

AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

1996

Disease Strategy

Rift Valley fever

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 Resource Management Council of Australia and New Zealand

This Disease Strategy forms part of:

AUSVETPLAN Edition 2.0, 1996

[AUSVETPLAN Edition 1.0, was published in 1991]

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:

There are occasional minor differences in the page breaks between the paper and this electronic version which we can unfortunately not avoid.

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PREFACE

This **Disease Strategy** for the control and eradication of **Rift Valley fever (RVF)** 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 Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) out-of-session in January 1996, for use in an animal health emergency caused by the introduction of RVF to Australia,

RVF is a serious zoonosis and information concerning human infection is included in this document both as an aid to animal health personnel working to control the disease and human health personnel assisting in the diagnosis and treatment of infected human patients.

RVF is designated as a List A disease by the Office International des Epizooties (OIE). List A diseases are, ‘Communicable diseases which have the potential for serious and rapid spread, irrespective of national borders; which are of serious socioeconomic or public health importance and which are of major importance in the international trade of animals and animal products’. The principles contained in this document for the diagnosis and management of an outbreak of RVF conform with the **OIE International Animal Health Code 1992** (OIE Code; see Appendix 3).

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

Detailed instructions for the field implementation of the strategies are contained in the AUSVETPLAN **Operational Procedures Manuals** and **Management Manuals**. Cross- references 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:

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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.

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1 NATURE OF THE DISEASE

Rift Valley fever (RVF) is an acute arboviral (insect-borne) virus disease mainly affecting ruminants and humans. RVF infection in ruminants causes abortion in pregnant animals and high mortality in young animals.

1.1 Aetiology

RVF is caused by infection with RVF virus, which is a member of the *Phlebovirus* genus of the family Bunyaviridae.

1.2 Susceptible species

RVF is highly pathogenic for sheep and cattle. Goats, buffalo and camels are also important hosts. Donkeys, horses, dogs and rodents have been infected during outbreaks but they are most unlikely to play a major role during RVF epizootics. Humans are also susceptible. The susceptibility of Australian native fauna is not known.

1.3 World distribution and occurrence in Australia

RVF has been recognised only in Africa, including Madagascar. It is widespread on the African continent especially in sub-Saharan areas. Major epizootics have occurred at irregular intervals of 5–20 years in southern and eastern Africa. A major outbreak occurred in Egypt in 1977–78 causing heavy losses of animals and a large number of human cases with approximately 600 human deaths. A further less severe outbreak occurred in Egypt in 1993.

RVF has never occurred in Australia.

1.4 Diagnostic criteria

[See Glossary for explanation of terms not defined in the text]

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

1.4.1 Clinical signs/symptoms

Animals

Sheep:

- most severe in lambs up to one week old when mortalities, which may occur 24–72 hours after infection, can reach 95%; mortalities in weaners can reach 40–60% and 15–30% in adult sheep;
- affected lambs do not feed, are reluctant to stand, and may exhibit a bloody diarrhoea;
- affected adult sheep have a high temperature, unsteady gait, bloody diarrhoea, nasal discharge, vomiting and jaundice;
- abortion is a very common consequence of RVF infection in pregnant ewes.

Cattle:

- affected calves exhibit fever, loss of appetite and weakness, and up to 30% may die; in adult cattle there is a drop in milk production and abortion.

Goats:

- the disease in goats is similar to that in sheep but is not as severe.

Buffalo, camels, horses, donkeys, cats, dogs and rodents:

- buffalo and camels are susceptible to infection but infections are often inapparent and death rates low;
- horses, donkeys, cats, dogs and rodents are low on the susceptibility scale and inapparent infections are the most likely outcome.

Humans

Four clinical syndromes are associated with RVF virus infection. These are described briefly below.

Mild form:

- characterised by the sudden onset of a fever that is sometimes biphasic (saddleback fever), rigor (shivering), headache, retroorbital pain (behind the eye socket), severe muscular pain (particularly in the lower back), cloudy conjunctiva, vomiting and loss of appetite.
- these symptoms generally persist for 4–7 days, followed by full recovery within two weeks.

Ocular form:

- less common form of RVF presenting initially as a fever;
- diminution of visual acuity between 7 and 20 days after onset;
- most commonly, macular, paramacular or extramacular retinal lesions are seen, which are frequently bilateral;
- oedema, haemorrhage and vasculitis are frequently observed and approximately 50% of the more severely affected patients suffer permanent loss of central vision.

Meningoencephalitic RVF:

- begins with an acute fever of about 5–10 days duration followed by hallucination, disorientation and vertigo;
- long-term neurological complications have been reported in some patients, although the mortality rate is low.

Haemorrhagic RVF (the most severe RVF syndrome):

- an acute fever of 2–4 days duration is followed by jaundice and haemorrhage;
- in the following 3–6 days either death occurs or the patient begins to recover slowly.

Clinical studies have not resolved the question of whether RVF can cause abortions in humans.

The subclinical infection rate, case fatality rate, and frequency and extent of long-term effects after ocular or meningoencephalitic illness are not known with certainty. In one study of 348 cases, 48 patients (13.8%) had the severe haemorrhagic form of the disease (of whom 25 died), 17 (4.9%) had encephalitis and 5 (1.4%) had ocular involvement. In a second epidemic, 20% of patients were reported as having retinitis associated with

defective vision. In a third epidemic, there were 224 deaths in a total of 1264 cases, a case mortality rate of 17.7%.

1.4.2 Pathology

Sheep. At postmortem, petechial and ecchymotic haemorrhages are present in the internal organs of affected sheep. The liver contains necrotic, greyish-white foci associated with haemorrhages under the outer layer, which are more severe in lambs than in adult sheep. There is a variable level of intestinal inflammation that may include haemorrhages (see Geering et al 1995 for further details).

1.4.3 Laboratory tests

NOTE: As a high concentration of virus is present in the blood and tissues of infected animals the processing of this material must be carried out in a biocontainment laboratory preferably by staff vaccinated against RVF. Such facilities are only available in Australia at the Australian Animal Health Laboratory (AAHL), Geelong, Victoria for animal specimens and the High Security Quarantine Laboratory in the Virology Department, Fairfield Hospital, Victoria, for human material.

Animals

Animal specimens should initially be sent to the State or Territory diagnostic laboratory from where they will be forwarded to the Australian Animal Health Laboratory (AAHL), Geelong for exotic disease testing after obtaining the necessary clearance from the chief veterinary officer (CVO) of the State or Territory of the disease outbreak and informing the CVO of Victoria (for transport of the specimens to Geelong).

Specimens required

Specimens required are whole blood (in EDTA anticoagulant) and serum, collected from animals at the peak of fever. Tissue specimens include clarified suspensions of fresh tissues (particularly spleen and liver), and duplicate samples in neutral buffered formalin for histopathology (see Geering et al 1995 for further details).

Laboratory diagnosis

The diagnostic tests for RVF currently available at AAHL are shown in Table 1. The disease agent can also be identified after virus isolation from fresh tissues samples.

Histopathology provides further confirmation of RVF diagnosis. Formalin-fixed sections of liver from infected animals and inoculated mice are examined and if multiple foci of diffuse necrosis is demonstrated in hepatic cells then a diagnosis of RVF is indicated. Immunofluorescent or immunoperoxidase staining of sections with a specific RVF antiserum strengthens this diagnosis.

Additional evidence of RVF can be obtained by examination of the antibody status of animals, especially adult animals that might not be showing clinical signs of disease. This is done using an ELISA test.

Table 1 Diagnostic tests currently available at AAHL for Rift Valley fever

Test	Specimen required	Test detects	Time taken to obtain result
Virus isolation and identification	whole EDTA blood fresh brain/spleen/liver	virus	5–10 days
ELISA	serum	antibody	1 day
Electron microscopy	tissues	viral antigen	12 hours
Histopathology	tissues	microscopic changes	2 days

Source: Information provided by AAHL, 1995 [refer to AAHL for the most up-to-date information].

Humans

The diagnosis of RVF infection in humans is carried out in the High Security Quarantine Laboratory of Fairfield Hospital, Victoria (see above). This hospital should be advised by telephone of the impending arrival of the specimens, including the name of the airline, date and time of expected arrival in Melbourne, and airway bill number.

The antigens used for immunofluorescence tests are supplied by the Centers for Disease Control, Atlanta, Georgia (USA). Initially the sera are titrated on slides containing a mixture of Congo-Crimean, Rift Valley, Ebola, Lassa and Marburg virus infected cells and using either antiluorescent human IgM or IgG. If antibody is detected, further tests are carried out on monovalent slides.

1.4.4 Differential diagnosis

Disease outbreaks in ruminants characterised by abortions, and deaths in young animals with liver necrosis, combined with an acute febrile illness in humans handling sick animals, are highly suspicious of RVF.

The following diseases should be considered in differential diagnosis of RVF:

- Wesselsbron disease
- Nairobi sheep disease
- Middleburg virus disease
- ovine enzootic abortion
- bovine brucellosis
- leptospirosis
- any disease capable of causing widespread outbreaks of abortion in sheep and/or cattle.

In humans the clinical signs of RVF are diverse, and the differential diagnosis should include the following:

- malaria
- brucellosis
- Lassa fever
- Ebola fever
- Marburg virus disease
- Congo-Crimean haemorrhagic fever
- dengue fever
- dengue haemorrhagic fever

Other viral encephalitides, including Australian encephalitis, should be considered if there are encephalitic signs or symptoms. It is particularly important that malaria be considered in any patient presenting with a fever within 12 months of leaving a malarious area.

When notified of a human case of RVF, the appropriate State or Territory health authority will collaborate with the Commonwealth Department of Human Services and Health (DHS) to undertake epidemiological studies (see Section 2.2.2 and 2.2.3).

1.5 Resistance and immunity

1.5.1 Innate and passive immunity

RVF virus infects a very wide range of animal species. However, as the animal becomes older, its susceptibility decreases. Mortality in lambs less than one week old is 90–100%, whereas in older lambs and in adult sheep the mortality drops to between 20 and 60%. However, 95–100% of pregnant ewes abort when infected with RVF virus. In calves the mortality is 10–70%, dropping to 10–20% in adult cattle. Again 80–100% of pregnant cows abort. Goats have a similar susceptibility to sheep.

Passive immunity can be transferred from mother to offspring in colostrum. However, the mother needs to have a sufficient level of antibody, produced by previous exposure to the disease, or by vaccination with an attenuated ‘live’ virus vaccine. Inactivated virus vaccines do not usually produce a sufficient level of antibody.

1.5.2 Active immunity

A high level of immunity is produced in animals following exposure to the virus. This immunity appears to be lifelong.

1.5.3 Vaccination

There are two forms of vaccine generally used overseas in livestock: attenuated virus vaccines and inactivated virus vaccines. Only the inactivated vaccines are used in humans.

Attenuated (‘live’) vaccines

Attenuated vaccines have been produced by serial passage through laboratory animals, usually mice. The Smithburn virus strain produces a high level of immunity and has been used extensively as veterinary vaccine. However, it causes abortions and birth defects, and some species (eg cattle) can be inadequately protected. Attenuated vaccines are produced in South Africa and in Kenya.

Note: Attenuated vaccine virus could be transmitted by insect vectors and revert to virulence.

Inactivated (‘killed’) vaccines

Inactivated vaccines are usually formalin or β -propiolactone treated. South Africa has produced an inactivated vaccine for veterinary use which protects sheep against RVF challenge. It gives low antibody responses and would require regular vaccination to maintain immunity. The vaccine has been used to prevent spread of RVF in South African sheep. Cattle develop a marginal virus-neutralising response and are protected for a short time.

An inactivated vaccine for human use has been produced by the United States Army Medical Research Institute for Infectious Diseases, Fort Detrick. It is only available in limited quantities and is not approved for use in Australia.

Other vaccine

A chemically-mutated RVF vaccine has recently been developed in the United States (MV P12) that is highly immunogenic and does not cause abortions in pregnant ewes (Baskerville et al 1992). However, this vaccine is not available in commercial quantities.

1.6 Epidemiology

RVF is a virus disease affecting mainly ruminants and humans and transmitted mainly by mosquitos. It causes abortions of pregnant animals, a high mortality rate in young animals, and a severe influenza-like disease in humans. The virus appears capable of causing outbreaks in a wide range of ecological zones.

1.6.1 Incubation period

Sheep and cattle

The viraemia in lambs can commence within 8–12 hours after exposure to the virus, and a febrile response can occur by 24–36 hours after inoculation. In cattle, the febrile response can occur from days 2–6 post-inoculation. Young animals rapidly produce clinical signs and die within 2–6 days.

The OIE Code gives the maximum incubation period for RVF as 30 days (see Appendix 3).

Humans

The incubation period in humans is uncertain. In one study, an incubation period of 3–4 days was reported, but the upper and lower limits are unknown. The limits for other vector-borne diseases are known to range from 1–21 days.

Vectors

Little is known of the dynamics of the virus in the vectors. One trial with the Egyptian vector *Culex pipiens* and RVF virus demonstrated that 7–15 days after feeding on blood, 78% of the mosquitos were infected. However less than half of these were able to transmit virus, as infection did not spread past the midgut. When mosquitos were inoculated intrathoracically with RVF virus, the virus titre reached a maximum after 3 days and remained at that level for up to 45 days. All inoculated mosquitos transmitted virus.

1.6.2 Persistence of virus

General properties/environment

- RVF virus is very susceptible to acid pH, being readily inactivated below pH 6.2. The virus is most stable within the pH range of 7–8.
- The virus rapidly loses titre at 56°C, but the presence of high levels of proteins, as in whole serum or plasma, can greatly stabilise the virus.
- Survival times of 3 hours at 56°C, 21 days at 37°C and 4 months at 25°C (Brès 1981) have been reported. The virus may be able to survive in dried blood for up to 3 months and it was reported that workers were infected when scraping the walls of an animal room used 3 months earlier for RVF studies (Brès 1981). When blood has

been spilt, the area should be disinfected with appropriate chemicals while wearing the correct protective equipment.

- RVF is highly stable in aerosol form at temperatures of 24°C and relative humidities between 50% and 85%;
- The virus is also destroyed by strong sunlight/ultraviolet radiation.

The RVF virus is relatively large in size and has a lipid-containing envelope making it susceptible to a range of disinfectants, including detergents (see Section 2.2.8).

Live animals

In adult animals, virus is rapidly cleared from the blood by day 6–9. However, virus has still been detected in spleen and liver after 21 days, and presumably can be transferred to humans at slaughter of the infected animal (see also Section 1.6.3, below).

Animal products and by-products

The virus content of meat decreases rapidly following slaughter, the pH dropping as the meat is stored. The RVF virus is excreted in milk but can be inactivated by pasteurisation or treatment with acid.

There is little known about the persistence of the virus in skins, wool (and other fibres), bones, or manure. Since wool, skin and bones may contain some blood, some virus may persist in these products. It is not known how long the virus would survive on wool after it is pressed into bales. Fibrous products can be decontaminated by scouring and carbonisation.

Fomites

Decontamination of blood spills from slaughtered animals is essential to prevent human infection.

Vectors

Adult mosquitos that become infected with an arbovirus will usually remain so for life. At least one species has been shown to transmit RVF 36 days after oral infection. The daily survival rate of a field population of mosquitos is governed by a range of factors such as temperature, rainfall, wind and availability of hosts. All these would need to be considered to determine how long adult mosquitos could survive and maintain RVF virus. However, in general, survival beyond about four weeks may be considered very low. Transovarial transmission is also an important factor for persistence of RVF virus in the field (see Section 1.6.3, below).

Wastewater might facilitate breeding of vectors and removal of such water from the area may be necessary.

1.6.3 Modes of transmission

RVF is predominantly a vector-borne disease. The major vectors are certain species of mosquitos (see Appendix 5), although ticks and biting midges have been implicated by some studies. A wide range of vertebrate hosts are susceptible to the virus, and transmission through physical contact with infected carcasses (eg meatworkers in an abattoir) has been reported. Laboratory workers have acquired RVF through aerosol transmission during the handling of infected animal tissues.

Vectors

Biological transmission. This is the major means of transmission of RVF. Virus has been isolated from 22 mosquito species in 6 genera collected in the field, and 15 species have been shown to transmit the virus experimentally. Virus has also been isolated from *Culicoides* biting midges and *Simulium* blackflies. The ability of Australian biting insects to transmit RVF virus is unknown.

Mechanical transmission. Experimental mechanical transmission of RVF virus has been shown for 3 mosquito species, a biting midge species, a phlebotomine sandfly, a tsetse fly and the stable fly. The explosive nature of epizootics and epidemics of RVF suggests that mechanical transmission is a probable means of spread.

Vertical transmission in vectors. RVF virus has been isolated from male *Aedes* floodwater mosquitos that emerged from dormant eggs after flooding of breeding sites. This demonstrates that RVF virus can be transmitted vertically between generations of mosquitos without a stage in a vertebrate host and, in particular, can be transmitted into eggs (transovarial transmission).

Transovarial transmission in floodwater *Aedes* mosquitos allows RVF virus to persist between seasons. These mosquitos lay eggs in which the first stage larvae develop to the point of being ready to hatch but then enter a resting phase until the egg is flooded. As a further aid to long-term survival of the species, not all eggs will hatch with the first flooding. Transovarial transmission has important implications for persistence of the virus in the field if it becomes established in an *Aedes* mosquito population. There is no evidence to show how long RVF virus can survive in mosquito eggs, but it may be measured in months or even years.

Aerosol transmission

A high rate of infection with RVF in people involved with slaughter, postmortem examination or laboratory handling of tissues from infected animals shows that aerosol transmission is an important means of infection.

Live animals

There is no evidence that contact transmission plays any significant part in the spread of RVF between live animals or humans.

Artificial breeding

The virus is likely to be present in semen and it is possible transmission may occur. It is known to be present in ova but is most probably not transmitted (see the **Artificial Breeding Centres Enterprise Manual**).

Animal products and by-products

Direct contact with carcasses and organs of freshly slaughtered sick animals has regularly caused disease in humans. Direct contact with blood and viscera of infected animals during slaughter or shortly afterwards poses the greatest risk of infection. Chilled or frozen meat is not likely to present a human health hazard.

RVF virus is excreted in milk during the viraemic phase in animals. However, pasteurisation inactivates RVF virus. The use of fresh, unpasteurised milk should be avoided in any RVF outbreak. If milk cannot be safely pasteurised it should be treated with acid to kill the virus.

Little or no information is available concerning the possible role of wool (and other fibres such as mohair), bones, skins and manure in the transmission of RVF virus. However,

since wool, bones and skins would contain some blood they would have the potential to spread the virus. Bones and skins from infected premises should be buried. The amount of viral contamination of wool would be much less than that of bones and skins. However, it is not known how long the virus would survive on wool after it is pressed into bales. Hence, wool shorn from sheep on infected premises should be despatched for scouring or scouring and carbonisation. Other fibres such as mohair should be treated by an equivalent process.

Transmission to humans

The human epidemiology of RVF is poorly understood. In areas where the disease is endemic, there is no regular seasonal pattern of human infection. Because RVF is a zoonosis, people who are exposed to susceptible animals or animal carcasses are at risk. At particular risk are abattoir workers, veterinary officers and laboratory staff with animal exposure (see Aerosol transmission, above).

1.6.4 Factors influencing transmission

Infection rates of vectors are directly proportional to the titre of the virus in the circulating blood of the host. The high titres that occur in vertebrates infected with RVF are conducive to high infection rates in a range of vectors. For instance, the experimental infection rate of *Culex pipiens*, the likely main vector in the epizootics of RVF in Egypt in 1977–78, was 87%. High titres of circulating virus are also an essential requirement for mechanical transmission. Titres as high as 10^{10} have been recorded in both sheep and humans.

Effects of rainfall

RVF appears to be maintained in an as yet undetermined cycle or stage in nature and has the capacity to break out of that cycle in epizootics. In southern Africa, such outbreaks are usually associated with wet seasons with above average, widespread and persistent rainfall, often over several months or even one or two years. This leads to flooding of large ground formations known as dambos with subsequent big increases in mosquito numbers. Such widespread rain helps to explain the simultaneous outbreak of RVF in widely-separated areas. The outbreaks in northern Africa have not been associated with heavy rain but have been mainly along the irrigation areas of the Nile River, where suitable breeding sites produce high numbers of vectors.

The initial spread of RVF after heavy rain could be initiated by *Aedes* mosquitos emerging from eggs, which may have been infected transovarially (see Section 1.6.3, above). This can lead to rapid spread of RVF as mosquitos with an existing infection at adult emergence can transmit virus at their first blood meal without the need to encounter a viraemic host and then go through an incubation period for virus multiplication and dissemination. Heavy rain also provides breeding sites for mosquitos of other genera, such as *Culex*, *Anopheles* and *Mansonia*, which do not have a resting phase in the egg stage but may become involved in the transmission cycle initiated by *Aedes* mosquitos.

Windborne vector spread

Windborne dispersal of infected vectors has been proposed as a means of spread of RVF. In the week immediately preceding the first outbreaks of the Egyptian epizootic in 1977, prevailing winds were from Sudan in the south, where infections had been recorded in the past. The distance travelled would have been 450–500 kilometres.

Effects of vector infection on feeding

It has been shown that *Culex pipiens* mosquitos infected with RVF are adversely affected by the virus. One sign of this is a reduced ability to engorge with blood, leading to increased probing behaviour and increased likelihood of feeding on a greater number of hosts, both of which can produce a higher transmission rate.

Preferential feeding

Recent experimental evidence has shown that mosquitos are more likely to feed on lambs that are infected with RVF than uninfected controls. There was a positive correlation with the higher temperature of the viraemic animal in very young lambs (3 days old) but not for older lambs (6–8 weeks).

1.7 Manner and risk of introduction

In principle, RVF could be introduced into Australia through the importation of infected vectors or hosts, including humans.

It has been reported that transovarial transmission of the virus occurs in at least some of the vectors, and it is therefore possible that any stage of the insect's life cycle could be infected. Under Australia's quarantine procedures, dissection of all inbound overseas vessels is undertaken to minimise the risk of introduction of vectors, and disease viruses such as yellow fever virus. Even though this dissection procedure may not always be 100% effective, the probability that RVF would be introduced into Australia in this way would appear to be low.

The limited available evidence suggests that RVF has a 3–4 day incubation period in humans, and it may be possible for the disease to be introduced into Australia by an infected person before clinical disease became apparent. Some vector species for RVF virus exist in Australia but no competency studies for the Australian strains have been undertaken. The ability of the virus cycle to be naturally maintained is therefore unknown. In the absence of this information it may be sensible to assume that competent vectors could exist in Australia.

Despite the lack of data, the risk of introduction of the disease by an infected person appears to be low. RVF has never been diagnosed in Australia, and for establishment of the disease, the patient would have to be bitten by a vector while he or she was viraemic, and in turn, pass the virus on to a suitable host(s) in sufficient numbers for the virus to become established.

2 PRINCIPLES OF CONTROL AND ERADICATION

2.1 Introduction

Control of RVF relies on four basic principles:

- preventing contact between susceptible animals and RVF virus;
- stopping the production of virus by infected animals;
- stopping the production of virus by insect vectors; and
- increasing the resistance of susceptible animals.

These principles can be applied by:

- stopping the spread of infection through quarantine and movement controls. These controls should especially be placed over infected premises (IPs) and dangerous contact premises (DCPs), and risk enterprises such as abattoirs, saleyards, and milk factories (see Section 2.2.1, 2.2.6; Appendixes 1 and 2);
- urgent identification of IPs and DCPs. This involves meticulous tracing of contacts with infected herds and intense surveillance in the areas involved (see Sections 2.2.2 and 2.2.3);
- establishing immunity by vaccination (see Section 2.2.9; Appendix 6);
- initiating vector control (see Section 2.2.11, Appendix 5);
- eliminating sources of infection by prompt slaughter and disposal of infected and exposed animals (see Sections 2.2.5, 2.2.7); and
- testing the contaminated premises 6 weeks after destruction by placing susceptible sentinel animals (cattle and sheep) on the premises (see Appendix 4). The period may be longer if insect transovarial transmission is considered a possibility (see Section 1.6.3 and 2.2.12).

RVF is not on the list of diseases covered by the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases. However, because of the serious nature of this disease from both an economic and a public health viewpoint, and because of the considerable costs that are likely to be involved in control or eradication, while eradication remains a possibility, special funding arrangements may be necessary.

2.2 Methods to prevent spread and eliminate pathogens

2.2.1 Quarantine and movement controls

Effective quarantine and movement controls are essential to prevent spread of virus by animals. Even if the virus has established in an insect vector population, it will still be necessary to reduce the spread by animal movements. **Initially, stringent controls on the movement and congregation of susceptible livestock should be imposed.** These may be relaxed once the situation has been fully assessed.

Quarantine and movement controls should be imposed at several levels as follows (see Appendixes 1 and 2 for further discussion of declared areas and movement controls).

Infected premises (IP):

- A premises on which RVF is confirmed or presumed to exist—total movement control is imposed.

Dangerous contact premises (DCP):

- A premises containing susceptible animals that have been on an IP—total movement control is imposed.

Restricted area (RA):

- A RA will be drawn around all IPs and DCPs. The distance in any one direction is determined by factors such as livestock concentrations, the weather and prevailing winds, the distribution and movements of susceptible wild animals, the presence of possible vectors, and should be at least 10 km from the location of any known infected animals. It is important to prevent the spread of the disease by animal movements although some local spread may still occur due to aerosols. A distance of 10 km should ensure that the disease will be contained if there is no insect vector spreading the disease and no illegal movement of animals. A high level of movement control and surveillance will apply.

Control area (CA):

- A CA will be imposed around the RA. The purpose of the CA is to control movement of susceptible livestock for as long as is necessary to complete trace-back and epidemiological studies. Less stringent movement control and surveillance will apply than for the RA. Once the limits of the disease have been confidently defined, the CA boundaries and movement restrictions should be relaxed or removed. However, if the disease becomes widespread in an insect vector population, the CA may be expanded to include that vector's known geographical range. The CA must include all premises adjacent to known IPs. (In settled areas adjacent premises are likely to be part of the RA.)

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

Zoning

The area at risk to RVF may be determined by the geographical range of a particular species of insect. If it can be established that the vector is limited to a particular geographical region of Australia, then control procedures can be largely confined to that region or zone. Movements of animals outside that zone should have little bearing on the spread of the disease and should be relatively unimpeded. However, it will still be necessary to perform serological and/or entomological surveillance outside the zone to ensure the disease is indeed confined to that zone.

It would not be possible to allow movements of animals from within the zone to outside the zone because the disease may be spread to humans in blood and the range of species of vectors is unknown. This restriction may be relaxed for vaccinated animals.

Zoning may reduce the economic consequences of the disease by freeing up export markets for products and live animals from outside the disease zone.

2.2.2 Tracing

Infected humans may play an important role in the transmission of RVF. It will therefore be necessary to trace both animals and people who have come into contact with RVF virus.

Animals

Urgent and meticulous trace-back and trace-forward of all contacts with infected animals and premises is vital if the disease is to be effectively contained.

Tracing should include both livestock and animal products such as blood, milk, semen and embryos (where virus is likely to persist and be potentially infective).

It is possible that the first reported animal case will not be the index case, and trace-back will identify other animal or human cases. Stock owners should be encouraged to maintain records of stock movements to facilitate tracing (see **Control Centres Management Manual, Part 1/Section 4.4; Part 2/LRD 101**).

Humans

A human case of RVF should be notified to the appropriate State or Territory health authority, which, in collaboration with DSHS and the Communicable Diseases Network — Australia, 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

Livestock in the RA should be observed daily for clinical signs of disease and blood taken at weekly intervals from a statistically valid sample of animals and tested for antibodies to RVF virus.

This testing should commence following the index case and continue for 30 days following the last confirmed case. Serological monitoring should then be continued at monthly intervals for the next 12 months, and then quarterly for a further two years.

Humans

Surveillance of RVF will be undertaken jointly by Commonwealth and State/Territory health authorities under the auspices of the Communicable Diseases Network — Australia. Close liaison will be maintained with agricultural authorities and relevant data will be published in the DSHS publication *Communicable Diseases Intelligence*.

Vectors

In the event of an outbreak, surveillance for vectors can be either for virus isolation or to record the current population of biting insects. Collection for virus isolation is labour and expertise intensive. Currently it is limited by the personnel available with the taxonomic capacity for accurate identification of vectors collected as live insects, because the vectors should be identified immediately. Laboratory capacity is limited and only relevant species need to be examined.

Collections made purely for population analysis can be made by 'unskilled' labour after brief instruction. An adequate number of carbon dioxide baited light traps should be available at short notice. A number of local councils and State/Territory departments of

health currently use such traps for arbovirus surveillance. Collections should be stored in suitable condition for later sorting. It may also be possible to process these insects for virus isolation with techniques currently being developed. Available expertise will be a limiting factor for the sorting of these collections, which may be a lengthy process.

A range of collection techniques, including carbon dioxide light traps, truck traps and larval sampling, would be necessary. Animal bait collections with the operator working closely beside a bait animal may have to be used cautiously, given that a number of species and types of biting flies have been shown to transmit RVF mechanically by interrupted feeding.

2.2.4 Treatment of infected animals

There is no effective treatment for this disease.

2.2.5 Destruction of animals

The destruction of all susceptible animals on an IP (stamping out) is likely to be used only on the index farm or when it is believed that the virus has not become widespread in insect vector or uncontrolled wildlife populations. (Destruction of animals and property is highly dependent on compensation being available.)

It is very important that the timing and sequence of operations is such that there is the greatest chance of eliminating RVF virus from IPs before the virus becomes widespread in an insect vector or uncontrolled wildlife population. The first step is to ensure that the virus is contained on the IP. Strict movement controls must be imposed. The next step is to eliminate the virus from the IP. Clinical cases should be destroyed first (by shooting), followed by animals in direct contact, then the remaining susceptible animals (see **Destruction of Animals Manual**).

There is considerable danger to operators from aerosols created by blood splash when shooting animals and slashing carcasses. Safety precautions that minimise exposure to blood and other body fluids should therefore be adopted. It is recommended that only vaccinated staff or staff wearing protective half suits with portable air supplies (such as Vickers Medical high efficiency respirator), handle the animals. It is recommended that slaughter of the animals in the burial pit be considered with slashing of the carcase only being carried out by vaccinated or respiratory-protected staff. The area and clothing can be decontaminated by formalin or glutaraldehyde-based disinfectants. Acids can also be used to disinfect effectively (see **Decontamination Manual**; and Section 2.2.8)

2.2.6 Treatment of products and by-products

- Animals in the RA must not be slaughtered for meat because of the high risk to humans during the slaughtering process. Animals in the CA however, may be sent to slaughter at an approved abattoir.
- Chilled or frozen meat is probably safe for consumption following storage and cooking.
- Milk from the RA and CA must be pasteurised before consumption. If the milk cannot be pasteurised, then it must be disinfected by acidification and disposed of by burial.
- Baled wool (and mohair) should be sent for treatment by scouring.

- Skins, bones and manure should be regarded as contaminated and therefore disinfected and disposed of as described in the **Disposal Procedures Manual**.

2.2.7 Disposal

The preferred method of disposal of carcasses and milk on an infected premises is by burial rather than cremation. Burial is generally easier, quicker, uses fewer resources, is less polluting, and there is less risk of creating infective aerosols, which would be hazardous to the operators. However, several factors such as topography, soil type, and water table depth must be considered in selecting a burial site (see **Disposal Procedures Manual, Sections 3.1, 3.2 and 4.1**).

Dead animals on other farms should be buried without postmortem examination. If a postmortem is to be performed, then staff should be adequately protected against exposure to the virus (current vaccination or half-suit respiratory protection; see Section 2.2.5). It is not necessary or advisable to slaughter healthy animals on properties past the index farm.

2.2.8 Decontamination

The survival of RVF virus in the environment is limited and it is susceptible to acid pH. Because RVF virus only survives for a short time on fomites, decontamination of inanimate objects is not so important in the control of the disease. However, blood may remain contaminated for up to 4 months at 25°C (Brès 1981; see Section 1.6.2). Although fomites have not been incriminated in the spread of RVF, places such as abattoirs or laboratories may remain infective for several weeks.

The surface of all areas contaminated with blood splash should be sprayed with a suitable disinfectant, **eg 2% acetic acid. ALKALIS SUCH AS 4% SODA ASH SHOULD NOT BE USED. At all stages of decontamination, steps must be taken to prevent the generation and dispersal of infective dusts and aerosols.** Buildings used to house livestock, dairies, woolsheds, yards and all areas concerned in the destruction and disposal activities should be decontaminated. Fumigation of enclosed premises with paraformaldehyde may be used. Alternatively, a suitable liquid disinfectant should be used. High pressure hoses should be avoided as they tend to create aerosols.

Particular care should be taken to decontaminate blood-contaminated areas. The destruction team in their biohazard suits would be appropriate personnel for this task, (see the **Decontamination Manual, Tables 2.12, 3.13 and 4** for further details).

2.2.9 Vaccination

Vaccination could be used in the face of an outbreak to protect animals in the immediate area of the index case. All ruminants on farms within the RA should be immediately vaccinated with an inactivated RVF vaccine. The most likely source of this vaccine is the Veterinary Research Institute, Onderstepoort, South Africa (see Appendix 6). The vaccine should be administered twice, separated by an interval of 2–4 weeks.

Attenuated vaccines are available from South Africa and Kenya. Although more effective than the inactivated vaccine, they pose serious problems because of their side reaction (abortions and birth defects), the need to ensure they are free of exotic agents, and the possibility of insect transmission and reversion to virulence (see Section 1.5.3). The use of attenuated vaccines should only be considered if RVF spreads beyond the initial restricted area. There is no vaccine currently approved for human use in Australia.

2.2.10 Wild animal control

Because of their potential to harbour and spread the virus, susceptible wild animals pose a considerable threat to RVF control. The species most likely to harbour the virus are goats, camels and buffalo. However, the full host range of RVF is unknown and it cannot be assumed that other wild animal species are not susceptible.

The actual or potential role of wild animals must be assessed early in an outbreak. Initially, the distribution and abundance of wild animals should be surveyed especially on and near IPs, to determine whether and which wild animals are likely to have come into contact with infected vectors. The presence or absence of RVF virus in these wild animal populations should be determined, using various techniques including intensive trapping, baiting and shooting operations. If serological or virological evidence of RVF is found, then more extensive and systematic epidemiological studies should be undertaken to monitor the extent and spread of the disease in wild animal populations. If a large wild animal population is found to be infected, then the disease should be considered endemic.

If wild animals are considered to be a risk factor in the dissemination of infection, then programs aimed at reducing contact between infected vectors, wild animals and uninfected susceptible stock should be instigated as soon as possible. This is because wild animals may remain a mobile reservoir of virus which would facilitate insect transmission back to domestic livestock.

The best method or combination of methods would depend on the prevailing circumstances, including the species, distribution and abundance of the wild animal to be controlled, the terrain, and the availability of suitable labour and equipment.

Evidence of widespread infection in an uncontrolled wildlife population is evidence of endemicity. Under such circumstances there may be little point in implementing wild animal control. The fact that it had become widespread would be indicative of widespread infection in an insect vector population.

See the **Wild Animal Control Manual, in press** for details on performing wild animal population surveys, containment, control, and disease surveillance.

2.2.11 Vector control

In the event of an outbreak, the decision to conduct vector control will depend on the particular circumstances. For a human case in a large metropolitan area there may be no need for vector control. For an animal case on an urban fringe or an isolated rural case it is highly likely that reduction of potential insect vector populations would be attempted as rapidly as possible, if the incident is still localised. Aerial spraying and ground application of insecticide as ultra low volume (ULV) fogs would be considered initially (see Appendix 5).

The most readily-accessible source of vector control expertise and equipment will be State and Territory health departments, local government authorities or a body such as the Plague Locust Commission. The chemical most likely to be used will be whatever is suitable and available, with guidance from appropriate authorities.

In the event of spraying being undertaken, care should be taken to advise all the appropriate persons/groups, including the local council, local landholders, police and beekeepers operating in the area.

Efficiency of vector control may be limited by lack of knowledge of the most important target species (ie the vectors of most concern) and thus an inability to focus control actions on the relevant mosquito-breeding areas.

Treatment of livestock in the area with either a systemic insecticide such as ivermectin or a topical insecticide will also reduce the population of some of the potential vector species. These chemicals have withholding periods that will need to be observed, eg for ivermectin administered subcutaneously, the withholding period for meat for human consumption is 42 days, and for milk and milk products is 28 days.

In Africa, remote-sensing satellites have been used to identify large bodies of groundwater, which are breeding grounds for mosquitos, in order to target control to vector sources. This may be feasible in Australia under some circumstances.

2.2.12 Sentinel and restocking measures

The period between destocking and the use of sentinel animals will depend on whether transovarial transmission within an insect vector is considered a possibility (see Section 1.6). In the absence of this, a period of six weeks should suffice. If transovarial transmission is likely, the period may be extended up to one year depending on the weather (particularly rainfall).

Serological monitoring will be necessary at monthly intervals for one year and quarterly for the next two years to demonstrate freedom from the disease (see Section 3.4).

A decision on when to allow full restocking will be made after taking epidemiological factors into account, eg presence and type of vectors and the presence/absence of disease elsewhere.

2.2.13 Public awareness

Public awareness programs will be mounted by the appropriate State and Territory authorities, in collaboration with DSHS. Because of the public health significance of RVF, it will be necessary to ensure that the public is kept fully and accurately informed. Producers must also be informed of the symptoms of RVF and what to do if they suspect it in their herd. There is likely to be a loss of consumer confidence in products such as meat, milk and wool although these items, as normally processed, present no risk. On the other hand, items such as raw milk may present a risk to consumers if the milk is derived from infected animals.

A media information kit similar to those recommended in the **Public Relations Manual, Appendix 1** should be available as soon as the disease is diagnosed. Specialised kits should be available to give to veterinary and medical practitioners.

2.3 Feasibility of control in Australia

If the index case(s) can be isolated rapidly and transmission to insect vectors and domestic and native animals prevented, it would be possible to prevent establishment of RVF in Australia. With the wide range of susceptible hosts and potential insect vectors in Australia, it is unlikely that RVF could be easily eradicated.

If RVF became established in Australia, it would need to be controlled through vaccination. The vaccine of preference would be an attenuated vaccine if one could be developed that does not cause abortions or birth defects (see Section 2.2.9). The MV P12 vaccine developed in the United States does not cause abortions in pregnant sheep

(Baskerville et al 1992) and could be a good candidate. In the mean time inactivated vaccine would be used.

3 POLICY AND RATIONALE

3.1 Overall policy for Rift Valley fever

Rift Valley fever (RVF) is an OIE List A disease that has the potential for rapid spread, which is important in the trade of cattle, sheep and goats and is of major public health significance.

The policy is to eradicate RVF if possible, or if the disease is widespread, to instigate a control policy using a combination of strategies including:

- ☞ *modified stamping out*, which involves quarantine, slaughter of all infected and exposed susceptible animals on the property that was first infected (the index property), sanitary disposal of destroyed animals and insect control. This strategy will be adopted only if the virus has not spread beyond the index property. If RVF has spread beyond the index property, it may be appropriate to limit slaughter to clinically-affected animals on infected premises;
- ☞ *quarantine and movement controls* on animals in declared areas to prevent spread of infection;
- ☞ *decontamination* of facilities, products and things to eliminate the virus on infected premises to prevent human infection;
- ☞ *tracing and surveillance* to determine the source and extent of infection both in animals and insects and to provide proof of freedom from the disease;
- ☞ *vaccination* of all non-affected susceptible animals in declared areas with an inactivated vaccine;
- ☞ *vector control* in declared areas to reduce spread of disease by insects;
- ☞ *zoning* to define infected and disease-free areas; and
- ☞ *a public awareness campaign* to facilitate cooperation from industry and the community.

An uncontrolled outbreak of RVF would cause severe production losses with consequent dislocation and financial losses in the cattle, sheep and goat industries and associated service and sales industries. There would also be severe human disease with probable loss of life. It will therefore be necessary to act immediately and effectively to eradicate the disease, if possible, or otherwise control the disease by intensive vaccination.

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

The CVO(s) and chief medical officer(s) (CMOs) 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 Exotic Animal Diseases (CCEAD), the State/Territory and Commonwealth governments, and representatives of the affected industries and the Commonwealth and State/Territory CMOs. 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, Sections 3 and 4**.

3.2 Strategy for control and eradication

If the disease cannot be detected before the virus has become widespread in an insect vector population, the eradication strategy of choice will be vaccination. Other strategies include stamping out, vector control, decontamination and zoning, which will involve tracing and surveillance.

Vaccination will be implemented to increase the resistance of livestock to possible infection. Stamping out will be used to eliminate the major source of virus only **if it is considered that the virus has not established in the insect population**.

Any strategy must be supported by close liaison with all affected industries, the media and the public.

3.2.1 Stamping out

Stamping out (see Section 2.2.5) will only be carried out in a limited ‘best case’ scenario (ie if the virus is not spreading in the insect population and there have been no animal movements) and then probably not on more than the index premises. It would be used in conjunction with vector control (Section 2.2.11).

3.2.2 Quarantine and movement controls

Quarantine and movement controls will be implemented immediately on the IP, DCPs, any suspect premises (SPs) and within the RA. These will remain in force until the extent and distribution of the virus within and between species and insect vectors is better defined. These controls will apply to both live animals and products in the first instance.

The RA will have its boundary at approximately 10 km around the index IP but must be large enough to take into account all prevailing factors such as the weather, possible insect vector populations, wind and possible wild animal hosts. It is necessary to include all IPs and DCPs and as many SPs as possible.

Strict movement controls will apply. Only fully immune animals will be allowed to move out of the RA and only under permit. Movements in will also be restricted to fully immune animals because of possible losses from infection occurring.

The CA will be of sufficient size to enable appropriate movement controls to be imposed to enable trace-back and trace-forward to be carried out and the extent of disease to be determined at that time. It is likely that in the first instance the CA may be along State

borders but this area may be expanded or contracted as the epidemiological investigations progress. Restrictions on movements in the CA are likely to be less strict than in the RA.

See Appendixes 1 and 2 for further details.

Zoning

If the insect vector(s) were found to have a definable and manageable geographical range, zoning with appropriate movement controls (ie to meet OIE, human health and veterinary considerations) could be used to allow increased access to overseas markets that would otherwise be unavailable due to the presence of RVF in Australia (see Section 2.2.1 and Appendix 2). The definition of insect vector identification and distribution is likely to take time and will not be readily accepted by trading partners.

3.2.3 Treatment of infected animals

There is no effective treatment for this disease.

3.2.4 Treatment of animal products and by-products

Treatment of animal products from the RA and CA will be necessary. Milk must be pasteurised or treated by acid disinfection and buried. Animals from the CA may be slaughtered for meat but because of the danger in handling possible infected animals those from the RA may not be sent to slaughter in the early stages of the outbreak.

By-products such as fibres may be used if subjected to scouring. Other products such as manure and hides must be subject to disinfection.

3.2.5 Vaccination

An inactivated vaccine would be used in the RA surrounding the index property. The vaccine would be obtained from the Veterinary Research Institute, Onderstepoort, South Africa. Animals would be vaccinated twice, separated by 2–4 weeks. The vaccinated animals, in the first instance, should be identified to the properties of origin in the RA for serosurveillance purposes.

Sufficient quantities of RVF vaccines might not be available for use in an outbreak situation in Australia. Further, vaccines would have to meet Australian quarantine requirements (see Appendix 6).

3.2.6 Tracing and surveillance

Trace-back should involve tracing the movements of susceptible animals, people and products for at least 30 days prior to the detection of the first clinical case. Trace-forward will involve movements from 30 days before the first clinical case to the time that quarantine is imposed.

Surveillance will need to be undertaken on animals, including wild animals, on and around the IP and DCPs to determine the range of the RA and CA and when zoning is introduced. This information will play a major role in establishing proof of freedom.

3.2.7 Vector control

To limit the spread of the virus, vector control should be attempted as rapidly as possible after identification of RVF. The methods used will be determined by what equipment and

insecticide is rapidly available, the weather, and, in the case of systemic or pour-on insecticides, stock density and accessibility (see Appendix 5).

3.2.8 Decontamination

For human health reasons and the necessity to demonstrate proof of freedom, property decontamination should be carried out preferably using an acidic disinfectant such as 2% acetic acid (see Sections 1.6.2 and 2.2.8).

Decontamination of sheds and structures where animals may have been held will be undertaken even though the virus is unlikely to survive for long in the environment. It is important to ensure the disinfection of blood-splattered areas and that this is done with care to reduce aerosol-borne infection.

3.2.9 Wild animal control

Investigations to determine the distribution and density of wild animals should be undertaken early in the outbreak to assess which wild animals are likely to be in contact with domestic stock on or near the IP. If they pose a threat, further epidemiological investigations will be undertaken to determine the presence and extent of antibody or virus in the various populations. There is a need to reduce contact between wild animals and domestic livestock and various strategies should be considered.

Widespread infection rates in wild animals would indicate that insect vector spread is occurring and reduction of wild animal populations would be unwarranted. For further details see the **Wild Animal Control Manual, in press**.

3.3 Social and economic effects

3.3.1 Social and economic effects of the disease in animals

An uncontrolled outbreak of RVF would cause serious stock losses in the sheep, cattle and goat industries. The resulting financial losses would have a serious effect on the local economy in the area of the outbreak. Job losses both on farm and in support industries would occur.

An export embargo on dairy products from the CA is inevitable. However, while there is little technical justification for doing so, it is quite likely that some export markets will place embargoes on meat and possibly other animal products from the whole of Australia. There could be quite major effects on the Australian economy as a whole.

It is, therefore, necessary to act immediately to control, and then, if possible, eradicate the disease, and to establish Australia's freedom from RVF so as to re-establish export trade in animal products. It may take up to 3 years to regain 'free' status as the international reaction to zoning is unknown.

If RVF became endemic, continuing economic loss would occur due to reproductive losses, mortalities and the cost of ongoing vaccination. Permanent loss of some markets would be expected with associated down-turn in the rural economy and increased rural unemployment.

As an outbreak of RVF in Australia might be expected to cause a high mortality, the control strategies used will not lead to significantly more loss of stock on IPs than the

disease itself would cause. The cost of vaccination will be considerable (see Appendix 6) as it will involve not only the cost of vaccine but also the costs of mustering for regular re-vaccination. Vaccinated stock may attract a higher market value. The cost of serological monitoring to demonstrate proof of freedom will be quite substantial (see Section 3.4).

Movement restrictions will cause loss of market opportunities and associated financial losses to non-affected properties in the area, and to support industries such as the stock transport industry. This effect may be reduced by implementation of zoning and/or if vaccination is practised.

3.3.2 Social and economic effects of the disease in humans

In humans, the precise percentage of patients who develop the more serious forms of RVF, and suffer permanent effects or death, is unknown. However, in a few studies where data have been presented, serious illness was reported in about 20%, and in this group, mortalities ranged from 2–18%. In a large epidemic, therefore, the numbers of patients requiring intensive medical care for the ocular, encephalitic or haemorrhagic manifestations of the disease may pose an acute and significant economic burden, while those suffering severe chronic ocular symptoms will have a long-term economic impact on the community. The relatively large numbers of deaths that could occur in such an epidemic would also have a significant social impact.

3.4 Criteria for proof of freedom

The OIE Code conditions for proof of freedom are shown in Appendixes 3 and 4. Specifically, Article 2.1.8.2 of the Code states: ‘A country may be considered free from RVF when RVF is compulsorily notifiable, when no *case*, either clinical or serological, has been confirmed for the past three years and when the country has not imported any susceptible animals from a country considered infected with RVF during this period. However, animals may be imported under the conditions of Article 2.1.8.6 of the OIE Code (see Appendix 3).

In addition, three years must elapse since the use of any attenuated (‘live’) vaccine. Countries may impose additional conditions the most likely one being a serological testing protocol with high confidence limits (at least 95%) assuming a low disease prevalence with random sampling to cover the whole CA.

3.5 Funding and compensation

As Rift Valley fever is not included in the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases, funds to pay the costs of eradication, including compensation, will have to be found from other sources. Possible sources are:

- State government funds;
- State disease compensation funds;
- Commonwealth government funds; and
- special industry levies;
- other agreed arrangements.

Alternatively, the costs and losses might have to be borne by individual owners. In the CA many producers may wish to change to the production of commodities that do not involve susceptible species. Advisory services must provide information on alternate enterprises. Rural assistance schemes should facilitate desirable on-property structural

changes. The adequacy of rural adjustment arrangements and institutions to cover potential demands for assistance should be reviewed. Policies to support rural communities should be developed at all levels of government.

3.6 Strategies if the disease becomes established

If RVF becomes endemic in Australia, the most effective control strategy would be to vaccinate animals with an attenuated RVF vaccine. However, present vaccines based on the Smithburn strain suffer from many problems and their use in an endemic situation should be discouraged (see Section 1.5.3).

The chemically-mutagenised RVF vaccine (MV P12 developed in the United States) should be investigated as the potential vaccine source. An Australian vaccine manufacturer should be encouraged to produce this vaccine under licence, and its use in livestock in the endemic regions should be mandatory.

At present there is no RVF vaccine approved for human use in Australia, and there is no specific therapeutic agent for the disease. Therefore, control strategies from a human perspective would be:

- vector control — adult and larval;
- public education on vector control and means of preventing exposure to vectors (eg insect repellents and mosquito nets); and
- strengthening of surveillance and intervention programs.

Vector control programs should be undertaken at the State/Territory government, local government and individual levels, while public education would be the responsibility of the State and Territory governments.

The strengthening of surveillance and intervention programs would be undertaken by Commonwealth Government and the State/Territory governments under the auspices of the Communicable Diseases Network — Australia.

APPENDIX 1 Guidelines for classifying declared areas

Infected premises (IP)

A premises declared as an IP will be a defined area (which may be all or part of a property) in which the virus of RVF exists or is believed to exist.

Infected premises will be subject to quarantine by notice and control or eradication procedures (including decontamination).

Dangerous contact premises (DCP)

Premises declared as DCPs will be those to which at least one animal from an IP has been moved since 30 days before the first signs of clinical disease were detected, and up to the time when quarantine was imposed.

If it is decided to destroy animals located at the DCP(s) then, wherever possible, such animals should be taken back to the IP for slaughter and disposal. This recommendation is made because, if RVF is indeed present, the act of slaughtering animals will substantially contaminate the environment.

Suspect premises (SP)

A suspect property is one located in the vector zone in which at least one animal has had a clinical diagnosis of RVF but confirmation by an appropriate laboratory test is yet to be finalised.

This term should be used sparingly. Every effort should be made to clarify the status of a property to either free, DCP or IP as quickly as possible.

Restricted area (RA)

The RA should contain an area of at least 10 km around known infected animals on the index farm. The boundary of this area should follow property boundaries and where possible use barriers such as roads and railways. Watercourses should be avoided as the boundary because of the possibility of insect vectors breeding in them.

Control area (CA)

The CA may be as large as the whole State initially but may be contracted on the basis of epidemiological and ecological data as it comes to hand. Even in the remote areas, however, the CA must include the IPs and any adjacent premises.

APPENDIX 2 Recommended quarantine and movement controls

Infected, dangerous contact and suspect premises

Movement out of susceptible animals:
Prohibited.

Movement in of susceptible animals:
Prohibited.

Movement out of specified products:
Milk must be acidified and buried.
Wool and fibres such as mohair must be sent straight for scouring.
Other ruminant products must be destroyed.

Movement out of other animals:
No movement of any animal capable of being naturally infected.

Movement in and out of people:
People will be advised to use an insect repellent and appropriate clothing. Only authorised personnel will be allowed on to an IP. Personnel and stockowners and their families who have been on an IP must undertake to contact the Chief Medical Officer of the State or Territory where they are at the time of developing symptoms to report any symptoms that might be due to Rift Valley fever.

Movement in and out of vehicles and equipment:
Vehicles leaving an IP or DCP must be sprayed with a knockdown aerosol insecticide. Water holding containers should be removed or sprayed and then covered.

Movement out of crops and grains:
No restriction.

Restricted area

Movement out of susceptible stock:
No ruminants may leave RA except fully-immune vaccinated animals under permit.

Movement in of susceptible stock:
No ruminants to enter RA.

Movement within of susceptible stock:
Not allowed (except within a property) but fully immune vaccinated animals may move under permit.

Movement through of susceptible stock:
Not allowed.

Control area

Ruminants may be sent for slaughter at an approved abattoir under permit. Fully-immune vaccinated animals may leave CA under permit.

May move under permit.

May move under permit.

A permit may be issued in urgent circumstances.

Movement of specified products:

Milk must be pasteurised.
 Wool (and other fibres) must be sent straight for scouring.
 Semen/embryos, movement out prohibited.
 Other ruminant products under permit.

Milk must be pasteurised.

Movement of other animals, people, equipment:

No restriction. People should be advised to see their doctor if they develop symptoms consistent with RVF.

As for RA.

Vehicles:

No restriction.

Enterprises:

Abattoirs can only receive under permit and all staff must be fully briefed as to the human health risk of RVF. Milk factories can receive under permit and supervision. Milk must be pasteurised as soon as possible and equipment disinfected as directed.

As for RA.

Sales, shows etc:

Not to be held.

Can be held under permit.

Stock routes, rights of way:

No movement.

Movement under permit.

APPENDIX 3 OIE International Animal Health Code for Rift Valley fever

[NB The following text is taken directly from the OIE International Animal Health Code (1992); Chapter 2.1.8. For definitions, Appendixes, etc see the original text. The OIE Codes are amended every year in May. There have been no amendments to the code for RVF in 1993, 1994 or 1995.]

Preamble: For diagnostic tests and vaccine standards, reference should be made to the *Manual* (A8) [See OIE publications under References]

Article 2.1.8.1.

For the purposes of this *Code*, the *incubation period* for Rift Valley fever (RVF) shall be 30 days.

Article 2.1.8.2.

For the purposes of this *Code*:

RVF: free country

A country may be considered free from RVF when RVF is compulsorily notifiable, when no *case*, either clinical or serological, has been confirmed for the past three years and when the country has not imported any susceptible animals from a country considered infected with RVF during this period.

RVF: infected country

A country shall be considered infected with RVF if RVF has been confirmed there during the past three years or if vaccination with a live vaccine has been carried out there during this period.

If a RVF free country imports susceptible animals from an infected country, the *importing country* will not be considered infected, provided the importation has been carried out in conformity with the provisions of Article 2.1.8.6.

Article 2.1.8.3.

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

– domestic and wild ruminants.

Article 2.1.8.4.

When importing from RVF *free countries*, *Veterinary Administrations* should require: for domestic ruminants

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

- 1) showed no clinical sign of RVF on the day of shipment;
- 2) were kept in a RVF free country since birth or for at least the past 30 days.

Article 2.1.8.5.

When importing from RVF free countries, Veterinary Administrations should require:
for wild ruminants

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

- 1) showed no clinical sign of RVF on the day of shipment;
- 2) come from a RVF free country;

if the country of origin has a common border with a country considered infected with RVF:

- 3) were kept in a *quarantine station* for the 30 days prior to shipment;
- 4) were subjected to the diagnostic tests for RVF with negative results;
- 5) were protected from insect vectors during quarantine and transportation to the *place of shipment*.

Article 2.1.8.6.

When importing from countries considered infected with RVF, Veterinary Administrations should require:

for domestic and wild ruminants

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

a) vaccinated animals

- 1) showed no clinical sign of RVF on the day of shipment;
- 2) were vaccinated using a vaccine complying with the OIE standards not less than 21 days and not more than 90 days prior to shipment;
- 3) were kept in a quarantine station in the country of origin under official veterinary supervision for the 30 days prior to shipment and showed no clinical sign of RVF during that period;

b) unvaccinated animals

- 1) showed no clinical sign of RVF on the day of shipment;
- 2) were subjected to the diagnostic tests for RVF with negative results within 30 days before entry into quarantine;
- 3) were kept in a *quarantine station* in the country of origin under official veterinary supervision for the 30 days prior to shipment and showed no clinical sign of RVF during that period;
- 4) were subjected to the diagnostic tests for RVF with negative results not less than 14 days after entry into quarantine;
- 5) were protected from insect vectors during quarantine and transportation to the *place of shipment*.

APPENDIX 4 Procedures for surveillance and proof of freedom

Proof of freedom

In order to comply with Article 2.1.8.2 of the OIE Code (see Appendix 3) the following minimal conditions must be followed:

- (1) RVF must be compulsorily notifiable.
- (2) There must have been no clinical cases or positive serology in the previous three years.
- (3) No importation of susceptible animals have been imported in the past three years from a country infected with RVF unless the importation was in accord with article 2.1.8.6.
- (4) No use of live vaccine has been used in the past three years.

Article 2.1.8.6 states that for vaccinated animals:

- (a) they showed no clinical sign of RVF on the day of shipment;
- (b) they were vaccinated using a vaccine complying with the OIE standards;¹
- (c) they were kept in a quarantine station in the country of origin for 30 days under veterinary supervision and showed no clinical signs of RVF.

For unvaccinated animals:

- (a) they showed no clinical sign of RVF on the day of shipment.
- (b) they showed a negative response to an approved diagnostic test² for RVF within 30 days of entering quarantine;
- (c) they were kept in a quarantine station in the country of origin for 30 days under veterinary supervision and showed no clinical signs of RVF;
- (d) they showed a negative response to an approved diagnostic test for RVF not less than 14 days after entering quarantine;
- (e) they were protected from insect vectors during quarantine and transport to the place of shipment.

It is likely that overseas countries may impose additional conditions relating to surveillance of livestock and possibly vectors before regarding Australia, or a zone within Australia, as 'free'.

¹ Appendix 4.1.3.2. to the OIE Code (1992) referring to Rift Valley fever vaccines includes both live and inactivated vaccines. This appears to be an ambiguity but it is most unlikely that Australia would ever import ruminants vaccinated with live RVF vaccines.

² Approved diagnostic tests are listed and described in Appendix 4.1.3.1. of the OIE Code and include complement fixation, agar gel diffusion, haemagglutination inhibition, micro serum neutralisation, immunofluorescence, plaque reduction neutralisation, mouse neutralisation, ELISA and enzyme-linked immunofluorescent assay.

Surveillance

A statistically valid sample of animals from herds within the RA must be sampled weekly until 30 days following the last confirmed case. Thereafter the samples may be collected monthly for the next twelve months and quarterly for a further two years.

In a widespread outbreak where vaccination is used, due to the sheer logistics, the amount of sampling may have to be reduced until no more clinical cases are being detected. In this case the monthly sampling may be commenced at this time.

The statistical formulae for sampling rate have not been determined although the need for a confidence limit of 95% or higher can be assumed. To some extent, it will depend on livestock density, climate and insect populations in the RA.

Surveillance of vectors may be carried out as described in Section 2.2.3 and Appendix 5.

Sentinel animals

In an isolated outbreak where the index farm has been slaughtered out, sentinel animals will be placed on the farm six weeks after destocking. However, if transovarial transmission in an insect population is considered a possibility, this period could be extended to up to one year.

The time of full restocking can only be decided after all epidemiological factors have been taken into account, but in a worst case scenario could be as long as three years after destocking. This would be in the case of a small isolated outbreak where *Aedes* species mosquitos are abundant but where there is no apparent spread to other farms and virus is not isolated from any trapped insects. The three year period would be to ensure that virus was not maintained in the area by transovarial transmission in the mosquito population.

APPENDIX 5 Procedures for vector monitoring and control

Because of the broad spectrum of genera and species of biting flies from which RVF virus has been isolated, all blood-sucking insects should be considered as potential vectors, although mosquitos will be the prime suspects.

Carbon dioxide-baited light traps have been used for vector sampling in a number of African studies. Health and local government authorities in most Australian States and Territories currently use similar traps for arbovirus and adult mosquito monitoring programs. Preference would be to base monitoring on sampling of adult mosquitos with carbon dioxide-baited traps. CSIRO uses light traps designed to collect *Culicoides* biting midges, and should be able to supply adequate numbers of these. The actual numbers of traps used will depend on the area to be sampled. Analysis of collections will be limited by the availability of staff with appropriate expertise.

Larval mosquito sampling can be considerably more time consuming than adult sampling and often less reliable as a measure of prevalence.

If collections are to be processed for virus isolation, insects will need to be collected live. If they are purely for population analysis they should be placed into 70% ethanol. The technology to allow virus isolation from specimens preserved in alcohol is currently being refined.

Collections should aim to give:

- a list of all the potential vector species present;
- the relative abundance of those species; and
- breeding sites of those species.

Much of this type of information may be available from those health and local government authorities who routinely conduct arbovirus disease control programs.

The main aim of any vector control program must be breaking the transmission cycle by rapid reduction of all insects that are capable of taking up virus from vertebrate hosts. The main types of insecticide application to control adult insects are:

- ultra-low volume (ULV) application from the ground;
- ULV from the air;
- thermal fogs or mists from the ground; and
- systemic or topical treatment of livestock.

The principal mosquito control measure would most likely be ground-based ULV spraying of adult mosquitos using malathion (Maldison[®]). The efficiency of such treatment depends on taking account of the following factors:

- identification of significant breeding sites of the important vector species;
- prevailing weather;
- machinery access (for ground-based spraying); and
- environmental concerns, especially if treating urban and adjacent areas.

Similar measures are probably appropriate for the control of adult biting midges. Local government authorities in many mosquito-prone areas own or have access to machinery suitable for the control measures described above.

Aerial application of insecticides may be necessary because of access difficulties and/or the need to cover large areas quickly. However costs are considerably increased over those for ground-based application.

Control of peri-domestic species, such as *Aedes aegypti* (present in Queensland only), *Ae. notoscriptus* and *Culex quinquefasciatus* may require more resources in order to mobilise house and landowners and to provide sufficient personnel and equipment for rapid control. There may be a need for indoor spraying to eradicate these species.

Larval mosquito control would be based on application (low-volume spray or granule) of temephos (Insecticides: Abate[®]) or the more environmentally-benign *Bacillus thuringiensis* var *israelensis* (Bti) based products. Maldison could be considered as back-up insecticide for larval control.

Appropriate protection should be provided for spray operators and its use made compulsory for staff involved in insecticide applications. These staff must follow recommended safety guidelines when using insecticides, and adequate first aid measures must be on hand. When systemic or topical insecticides are used, the requisite withholding periods must be observed.

A control program should also include promotion of personal protection measures, such as use of repellents (products containing up to 20% DEET (N,N diethyl-m-toluamide) are the most effective) and long, loose clothing, and avoidance of areas where and when vectors are prevalent.

APPENDIX 6 Procedures for vaccination

A formalin-inactivated tissue culture grown (BHK21 cells) vaccine is available from the Veterinary Research Institute, Onderstepoort, South Africa. This inactivated RVF vaccine is registered with the South African government (registration number G1349 in terms of South African Act 36 of 1947). It is an adjuvanted vaccine made up in an equal volume of Alhydrogel (aluminium hydroxide gel). The vaccine cost is approximately \$0.37 (0.75 SA Rand) per cattle dose and \$0.19 (0.375 SA Rand) per sheep dose. South Africa holds a strategic reserve of 2 million doses of the inactivated vaccine. The vaccine must meet innocuity and potency requirements as defined by the OIE Code (see Appendix 3).

The inactivated vaccine is given subcutaneously at doses of 2 mL to cattle and 1 mL to sheep or goats. In a disease outbreak situation, animals are revaccinated 2–4 weeks after the primary vaccination. In an endemic situation, revaccination can be given 2–3 months after the primary vaccination and then annually to maintain a high level of immunity.

Note: No vaccine is at present available in Australia. The Onderstepoort vaccine is likely to meet OIE requirements.

There is no vaccine approved for human use in Australia.

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.
AUSVETPLAN	A series of documents that describe the Australian response to exotic animal diseases, linking policy, strategies, implementation, coordination and counter-disaster plans.
Consultative Committee on Exotic 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 declared area in which defined conditions apply to the movement into, out of, and within, of specified animals or things. Conditions applying in a control area are of lesser intensity than those in a restricted area (<i>see</i> Appendix 1).
Dangerous contact premises	Premises containing a dangerous contact animal(s) (<i>see</i> Appendix 1).
Decontamination	Includes all stages of cleaning and disinfection.
Ecchymotic haemorrhages	Small round spots or purplish discolouration caused by bleeding or bruising in the skin or mucous membrane.
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.
Epizootic	Disease affecting a large number of animals simultaneously; spreading rapidly through a large area (if epidemic).
Fomites	Inanimate objects (eg boots, clothing, equipment, vehicles, crates, packagings) that can carry the exotic agent and spread the disease through mechanical transmission.
Immunoglobulin	Antibody proteins
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.
Index property	The property on which the first or original case (index case) in a disease outbreak is identified to have occurred.
Infected premises	<i>see</i> Appendix 1.

Local disease control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Haemagglutination	Agglutination of red blood cells by a specific antibody or other substance.
Macula (adj: macular)	A small, yellow area seen on examination of the retina.
Meningoencephalitis	Inflammation of the brain, spinal cord and spinal nerves.
Movement controls	Restrictions placed on movement of animals, people and things to prevent spread of disease.
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.
Restricted area	A declared area in which defined rigorous conditions apply to the movement into, out of, and within, of specified animals, persons or things (<i>see</i> Appendix 1).
Risk enterprise	A livestock or livestock-related enterprise with a high potential for disease spread, eg an abattoir, milk factory, artificial breeding centre or livestock market.
Sentinel animals	Animals used for the express purpose of detecting the presence of the Rift Valley fever virus.
Stamping out	Eradication procedures based on quarantine and slaughter of all infected animals and animals exposed to infection.
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, insects or things to determine the presence of Rift Valley fever.
Susceptible species	Animals that can be infected with the disease (for RVF — all ruminants and humans; other species can become infected but are not usually epidemiologically significant).
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.
Suspect premises	Premises containing suspect animals that will be subject to surveillance (<i>see</i> Appendix 1).
Tracing	The process of locating animals, persons or things that may be implicated in the spread of disease, so that appropriate action be taken.

Vaccines	
– 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 <i>biological</i> vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A <i>mechanical</i> vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent.
Vector competence	The ability of a blood-sucking insect to become infected with an arbovirus after ingestion of an infective blood meal, and to transmit the virus subsequently when feeding on a vertebrate host.
Viraemia	The presence of viruses in the blood.
Zoning	Dividing a country into defined infected and disease-free zones. A high level of movement control between zones will apply.
Zoonosis	Disease transmissible from animals to people.

Abbreviations

AAHL	CSIRO Australian Animal Health Laboratory, Geelong
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CA	Control area
CCEAD	Consultative Committee on Exotic Animal Diseases
CMO	Commonwealth medical officer
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	Chief veterinary officer
EDTA	Ethylene diamine tetra-acetic acid (anticoagulant for blood)
DCP	Dangerous contact premises
DHSH	Department of Human Services and Health (Cwlth)
ELISA	Enzyme-linked immunosorbent assay
Ig	Immunoglobulin
IP	Infected premises
MV P12	Chemically-mutagenised RVF vaccine
OIE	World Organisation for Animal Health [Office International des Epizooties]
RA	Restricted area
SP	Suspect premises
RVF	Rift Valley fever
ULV	Ultra-low volume

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Video/training resources

Hypothetical — Rift Valley fever (video), AAHL (available from the Animal Diseases/Incidents Section, DPIE, Canberra; or AAHL).

[See the **Summary Document** for a full list of training resources.]

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OIE Code (1992). *International Animal Health Code* (6th edition), OIE, Paris, France.

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