AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

1998

Disease Strategy

Japanese encephalitis

AUSVETPLAN is a series of technical response plans that describe the proposed Australian approach to an exotic animal disease incursion. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.

Agriculture and Resources Management Council of Australia and New Zealand

This Disease Strategy forms part of:

AUSVETPLAN Edition 2.0, 1996

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This strategy will be reviewed regularly. Suggestions and recommendations for amendments should be forwarded to the AUSVETPLAN Coordinator (see Preface).

Record of amendments to this manual:

[Insert record of amendments as necessary]

PREFACE

This **Disease Strategy** for the control and eradication of **Japanese encephalitis** is an integral part of the **Australian Veterinary Emergency Plan**, or AUSVETPLAN (Edition 2.0). AUSVETPLAN structures and functions are described in the **Summary Document**.

This strategy sets out the disease control principles that were approved by the Australian Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) in session on February 27 1998**,** for use in a veterinary emergency caused by the introduction of Japanese encephalitis. There are serious human health implications with this disease and how these are handled is beyond the scope of this manual (ie the responsibility of health authorities).

Japanese encephalitis is designated as a List B disease by the Office International des Epizooties (OIE). List B diseases are, 'Communicable diseases which are considered to be of socioeconomic and/or public health importance within countries and which are significant in the international trade of animals and animal products. The principles contained in this document for the diagnosis and management of an outbreak of Japanese encephalitis conform with the **OIE International Animal Health Code 1992** (OIE Code; see Appendix 3).

Japanese encephalitis is not included in the Commonwealth/States cost-sharing agreement for the eradication of certain exotic diseases.

Detailed instructions for the field implementation of the strategies are contained in the AUSVETPLAN **Operational Procedures Manuals** and **Management Manuals.** Cross reference to strategies, manuals and other AUSVETPLAN documents are expressed in the form:

> Document Name, Section no.
> For example, **Decontamination Manual, Section 3**.

In addition, *Exotic Diseases of Animals: A Field Guide for Australian Veterinarians* by W.A. Geering, A.J. Forman and M.J. Nunn, Australian Government Publishing Service, Canberra, 1995 (**Exotic Diseases Field Guide**) is a source for some of the information about the aetiology, diagnosis and epidemiology of the disease and should be read in conjunction with this strategy.

This strategy will be reviewed regularly. Suggestions and recommendations for amendments should be forwarded to:

The AUSVETPLAN Coordinator
Animal Diseases/Incidents Section
Livestock and Pastoral Division
Department of Primary Industries and Energy
GPO Box 858
Canberra ACT 2601
Tel: (02) 6272 5540; Fax: (02) 6272 3372

Membership of writing group

Andrew Turner (convenor)	Department of Natural Resources and Environment, Vic
Rod Hoare	NSW Agriculture, NSW
Ian Douglas	Department of Primary Industries, Qld
Hugh Millar	Department of Natural Resources and Environment, Vic
Peter Daniels	CSIRO, Australian Animal Health Laboratory, Vic
Jeffrey Hanna	Queensland Health, Cairns, Qld
Chris Bunn	Department of Primary Industries and Energy (Cwlth), ACT
Patricia Ellis	Department of Natural Resources and Environment, Vic

The writing group was responsible for drafting this strategy. However, the text may have been amended at various stages of the consultation/approval process and the policies expressed in this version do not necessarily represent the views of all members of the writing group. Contributions may also have been made by other people not listed above and the assistance of all involved is gratefully acknowledged.

CONTENTS

1 NATURE OF THE DISEASE

Japanese encephalitis (JE) is an acute arbovirus disease affecting mainly pigs, horses and humans. JE infection causes abortion, stillbirths or mummified foetuses in sows, and fever and encephalitis with deaths in piglets, horses and humans.

1.1 Aetiology

JE is caused by infection with JE virus which is a member of the genus *Flavivirus* of the family Flaviviridae. Murray valley encephalitis (MVE) virus, which is endemic in Australia and associated with Australian encephalitis, is closely related to, but distinct from JE virus. A second flavivirus, Kunjin virus, has also been shown to be an aetiological agent of Australian encephalitis, although in milder form than MVE.

1.2 Susceptible species

Waterbirds (herons and egrets) are the main reservoir for spreading the JE virus. Pigs and waterbirds are important amplifying hosts. Infection in humans and horses may cause severe and often fatal encephalitis, but these species are incidental hosts. Inapparent infections occur in cattle, sheep, goats, dogs, cats, rodents, snakes and frogs.

Several species of bat are susceptible to JE.

The susceptibility of Australian native fauna is not known.

1.3 World distribution and occurrence in Australia

JE occurs in widely dispersed areas in eastern Asia. It is present in Japan, Korea, the eastern provinces of the Russian Federation, China, Taiwan, Thailand, the Lao PDR, Cambodia, Vietnam, the Philippines, Malaysia, Indonesia, Myanmar, Bangladesh, India, Sri Lanka, Nepal and Guam. There is serological evidence of possible JE infection in humans and pigs in south western Papua New Guinea. In 1995, clinical, virological and serological evidence was obtained of the presence of JE on the islands of western and northwestern Torres Strait.

In the past, JE and MVE viruses have been regarded as occurring in mutually exclusive geographical zones, with the border between them coinciding approximately with Wallace's line, which separates the oriental and Australasian biogeographical realms. However, in early 1995 clinical and serological evidence was obtained of the presence of JE in the Torres Strait (Hanna et al 1996). JE virus was isolated from human cases of encephalitis on Badu Island and serological testing confirmed the presence of antibody in dogs, pigs, horses and humans on this and some other islands. *Culex annulirostris* was demonstrated to be the likely vector in the Torres Strait.

It is estimated that world-wide some 50 000 human cases of JE occur each year, and that about one-quarter of these are fatal.

1.4 Diagnostic criteria

[For terms not defined in the text see Glossary]

JE can be suspected on the basis of clinical history, but laboratory support is required to confirm a diagnosis.

1.4.1 Clinical signs

Pigs

Adult non-pregnant pigs show no overt signs of infection. However, pregnant sows may abort, produce mummified foetuses or give birth to stillborn or weak piglets at term. Central nervous system signs, indicative of encephalitis, are occasionally seen in pigs up to six months of age.

At the time of first detection in the Torres Strait, between 33% and 100% of pigs on the affected islands had developed antibody to JE without clinical disease.

Horses

Most infections are without clinical signs. Three clinical syndromes are described:

- *transient type* — fever up to 40ºC for 2–3 days, with anorexia, sluggish movement, congested or jaundiced mucous membranes and uneventful recovery;
- *lethargic type* — fluctuating fever up to 41ºC with pronounced lethargy, loss of appetite, difficulty in swallowing, jaundice, petechial haemorrhages in visible mucous membranes, incoordination, staggering and falling, transient neck rigidity and radial paralysis, and usually recovery within a week; and
- *hyperexcitable type* — high fever, with aimless wandering, violent and demented behaviour, blindness, profuse sweating, muscle trembling, collapse and death.

The mortality rate in clinically-affected horses is generally about 5% but may be as high as 30 – 40% in severe outbreaks.

Sheep, cattle, goats

Inapparent infections occur in cattle, sheep and goats.

Humans

Most human infections are asymptomatic. Mild cases present with fever and headache or as aseptic meningitis. Severe illness begins with a non-specific prodrome lasting several days, followed by an abrupt onset of high fever, chills, severe headache, meningismus, sensitivity to light, nausea, vomiting, abdominal pains, dizziness, restlessness, hyperexcitability, or drowsiness. Convulsions occur more frequently in children than adults. As the disease progresses, objective neurological signs appear, including cranial nerve palsies, tremors, loss of coordination, rigidity and Parkinsonian manifestations, abnormal reflexes, and upper motor neurone paralysis, most commonly of the upper extremities.

From 0.4% to 5% infections result in typical encephalitis with a fatality rate among these cases of approximately 25%. A proportion (about 30%) of survivors have varying degrees of ongoing and usually severe neuropsychiatric problems. In pregnant women infected during the first or second trimester, spontaneous abortion and foetal death have been documented and the virus has been isolated from the conceptus. The risk of congenital infection in the third trimester is uncertain.

The prevalence of people with antibody in endemic areas varies from 15% to 40%.

1.4.2 Pathology

Gross lesions

There are no characteristic gross lesions in animals or aborted foetuses.

Microscopic lesions

There is a diffuse non-suppurative inflammation of the brain and spinal chord with phagocytic destruction of nerve cells and a clustering of glial cells, perivascular cuffing, and engorged blood vessels containing many mononuclear cells. Death of Purkinje cells in the cerebellum is pronounced. There are no inclusion bodies.

1.4.3 Laboratory tests

The determination by serology of a recent infection requires demonstration of a four-fold rise in the titre of JE specific antibody. Infection can be diagnosed by either isolation of the JE virus, or detection of JE specific antibody. However, to support a diagnosis of disease, isolation of the virus should be consistent with the observed clinical signs and epidemiological considerations.

Most JE infections occur without clinical signs. 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 haemagglutination inhibition (HI) test will give cross-reactions between JE and the dengue viruses. Within the JE serogroup, Australia has five endemic viruses, MVE, Kunjin (KUN), Kokobera, Stratford and Alfuy. It is not known to what extent cross-reactions may occur between antibody to JE infection and infections with the related Australian viruses, particularly in situations where multiple infections have occurred. Hence determination of specificity for JE antibody is currently based on comparison of results using JE, MVE and KUN antigens. Tests performed two to four weeks after an initial test, to detect rising titres, may assist in clarifying the principal infecting virus. The definitive test of highest specificity currently is the serum neutralisation test.

A presumptive diagnosis of recent infection could be made serologically by detection of virus specific IgM, if only one serum was available from an animal. The results of single samples should be validated by the collection of further samples to confirm infection at a site or in an area.

The diagnostic tests currently available in Australia are shown in Table 1.

Virus identification

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

Table 1 Diagnostic tests currently available at Australian laboratories for Japanese encephalitis

Test	Specimen required	Test detects	Time taken to obtain a result
Virus isolation and identification[1]	whole blood, CNS tissue	virus	2 – 3 weeks
Flavivirus C-ELISA	serum	antibodies to the flaviviruses	1 day
Serum neutralisation test	serum	neutralising antibody to specific flaviviruses, (ie JE, MVE, KUN)	1 week
JE, 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[2]	2 days
IgM C-ELISA[3]	serum	JE IgM antibody	1 day
Histopathology	formalin-fixed tissues (especially CNS and aborted foetuses)	microscopic changes	2 days
Immunohisto-chemistry	formalin-fixed or fresh tissue (especially CNS and porcine foetuses)	viral antigens in tissue	3 days

1 Isolates subjected to ELISA or HI tests to identify the virus as a flavivirus and serum neutralisation to confirm the virus as JE (PCR for JE is an experimental test in Australian laboratories.)

2 Does not reliably differentiate between antibodies to JE and MVE in all situations

3 Test of choice for rapid diagnosis of infected humans

Animal specimens required

Postmortem specimens should be collected from clinically-affected animals 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 a range of brain tissue specimens collected into sterile containers. A full range of tissues (including brain, aborted foetuses, 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 prior to shipment to prevent haemolysis. Both clot and serum should be submitted.

Transport of specimens

Unpreserved tissue specimens and serum should be chilled and forwarded to AAHL on water ice or with frozen gel packs. If delays in transit of 48 hours or more are anticipated, specimens should be frozen and forwarded on dry ice. For further information see **Laboratory Preparedness Manual, Section 6 and Appendix 3**.

1.4.4 Differential diagnosis

Disease outbreaks in pigs characterised by abortions, foetal mummification or stillbirths, and encephalitis in pigs to 6 months of age, or disease outbreaks in horses characterised by fever, jaundice or nervous signs of depression and incoordination or hyper-excitability should be considered as possible JE infections.

Diseases that should be considered in the differential diagnosis for the following species are:

Pigs
Aujeszky's disease
classical swine fever
haemagglutinating encephalomyelitis
leptospirosis
porcine polioencephalomyelitis (either talfan or Teschen type)
porcine parvovirus
porcine reproductive and respiratory disease
salmonellosis
salt poisoning

Horses
arsenic poisoning
Australian encephalitis
Borna disease
botulism
equine encephalosis
equine herpesvirus 1 (neurological form)
equine infectious anaemia
equine viral encephalomyelitis
hepatic encephalopathy (eg *Crotalaria* plant poisoning or post-vaccine hepatitis)
Indigophera plant poisoning
rabies
tetanus

Humans
In humans, the clinical signs of JE are diverse, and the differential diagnosis should include the other viral meningitides and encephalitides, including Australian encephalitis

It is particularly important that malaria be considered in any patient presenting with a febrile illness within 12 months of leaving a malarious area.

1.5 Resistance and immunity

JE virus infects a very wide range of animal species without causing disease.

1.5.1 Innate and passive immunity

There are probably few species in endemic countries innately resistant to infection.

Passive immunity is transferred from dam to offspring in colostrum and lasts two to three months. 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.

1.5.2 Active immunity

A high level of immunity is produced in animals following infection with the virus. This immunity is reported to be lifelong.

1.5.3 Vaccination

Pigs

In countries where the disease is endemic, inactivated and attenuated ('live') virus vaccines are available. Protective immunity develops in pigs within 14–21 days of vaccination with a single dose of the attenuated vaccine. Piglets under 4 months should receive a second dose of attenuated virus vaccine after an interval of 4 weeks (this is in order to ensure vaccination of all pigs as maternal immunity will be variable in the early stages of an outbreak). Immunity for 2 years is claimed but an annual booster vaccination is recommended. The vaccine is administered in a 1 mL dose, subcutaneously in the neck.

The attenuated virus vaccine is considered safe for administration to pregnant sows and the vaccine strain does not spread between animals.

Vaccine manufacturers have advised that three 10 mL doses of inactivated vaccine are required to produce protective immunity in pigs. A recent unpublished trial in Queensland demonstrated that two 10 mL doses of inactivated vaccine (see appendix 5) given one month apart produced protective immunity in only one of six pigs vaccinated (I Douglas pers comm). Inactivated vaccines alone therefore cannot be relied upon to produce protective immunity in pigs.

An alternate regime is to use an attenuated or inactivated combination of vaccinations in series (see Section 2.2.9). This enables the dose of inactivated vaccine to be reduced to 2 mL when used as a booster to an initial attenuated virus vaccination.

Horses

A formalin-inactivated tissue culture vaccine prepared from pig kidney cells infected with JE virus derived from the Beijing strain is commercially available and widely used in Japan and Asia. The primary course consists of two doses each of 1 mL administered subcutaneously in the neck with an interval of 4 weeks between each vaccination. A booster dose of 1 mL is injected annually. For maximum protection it is recommended that vaccination be scheduled so that the primary course is completed before the epizootic season for JE (see section 1.6). Inactivated vaccines are also used in Hong Kong and Singapore to protect racehorses, all of which are imported from non-endemic areas. A marked decline in the incidence of clinical disease in horses has been noted in Japan, Singapore and Hong Kong following the introduction of vaccination. Apart from an occasional transient local reaction at the site of injection, no side effects have been reported.

An attenuated vaccine has been used in China in more than 500 000 horses with a seroconversion rate of 80–90% after a single dose. Foals born to immunised mares acquired maternal antibodies which persisted for 4–5 months and interfered with active immunisation. In Korea, foals inoculated intramuscularly with a vaccine of the Anyang strain attenuated in chick embryo fibroblast cells developed solid immunity and showed no adverse reactions. Foals with maternal antibody at a serum neutralising antibody titre of less than 320 international units also acquired solid immunity after a single inoculation.

Humans

The JE vaccine currently available for human use in Australia is a highly purified formalin-inactivated virus preparation derived from mouse brain, but side effects have been reported (allergic reactions). Studies by USA and UK workers have shown that three doses are required for the development of protective antibody levels in vaccinees who are not continually exposed to the virus from birth. Neutralising antibody sufficient for protection developed in 99% of vaccinees after three doses but in only 89% of those who received two doses. The antibody level after two doses also declined substantially over a period of 6–12 months. A series of three doses of 1 mL each is therefore given subcutaneously on days 0, 7 and 28. Children from 1 to 3 years of age are given doses of 0.5 mL. The vaccine is not used in children under 1 year. Booster doses should be considered after 1 to 2 years in individuals who remain at risk. For further information on indications, contraindications and possible adverse effects, see the Australian Immunisation Handbook (NHMRC 1997).

1.6 Epidemiology

In the northern temperate areas of Asia, the disease occurs principally in late summer and autumn. *Culex tritaeniorhynchus*, a mosquito that breeds in rice paddies, fish ponds and ditches is the main insect vector. Infection builds up in waterbirds (principally the black-crowned night heron) and then in pigs in late spring and early summer, and finally spills over to humans and horses. Although cases in both humans and horses tend to be sporadic or occur in small clusters, particularly during the monsoonal seasons, serious outbreaks may occur at irregular intervals of several years when a high level of susceptibility develops in populations. Major epidemics have also occurred when the virus spreads into new areas, as it did in the Indian subcontinent in the late 1970s. The overwintering mechanism for the virus has not been elucidated. It may involve transovarial transmission in the insect or infection of other vertebrate hosts such as bats, frogs or snakes. Either or both mechanisms may operate.

In tropical areas, the virus circulates more or less continuously between mosquitoes, birds and pigs. There are a number of mosquito vectors, but *Cx tritaeniorhynchus, Cx vishnui* and *Cx gelidus* are the principal ones. Several Asian species of bats are susceptible to JE. Viraemia lasts for 6 days or more and is sufficient to infect mosquitoes.

Serological surveys of feral pigs and grey and red kangaroos after the 1974 outbreak of MVE demonstrated the continuing presence of animals with MVE antibody. No new infections were observed. Although erratic results have been obtained in laboratory inoculation studies, significant viraemias have been demonstrated. For example, feral and domestic rabbits have been demonstrated to maintain high titred viraemias even in the presence of high titres of MVE antibody (Marshall 1986). Recent studies on possums from northern Australia have demonstrated MVE antibody (Azuolas, pers comm.), and this is also the case for many marsupials in northern Australia (J MacKenzie, University of Queensland pers comm.). Australian native fauna could thus prove to be significant hosts for JE virus and the capacity of these animals as amplifiers needs to be determined.

Of the domestic animals, the pig is the most sensitive animal. Dogs and ducks are considered to be of intermediate sensitivity and horses and chickens are classified as having low sensitivity. These sensitivities apply to the level of viraemia and are not relevant to the question of surveillance, which depends on detection of serological reactors. Where serological results are obtained from single samples it is important that further samples are collected to validate infection at a site or in a new area.

1.6.1 Incubation period

Livestock

In pigs, 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).

In horses, the incubation period is from 8–10 days, with subsequent signs lasting 4–9 days.

In herons, there is a viraemia of 3–5 days duration commencing on the first or second day after inoculation (Boyle et al 1983).

Humans

The incubation period is 6–16 days.

Bats

Artificial hibernation studies 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.

1.6.2 Persistence of virus

The virus cannot persist in the environment outside mosquitoes and vertebrate hosts.

1.6.3 Modes of Transmission

General properties/environment

There is no evidence that JE is naturally transmitted directly from animal to animal, although for pigs, infection has been transmitted by the semen of experimentally-infected boars (Habu et al 1977). Environmental considerations should be directed toward procedures that control insect vectors, including the removal of wastewater in the area that may facilitate breeding of mosquitoes. Environmental contamination plays no role in the transmission of infection.

Live animals

Waterbirds (herons and egrets) are the main reservoir for the virus; although the dynamics of infection and length of viraemia are uncertain (viraemias are thought to be of 3–5 days duration during which the birds are capable of infecting mosquitoes.

Pigs develop high viraemias of 2–4 days duration and are major amplifiers for the virus. Viraemia can persist for up to 6 days but it appears that sufficient viraemia to infect mosquitoes is unlikely after 4 days in individual pigs (Maeda et al 1978, Sasaki et al 1982). However the period during which JE virus is transmissible in a pig population in a restricted area can be 2 or more weeks (Ueba 1972).

There is little data on the period of viraemia in horses. Horses are considered dead–end hosts that, unlike pigs, do not develop viraemias of sufficient titre to infect mosquitoes.

Cattle, sheep, and goats may become subclinically infected but play no major role in JE transmission.

The virus has been recovered from reptiles and bats, which may play a role in the overwintering of the virus in some endemic areas (Doi et al 1983). In bats viraemia may last for six days or more and is sufficient to infect mosquitoes. Transplacental transmission also has been documented in experimentally infected bats.

Humans

The viraemic period in humans is uncertain, but is not usually demonstrable when clinical signs have become evident. Humans are also considered not to be significant in the

epidemiology of the disease. As in horses, it is believed that the low titre viraemia that develops in humans is insufficient to infect mosquitoes.

Animal products and by-products

JE is not spread through animal products. Virus transmission to gilts has been demonstrated from semen of experimentally-infected boars (Habu et al 1977).

There are no reports of abattoir workers becoming infected from processing viraemic pigs.

Fomites

Fomites do not present a risk of transmitting the disease.

Vectors

Australia has various mosquitoes in the *Culex, Aedes* and *Anopheles* genera. In the Torres Strait, JE virus was only isolated from *Cx annulirostris* although *Ae. kochi* and *Ae. culiciformes* along with *Cx annulirostris* accounted for 99% of the collection (Hanna 1996). *Cx annulirostris* has also been implicated in the transmission of JE in Guam.

In Indonesia the virus has been isolated from *Cx tritaeniorhynchus, Cx gelidus, An. vagus* and *An. annularis* (Daniels et al 1995).

Cx annulirostris is considered to be the major vector species in Australia and it occurs throughout the country. This was the only mosquito species from which JE was isolated in the Torres Strait epidemic. Specific vector competency testing is needed to identify other potential vector species.

Following emergence, the adult female will generally seek out a carbohydrate meal of plant juices to replenish expended energy reserves. It will then mate with a male, usually near the breeding site, often at dusk. Female mosquitoes mate only once, the sperm packet introduced by a male during the mating act serving the female to fertilise all batches of eggs she subsequently produces.

For development of eggs, female mosquitoes require protein and this is provided either from nutritional reserves carried from the larval stage or from a meal of high protein source such as blood.

Females can survive on plant juices, but most of the species important as pests or disease vectors seek blood soon after mating, at about 2–3 days of age. The preferred source of blood meal can vary widely between mosquito species and with different situations. Generally, *Cx annulirostris* will feed on bird and/or mammal hosts and also on humans. Adult mosquitoes that become infected with arbovirus usually remain so for life.

In the Torres Strait, pigs and horses had the highest percentage of animals with JE antibody, humans and dogs were intermediate and chickens had the lowest percentages with antibody.

In general terms, mosquitoes are attracted to warm-blooded hosts by a combination of factors. Carbon dioxide is an important attractant, as are various body odours.

After taking a bloodmeal, the female searches for a secluded resting spot where the meal can be digested and the ovaries can develop the eggs. Transovarial transmission can occur. JE virus has been isolated from adult mosquitoes reared from field-collected larvae. and in laboratory studies of mosquitoes, *Ae. albopictus* and *Ae. togai.* Field studies are still needed to assess the epidemiological significance of transovarial transmission.

The daily survival rate of a field population of mosquitos is governed by a range of factors such as temperature, rainfall, wind, availability of hosts and humidity. All these would need

to be considered to determine how long adult mosquitoes could survive and maintain JE virus. In general, the survival rate beyond about four weeks may be considered very low.

Mechanical transmission by biting insects other than by mosquitoes is not known to occur.

1.6.4 Factors influencing transmission

The local rate of transmission of the virus is governed by a complex interaction between vectors and hosts. Although serious effects will be seen in humans and horses, these hosts will not contribute significantly to an epidemic.

If the virus enters mainland Australia, it will be transmitted by competent mosquito vectors. Pigs and birds will contribute most to the epidemic pattern of the disease. The proportion of the vector population carrying the virus will be dependent on the number of infected hosts and on their level of viraemia.

Occurrence in the same area of water masses, mosquitoes, birds and pigs (both wild and farmed) would provide a suitable circumstance for rapid spread.

If the virus is carried with a high frequency by mosquitoes, then situations in which there are close associations between humans and dense pig populations will be particularly dangerous for humans.

The epidemic potential of JE will be lessened by a high proportion of antibody positive amplifying hosts and, to a lesser extent by a high level of maternal immunity in young pigs. It is likely that rapid lateral spread and high morbidity will result in development of highly immune populations.

There is evidence that *Cx annulirostris* may disperse over a range of about 10 km around a breeding site. Under still area conditions, mosquitoes disperse about 2 km per day. Under suitable moisture and wind speed conditions, however, mosquitoes can be transmitted distances of hundreds of kilometres.

The overwintering mechanisms of JE virus are not well understood. Transovarial transmission (see Section 1.6.3) would have important implications for persistence of the virus in the field if it becomes established in a mosquito population. There is no evidence to show how long JE virus can survive in mosquito eggs. Overwintering in female mosquitoes appears unlikely in many areas of Japan where studies have concluded that re-introduction (via birds), and the survival of the virus in reptiles and hibernating microbats, provide a more likely explanation (Doi et al 1983, Hayashi 1976). For bats artificial hibernation at 10^0C for up to 107 days demonstrated viraemias could be reinstated when warmed to room temperature (Burke and Leake 1988). Persistence of the virus in Australian ecosystems would require mechanisms for harbouring virus over dry periods when mosquito activity becomes low or over post-epidemic periods while new cohorts of susceptible mammalian hosts expanded.

1.7 Manner and risk of entry

JE has occurred in the western and northwestern islands of the Torres Strait, with its first recognition in April 1995 associated with clinical disease in three humans on Badu Island, two of whom died.

Serological surveillance showed widespread exposure of human and animal populations. Sentinel studies have demonstrated virus activity in the wet seasons (March/April) of 1996

and 1997. It seems likely that JE virus was introduced to this area by migratory birds. Herons have been implicated in Southeast Asia.

The disease may spread further south to the Australian mainland in three ways:

- waterbirds may carry the virus further south;
- infective insects may be dispersed by the wind; and
- viraemic pigs may be transported.

Infection may also spread directly from Papua New Guinea without the need to stage via the Torres Strait. Effective endemic infection of the Torres Strait area could increase the risk to adjacent mainland areas.

Animal movement within the Torres Strait is controlled and few animals move south from the Thursday Island group of islands.

Pigs and certain wild bird species amplify the virus before it can spill over to humans and horses, which are incidental dead-end hosts and cannot introduce infections into new areas.

Overall, the risk for travellers of acquiring clinical disease is extremely low. The risk for an individual traveller is highly variable and is a function of place, season, and duration of residence, but may approach 1 per 5000 per month of exposure. This risk of infection combined with low viraemia in humans, suggests the risk of entry via infected people is very low.

2 PRINCIPLES OF CONTROL AND TRANSMISSION

2.1 Introduction

Control of JE relies on four basic principles:

- controlling insect vectors;
- preventing exposure of susceptible animals to JE virus infected mosquitoes;
- limiting the amplification of virus by susceptible animals; and
- protecting susceptible animals and humans from disease by vaccination.

These principles could be applied by:

- stopping the spread of infection through movement controls on significant amplifying hosts (domestic pigs) (section 2.2.1);
- initiating vector control (section 2.2.11); and
- establishing immunity by vaccination (section 2.2.9).

2.2 Methods to prevent spread and control pathogens

Due to the time taken to establish a diagnosis, continuing virus transmission by insects, the wide range of hosts and the lack of clinical signs in most infected animals, control by slaughtering exposed animals is inappropriate.

2.2.1 Movement controls/zoning

No benefit will be gained by placing restrictions on the movement of horses, cattle, sheep and goats from infected premises or areas.

Movement controls on pigs to prevent spread of virus will require careful consideration. Even if the virus has established in an insect vector population, it will still be necessary to control spread by pig movements from premises where there is evidence of active infection. Controls on the movement and congregation of pigs may be relaxed once the situation has been fully assessed. The movement of pigs for immediate slaughter at times of low mosquito activity is a lower risk activity than the movement of pigs for restocking purposes.

Movement controls should be imposed at two levels.

Infected premises (IP): A premises on which JE is confirmed or presumed to exist. Movement and vector controls and vaccination may be considered.

Control area (CA): A CA will be imposed in consultation with public health authorities for disease control and surveillance purposes. Less stringent movement controls and surveillance will apply than for most other emergency diseases. Once the limits of the virus activity have been confidently defined, the CA boundaries and movement restrictions can be reviewed. If the disease does not spread, the application of a CA and controlling movement from it may assist relationships with trading partners.

The CA must include all premises adjacent to known IPs and attempt to include all areas of known virus activity.

Movement controls should be maintained to some degree until the disease either disappears or is declared endemic. If a vaccination campaign is carried out, the restrictions on vaccinated animals (once their immunity is established) can be reduced compared to non-vaccinated animals.

Zoning

Zoning may reduce the economic consequences of the disease by facilitating movement of live animals within and out of the free zone. Maintenance of the free zone will require movement controls and intensive surveillance to ensure freedom from JE virus infection. The cost effectiveness of maintaining free zones will be determined by international trade factors.

2.2.2 Tracing

It will be necessary to trace back from both animals and people, with confirmed JE infection, to assist in defining the source and extent of infection.

Animals

It is likely that the index case will be in people, and trace-back will identify animal or other human cases. Limited trace-forward of pigs moved for store or restocking purposes may assist with defining further infection points.

Stock owners need to be encouraged to maintain records of stock movements to facilitate tracing.

Humans

A human case of JE should be notified to the appropriate State or Territory health authority which, in collaboration with the Commonwealth Department of Health and Family Services (CDHFS) and the Communicable Diseases Network – Australia and New Zealand, will undertake epidemiological studies. These are essential to trace both the source of the infection and possible secondary cases.

The State and Commonwealth health authorities will also notify agricultural authorities in their respective jurisdictions, and liaise as required to minimise the impact on the agricultural sector.

2.2.3 Surveillance

Livestock

Owners of pigs and horses in the CA and areas potentially at risk, as assessed from time to time, should be advised to observe their stock daily for clinical signs of disease. In horses, daily monitoring of rectal temperature may provide an early warning of JE virus activity. Blood should be taken from clinically-affected animals and tested for antibody to JE virus. Follow-up sampling may be necessary to demonstrate antibody developing after the clinical signs.

Serological surveillance can be used to demonstrate the extent or distribution of infection. Initially, the National Arbovirus Monitoring Program (NAMP) and flavivirus sentinel programs should be used to determine the spread of JE. Pigs are sensitive indicators of the presence of JE but would not be used specifically as sentinels because of operational difficulties, and the risk of amplifying the disease agent and facilitating spread. The effectiveness of other animals as sentinels should be investigated. Pigs and horses show high seroprevalences and hence would be expected to be sensitive sentinels. Cattle and dog also show moderately high seroprevalences and could be useful sentinel species. Poultry usually show a low seroprevalence and may not be useful as sentinels for JE as they are for MVE. In

the event of JE spread into Australia, new surveillance systems may have to be devised to ensure timely information is obtained to initiate appropriate control systems.

Humans

Surveillance for JE will be undertaken jointly by Commonwealth and State/Territory health authorities under the auspices of the Communicable Diseases Network – Australia and New Zealand. Close liaison will be maintained with agricultural authorities and relevant data will be published in the CDHFS fortnightly publication *Communicable Diseases Intelligence.*

Vectors

An adequate number of carbon dioxide baited light traps should be available at short notice for vector surveillance. Most State/Territory health departments (1997) use such traps and sentinel animals for arbovirus surveillance. Collections should be stored in a suitable condition for later sorting. It may also be possible to process these insects for virus identification by conventional isolation or by PCR. Insects collected for NAMP and other sentinel programs should also be tested for JE infections.

A range of collection techniques, including carbon dioxide baited light traps, truck traps and larval sampling, are available.

2.2.4 Treatment of infected animals

There is no effective treatment for this disease. Ivermectin treatment (Equimec®) of horses and other livestock may disrupt transmission of the virus and lower the likelihood of infection. Effects on mosquitoes (death, decreased egg production, and reduced egg production) fed on blood containing various concentrations of ivermectin have been observed (Tesh and Guzman 1993). The authors suggested that the widespread use of ivermectin in veterinary and human medicine may have an unrecognised effect on mosquito populations.

2.2.5 Destruction of animals

Destruction of infected animals will not assist disease control, but sick animals (particularly horses) may need to be destroyed on welfare grounds.

2.2.6 Treatment of products and by-products

Animal products and by-products represent negligible risk in the spread of infection, and treatment of such products is unnecessary. The public needs to be informed that the consumption of pork products presents no risk to their health. JE is an insect vector transmitted disease which does not spread between hosts in the absence of mosquitoes.

2.2.7 Disposal of animals

There are no special requirements for the disposal of carcases from infected premises.

2.2.8 Decontamination

Fomites are not considered to play any role in the epidemiology so no decontamination precautions are necessary.

2.2.9 Vaccination

Pigs

In the face of a rapidly-spreading outbreak vaccine would need to be obtained speedily and applied quickly to a high proportion of the population to achieve an effect. While vaccination of pigs might be expected to slow the spread of the virus and may reduce the challenge to human populations in situations where significant human and pig populations interface, practical considerations such as the rapid turnover of pig populations and the relative costs of vaccines would make effective and timely vaccination of pigs difficult to achieve. The usefulness of inactivated vaccines in the protection of pigs is highly suspect (see Section 1.5.3). Attenuated virus vaccine represents the only means by which pig populations could be effectively vaccinated but the import of an attenuated vaccine presents a quarantine difficulty that at the time of writing the manual had not been assessed.

Horses

Vaccination of horses would protect valuable animals but not influence the epidemic spread of JE. Horse owners in likely infected areas would be advised to vaccinate their unvaccinated horses.

Humans

People living near and working in piggeries may need to be vaccinated along with animal health personnel carrying out investigations in the endemic area. Appropriate clothing and the use of insect repellents will also reduce human infection rates.

Other animals

If Australian marsupials such as macropods, flying foxes, bats and possums prove to be efficient amplifiers of JE virus, even effective vaccination of piggeries might do little to control the numbers of infected mosquitoes.

Vaccination of birds and wildlife is impractical.

2.2.10 Wild animal control

Wild animals can and do act as a reservoir for JE virus. The species most likely to harbour the virus are rufous night herons, egrets and other waterbirds, pigs and reptiles. The susceptibility of Australian marsupial species for JE and the part they may play in spread of infection is unknown.

While the role of other wild animals is not known, there is no advantage to be gained from wild animal control in an attempt to control virus spread. If JE virus is spreading through a region, the ability of various wild animals to become infected with JE should be determined by serological sampling for future epidemiological reference.

While wild pigs may play a significant role in maintaining and disseminating JE, it will be difficult to limit their role in the epidemiology of JE infection. However, strategic control of wild pigs near centres of population may have to be considered.

2.2.11 Vector control

Vector control will be exercised to protect human populations. In the event of an outbreak, the decision to conduct broad scale vector control will rest with local and State health authorities. Where extended vector control is undertaken using chemicals, care should be taken by the local council under direction of the appropriate health authority to advise all the appropriate persons/groups including local landholders, police and apiarists in the area.

As a preventive measure, before vaccination becomes available, horse owners should treat their animals with a topical insecticide containing an insect repellent and to ensure their minimal exposure to mosquitoes by housing horses in screened stables during peak periods of mosquito activity. Procedures to limit mosquito breeding adjacent to horses can also reduce the risk of infections.

In endemic areas, piggeries should be sited away from human housing and from water where mosquitoes breed, and be of a type that will allow for control of mosquitoes.

2.2.12 Sentinel and restocking measures

Restocking measures for proving disease freedom are not applicable. Refer to Section 2.2.3 for information on surveillance or sentinel programs.

2.2.13 Public awareness

It is likely that JE will affect humans shortly after incursion. Its initial impact may well be extensive and sudden. The public will respond with dread at a new pathogen, capable of causing encephalitis with a significant mortality rate and serious sequelae. A similar reaction may be expected from horse owners. The public needs to be informed that the consumption of pork products presents no risk to their health.

The nature of the virus's introduction, the impossibility of eradication, the protective capacity of vaccination and the importance of mosquito control will need to be stressed.

As JE is primarily a disease of public health concern, human health agencies at Commonwealth and State levels must play a lead role in public communication.

2.3 Feasibility of control in Australia

If the local conditions are not suitable, an initial incursion of JE might not establish in Australia. However, with the wide range of susceptible hosts and potential insect vectors in Australia, it is unlikely that JE could be eradicated once it became established. The virus range could become more widespread than MVE virus.

If JE became established in Australia, it would need to be controlled through vaccination. Available vaccines all suffer disadvantages. For reasons of cost, ease of application and quicker development of protective immunity, an attenuated vaccine is favoured, but concern may be expressed about the importation of a foreign genotype. Supplies of both the human and horse inactivated vaccines (see Section 1.5.3) is likely to be limited, given current (1996) production levels by Japanese manufacturers.

3 POLICY AND RATIONALE

3.1 Overall policy for Japanese encephalitis

Japanese encephalitis (JE) is an OIE List B disease that has the potential to cause serious disease in humans and is important for the health and international trade of horses. The overall policy is to control JE in domestic animal populations as necessary to support public health agencies/programs, and the pig and horse industries. The policy will be as follows:

- ☞ **maintain sentinel animal systems to monitor for JE incursion and spread;**
- ☞ **establish a control area to facilitate outbreak management;**
- ☞ **facilitate access to efficacious vaccines (which currently are only available for horses);**
- ☞ **limit impacts on trade through timely information, negotiation with trading partners and zoning plans, as necessary; and**
- ☞ **implement a public awareness campaign to inform the public, encourage rapid reporting of suspected cases and to facilitate cooperation from industry and community**

An outbreak of JE could have a major impact on people, the horse industry and governments by disrupting tourism and equestrian activities. There should be minimal long-term disruption to horse exports; some may occur until vaccine is available in sufficient quantities.

JE is not in the Commonwealth/States cost-sharing agreement.

The chief veterinary officers in the State(s)/Territory(s) in which the outbreak(s) occurs will be responsible for implementing disease control measures (in accordance with relevant legislation), and will make ongoing decisions on follow-up disease control measures in consultation with the Consultative Committee on Emergency Animal Diseases (CCEAD), the State/Territory and Commonwealth governments, and representatives of the affected industries. The detailed control measures adopted will be determined using the principles of control and eradication (Section 2) and epidemiological information about the outbreak. For further information on the responsibilities of the State/Territory disease control headquarters and local disease control centre(s), see the **Control Centres Management Manual, Part 1, Section 3 and 4**.

3.2 Strategy for control

It has been assessed by the writing group that if JE becomes established in Australia, eradication would not be feasible. However, initial incursions to new areas may fail to establish in some ecosystems. This assessment means that the initial spread south and incursions of infection into new areas will need to be managed to the extent that the impact on humans, animals and trade will be minimised.

Overall, the epidemiology of JE in Australia is likely to be similar to MVE in respect of range of territory and the time of year when outbreaks will occur. However, in respect of its potential to survive between seasons in vectors and its ability to amplify in wild pigs and pigs in large pig enterprises, JE may well demonstrate a very different epidemiology in eastern Australia to MVE, with a higher frequency of outbreaks.

3.2.1 Stamping out

Stamping out is not seen as a policy that would be effective in the control of JE. Virus will be maintained in vector, wild animal and bird populations and there will be resurgences as occurs with MVE. Horses suffering the clinical effects of JE infection may need to be killed on animal welfare grounds.

3.2.2 Movement controls

Establishment of a control area (CA) will enable strategic controls to be placed on pig movements out of the CA that will minimise the transfer of viraemic pigs to new areas. The movement of pigs for restocking and breeding purposes from piggeries that are undergoing infection into free areas needs to be controlled. When a high level of immunity can be demonstrated in a piggery, controls on movements should be lifted. The movement of pigs to slaughter should be controlled to minimise the chance of infection spread to new areas, eg timing of dispatch when mosquito activity is low and slaughter without undue delay at the abattoir.

When a CA is declared, samples collected from sentinel programs for other arboviral infections, eg NAMP and the MVE sentinel chickens should be tested for evidence of JE infection.

Serological surveillance of piggeries and the testing of mosquito collections to demonstrate JE virus infection are mechanisms by which the spread of virus infection can be assessed.

Careful consideration would need to be given to establishing a free zone. A zoning strategy probably would only be implemented to facilitate trade when there is a clear benefit cost ratio.

3.2.3 Treatment of animal products and by-products

Animal products and by-products represent negligible risk in the spread of the disease, and treatment of such products is unnecessary. JE is an insect vector transmitted disease which does not spread between hosts in the absence of mosquitoes. The public should be informed that the consumption of pork products presents no risk to their health.

3.2.4 Vaccination

Vaccination may be required in certain circumstances to protect humans and should be advised to horse owners who want their horses protected. Vaccination of pigs would do little to advance pig health and routine vaccination is not recommended for use in piggeries

because the turn-over of pigs would make it difficult to maintain high levels of immunity and the currently available inactivated vaccines make it impractical to vaccinate piggeries efficiently. The expense of implementing a vaccine program also needs to be taken into consideration.

Use of an inactivated or attenuated vaccine (if cleared by quarantine authorities — see Section 2.2.9) will achieve little control of infection in the face of an outbreak, because of the delay before protective immunity is achieved. Primary vaccination of humans would ensure the most direct protection against JE.

There is likely to be significant initial difficulties in providing large quantities of vaccines for horses and humans, given the limited production in Japan.

3.2.5 Vector control

As JE virus is spread by mosquitoes, vector control provides an important measure to control infection of humans. The decision to use insecticide and other mosquito controls in towns and cities will be taken by local and State health authorities, based on information obtained from surveillance systems tracking the spread of virus infection and vector populations.

Early detection of infection in a piggery that is in reasonable proximity to a township or city could result in area vector control measures being applied to suppress infected mosquito populations entering the township or city. Currently some local health authorities practice vector control for MVE and Ross River virus infections in areas within a 10 km radius from townships. Piggeries within such areas would need to have vector controls.

Following detection of infection in horses, advice should be given to use topical insecticides/repellents and other measures to limit mosquito numbers in and around horses.

Publicity about vector control to limit the exposure of humans can also be issued as an alert to pig and horse owners.

3.2.6 Surveillance

After a CA is declared in northern Australia, NAMP would be used to carry out surveillance for JE. In northwestern, northern and southern Australia existing arbovirus and vector surveillance systems would be used to provide additional monitoring along river systems. Currently available mosquito monitoring systems could be augmented by establishing additional monitoring sites. Information obtained from serological monitoring of sentinel animals would indicate if virus isolation from mosquitoes was necessary.

As part of the emergency response, any clinical disease in pigs and horses that may be JE would be investigated to establish the extent of infection. Isolation of virus would be attempted from suitable cases. Serology would be conducted on sick horses and cohorts, with re-sampling two weeks later to confirm antibody conversion to JE. Similar serological monitoring would be conducted in piggeries suspected of being infected (see Section 2.2.3).

If it was desired to define free zones, the surveillance requirements to establish and maintain the zone will have to be developed at the time. Pigs would be the most sensitive sentinel animals, though, because of operational difficulties, the existing arbovirus surveillance programs (that do not use pigs) would need to be used.

Depending on where the initial infection has occurred, it may be necessary to establish additional surveillance systems to monitor the spread of infection within and around the CA. Increased frequency of bleeding of NAMP sentinel herds may be one such response.

In some States, sera from structured surveillance schemes will be available for retrospective analysis.

3.2.7 Wild animal control

Control of infection in wild animals is not feasible over a wide area but control of wild pigs around population centres may need to be undertaken for public health reasons.

3.3 Social and economic effects

3.3.1 Horse industry

Inapparent or subclinical infections are much more common than cases of recognisable encephalitis. Many horses only develop a transient fever (see section 1.4.1) and recover after five days. Disruption to the industry would occur through non-immune horses being potentially exposed to infection. Racing organisations, especially, would need to advise owners about movements between zones and the need for vaccination to protect horses.

Restrictions are likely to apply to horses exported from JE-affected areas (see Appendix 3). The current OIE Code does not take account of the protection provided by vaccination in the safe movement of animals. Restrictions on movements to Asian countries are unlikely. Immediate negotiations, especially with Europe and North America, will be required, particularly to define the disease-free zone and the protection provided by vaccination.

Horse owners in likely infected areas would be advised to vaccinate their animals (once the vaccine is available) or to treat them with a topical insecticide such as ivermectin, or repellent and to ensure their minimal exposure to mosquitoes. Ivermectin treatment will restrict the transfer of infection to horses while the wave of infection is passing through.

3.3.2 Pig industry

The economic impact on pig production is likely to be variable and not predictable. There should be little long-term impact on the consumption of pork products, but there may be an initial impact.

3.4 Criteria for proof of freedom

JE is an OIE List B disease and there are no OIE criteria for declaring free areas.

Long-term surveillance will demonstrate those areas to which JE will spread. It will be necessary to determine the range of mosquito species that can transmit infection. This will initially be determined from field collections. The knowledge on mosquito hosts will determine the range and extent that JE will spread in Australia. The likely wide range of vector mosquitoes will make declarations of area freedom from vectors impractical to sustain. Claims for area freedom would have to be based on active on-going surveillance for evidence of virus in vectors and/or susceptible hosts (see Table 1 for specific tests).

3.5 Funding and compensation

Local measures to protect human health will need to be put into effect and funding for most measures in this strategy would be met from human health resources, as currently occurs for MVE.

JE is not on the list of diseases covered by the Commonwealth/States cost-sharing agreement. This agreement requires that eradication be pursued for cost-sharing to operate. Where the nature of operations are not targeted to eradication, an extension of the current agreement to incorporate JE is not possible. The approach as outlined above is that eradication is not feasible and environmental factors will determine the extent of infection. Control activities proposed are minimal.

The protection of susceptible livestock will be the responsibility of owners, with horse and pig owners paying for vaccination costs unless it was determined to be in the interests of public health.

In the initial stages, the costs of investigations will be borne by government but in the long-term it would be expected that animal owners would pay for any diagnostic investigations.

3.6 Strategy if the disease becomes established

This strategy response plan has been based on the expectation that the disease will become established and that eradication is not feasible. Environmental factors will determine the extent of infection.

Local measures to protect human health, including surveillance to predict outbreaks, will need to be put into effect.

The protection of susceptible livestock will be the responsibility of owners.

APPENDIX 1 Guidelines for classifying declared areas

Infected premises (IP)

A premises classified as an IP will be a defined area (which may be all or part of a property) in which JE exists or in which the infection exists or is presumed to exist.

Control area (CA)

The control area will be determined by the tracing and surveillance being undertaken immediately following the detection of disease but should attempt to encompass the area of known virus activity (and if feasible include an abattoir). Movement controls would be as in Appendix 2.

Virus-free zones may need to be defined for trade purposes. The following factors must be taken into account for assessment of a disease-free zone:

- number, distribution and density of humans, pigs, wild birds and horses;
- vectors;
- climate;
- geographical features; and
- virus activity as demonstrated by seroconversions.

APPENDIX 2 Recommended quarantine and movement controls

The movements of pigs out of the control area will be restricted to the extent that pigs for restocking or breeding purposes would only be moved under permit conditions minimising likely spread of infection to new vector populations. Pigs for slaughter on recently–infected premises would be unrestricted for slaughter within the control area and movements out of the control area would be by permit taking account of reducing the likelihood of infection spreading to mosquitoes at new sites.

For horses moving into the control area, vaccination is recommended.

APPENDIX 3 OIE Animal Health Code for Japanese encephalitis

[NB The following text is taken directly from the OIE International Animal Health Code (1992); Chapter 3.4.15. For definitions, Appendices etc see the original text. The OIE Codes are considered for amendment every year in May.

Preamble: For diagnostic tests, reference should be made to the *Manual* (B45).

[☞see OIE publications under References].

Article 3.4.15.1.

For the purposes of this *Code*, the *incubation period* for Japanese encephalitis shall be 21 days.

Article 3.4.15.2.

Veterinary Administrations of countries free from JE may prohibit importation or transit through their territory, directly or indirectly, from countries considered infected with Japanese encephalitis of:

domestic and wild equines.

Article 3.4.15.3.

When importing from countries considered infected with Japanese encephalitis, *Veterinary Administrations* should require:

<u>for horses</u>

the presentation of an international animal health certificate attesting that the animals:

1) showed no clinical sign of Japanese encephalitis on the day of shipment;
2) were kept for the 21 days prior to shipment in an establishment where no case of Japanese encephalitis was officially reported during that period;
3) were kept in a quarantine station for the 21 days prior to shipment, were not in contact with swine and were protected against insect vectors during that period.

APPENDIX 4 Procedures for surveillance – a model surveillance program

The existing sentinel programs of NAMP operated by agricultural agencies and sentinel chickens operated by health agencies provide the basis for the ongoing surveillance programs.

Refinement of these models would best be undertaken based on observations of the patterns of spread from existing systems that might indicate deficiencies.

See Section 3.2.6.

APPENDIX 5 Vaccination procedures and products

For People

According to WHO (1994) inactivated JE vaccines derived from infected mouse brains are produced in Taiwan, India, Japan, Korea, Thailand, and Vietnam. In China inactivated and attenuated JE vaccines are produced in hamster kidney cells.

The product available for use in Australia is 'JE−VAX' Japanese encephalitis virus vaccine, inactivated — a sterile, lyophilized vaccine for subcutaneous use, prepared by inoculating mice intracerebrally with JE virus, manufactured by the Research Foundation for Microbial Diseases of Osaka University (BIKEN).

For horses

The product used in Hong Kong, Macau, and Singapore is a killed vaccine, BM111 strain derived from Beijing 1 strain. It is grown in MPK111a cells and formalin inactivated. The cells are a cloned cell line derived initially from a porcine kidney.

The product has been used in Hong Kong since 1980, with no reported side effects. This vaccine is the one that has been used to vaccinate Australian horses travelling overseas..

Two doses are administered four weeks apart followed, if necessary with an annual booster. One mL is administered subcutaneously, regardless of body weight.

Manufacturer

Neisseiken Company Limited
222-1, Shin-Machi
Ome
Tokyo 198
Japan

Telephone: 0428 31 5135
Facsimile: 0428 31 6606
Telex: 2852077 NIBS J
Cable: NIBS OME

Distributor

Asafuji Industrial Company Limited
PO Box 5139
Tokyo International
Tokyo, 100-31
Japan

For Pigs

The vaccine used in a recent trial in Australia (see Section 1.5.3) was supplied by a Japanese firm, *Kyoto Biken.* The vaccine was prepared on chicken embryo cell culture substrate, inactivated with formalin and mixed with an aluminium chloride adjuvant. The minimum titre before inactivation was log 8.8 TCID50 (per mL). The manufacturer recommended two

doses, each of 10mL at a one month interval. The vaccine was supplied in a 20mL vial and was stored at 4ºC.

The attenuated product for which most information is available is JEVAC KBL Japanese Encephalitis Modified Live Virus Vaccine from Biken (Kyoto). Documentation indicates it is manufactured from strain M.

GLOSSARY

Animal by-products	Products of animal origin destined for industrial use, eg raw hides and skins, fur, wool, hair, feathers, hooves, bones, fertiliser.
Animal products	Meat products and products of animal origin (eg eggs, milk) for human consumption or for use in animal feeding.
Arbovirus	A virus carried by an arthropod such as a mosquito.
AUSVETPLAN	A series of documents that describe the Australian response to exotic animal diseases, linking policy, strategies, implementation, coordination and emergency-management plans.
Consultative Committee on Emergency Animal Diseases	A committee of State/Territory CVOs, AAHL and CSIRO, chaired by the CVO of Australia (Cwlth DPIE), to consult in emergencies due to the introduction of an exotic disease of livestock, or serious epizootics of Australian origin.
Control area	A bigger area than a restricted area (possibly as big as a State) where restrictions will reduce the chance of the disease spreading further afield (*see* Appendix 1).
ELISA	Enzyme-linked immunosorbent assay — 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.
Encephalitis	Inflammation of the brain, often caused by viral infection.
Fomites	Inanimate objects (eg boots, clothing, equipment, vehicles, crates, packagings) that can carry an infectious agent and spread disease through mechanical transmission. Fomites do not play any role in the spread of Japanese encephalitis.
Haemagglutination inhibition test	Test for the presence of antibody.
Immunoglobulin	Antibody proteins.
– IgE	Immunoglobulin usually present at very low levels but increases in hypersensitivity (allergic) reactions.
– IgG	The main form of immunoglobulin produced in response to an antigen. It is mainly found in body fluids.
– IgM	High molecular weight immunoglobulin; IgM antibodies are the first to be synthesised and released in response to a primary antigenic stimulation.
Incubation period	The period which elapses between the introduction of the pathogen into the animal and the occurrence of the first clinical signs of the disease.
Infected premises	*see* Appendix 1.
Local disease control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Meningitis	Inflammation of the meninges (membranes surrounding the brain), often caused by viral infection.

Movement controls	Restrictions placed on movement of animals, people and things to prevent dissemination of disease.
Mummified foetus	Dry/shrivelled foetus due to the resorption of fluids from the placenta following death in the uterus.
Non-suppurative	Not pus producing.
Parkinsonism	A condition marked by rigidity and tremor.
Polymerase chain reaction	A method of amplifying and analysing DNA sequences that can be used to detect the presence of virus DNA.
Petechial haemorrhages	Tiny flat red or purple spots in the skin or mucous membrane caused by bleeding from small blood vessels.
Premises	A defined area or structure, which may include part or all of a farm, enterprise or other private or public land, building or property.
Quarantine	Legal restrictions imposed on a place, animal, vehicle or other things limiting movement.
Seroconversion	Appearance in the blood serum of antibodies following vaccination or natural exposure to an infected agent.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.
Sentinel animals	Animals of known health status monitored for the purpose of detecting the presence of a specific exotic disease agent.
Serum neutralisation test	A serological test designed to detect and measure the presence of antibody in a sample. The test is based on the ability of an antibody to neutralise the biological activity of an antigen. 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.
Stamping out	Eradication procedures based on quarantine and slaughter of all infected animals and animals exposed to infection. A stamping-out strategy is not appropriate for JE.
State/Territory disease control headquarters	The emergency operations centre that directs the disease control operations to be undertaken in the State/Territory.
Surveillance	A systematic program of inspection and examination of animals, areas or things to determine the presence or absence of JE or its insect vectors.
Susceptible species	Animals that can be infected with the virus.
Suspect animal	An animal that may have been exposed to an exotic disease such that its quarantine and intensive surveillance is warranted; OR an animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Tracing	The process of locating animals, persons or things that may be implicated in the spread of disease, so that appropriate action can be taken.
Transovarial transmission	Transmission of virus vertically between generations of vectors without a stage in a vertebrate host (particularly transmission into eggs).
Vaccine	

– attenuated	A vaccine prepared from infective or 'live' microbes that have lost their virulence but have retained their ability to induce protective immunity.
– inactivated	A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment.
Vector	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 life cycle of the agent. Japanese encephalitis is transmitted biologically.
Viraemia	The presence of viruses in the blood.
Zoning	The process of defining disease-free and infected zones in accord with OIE guidelines, in order to facilitate trade.

Abbreviations

AAHL	CSIRO Australian Animal Health Laboratory, Geelong
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
CA	Control area
CCEAD	Consultative Committee on Emergency Animal Diseases
CDHFS	Commonwealth Department of Health and Family Services
CNS	Central nervous system
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	Chief veterinary officer
EDTA	Ethylene diamine tetra-acetic acid (anticoagulant for whole blood)
ELISA	Enzyme-linked immunosorbent assay
Ig	Immunoglobulin
IP	Infected premises
JE	Japanese encephalitis
KUN	Kunjin
NAMP	National Arbovirus Monitoring Program
MVE	Murray valley encephalitis
OIE	World Organisation for Animal Health [Office International des Epizooties]

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