

Rabies

Research Paper 94/98

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This paper discusses UK rabies policy in the light of moves towards a single Europe, and describes the European anti-rabies campaign. Norway and Sweden have recently switched from using quarantine to a vaccination and 'passport' system for pets.

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I The disease

Rabies, an infection of the central nervous system by a virus, is a disease of most warm blooded animals as well as human beings. According to the World Health Organisation's (WHO's) Expert Committee on Rabies, rabies in humans "almost inevitably ends in death"¹.

A. The rabies virus

The agent that causes rabies was first isolated by Pasteur's colleague Emile Roux in 1881². The rabies virus belongs to a group or genus of viruses known as the lyssaviruses, which in turn are members of the large family of bullet-shaped viruses known as the rhabdoviruses³.

As organisms, viruses show the lowest possible level of organisation. This is not to say that they are primitive, since they are in some ways extremely sophisticated and successful life forms. Indeed, familiar viruses such as the influenza virus, the HIV virus and the rabies virus, elude our attempts to control them. However, the structure of viruses is far simpler than even that of bacteria. The rabies virus is typical in consisting of simply a single strand of genetic material (called RNA) contained within a protein coat. It has no cellular mechanisms for reproducing itself, so it has to invade a cell of a host, and take over that cell's machinery to make multiple copies of its own genetic material.

There are many different strains of the rabies virus, which have been identified through the use of monoclonal and polyclonal antibodies. The prototype strains known at present are¹;

- Serotype 1: Challenge Virus Standard. The majority of viruses isolated from mammals in the field and in some cases in the lab.
- Serotype 2: Lagos bat. First isolated from bats on Lagos Island, Nigeria (Lagos-bat 1) and then from bats and a cat elsewhere (Lagos-bat 2 and 3).
- Serotype 3: Mokola. First isolated from shrews in Nigeria and then from a human (Mokola 1), further from shrews elsewhere (Mokola 2 and 3) and dogs in Zimbabwe (Mokola 5).

¹World Health Organisation *WHO Expert Committee on Rabies Eighth Report* 1992 WHO Technical Report Series 824

²Kaplan, Turner and Warrell *Rabies: the facts* 2nd edn. 1986

³*The Lancet* Vol 343 1 January 1994 pp5-6

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- Serotype 4: Duvenhage. First isolated from a human in South Africa (Duvenhage 1) and from bats in South Africa and Zimbabwe (Duvenhage 2 and 3).

Further more recently isolated strains remain to be identified.

The rabies virus is notable in having a variable incubation period that may last for only about 8 weeks but which has been well proven to last for up to six months. During this time the animal will show no signs of being infected⁴.

This possible six month incubation period is the reason why our rabies regulations stipulate a quarantine period of six months for animals entering the country (see section III B).

B. Infection

In man, rabies infection is almost always a result of a bite from an animal which is already infected with rabies and which contains the virus in its saliva. The virus can enter the body across intact mucous membranes (such as those lining the nose and mouth) or through cuts in the skin; the virus cannot infect someone through unbroken skin⁵. In laboratory animals infection has been shown to happen through eating infected food (which is important because this means that animals can also be immunised orally - see section II C).

Far less commonly, humans may be infected with rabies through breathing in airborne rabies virus. Some laboratory scientists in the US have died from rabies caught in this way.

C. Invasion of the host

After infection the virus, deposited in the tissue of the new host, starts off its cycle of infection and multiplication, first of all using the cell replication machinery in the host's muscle cells. The virus enters the nervous system at the site where nerve cells innervate [connect to] muscle, and virus particles travel passively via the peripheral nerves to the central nervous system (CNS).

⁴MAFF *RABIES Prevention and Control. Government Policy* June 1991

⁵Kaplan, Turner and Warrell *Rabies: the facts* 2nd edn. 1986

The virus is not able to multiply a great deal while travelling in the nervous system since nerve cells are highly specialised elongated or stretched out cells with a cell body only at one end; the cell replication machinery that the virus needs is therefore only present at intervals. When the virus reaches the CNS, there are far more cell bodies present for the replication of the virus and so the amount of virus in the spinal cord and brain increases enormously.

When the virus reaches the brain, clinical signs appear. There may be three stages of the disease⁴:

- Prodromal stage. The animal becomes irritable, anxious, uneasy and photosensitive and may bite the original wound site.
- Excitement stage. Irritability gives way to aggressiveness and fits. The animal attempts to bite objects and other animals and may try to break loose. The eyes stare, it salivates copiously, the lower jaw sags, its voice may change.
- Paralytic stage. A progressive paralysis develops with staggering and respiratory distress, quickly followed by coma and death.

However, the first phase may pass unnoticed, and typically one or other of the last two conditions, excitement or paralysis, will be the predominant symptom, leading rabies to traditionally be split into two forms; furious and dumb rabies (see below). In the early stages of CNS infection the virus is still localised and affects only selected populations of nerve cells. According to one description⁶;

"the alertness, loss of natural timidity, abnormal sexual behaviour, and aggressiveness that typify clinical rabies represent a diabolical adaptation of the virus to selected neuronal populations - neurons [nerve cells] capable of driving the host in a fury to transmit the virus to another host animal".

In other words, the virus causes symptoms that will further its spread to a new host.

From the CNS the virus spreads outwards to the nerve cells of virtually every organ in the body, including the salivary glands, where it undergoes further replication; the infected animal is now able to infect another through its saliva.

⁶Kaplan, Turner and Warrell *Rabies: the facts* 2nd edn. 1986

D. Clinical course of the disease in humans

"...rabies in humans almost inevitably ends in death...The clinical course of the disease, with either excitation or paralysis as the predominant symptom, is of short duration and entails much suffering. Patients remain conscious, often aware of the nature of their illness..." (World Health Organisation Expert Committee on Rabies)

The first sign that the virus is invading the CNS may be a vague, feverish illness, with symptoms similar to those of influenza. Many symptoms may appear that will not in themselves be diagnostic of rabies, such as nausea, vomiting, headache, aches and pains, weakness, tiredness, loss of appetite, a change of mood, anxiety, a sense of foreboding, sleeplessness and fever.

The first symptom that may develop that is highly indicative of rabies is itching, at the site of the healed wound or over the whole limb involved. This intense itching may trigger vigorous scratching. In other cases sensations such as burning, stabbing, tingling or numbness may be felt at the site of a bite. Such abnormal sensations present at the site of the bite in one- to two-thirds of human rabies cases during the prodromal period, may be due to the initial replication of the virus and its entry from the muscle cells to the nervous system.

At these early stages doctors are unlikely to diagnose rabies unless the animal bite is mentioned. However, abnormal sensations around a wound scar "should always prompt enquiries about animal bites, especially if a patient has been to a part of the world where rabies is still endemic"⁶.

As noted above, either excitation or paralysis may be the predominant symptom. Thus rabies has traditionally been described as taking two clinical forms; i) furious or excited rabies (most commonly recorded on admissions to hospitals) and ii) dumb or paralytic rabies.

1. Furious rabies

Most patients with furious rabies die within a week of the first prodromal symptom and within a few days of developing hydrophobia. The clinical course of the disease has been described as "short and horrifyingly hectic", with phobic spasms (hydrophobia and aerophobia) and periods of extreme excitement interspersed with periods of lucidity and full

comprehension before the patient finally reaches unconsciousness and complete paralysis.

Hydrophobia, literally "dread of water", is still sometimes used as a synonym for rabies, although it is only one symptom, present in perhaps 80% of rabies cases. The descriptions of patients suffering from rabies with hydrophobia make unpleasant reading.

One of the most upsetting features of rabies for any friends or relatives of the patient is an alternation between periods of wild agitation and lucid calm. The patient may be extremely agitated and hallucinating, shouting incomprehensively and distortedly. The body may be racked with spasms and the face distorted with terror, and the patient may try to escape from constraints or from the room. After a few minutes of this the patient may become calm again and be able to discuss his or her symptoms rationally.

Fearing the effects of trying to drink, patients may go for 24 hours without drinking until they become unbearably thirsty. Trying to drink, the patient's arm may tremble violently, as they try desperately to sip, but the neck and breathing muscles may contract forcibly, making the patient clutch at his or her throat. A "last minute terror" may cause them to fling away the cup, falling back with the neck extended or even hiding under the bedclothes. The patients may vomit violently, and cry with alarm, but because the vocal chords are paralysed or swollen the sound will be distorted.

As the disease progresses the hydrophobic response may be triggered by the sound of running water or the sight or mention of water. Some patients start fitting and die during hydrophobic spasms, and breathing may stop because of the contraction of the breathing muscles or through choking. The heart may race yet may be starved of oxygen if the patient is not breathing. Eventually hydrophobic spasms may happen spontaneously and more and more frequently, without apparent provocation.

Phobic spasms may also occur in response to other stimuli such as draughts of air on the face ("aerophobia"), or other visual or olfactory stimuli; some patients show a general increased sensitivity and responsiveness to all sensory stimuli. Phobic spasms usually occur at some time in all patients in whom excitation is the prominent symptom (furious rabies), but are less common in patients showing paralytic or dumb rabies.

A very wide range of other symptoms may be present. For instance, dilated pupils, paralysis of part of the face, increased salivation (frothing at the mouth) and lacrimation [crying] are common.

The terminal phase is a relatively calm period of coma with irregular breathing and raised

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pulse rate; general paralysis takes over and eventually the patient may die of respiratory and cardiac failure. Without intensive care patients usually die on the second to fourth day of their illness and they rarely survive longer than a week.

2. Dumb rabies

This is the commoner clinical form of rabies in animals including dogs, but in humans it is less common. "Dumb rabies" describes the more tranquil nature of this form of rabies, when paralysis rather than excitation is the predominant symptom, but also signifies the fact that the victim may be struck dumb through paralysis of the vocal chords.

The illness, starting with fever and headache, may progress through numbness, cramp and weakness to general paralysis and loss of feeling. The legs, trunk, arms, and finally the breathing and swallowing muscles may be affected in turn. From being fully conscious and rational the patient may become delirious and comatose. Most patients with paralytic rabies do not experience hydrophobia and they may survive longer; for up to thirty days without intensive care, before dying⁷.

Although in reality there may be no absolute distinction between dumb and furious rabies, this illustrates the very important point that rabid animals will not necessarily exhibit the classic symptoms of running about madly, foaming at the mouth.

Rabid animals may be morose or inactive, and behaving out of character by being visible to or approachable by humans.

E. Treatment in humans

Following exposure, the most effective means of protection against the rabies virus is to eliminate it at the site of infection.

The WHO Expert Committee on Rabies (reference 1) recommends that first aid treatment should include prompt and thorough local cleaning of the wound with detergent, soap and water, or water alone, and if possible ethanol or iodine should then be applied. This should be followed by the administration of serum and vaccine immediately after exposure.

⁷Kaplan, Turner and Warrell *Rabies: the facts* 2nd edn. 1986

Once rabies has developed in humans it has an extremely high fatality rate. Recovery has been recorded in only a "few cases". This has been following immediate post-exposure treatment with brain vaccines from duck embryos or suckler mice.

Significant advances have been made in the production of rabies vaccines in the past ten or so years. The earliest rabies vaccines were made from nerve tissue. Over ten years ago the WHO Expert Committee on Rabies supported the trend away from brain-tissue vaccines, and strongly advocated the production of inactivated cell-culture rabies vaccines, since these combine safety with high efficacy; they are safer and more effective than nerve-tissue vaccines. New oral vaccines are being developed to vaccinate various species of wildlife and dogs in the field.

However, vaccines of high efficacy and safety are not available in many areas of the world. Cell-culture vaccines, for both human and animal use, are expensive. During vaccine production strict quality control is necessary and potency tests need to be carried out on all vaccine batches, by national authorities. Advances in biotechnology are making the production of rabies vaccines on an industrial scale possible, and are reducing costs. Such technology is also increasing safety, since recombinant or genetically altered vaccines do not run the risk of actually themselves causing the disease, unlike live-virus or inactivated rabies vaccines (see section II C).

As yet however, no inexpensive vaccines are available for mass pre-exposure vaccination. The inability to provide mass vaccination is confounded by the fact that a single injection is inadequate. People at high risk, such as animal handlers, vets and wildlife officers, may be given pre-exposure vaccination. This usually consists of three intramuscular injections into the arm, of tissue-culture vaccine on days 0, 7 and 28. A few weeks after the last dose the vaccinated individual needs to have a blood test to check that antibodies have been produced. Boosters are recommended for people at continuing risk of rabies, who should be tested for antibodies every year. A booster is given if the antibody count falls below a certain level.

Following exposure to rabies, people who have previously been vaccinated for rabies may be treated with two booster doses of rabies vaccine, and people who have not should be given vaccination and treatment with rabies immunoglobulins. According to the WHO, "prompt and thorough cleansing of the wound and administration of purified equine or human rabies immunoglobulins and cell-culture rabies vaccines immediately after exposure virtually guarantee complete protection".

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According to a recent letter from a MAFF employee in the *Veterinary Record*⁸:

"In 1989 (the last year for which figures are available), nearly 28,000 people across Europe received post-exposure treatment and waited months to see if it had worked".

Such treatment may be feasible in, for instance, a rabies laboratory or in an affluent country with the necessary (expensive) vaccines to hand, but not so easy to perform in the field or in a developing country. Once rabies develops, although various treatments have been tried so far without effect, there is little that can be done other than isolating and sedating the patient.

II Rabies in animals

All warm-blooded animals are susceptible to rabies, but some are more common hosts than others and some animals come into contact with man more frequently than others. In many countries, by far the most dangerous rabies reservoir is the dog population. In Europe, the main reservoir is the fox population. The two species carry different strains of the rabies virus (various rabies strains were listed in section I A above).

The precise ways in which rabies strains are transmitted between different species is rather unclear as yet. It is probably more likely that foxes would pass rabies to dogs, rather than *vice versa*, since the dog is thought to be the end-host for the fox-mediated rabies which is present in Europe. On the other hand, dogs or cats coming into Europe from outside might bring in dog (or "street") rabies from parts of the world, such as developing countries, where dog rabies is commonplace⁹.

A. Dogs

Over 99% of human rabies cases occur following transmission of the rabies virus from a dog¹⁰. Worldwide, around 6.5 million people receive treatment every year after being bitten or scratched by dogs, and 33,000 people die each year from dog rabies¹¹.

⁸Letter to *Veterinary Record* 6 August 1994 p.144

⁹"Rabies Policy" Letter to *Veterinary Record*, 27 August 1994 p.215

¹⁰World Health Organisation *WHO Expert Committee on Rabies Eighth Report* 1992 WHO Technical Report Series 824

¹¹"Rabies Campaign" *New Scientist* 2 July 1994

Almost all canine rabies occurs in developing nations, where dogs are not confined to owners' premises and where dog populations are generally uncontrolled¹⁰.

Following research carried out by the WHO between 1981 and 1988 it was realised that simply removing and humanely killing stray dogs was of little use (and costly). There is no evidence that removal of dogs has ever had a significant impact on population densities or on the spread of rabies. Dog populations turn over so quickly that even after removing 15% of the population other dogs will simply survive for longer (pressures on them such as overcrowding or shortage of food are relaxed) and these increased survival rates easily compensate for the dogs removed. On top of this, dog removal may not be acceptable to communities; dogs that appear to be strays may in fact be neighbourhood dogs that everyone feeds.

So the relationships between the dogs and humans and the population dynamics of dogs need to be investigated before any control measures are undertaken. For instance, some dogs will be closely attached to humans and dependent on them to varying degrees for food; other dogs may live in totally feral packs. Dogs which are individually owned, well supervised and controlled may be vaccinated; at the other end of the scale packs of totally feral dogs could be removed and humanely destroyed with little objection from the public. Controlling the dogs' ecosystem (by for instance limiting their food supply by not leaving rubbish out) might have a greater effect than direct control. The WHO considers that responsible dog ownership and a shift in public attitudes towards dogs have to be principle goals of dog control programmes.

Mass canine vaccination has been the most important rabies control measure yet applied in developing countries. For a successful programme, 75% of the dog population should be vaccinated within a month. However, if the dog turnover is high, vaccination may need to be carried out again every year, unless vaccinated dogs can be tagged in some way (such as by using brightly coloured plastic tags) and the vaccine can be relied on to last for two years or so.

Whether or not dogs are owned, when a mass vaccination programme is carried out it has been found that only 10-15% of the dog population avoid being caught. Combinations of house-to-house visits, fixed vaccination posts and mobile clinics may be used. In such ways, vaccination coverage rates of 75% or higher can be achieved, particularly with informational campaigns and the involvement of the community.

International co-operation and research is being encouraged by the WHO to further the effectiveness of dog control programmes.

B. Wild animal rabies reservoirs

Bearing in mind that rabies is a disease of all warm-blooded animals, around the world, the animals that act as the major wildlife reservoir species for rabies include the arctic and red foxes, mongooses, racoons and racoon dogs, skunks, jackals and bats. Only rare cases of rodent rabies have been recorded, so rats, mice and similar animals are not considered rabies reservoirs.

Massive outbreaks of cattle rabies in the Americas in the 1910s were attributed to vampire bats. Human rabies cases attributed to bites from vampire bats have been reported in Guyana, Mexico and Trinidad, and more recently in Bolivia, Peru and Brazil. As control measures, cattle may be vaccinated and bats or cattle may be dosed with anticoagulants. Very few bat species feed on blood however; most feed on fruit or on insects; all British bats, for instance, are insectivorous.

Rabies has been diagnosed in several species of insectivorous bats in North America and Europe. Human rabies from insectivorous bats is uncommon; thirteen cases have been reported in Canada and the US, and two in Europe. The WHO considers that the generally low prevalence of rabies in bat populations does not justify specific control measures, particularly because bats are usually designated endangered species. Also, bats very rarely come into contact with humans. However, the WHO recommend that people in rabies-infected countries should be made aware of bat rabies, so that anyone bitten by an insectivorous bat should receive post-exposure treatment.

Skunks, foxes and raccoons are increasingly found in urban areas, and are well able to adapt to a variety of urban ecosystems. The fox, for instance, can be described as a generalist forager. It will feed on both small vertebrates and invertebrates including earthworms, and will scavenge and feed on refuse left out by humans. This makes it successful in the urban environment. It is also generally tolerated by the humans living in urban areas, who may even feed foxes deliberately, so further encouraging them.

In many urban areas in southern Ontario, Canada, skunks and foxes have carried rabies since the 1960s. Rabies was identified in racoons in Florida in the 1950s and has spread northwards up the east coast of the US. In large metropolitan areas such as Toronto, Washington DC and Baltimore, there has been an increasing number of rabies exposures in humans and domesticated animals, linked to increasing densities of wild urban carnivores.

In 1991 "panic and hysteria" were reported to be sweeping New York in the wake of rabid

racoons moving through the City's vast sewerage system¹². Westchester County, New York, declared a rabies alert after rabies was confirmed in six racoons, and mandatory vaccination of cats and dogs was introduced (at a cost of \$10 per animal) to prevent the spread of rabies to pets from the estimated 70,000 racoons in the state¹³.

In the UK of course, the fox *Vulpes vulpes* is the main potential rabies reservoir. It is responsible for the maintenance and spread of rabies in subarctic and north-eastern North America, sub-arctic Asia, and in central and eastern Europe¹⁰. Since the 1940s, a strain of fox rabies has spread across Europe from Poland. Every year 200,000 Europeans receive post-exposure rabies treatment, and hundreds of cattle are destroyed¹⁴.

Apart from its generalist foraging behaviour, which makes the fox adept at living within human settlements, other features of fox biology are important in maintaining rabies epizootics (epizootics are simply disease epidemics in animals) and enzootics (maintenance of a disease in an animal population at a particular location).

Female foxes reach sexual maturity at 9 months and give birth to one litter a year. The average litter size is five puppies. Such high reproductive rates help populations recover quickly from natural diseases or from artificial control operations. When the foxes are about 6 months old, males in particular will disperse to other territories, over typical dispersal distances of 10-50 km. A high population density, which allows contact between infected animals of the same species, is necessary for the maintenance of rabies in a population.

Simply removing animals from the population, to reduce population densities to such levels that the disease will not be able to maintain itself, is one way of controlling rabies. However, such operations have never reduced populations enough to eliminate the disease, and animals will simply move in from surrounding areas to replace those removed. Also, pest species such as rodents, whose population levels are normally controlled by that animal, may increase in number.

Hence the WHO considers that wildlife reduction techniques should not be carried out on a large scale, and control of wildlife rabies has moved more and more towards using oral vaccination techniques.

¹²"Rabies hysteria in New York" *Independent* 7 May 1991 p.13

¹³"Racoons spread rabies to suburban New York" *British Medical Journal* 18 May 1991 p.1172

¹⁴"Europe launches spring offensive against rabies" *New Scientist* 30 April 1994 p.6

C. Oral immunisation of foxes in Europe

In 1978 Switzerland started a large scale field trial of immunising foxes, using chicken-head baits carrying a live rabies vaccine. The same Swiss chicken-head bait was also used in trials in France, Germany and Italy from 1985-1987. In 1985 German workers invented an artificial bait based on tallow and fish meal, that could be produced artificially¹⁵. Today, artificial fat and fish meal or chicken head baits are dropped by plane in central and in eastern Europe, rather than being distributed manually. The WHO conducts trials with different vaccines, dosages and baits to test effectiveness.

The live vaccine used in such immunisation programmes is weakened or modified so that it will not itself cause rabies. Such modified, treated or "attenuated" viruses (or bacteria) are commonly used in immunisations. Attenuated viruses are rendered less able to produce disease (their pathogenic properties are reduced) through, for instance, treatment with heat or chemicals, through drying, or by passing them through another organism.

The trick lies in administering a type and dose of virus potent enough to stimulate immunity, while not actually producing the disease. In other words, one needs to retain immunogenicity while losing pathogenicity. For instance, there is a possibility that attenuated viruses used for adult dogs might run a greater risk of causing rabies in puppies whose immune systems are not fully developed¹⁶. It is also realised that non-target species or even children could eat baits intended for dogs or foxes, so before field tests, all vaccines have to be assessed against non-target species.

Between 1978 and 1990, 1.3 million modified live-virus baits were distributed in Switzerland. Only three cases of vaccine-induced rabies in foxes were detected. Over 20 million baits carrying a different strain of modified live-virus have been distributed through Europe, with no deaths among non-target species. A quarter of a million doses of a further strain were distributed in France and Switzerland in 1989-90, with no vaccine-induced rabies cases being noted¹⁰.

Advances in genetic engineering techniques have given rise to various classes of genetically altered or "recombinant" rabies vaccines, which are potentially even safer. In these, only parts of the virus are used, to stimulate immunity. They cannot show any residual pathogenicity because certain genes have been removed. For example, the Rhône-Mérieux vaccine consists of a vaccinia virus containing only the glycoprotein gene from the rabies

¹⁵"Eradication of rabies in Europe" *Nature* 12 November 1992 p.115

¹⁶"Rabies campaign" *New Scientist* 2 July 1994

virus¹⁷. This is enough to stimulate an immune response, while not causing the disease.

Studies over almost a decade have shown no pathogenic effects (no vaccine-induced rabies) in over 10 bird species and 35 mammals, regardless of dose. Over a million doses of recombinant vaccines have now been distributed in field trials in Europe, and more in the US, with no apparent adverse effects. Of course, such genetically modified vaccines have to be thoroughly tested in the laboratory before release in the field, and their use has to be covered by each country's biosafety regulations.

Today, oral immunisation has become the essential tool for rabies control programmes in Europe and elsewhere. In 1989 the European Community adopted measures based on oral vaccination designed to eradicate rabies from Europe²². Since 1988 the Commission has met half the costs of any national rabies campaigns¹⁸.

Fox rabies has now been eliminated from Luxembourg and the Netherlands, and from significant parts of Germany, France, Belgium, Italy, Switzerland and former Czechoslovakia¹⁹, proving the efficacy of oral vaccination. In southern Finland racoon dogs and foxes have been orally immunised since 1988; rabies was eliminated from the wild populations of these animals within 12 months¹⁰. Following the initial Swiss trials in 1978, vaccination zones freed areas in Switzerland from rabies one by one, and in eastern Switzerland, high rabies prevalence which had lasted for 18 years was ended after three vaccination campaigns covering the entire region¹⁷.

However, a major problem is the need for concerted and co-ordinated vaccine programmes. There is little point in treating foxes in one area if reinfection can occur through foxes coming in from neighbouring regions. According to Klaus Stohr of the WHO's Veterinary Public Health Unit, eliminating rabies may allow fox populations to double or triple, so making the problem worse than it was in the first place, if reinfection occurs. France, for instance, began its vaccination programme after fox rabies had spread halfway across its land, but it started in the centre of the country, allowing French foxes from its border regions to reinfect foxes in the (by then) rabies-free neighbouring Germany.

The Commission co-ordinates rabies campaigns and now refuses to fund those Member States that do not co-ordinate campaigns with neighbouring states. In 1994's campaign, the EU was aiming to extend the rabies-free zone to Poland, Slovakia, Hungary and Slovenia. Six million baits were to be distributed at a cost of £5 million in rabies-infected areas and border

¹⁷"Eradication of rabies in Europe" *Nature* 12 November 1992 p.115

¹⁸"Europe launches spring offensive against rabies" *New Scientist* 30 April 1994 p.6

¹⁹ *ibid*

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regions. Over two-thirds of these fat and fish meal baits carried attenuated virus, and the rest the new Mérieux recombinant vaccine.

The WHO expects eventually to have to consider a permanent vaccination belt across Russia to prevent reinfection from Asia (ibid).

Another problem is bait uptake; some early studies in this country indicated a low take-up rate. The WHO continues to experiment with different baits. However, because of reservations about uptake, and because there is a high urban fox population in Great Britain, MAFF has felt in the past that the success of an oral immunisation programme for British foxes would be low. Its strategy is therefore to stamp out any outbreak before this could become established in wildlife. The present plan is to poison all foxes within a 19 km radius of any rabies outbreak, but a MAFF spokesman has said that future policy might entail using poisoned bait in a smaller area, surrounded by a ring of oral vaccination²⁰.

Dog rabies and fox rabies are caused by different strains of the same virus, but the experiences gained in Europe in controlling fox rabies by oral vaccination will be used in dog rabies campaigns in developing nations. Dogs pose a much greater threat to humans than foxes, not least because they come into much closer contact with us. Baits carrying attenuated rabies virus, aimed at stray dogs, may be distributed in villages across Africa and Asia next year if present trials with baits and doses are successful¹⁶.

III UK rabies legislation

Britain has been rabies-free for 90 years²¹. The English Channel provides a natural barrier against infection, and there has not been a case of rabies outside quarantine in Britain since 1970. Two dogs have developed rabies in quarantine (one imported from the US and the other from Zambia); both had been vaccinated. The central responsibility for anti-rabies measures in Great Britain lies with the Agriculture Departments, and MAFF stresses that there is no room for complacency²².

²⁰"The way to outfox rabies" *New Scientist*, 16 April 1994

²¹"MAFF outlines new rabies control arrangements" *The Veterinary Record* 9 April 1994 p.362

A. The Rabies (Control) Order 1974

UK rabies policy is aimed primarily at keeping rabies out of the country, but there is a second tier of contingency measures designed to deal with any outbreaks that might occur. The *Rabies (Control) Order 1974* (SI 1974/2212) provides far-reaching powers to deal with outbreaks.

As soon as an animal is suspected of having rabies, the premises at which it has been kept would be declared an infected place. The animal (and any contact animals) could be confined or removed to secure MAFF premises. If an isolated animal did not recover but died, or if it were immediately slaughtered to determine whether rabies was present, its brain would then be tested for rabies by MAFF (all suspect cases are investigated, to further staff training and the development of contingency plans).

If rabies were discovered, the follow-up action would depend on circumstances²². A single animal that had contact with no other animals might be easily dealt with, but on the other hand a whole area containing domesticated and wild animals might have been exposed. An infected area might be declared, in and out of which the movement of animals would be restricted. Animals within the area could be confined (dogs muzzled and cats leashed). Any animals not under control could be seized, and all animals within the area compulsorily vaccinated. The gathering of animals (for hunts or racing, for instance) could be banned, and as mentioned in section II C above, foxes in the area around the outbreak would be poisoned, and perhaps vaccinated in a wider area.

B. Rabies (Importation of Dogs, Cats and Other Mammals) Order 1974

The major piece of legislation which seeks to prevent rabies entering Great Britain is the *Rabies (Importation of Dogs, Cats and Other Mammals) Order 1974* (SI 1974/2211) (the Rabies Order) as amended by further Orders in 1977, 1984, 1986 and 1990.

The Rabies Order covers all warm-blooded mammals except farm stock and some herbivores (plant eaters). However, these exceptions are covered if they have been in contact with animals subject to quarantine regulations. They are also subject to other animal health import controls that guard against rabies.

The Rabies Order prohibits the landing of an animal in Britain from outside, except under the

²² MAFF *RABIES Prevention and Control. Government Policy* June 1991 p.12

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terms of a licence (issued by MAFF). Animals from Northern Ireland, Eire or the Isle of Man are not prohibited unless the animals have been brought into those countries from outside and have not then undergone quarantine. Animals may only be landed at certain ports and airports listed in Schedule 2 to the Order.

The most familiar condition of an import licence is detention in quarantine. Any animal that has been taken outside the British Isles, for however short a time, and whether or not it has landed outside, is counted as an imported animal and is subject to quarantine on return. This is for a period of six months for most species (including cats and dogs), 35 days for birds, and life for a vampire bat, all at the owners' expense.

In addition, the rabies provisions impose additional requirements such as a rabies vaccination for dogs and cats in quarantine. The six month quarantine period may be extended if a rabies outbreak occurs.

Import licences under the Order also require, *inter alia*:

- Transportation to and from quarantine premises in a MAFF-approved vehicle.
- Quarantine at MAFF-approved premises, which may be at a permanent cattery or kennels or on display at a zoo if so approved. Birds are allowed less stringent isolation.
- Regular inspection of quarantine quarters by a vet.
- Cleansing and disinfection of premises and equipment, especially if an infected animal is found.
- Disposal of any infected animal which is landed in Britain, by re-exportation, or slaughter.

Offences against rabies regulations carry heavy penalties including the destruction of the animal. Special arrangements may be made for animals travelling for sport, entertainment or breeding purposes²³. The number of prosecutions for breaching the Rabies Order in the last three years are as follows²⁴:

1991	64
1992	45
1993	24

²³ M E Cooper *An Introduction to Animal Law* 1987

²⁴HC Deb 23 June 1994 c319w

IV Towards a single Europe

A. Changes in the UK rabies regulations under the Balai Directive

Recent changes in the rabies regulations have been agreed under the so-called Balai Directive. This is also sometimes referred to as the Catch-All Directive; its full title is *Council Directive 92/65/EEC laying down animal health requirements governing trade in & imports into the Community of animals, semen, ova & embryos not subject to animal health requirements laid down in specific Community rules referred to in Annex A(I) to DIR90/425/EEC*.

The changes concern only commercially bred mammals and applied to small mammals (mainly rodents), from 1 January 1994, and to traded cats and dogs from 1 July 1994.

Certain commercially-traded animals such as rabbits and rodents which, like farm animals, are susceptible to rabies but present no real disease risk, are now able to enter Britain without undergoing six months' quarantine, but the UK has negotiated derogations to protect its rabies-free status, and the animals may enter only under tightly controlled conditions. The animals must have been born and bred in the holding of origin, and will be being exported to the UK for commercial or research purposes (again to be kept at a secure establishment)²⁶. Around 1,000 such animals are thought to enter the UK each year²⁵.

The rules are tighter for cats and dogs travelling under the Directive. According to Mr Gummer²⁶:

"We negotiated some particularly tough rules to cover cats and dogs within this directive - that is, largely those imported for breeding purposes....The veterinary advice is clear that this constitutes as effective a safeguard against rabies as the quarantine system."

Under the *Rabies (Importation of Dogs, Cats, and Other Mammals) (Amendment) Order 1994* laid in June, the cats and dogs must be the subject of commercial trade, and must have come

²⁵"Rabies rules a victory for Britain, says Gummer" *Daily Telegraph* 16 June 1992

²⁶HC Deb 16 June 1992 c455w

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from a single registered rabies-free secure establishment in an EC country where they have been kept since birth without contact with wild animals. They must have been vaccinated against rabies when at least three months old and revaccinated at least six months before export; subsequent blood tests must have shown this vaccination to be effective. Further, the animals will have to be microchipped, have full veterinary records and health checks, and be carried in an approved manner in a secure vehicle between establishments²⁷.

So in effect, such animals will be undergoing quarantine in the country of origin rather than when they arrive in the UK. The animals will never be outside secure establishments, and none of these changes will apply to pets, or in any other circumstances²⁸. The changes will "not increase the risk of importing rabies into the United Kingdom".²⁹

As MAFF are at pains to point out, it remains illegal for anyone to bring an animal into the UK without an import licence (from MAFF, or from the DOE as well in the case of an endangered species)³⁰:

"There will be no change in the quarantine rules governing the import of domestic pets next year, the Ministry of Agriculture reminded pet owners today. The new regulations apply only to commercially traded dogs, cats and other mammals".

This point has been reiterated subsequently³¹.

B. Animal movements within the single Market

The changes under the Balai Directive arise from the need to operate within a single European Market. There have been general fears that the single Market and the removal of customs barriers may lead to a lowering in the level of protection against rabies entering the UK.

For instance, the Farmers' Union of Wales has alleged that opening up Europe's borders will increase cross-border trafficking in pets and the possibility of rabies entering Wales. Citing

²⁷HC Deb 30 June 1994 c660w

²⁸Source: Rabies Section, MAFF Animal Health and Veterinary Group

²⁹HC Deb 21 April 1994 c631w

³⁰MAFF News Release 472/93 *New rules for commercially traded animals* 30 December 1993

³¹See for instance, HC Deb 27 January 1994 c.384w

cuts in the Customs service and lenient sentencing for rabies offences (it claims that the average fine has risen by £285 since 1978 to £614), it believes that West Wales may be particularly threatened because of a large number of small ports, sweeping coastlines and a high fox population density³².

Rabies is of course not the only animal disease whose control will be affected by the new more open arrangements. Movements of animals from former Eastern Bloc countries into the EU is thought to be one of the most worrying problems. France and Germany act as a "funnel" for hauliers from countries such as Poland, carrying horses, cattle and other livestock³³.

The NFU has said that one of its primary concerns is the import of animals from third countries, such as those in eastern Europe, into the EU. This concern has been highlighted by several recent cases of warble fly and brucellosis in cattle that are believed to have been imported into the UK. The NFU Vice President has said that "farmers will need to be extra vigilant in preventing disease from being brought on to their farms following the opening up of frontiers with the arrival of the European Single Market"³⁴.

MAFF say that they have devoted extra staff resources to increase the number of veterinary checks made on animals being imported, and that they have pinpointed potential risks. For instance, all cattle imported from France have been checked for warble fly, 12 consignments with infested animals have been returned to France, and post import checks of poultry have been stepped up because of the threat of Newcastle disease. Announcing these checks and the relaunch of the leaflet "Don't Import Disease" for all livestock farmers, the former Agriculture Minister Mrs Shephard noted earlier this year that³⁵:

"The facts show that the introduction of the Single Market has not led to the increase in disease which some feared. There have been a few problems, but we have been able to deal with these sensibly and effectively.

We must not be complacent however - we shall continue to make every effort possible to keep disease out of Britain".

Normal customs surveillance has always been the "first line of defence" against rabies²². With the new Single Europe arrangements there are fewer or no visible customs officers at ports these days, but MAFF says that Customs will still be performing surveillance, and MAFF relies on HM Customs and Excise to notify it of any cats or dogs coming into the UK

³²"Extra rabies risk' in EC open border deal" *Western Mail* 21 June 1993

³³"Quarantine rules change as rabies defences weaken" *Independent* 15 January 1994 p.8

³⁴"More effective enforcement required" *NFU News* 27 April 1994

³⁵MAFF News Release 268/94 *Veterinary checks help keep out disease* 13 July 1994

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from the rest of Europe³⁶. The Welsh Office is reported to have admitted that "there will not be a visible presence" of customs officers at ports of entry, but that it hopes that boat owners, the yachting community and others will spot animals being brought in from abroad³².

The former Parliamentary Under-Secretary of State for the Home Department, Mr Wardle, has pointed out that³⁷:

"The larger risk of the introduction of rabies into this country, which exists now in our ports of entry, comes from those irresponsible people who smuggle animals upon their person or about their baggage. The controls here would be the same as at other ports of entry. Customs and Excise retain the power to deal with illegally imported animals and other authorities will be watchful for any breach of our laws".

C. "Pet passports"

On 1 May 1994, Sweden relaxed its quarantine restrictions on the import of pet animals from EU and EFTA states. It formerly required a four month quarantine period for animals entering the country, but this has now been replaced by a vaccination and certification scheme. Such a system is commonly referred to as a "pet passport".

The Swedish Board of Agriculture has said that animals will now have to be vaccinated against rabies at least six months before import, and tested four months later before leaving for Sweden, to check that antibodies are present at sufficient levels to confer resistance. This blood test may be carried out in Sweden's National Veterinary Laboratory in Uppsala, or at the French Rabies Studies and Wildlife Pathology Lab in Nancy. (The animals will also have to be vaccinated against distemper and leptospirosis.)

The animal will have to be individually marked (by tattoo or chip for instance), and this identity mark will be included on the animal's vaccination and antibody titre certificates, along with its general health certificates and import licence, altogether making up that pet's passport.

³⁶Source: Rabies Section, MAFF Animal Health and Veterinary Group March 1993

³⁷Fifth Standing Committee on SIs etc. *Draft Channel Tunnel (International Agreements) Order 1993* 30 June 1993

The Norwegian government has also announced that it will introduce a vaccination system to replace quarantine for cats and dogs. This will only cover animals originating in Norway and being reimported at first, but it will eventually cover all pets entering.

There are some problems. The immunity conferred by the vaccination is considered to last only a year, so an animal travelling regularly would have to be revaccinated. The rules will not apply to animals coming from outside the EU, where strains other than the fox strain of rabies are prevalent. The antibody titre is designed only to pick up fox rabies, and might not pick up an animal carrying dog ("street") or racoon rabies. So animals coming from developing countries (where dog rabies is common) or from the US (where raccoons carry rabies, see section II B above) will not be allowed into Sweden under the new arrangements.

The changes in Sweden and Norway's rabies policies leave only Britain and Ireland within Europe operating quarantine policies^{38,39}.

The Commission is reported to oppose quarantine for rabies, on the grounds that it is a barrier to the free movement of people and goods. It is also expensive for pet owners. Shipping a dog from Germany and placing it in quarantine for six months, for instance, can cost up to £1,000⁴⁰, as campaigners among British Forces overseas have pointed out. The Commission is said to favour free movement of animals within the EC with "pet passports"⁴¹.

However, the concessions that Britain has made for commercially bred animals under the Balai Directive (see section IV A above) are, according to MAFF⁴³:

"the only area we are prepared to concede".

The Government has stated unequivocally that it has no plans to reduce the present six months quarantine for imported pet dogs, cats and other rabies-susceptible animals⁴².

Despite this, there are reports that officials in Brussels expect Britain to follow Sweden and Norway's examples eventually, since they say that vaccination and blood tests are as effective as quarantine. They also hope that fox rabies will be eliminated from the EU within four years⁴³.

³⁸"Swedes and Norwegians to relax rabies quarantine rules" *The Veterinary Record* 8 January 1994 p.26

³⁹"Trouble-free tourism for pets" *New Scientist* 22 January 1994 p.7

⁴⁰"A rabid note from the kitchen to the Queen" *The Observer* 29 May 1994 p.18

⁴¹ for example, *The Independent*, 4 January 1993

⁴²HC Deb 27 January 1994 c384w

⁴³"Trouble-free tourism for pets" *New Scientist* 22 January 1994 p.7

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Christopher Jackson, the MEP for Kent East who chairs the European Parliament's Intergroup on Frontier Control, believes that rabies will have been eradicated from the EC by 1995 or soon after (now the Commission's rabies campaign is being properly co-ordinated and followed in, for instance, France). This would be subject to a *cordon sanitaire* of perhaps 100km wide being maintained on Europe's borders, as described in section II C above.

Mr Jackson believes that Britain should adopt pet passports, and cites the example of rabies-free Denmark, which has allowed free movement of vaccinated pets from rabies-infected Germany, with no resulting rabies cases. He further argues that in France, rabies has spread only within the fox population, with no leap through pet movements from the north (where rabies is prevalent in the fox population and pets are vaccinated) to the south (where rabies is absent and pets are not vaccinated)⁴⁴.

The recent changes in Scandinavia have prompted a continuing debate in the letters pages of the *Veterinary Record*. The British Veterinary Association (BVA) has monitored the situation in Denmark and the other recent developments in rabies control, and "fully supports MAFF in its view that any new system would have to be as effective as quarantine". The BVA does not see the current arrangements being maintained in perpetuity, but equally is not as yet convinced that proposed alternatives are indeed as effective as quarantine. According to the Chairman of the BVA's Rabies Working Group⁴⁵:

"We have no problem regarding the efficacy of modern vaccines. We are also encouraged by the apparent success of the oral vaccination of foxes, although view with caution the claim that by virtue of that programme the incidence of rabies in the wildlife population will be reduced "virtually to nil"; we shall be happier when nil means nil. We monitor with interest the situation along the borders with former Eastern bloc countries where the incidence of rabies is high and the economic situation does not allow for wildlife vaccination on the scale carried out in the EU, despite financial help from the latter.

"We are not encouraged by the introduction of equine viral arteritis and the reintroduction of warble fly following the relaxation of border controls on January 1, 1993. We are not convinced that a uniformly high standard of health certification is in place throughout the EU. We need to know ... what measures are to be taken to prevent the back door entry of dogs and cats from third countries ... we need to be quite sure that methods of permanent identification ... are well nigh foolproof...

⁴⁴"Passports for pets-nothing mad about that" *Independent* 16 June 1993 p.23

⁴⁵"Rabies Policy" *The Veterinary Record* 10 September 1994 p.263

"We may seem to be overcautious. I make no apology for that. The reintroduction of rabies into this country would have serious economic and animal welfare implications... "

Despite this, there has been speculation that following its most recent investigation *Health controls on the importation of live animals*, the Agriculture Select Committee is about to call for an end to our six month quarantine. Calling the present system a financial incentive to smuggle pets, Sir Jerry Wiggin is reported to have said that⁴⁶:

"The average Frenchman or German does not walk around with steel gumboots on frightened of being bitten by a rabid fox".

While taking evidence, Mr Campbell-Savours urged Mrs Shepherd, the then Agriculture Minister, to "take the courageous step" and switch from quarantine to vaccination⁴⁶. The Agriculture Select Committee minutes of evidence have yet to be published.

On the other hand, a spokesperson from the WHO rabies centre in Tubingen, commenting on the success of oral immunisation campaigns leading to the Scandinavian moves, has noted that⁴⁰:

"Quarantine is clearly the most certain measure against rabies and the British are probably right to wait and see how well the Scandinavians get along with their new system".

D. The Channel Tunnel

There has long been speculation about rabies entering Great Britain via the Channel Tunnel⁴⁷. In response to a Lords PQ in January 1993, the Earl of Caithness said that⁴⁸:

"... animal health controls at the Channel Tunnel and its terminals will be just as strict as those presently in force at the sea ports and airports. In addition, the Channel Tunnel concessionaires have established a number of preventative measures to stop wild animals straying into the tunnel, and more will be put

⁴⁶"MPs support removal of anti-rabies quarantine" *Guardian* 14 July 1994 p.11

⁴⁷For example, "Can rabies be halted? The Channel Tunnel will be a barrier-but not to Germany's pet rats" *The Times* 13 March 1989 p.14

⁴⁸HL Deb 18 January 1993, c715-6

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in place once the tunnel is operational ... There will be three lines of defence; there will be a main perimeter fence, a secure boundary, and an electric system all the way round the interior of the tunnel to try to prevent animals entering. There will also be baited traps throughout the tunnel system".

In May 1993 MAFF announced that⁴⁹:

"An order will shortly be presented to the House which will provide the legal backing for policing and frontier controls in respect of the channel tunnel. The order will not contain any new rabies measures, but will adapt our current procedures at ports of entry around the United Kingdom to the unique physical circumstances of the Channel Tunnel".

The above-mentioned *Draft Channel Tunnel (International Agreements) Order 1993* was debated by the Fifth Standing Committee on SIs etc. on 30 June 1993. The then Parliamentary Under-Secretary of State for the Home Department, Mr Charles Wardle, said during the debate that:

"The physical barriers will help prevent animals from making their own way through the system. I can assure the Committee that they would have to be super rodents to get through because there will be deep-dug security fences based in concrete well below the ground. There will also be close circuit television, not to mention the trains themselves ... The rodent ... will be deterred, if not destroyed by an electrified grid".

The Order also deals with the arrangements for French and British police and other enforcement officers to carry out their duties in the control zones of the Tunnel.

The anti-smuggling arrangements will be exactly the same at the Tunnel as at any other port of entry; with the new Single Europe arrangements, there are no visible customs officers at any ports these days, but customs officers will still be performing surveillance, as at any other port.

If anything, according to MAFF, it may even be harder for anyone to bring an animal in a car through the Tunnel than through a conventional port, because a driver would have to drive on to a shuttle train, at which point they could easily be checked, and they would then have to keep the animal concealed and quiet throughout the journey on the train; there will be a

⁴⁹HCDeb 13 May 1993, c542-3w

tunnel security person patrolling each train. Still further anti-rabies measures may be agreed and put in place by Eurotunnel.

The electrified grids on the floor of the tunnel will be sufficient to deter any animal (although not kill them), and should any animals (such as bats or rodents) start to colonise the tunnel, there will be hygiene squads which would move in to remove them. There will be barriers at both ends. Furthermore, the air turbulence behind a high-speed train, which is a roughly 160mph wind, would suck any unfortunate animal in the tunnel under the trains⁵⁰.

⁵⁰Source: Rabies Section, MAFF Animal Health and Veterinary Group

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Selected further reading

World Health Organisation *WHO Expert Committee on Rabies Eighth Report* WHO Technical Report Series 824 1992

MAFF *RABIES Prevention and Control. Government Policy* June 1991

"Eradication of rabies in Europe" *Nature* 12 November 1992 p.115

"Europe launches spring offensive against rabies" *New Scientist* 30 April 1994 p.6

Draft Channel Tunnel (International Agreements) Order 1993 Fifth Standing Committee on SIs etc. 30 June 1993

"Trouble-free tourism for pets" *New Scientist* 22 January 1994 p.7

"Passports for pets - nothing mad about that" *Independent* 16 June 1993 p.23 [written by the MEP for Kent East, chairman of the EP Intergroup on Frontier Control]

"A rabid note from the kitchen to the Queen" *The Observer* 29 May 1994 p.18 [mentions pets of British Forces overseas]

MAFF "New rules for importing commercially traded dogs and cats from 1 July" *MAFF News Release 257/94* 30 June 1994