

**AUSTRALIAN VETERINARY EMERGENCY PLAN**

# **AUSVETPLAN**

**1996**

## **Disease Strategy**

### **Rabies**

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 **rabies**, 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 in February 1991 by the then Australian Agricultural Council out-of-session at meeting 135, for use in an animal health emergency caused by the introduction of rabies into Australia. The strategy has been upgraded and approved by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), out-of-session in January 1996.

Rabies is designated as a List B 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 socioeconomic and/or public health importance within countries and which are significant in the international trade of animals and animal products'. The principles contained in this document for the diagnosis and management of an outbreak of rabies conform with the **OIE International Animal Health Code 1992** (OIE Code; see Appendix 3).

Rabies is included in the list of diseases for which arrangements exist under the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases. Information on the cost-sharing arrangements can be found in the AUSVETPLAN **Summary Document** and in the **Valuation and Compensation Manual**.

Detailed instructions for 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. In addition, the *Amended Plan for the Eradication of Rabies, Appendix XXVIII* (National Health and Medical Research Council, October 1984) is a joint document from the Commonwealth Department of Human Services and Health and the Department of Primary Industries and Energy. This document is currently being reviewed.

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

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# 1 NATURE OF THE DISEASE

Rabies is an almost invariably fatal viral encephalitis affecting all warm-blooded animals. It is characterised by a unique mode of transmission (usually by the bite of a rabid animal) and a long and variable incubation period (four days to many years). The disease is of great public health significance as well as being of veterinary importance.

In Europe and North America endemic rabies is primarily a disease of wildlife, which has proved extremely difficult to eradicate. In Central and South America, Africa, the Indian subcontinent and Asia, rabies is primarily a disease of urban areas and is carried by dogs.

## 1.1 Aetiology

Rabies is caused by a virus belonging to the *Lyssavirus* genus of the family Rhabdoviridae. These are bullet-shaped viruses that contain single-stranded, unsegmented RNA, which is complementary to messenger RNA and is enclosed in a nucleocapsid protein complex.

As well as classical rabies virus, the *Lyssavirus* genus also contains a number of related viruses that have the potential to cause rabies-like disease in man and animals (Table 1).

There are several other viruses that show some antigenic relatedness to rabies, including Obodhiang and Kontonkan. One such rhabdovirus, Adelaide River, has been reported in Northern Australia.

**Table 1 Rabies-related viruses**

<b>Serotype</b>	<b>Known distribution</b>	<b>Significant animal hosts</b>
Rabies	Worldwide, except Australasia, Japan, UK, parts of Europe and island nations	canines, foxes, skunks, bats, raccoons, etc
Lagos Bat	West, Central and Southern Africa	fruit bats, cats
Mokola	West, Central and Southern Africa	shrews, cats, dogs, rodents
Duvenhage	Southern Africa and northern Europe	insectivorous bats
Finland	Finland	insectivorous bats

## 1.2 Susceptible species

All warm-blooded animals are susceptible to rabies. However the susceptibility is by no means uniform, as shown in Table 2. Birds do not play any part in the maintenance or spread of rabies infections.

**Table 2 Animal susceptibility to rabies infection<sup>1</sup>**

<b>Extremely high</b>	<b>High</b>	<b>Moderate</b>	<b>Low</b>
foxes	hamsters	dogs	American opossums
coyotes	skunks	sheep <sup>2</sup>	
jackals <sup>2</sup>	raccoons	goats <sup>2</sup>	
wolves <sup>2</sup>	domestic cats	horses <sup>2</sup>	
kangaroo rats	bats	non-human primates	
cotton rats	cattle		
common field voles	bobcats		
	mongooses <sup>2</sup>		
	meerkats <sup>2</sup>		
	rodents		

<sup>1</sup> Adapted from the WHO Expert Committee on Rabies, 6th Report (1973).

<sup>2</sup> Epidemiological evidence only.

**Notes:** Unless otherwise indicated, susceptibility is based on the intramuscularly inoculated dose required to infect at least 50% of the animals (the virus strain used is not given).

Although not mentioned in the table, human beings are only moderately susceptible.

The susceptibility of Australian native animals is unknown. One study has indicated that New Guinea marsupials may be more susceptible than New World species.

The most important animal families in maintaining rabies cycles are:

- Canidae — dogs, foxes, jackals, wolves, etc
- Mustelidae — skunks, martens, weasels, ferrets and stoats
- Viverridae — mongooses and meerkats
- Procyonidae — raccoons
- Chiroptera — bats

Many animal species can be regarded as accidental hosts or ‘dead-end’ hosts, and these species have no epidemiological significance in sustaining rabies epidemics. These include humans and other primates, horses, cattle, sheep and pigs. Feral pigs under conditions of high density may be a factor in the transmission of the disease.

In any ecosystem overseas, in which rabies is currently endemic, one or at the most two of the above species are responsible for perpetuation of epidemics, although accidental infections can also occur in a wide range of other species. Rabies viruses appear to adapt to specific host species. Species-adapted biotypes can be identified by modern monoclonal antibody studies, and these generally seem to be quite stable genetically. Whilst biotypes may readily cause infection in another species, continuing transmission cycles are not maintained in the second species. For example, well defined canine, fox, skunk, raccoon and bat biotypes are recognised in different areas. There are of course exceptions, one being the establishment of a jackal strain in kudu (a species of African antelope) populations in southwest Africa in recent years.

### 1.3 World distribution and occurrence in Australia

Rabies is present in most of Europe except the United Kingdom, Ireland and parts of Scandinavia. Rabies is also present throughout Africa, the Middle East, most of Asia, and the Americas. Japan, Singapore, New Zealand, Papua New Guinea and the Pacific Islands are free of the disease (Geering et al 1995).

There has been one probable occurrence involving transmission of rabies in Australia — in Tasmania in 1867, involving several dogs, a pig and a child bitten by one of the dogs. In two more recent cases, children (one each in 1987 and 1990) who have contracted the infection in endemic countries, have developed the clinical disease in Australia after a protracted incubation (Geering et al 1995).

### 1.4 Diagnostic criteria

#### 1.4.1 Clinical signs

##### Animals

##### *Dogs*

There is a prodromal stage, which lasts 2–3 days but is often missed by the dog's owner. In this stage there often is a sudden change in temperament. Dogs that are normally friendly towards people may suddenly become snappy and uncertain, and shy dogs may become affectionate.

The prodromal stage is followed by one of two syndromes — furious or dumb rabies. The dumb form is more common, but some dogs may alternate between dumb and furious rabies. The clinical course is often shorter in dumb rabies, but in both forms death occurs 3–7 days after the end of the prodromal stage. There may be increased or exaggerated sensitivity at the wound site to any sensory stimulus, especially touch.

In the furious form the dog becomes unusually restless, seldom lying or sitting in one spot for more than a short time and if confined it moves around ceaselessly in the confined space. The pupils are dilated, there is loss of the corneal reflex, and sometimes a squint. The animal assumes a watchful, puzzled or apprehensive look (an important sign) and may snap at imaginary objects. There is a change in phonation (voice), often with a characteristic low-pitched hoarse howling. At certain periods the dog seems possessed of abnormal strength and insensitivity to pain. Bars of cages, furniture and other objects are frequently attacked to the point where the animal's teeth are reduced to stumps and the mouth lacerated. If the dog is not under restraint, this excitable energy is manifested by furious, aimless running (sometimes for long distances) and by snapping at animate or inanimate objects in its path. There is depraved appetite, with animals eating such items as stones, sticks or earth. The furious signs abate after 1–4 days and are replaced by rapidly progressing ataxia, convulsions and ascending paralysis.

In the dumb form the dog remains quiet, is not irritable, and only bites when provoked. It is lethargic and may hide behind any cover. The watchful, apprehensive look in the eyes, noted in the furious form, is also present. There is paralysis of the hindquarters and muscle tremors. A characteristic late sign is paralysis of the jaw ('dropped jaw'). The tongue is also paralysed and hangs flaccidly from the mouth, and there is drooling of saliva. The dog is unable to eat. It is also unable to lap water, although it may try hard to do so. The owner may suspect oesophageal obstruction and attempt to examine the animal

or have it examined by a veterinarian. In contrast to human rabies, hydrophobia is a rare sign in dogs and other animals. Paralysis increases and death supervenes within a few days, usually from paralysis of respiratory muscles.

#### *Cats*

The clinical signs are generally similar to those of dogs, but the furious form occurs in about 75% of cases. The prodromal stage seldom lasts for more than 24 hours. The furious stage lasts 1–4 days. Rabid cats often retreat into hiding from which they ferociously spring to attack people or other animals when approached. Their pupils are dilated, backs arched and claws protruded. They may mew continuously and this becomes hoarse.

As the disease progresses into the paralytic phase, the animal shows marked incoordination followed by posterior paralysis. The muscles of the head become paralysed and the animal soon lapses into a coma and dies.

#### *Horses*

Clinical signs of rabies in the horse are highly variable and can be easily confused with other diseases affecting the nervous system, such as cervical vertebral malformation or other viral encephalitides. There are three forms of rabies in the horse, the furious or cerebral form, the dumb or brainstem form and the spinal cord or paralytic form. Absence of aggression in horses does not rule out rabies.

Clinical signs can include colic and lameness but in most cases horses show hyperaesthesia, fever, ataxia and paresis. Ataxia and paresis frequently begin in the hindquarters and progress cranially. Loss of tail and anal sphincter tone is common. The disease will progress with most animals becoming depressed, recumbent and comatose before death.

In the furious form, periods of marked excitation and aggressiveness alternate with periods of relative calm. Affected horses become restless, stare, paw, or move their ears and draw their upper lips back and forth continually and salivate excessively. Sexual excitement may be intense. They may grind their teeth and whinny as if in great pain and show signs of acute colic. They may lash out with incredible fury at any perceived threat or restraint and may bite or charge other animals or moving objects. They often bite or rub at the bite site causing self-mutilation.

As paralysis develops horses fall repeatedly, finally remaining down with their legs thrashing. Equine rabies progresses rapidly with most affected animals dying 5 days after onset of clinical signs.

#### *Cattle*

There is initial depression and cessation of milk production. Paralysis of throat muscles with grinding of teeth and excess salivation is common and may lead to a false diagnosis of oesophageal obstruction. Cattle may bellow frequently in a low-pitched voice. There is increased sexual excitement. Some animals develop one or more furious stages and may attack other animals or objects; they charge and butt, but seldom bite. Other animals show little excitement.

As paralysis develops, cattle knuckle over at the fetlocks, stumble and fall frequently. Finally they are unable to rise, lapse into a coma and die.

*Sheep*

Several almost simultaneous cases often occur in a flock, resulting from multiple attacks by a rabid predator. There is a period of excitement during which affected sheep move restlessly, salivate, grind their teeth, show twitching of the lips and oscillation of the tongue, pulling of wool and aggressive butting of other sheep or objects. Rams exhibit sexual excitement. Sheep may be either silent or emit frequent hoarse bleats. The excitation stage is followed by depression, increasing weakness, paralysis and recumbency. Sheep generally die within 72 hours of the onset of clinical signs.

*Pigs*

Affected pigs tend to stand trembling in a darkened corner but may dash out and bite if provoked. They may rub or gnaw at the bite site. There is abnormal deep grunting. Depraved appetite is common. There may be alternate periods of intense activity and recumbency. Sows may kill their offspring. There is increasing dullness, incoordination and paralysis.

*Foxes*

Both dumb and furious forms occur. There is anorexia, agitation and a characteristic abnormal cry. Normal fear of people and other animals is lost. Foxes may snarl, charge and snap at passing people, animals and even vehicles. As the disease progresses the animal becomes more confused and uncoordinated. With the onset of paralysis it falls and may be unable to rise. It may attempt to drag itself before finally lapsing into a coma and dying.

*Other wildlife species*

The clinical signs are variable. A most important common feature is loss of normal shyness and fear of people and other animals. This makes such animals particularly dangerous to people, who wrongly interpret this behaviour as indicating friendliness.

**Humans**

The clinical manifestations of rabies in humans can be divided into five stages as follows.

- 1) An incubation period of variable length (between 20 and 90 days in more than 90% of cases).
- 2) A prodromal phase of 2–10 days marked by non-specific symptoms, such as headache, malaise, muscular pain, loss of appetite, nausea, vomiting and a non-productive cough. The prodromal symptom, which most suggests impending rabies, is the complaint of paraesthesias (numbness or tingling) and/or fasciculations (twitching) at or about the site of inoculation of the virus.
- 3) An encephalitic phase characterised by periods of excessive motor activity, excitation and agitation. Confusion, hallucinations, muscle spasms, seizures and facial paralysis occur. Characteristically, lucid periods are interspersed with the episodes of mental aberration. Brain stem dysfunction begins shortly after the onset of the encephalitic phase. Excessive salivation and difficulty in swallowing appear and hydrophobia is seen in about 50% of cases.
- 4) Coma
- 5) Respiratory failure and death, or recovery (extremely rare). The median survival after the onset of symptoms is about four days, unless intensive respiratory support is instituted.

### 1.4.2 Pathology

There are no consistent macroscopic lesions in animals that die of rabies. Animals may be emaciated and there may be self-inflicted injury, particularly at the site of infection in carnivores, or injuries sustained in fights. Foreign bodies may be found in the stomach, particularly in monogastric animals.

Microscopically, the most significant lesions are in the central nervous system and cranial and spinal ganglia. There is perivascular cuffing, focal and diffuse gliosis, neuronal degeneration and intracytoplasmic inclusion bodies or Negri bodies in the neurones. Negri bodies vary in size with the host, are large in dogs and cattle and are found most commonly in the neurones of the hippocampus or in the Purkinje cells of the cerebellum in cattle. They are found less frequently in the glial cells, in ganglion cells of the salivary glands and adrenal medulla and in the retina.

Ganglioneuritis occurs particularly in the Gasserian ganglion and it has been recommended that this site should be examined when traumatic destruction or putrefaction renders it impossible to examine brain tissue. In the absence of Negri bodies, lesions in the ganglia are not specific for rabies, but lack of lesions in the Gasserian ganglion is considered to be an indication that a diagnosis of rabies is unlikely.

See Section 1.4.5 for safety precautions when working with live rabies virus.

### 1.4.3 Laboratory tests

Rabies may be suspected in animals that display neurological signs, including behavioural changes and paralysis, followed by death within 10 days. The diagnosis must be confirmed by laboratory tests.

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/transport**

Whole brains collected after natural death or from animals sacrificed during any stage of the clinical syndrome are required for rabies diagnosis. Severed heads and, for small animals, whole carcasses, should be forwarded, chilled. Care should be taken not to damage the brain during slaughter (see Section 1.4.5).

Unpreserved and formalin-fixed samples of other tissues should be collected at autopsy to aid differential diagnosis. Whole blood (in EDTA anticoagulant) and serum are required for the RFFIT test (see Table 3). Lung, liver and stomach contents should be collected for toxicological investigations (for further details see Geering et al 1995).

#### **Laboratory diagnosis**

*AAHL tests.* The tests currently available at AAHL for the diagnosis of rabies are shown in Table 3. Results of fluorescent antibody tests are available within 4 hours. Virus isolation using mouse neuroblastoma cells has all but replaced intracerebral inoculation of mice. Mouse intracerebral inoculation is only used as a last resort where all other tests are negative but there is still strong suspicion of rabies.

**Table 3 Diagnostic tests currently available at AAHL for rabies**

Test	Specimen required	Test detects	Time taken to obtain result
Fluorescent antibody test	fresh brain	antigen	4 hours
Histopathology	formalin-fixed brain	characteristic lesions	2 days
Immuno-peroxidase staining	formalin-fixed brain	antigen	2 days
Virus isolation using mouse neuroblastoma cells	fresh brain	virus	3 days
Polymerase chain reaction	virus or tissue	virus genome	1–2 days
Rapid fluorescent focus inhibition test (RFFIT)	whole EDTA blood or serum	virus antibody	3 days
Mouse intracerebral inoculation (rarely used)	fresh brain	virus	10–28 days

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

*Other tests.* The initial virus isolate in an outbreak can be further characterised by examination against a panel of monoclonal antibodies. This not only differentiates classical rabies virus (serotype 1) from other lyssaviruses, but can also provide valuable epidemiological information on the possible origin of the virus and its likely vertebrate host spectrum (biotype).

Weak or negative fluorescent antibody staining may be obtained from brain specimens of human or animal patients that have had clinical signs indicative of rabies. If neurological signs and death occur in mice inoculated with the above brain specimens, a rabies-related virus (eg Mokola, Duvenhage, Lagos Bat) should be suspected as the aetiological agent. Diagnostic tests utilising a range of monoclonal antibodies for all of the Lyssavirus genus members would then be undertaken.

#### 1.4.4 Differential diagnosis

##### **Carnivores**

Clinical signs of rabies can look similar to any illness that causes flaccid paralysis of the larynx, general depression or abnormal aggression. Change in behaviour is the key clinical sign for wildlife and domesticated animals and this sign may be missed by the owner of an affected animal. The behaviour changes described for rabies can also occur with canine distemper in dogs, foxes and ferrets.

##### **Herbivores**

Clinical signs of rabies can look similar to choke or laryngeal/pharyngeal obstruction with a foreign body, any neurological disease that causes ataxia or any metabolic disease that causes depression. Change in behaviour is a key clinical sign for wildlife.

#### 1.4.5 Safety precautions

**IMPORTANT: Potentially rabid animals should be approached with extreme caution.** Every effort should be made to capture and safely confine them. Nets or dog-catching poles with stout rope or wire loops may be used for small animals and ropes or other restraint for large animals. Containers, cages or pens should be very strongly constructed and well secured. If a suspected case is first presented at a veterinary clinic it should be hospitalised away from other animals. Confined suspect rabid animals should be under veterinary care.

If the animal cannot be safely captured or confined and therefore constitutes a risk to people or other animals it should be destroyed immediately. If destruction is to be carried out with a firearm, it is recommended to try to shoot through the heart rather than the head as fixed brain samples are used in diagnosis of the disease. However, this approach may prove too difficult in an emergency and shooting through the head would not preclude laboratory examination and diagnosis, although it should be noted that a head shot with a large calibre weapon would not only destroy all useful tissue but may pose considerable danger to the shooter and other bystanders from virus aerosols. Smaller calibre weapons should therefore be used (32-calibre maximum for cats and small dogs). Companion animals can be destroyed with a lethal injection using a crush cage if necessary.

Thick rubber gloves, eye goggles, face mask and a plastic or rubber apron that can easily be disinfected should be worn when doing autopsies or when working with live rabies virus in a laboratory. Aerosols created by an open spinning centrifuge have been known to infect a microbiologist in a New York laboratory. Carcasses should be incinerated, and used instruments soaked in disinfectant and then boiled or autoclaved.

If a person is bitten by a suspected rabid animal, or if a fresh wound or skin abrasion is contaminated with its saliva or tissue fluids, post-exposure treatment as outlined in Appendix 5 should be started immediately. The treatment course may be suspended if laboratory examination conclusively shows that the animal was not rabid.

## **1.5 Resistance and immunity**

### **1.5.1 Innate and passive immunity**

Although all warm-blooded animals, including humans, are susceptible to rabies, the degree of susceptibility is by no means uniform, as shown in Table 2.

Once rabies virus infects the brain and clinical signs occur, the disease is almost invariably rapidly fatal. However, on the basis of the finding of naturally-occurring rabies antibodies, much presumptive evidence suggests that abortive infections may occur in a proportion of animals in bat and carnivore populations during rabies epidemics.

### **1.5.2 Active immunity**

Apart from the few instances of dogs surviving rabies or developing chronic infection in West Africa, Ethiopia and India, there have been isolated unconfirmed reports of similar incidents occurring elsewhere in the world, but until further evidence is produced it can be assumed that the carrier state in dogs is extremely rare.

A non-fatal form of rabies in dogs was first recognised in Senegal and Niger in 1912 and its distribution apparently extended across Zaire, Cameroon, Ivory Coast, Ghana, Nigeria and the Sudan. There have been no recent reports, but strains of virus capable of producing non-fatal and chronic infection of dogs were isolated in Ethiopia in the 1950s and 1970s and similar findings were reported in India. Naturally-infected dogs were capable of transmitting fatal disease to humans, in some instances over a period of years. The site of chronic infection may be the tonsil. In a recent investigation, four isolations of rabies virus were made from saliva of healthy dogs presented for vaccination over a period of 5 years in Nigeria. Only one of these isolates produced fatal disease in puppies (Aghomo et al 1990).



### 1.5.3 Vaccination

#### Domestic animals

Modern rabies vaccines that afford a high level of immunity are available for dogs, cats and domestic livestock species. These are broadly classified into three types:

- attenuated ('live') virus vaccines: eg, ERA;
- inactivated nervous tissue vaccines, eg suckling mouse brain origin (SMBO); and
- inactivated tissue culture vaccines.

Safety problems have been experienced with some attenuated virus vaccines, with occasional field reports of vaccine-induced rabies in dogs and cats. For this reason they have largely been supplanted overseas by **inactivated tissue culture vaccines**, and it is recommended that **only inactivated tissue culture vaccines be used for parenteral vaccination of domestic animals in Australia.**

Several vaccines are available that provide solid immunity in adult animals for at least three years. However some studies have demonstrated poorer immune responses in young dogs, which are not necessarily associated with interference from maternal antibodies. It is recommended that pups vaccinated under 6 months of age be revaccinated 6 months later.

**Within one month after primary vaccination, a peak rabies antibody titre is reached and the animal can be considered immunised.**

Further detailed information on immunisation of domestic animals can be found in the *Compendium of Animal Rabies Control* (National Association of State Public Health Veterinarians 1995).

A single vaccination of an already infected animal will not prevent the onset of clinical rabies. The more extensive post-exposure therapy of vaccine and antiserum used after dangerous exposure of humans is not used in animals.

Mass vaccination of dogs and cats, along with elimination of stray animals and control over the movement of owned animals, is the integral part of urban cycle rabies eradication. This has been well demonstrated by several field studies. For example a serious rabies outbreak in Memphis in 1948 could not be halted although efficient dog control measures were in place. However the disease was eradicated within four months of a compulsory mass dog vaccination campaign. In another urban outbreak involving a much larger area, in Houston in 1954, [elimination of the rabies virus](#) was achieved within 12 months of instituting mass vaccination.

Vaccination of livestock is not essential for eradication, but may be desirable to prevent sporadic cases in these animals. Pleasure horses, valuable stud animals and any other animal that comes into frequent human contact during the incursion should be considered for vaccination.

At present there are no commercially available vaccines for the other rabies-like Lyssaviruses.

#### Humans

Modern, safe and potent vaccines are available for human use, both for pre- and post-exposure prophylaxis. Human diploid cell vaccine (HDCV), an inactivated vaccine prepared from rabies virus cultured in a diploid cell line, is the vaccine approved for use in Australia. Rabies immunoglobulin, human (RIGH), obtained from hyperimmunised

human donors, may be used in post-exposure treatment. A small stock of RIGH is held in Australia.

Pre-exposure immunisation may be administered to people who may be occupationally exposed to infection, such as veterinarians and laboratory diagnostic staff. The primary immunisation course consists of three injections of HDCV over a 28-day period followed by boosters at regular intervals.

Post-exposure prophylaxis, combined with appropriate first-aid treatment should be administered as soon as possible after a potentially dangerous exposure to the virus (eg after a bite from a suspect rabid animal). Post-exposure prophylaxis consists of up to five injections of HDCV, with or without human rabies immune gamma globulins, depending on the pre-existing immune status of the patient.

For further information on human vaccines see Appendix 5.

## **Wildlife**

### *Vaccination*

Oral vaccination can be delivered to wildlife by a bait system, based on attenuated (modified live) Evelyn Rokitnicki Abelseth (ERA) strain and Street Alabama Dufferin (SAD) strain vaccines have been used successfully in the control and elimination of wildlife rabies in Europe and North America. The ERA strain is a derivative of the SAD strain.

Oral vaccination is made possible by the ability of vaccine strains to produce immunising infection through the oral/pharyngeal route. High vaccine virus doses ( $>10^{6.0}$ TCID<sub>50</sub>) are incorporated with stabilisers into suitable baits (eg chicken heads or custom manufactured sausages). Strategic vaccination in Switzerland, in which target areas were seeded three times per year with 12–15 baits per square km, achieved eradication of fox rabies from the country within a few years. Successful large-scale, campaigns against fox rabies have now been mounted in Europe, and in Canada in combination with the trap–vaccinate–release (TVR) method (see below).

Attenuated ('live') vaccines used in oral rabies baiting programs do have the problem of occasionally causing vaccine rabies in some target and non-target species, ie fox, raccoon, skunk and calf. In most species where the vaccine immunises successfully there will be individuals who develop clinical rabies. However, the strain isolated from these cases has always been vaccine strain. There will always be individuals with depressed immune systems that will be at risk (Lawson et al 1987, 1989; C. MacInnes, Ministry of Natural Resources, Canada, 1995, pers. comm.). The success of these oral vaccines also varies according to the species involved. Some species accept baits easily and can absorb vaccine well via the oropharyngeal mucosa and develop immunity, while others do not easily accept baits, have poor absorption via the oropharynx and develop better immunity with intramuscular injection (ie TVR — see below).

Other important developments have occurred in virus-vector vaccine technology. A vaccinia-rabies glycoprotein recombinant virus vaccine (V-RG) has been developed between the Wistar Institute, Philadelphia and Rhone Merieux, France and was trialed by the University of Liege in Belgium. It has now been used very successfully in the field in Europe and North America and now has a limited licence for field use in the USA. American experience is that V-RG is an effective vaccine for foxes but not for skunks. Results from its use in France shows that V-RG has better thermostability in medium to

high temperature conditions than modified 'live' vaccines SAD-19 and SAD avirulent Gif [SAG1, derived from SAD] (Rupprecht et al 1994).

Another vaccine under development is the human adenovirus recombinant (HAd5-RG). This vaccine, which is the cause of less concern to human health experts than the vaccinia vector, is being developed by collaboration between the University of Toronto and McMaster University. It has proven more effective in skunks than the V-RG but has not been fully tested in raccoons. A preliminary experiment indicated it is effective. Tests of efficacy and safety in a wide range of species that might encounter this bait vaccine must be completed (C. MacInnes 1995, pers. comm.).

Before such techniques could be used widely against a possible outbreak of rabies in Australian wildlife, it would be necessary to carry out trials years ahead of time to ensure that it could be safely used within the Australian environment. The safety and efficacy of oral vaccine strains and bait preference would need to be researched in target and non-target species. Some of this experimental work in Australia could be carried out in advance at AAHL, but only if the risk warranted the research.

#### *Trap–vaccinate–release (TVR)*

This involves live capturing of wildlife with cage traps and vaccinating by intramuscular injection. This method could be used for endangered species or species of wildlife that live in areas inhabited by people where population reduction methods and oral baiting methods are unsuitable, not acceptable to the public or satisfactory baits have not been developed. TVR is preferred to depopulation as the latter causes a population sink into which infected or susceptible animals migrate. Population reduction (by shooting, gassing, poisoning) cannot be carried out in urban areas and sometimes oral baiting is unsuccessful in these areas because of the abundant food supplies available to wildlife. TVR is expensive and time consuming. However, overseas field trials have been very successful if the species targeted is easily trapped.

A concerted and highly successful rabies elimination program has been mounted by the Ministry of Natural Resources in Ontario, Canada. Rabies currently cycles in red fox and striped skunk, and that strain has been combated using baits containing ERA vaccine dropped over large areas from low flying aircraft. A second strain, spread by raccoons and skunks, is close to Ontario in New York State. It is being combated by trap-vaccinate-release pending development of an effective and affordable vaccine and bait combination. To date, the fox rabies program has reduced animal cases by 90% and complete rabies elimination seems achievable. It is too early to evaluate whether the exclusion of raccoon rabies is effective.

## **1.6 Epidemiology**

### **1.6.1 Incubation period**

The incubation period is prolonged and variable. It is generally of the order of 4–8 weeks, but can vary from 4 days to six months or even longer. Incubation periods in excess of one year have been documented, but this is rare. The maximum incubation period given in the OIE Code, for regulatory purposes, is six months (see Appendix 3).

Several factors influence the duration of the incubation period. These include the virus strain, virus dose, the distance of the bite site from the central nervous system and the richness of the sensory innervation at the site of virus entry into the body. The last two of

these factors are most important. For example, the incubation period following a bite on the face or muzzle could be expected to be much shorter than that after a bite on the trunk or limbs.

### 1.6.2 Persistence of virus

#### General properties/environment

- Rabies virus is comparatively fragile and does not survive for long periods outside the host.
- It remains stable for several months at 0–4° C but it is rapidly inactivated by heat, direct sunlight and lipid solvents (Swanepoel 1994).
- The virus is stable at pH 5–10.
- Infectivity is lost when the virus is treated with proteolytic enzymes; and in saliva in temperate climates it can survive for up to 24 hours.

Rabies virus is relatively large and contains lipid and hence is susceptible to a wide range of disinfectants, including warm soapy water and detergents (see Section 2.2.8).

Environmental contamination, other than aerosol contamination in bat caves, is of very little significance in transmission of the disease.

#### Live animals

Virus excretion in the saliva may commence at up to 14 days (but usually only from 7 days) before onset of clinical signs, and continues until the death of the animal. Not all rabid animals excrete virus.

Clinical recovery is exceptionally rare in man with only three recorded cases worldwide and in these cases rabies virus was not detected. Infection and recovery is sometimes recorded in wildlife (foxes, bats) and in dogs. Virus may persist in these recovered animals.

Chronic or latent infection is epidemiologically quite rare, but has been reported with some African virus strains. Asymptomatic non-fatal rabies in dogs has been reported from Ethiopia, the United States and India. However, there is at present no indication that symptomless carriers play any great part in the spread of the disease.

#### Carcases

In addition to the salivary glands, there is neural spread of virus from the brain to various other organs and tissues during the clinical phase of the disease. Virus transmission to carrion animals eating fresh rabies carcasses is at least theoretically possible. Corneas removed from human donors dying with undiagnosed or unsuspected rabies have been incriminated in the transmission of the virus to graft recipients.

#### Animal products and by-products

The milk of a rabid cow may contain rabies virus and although of very little significance in the transmission of the disease should not be used for human or animal consumption. Transmission of rabies from mother to suckling infant via the breast milk has been suspected in at least one human case, and is well documented in animals (Swanepoel 1994).

### 1.6.3 Modes of transmission

Rabies virus is transmitted by contamination of a fresh wound with infected saliva. This is usually from the bite of a rabid animal, but can also result from licking abraded skin or mucous membranes. The virus cannot penetrate intact skin.

Respiratory and oral transmission can also occur but, apart from suckling infants (see Section 1.6.2), only in the most exceptional circumstances and, for all practical purposes, these routes can be ignored in framing control strategies.

Post-vaccinal rabies after immunisation with vaccine that accidentally contained tissue adapted rabies virus because of incomplete inactivation has occurred in both humans and animals.

Since 1978, six people have died of rabies after receiving corneal grafts from donors who had died of unsuspected rabies. The risk of acquiring rabies in this way is very small.

In several species of mammals, including dogs, cattle, bats and laboratory rodents, rabies has been transmitted across the placenta from mother to foetus. This has only been recorded once in a human patient (Swanepoel 1994).

Insect vector transmission does not occur.

#### **Artificial breeding**

No evidence exists for transmission in semen or embryos. Transmission through dog's semen is considered to be extremely unlikely.

### 1.6.4 Factors influencing transmission

The main determinant of transmission is the population density of susceptible (ie non-immunised) key host species that are free roaming within an ecosystem. Epidemics often spread on a slow-moving front, of say 25–50 km per year, that is influenced by migration and seasonal dispersion patterns of key host species. However, urban rabies can be spread to new areas more rapidly by dogs with furious rabies that have running fits (where they may travel for 30 km or more) or by pets moved to new areas by the owners.

Australia has widespread and abundant populations of species that have played a role in sylvatic (wildlife) rabies in other countries but it is difficult to predict with certainty which wildlife species are most likely to be involved. These include the European red fox, the feral cat, the feral dog and the dingo. Although threshold densities needed to maintain rabies vary widely even for the same species (eg, the red fox in Canada and Europe), it is now clear that Australia has densities of European red fox that greatly exceed the densities in which rabies is endemic in other countries.

In addition, a number of native species have the theoretical potential, on both ecological and other grounds, to play a role. The brush-tailed possum, which is widely distributed, and particularly abundant in urban areas in close proximity to domestic pets; and the larger dasyurids (spotted and tiger quolls and Tasmanian devil) are potential vectors, although these may only be in sufficient numbers in Tasmania to cause problems.

## 1.7 Manner and risk of introduction into Australia

The highest threat for a canine biotype to enter Australia is by the illegal entry of an infected animal (through, for example, smuggling or itinerant yachts) (see Sections 2.1, 2.2.10). A dog biotype virus is unlikely to become established in foxes or native animals.

A dog biotype virus entering Australia could, if undetected and uncontrolled, spread into our urban and feral dog populations and cycle in the feral dog population. This biotype spills over into any warm-blooded species such as cats, foxes and native animals but is considered unlikely to set up a sylvatic cycle in these species. Experience in North America and Canada shows that the arctic fox strain that established in foxes has also adapted to skunks and raccoons. Veterinarians who work with rabies in the field overseas have urged caution when assuming that a fox or native animal cycle will *not* occur with the introduction of an uncontrolled or undetected dog rabies biotype (D. Geale, Agriculture Canada, 1994, pers. comm.).

The possibility of a fox biotype rabies virus entering Australia via a smuggled fox is remote. The possibility of a dog infected with fox biotype being smuggled in or passing through quarantine and then developing rabies and passing it directly onto a fox is even more remote.

It is possible that rabies could be introduced into Australia by migrating bats. Fruit and insect-eating bats in Australia could harbour and transmit rabies, as similar species have done overseas. Serological studies in Australia have shown no evidence of rabies infection in our frugivorous/insectivorous bats, but theoretically they could become vectors for any of the biotypes of rabies. Our one carnivorous bat, the ghost bat, has patchy distribution in northern Australia and has not been studied (Saunders 1993). We have no haemophagous ('vampire') bats in Australia that can directly spread disease from normal feeding behaviour. Bats have not been incriminated in sylvatic cycles of rabies in the Pacific area.

Humans incubating rabies have returned from overseas holidays and immigrants have also come to Australia infected with rabies. There is no risk that human cases of rabies will spread to animals or other people, due to the clinical signs that humans develop with this disease and their behaviour associated with the illness. Humans are dead-end hosts and the only cases of spread relate to babies acquiring the disease from their infected mother via breastmilk or during gestation (see Section 1.6.3); by transplantation of corneas from cadavers; and, in one instance in Pakistan, by application of human saliva to circumcision wounds (Swanepoel 1994).

## 2 PRINCIPLES OF CONTROL AND ERADICATION

### 2.1 Introduction

Of all the exotic animal diseases, rabies has perhaps the least capability to disrupt Australia's significant export markets of animals and animal products. Yet, in a world afflicted by many varieties of disease, rabies stands out as uniquely terrifying. It has a hold on the human imagination out of all proportion to the real risks. This is because the infection is usually transmitted to man by a bite from a rabid dog; treatment in the past was painful and uncertain; there is a long delay till freedom from disease is established; and finally, if the clinical signs of disease appear it is fatal. It is the public health significance of rabies that makes it an important exotic animal disease. Its prevention, control and eradication is primarily driven by the necessity to prevent spread to people.

The first line of defence against rabies is the continued implementation of preventive customs and quarantine measures. These measures are periodically reviewed and strengthened; there is a need to focus on illegal introductions as the most likely scenario for the introduction of rabies into Australia. In the past, foreign fishing vessels, sighted by Coastwatch aircraft and apprehended by navy patrol boats, have had no animals on board (except for domestic poultry on three Indonesian fishing vessels in 1984) but such surveillance should continue in line with the Northern Australia Quarantine Strategy (NAQS). NAQS is a surveillance system designed to detect the presence of exotic diseases in neighbouring countries and islands as well as providing early detection of exotic diseases that may have entered Australia from the north.

It is very rare for a yacht to carry animals other than dogs and cats, and the vast majority of yachts enter Australia via first port of entry where quarantine or customs officers inspect the vessels and impose conditions for any animals on board. Out of 506 overseas yacht arrivals in 1988–89, 20 had animals on board.

If rabies occurs in Australia, animal health authorities could be faced with situations from:

- at one extreme, an infected dog, cat or horse in a quarantine station, or a domestic pet which had no contact with other animals; to
- the other extreme of an area containing infected or exposed domestic pets, farm livestock and wildlife.

In the first scenario, quite limited measures to deal with the situation should easily contain the disease, whereas in the latter situation the problems of containment and eradication will be much more complex than those arising from even serious outbreaks of other exotic animal diseases. The long incubation period that can occur with rabies could also produce unfamiliar problems, such as those of maintaining some restrictions and monitoring for possible cases over relatively long periods after the last case has actually occurred.

## 2.2 Methods to prevent spread and eliminate pathogens

In this description of methods for the control and eradication of rabies, the following terms are used:

- *infected animal* — an animal that has confirmed rabies or is believed to have rabies;
- *dangerous contact animal* — an animal that has been in direct contact with an infected animal;
- *suspect animal* — other animals that may have been in the same area as the infected animal.

In a normally rabies-free country like Australia, the chances that an animal has rabies are very low unless either the signs are exceptionally ominous or there are other ‘suspicious factors’. The approach to any potential rabies situation must be conditioned by both the extent of the signs the animal is showing and the chance that the animal has come in contact with an infected animal. Control action should initially be directed towards preventing, as far as is practicable, human exposure and taking every possible precaution to reduce the risk to those involved in the handling of infected animals. Control measures could involve any or all of the following measures:

- early recognition of rabies cases in animals;
- delineation of the geographic area of the outbreak;
- seizure and quarantine or destruction of infected animals;
- tracing, seizure and quarantine or destruction of dangerous contact animals;
- movement controls over animals;
- control of stray animals;
- vaccination and identification of animals;
- seizure and detention or destruction of animals not properly controlled or vaccinated;
- detection and management in wildlife;
- prohibition of gatherings, sporting and recreational activities involving animals;
- mounting of publicity campaigns;
- reporting of animal bite cases in humans and the implementation of a mechanism for the seizure, quarantine or destruction of the offending animal;
- prophylactic treatment in humans.

### 2.2.1 Quarantine and movement controls

#### Infected animals

When there are reasonable grounds for suspicion of rabies in an animal, an order may be made under the relevant stock diseases or exotic animal diseases act of the State/Territory concerned to declare the premises as an *infected premises* (IP) (see Appendix 1) and to detain and isolate the infected animal in quarantine. However, any evidence that the animal could have been illegally imported or in contact with an illegally imported animal would be important and might justify compulsory destruction for diagnosis.

There are likely to be very much stronger grounds for compulsory destruction of infected dogs and cats than farm stock because biting animals have a high capacity to transmit rabies whereas non-biting animals, such as cattle, horses, sheep and other farm livestock, are unlikely to transmit the disease to other animals (although those humans tending to them might be at some risk).



Capture and handling of infected animals will depend on the physical state of the animal (furious or paralytic), its size, its ability to move at speed, the nature of confinement, if any, and the hazards that undoubtedly arise in dealing with a suspect rabid animal. **Human safety is of first priority.** Where an animal appears too dangerous to approach or where the limits of its confinement are too wide, it should be destroyed (see the **Destruction of Animals Manual**).

### **Dangerous contact animals**

Animals coming in contact with rabies cases may pose even more problems than the infected animals themselves. Diagnosis of an infected animal will normally be confirmed within a few days, a week or two at the most, and it will be known whether or not rabies is present. However, a dangerous contact animal could incubate the disease for many months. Ensuring the secure quarantine of such animals for long periods will be a significant problem in a rabies outbreak. The recommended actions shown in Table 4 should be taken with vaccinated and non-vaccinated animals in the restricted area. The circumstance of the outbreak and factors involved in each case could modify these recommendations.

The usual local government pound facilities may be inadequate in a rabies control situation. It would be necessary to provide secure temporary accommodation such as at government quarantine stations, local government authority/police accommodation facilities for dealing with normal strays, private dog kennels, private veterinary clinics or at the RSPCA kennels. The availability of such secure accommodation for a period of up to six months is a factor in deciding whether to detain or destroy suspects.

A problem applying to all these possibilities is that it might not be practicable in the event of an outbreak to switch from the current use of the accommodation to taking rabies suspects. All temporary accommodation will be subject to the direct supervision of the local disease controlling authority.

If rabies is confirmed in an animal in quarantine, any animals kept in close proximity to the rabid animal and released within the previous 15 days would need to be recalled. Such animals, if previously vaccinated for rabies, should be serologically tested for rabies antibodies (see the **Quarantine Stations Manual, in press**).

### **Movement controls**

When a case of rabies in an animal has been confirmed, and if the epidemiological circumstances warrant it, an order may be made to declare an *infected premises* (IP) and a *restricted area* (RA) around the IP.

#### *Infected Premises (IP)*

The infected premises will only exist until the index case is destroyed, the appropriate area disinfected and other susceptible animals on the premises quarantined. There will be no movement of unvaccinated susceptible animals on or off the IP (see Appendixes 1 & 2).

After the index case has been removed from the IP, and other susceptible animals vaccinated, the IP would be downgraded to a dangerous contact premises (DCP) and animals remaining on the DCP will remain under quarantine until further direction from the CVO.

#### *Restricted Area (RA)*

The size of the RA will depend on factors such as the number and species of infected animals and dangerous contacts, their geographical location, known or suspected

movements, human risk and possible exposure to wildlife. Restriction of unsupervised movement is a critical aspect of urban rabies control.

**Table 4 Actions for vaccinated and non-vaccinated animals in the restricted area**

<b>Animals</b>	<b>Action</b>
<b>Vaccinated animals</b>	
– bitten/scratched	quarantine, titre test for vaccine antibody: <ul style="list-style-type: none"> <li>• if adequate (&gt;or = 0.5 IU/mL) quarantine at home or at declared government quarantine station (DGQS) for 30 days with observation; or</li> <li>• if inadequate, place in a DGQS, retest after 30 days and, if again inadequate, destroy with the owner's consent or 270 days quarantine at a DGQS</li> </ul>
– in-contact	titre test, and <ul style="list-style-type: none"> <li>• if adequate 30 days home quarantine; or</li> <li>• if inadequate treat as unvaccinated.</li> </ul>
<b>Non-vaccinated animals</b>	
– bitten/scratched	destroyed with owner's consent, or 270 days quarantine at DGQS.
– in-contact	destroyed with owner's consent, or vaccinate, titre test after 30 days: <ul style="list-style-type: none"> <li>• if titre adequate 120 days quarantine at a DGQS, or</li> <li>• if inadequate, quarantine 270 days at a DGQS.</li> </ul>

**Notes:**

- (1) Where a rabid animal has been at large in an area and there are a number of possible contacts, it is not feasible to apply IP/dangerous contact premises (DCP) procedures to all possible contacts; the more practicable course of action for such a situation would be the declaration of a *restricted area* (RA) as described in Appendix 1, and introduction of general confinement and movement controls for appropriate species in that area.
- (2) If a bite wound is identified on a contact animal, the animal should be treated according to protocol outlined above.
- (3) If a human has been bitten by a dangerous contact animal, the animal should be destroyed and the intact head submitted to the laboratory for rapid diagnosis.

Household pets need to be confined at home until the emergency is considered to have passed, and the movement of dogs and cats to other localities only permitted by the CVO. The emergency must be regarded as continuing for at least one theoretical incubation period (6 months according to the OIE Code) following the completion of the vaccination program in the RA, or of the occurrence of the last case, whichever is the more recent.

If wildlife involvement is suspected, careful consideration would have to be given to vaccination and movement restrictions of farm animals on a property in the RA. The same would apply in the case of susceptible exotic species if there happened to be a safari park in the area of wildlife infection.

In the RA it is the responsibility of the owner or person in charge of a dog, cat, or ferret and of the occupier of the premises at which it is normally kept, to ensure that the animal is at all times securely confined within their home. All dogs, cats and ferrets will be vaccinated and must not come into contact with any animal (other than an animal with which it is normally in contact at the premises) within 30 days of the rabies vaccination. Vaccinated animals will be permanently identified in an approved manner and recorded.

Newly vaccinated dogs may leave premises in the RA for exercise if on a leash and muzzled, and prevented from coming into contact with any other animal. After the 30 days immunisation period, muzzles may be discarded. **These privileges are at the discretion of the CVO.**

An unvaccinated dog, cat or ferret may be moved to another place within the same RA **with approval from the CVO** provided it is either carried in a secure container or muzzled and on a leash and does not come into contact with any other animal at the premises to which it has been moved. An exemption may be made to the above requirements by licence where a veterinary inspector is satisfied that their application would unduly restrict the use of the animal for the purpose for which it is kept (eg guide dogs for the blind, working dogs on farms, guard dogs). It is intended, however, that these exemptions should apply only when the dog is actually carrying out its special function. Compulsory vaccination of all working dogs in the RA should be implemented.

Control and vaccination of animals other than dogs, cats and ferrets may be prescribed in an RA (eg horses, farm animals). The decision on which species of animal to be controlled and vaccinated will depend on the circumstances and whether that particular species was infected or had been exposed to infection or was at high risk of being bitten by rabid animals.

#### **Seizure, detention and disposal of uncontrolled and unvaccinated animals**

A cornerstone of effective urban rabies control is the elimination or dramatic reduction in the number of stray or uncontrolled dogs and cats by local government authorities. Procedures should be adopted early in a control campaign and controls would need to be imposed with differing levels of urgency in different circumstances.

If there has been a single rabid dog that has had little or no opportunity to bite other dogs, the situation could be monitored without implementing the full strategy of the AUSVETPLAN. Under these circumstances, owners of straying dogs may be given a short period of grace to control their dogs. The aim here is to minimise the number of dogs impounded and destroyed (see Section 2.2.5). However, in a situation where a rabid animal was free to roam, then stray dogs should be controlled promptly, an RA declared, contacts between animals reduced to the minimum and vaccination programs implemented.

The CVO may decide to divide RA strays into two groups. All stray unidentifiable animals would be collected and destroyed. All stray animals with identification would be impounded for collection within 24 hours. Those not collected within the specified period would be destroyed. This would decrease demand on pound facilities in an outbreak.

It will be the responsibility of the disease controlling authority to advertise the locations of the pound facilities as widely as possible since any animal not claimed by its owner within the specified period can be destroyed without compensation being paid. Release of detained animals would relieve pressure on the accommodation. Any animals released

back to their owners would be subject to confinement and vaccination stipulated in Section 2.2.9.

### **Prohibition of gatherings, sporting and recreational activities involving animals**

The prohibition of gatherings of animals in an RA may be necessary to minimise the risk of disease spread. The type of event that might be covered here includes dog and cat shows, sheep dog trials, agricultural shows. Having made a general prohibition it is then possible to make exemptions by licence granted by the controlling authority.

The prohibition of sporting and recreational activities may be necessary to minimise spread of the disease and prevent interference with ongoing control measures. The type of event that might be covered here includes hunting, racing or the training of any hounds or dogs, the shooting of game or other wildlife. If rabies has been confirmed or even suspected in wildlife, the prohibition of hunting will be necessary. Organised shoots would likely disturb and disperse the wildlife although normal culling activities of pests in farms would be likely to be permitted.

## **2.2.2 Tracing**

### **Tracing of people and animals and treatment of all potentially exposed humans is the most costly aspect of rabies control.**

In a rabies outbreak people will be bitten or scratched by rabid and non-rabid animals. The majority will be bites/scratches from non-rabid animals. However, all bitten/scratched humans must be treated as though the attacking animal had rabies unless it is obvious that incident occurred in a region outside the controlled area. It must always be assumed that the animal causing potential exposure was rabid if it was not available for diagnosis. The tracing and recording of persons exposed, what animal was involved and whether that animal had the disease is one of the most difficult aspects of a rabies outbreak.

The coordination of recording, tracing and treating of humans and the tracing and destruction/diagnosis or quarantine of animals will involve an extraordinarily high degree of cooperation between veterinary, medical and local government authorities, and the media and the public.

### **Reporting of animal bite cases in humans and follow-up measures**

The reporting of animal bite cases in a rabies RA, where the disease has spread to a number of domestic pets and other animals including wildlife, is essential for early evaluation and institution of post-exposure treatment of the human patient by the physician. The reporting centres will need to be properly resourced to handle a large volume of reports and inquiries from anxious and possibly irrational members of the community. Qualified on-site advice on post-exposure treatment and on the epidemiology of the disease would be essential. It will be desirable to make available a freecall 1-800 hot-line, which the public can use to seek advice.

The reporting process should also set in motion a previously agreed mechanism for the tracing, seizure and detention or destruction of the offending animal or where this is not possible, as in the case of wildlife, sampling (wild caught and road kills) should be instituted in the area where the biting took place. Where the animal is caught and destroyed immediately or dies within 10 days of detention, specimens for the diagnosis of rabies should be collected from the dead animal and submitted to a rabies diagnostic laboratory.

The laboratory report should provide the physician and the public health authority with information that will form the basis for continuing any post-exposure treatment already initiated. The report should provide to the veterinary practitioner, local government authority and the controlling authority information on new foci of infection and serve as a means of monitoring the spread of the disease and the effectiveness of the control measures being instituted.

Animal bite reporting/counselling services (hot line) may be required throughout the RA or country at large or access to the 1-800 freecall number in the RA should be available to the public. Qualified staff in those centres will need to assess each report and determine whether the offending animal is a possible rabies suspect and whether it should be placed under surveillance, and whether routine post-exposure treatment of the patient is warranted. In reaching these decisions, staff will need to take into account the stability of the boundaries of the known IPs and the RAs, and the reliability of the history available on the offending animal.

In areas adjacent to the RA there is a greater need to follow up animal bite cases because of the need to determine post-exposure treatment in humans and for the detection of spread of the disease outside the RA.

### 2.2.3 Surveillance

Surveillance will target the host species involved in the outbreak and or the animals involved in spillover infection from the host species. Surveillance will be necessary:

- when there is suspicion that rabies has entered Australia;
- during an outbreak to determine the extent of the affected area; and
- when the outbreak has been contained to ensure freedom from further disease and associated quarantine restrictions.

The following animals should be tested in a rabies surveillance program. For tests see Table 3.

- all suspect rabid animals that have been in contact with humans or owned domestic animals;
- all potentially rabid animals that come to the attention of veterinary authorities, regardless of human contact;
- fresh roadkills — this is usually done by municipal animal control authorities or a few people that travel regular routes; the least costly way to do this is to enlist the cooperation of individuals who commute some distance from home to work or who drive regular routes for their work.
- trapped animals — ask hunters to submit sick animals found in the bush, or use a specific trapline or collect all carnivore carcasses taken by hunters in the study area (Raccoon Rabies Task Force Report 1992).

Sampling to detect the limits of rabies is a very difficult matter. The best animals to get are those that are dead or sick. Roadkills and trapped animals are in general, not a good source. Because rabies is fatal within days of clinical onset, the number of detectably rabid animals in a wild population is always low. In trapped samples of foxes in Ontario in the middle of an intense outbreak, the highest ever observed prevalence was 4.5%. Enlisting the support of the public to report sick and dead animals is the most productive

way to get relevant specimens. Widespread killing is not productive when mapping a rabies outbreak. (C. MacInnes, pers. comm. 1995)

#### **2.2.4 Treatment of infected animals and humans**

##### **Animals**

Animals with clinical signs of rabies or who have a high suspicion of being infected with rabies should be immediately destroyed to protect human life and for animal welfare reasons. In all cases specimens should be submitted for laboratory testing to confirm the disease. There is no treatment for rabies once clinical signs appear. Death is almost always inevitable.

##### **Humans**

Post-exposure treatment for rabies would be as outlined in Appendix 5. Pre-exposure (ie vaccination) and post-exposure treatment regimens for rabies in humans should be made available to all medical practitioners as well as health centre and hospital staff in the RA (see Section 2.2.9 and Appendix 5).

#### **2.2.5 Destruction of animals**

All animals in direct contact with a rabies case, ie animals that have had access to the same cage, pen or yard or which have been separated only by a single wire fence, within 14 days before the disease was detected, will be treated according to Table 4. Depending on vaccination status, antibody titre result and factors relating to the extent of exposure to the rabid animal, either further quarantine or destruction of the animal will need to be considered. The areas that the animals occupied will need to be cleaned and disinfected.

Stray, unvaccinated dogs and cats should be destroyed if not claimed soon after capture. Stray dogs registered with the local government authority and vaccinated against rabies in contravention of the rabies control order, should be captured and impounded for a fixed time, (ie 24 hours) for the owner to claim his/her animal, failing which, the animal would be destroyed. Unvaccinated dogs not under control in a vaccination zone should be destroyed (see the **Destruction of Animals Manual, Sections 4.8 and 4.9**).

#### **2.2.6 Treatment of animal products**

Where a suspected or known rabid animal is found on a farm, attention should be given to the disposal of farm products from both suspect and contact animals. Milk from affected or suspect cows should be disposed of as unsuitable for human or animal consumption (see the **Disposal Procedures Manual, Section 4.1**).

#### **2.2.7 Disposal**

In the RA, dead and destroyed animals should be burnt or buried after the necessary diagnostic specimens have been taken (see the **Disposal Procedures Manual, Sections 3.1 and 3.2**).

#### **2.2.8 Decontamination**

The infectivity of rabies virus is destroyed by most organic solvents, by oxidising agents, and by surface-active agents (quaternary ammonium compounds, soaps, and detergents). Oxidising agents such as hypochlorite may be used for environmental decontamination and Virkon<sup>®</sup> sachets can be used on inanimate objects and human skin. Quaternary ammonium compounds are also useful for personal disinfection.

Should accidental exposure occur as when a person is bitten, saliva is splashed on the hands or face, or suspensions containing virus are spilled or splashed, first aid as outlined in Appendix 5 should be applied immediately to eliminate the pathogen.

If rabies is detected or suspected in an animal held or handled in a quarantine centre, laboratory, pound or kennel or household, the areas contaminated by the rabid or suspect animal should be cleaned and disinfected with warm soapy water, an oxidising agent such as sodium hypochlorite or Virkon<sup>®</sup> or an acid or alkali after the animal has died or been destroyed.

Vehicles used to transport dogs, cats and other animals to a detention centre or to a laboratory should be periodically cleaned and sprayed with one of the disinfectants stated above.

For further details see the **Decontamination Manual, Tables 2.11, 3.12 and 4.**

## **2.2.9 Vaccination**

### **Animals**

Compulsory vaccination in a RA may be carried out when initial control measures are implemented. Dogs, cats and ferrets should be vaccinated. Cats are particularly at risk if wildlife is infected because of their nocturnal hunting behaviour. Recreational horses in the RA should also be considered for vaccination due to their close contact with humans and vulnerability to attack from rabid animals. Vaccination of at-risk, valuable farm animals may also be a sensible precaution. In a high risk area one might also have to consider the position of exotic species, eg in a safari park. Safe and effective inactivated vaccines to protect animals against rabies are now available and attenuated parenteral vaccines need not be considered.

Compulsory mass vaccination of dogs, cats and ferrets may be carried out at designated vaccination centres or at the premises of owners. Vaccination centres offer the best cost-effective means of rapidly immunising a population but has the disadvantage of the risk of contact amongst the animals and the possibility that not all owners would be in a position or want to bring in their animals to a vaccination centre. House-to-house vaccination campaigns would be more costly and perhaps slower but will be expected to achieve 100% coverage and an assurance that all animals are vaccinated. A combination of both options may be the preferred line of action starting with a vaccination centre approach and followed by a house-to-house vaccination campaign, which will have the added advantage of obtaining an accurate census of dogs and cats in the RA.

The identification of vaccinated animals by some suitable means (eg serially numbered dog tag, collar of coloured rope inside plastic tubing, tattooing, electronic identification implants), and an effective recording system would be necessary as it will help identify unvaccinated animals.

### **Humans**

Pre-exposure, prophylactic immunisation would be required for people with a high-risk of exposure to rabies. Veterinarians and their assistants in an RA and at the diagnostic laboratory, stray dog and cat catchers, animal handlers at pounds, quarantine centres and laboratories and wildlife control workers in a rabies CA should all be considered at high-risk and be immunised. With the exception of those in the diagnostic laboratory at AAHL and quarantine centres, where immunisation would usually have been carried out before



an outbreak, all the others would only receive the required course of vaccinations at the onset of an outbreak and would not be protected till after the full course of vaccinations.

### **2.2.10 Detection and management in wildlife**

Overseas, where rabies has become established in wildlife, the disease is usually intractably endemic. However, rabies requires moderate to high densities of medium-sized carnivores, over large areas (>5000 square km) in order to persist. Overseas experience also indicates that local rabies infections are adapted to be spread by only a small number of species. Although any mammal may be infected by any of these variants, only 1–5 species are involved in persistence and spread of a particular form. Therefore, the highest risk to Australia probably stems from the rabies virus that is adapted to red fox populations in Canada, Alaska and the northern parts of Europe and Asia. In the tropics, including Indonesia, rabies persists in dog populations: those forms have some potential to become established in dingoes and feral dogs. Rabies spread chiefly by cats exists only in southern Africa, (C. MacInnes 1995, R. Swanepoel 1994) so the risk of feral cats seems less. There is no rabies adapted to persistence in marsupial populations anywhere in the world, so the possibility that rabies might become established in Australian native mammals seems remote, especially as most of the native carnivores are scarce on the mainland. However, the possibility cannot be discounted entirely, and management measures must be prepared.

Prevention of spread of introduced rabies to susceptible wildlife may best be achieved by the control and confinement of domestic animals in the RA. Prompt and effective measures to detect and eliminate any outbreak in wildlife are essential, to stop the disease at an initial focus before it becomes widespread. It is imperative that wildlife involvement does not become extensive.

Early detection and delineation of the wildlife species involved, and the geographical extent of rabies, requires disease sampling in potential hosts. Sampling for diagnosis of rabies and establishment of virus serotype and biotype, could be done in a number of ways. Detection of rabies outside the RA requires monitoring of susceptible wildlife over a wider area. Sampling should be directed according to the situation. Roadkills, sick animals encountered by hunters or arranged sampling of wildlife are options (see Section 2.2.3). The RA would then have to be redefined on the basis of survey results and rabies elimination procedures implemented.

From the outset, wildlife specialists should be consulted to determine likely implications of a sylvatic cycle or wildlife involvement in an urban cycle. Unrealistic expectations of wildlife control operations must be avoided.

The following methods are used overseas to control rabies in wildlife:

- population reduction
- trap–vaccinate–release (TVR)
- oral vaccination
- combinations of the above

#### **Population reduction**

Where there has been demonstrated exposure of wildlife in an urban situation, and the focus outbreak has been detected early, it may be desirable to initiate wildlife reduction in the RA concurrently with control measures in domestic animals. Where sampling demonstrates rabies presence in wildlife *in a discrete and controllable area*, actions

should be undertaken to reduce the population density of involved species to below the threshold for rabies persistence in the RA. Threshold densities for reservoir species are widely variable, and the rate of rabies movement through populations is not a species constant. Threshold densities do not provide a reliable indicator of the likelihood of rabies persistence and are an unlikely predictor for the management of the disease in Australia. Consequently, host elimination will be the specific goal in focal outbreaks of wildlife rabies, if the species affected is an exotic feral animal (fox). The decision for stamping out will be much more difficult if the species affected are endangered native species, eg quolls.

Wildlife population reduction may not achieve disease control if the level or extent of reduction is inadequate. It is a highly controversial issue due to social and legal pressures exerted by animal welfare and conservation groups. It is also a costly and labour-intensive exercise. In Europe it has been noted that the removal of foxes and other wildlife from an area creates a sink into which healthy and infected animals immigrate. Furthermore hunting, spotlight shooting and shooting drives have caused unnatural dispersions of the wildlife and spread of the disease.

#### **Trap–vaccinate–release (TVR)**

If wildlife reduction is unacceptable to the community, or the outbreak is in an urban area where gassing, shooting and poisoning of target animals cannot be undertaken, TVR programs may have to be initiated (see Section 1.5.3). TVR may become the only option where vaccine baits have not been developed for a species. TVR can be used with a buffer perimeter zone of oral vaccination. TVR can also be used with population reduction in the vicinity of point infections.

#### **Oral vaccination**

When rabies in wildlife is accepted to be widespread and to have established a sylvatic cycle, serious consideration should be given to large-scale wildlife vaccination programs based on baiting with accepted oral vaccines for the target species (see Sections 1.5.3). These programs take years to develop and implement but programs in Europe and North America have been highly successful.

For further information on wildlife control techniques, baiting and other procedures see the **Wild Animal Control Manual, in press**.

#### **2.2.11 Vector control**

There is no evidence that insect/arthropod vectors are involved in either the mechanical or biological spread of rabies.

#### **2.2.12 Public awareness**

The active support of the public is an important part of the defences against rabies. This may be achieved by intensive publicity campaigns at home and overseas, through Australian embassies. See the **Public Relations Manual** for further details.

The roles and responsibilities of veterinary and medical practitioners and local government, wildlife and public health authorities in an outbreak area should be clearly defined and made known to all concerned. Veterinary and medical practitioners would be required to report all suspect cases of rabies and take appropriate post-exposure measures. Local government and public health authorities would be required to assist in rabies control measures in the RA and would have to be properly briefed. There would be an

immediate need for the reporting of all animal bite cases in humans in the RA and for a mechanism for the tracing, seizure, detention or destruction of the offending animal (see Section 2.2.2). For this to operate smoothly, close liaison among the medical, veterinary, local government, wildlife and public health authorities is essential.

The public should be kept informed on the public health aspects of rabies, the requirements related to the control and eradication campaign including the reporting of animal bite cases, progress made and events of public interest. Campaigns to educate the public on the nature of the disease, especially the clinical signs in animals and the mode of transmission of the disease to humans, should be conducted at schools, community centres, health centres, factories and other places of mass gatherings as well as through the available media. It is vitally important to emphasise the usually fatal course of the disease and the danger of handling rabid animals.

The controlling authority would have to mount education campaigns emphasising the need for the control of dogs and cats and other animals, movement restrictions, compulsory vaccination and wildlife control. Wide publicity should be given to the venues and times of vaccination. For monitoring the disease, the reporting by members of the public of any animal bite incidents with details of the offending animal and of any deaths of dogs, cats and wildlife should be encouraged and facilitated. All prohibitions such as those related to gatherings of animals and sporting and recreational activities, should be disseminated as widely as possible.

### 3 POLICY AND RATIONALE

#### 3.1 Overall policy for rabies

Rabies is an OIE List B disease that is of socioeconomic and major public health importance.

The policy is to eradicate rabies quickly for public health reasons and to prevent spread to both domestic and wild animals. This will be achieved through a combination of strategies that will include:

- ☞ *quarantine and movement controls* on carnivores in declared areas to prevent the spread of infection;
- ☞ *destruction of infected and dangerous contact animals* to remove the most dangerous source of virus;
- ☞ *vaccination* of all domesticated carnivores in declared areas to protect animals against infection and reduce exposure of humans;
- ☞ *vaccination and/or destruction* of wild carnivores if disease establishes in those populations;
- ☞ *tracing and surveillance* to determine the source of extent of infection and to provide proof of freedom from the disease; and
- ☞ *a public awareness campaign* to facilitate public cooperation from animal owners and the community.

Immunisation of humans would be under the control of medical authorities.

The introduction of rabies would have significant public health implications and social effects, particularly if the disease became widespread or established in stray or wild animal populations. There would also be environmental and conservation concerns.

The movement of pet animals in the international arena would be subject to greater restrictions but the effect on trade would be minimal.

Rabies is included in the Commonwealth/States cost-sharing agreement.

The CVO(s) 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. 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.**

Further information for medical personnel is given in the *Amended Plan for the Eradication of Rabies, Appendix XXVIII* (National Health and Medical Research Council, October 1984), which is a joint document from the Commonwealth Departments of Human Services and Health and of Primary Industries and Energy. The second edition is currently in preparation.

## 3.2 Strategy for control and eradication

The objective is to eliminate the pathogen and to prevent exposure of humans to infected animals.

The strategies will be to seize and destroy the infected animals in the first instance and undertake laboratory diagnosis to confirm the infection and the biotype involved so that a strategy can be developed towards the biotype host and the most likely in-contact susceptible species. It will be necessary to prevent dangerous contact animals from spreading the disease through the introduction of quarantine and movement controls and to protect the most susceptible animals from infection through a mass vaccination program within the RA.

The control and eradication of an outbreak of rabies will require the concerted efforts of both animal and human health services working in liaison. Medical and wildlife authorities must be represented on the various decision-making levels of control.

All authorities responsible for specific legislative matters likely to have an influence on the control and eradication strategies must be involved in the planning at the appropriate levels. This is particularly so for rabies, which could involve humans, companion animals, and wildlife with, most likely, the destruction of some companion animals and wildlife, possibly including rare and endangered species.

Raising public awareness through a wide range of sources including the media and public and media cooperation will be essential elements of the eradication strategy.

### 3.2.1 Stamping out

The destruction of the infected animals, and possibly dangerous contact animals, is a necessary strategy because the disease is invariably fatal and infected animals are the only source of spread. The destruction of stray animals will occur if these animals are dangerous contacts or cannot be confined and, if the disease spreads to wildlife, destruction, by various means, may be undertaken of specific species according to the virus biotype.

### 3.2.2 Quarantine and movement controls

The infected premises (IP) will be immediately declared and quarantine requirements imposed. The area around the IP will be declared as a restricted area (RA) and movement controls will apply. Dogs and cats and other pets must be confined. The most at-risk animals may be placed into quarantine confinement in one or many locations to enable observation of the animals over time and to reduce exposure of people. As quarantine facilities will be limited it may not be possible to place all animals in these facilities. Quarantine and confinement may be undertaken in-house, with owners being responsible for maintaining isolation of their animals and reporting to the authorities on any unusual changes. It is important, however, that the most suspect animals are confined in an official confinement area to prevent or reduce exposure of humans.

A control area may be declared but such an area does not appear to be warranted.

The declaration of the RA must take into consideration any wildlife populations that are considered may have become infected. If infection in wildlife is believed to be a possibility or has occurred then it is recommended that farm animals, particularly working dogs, should be confined, where possible, so that contact with wildlife is prevented or reduced. While farm animals such as cattle and horses are unlikely to transmit rabies to other animals there is the possibility that humans handling these animals could be infected.

The movement of animals into, out of and within the RA will be controlled under a permit system. If vaccinated animals need to be moved outside of their designated confined area in the RA they must do so only in cages or on a leash and in the case of dogs they must be muzzled, and only **at the discretion of the CVO** (see Section 2.2.1).

Animal gatherings will not be permitted in the early part of the outbreak but as animals become protected through vaccination programs and immunity develops normal gatherings, such as dog shows, may be approved under permit.

For further details on declared areas and movement controls see Appendixes 1 and 2.

### 3.2.3 Treatment of infected animals

The treatment of infected animals is ineffective.

### 3.2.4 Treatment of animal products and by-products

The main animal products/by-products that need to be considered are meat, milk, semen and embryos. All products from infected animals must be destroyed. It may be possible for meat to be infected with virus during the period when clinical signs are apparent but transmission to other animals or humans by this means is unlikely. Milk from infected animals can contain virus and infection can be transmitted. Product from suspect sources must, therefore, be destroyed. No evidence exists for transmission in semen or embryos.

The rabies virus is readily destroyed by heat so normal rendering times and temperatures will overcome any concerns about transmission.

### 3.2.5 Vaccination

Vaccination will be used either in individual animals or in a mass vaccination program if the disease is considered to be widespread or if a large number of animals are suspected of being exposed to infected animals.

The vaccine of choice will be an inactivated tissue culture vaccine that has been approved for use in Australia and is considered safe and effective. All animals within the RA will be vaccinated and identified in an approved manner. It is important that 100% of animals be vaccinated under these circumstances. Vaccination may occur at central points or by house-to-house vaccination or a combination. Young animals should be given a booster after 6 months.

Farm animals may be vaccinated if the virus gets into the wild animal populations and if adequate supplies are available. There may be a special need to protect susceptible zoological animals. Rabies in farm animals is usually as a result of contact with infected wildlife.

New recombinant vaccines have been developed but are not yet available commercially. They are considered to be safe and effective as both parenteral and oral vaccines but are still under assessment.

Vaccine and immunoglobulin to protect and treat humans will need to be available. Personnel who are likely to handle infected animal parts and laboratory workers should be protected pre-exposure by vaccination. Unprotected personnel exposed to infection will need to be treated with post-exposure immunoglobulin (see Appendix 5).

Should infection get into wildlife, effective oral vaccines are available but their use in Australia will need to be assessed beforehand for possible adverse effects on non-targeted species.

### **3.2.6 Tracing and surveillance**

Tracing of all animals that have been in contact with the infected animals will be essential and the source of entry to the country of the infected animal(s) quickly determined. Imported dogs, which have entered the country either legally or illegally, are the most likely source of the virus. If an outbreak occurs in a quarantine station all animals that have been released during the last 14 days must be traced and placed under quarantine. The disposition of these animals will depend on their possible contact with the infected animal(s) and their vaccination status, and may warrant destruction, vaccination and/or an extended quarantine period. In most cases they will be held for a period of observation before a decision is made.

All animals in contact with the infected animal during the past 14 days must be traced and quarantined for observation while a decision on their situation is made.

Susceptible animals within the RA will need to be surveyed and this will need to include targeted wildlife species. This will involve trapping and the capture or destruction of animals exhibiting abnormal behaviour and the collection of dead animals for laboratory examination. Monitoring for rabies in wildlife is difficult and it may be that carrier cases are detected only when they exhibit clinical signs.

Veterinary and medical reports of dog bites must be pursued and the offending animal examined and destroyed for laboratory examination or placed under observation as considered necessary.

### **3.2.7 Decontamination**

A high level of hygiene and safety measures for personnel are required in the handling of infected and suspected animals. Contamination with aerosols and saliva is a likely

possibility and all personnel associated with the program and handling animals and parts of animals must take all necessary precautions such as the use of gloves, masks and eye protection.

Examination areas must be washed and disinfected and kept clean and hands and clothing washed and disinfected.

### 3.2.8 Wild animal control

The major concern with wildlife is to try to prevent contact between wild animals and domestic animals during an outbreak and to prevent spread to other areas. If the disease is detected in a wildlife population this population must be included in the RA at the earliest possible time.

Wildlife experts must be used in the planning, monitoring and surveillance programs to attempt to maintain the wildlife within the confined areas and measures should not be introduced that are likely to disperse these populations. The initial concern is to attempt to identify the respective hosts related to the specific biotype to initiate eradication of these and monitor other possible contact susceptible species.

The extent of wildlife control areas should be determined on the basis of:

- epidemiological features of the index case;
- biology of the principal vector;
- known or acquired information on the population densities of susceptible species in the risk areas.

Sampling as a means of determining the extent of declared areas should be carried out as described in Sections 2.2.10 and 2.2.3.

### 3.2.9 Special legislative requirements enabling adequate response to a rabies outbreak or incursion

While all States/Territories are working towards consistency in their exotic animal disease control legislation, control of a rabies incursion may require additional powers because of the involvement of companion animals and people in the epidemiology of the disease.

It is important that any rabies incursion be controlled by the normal exotic animal disease control agencies through AUSVETPLAN (in close consultation with medical authorities and local government), and that the controlling authority has adequate powers to enable unrestricted activity in some areas normally managed through wildlife, rural lands or local authority legislation.

In reviewing relevant State/Territory legislation, attention should be given *inter alia* to the following aspects.

- Extended definition of 'stock' or provision of alternative arrangements for the purposes of empowering measures such as movement control, treatment, testing, seizure and destruction, of all animals, including domestic, companion and sporting animals and wildlife.
- In relation to companion or sporting animals and unowned or wild/feral animals, the legal requirement to notify suspicion of disease would need to be extended to *all* persons, rather than only to those *specified* persons (owner/agent/veterinarian) so obligated for livestock under most stock acts or exotic disease legislation.



- Specific powers to require control or confinement of companion animals, and to enable seizure or destruction of straying or suspect animals.
- Specific powers to require leashing and muzzling of dogs and confinement or leashing of cats.
- Specific powers to require vaccination and/or identification of all classes of domestic animals.
- Specific powers to enable entry on to crown lands and reserves, including Aboriginal or Torres Strait Islander lands.
- Specific powers to allow for the taking, keeping, testing, identification or destruction of protected species, including the use of poisons, traps and firearms.
- Specific powers to allow for the conduct of vaccination programs in wildlife.

States/Territories will need to review compensation arrangements to determine the eligibility or otherwise of claims for classes such as household pets, stud breeding dogs and cats, racing greyhounds and racing horses; and to establish methods for valuing such animals (see the **Valuation and Compensation Manual, Section 3**).

### 3.2.10 Media and public relations

The threat of rabies to human life, would ensure that any kind of incident concerned with rabid animals would attract the full glare of publicity. A vital aspect of disease control will be to satisfy the public by all available means that the authorities are taking, and are in a position to take, all measures necessary to control the situation. People must be warned of the dangers of rabies, the location of the quarantine area and where to obtain treatment should the need arise.

The media will play a major role in informing the public about rabies and the control measures that must be adopted. It will be important to closely liaise with the media and keep it informed on progress and in providing confidence to the public (see the **Public Relations Manual**).

The close cooperation of the public will be required to enable people to take the necessary precautions both with themselves and for the sake of their animals and to assist the authorities in the management of the eradication campaign. The reporting by the public of dog bites, the presence of stray dogs and the proper quarantining of their animals will help the authorities to more rapidly progress the operation. Special information and guidelines on measures to be adopted by the public should be readily available at veterinary and medical clinics and other places.

Rabid food animals and horses tend to have many dangerous human contacts through examination and nursing and these generate considerable expense for post-exposure human immunisation. Public awareness is therefore important and deserving of full attention. This may be achieved with intensive publicity campaigns.

Irresponsible overseas reports of an uncontrolled outbreak of rabies in Australia could have an impact on tourism.

### 3.3 Social and economic effects

The socioeconomic consequences of rabies would result mainly from its public health importance. In the course of an outbreak hundreds, possibly thousands of people may require to undergo a lengthy and expensive course of post-exposure therapy of vaccine and/or immunoglobulin as a result of dangerous animal contacts. A full course of post-exposure treatment in humans is estimated to cost \$1500 per previously non-immunised person or \$350 per previously immunised person. All potentially exposed people would have to be vaccinated. Evaluation of the economic loss from rabies, which primarily affects public health, is difficult to compare with other livestock diseases as human health cannot be valued by normal market measures. To this must be added the social costs of having such a feared disease present in the country.

The economic costs of control and eradication programs in domestic animals and wildlife would also be very substantial. Compulsory vaccination of dogs, cats and ferrets in an urban rabies situation would reduce the need for a great number of post-exposure prophylaxis in humans thus reducing the overall costs of a rabies outbreak. The cost of vaccination during a campaign would be around \$10 per animal. The cost of researching, developing and implementing a wildlife vaccination program would be considerable.

The social effect of orders impounding, controlling and destroying animals has the potential to provoke great animosity in the local community. The implementation of wildlife control/vaccination programs also have the potential to do the same domestically and internationally. They should not be undertaken unless an adequate preliminary communications program has been implemented (see the **Public Relations Manual**).

The long incubation period that can occur with rabies could produce unfamiliar problems, such as those of maintaining certain movement controls and monitoring for relatively long periods after the last case is detected.

### 3.4 Criteria for proof of freedom

Proof of freedom from rabies is not as important for trade as it is for many other exotic diseases. However, it does have very important social implications. The situation for urban dog rabies is again different from wildlife rabies. In the case of urban rabies, it would be reasonable that there could be a declaration of freedom, one year after the last case. This will mean the time of disbandment of the RAs. The quarantine protocols may have to be revised country by country.

With wildlife rabies, a longer period would be required because of the limited sampling ability, which consists essentially of examinations of animals found dead or with clinical signs, only. The time here would be two years of surveillance incorporating this limited sampling, after vaccination ceases.

### 3.5 Funding and compensation

Rabies is included in the list of diseases for which arrangements exist under the Commonwealth/States cost-sharing agreement for the eradication of certain exotic animal diseases. Information on the cost-sharing arrangements can be found in the

AUSVETPLAN **Summary Document, Appendix 3** and in the **Valuation and Compensation Manual**.

Compensation payments for animals destroyed as part of the rabies eradication program is not expected to be as high when compared to other exotic animal diseases. Exotic diseases of ruminants that may incur the slaughter of many thousands of animals (ie in an FMD virus outbreak) would be a far greater cost than the destruction of rabid/potentially rabid companion animals with compensation to owners at market value. However, education of the public, mass vaccination programs and the high cost of post-exposure treatment for any human exposed to a potentially rabid animal will incur enormous costs (see the **Valuation and Compensation Manual, Section 3**).

Large amounts of public funding are directed to rabies control and eradication in many overseas countries to protect the human population. The payment of compensation for domestic and companion animals is, therefore, justified to ensure that full public cooperation is forthcoming. However, the provision of compensation needs to be balanced against the requirement that owners practise responsible animal ownership.

### **3.6 Strategy if disease becomes established**

Endemic dog rabies (an unlikely scenario in Australia) is readily controlled through vaccination of about 80% of the host reservoir. The program includes compulsory vaccination and licensing of dogs, destruction of strays and, if necessary, strict confinement of pet animals.

Key support measures include:

- continuing public education program on rabies;
- investigation of all reported suspect cases;
- upgraded dog licensing and registration programs;
- confinement of pets and upgraded stray animal control programs;
- mass immunisation clinics for dogs and cats in affected areas.

It has been shown by European experience that endemic rabies in foxes is controllable by the strategic application of oral vaccination. Trials in the United States provide cautious optimism that red fox rabies can be eliminated by large-scale vaccination. Raccoon rabies also appears to be vulnerable to vaccine control. Elimination of skunk rabies is less certain at the present.

## **APPENDIX 1 Guidelines for the classifying of declared areas**

### **Infected premises (IP)**

A premises classified as an IP will be a defined area (which may be all or part of a property) in which an animal with clinical rabies exists or is believed to exist.

An infected premises will be subject to quarantine served by notice. After clinical cases have been destroyed, and if there are remaining domestic carnivores, the premises will be reclassified as a DCP. If no carnivores remain, quarantine will be lifted after appropriate decontamination.

### **Dangerous contact premises (DCP)**

Premises classified as DCPs will be those containing animals (dangerous contact animals) that have been in direct contact with infected animals.

### **Suspect premises (SP)**

Premises classified as those containing animals that could have had contact with the index case. Diagnosis of rabies in the index case would need to be known as soon as possible in order to move animals out of this category.

### **Restricted area (RA)**

This will be the area around the IP where movement controls and general confinement for appropriate species in that area will apply.

This area could be as large as a city or as small as a town or suburb.

### **Control area (CA)**

This area could be declared (eg State or city) but such an area does not appear to be warranted.

## APPENDIX 2 Recommended quarantine and movement controls

### Infected and dangerous contact premises

*Movement out of/into/within of susceptible mammals:*  
Prohibited.

*Movement in/out of other (non-susceptible) animals :*  
No restriction.

*Movement in/out of people:*  
No restriction.

*Movement in/out vehicles and equipment:*  
No restriction.

*Movement in/out of products:*  
Milk, meat, from infected and suspect ruminants to be destroyed.

*Movement in/out of semen and embryos :*  
No evidence exists of transmission via semen or embryos  
No restrictions should normally be applied.

### Restricted area (RA)

*Movement in/out:*  
Permit and proof of vaccination needed for carnivores; Permit needed for production animals.

*Movement within the RA after vaccination, but before 30 days post vaccination:*  
Dogs, cats, ferrets confined; exercise by permit (muzzled and leashed)

*Movement within the RA after vaccination and after 30 days:*  
CVO discretion with or without muzzle/leash

### Working animals

An exemption may be made to requirements by licence where a veterinary inspector is satisfied that the conditions unduly restrict the use of the animal for the purpose for which it is kept (eg guide dogs for the blind, working dogs on farms, guard dogs). It is intended, however, that these exemptions should apply only when the dog is actually carrying out its special function. Compulsory vaccination of all working dogs in the RA should be implemented.

### Animal gatherings and shows

Animal gatherings will not be permitted in the early part of the rabies outbreak. However, as animals become protected through vaccination programs and immunity develops normal gatherings, such as dog shows, may be approved *under permit*.

## APPENDIX 3 OIE International Animal Health Code for rabies [1995]

[NB The following text is taken directly from the OIE International Animal Health Code (1992); Chapter 3.1.5. For definitions, Appendixes and other related material, see the original text. The OIE Codes are amended every year in May. The Code for Rabies was amended in 1994 and 1995; the amended version is shown below.]

**Preamble:** For neutralising antibody titration tests and vaccine standards, reference should be made to the *Manual* (B 8) [see OIE publications under References].

### Article 3.1.5.1.

For the purposes of this *Code*, the *incubation period* for rabies shall be six months, and the *infective period* in domestic carnivora starts 15 days before the onset of the first clinical signs and ends when the animal dies.

### Article 3.1.5.2.

For the purposes of this *Code*:

#### **Rabies: free country**

A country may be considered free from rabies when:

- 1) the disease is compulsorily notifiable;
- 2) an effective system of disease surveillance is in operation;
- 3) all regulatory measures for the prevention and control of rabies have been implemented including effective importation procedures;
- 4) no *case* of indigenously acquired rabies infection has been confirmed in man or any animal species during the past two years; however, this status would not be affected by the isolation of a European Bat Lyssavirus (EBL1 or EBL2);
- 5) no imported case in carnivora has been confirmed outside a *quarantine station* for the past six months.

### Article 3.1.5.3.

When importing from rabies *free countries*, *Veterinary Administrations* should require: for domestic mammals, and wild mammals reared under confined conditions

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

- 1) showed no clinical sign of rabies on the day of shipment;
- 2) were kept since birth or for the six months prior to shipment in a rabies free country or were imported according to the regulations stipulated in Article 3.1.5.5., 3.1.5.6. or 3.1.5.7.

## Article 3.1.5.4.

When importing from rabies *free countries*, *Veterinary Administrations* should require:

for wild mammals not reared under confined conditions

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

- 1) showed no clinical sign of rabies on the day of shipment;
- 2) have been captured in a rabies free country, at a sufficient distance from any infected country. The distance should be defined according to the species exported and the reservoir species in the infected country.

## Article 3.1.5.5.

When importing from rabies infected countries, *Veterinary Administrations* should require:

for dogs and cats

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

- 1) showed no clinical sign of rabies within 48 hours of shipment;

AND EITHER

- 2) were vaccinated against rabies:
  - not less than six months and not more than one year prior to shipment in the case of a primovaccination, which should have been carried out when the animals were at least three months old;
  - not more than one year prior to shipment in the case of a booster vaccination;
  - with an inactivated virus vaccine;
- 3) were identified by a permanent mark before the vaccination (their identification number shall be stated in the certificate);
- 4) were subjected not less than 3 months and not more than 24 months prior to shipment to a neutralising antibody titration test, and their serum contained at least 0,5 IU/ml;

OR

- 5) have not been vaccinated against rabies or do not meet all the conditions set out in points 1, 2, 3 and 4; in such cases, the *importing country* may require the placing of the animals in a *quarantine station* located on its territory, in accordance with the conditions stipulated in its animal health legislation.

## Article 3.1.5.6.

When importing from rabies infected countries, *Veterinary Administrations* should require:

for domestic ruminants, equines and pigs

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

- 1) showed no clinical sign of rabies on the day of shipment;
- 2) were kept for the six months prior to shipment in an *establishment* where no *case* of rabies was reported for at least 12 months prior to shipment.

## Article 3.1.5.7.

When importing from rabies infected countries, *Veterinary Administrations* should require:

for laboratory reared monkeys, rodents and lagomorphs, and lagomorphs or wild mammals reared under confined conditions

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

- 1) showed no clinical sign of rabies on the day of shipment;
- 2) were kept since birth or for the twelve months prior to shipment in an *establishment* where no *case* of rabies was reported for at least twelve months prior to shipment.

## Article 3.1.5.8.

When importing from rabies infected countries, *Veterinary Administrations* should require:

for wild mammals not belonging to the order of carnivora and not reared under confined conditions

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

- 1) showed no clinical sign of rabies on the day of shipment;
- 2) were kept in a *quarantine station* for the six months prior to shipment.

## Article 3.1.5.9.

When importing from rabies infected countries, *Veterinary Administrations* should require:

for frozen *semen* of dogs

the presentation of an *international animal health certificate* attesting that the donor animals showed no clinical sign of rabies during the 15 days following collection.



## APPENDIX 4 Procedures for surveillance and proof of freedom

**Surveillance** will be necessary:

- when there is suspicion that rabies has entered Australia;
- during an outbreak to determine the extent of the affected area; and
- when the outbreak has been contained to ensure freedom from further disease and associated quarantine restrictions.

Sampling to detect the limits of rabies is a very difficult matter. The best animals to get are those that are dead or sick. Roadkills and trapped animals are in general, not a good source. Because rabies is fatal within days of clinical onset, the number of detectably rabid animals in a wild population is always low.

For monitoring the disease, the reporting by members of the public of any animal bite incidents with details of the offending animal and of any deaths of dogs, cats and wildlife should be encouraged and facilitated.

Wildlife experts must be used in the planning, monitoring and surveillance programs. The initial concern is to attempt to identify the respective hosts related to the specific biotype to initiate eradication of these and monitor other possible contact susceptible species.

**Proof of freedom** from rabies is not as important for trade as it is for many other exotic diseases. However, it does have very important social implications. In the case of urban rabies, it would be reasonable that there could be a declaration of freedom, one year after the last case.

With wildlife rabies, a longer period would be required because of the limited sampling ability, which consists essentially of examinations of animals found dead or with clinical signs, only. The time here would be two years of surveillance incorporating this limited sampling, after vaccination ceases (see **Appendix 3** for OIE requirements).

## APPENDIX 5 Rabies immunisation and post-exposure prophylaxis for humans

Human diploid cell vaccine (HDCV) is the vaccine of choice. It is available in Australia as Merieux Inactivated Rabies Vaccine.

Rabies immunoglobulin, human (RIGH) is used in combination with vaccine in post-exposure prophylaxis. Small stocks of an American product, Hyperab, and a May & Baker product, Imogam, are held at the Commonwealth Serum Laboratories.

### Pre-exposure immunisation

- HDCV (1 mL per dose) is administered intramuscularly to the deltoid area on days 0, 7 and 28.
- Persons with a continuing exposure (laboratory staff working with live rabies virus) should have the rabies antibody titre of their serum evaluated every six months; booster doses of vaccine should be given, as needed, to maintain an adequate titre.
- Others should have boosters every two years or should have their serum tested for antibodies every two years and boosters given if required.
- Serological testing for antibody response to vaccination is not necessary except in persons in whom immunologic responses might be impaired, eg persons on steroid therapy.

### Post-exposure prophylaxis

The essential components of post-exposure prophylaxis are first-aid treatment of wounds and scratches and immunisation.

#### *First-aid*

- Immediate washing and flushing with soap and water, detergent or water alone is essential.
- A disinfectant, either a phenolic, alcoholic, halide or quaternary ammonium compound eg Dettol, alcoholic chlorhexidine, tincture of iodine, Betadine, Milton's solution, Savlon, Cetrimide, should be applied.
- Local infiltration of RIGH if not previously immunised (see below).
- Postpone suturing. (In general, animal bite wounds are better not sutured.)
- Anti-tetanus procedures and antibiotics where indicated.

#### *Immunisation*

##### 1) Previously unimmunised subjects:

- five 1 mL doses of HDCV should be administered intramuscularly to the deltoid area. In children administration into the anterolateral aspect of the thigh is also acceptable;
- the first dose of HDCV should be given as soon as possible after exposure (day 0) and additional doses on days 3, 7, 14 and 28;
- RIGH should be administered in a dose of 20 IU/kg in a single dose at day 0. If possible up to half the dose of RIGH should be administered locally by careful instillation in the depth of the wound and by infiltration around the wound and the rest should be given intramuscularly;
- if not given with the first vaccine dose at day 0, RIGH may be given up to the eighth day but should not be given after the eighth day of the course of vaccine.

## 2) Previously immunised subjects:

- two 1 mL doses of HDCV should be administered intramuscularly to the deltoid area;
- the first dose of HDCV should be given as soon as possible after exposure (day 0) and the second three days later;
- RIGH is not necessary;
- in cases where the immune status is uncertain because the patient did not receive a full course of HDCV, and rabies-neutralising antibodies are not detected in serology, full primary post-exposure treatment should be considered, ie five doses of HDCV and one dose of RIGH.

**NB For further details see also NHMRC *Handbook on Immunisation Procedures* . In addition, there is the *Amended Plan for the Eradication of Rabies, Appendix XXVIII October 1984 National Health and Medical Research Council*, which is a joint document from the Department of Primary Industries and Energy and the Commonwealth Department of Health. This document is currently being reviewed.**

## GLOSSARY

AUSVETPLAN	A series of documents which outline the Australian approach to the eradication/control of the more important animal diseases not presently occurring in this country; linking policy, strategies, implementation, coordination and counter-disaster agency plans.
Biotype	A group of individuals within a species with identical, or almost identical genetic constitution.
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. The limits of a control area and the condition applying therein may be varied rapidly according to need.
Dangerous contact animal	An animal that has come into direct physical contact with an infected animal because of close housing (eg in a quarantine station or pound) or, in the case of rabies, has been bitten but is currently showing no clinical signs of the disease.
Declared area	A defined tract of land for the time being subject to disease control restrictions under exotic disease legislation. Types of declared areas include <i>restricted area</i> ; <i>control area</i> ; <i>infected premises</i> ; and <i>dangerous contact premises</i> (see Appendix 1).
Disinfectant	An agent used to destroy microorganisms outside a living animal.
Disposal	Sanitary removal of animal carcasses, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease.
Fluorescent antibody test	Use of a fluorescently tagged antibody to detect a specific antigen.
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 case	The first or original case identified to have occurred in a disease outbreak.
Infected premises	see Appendix 1
Infectious units (IU)	Measure of the amount of virus, where: 1 IU = 1.4 TCID <sub>50</sub> . Tissue culture infectious dose (TCID <sub>50</sub> ) is a measure of virus concentration or dose. Serial dilutions of virus are added to susceptible cells in culture. The dilution of virus at which half of the cultures are infected is called the TCID <sub>50</sub> .
Local disease control centre	An emergency operations centre responsible for the command and control of field operations in a defined area.
Movement control	Restrictions placed on movement of animals, people and things to prevent the spread of disease.

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 relatively small declared area (compared to a control area) around an infected premises that is subject to intense surveillance and movement controls ( <i>see</i> Appendix 1).
Serotype	A subgroup of a genus of microorganisms identifiable by the antigens carried by the members.
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 or things to determine the presence or absence of an exotic disease.
Susceptible species	Animals that can be infected with the disease (for rabies — all warm-blooded animals)
Sylvatic rabies	Term used to denote a cycle of rabies infection involving wildlife (derived from <i>sylvan</i> [adj] — pertaining to or inhabiting the woods).
TCID <sub>50</sub>	<i>see</i> Infectious units
Tracing	The process of locating animals, persons or things that may be implicated in the spread of disease.
Vaccine	
– attenuated	A vaccine prepared from infective or ‘live’ microbes that have lost their virulence but have retained their ability to induce protective immunity.
– inactivated	A vaccine prepared from a virus that has been inactivated (‘killed’) by chemical or physical treatment.
– recombinant	A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect (subunit and construct vaccines).
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.

## Abbreviations

AAHL	CSIRO Australian Animal Health Laboratory, Geelong
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CCEAD	Consultative Committee on Exotic Animal Disease
CVO	Chief veterinary officer
DCP	Dangerous contact premises
DGQS	Declared government quarantine station
DPIE	Department of Primary Industries and Energy
EDTA	Ethylene diamine tetra-acetic acid (anticoagulant for whole blood)
ERA	Evelyn Rokitnicki Abelseth [strain of oral rabies vaccination]
FMD	Foot-and-mouth disease
HDCV	Human diploid cell vaccine
IP	Infected premises
IU	Infectious unit
NAQS	Northern Australia Quarantine Strategy
NHMRC	National Health and Medical Research Council
OIE	World Organisation for Animal Health [Office International des Epizooties]
PCR	Polymerase chain reaction
RA	Restricted area
RIGH	Rabies immunoglobulin, human
RNA	Ribonucleic acid
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SAD	Street Alabama Dufferin [strain of oral rabies vaccination]
SMBO	Suckling mouse brain origin
TCID	Tissue culture infective dose
TVR	Trap, vaccinate, release
WHO	World Health Organization

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### **Video/training resources**

*A strange kind of madness (rabies)* (video), AAHL 1992 (available from the Animal Diseases/Incidents Section, DPIE, Canberra; or AAHL)

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

### **OIE publications**

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

OIE Manual (1992). *Manual of Standards for Diagnostic Tests and Vaccines* (2nd edition), OIE, Paris, France.

### **NHMRC document update**

National Health and Medical Research Council (1984). *Amended Plan for the Eradication of Rabies, Appendix XXVIII October 1984*, Australian Government Publishing Service, Canberra.

[This a joint document from the Commonwealth Department of Human Services and Health and Department of Primary Industries and Energy. It is currently being reviewed.]



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