THE EPIDEMIOLOGY OF DOG RABIES AND ITS CONTROL IN EASTERN AND SOUTHERN AFRICA

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Introduction

Dog rabies has been reported with apparent increasing incidence in the eastern and southern African region over the last twenty years, and many countries are currently documenting record numbers of confirmed cases. Furthermore it is generally agreed that the disease is grossly under-reported, both in dogs and in man, and the extent of underreporting may also be on the increase due to a variety of factors. If rabies is to be effectively controlled in the region, it is important that its occurrence is well-documented, its epidemiology is well-understood, and its impact is carefully quantified in order to attract the appropriate level of financial and logistical support from governments, donor agencies and local communities. This paper reviews the main epidemiological features of dog rabies recorded in recent studies in the region, reviews the efficacy of control measures currently in use, and proposes some needs for the future to ensure more effective control of this most severe of zootic diseases.

Epidemiological features of dog rabies

Role of the dog

Numerous of the authors of country reports in this Proceedings have documented the importance of the dog compared to other species with regard to confirmed rabies cases in different species in their countries; the reported proportion of confirmed dog rabies cases diagnosed in the region is shown in Table 1. In general it appears that dogs make up a higher proportion of rabies cases in eastern Africa that in southern Africa; in southern Africa various wildlife species, notably the black-backed jackal *(Canis mesomelas),* the side-striped jackal *(C. adustus)* and the yellow mongoose (*Cynistis penicillata),* play a significant role in certain areas. This may be a real phenomenon, dependent upon factors such as the differing wildlife population densities and land-use systems in the two sub-regions. However, it may be an artificial phenomenon, reflecting better dog rabies control in southern Africa than eastern Africa, and thus a greater relative contribution of wildlife to the total numbers of cases recorded in southern Africa. In Europe and North America, wildlife species became increasingly important in the epidemiology of the disease following the control of dog rabies (Steck and Wandeler, 1980; Perry, 1987). The apparent difference between the two sub-regions could well be a combination of the two factors.

Furthermore, differences in the proportions of dog rabies cases in different countries should be interpreted cautiously due to the different times over which these observations have been made. Some authors listed in Table 1 report results of long-term surveillance, while others report short-term studies.

For example, the proportion of dog rabies cases assessed over the period of 1950 - 1991 in Zimbabwe is 52% (Foggin, 1988; Bingham, 1992), but this proportion was lower during the jackal rabies epidemics of 1979-82 (Foggin, 1988) and 1991-92 (Bingham, 1992). A similar change, in this case an increase in the proportion of dog cases, has recently been reported from South Africa, due to the dog rabies outbreak currently occurring in Natal (Bishop, 1992).

Table 1.
Proportion of total reported rabies cases occurring in dogs in eastern and southern Africa.

Eastern Africa		Central Africa		Southern Africa	
Ethiopia	90%[1]	Malawi	80-87%[2]	Zimbabwe	53%[3]
Kenya	65%[4]	Mozambique	89%[5]	Botswana	16-41%[6]
Tanzania	89%[7]	Zambia	78%[8]	South Africa	55%[9]
				Namibia	20%[10]

For refs. See : 1(Fekadu, 1982); 2(Msiska, 1988); 3(Foggin,1988); 4(Anon,1991); 5(Lopes Pereira et al, 1988); 6(Mosienyane,1988); 7(Machuva,1988); 8(Hussein et al., 1984); 9(Gummow and Turner,1988) and 10(Schneider, 1985).

Incidence of rabies

There has been an increasing incidence of rabies, and in particular dog rabies, reported from many countries of the region over the past twenty years, and this is perhaps typified by the incidence figures reported for Kenya over the period 1958-90 (Figure 1).

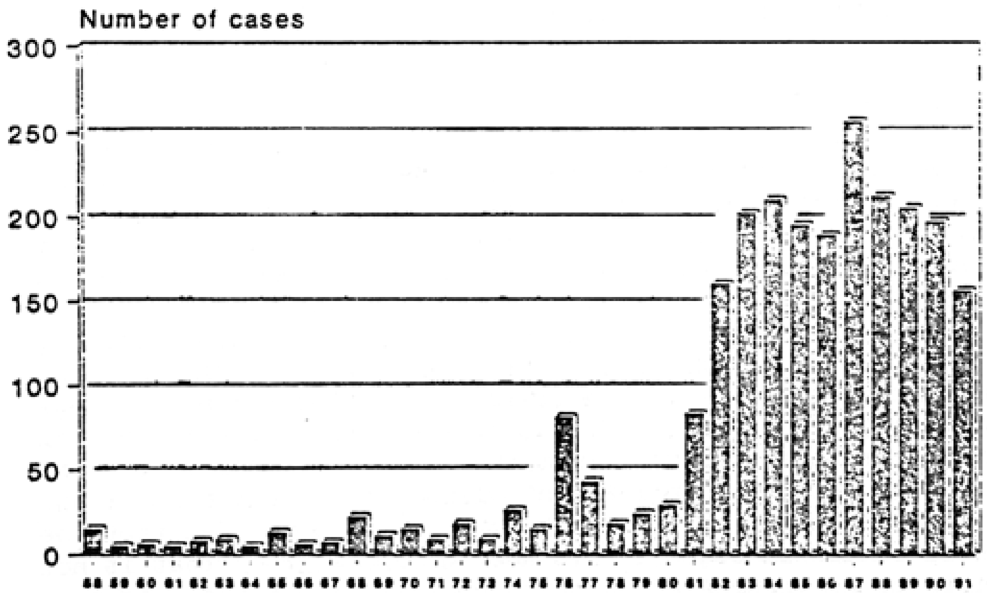

Fig. 1. Incidence of rabies (all species) in Kenya 1958 - 1990

However, incidence figures are influenced by several factors, not just increasing numbers of cases per unit of population, and many of these have been operating in the region. It is thus important to differentiate between real changes in incidence, and apparent changes which are the results of other changing factors, such as changes in the population size or structure and changes in diagnostic efficiency.

True incidence rates are a function of the dog population at risk of rabies, (incidence is the number of new cases divided by the (dog) population at risk (Thrustield, 1986; Martin et al., 1987), but for most countries of the region the size and structure of the dog population is not known or even estimated. For countries there dog population surveys or censuses have not been carried out, estimations may be made on the basis of the ratio of dogs to humans, as human census data and population projections are usually available. Bögel et al. (1982) estimated dog:human ratios of from 1:8 to 1:11 under different circumstances and conditions in the world, although clearly these ratios vary widely both within and outside these ranges depending on numerous factors.

In his census of the dog population of Zimbabwe in 1986, Brooks (1990) estimated the ratio to be 1:6.3, and comparing this with dog population figures published by Adamson in 1954, Foggin (1988) calculated a rate of growth of the dog population over those 32 years to be 5.15% per annum, considerably greater than the 2.94% growth of the human population of Zimbabwe over that period. Clearly throughout the region the dog population has increased dramatically over the last 30 years, and this must be taken into consideration carefully when assessing apparent changing disease incidence rates.

Apparent changes in rabies incidence are also caused by changes in sample submission rates or policies, and by changing diagnostic capacity. This was most dramatically illustrated in the Uganda country report of these proceedings, where recorded rabies cases over the three decades of 1961-70, 1971-80 and 1981-90 were 226, 132 and 12 respectively. This apparent decline in rabies incidence is in total contrast to the marked increase in cases seen in neighbouring Kenya in the latter period (Kariuki, 1988), and is reportedly the result of both decreased sample submission due to national insecurity, and to declining diagnostic capacity due to lack of reagents and equipment (Illango, 1992).

Other epidemiological features

Perhaps the most comprehensive study of dog rabies epidemiology in Africa was that recently carried out by Foggin (1988) in Zimbabwe, and the reader is referred to this work for extensive discussion of rabies in southern Africa. Among other things, he analysed data accompanying rabies submissions over the period 1950 - 1986, in which he included an analysis of data on age-specific incidence, incubation period, clinical signs and the interaction of rabid dogs with other species. He reported that almost 76% of confirmed rabies cases were in dogs over 12 months old, and only 4% of cases were under three months of age. Relating the age-specific incidence to the results of the Zimbabwe dog census performed in 1986 in which 20% of dogs were found to be under three months of age (Brooks, 1990), he concluded that the low incidence of rabies in dogs of this age group, a group that is not legally required to be vaccinated in that country, is unlikely to pose a significant threat to the control of dog rabies.

Incubation periods were calculated from case-history forms accompanying 77 confirmed cases where the contact which resulted in infection was confirmed, and these are presented in Table 2. They fall within the range known for dogs.

Table 2.

*Incubation period of rabies in 68 dogs in Zimbabwe.**

Incubation period (weeks)	No. of dogs
<2	4
2 - 3	39
4 - 5	14
6 - 7	5
>7	6

Mean incubation period 3.6 weeks, Range: 10 days - 12 weeks.
*(From Foggin, 1988).

Foggin (1988) classified the clinical signs reported in rabies positive submissions into three main groups; those showing aggressive behaviour, those showing predominantly paralytic signs and those not fitting into either of the first two groups (Table 3). The mean reported duration of signs was 5.7 days (range 2 - 12 days). The proportion of paralytic rabies was lower than that generally recorded in dogs, and Foggin suggested that this might have been due to his classification as furious any dog that attempted to bite at any stage during the clinical course.

Table 3.

*Signs shown by vaccinated and unvaccinated dogs with confirmed rabies in Zimbabwe**

Sign	Vaccinated	Dogs with rabies (unvaccinated)	Percent of total
Typical furious rabies or tendency to bite	83	2298	75.9
Paralytic rabies without marked behavioural changes	57	180	7.6
Signs not conforming to either group	39	327	11.7
Signs unknown or not recorded	7	145	4.8
Total	**186**	**2950**	**100.0**

*(From Foggin, 1988)

Of 687 rabid dogs for which data were gathered for the period 1982-86, 193 were observed attacking and biting other dogs. Foggin (1988) suggests that this observation of one dog in five biting at least one other dog is probably a gross underestimate of the number actually exposing other dogs, as few would have been under close supervision during the entire course of the clinical disease. Very few of these observed rabid dogs (about 3%) exposed other domestic animals.

The control of rabies

The WHO Expert Committee on rabies describes five basic elements of dog rabies control (WHO, 1992). These are:

Epidemiological surveillance
Community education and participation
Immunisation
Dog control
Organisation and implementation

In this paper, I will discuss two of these elements, immunisation and dog control, and review methods for evaluating their efficacy.

Immunisation

i Vaccines used

Many countries of the region have developed the capacity to produce rabies vaccines for dogs, and these include Kenya, Mozambique, South Africa and Zambia. Vaccines produced in these countries have generally been the low egg passage (LEP) and high egg passage (HEP) vaccines; the lamb brain vaccine was produced in Zambia. However, with the greater international availability of well-tested and relatively cheap vaccines for dogs from commercial sources, there has been an increasing trend to use these rather than prepare vaccines locally, and it is understood that LEP vaccine is no longer produced in Kenya and South Africa and the lamb brain vaccine is no longer available in Zambia. Some countries, such as Zimbabwe, have relied entirely on the importation of rabies vaccines since the egg-adapted vaccines became available in the early 1950s.

Rabies vaccinations of dogs are generally provided by government veterinary services free of charge to the majority of the dog owning population, although some countries, such as Kenya, levy a nominal charge (for Kenya it is KSh.2, or about 6 US cents). Some urban residents of the region obtain rabies vaccinations of dogs through private veterinarians at commercial prices.

A number of rabies vaccines, both attenuated and recombinant, have induced neutralising antibodies when given to dogs by the oral route, but to date none of these has been field tested (WHO, 1992). At least two bait systems for delivering oral vaccines to dogs have been tested in Africa, one in Zimbabwe (Perry et al., 1988) and one in Tunisia (Kharmachi et al., 1992). Oral rabies vaccination provides an alternative technology for the future to supplement traditional immunisation procedures, particularly for the neighbouring dogs, but strategies for delivering these must be carefully designed and tested. The WHO (1991) has developed protocols for such studies.

ii Targeting vaccine delivery

The delivery of rabies vaccine to dogs is generally conducted by Veterinary Departments, the frequency and logistics of which vary from country to country. In many countries vaccination is carried out on an annual basis, and for rural populations this is often delivered in conjunction with other livestock vaccinations at cattle dip tanks or vaccination centres. In general, the onus is on the dog owner to present dogs for vaccination, and little or no targeting at specific segments of the dog-owning populations is carried out.

The WHO has recommended the use of a classification system for dogs, based on their level of dependence on humans for food, shelter and companionship, and on the level of restriction or supervision imposed. This system is designed to provide the classification that can be used for the improved targeting of rabies control measures to specific components of the dog-owning population (WHO, 1988). This classification is shown in Figure 2. For example, the restricted dogs and the family dogs are highly accessible for immunisation, but may also be the target for dog removal if not immunised in a vaccination programme. True feral dogs are removed if possible. The term stray dog, commonly used in the past, should be used to describe a dog not in compliance with local regulations (WHO, 1988). A straying dog may be a feral dog, an abandoned or lost animal or merely a free-roaming family dog.

	FULL RESTRICTION *Dog is physically separated from the rest of the population on a permanent basis*	SEMI-RESTRICTION *Dog has access to the rest of the population some of time*	NO RESTRICTION *Dog has free access to the population at all times*
FULL-DEPENDENCY Dog given all of its essential needs intentionally by humans	RESTRICTED DOG	FAMILY DOG	
SEMNI-DEPENDENCY Dog is given a proportion of its essential needs intentionally by humans		NEIGHBOURHOOD DOG	NEIGHBOURHOOD DOG
NO DEPENDENCY Dog is given none of its essential needs intentionally by humans			FERAL DOG

Fig. 2. Classification of the dog-owning population.

In addition, it has also been shown that knowledge of dog population ecology can enhance rabies control programmes and study methodologies have been developed and tested, (WHO, 1990). Of particular importance air total population size, proportion of dogs accessible for immunisation by a given vaccination strategy, and population turnover. However, very few such data have been gathered within the eastern and southern Africa region. An exception to this is the study of Brooks (1990) in Zimbabwe, and the results of this work will provide a useful baseline for future comparative studies in other countries of the region. A brief summary of his findings are presented in Table 4.

Table 4.

*Summary of a dog census in Zimbabwe**

Parameter	Value
Average age	2.3 years (female:2.0, male:2.5)
Life expectancy	4.6 years (female:4.0, male:5.5)
Surviving puppies /female/year	1.4
Dog density	
-by province	1.4 - 6.7 per sq.km
-by land use	
commercial	0.6 per sq.km
commercial	6.0 per sq.km
urban	20.0 per sq.km
Dog:human ratio	1:8 to 1:4.7 (by province)

*(From Brooks, 1990)

The total dog population size of Zimbabwe in 1986 was found by Brooks to be 1.3 million, providing an overall dog: human population ratio of 1:6.3. Although this is a slightly larger ratio than that discussed by Bögel et al. (1982), the close comparability illustrates the validity of using such ratios in estimating dog population sizes. Table 5 shows the estimated and projected human population of Zimbabwe for the years 1969, 1982 and 1986 (World Bank, 1990) and compares the derived estimated dog population figures for those years, using the ratios proposed by B69el et al. (1982), with the 1986 dog census data.

Table 5.

Estimated human population of Zimbabwe 1969 – 1990* *and calculated dog population based on dog:human ratios and dog census figures for* 1986.

		Estimated dog population		Dog census
Year	Human population	1:8	1:11	(Brooks,1990)
1969	5.1	0.64	0.5	-
1982	7.5	0.94	0.7	-
1986	8.5			1.3
1990	10.0	1.25	0.9	

*Figures derived from World Bank, 1986, in millions.

iii Assessing vaccination coverage

Several authors have suggested that dog vaccination coverage levels of 60-80% are required to effectively control rabies, and WHO proposes a target for vaccination coverage of 70% of the dog population (WHO, 1987). Foggin (1988) proposed that a sustained vaccination coverage of 50% of dogs would be sufficient to keep dog rabies to an acceptable and possibly controlled level. These coverage levels are not based on results of controlled studies, but although effective vaccination coverage levels will depend on numerous factors, including potential contact rate between infected and susceptible dogs and thus dog densities, these figures provide pragmatic and practical targets for local and national campaigns.

Clearly, it is important to be able to assess vaccination coverage levels at both national and sub-national levels. Five possible methods for assessing *vaccination coverage* are presented and discussed.

a) Vaccine doses used as a proportion of dog population

A useful rough estimate of coverage may be derived on the basis of the number of doses of vaccine distributed as a function of the estimated dog population. If reasonably accurate data on dog population size are not available, these may be calculated on the basis of estimated dog:human ratios, and the values of from 1:8 to 1:11 proposed by Bögel et al. (1982) provide a good starting point. Using human population estimates of the World Bank (1986), and vaccine issue statistics derived from Luusah (1988), Machuva (1988) and Msiska (1988), I have calculated rough dog population sizes and estimated vaccination coverage for Kenya, Tanzania and Malawi, and these are illustrated in Table 6. The highest value calculated by this method is for Malawi in 1980 (12.9%), and the lowest value rate was for Kenya in 1979 (2,4%).

Clearly these are crude estimates, but they do raise interesting questions relating to the efficacy of rabies control programmes. In Zimbabwe, using dog census data and vaccine doses issued, Brooks (1990) calculated a national vaccination coverage of 40% for 1986,and using a similar method to that described here, Bishop (1992) estimated a coverage of about 35% in South Africa for 1991. It is significant to note that all of these fall well below the 70% level advocated by WHO (1987), and the 50% level proposed by Foggin (1988). In Kenya for example, current vaccine issue is approximately 300,000 doses annually (Gituma, M.G., personal communication, 1992). Coverages of 70% or 50% in 1992 for that country would require 1,610,000 and 1,150,000 doses respectively, based on an estimated dog:human ratio of 1:11 and projected human population statistics derived from the World Bank (1986).

Table 6

Estimated human and dog population sizes and dog vaccination coverage for three countries in the region

			Kenya	**Tanzania**	**Malawi**
population (millions)					
	1969		11.0	12.3	4.0
	1979		15.3	17.5	5.6
	1990		25.0	27.0	8.0
Estimated dog populations (millions)					
	1969	1:8	1.4	1.5	0.5
		1:11	1.0	1.2	0.36
	1979	1:8	2.0	2.2	0.7
		1:11	1.4	1.6	0.5
	1990	1:8	3.2	3.4	1.0
		1:11	2.3	2.5	0.73
Estimated rabies vaccination coverage, based on dog: human ratio of 1:11					
	1969		4.3		
	1978			5.3	
	1979		2.4		
	1980				12.9
	1987				5.0
	1988			3.9	

b) Vaccinal status of rabies submissions

The only recorded use of this method in Africa has been reported by Foggin (1988), who analysed the reported vaccinal status of dogs submitted for rabies examination during the period 1983 to 1986. He found that 14.3% of the 1206 dogs submitted had been vaccinated according to the legal requirements of Zimbabwe, and in a further 8.8% the vaccination had expired. The level is considerably lower than the 40% vaccinal cover calculated and reported by Brooks (1990) for 1986, but it is of course to be expected when examining dogs suspected of rabies, a sample biased in favour of being unvaccinated.

c) Antibody prevalence

Antibody prevalence data have been used, along with other indicators, to assess the vaccination coverage afforded by a mass vaccination campaign in Lima, Peru (Choel et al., 1987). These authors sampled 616 dogs chosen randomly in four age cohorts, and serum was tested by the rapid fluorescent focus inhibition test. One year after vaccination, 97% of sampled dogs had titres of greater than 0.IU/ml, although the prevalence of titres greater than 5IU/ml declined from 64% at 2-3 months after vaccination to 40% at 12 months after vaccination. In the eastern and southern African region, Foggin (1988) carried out a serological study to evaluate the effects of the breakdown in animal health services during the independence war in Zimbabwe. In 1981, one year after the end of the war, 1,806 dogs were bled in seven areas of the country, and tested using the rapid fluorescent focus inhibition test. Overall, 11.8% of sera had neutralising antibody, but there was considerable variation by area, ranging from 0% - 22%.

d) Comparison of vaccine use with rabies incidence

The comparison of rabies vaccine doses issued or used with reported dog rabies incidence offers a potential tool for assessing the efficacy of vaccination procedures, but it has rarely been used effectively in the region for several reasons. Firstly, vaccine quantities issued to the field are not necessarily an indicator of demand, but often an indicator of the availability of government resources, often in foreign exchange, to purchase vaccines, and of the priority given to rabies control. Secondly, if less than 15% of the dog population are being vaccinated, as estimations presented earlier in this paper suggest may be occurring in the region, vaccination is unlikely to have any measurable effect on the numbers of rabies cases reported at national level. Thirdly, the efficacy of this technique will also depend on the long-term consistency and efficacy of the rabies diagnostic service.

Msiska (1988) provided data on the recorded rabies cases and dog vaccinations for Malawi over the period of 1978 to 1987, and commented that "there is no direct relationship between the number of positive cases and the number of animals vaccinated". Approximate calculations presented earlier in this paper suggest that vaccination coverage in Malawi may have been in the order of 13% and 5% for the years 1980 and 1987 respectively (Table 5).

When Bleakley (1987) compared the number of reported dog rabies cases in Zimbabwe with the number of free vaccinations carried during the latter stages of the independence war, a period when animal health services were severely disrupted, she demonstrated a definite inverse relationship. During the period 1968-72, Foggin (1988) estimated a vaccine coverage rate of 59%. These observations suggest that a clear relationship between dog rabies occurrence and vaccinations carried out can only be demonstrated where vaccination levels have been sufficient to affect national rabies incidence rates.

e) Marking vaccinated dogs

The technique of estimating population size by capturing animals, marking them, releasing them and recapturing them, either visually or in traps, has been used extensively with wild animal populations (Seber, 1973; Davies, 1982). The technique has been adapted to dog populations in urban and rural settings (Beck, 1973; 1979).

Recently, Perry et al (in preparation) used a captive/recapture method to estimate the proportion of dogs vaccinated in a high-density suburb of Nairobi, Kenya. In a five day vaccination programme, 433 dogs were vaccinated and each vaccinated dog was fitted with a nylon collar. One week after vaccination, a team traversed the high-density suburb observing and counting collared and uncollared dogs. Of 339 dogs observed, 242 had collars. Using the Lincoln Peterson method (Seber, 1973), the dog population size for the area was estimated to be 580-635 (with 95% confidence), and the vaccination coverage was thus calculated as 68-75%. This technique offers a simple but effective method of estimating vaccination coverage that has been used in several countries outside the region.

Dog population control

The WHO (1992) describes four methods of dog population control that may be used as adjunct procedures to control rabies. These are confinement, habitat control, reproductive control and removal. Although confinement measures, in the form of tie-up orders, have been used in the past in most of the region, they are rarely applied now, and the only measure in fairly widespread use is dog removal. However, dog removal is rarely applied effectively. To be effective, it should be timed appropriately, ideally following a comprehensive vaccination programme in which vaccinated dogs are identified and marked and the unmarked dogs are subsequently removed efficiently and humanely by shooting or poisoning.

Furthermore, the unmarked dogs, which will generally be neighbourhood dogs, should be reduced to a level at which rabies transmission is interrupted, and this level (which is highly density dependent) should be maintained (WHO, 1992). If this is not achieved, dog removal is likely to be ineffective, and even counter-productive. Where dog removal is used in the absence of an effective immunisation programme, it often removes dogs which are easily accessible for immunisation, and provokes public antipathy to rabies control programmes.

Probably the best illustration of effective dog removal, although unlikely to be reproduced in the future, is from Zimbabwe, where during the rabies outbreak of 1902-13, 60,000 dogs were killed over a two-year period (Sinclair, 1922). It is likely that the total dog population of the country at the time was under 100,000!. Current levels of dog removal are considerably less. Machuva (1988) reported figures for dog removal in Tanzania for the period 1978-88. If the World Bank (1986) human population estimates for the country during those years and the 1:11 dog to human ratio used earlier are taken, crude calculations suggest that annual dog removals have not exceeded 1% since 1981.

Significantly, that 1% of dogs represents over 22,000 animals, and the valiant effort in removing the number of dogs undoubtedly drew on not inconsiderable human and financial resources of the veterinary department. Although it is dangerous to generalise from broad statistics such as these, it is possible that given the rapid turnover rate of dog populations in Africa, the resources used to destroy 1% of the dog population might be more effectively allocated to the vaccination or surveillance aspects of rabies control programmes.

Some selected needs for the future

There are clearly numerous requirements to enable effective rabies control programmes to operate throughout the eastern and southern African region. I have selected four needs that I consider to be crucial.

i An improved understanding of dog ecology

The dog population of the region has grown considerably over the last 30 years, and with it the socio-economic status of its owners or keepers has diversified, making access to dog populations for immunisation a much more complicated process. An effort is required to review dog ecology in the region with the aim of determining the approaches and techniques necessary to reach the desired proportion of the dog population with the desired frequency. Numerous sets of guidelines have been prepared as to how to achieve this (WHO, 1987; 1988; 1990; 1992) and studies based on these have been carried out in several countries outside the region, including Ecuador, Tunisia, Sri Lanka and Nepal. Studies within the region are currently underway in Machakos, Kenya and in Lusaka, Zambia.

ii Co-operation with others at all levels

Rabies control in the region has traditionally been in the hands of the government veterinary authorities, with, in many cases, limited collaboration or communication with the government health authorities. This centralisation of implementation responsibility is unlikely to be sustainable for much longer. Veterinary departments throughout much of the region have undergone considerable changes during the past 30 years. Departmental budgets have declined dramatically in real terms, the numbers of professional staff have increased substantially, and in many countries extremely limited funds remain available for operational activities.

Furthermore, the livestock-owning community has increased in size and diversified, making veterinary services more difficult to deliver under a department umbrella. For the control of diseases that affect livestock productivity, many countries in Africa are moving towards cost-sharing in government-delivered services, and in the development or enhancement of private veterinary services. However, this trend is unlikely to include the control of rabies, a zoonotic disease for which governments will continue to bear a considerable portion of the control responsibility. It is thus crucial that to be effective, the load of responsibility within governments is spread to include departments of health and local government, and the delivery of rabies control is carried out through organised community participation to improve the adaptability and sustainability of dog vaccination programmes.

iii Objective appraisal of problems, resources and appropriate control measures

Rabies control measures in the region have changed very little for much of this century, and certainly since the introduction of the egg adapted vaccines in the early 1950's. However, the dog population, the epidemiology of the disease, and the human and financial resources available to control it have changed dramatically. In many parts of the region, a fresh look at rabies and its control by veterinary authorities in the light of current conditions may well be justified, in order that limited resources can be appropriately allocated to activities that are important and achievable.

iv Put rabies in context

Having suggested that rabies control will continue to be largely a governmental responsibility, it will be important to ensure that appropriate funding levels are available to achieve this. Both veterinary and health authorities of the region have an increasing number of demands on their services, and often a decreasing level of resources to meet these demands. It is therefore of great importance that rabies control is put in context with the other demands on veterinary and health services, and this is done by means of socio-economic studies that include benefit: cost analysis. Throughout the region, studies are required that calculate and document the cost of the disease (in financial and human terms), the cost of control programmes, and the benefits to be derived from effective control. The results will allow disease control planners and others to put rabies in a more appropriate context within the broader concerns of animal disease control, livestock production and human health.

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