinical disease is infrequent, so surveillance based on detection of clinical signs is unlikely to provide sufficient warning of an impending outbreak to allow preventive measures to be implemented. Further, because equine (and human) infection occurs after virus amplification, the virus may be well established in the area before fever (or other clinical signs) are detected. This also limits the value of serosurveillance in these species for early warning of virus activity.

The most practical animals to target for surveillance on ARPs and PORs (in effect, sentinel animals) are susceptible domestic species that become infected at an early stage in an outbreak, possibly as a result of their attractiveness or accessibility to feeding vectors. Pigs are the most sensitive domestic animal indicators of the presence of JEV and, if present on ARPs and PORs, should be targeted for surveillance.

Testing of young pigs is recommended; the ideal age is 3–12 months, to avoid cross-reactions with maternal antibodies in young piglets and with cross-reacting antibodies to endemic flaviviruses in older animals.

If pigs are not present on ARPs or PORs, species in which infection is usually inapparent (such as cattle, goats and dogs) may be useful for surveillance. Chickens usually show a low seroprevalence and are therefore less well suited as sentinel animals.

## 7.2 Proof of freedom

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Providing confidence that JEV is no longer present will be important to satisfy trading partners and regain access to international markets, and to support biosecurity controls to prevent the reintroduction of JE.

JE is a World Organisation for Animal Health (OIE)–listed disease. However, the OIE *Terrestrial animal health code* does not provide detailed requirements for the recognition of JE-free areas. General provisions relating to animal health surveillance can be found in Chapter 1.4 of the OIE Terrestrial Code.<sup>20</sup> Acceptance of a return to freedom following an outbreak will have to be negotiated with individual trading partners.

To provide evidence to support a declaration of freedom, a comprehensive surveillance program will be required. This will build on the surveillance, tracing and diagnostic testing done during the disease control phase. It will include surveillance in relevant domestic animals, feral pigs, other wild animal populations and vectors. The advice of entomologists, wildlife disease veterinarians, and other experts familiar with the ecology of vector and wild animal populations should be sought.

Specific recommendations for this surveillance will be developed using the technical expertise of competent and experienced epidemiologists, and will be based on the characteristics of the outbreak. The design of this program will also consider the recommendations in the OIE Terrestrial Code, and the specific considerations for JE surveillance outlined in [Section 7.1](#).

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20 [www.oie.int/international-standard-setting/terrestrial-code/access-online](http://www.oie.int/international-standard-setting/terrestrial-code/access-online)



# Glossary

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## Disease-specific terms

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|                                  |   |
|----------------------------------|---|
| <b>Arbovirus</b>                 | A virus carried by an arthropod such as a mosquito.   |
| <b>Encephalitis</b>              | Inflammation of the brain, often caused by viral infection.   |
| <b>Gilt</b>                      | A young female pig that has been selected to join the breeding herd but has not had her first litter.                                       |
| <b>Meningitis</b>                | Inflammation of the meninges (membranes surrounding the brain), often caused by viral infection.  |
| <b>Mummified fetus</b>           | Dry and shrivelled fetus resulting from the resorption of fluids from the placenta following death in the uterus.                           |
| <b>Nonsuppurative</b>            | Not pus producing.  |
| <b>Transovarial transmission</b> | Transmission of virus vertically between generations of vectors without a stage in a vertebrate host (particularly transmission into eggs). |

## Standard AUSVETPLAN terms

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|                                     |  |
|-------------------------------------|--|
| <b>Animal byproducts</b>            | Products of animal origin that are not for consumption but are destined for industrial use (eg hides and skins, fur, wool, hair, feathers, hoofs, bones, fertiliser).  |
| <b>Animal Health Committee</b>      | <p>A committee whose members are the chief veterinary officers of the Commonwealth, states and territories, along with representatives from the CSIRO Australian Centre for Disease Preparedness (ACDP) and the Department of Agriculture, Water and the Environment. There are also observers from Animal Health Australia, Wildlife Health Australia, and the New Zealand Ministry for Primary Industries. The committee provides advice to the National Biosecurity Committee on animal health matters, focusing on technical issues and regulatory policy.</p> <p><i>See also</i> National Biosecurity Committee</p> |
| <b>Animal products</b>              | Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff.  |
| <b>Approved disposal site</b>       | A premises that has zero susceptible livestock and has been approved as a disposal site for animal carcasses, or potentially contaminated animal products, wastes or things.   |
| <b>Approved processing facility</b> | An abattoir, knackery, milk processing plant or other such facility that maintains increased biosecurity standards. Such a facility could have animals or animal products introduced from lower-risk premises under a permit for processing to an approved standard.   |

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| <b>At-risk premises</b>                    | A premises in a restricted area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, dangerous contact premises, dangerous contact processing facility, suspect premises or trace premises.   |
| <b>Australian Chief Veterinary Officer</b> | The nominated senior veterinarian in the Australian Government Department of Agriculture, Water and the Environment who manages international animal health commitments and the Australian Government's response to an animal disease outbreak.<br><br><i>See also</i> Chief veterinary officer   |
| <b>AUSVETPLAN</b>                          | Australian Veterinary Emergency Plan. Nationally agreed resources that guide decision making in the response to emergency animal diseases (EADs). It outlines Australia's preferred approach to responding to EADs of national significance, and supports efficient, effective and coherent responses to these diseases.                            |
| <b>Carcase</b>                             | The body of an animal slaughtered for food.   |
| <b>Carcass</b>                             | The body of an animal that died in the field.   |
| <b>Chief veterinary officer (CVO)</b>      | The senior veterinarian of the animal health authority in each jurisdiction (national, state or territory) who has responsibility for animal disease control in that jurisdiction.<br><br><i>See also</i> Australian Chief Veterinary Officer   |
| <b>Compartmentalisation</b>                | The process of defining, implementing and maintaining one or more disease-free establishments under a common biosecurity management system in accordance with OIE guidelines, based on applied biosecurity measures and surveillance, to facilitate disease control and/or trade.   |
| <b>Compensation</b>                        | The sum of money paid by government to an owner for livestock or property that are destroyed for the purpose of eradication or prevention of the spread of an emergency animal disease, and livestock that have died of the emergency animal disease.<br><br><i>See also</i> Cost-sharing arrangements, Emergency Animal Disease Response Agreement |

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| <b>Consultative Committee on Emergency Animal Diseases (CCEAD)</b> | The key technical coordinating body for animal health emergencies. Members are state and territory chief veterinary officers, representatives of CSIRO-ACDP and the relevant industries, and the Australian Chief Veterinary Officer as chair.  |
| <b>Control area (CA)</b>   | A legally declared area where the disease controls, including surveillance and movement controls, applied are of lesser intensity than those in a restricted area (the limits of a control area and the conditions applying to it can be varied during an incident according to need).  |
| <b>Cost-sharing arrangements</b>                                   | <p>Arrangements agreed between governments (national and state/territory) and livestock industries for sharing the costs of emergency animal disease responses.</p> <p><i>See also</i> Compensation, Emergency Animal Disease Response Agreement</p>  |
| <b>Dangerous contact animal</b>                                    | A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation.  |
| <b>Dangerous contact premises (DCP)</b>                            | A premises, apart from an abattoir, knackery or milk processing plant (or other such facility) that, after investigation and based on a risk assessment, is considered to contain a susceptible animal(s) not showing clinical signs, but considered highly likely to contain an infected animal(s) and/or contaminated animal products, wastes or things that present an unacceptable risk to the response if the risk is not addressed, and that therefore requires action to address the risk. |
| <b>Dangerous contact processing facility (DCPF)</b>                | An abattoir, knackery, milk processing plant or other such facility that, based on a risk assessment, appears highly likely to have received infected animals, or contaminated animal products, wastes or things, and that requires action to address the risk.   |
| <b>Declared area</b>   | A defined tract of land that is subjected to disease control restrictions under emergency animal disease legislation. There are two types of declared areas: restricted area and control area.  |
| <b>Decontamination</b>   | Includes all stages of cleaning and disinfection.   |
| <b>Depopulation</b>  | The removal of a host population from a particular area to control or prevent the spread of disease.  |

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|  |   |
|--|---|
| <b>Destroy (animals)</b>                           | To kill animals humanely.   |
| <b>Disease agent</b>                               | A general term for a transmissible organism or other factor that causes an infectious disease.  |
| <b>Disease Watch Hotline</b>                       | 24-hour freecall service for reporting suspected incidences of exotic diseases – 1800 675 888.  |
| <b>Disinfectant</b>                                | A chemical used to destroy disease agents outside a living animal.  |
| <b>Disinfection</b>                                | The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; applies to premises, vehicles and different objects that may have been directly or indirectly contaminated.   |
| <b>Disinsectisation</b>                            | The destruction of insect pests, usually with a chemical agent.   |
| <b>Disposal</b>                                    | Sanitary removal of animal carcasses, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease.  |
| <b>Emergency animal disease</b>                    | <p>A disease that is (a) exotic to Australia or (b) a variant of an endemic disease or (c) a serious infectious disease of unknown or uncertain cause or (d) a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social or trade implications.</p> <p><i>See also</i> Endemic animal disease, Exotic animal disease</p>            |
| <b>Emergency Animal Disease Response Agreement</b> | <p>Agreement between the Australian and state/territory governments and livestock industries on the management of emergency animal disease responses. Provisions include participatory decision making, risk management, cost sharing, the use of appropriately trained personnel and existing standards such as AUSVETPLAN.</p> <p><i>See also</i> Compensation, Cost-sharing arrangements</p> |
| <b>Endemic animal disease</b>                      | <p>A disease affecting animals (which may include humans) that is known to occur in Australia.</p> <p><i>See also</i> Emergency animal disease, Exotic animal disease</p>   |
| <b>Enterprise</b>                                  | <i>See</i> Risk enterprise  |

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| <b>Enzyme-linked immunosorbent assay (ELISA)</b> | A serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen–antibody binding occurs.  |
| <b>Epidemiological investigation</b>             | An investigation to identify and qualify the risk factors associated with the disease.<br><br><i>See also</i> Veterinary investigation   |
| <b>Epidemiology</b>                              | The study of disease in populations and of factors that determine its occurrence.  |
| <b>Exotic animal disease</b>                     | A disease affecting animals (which may include humans) that does not normally occur in Australia.<br><br><i>See also</i> Emergency animal disease, Endemic animal disease  |
| <b>Exotic fauna/feral animals</b>                | <i>See</i> Wild animals  |
| <b>Fomites</b>                                   | Inanimate objects (eg boots, clothing, equipment, instruments, vehicles, crates, packaging) that can carry an infectious disease agent and may spread the disease through mechanical transmission.   |
| <b>General permit</b>                            | A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which permission may be granted without the need for direct interaction between the person moving the animal(s), commodity or thing and a government veterinarian or inspector. The permit may be completed via a webpage or in an approved place (such as a government office or commercial premises). A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements.<br><br><i>See also</i> Special permit |
| <b>In-contact animals</b>                        | Animals that have had close contact with infected animals, such as noninfected animals in the same group as infected animals.  |
| <b>Incubation period</b>                         | The period that elapses between the introduction of a pathogen into an animal and the first clinical signs of the disease.   |

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| <b>Index case</b>                      | The first case of the disease to be diagnosed in a disease outbreak.<br><br><i>See also</i> Index property   |
| <b>Index property</b>                  | The property on which the index case is found.<br><br><i>See also</i> Index case   |
| <b>Infected premises (IP)</b>          | A defined area (which may be all or part of a property) on which animals meeting the case definition are or were present, or the causative agent of the emergency animal disease is present, or there is a reasonable suspicion that either is present, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.  |
| <b>Local control centre</b>            | An emergency operations centre responsible for the command and control of field operations in a defined area.  |
| <b>Monitoring</b>                      | Routine collection of data for assessing the health status of a population or the level of contamination of a site for remediation purposes.<br><br><i>See also</i> Surveillance   |
| <b>Movement control</b>                | Restrictions placed on the movement of animals, people and other things to prevent the spread of disease.  |
| <b>National Biosecurity Committee</b>  | A committee that was formally established under the Intergovernmental Agreement on Biosecurity (IGAB). The IGAB was signed on 13 January 2012, and signatories include all states and territories except Tasmania. The committee provides advice to the Agriculture Senior Officials Committee and the Agriculture Ministers' Forum on national biosecurity issues, and on the IGAB.   |
| <b>National Management Group (NMG)</b> | A group established to approve (or not approve) the invoking of cost sharing under the Emergency Animal Disease Response Agreement. NMG members are the Secretary of the Australian Government Department of Agriculture, Water and the Environment as chair; the chief executive officers of the state and territory government parties; and the president (or analogous officer) of each of the relevant industry parties. |
| <b>Native wildlife</b>                 | <i>See</i> Wild animals  |

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| <b>OIE Terrestrial Code</b>            | OIE <i>Terrestrial Animal Health Code</i> . Describes standards for safe international trade in animals and animal products. Revised annually and published on the internet at: <a href="http://www.oie.int/international-standard-setting/terrestrial-code/access-online">www.oie.int/international-standard-setting/terrestrial-code/access-online</a> .  |
| <b>OIE Terrestrial Manual</b>          | OIE <i>Manual of diagnostic tests and vaccines for terrestrial animals</i> . Describes standards for laboratory diagnostic tests, and the production and control of biological products (principally vaccines). The current edition is published on the internet at: <a href="http://www.oie.int/en/standard-setting/terrestrial-manual/access-online">www.oie.int/en/standard-setting/terrestrial-manual/access-online</a> . |
| <b>Operational procedures</b>          | Detailed instructions for carrying out specific disease control activities, such as disposal, destruction, decontamination and valuation.   |
| <b>Outside area (OA)</b>               | The area of Australia outside the declared (control and restricted) areas.  |
| <b>Owner</b>                           | Person responsible for a premises (includes an agent of the owner, such as a manager or other controlling officer).   |
| <b>Polymerase chain reaction (PCR)</b> | A method of amplifying and analysing DNA sequences that can be used to detect the presence of viral DNA.  |
| <b>Premises</b>                        | A tract of land including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.   |
| <b>Premises of relevance (POR)</b>     | A premises in a control area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, suspect premises, trace premises, dangerous contact premises or dangerous contact processing facility.  |
| <b>Prevalence</b>                      | The proportion (or percentage) of animals in a particular population affected by a particular disease (or infection or positive antibody titre) at a given point in time.   |
| <b>Proof of freedom</b>                | Reaching a point following an outbreak and post-outbreak surveillance when freedom from the disease can be claimed with a reasonable level of statistical confidence.   |
| <b>Quarantine</b>                      | Legally enforceable requirement that prevents or minimises spread of pests and disease agents by controlling the movement of animals, persons or things.  |

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| <b>Resolved premises (RP)</b>    | An infected premises, dangerous contact premises or dangerous contact processing facility that has completed the required control measures, and is subject to the procedures and restrictions appropriate to the area in which it is located.   |
| <b>Restricted area (RA)</b>      | A relatively small legally declared area around infected premises and dangerous contact premises that is subject to disease controls, including intense surveillance and movement controls.   |
| <b>Risk enterprise</b>           | A defined livestock or related enterprise that is potentially a major source of infection for many other premises. Includes intensive piggeries, feedlots, abattoirs, knackeries, saleyards, calf scales, milk factories, tanneries, skin sheds, game meat establishments, cold stores, artificial insemination centres, veterinary laboratories and hospitals, road and rail freight depots, showgrounds, field days, weighbridges and garbage depots. |
| <b>Sensitivity</b>               | The proportion of truly positive units that are correctly identified as positive by a test.<br><br><i>See also</i> Specificity  |
| <b>Sentinel animal</b>           | Animal of known health status that is monitored to detect the presence of a specific disease agent.   |
| <b>Seroconversion</b>            | The appearance in the blood serum of antibodies (as determined by a serology test) following vaccination or natural exposure to a disease agent.  |
| <b>Serosurveillance</b>          | Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.   |
| <b>Serotype</b>                  | A subgroup of microorganisms identified by the antigens carried (as determined by a serology test).   |
| <b>Serum neutralisation test</b> | A serological test to detect and measure the presence of antibody in a sample. Antibody in serum is serially diluted to detect the highest dilution that neutralises a standard amount of antigen. The neutralising antibody titre is given as the reciprocal of this dilution.   |
| <b>Slaughter</b>                 | The humane killing of an animal for meat for human consumption.   |

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| <b>Special permit</b>            | <p>A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which the person moving the animal(s), commodity or thing must obtain prior written permission from the relevant government veterinarian or inspector. A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements.</p> <p><i>See also</i> General permit</p> |
| <b>Specificity</b>               | <p>The proportion of truly negative units that are correctly identified as negative by a test.</p> <p><i>See also</i> Sensitivity</p>  |
| <b>Stamping out</b>              | <p>The strategy of eliminating infection from premises through the destruction of animals in accordance with the particular AUSVETPLAN manual, and in a manner that permits appropriate disposal of carcasses and decontamination of the site.</p>   |
| <b>State coordination centre</b> | <p>The emergency operations centre that directs the disease control operations to be undertaken in a state or territory.</p>   |
| <b>Surveillance</b>              | <p>A systematic program of investigation designed to establish the presence, extent or absence of a disease, or of infection or contamination with the causative organism. It includes the examination of animals for clinical signs, antibodies or the causative organism.</p>  |
| <b>Susceptible animals</b>       | <p>Animals that can be infected with a particular disease.</p>   |
| <b>Suspect animal</b>            | <p>An animal that may have been exposed to an emergency disease such that its quarantine and intensive surveillance, but not pre-emptive slaughter, is warranted.</p> <p>or</p> <p>An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.</p>  |
| <b>Suspect premises (SP)</b>     | <p>Temporary classification of a premises that contains a susceptible animal(s) not known to have been exposed to the disease agent but showing clinical signs similar to the case definition, and that therefore requires investigation(s).</p>   |

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**Swill**

Also known as 'prohibited pig feed', means material of mammalian origin, or any substance that has come in contact with this material, but does not include:

- i. Milk, milk products or milk by-products either of Australian provenance or legally imported for stockfeed use into Australia.
- ii. Material containing flesh, bones, blood, offal or mammal carcasses which is treated by an approved process.<sup>1</sup>
- iii. A carcass or part of a domestic pig, born and raised on the property on which the pig or pigs that are administered the part are held, that is administered for therapeutic purposes in accordance with the written instructions of a veterinary practitioner.
- iv. Material used under an individual and defined-period permit issued by a jurisdiction for the purposes of research or baiting.

<sup>1</sup> In terms of (ii), approved processes are:

1. rendering in accordance with the 'Australian Standard for the Hygienic Rendering of Animal Products'
2. under jurisdictional permit, cooking processes subject to compliance verification that ensure that a core temperature of at least 100°C for a minimum of 30 minutes, or equivalent, has been reached.
3. treatment of cooking oil, which has been used for cooking in Australia, in accordance with the 'National Standard for Recycling of Used Cooking Fats and Oils intended for Animal Feeds'
4. under jurisdictional permit, any other nationally agreed process approved by AHC for which an acceptable risk assessment has been undertaken and that is subject to compliance verification.

The national definition is a minimum standard. Some jurisdictions have additional conditions for swill feeding that pig producers in those jurisdictions must comply with, over and above the requirements of the national definition.

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| <b>Swill feeding</b>                | <p>Also known as ‘feeding prohibited pig feed’, it includes:</p> <ul style="list-style-type: none"> <li>• feeding, or allowing or directing another person to feed, prohibited pig feed to a pig</li> <li>• allowing a pig to have access to prohibited pig feed</li> <li>• the collection and storage or possession of prohibited pig feed on a premises where one or more pigs are kept</li> <li>• supplying to another person prohibited pig feed that the supplier knows is for feeding to any pig.</li> </ul> <p>This definition was endorsed by the Agriculture Ministers’ Council through AGMIN OOS 04/2014.</p> |
| <b>Trace premises (TP)</b>          | Temporary classification of a premises that contains susceptible animal(s) that tracing indicates may have been exposed to the disease agent, or contains contaminated animal products, wastes or things, and that requires investigation(s).   |
| <b>Tracing</b>                      | The process of locating animals, people or other items that may be implicated in the spread of disease, so that appropriate action can be taken.  |
| <b>Unknown status premises (UP)</b> | A premises within a declared area where the current presence of susceptible animals and/or risk products, wastes or things is unknown.  |
| <b>Vaccination</b>                  | Inoculation of individuals with a vaccine to provide active immunity.   |
| <b>Vaccine</b>                      | A substance used to stimulate immunity against one or several disease-causing agents to provide protection or to reduce the effects of the disease. A vaccine is prepared from the causative agent of a disease, its products or a synthetic substitute, which is treated to act as an antigen without inducing the disease.  |
| <b>– adjuvanted</b>                 | A vaccine in which one or several disease-causing agents are combined with an adjuvant (a substance that increases the immune response).  |
| <b>– attenuated</b>                 | A vaccine prepared from infective or ‘live’ microbes that are less pathogenic but retain their ability to induce protective immunity.   |
| <b>– gene deleted</b>               | An attenuated or inactivated vaccine in which genes for non-essential surface glycoproteins have been removed by genetic engineering. This provides a useful immunological marker for the vaccine virus compared with the wild virus.   |

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| <b>– inactivated</b>   | A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment.  |
| <b>– recombinant</b>   | A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect.   |
| <b>Vector</b>  | A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A biological vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A mechanical vector is one that transmits an infectious agent from one host to another but is not essential to the lifecycle of the agent. |
| <b>Veterinary investigation</b>  | An investigation of the diagnosis, pathology and epidemiology of the disease.<br><br>See also Epidemiological investigation  |
| <b>Viraemia</b>  | The presence of viruses in the blood.  |
| <b>Wild animals</b><br><b>– native wildlife</b><br><b>– feral animals</b><br><b>– exotic fauna</b> | Animals that are indigenous to Australia and may be susceptible to emergency animal diseases (eg bats, dingoes, marsupials).<br><br>Animals of domestic species that are not confined or under control (eg cats, horses, pigs).<br><br>Nondomestic animal species that are not indigenous to Australia (eg foxes).   |
| <b>Wool</b>  | Sheep wool.  |
| <b>Zero susceptible species premises (ZP)</b>  | A premises that does not contain any susceptible animals or risk products, wastes or things.   |
| <b>Zoning</b>  | The process of defining, implementing and maintaining a disease-free or infected area in accordance with OIE guidelines, based on geopolitical and/or physical boundaries and surveillance, to facilitate disease control and/or trade.  |
| <b>Zoonosis</b>  | A disease of animals that can be transmitted to humans.  |



# Abbreviations

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## Disease-specific terms

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|            |                               |
|------------|-------------------------------|
| <b>CNS</b> | central nervous system        |
| <b>JE</b>  | Japanese encephalitis         |
| <b>JEV</b> | Japanese encephalitis virus   |
| <b>PNG</b> | Papua New Guinea              |
| <b>PPE</b> | personal protective equipment |

## Standard AUSVETPLAN abbreviations

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|                   |  |
|-------------------|--|
| <b>ACDP</b>       | Australian Centre for Disease Preparedness                   |
| <b>AN</b>         | assessed negative  |
| <b>ARP</b>        | at-risk premises   |
| <b>AUSVETPLAN</b> | Australian Veterinary Emergency Plan                         |
| <b>CA</b>         | control area   |
| <b>CCEAD</b>      | Consultative Committee on Emergency Animal Diseases          |
| <b>CSIRO</b>      | Commonwealth Scientific and Industrial Research Organisation |
| <b>CVO</b>        | chief veterinary officer                                     |
| <b>DCP</b>        | dangerous contact premises                                   |
| <b>DCPF</b>       | dangerous contact processing facility                        |
| <b>EAD</b>        | emergency animal disease                                     |

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| <b>EADRA</b> | Emergency Animal Disease Response Agreement                     |
| <b>EADRP</b> | Emergency Animal Disease Response Plan                          |
| <b>EDTA</b>  | ethylenediaminetetraacetic acid (anticoagulant for whole blood) |
| <b>ELISA</b> | enzyme-linked immunosorbent assay                               |
| <b>GP</b>    | general permit  |
| <b>IETS</b>  | International Embryo Transfer Society                           |
| <b>IP</b>    | infected premises   |
| <b>LCC</b>   | local control centre  |
| <b>NMG</b>   | National Management Group                                       |
| <b>OA</b>    | outside area  |
| <b>OIE</b>   | World Organisation for Animal Health                            |
| <b>PCR</b>   | polymerase chain reaction                                       |
| <b>POR</b>   | premises of relevance   |
| <b>RA</b>    | restricted area   |
| <b>RP</b>    | resolved premises   |
| <b>SCC</b>   | state coordination centre                                       |
| <b>SP</b>    | suspect premises  |
| <b>SpP</b>   | special permit  |
| <b>TP</b>    | trace premises  |
| <b>UP</b>    | unknown status premises   |
| <b>ZP</b>    | zero susceptible stock premises                                 |

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