PROCEEDINGS OF THE SOUTHERN AND EASTERN AFRICAN RABIES GROUP MEETING

SUDAN
ERITREA
ETHIOPIA
UGANDA
KENYA
RWANDA
TANZANIA
MALAWI
MOZAMBIQUE
MADAGASCAR
ZAMBIA
ZIMBABWE
BOTSWANA
NAMIBIA
SWAZILAND
LESOTHO
SOUTH AFRICA

NAIROBI, KENYA - 4-6 MARCH 1997

PROCEEDINGS OF THE SOUTHERN AND EASTERN AFRICAN RABIES GROUP (SEARG)
MEETING

NAIROBI, KENYA, 4-6 MARCH, 1997

CONTENTS

SESSION 1 :
OFFICIAL OPENING

SESSION 2 :
RABIES OCCURRENCE AND CONTROL IN THE REGION : COUNTRY REPORTS

SESSION 3 :
HUMAN RABIES : OPPORTUNITIES FOR IMPROVED SURVEILLANCE AND CONTROL

SESSION 4 :
RABIES IN HUMAN AND ANIMALS AT THE WILDLIFE / DOMESTIC CARNIVORE INTERFACE

SESSION 5 :
OPEN SESSION

SESSION 6 :
SEARG BUSINESS MEETING

Programme

<u>**Tuesday, 4 March**</u>

08.00   Registration

Session 1.   Official Opening
Chairman: *Dr. P. Kitala,* Chairman, SEARG

08.30	Welcoming remarks:	*Dr. P. Kitala,* Chairman, SEARG
08.40	Welcoming remarks:	*Dr. F.X. Meslin,* WHO
08.50	Introduction to SEARG and overview of the meeting	*Dr. B. D. Perry,* Secretary, SEARG

Session 2.   Rabies Occurrence and Control in the Region: Country Reports
Chairman: *Dr. B. D. Perry*   *Rapporteur*: *Dr. A. A. King*

09.00	Eritrea	*A. Mehreteab*
09.20	Ethiopia	*S. Zewde*
09.40	Rwanda	*S. Mbarubukeye*

10.00   **Official Opening** : **Minister of Agriculture, Livestock Development and Marketing**

10.15 Tea/Coffee

11.00	Uganda	*C. S. Rutebarika*
11.20	Kenya	*A. M. Karugah*
12.00	Zambia	*A. Mutemwa*
12.20	Malawi	*S. J. Ndaomba*
12.40	Mozambique	*F. Rodregues*

13.00 Lunch

Chairman: *Dr. R. Injairu*   Rapporteur: *Dr. A. A. King*

14.00	Zimbabwe	*D. S. Javangwe*
14.20	Swaziland	*R. Dlamini*
14.40	Lesotho	*K. Moshoeshoe*
15.00	South Africa	*G. Bishop*

15.20   Tea/Coffee

15.40   Discussion

Note: The arrival of Dr. Ali Hassan Ahmed from Sudan was unavoidably delayed but his presentation, though not open for discussion, is reproduced in these Proceedings. Representatives from Namibia and Botswana were unable to attend.

17.15   Cocktail Party at KWS

<u>**Wednesday, 5 March**</u>

Session 3. Human Rabies: Opportunities for Improved Surveillance and Control
Chairman: *Dr. F.-X. Meslin*   Rapporteur: *Dr. P. Coleman*

08.30   Human rabies diagnosis and reporting: can we do better?

Dr. A. I. Wandeler

09.00   WHO recommendations on human rabies post-exposure treatment

Dr. F.-X. Meslin

09.30   Rabies policy and post-exposure protocols in South Africa

Dr. A. Robinson

10.0   Human rabies surveillance and control in Ethiopia

Dr. Makonnen Fekadu

10.30   Tea/Coffee

11.00	Surveillance and management of bite wounds in Machakos, Kenya

Dr. B. M. Nzioka

11.30	Human rabies surveillance in a District of Uganda

Dr. R. W. Kaboyo

12.00	The management of clinical human rabies: the experiences from Kwazulu-Natal

Dr. J. Godlonton

12.30	Discussion
13.00	Lunch

Session 4. Rabies in Humans and Animals at the Wildlife/Domestic Carnivore Interface
Chairman: *Dr. Makonnen Fekadu*   Rapporteur: *Dr. J. J. McDermott*

14.00	Rabies as a threat to the Ethiopian wolf

Dr. Karen Laurenson

14.30	The role of wildlife in the epidemiology of rabies in Kibwezi, Kenya

Dr. J. K. Githaiga

15.00	Domestic dog vaccination strategies around the Maasai Mara National Reserve

Dr. P. Coleman

15.30	Tea/Coffee
16.00	Rabies control in the Serengeti : the rationale for a targeted strategy

Dr. M. Kaare

16.30	Jackal rabies and dog rabies in Zimbabwe : epidemics and species interactions

Dr. J. Bingham

17.00	Discussion

Thursday, 6 March

Session 5. Open Session
Chairman: *Dr. A. I. Wandeler*   Rapporteur: *Dr. Karen Laurenson*

08.30	Rabies in eastern and southern Africa : epidemiological patterns

Dr. A. A. King

09.00	The epidemiology of rabies in Machakos, Kenya

Dr. P. Kitala

09.30	Rabies control in Mpumalanga, South Africa

Dr. P. Kloeck

10.00	Clinical observations on cattle rabies in the Kiambu District of Kenya

Dr. A. G. Thaiya

10.30	Tea/Coffee
11.00	Oral rabies vaccines for dogs: research update

Dr. Carolin Schumacher

11.30	Recombinant raccoon pox rabies vaccines for cats

Dr. C. Ngichabe

12.00	Dog population reduction in rabies control: does it work?

Dr. P. Coleman

12.30	Discussion
12.50	**Official Closure of Conference** **Dr. J. K. Kajume**
13.00	Lunch

Session 6. SEARG Business Meeting

Chairman: *Dr. P. Kitala*   Rapporteur: *Dr. Sarah Cleaveland*

14.00 Perspectives on the future of SEARG

Dr. B. D. Perry

14.10 The viewpoint of a Director of Veterinary Services

Dr. J. K. Kajume

14.20 The viewpoint of a Director of Medical Services

Dr. J. Nyamongo

14.30 The viewpoint of WHO

Dr. F.-X. Meslin

14.40 A revised Training Manual   (edited by) *J. Barrat, A. I. Wandeler & A. A. King*

14.45 Discussion

15.15 Any Other Business

Dinner at the Carnivore Restaurant

FOREWORD

The Southern and Eastern African Rabies Group (SEARG) was founded in 1992 at a gathering of rabies scientists, diagnosticians and policy makers in Lusaka, Zambia. The following year, in South Africa, two meetings were held under the auspices of SEARG, in Pietermaritzburg and Onderstepoort. At the meeting in Pietermaritzburg a decision was taken to hold the third meeting of the Group in Mozambique, but due to logistical difficulties the venue was changed to Zimbabwe and the meeting took place in Harare during March 1995. At this meeting Kenya was chosen as the next venue, Dr Philip Kitala was elected Chairman and Dr Brian Perry Secretary. A Kenyan organising committee was set up involving representatives of all the institutions involved in rabies research, diagnosis and control.

This meeting would not have been possible without the financial assistance of the World Health Organisation, Geneva; the Danish International Development Agency, (DANIDA), the Kenya Wildlife Services; Virbac Laboratories, France and Rhone Poulenc, France. We gratefully thank all of these sponsors and we look forward to their support at future meetings. The meeting was held at the International Livestock Research Institute (ILRI) and their assistance and support is gratefully acknowledged.

We were heartened by the addition of representatives from four countries new to our Group - Ethiopia, Eritrea, Sudan and Rwanda. Regrettably, three countries - Namibia, Botswana and Madagascar were not represented on this occasion.

As at the Harare meeting, National Presentations were followed by sessions devoted to human rabies. It had become apparent from the three previous meetings that co-operation between the veterinary and medical professions within our region urgently needed to be strengthened and how this need might be fulfilled was widely discussed throughout this meeting.

The Southern and Eastern African Rabies Group is now well-established as a forum for the gathering and dissemination of rabies information and we are delighted and honoured that the World Health Organisation, which has supported the Group from its inception, has joined us as a partner. We shall in future be known as SEARG/WHO.

We are, of course, all 'volunteers' but it has become clear that, in addition to the appointment of a Chairman, Vice-chairman and Secretary for the next meeting, we need a permanent Secretary who will liaise with our new partner and ensure the future of the Group. George Bishop, who has served in one capacity or another since the first meeting in Lusaka, has undertaken that task.

During the business meeting, four countries were suggested as hosts for the next meeting and the committee decided that the venue should be in Uganda and the meeting take place in 1999.

Philip Kitala, Brian Perry, Jacques Barrat and Arthur King (editors)

OPENING SPEECH

Dr Robert M. KIMANZI, Director of Veterinary Services, Kenya.

It gives me great pleasure to welcome you to this international meeting on the epidemiology and control of rabies, co-hosted by the Southern and Eastern African Rabies Group (SEARG) and the World Health Organisation (WHO). I bid a particularly warm welcome to those of you visiting Kenya, both representatives of many southern and eastern African countries and also authorities on rabies from other parts of the world. I understand that previous gatherings of the SEARG have all taken place in southern Africa, so I am particularly pleased to see the group hold a meeting in eastern Africa and to choose Kenya as its venue.

Rabies has been with us in Kenya for a long time and the first case was diagnosed in a dog in 1912. The dog is still the major source of the disease to humans and other animals in Kenya and more than half of the animal rabies cases diagnosed in our laboratories occur in dogs. Other animal species probably play a limited role in the maintenance of the disease in most parts of the country. Human rabies remains a significant threat to the health and well-being of our inhabitants and in addition incurs a significant cost to the nation in terms of post-exposure therapy. Moreover, we believe that the official figures of laboratory-confirmed cases of rabies in humans are a considerable under-estimate of the actual human mortality from this disease.

Like many other countries in the region, we base our rabies control on regular dog vaccination programmes and as a result of this measure, the disease was almost eliminated from the country in the early 1970s. However, since that time the incidence of rabies has risen dramatically and it has spread to virtually all corners of Kenya.

To respond to the challenge of controlling this most fearful of diseases, we developed our own capacity to produce animal rabies vaccines and for many years the vaccine produced at Kabete met our needs. Now we take advantage of high quality low cost vaccines on the international market and are endeavouring to develop more effective ways of delivering these to the urban and rural dog populations of the country.

Rabies is a disease which requires cross-disciplinary and cross-institutional collaboration if control is to be successful. Traditionally, responsibility for rabies control in many countries has fallen upon the veterinarians and thus in government, to the Departments of the Veterinary Services. In treating the disease in man, the responsibility for providing pre- and post-exposure vaccination of humans generally falls under the medical profession and thus to the Departments of Medical Services. In Kenya, as in other countries of the region, rabies affects certain wildlife populations, bringing in organisations such as our Kenya Wildlife Services to assist in the control of the disease, thus helping to protect and preserve our wildlife. In addition to these field services is the need for research to develop, for example, more effective diagnostic techniques and more effective vaccine delivery programmes. Thus in many countries, wildlife rabies control and rabies research may be housed and managed in separate institutions, making the need for collaboration and communication vital if the threat of rabies to our human and animal populations is to be reduced. I note with pleasure that in your programme you have representatives and contributions from all the different bodies involved in rabies diagnosis, control and research and I hope that your own collaboration will provide an example to all of us for the future.

Despite having rabies, Kenya is a beautiful country, well-worth exploring and for those of you visiting us for the first time from abroad, I urge you to take the opportunity to travel and enjoy the many pleasures we can offer. I wish you all a successful and rewarding meeting and hereby declare this fourth International Meeting of the Southern and Eastern African Rabies Group open.

CLOSURE OF CONFERENCE

Dr. J.K. Kajume[1]

Dr. Kitala : The Minister of Health has urgent business and so cannot close the Conference. However, Dr. Kajume, Deputy Director of the Ministry of Health has kindly agreed to close the Conference for us.

Dr. Kajume :

Chairman, Ladies and Gentlemen, I have a formidable task ahead of me as I was asked only a few minutes ago to stand in for the Minister. However, I am talking to colleagues and so let me take this opportunity to thank you and the meeting organisers for making the meeting such a success.

Rabies is a very serious problem and not for just veterinarians and public health workers. It is clear that this problem is not just for one side or the other and that the two professions must come together to find a solution. This forum has given us an opportunity to exchange ideas and knowledge and so we must move to the next stage; we have done enough talking but we can never take too much action. This is easy to say, but we must not fall short of taking such action. This will be a reflection of the commitment of all of us to this cause - we cannot move backwards now. We must find better options for controlling rabies and therefore do justice to our countries and of course the human race.

This meeting has been a wonderful opportunity to exchange ideas from which we must take action. We must focus on the dog owners : the ultimate responsibility rests with the owners and we techno-crats must market our knowledge for them so that they can take responsibility for their animals. If not, we will never control or eradicate rabies. As long as the dog owners are ignorant of the disease we shall have a problem and all improvements in vaccines and vaccination strategies will be irrelevant without this. The marketing and packaging of this message to dog owners is crucial so that they can understand the problem and its solution and participate in rabies control.
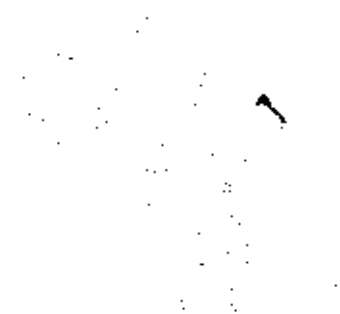
Ladies and Gentlemen, with these remarks I declare this meeting officially closed.

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[1] Kabete Veterinary Laboratory - P.O. Kabete - KENYA

National Reports

RABIES IN ERITREA

Afewerki Mehreteab[2]

1 INTRODUCTION.

Eritrea is the latest independent African country. It is located in the north-eastern part of the continent and borders the Sudan in the north and west, Ethiopia in the south, Djibouti in the south-east and the Red Sea in the east. It has an area of 124500 km^2 and a population estimated to be between 3.0 to 3.5 million. The country consists of a central highland mass which separates the eastern and western lowlands. Altitudes vary from over 3000 m above sea level in the highlands to below sea level in the Denakil depressions. The highlands have a rugged topography and suitable land for annual cultivation is limited to some valley bottoms. The lowlands are generally flat plains with hills here and there. Most of the population in the highlands lives at altitudes of about 1500-2000 m above sea level. The climate in Eritrea is influenced by its topography. Temperatures range from hot in the arid coastal plains to cool in the highlands. The main rain season is from June to August, but this is often preceded by small rains in April and May. In the coastal plains most rainfall occurs from November to March. Generally, the country has scanty rainfall.

2 THE LIVESTOCK SUBSECTOR.

In terms of food security, livestock comprises the most important subsector after food crops. Sheep, goats, cattle, camels and equines are particularly important in the western and eastern lowlands and the population in these areas depends mainly on them for their livelihood. Camels and equines also provide means of transport in remote and inaccessible areas. The current dog population is not known, but considering their use by farmers, their estimated number could be above 50000. Dogs are usually kept because they serve as guards for livestock, but a small number of dogs are kept as pets in towns. There has been no census in Eritrea and current animal population figures (Table 1) are based on estimates.

Table 1 : Estimated livestock population (X 1000 head)

Species	Population
Cattle	1300
Sheep and goat	5308
Camels	196
Equines	284
Poultry	2653
Dogs	50

2 Ministry of Agriculture - Veterinary Department - P.O. Box 1048 – Asmara - ERITREA

Organisation of the Veterinary Services.

The Ministry of Agriculture, through its Animal Resources Department (ARD) is responsible for livestock development. The ARD is comprised of three divisions, Animal Production, Feeds and Range Lands Development, and Animal Health. The Animal Health division in turn has three units, Disease Prevention and Control, Veterinary Public Health and Diagnostic Services:

The Disease Prevention and Control unit conducts the work of the field services which involves planning management, disease investigation, prevention and control, and collection of data on the incidence and prevalence of disease.

The Veterinary Public Health unit conducts meat inspection, manages the quarantine services, controls livestock movements and also, in collaboration with the Public Health unit, controls zoonotic diseases

Laboratory diagnostic services are conducted by the Central Veterinary Laboratory (CVL) and regional laboratories. During the period 1950-1970 the CVL, which was established at the turn of the century, had a reputation in Africa for producing various killed vaccines (including rabies) and was also carrying out disease investigation. Later however, as a result of negligence by the Ethiopians and the escalation of the war in Eritrea, its capabilities were reduced to such a low standard as to be almost non-functional. After the liberation of the country, rehabilitation of the CVL was given priority, enabling it to function reasonably well.

Manpower: The Animal Health Division operates through 14 clinics and 70 veterinary stations in which vaccinations and various treatments are carried out. The CVL is reasonably well equipped and minor laboratory services are also carried out in the clinics. To execute the veterinary services there are 17 Veterinarians, 21 Animal Health Assistants and 87 Animal Health Technicians. The Ministry is also training 25 Animal Health Assistants in order to fulfil the manpower requirements.

3 DISEASE CONTROL.

Livestock diseases are a major constraint to livestock production. Many animals die of major diseases and sometimes of less serious diseases when they become weak due to poor nutrition. At present, precise data on the incidences and prevalence of the different diseases is not available. However, based on the reports from veterinary services, all major diseases in the country are presented as follows:

Viral Diseases: The most dreaded disease is Rinderpest and it has been controlled through regular vaccination. However, seasonal movement to and from neighbouring countries is a threat and warrants the use of effective surveillance systems in the border areas until the disease is eradicated from the region. Other viral diseases include sheep and goat pox. FMD causes considerable economic losses in the highlands and peste-des-petits-ruminants (PPR), introduced into the country in 1993, is becoming hazardous in small ruminants. African Horse Sickness occurs at the end of the rains. And rabies, which is the most important zoonotic disease, is present in most of the towns. Except for FMD, vaccination is carried out as a means of control against all of these viral diseases, but since the coverage is low it is not effective.

Bacterial Diseases: Among the bacterial diseases present are Pasteurellosis, against which sheep and goats are vaccinated. Black-leg and anthrax occur sporadically and preventative vaccination is carried out. Bovine tuberculosis is prevalent and Brucellosis occurs with low incidence in dairy cattle.

Parasitic Diseases: Both endo- and ecto-parasites are present throughout the country and cause significant economic losses.

Poultry Diseases: Endemic are Newcastle disease, infectious laryngotracheitis, coccidiosis, salmonellosis and chronic respiratory diseases. NCD vaccination is commonly practised.

Zoonoses: The most serious zoonotic diseases are bovine tuberculosis and rabies. Brucellosis and anthrax are endemic in several parts of the country. At present, insufficient prevention and control measures are practised. There is urgent need to develop policies and strategies for tackling the problems associated with zoonoses control.

Human Rabies: Rabies is one of the important zoonotic diseases which requires urgent action as its consequences are hazardous to man. According to the Public Health epidemiology unit, two human cases were reported in 1995, which coincides with the outbreak of rabies reported by the veterinary service in the same year. In 1995-1996 a total of 365 dogs which had bitten persons were detained for rabies investigation. Dogs which die during the detention period are suspected of rabies and are taken to the CVL for rabies confirmation. Of the 365 samples submitted to the CVL for rabies confirmation during 1995-1996, 67 (18.4%) were positive (Table 2). Bite patients were sent to public health poly-clinics for rabies post-exposure treatment (PET).

Recent trends: Information gathered in regard to rabies is inadequate to assess the true picture of the disease, but it is suggested that the disease situation will worsen and will further endanger the public unless proper control measures are taken urgently.

Diagnostic Methods: In human cases, laboratory diagnosis is not carried out. Health workers in hospitals and clinics report cases on the basis of the history and clinical manifestations observed in the patient.

Reporting: At present, animal rabies cases are reported through the veterinary clinics, whilst human rabies cases are reported by health stations, clinics and hospitals and compiled by the veterinary and public health epidemiology units for further action.

4 ANIMAL RABIES CONTROL.

Animal rabies appears sporadically throughout the country and is endemic in some parts. To control this disease, all dog owners living in towns or villages are advised to have their dogs vaccinated against rabies and anti-rabies vaccine is made available in all the veterinary clinics. From early 1950, all of the municipalities in bigger towns contributed towards the control of rabies and the hygiene section of the municipality performed an important task in organising and providing all the necessary materials and manpower to facilitate the vaccination of owned dogs and the disposure of stray dogs. At present the programme of vaccination is carried out by the veterinary services from which certificates are also issued, while the municipality now only gives tag numbers and collects taxes for licensed dogs.

Dogs suspected of rabies or those that bite a person are detained in a municipal dog kennel where they are given food and water. These dogs are kept for 15 days under strict observation by a veterinary officer. If the detained dog dies showing clinical signs of rabies, it is immediately sent to the CVL for confirmation. The number of dogs detained from the year 1991-1994 was very low. In 1995 and 1996 rabies cases significantly increased and the number of dogs detained and found rabies positive also increased proportionately. In 1995, 10 of 155 (6.4%) detained dogs were positive, but in 1996, 57 of 210 (27.1%) were positive (Table 2).

Table 2 : Number of biting dogs detained and number of animals found positive

	1991	1992	1993	1994	1995	1996
	Pos/Neg	Pos/Neg	Pos/Neg	Pos/Neg	Pos/Neg	Pos/Neg
Stray dogs	0/9	0/30	0/17	0/9	10/115	57/74
Owned dogs	0/18	0/85	0/61	0/19	0/30	0/79
Bovines					0/2	0/2
Equines						2/0

Reduction of dog population is only sought when there is an outbreak of rabies; stray dogs are then killed either by poisoning or shooting. When the disease is under control, stray dog elimination is stopped and the dog population increases. In order to control the outbreak of rabies which occurred in late1995/early 1996, 1947 and 2416 dogs respectively were vaccinated in those years (Table 3).

Farm animals: These are also affected due to close association with dogs which are kept as guards. In 1995 and 1996 two bovine heads were brought to the laboratory for examination but were negative. However, in 1996 two equine heads were positive (Table 2).

Reported rabies cases and the coverage of routine vaccinations carried out in towns are both low compared with the total dog population of the country. This could be due to underreporting through a poor surveillance system. Apparently, the newly established epidemiology unit within the ARD will start

to collect adequate information which will be analysed and used to formulate disease control strategies and to design control measures.

Table 3 : Numbers of dogs vaccinated or destroyed in Asmara Municipality

	1991	1992	1993	1994	1995	1996	Total
Dogs vaccinated	200	799	675	2180	1947	2416	8217
Stray dogs killed	761	612	552	800	200	126	3051

4.1 Diagnosis at the Central Veterinary Laboratory (CVL).

In Asmara suspected dogs are taken to municipal kennels and isolated to be observed for 15 days. If the dog dies during this period, it is taken to the CVL, where the cranium is opened and the brain removed. For the FAT smears are made of the cerebrum, cerebellum and hippocampus and are fixed and stained with Centocor, together with smears from control positive and negative specimens.

If the sample is positive, the municipality from which the dog came, the owner (if known), others who may have been bitten by the dog and the hospital authorities are all informed so that action may be taken. Negative samples are further tested by the mouse inoculation test and the brains of mice which die between 5-14 days after inoculation are also tested by FAT.

4.2 Rabies diagnosis in the Regions.

In the regions where laboratory facilities are not available, biting dogs are kept under strict supervision by the veterinary officer or his assistant. If the dog dies within the detention period, the head is sent to the CVL for diagnosis.

Identification: Tag numbers, which are used to identify properly licensed dogs, are written on a piece of iron and attached with the collar. These numbers are prepared and issued by the municipality when they ascertain that the dog has been vaccinated. An inactivated, adjuvated vaccine (Rabisin) is used for animals (whereas an inactivated vaccine prepared in Vero cells (Imonvax Rabies Vero) is used for post exposure treatment in man).

Recent trends: Previous control measures included the use of strychnine to reduce dog populations. At present this is not available and the increase in the number of positive dog cases is probably a result of increased stray dog populations. Without proper control measures it is likely that the incidence of human rabies will increase. The public is being asked to co-operate in control measures by eliminating strays and vaccinating owned dogs.

So far, there has been no funding allocated for rabies diagnosis, research and control. The Veterinary Service purchases vaccines after estimating the number of doses needed for the year. For disease investigation purposes, the ARD has established a project to strengthen the CVL in its diagnostic capabilities. Zoonotic diseases are among the priority research items for the next five years. Rabies control will be given major emphasis in the national livestock development project.

RABIES IN ETHIOPIA

Sileshi Zewde[3]
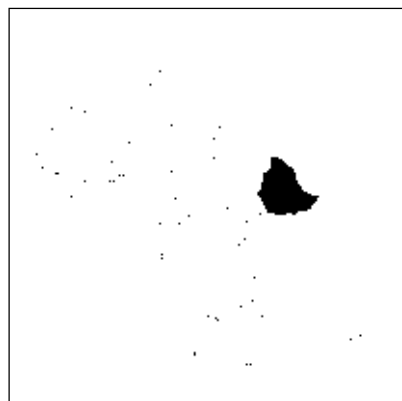
1 INTRODUCTION.

Ethiopia is one of Africa's largest countries, with an area of approximately 1.1 million km^2; the population is estimated to be 55 million, with 2.5 million people living in Addis Ababa, the capital city. The country has borders with Eritrea and Djibouti in the north, Sudan to the west, Kenya to the south and Somalia to the east and north-east. Most of the country is highlands rising to 13000 ft, but dropping sharply to the Sudan border in the west and towards the Denakil lowlands in the north-east. The land falls more gently towards Kenya in the south and the Ogaden desert and Somalia in the east. The highlands are divided by the northern end of the Rift Valley, which forms a series of lakes. The climate is temperate on the plateau but hot in the lowlands. The main primary products are wheat, barley, maize, sorghum, millet, coffee, cotton, sugar cane, beans and peas, cattle, timber and salt, whilst the main exports are coffee, hides and skins, beans, cotton and sesame seeds. Unfortunately, drought is common and frequently leads to famine.

Livestock holds the key to sustainable agricultural development and to improving the cash income of the majority of Ethiopian farmers. Apart from that, livestock also provides fuel, clothing and traction power, and animal agriculture is the key factor in food security in the dry areas, where it is the predominant economic activity. In general, the livestock sub-sector is considered the most important in the country, with some 28 million cattle, 23 million sheep, 17 million goats, 7 million equines and 1 million camels. The income from these represents 15% of the country's GNP. About 70% of the livestock are raised in the highlands mixed agricultural system, while the remaining 30% are found in the various grazing systems in the lowlands.

Livestock productivity is low, being most often below the known average for Africa. The most important obstacle to increasing animal production in Ethiopia is still the occurrence of diseases. This is especially true for highly contagious diseases such as Rinderpest and Contagious Bovine Pleuropneumonia (CBPP). Ranking equally as an obstacle in this respect is inadequate nutrition. Improvement in both situations are very much dependent upon the availability of good veterinary and extension services.

2 RABIES OCCURRENCE AND CONTROL.

Urban rabies is essentially maintained by dogs wherever it is endemic world-wide. It is a problem of veterinary public health importance because of the relationship which exists between man and animals. Regardless of whether or not rabies is present in wildlife reservoirs, over 90% of human deaths from rabies are caused by dog bites. Therefore, if we control dog rabies, we will prevent human rabies. In Ethiopia rabies is one of the most feared zoonotic diseases. It is generally understood that rabies cannot be cured even by highly reputed herbal medicines. As a result of this there is an awareness of the disease both in rural and urban areas. It is estimated that the dog/human population is 1:6 in urban areas and 1:8 in rural areas.

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[3] Ministry of Agriculture - P.O. Box 7491 - Addis Ababa - ETHIOPIA

Rabies is reported in all regions of Ethiopia and the incidence in humans reported from hospitals and health centres is alarming. In Addis Ababa in three hospitals alone, 2031 persons were reported to have received anti-rabies therapy (post-exposure treatment) in one year. In the following year, 1838 were treated. Recent data will be presented later at this conference by Dr. Makonnen Fekadu.

At present, the Institute that is carrying out diagnosis and vaccine production against is the Ethiopian Health and Nutrition Research Institute (EHNRI). The production capacity is small and the production technology of the Institute is outdated. The Ministry of Agriculture plans to start the production of anti-rabies vaccine for animals using the most recent technology.

3 REPORTING.

The occurrence of animal rabies is reported to the veterinary clinics, which fill in the monthly reports of disease occurrence and vaccination and send them monthly to the Veterinary Department.

4 ANIMAL RABIES CONTROL.

Vaccination is carried out by city councils in urban areas. In rural areas, vaccination is carried out by the Veterinary Services Department in response to outbreaks. In Addis Ababa, dog owners take their dogs to vaccination posts where vaccine is provided. The vaccine is available at the EHNRI at a cost of US$ 0.15cents/dose.

The vaccine used for rabies control in dogs is inactivated nerve tissue vaccine (NTV). To reduce the dog population, stray dogs are being killed (but irregularly) by the city councils. When the Ministry of Agriculture commences vaccine production the rabies control programme will be handed over to the Ministry of Agriculture and the programme will be executed by the Veterinary Departments.

5 PROPOSED RABIES CONTROL ORGANISATION.

The Veterinary Department has a well established network; the services reach down to the grass roots. The clinics are equipped with cold-chain and other equipment They carry out disease control and render clinical services. When the rabies vaccination programme is started by the Ministry of Agriculture, they will be also provided with other necessary field and camping equipment.

The Pan-African Rinderpest Campaign project operates through a system of Branch Co-ordinating Offices (BCOc) where the project owns the equipment but the staff is supplied by the regional states The BCOs have proved to be an effective method of coordinating infectious disease control where the federal and regional states collaborate to implement the programme The BCOs can also co-ordinate other disease control programmes.

RABIES IN RWANDA

Sylvain Mbarubukeye[4]
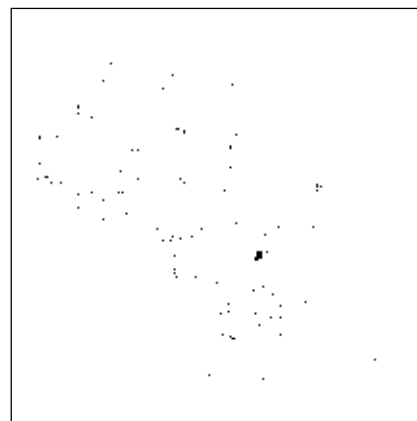
1 INTRODUCTION.

Rwanda is a small, landlocked, country of only 26338 km^2. It is located between 1° 40' and 2° 51' South and 28° 53' and 30° 53' East. Neighbouring countries are Burundi in the south, Tanzania in the east, Uganda in the north and Zaire in the west. The nearest port is Mombassa in Kenya, some 2200 km from the capital Kigali. The topography consists mainly of many mountains, which have given Rwanda the name of 'the thousand hills country'. Altitude ranges from 1000 m in the low eastern plateaux to 4500 m in the high volcanic mountains of the north; there are many lakes and rivers. The climate is characterised by temperatures ranging from 15 - 30°C, mean 20 - 25°C. Annual rainfall is 800 mm to greater than 1200 mm.

Rwanda is a densely populated country, the total population being estimated at more than 7 million. In some areas density reaches 350 inhabitants/km^2. In general, the population is poor. About 95% of the active population works in traditional agriculture, producing bananas, cassava, potatoes etc., whilst coffee, tea, hides and skins respectively are the main exports. Livestock includes cattle (600000), small ruminants (300000), poultry, pigs etc. The number of domestic animals was seriously reduced during wartime in 1994 but effort is being made to reintroduce these species. The economy suffers from the lack of a port and has further suffered greatly from the war. Many sectors of development need to be rehabilitated; many international organisations and NGOs are helping in this respect.

In Rwanda, animal and human rabies exists even if the situation is not well documented. Before the 1994 war, Veterinary Services contributed to the reduction of cases by the annual vaccination of domestic dogs and cats. The National Veterinary Laboratory was equipped and had skilled personnel to carry out rabies diagnosis. Those measures helped to maintain the human rabies cases at a very low level. Unfortunately, during and after the war, rabies control measures were abandoned and the risk of human and animal rabies is now high.

2 DOMESTIC DOG AND CAT POPULATIONS IN RWANDA.

Census figures for domestic carnivore populations are taken from annual reports of the Ministry of Agriculture and Livestock for the years 1985-1988 (Table 1). The situation in the following years is not documented, but it may be assumed that there was little change before the 1994 war.

Table 1 : Census of domestic dogs and cats, 1985 - 1988

	1985	1986	1987	1988
Dogs	55 768	53 442	53 341	53 149
Cats	31 997	32 734	35 556	35 553

The number of dogs and cats may have changed since the war. During the war, many animals were abandoned by their owners, the number of stray animals increased and the risk of disease became

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[4] Laboratoire Veterinaire National de Rubilizi - PB 804 - Kigali - RWANDA

more serious. However, it is estimated that more than 25% of dogs and cats were lost during wartime and dog and cat populations are now estimated to be 40000 and 27000 respectively.

3 RABIES SITUATION IN DOMESTIC ANIMALS.

Rabies cases in domestic animals have been often reported, even if in small numbers. Confirmed cases were reported after diagnosis in the Veterinary Laboratory of Rubilizi on killed animals that had bitten one or more persons. The figures are shown in Table 2.

Table 2 : Domestic animal rabies cases diagnosed in the laboratory 1976 – 1990

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
5	7	0	4	5	3	2	6	0	2	0	2	6	5	4

Clinical rabies cases in animals other than dogs and cats have always been rare, but there have been occasions when the disease has been epidemic. In 1985, 77 clinical cases were reported, with 52 cases in the Gikongoro zone, 17 in Kigali and 6 in Butare. In 1987, however, fewer cases (4, 5 and 0 respectively) were observed in the same areas. In 1988, epidemic rabies appeared in Gitarama zone (Mugina) in jackals which transmitted the disease to domestic dogs (17) and cattle (4).

4 HUMAN RABIES.

The incidence of rabies in humans is not well documented, but it appears that its importance is limited to urban and peri-urban areas, where the number of stray animals is relatively high when compared with the number of owned animals. An explanation of the low incidence in humans may be that the total number of dogs is also low and any dog or cat which bites a person is immediately destroyed. In addition, Rwandan culture does not show a strong link between man and dogs. Nevertheless, human rabies cases have been reported in Kibuye and Gikongoro areas in 1994-1995.

5 DIAGNOSTIC METHODS.

In Rwanda before 1994, rabies diagnosis was carried out at the National Veterinary Laboratory, Rubilizi. The diagnostic techniques used were the detection of Negri bodies by Seller's staining and the fluorescent antibody test (FAT). Unfortunately, all of the equipment necessary to carry out these tests was looted during the war and at present the Laboratory is unable to perform any rabies tests. Skilled technicians are needed and there is a need to have the viral serology service operational once again.

6 ANIMAL RABIES CONTROL.

Before 1994, massive annual dog and cat vaccination programmes were the main prophylactic measure to control rabies; the population was encouraged to take care of their animals. Since 1994, however, the Veterinary Services have been seriously weakened and those prophylactic measures are no longer applied except in urban areas, where some people, mainly expatriates, have their dogs and cats vaccinated. The vaccine generally used for dogs is Rabisin. That used for human vaccination and post-exposure treatment was Wistar PMWI38615036-3M from Pasteur Merieux. In rural areas, stray dogs are mechanically eliminated and in urban areas, when people are disturbed by stray dogs, they may remove them by use of acaricide poisons. At present there is no project or funding allocated to rabies control. In 1994 an application to FAO by the Ministry of Agriculture for a rabies control project was rejected on the grounds that such a project was the prerogative of WHO; WHO has suggested that FAO could fund such a project.

Rabies is still a Public Health threat in Rwanda. To control the disease there is a need to rehabilitate the diagnostic laboratory and to restore vaccination of the canine population to its pre-1994 levels. The human population must be re-educated in the dangers of non-vaccinated and stray dogs. Substantial funding needs to be allocated for the control of rabies.

RABIES IN UGANDA

Christopher S. Rutebarika[5]
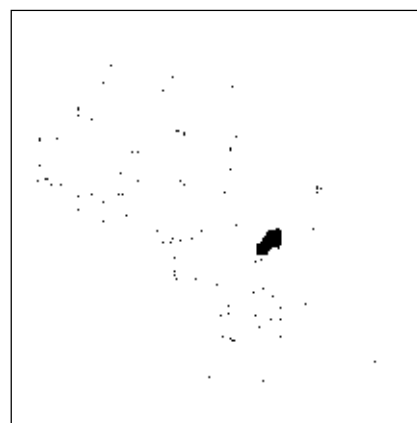
1 INTRODUCTION.

The incidence of rabies in Uganda has remained high in the past two decades because of political and socio-economic circumstances in the country. This has been accentuated by the increasing number and mobility of both human and dog populations.

The domestic dog accounts for more than 95% of the rabies cases reported, while other domestic stock and wildlife play a minor role. The Department of Veterinary Services is responsible for the control of dog rabies through preventive measures.

2 HUMAN RABIES.

In a report for January - June 1996, nine cases of rabies were recorded, while a total of 1698 dog bite victims received post-exposure treatment (PET) with anti-rabies vaccine (ARV) in various health units. Of the total of 39 districts in the country, all but four (Kalangala, Kisoro, Bundibugyo and Gulu) requested ARV.

A decreasing trend of rabies incidence, where 50, 23, 15 and 14 cases were reported for 1992, 1993, 1994 and 1995 respectively, is shown in Table 1. The doses of ARV used increased from 3976 in 1992 to 16000 in 1996 due to public sensitisation programmes on the importance of rabies by members of the Technical Committee for Rabies Control (TECOR). The beginning of the 1996 1997 financial year saw government recognition of the public health importance of rabies by offering free PET to all suspected rabies victims.

Table 1 : Suspected human cases given PET; estimated cost and number of fatalities

|	Suspect victims	ARV doses	Estimate cost US$	died
1992	766	3976	36000	50
1993	1518	5720	51000	23
1994	2614	8298	74700	15
1995	3222	13623	122000	14
1996	1698	16000	144000	9
Total	9818	47617	427700	111

Source: Departmental Annual Reports, 1992-96

Currently, rabies is diagnosed on clinical grounds alone. The district medical and veterinary staff co-ordinate data collection, analysis and dissemination in the districts and reports are later sent to the

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[5] Ministry of Agriculture, Animal Industry & Fisheries - Office of the Director of Animal Resources - P.O. Box 513 – Entebbe - UGANDA

central co-ordinating committee at the national level. In districts where a multisectoral approach (MSA) has been established (Figure 1), the local administrators, the communities and the medical and veterinary staff co-ordinate reporting at the local level and later send reports to the national level. The national committee makes reports to the policy makers and regional and international organisations.

Figure 1 : Districts with MSA committees
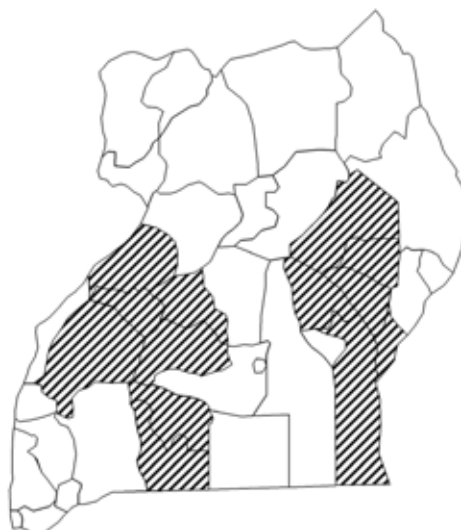
3 ANIMAL RABIES AND ITS CONTROL.

The Department of Veterinary Services, which belongs to the Directorate of Animal Resources, is mandated to control major epidemics including rabies. Rabies has become a serious epidemic in the last two and a half decades and government attaches a lot of importance to its control and eventual eradication.

The following are current strategies employed in rabies control :

1) Notification in case of disease outbreak (Tie up order).

2) Compulsory mass vaccination of dogs and cats.

3) Destruction of stray and unvaccinated dogs.

4) Laboratory diagnosis.

5) Control of dog movement (internal and external)

6) Public awareness programmes: A multisectoral approach (MSA) to rabies control and surveillance has been adopted. The districts of Kabarole, Masaka, Kumi, Iganga, Tororo, Kamuli, Rakai, Soroti and Mubende have had MSA implemented. The rest of the country will be covered, funds permitting. Areas where MSA has been implemented have registered high levels of compliance during campaigns.

7) Provision of appropriate legislation.

4 FUNDING FOR RABIES CONTROL, DIAGNOSIS AND REPORTING.

In the years 1995 and 1996 rabies received reasonable funding; rabies ranks third to CBPP and Rinderpest. Funding covers procurement of vaccines and logistical support for campaigns. The central diagnostic laboratory at Entebbe received equipment and reagents and public awareness programmes were funded, though inadequately. The amount of vaccine procured and the number of dogs and cats vaccinated are indicated in Table 2.

5 ROLE OF DONOR ORGANISATION PROJECTS, COMMERCIAL COMPANIES AND NGOS.

Donor organisations

The Livestock Services Project, an IDA funded project, is the only project that has facilitated control programmes. It has procured 500,000 doses of rabies vaccine, facilitated rabies vaccination campaigns and provided transport to field staff in all the districts of the country. It has enabled TECOR to carry out public awareness programmes through seminars, radio and TV programmes since 1993. It has also equipped the Central Veterinary Laboratory at Entebbe, which deals with rabies diagnosis.

Table 2 : Animal rabies control: number of dogs and cats vaccinated, doses purchased and estimated cost

	Animal ARV	Doses Procured	Estimate Cost US$
1992	56662	80000	25600
1993	24875	0	0
1994	82306	100000	32000
1995	73906	90000	28800
1996	63390	400000	128000
Total	301139	670000	214400

Source: Departmental Annual Reports, 1992-96

Commercial companies

Rhone Poulenc (RP) and Coopers Ltd have been the major suppliers of vaccine for dogs and of audio-visual aids for our public awareness programmes. In February 1996, RP provided 250 undergraduate students at the Faculty of Veterinary Medicine, Makerere University, with pre-exposure immunisation, before which they had radio and TV awareness campaigns. Coopers has recently donated dog muzzles to facilitate vaccination campaigns.

NGOs

Most NGOs have not shown an interest in rabies control. Only CUAM, an Italian NGO, provided Arua district with 6000 doses of vaccine during the early 1990s, when the district was faced with an influx of both human and dog populations from Sudan and Zaire. There are six private small-animal clinics in Kampala City, including that at the Faculty of Veterinary Medicine.

6 USE OF DOG POPULATION REDUCTION.

The strategy of dog population reduction, though temporary in nature, has been used. Until quite recently it was used mainly in urban areas, but later it was used in rural areas where large populations of stray dogs were left behind by displaced people during the civil strife in the north and eastern parts of the country and Rwandanese refugees returning to their country. Such dog populations were reduced by poisoning, shooting and hunting.

In 1995 a total of 1401 dogs and 35 cats were destroyed while 1989 dogs, 357 cats, 97 foxes and 17 jackals were destroyed in 1996. For this exercise to be effective, it needs to be carried out twice a year but it is expensive and therefore unaffordable. The cheaper alternative is compulsory and free dog and cat mass vaccination.

7 HUMAN AND ANIMAL VACCINES.

Human vaccines: Vaccine currently in use is the inactivated cell culture vaccines prepared on VERO cells (Verorab). In the past (1992-1993) human diploid cell vaccine (HDCV) and duck embryo vaccine (DEV) were used.

The number of rabies suspected victims who received PET and doses imported annually are shown in Table 1. The vaccines were used in all the districts of the country, but districts were limited by resources to purchase the amount of vaccine they required from the central medical stores. In the financial year 1996-1997 the government is providing free vaccine for the whole country.

Animal vaccines: The vaccination returns for 1992-1996 are shown in Table 2. A total of 301139 cats and dogs were vaccinated in those years.

The country has been importing inactivated cell culture vaccines which provide immunity for 1 or 3 years since 1992. The 3-year immunity vaccine is ideal for our situation where vaccines are irregularly available and vaccination coverage are usually low. The number of vaccine doses procured and used are shown in Table 2. These vaccines have been used in all districts of the country.

The cases of rabies reported in the different animal species for the period 1992 - 1996 are shown in Table 3. Rabies has been stable, though sporadic cases are reported in 90% of the districts. Districts which have reported no rabies during 1995 and 1996 are shown in Figure 2 and Figure 3 respectively.

Table 3 : Reported cases of animal rabies in Uganda, 1992 -1996

		1992	1993	1994	1995	1996	Total
Domestic	Dog	243	228	376	252	38	1137
	Cat	0	0	1	4	11	16
	Cattle	1	2	0	4	1	8
	Goat	2	0	7	5	8	22
	Total	**246**	**230**	**384**	**265**	**58**	**1183**
		1992	1993	1994	1995	1996	Total
Wildlife	Fox	0	2	0	5	8	15
	Jackal	3	6	0	4	2	15
	Monkey	0	0	1	0	3	4
	Rabbit	0	0	0	0	2	2
	M'goose	0	0	0	2	0	2
	Total	**3**	**8**	**1**	**11**	**15**	**38**
All cases		**249**	**238**	**385**	**276**	**73**	**1221**

Source: Departmental Annual Reports, 1992 - 1996

8 CONSTRAINTS OF RABIES CONTROL.

Rabies control programmes are constrained by :

1) Irregular and insufficient funding

2) Control of stray dog populations, which are on the increase

3) Public awareness of rabies is still insufficient

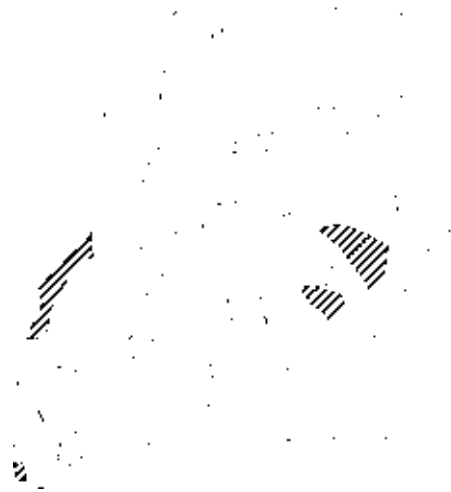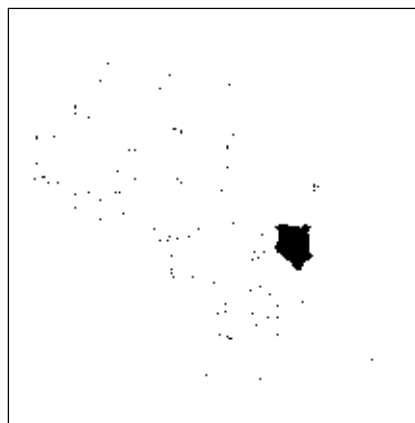**Figure 2 : Rabies infected districts in 1995**

Figure 3 : Rabies infected districts in 1996

RABIES IN KENYA

A. K. Karugah[6]

1 DIAGNOSIS AND SURVEILLANCE.

All rabies diagnosis in the country is carried out at the Central Veterinary Laboratory (CVL) Kabete and at Mariakani Regional Laboratory. The CVL handles almost 90% of the total samples submitted for diagnosis. The numbers of diagnostic samples submitted during 1995 and 1996 are considered few considering reports from some districts that rabies is widespread. Thus, under-reporting is still a serious problem. Reasons for the under-reporting include lack of the necessary education and public awareness, lack of funds and long distances to the diagnostic laboratories.

During 1993 - 1996 the percentage positivity of the total number of samples submitted to the laboratory was 33.07% of 387 samples in 1993, 35.75% of 207 samples in 1994, 33.43% of 341 samples in 1995 and 67.07% of 167 samples in 1996. The number of positive cases diagnosed during 1995 and 1996 are summarised by species in Table 1.

Table 1 : Positive cases according to species, 1995 and 1996

	1995	1996	Total
Domestic animals.			
Dogs	77	52	129
Cats	6	2	8
Cattle*	26	50	76
Equines	7	7	14
Total	116	111	227
Wildlife			
Hyenas	3	0	3
Baboons	1	0	1
Gorillas	1	0	1
Hedgehogs	0	1	1
Total	5	1	6
Total	**121**	**112**	**233**

Mostly cattle, some other ruminants.

Source: Kabete and Mariakani Investigation Centres

[6] Veterinary Research Laboratory - P. O. Kabete - KENYA

2 CONTROL STRATEGIES.

The control strategies currently in use include vaccination, targeted mainly at dogs; destruction of stray dogs; restriction of dog movements and post-exposure treatment (PET) of humans. Thus the main target of control measures is the dog population, which to date remains largely unknown. Dog de-population is carried out through baiting whenever there is an outbreak of rabies. This is done according to the law(s) which spell-out procedures for baiting.

There is still very little data on the ecology of dogs and wildlife. Ecological studies are meant to give a better understanding of the disease in dogs and wildlife so that optimal immunisation programmes for dogs can be worked out. We are therefore in a situation where rabies cases are reportedly on the increase, under-reporting is increasing and control programmes are covering a smaller proportion of the dog population.

3 RABIES CONTROL FUNDING.

The 1996 allocations for disease and pest control are shown in Table 2.

Table 2 : Allocated funds for disease and pest control, 1996

	Kenya £s X 1000
Rabies	120
Foot and Mouth Disease	2850
Rinderpest	1700
Tick control	4000
Tse Tse control	2777
General*	4900

Though rabies may appear to have a fairly small allocation, it is necessary to clarify that funds allocated under the General Fund (* above) are also available for control of rabies and other diseases such as lumpy skin disease, anthrax, contagious bovine pleuropneumonia, FMD, rinderpest, trypanosomiasis, etc …

4 VACCINE PRODUCTION AND USAGE TRENDS.

All vaccines used in the country are cell culture in origin. In the past few years most of the vaccinations have been carried out by the Department of Veterinary Services and the Kenya Society for the Protection and Care for Animals (KSPCA). However, although we do not have their data, we know that private clinics vaccinate dogs and this may be a large number of dogs. Other bodies such as the Kenya Veterinary Association also organise vaccination campaigns, though not on a regular basis. The details of vaccine production and usage trends are shown in Table 3.

5 OTHER BODIES INVOLVED IN RABIES WORK

Apart from the Department of Veterinary Services, bodies such as KSPCA and the Kenya Veterinary Association, private clinics are also involved in the control of rabies to a varying extent. Bodies such as the University of Nairobi, Egerton University, Kenya Agricultural Research Institute and Kenya Wildlife Services are, however, more concerned with research into the disease than into the control of rabies. There is a need for future co-operation between these bodies and the Department, leading to the exchange of research findings and surveillance/control experiences.

That way, it may become possible to share resources (human, financial, etc.), thus avoiding duplication of effort and having a greater impact on rabies control.

Table 3 : Vaccine production and usage trends

	1991	**1992**	**1993**	**1994**	**1995**	**1996**
Vaccine production						
Local	0	0	0	0	9000	55000
Imported	44000	150000	0	150000	100000	100000
Vaccinations						
Department	8026	96510	42108	42249	59764	52384*
KSPCA	0	0	600	720	11819	780
Total	**8026**	**96510**	**42708**	**42969**	**71583**	**53164**

Figures apply to vaccinations up to November, 1996.

RABIES IN ZAMBIA

Alisheki Mutemwa [7]

1 HUMAN RABIES.

Human rabies is still frequently reported in Zambia. Diagnosis is mainly based on clinical symptoms, followed by histopathology of the hippocampus. The results are sent to the Epidemiology Unit of the Ministry of Health. The figures for 1993 - 1997 are summarised in Table 1. Many of the cases occur in Lusaka Province.

Table 1 : Human rabies cases in Zambia, 1993 -1997

	1993	1994	1995	1996	1997
Notified cases	4	0	4	1	N.A
Hospital cases	118	12	21	N.A	N.A
Lusaka alone	N.A	N.A	66	51	4*

N.A. = Figures not available.   * = Jan-Feb only.

Each year cases of dog bites are reported to the Veterinary Authorities - the public appears to have a clear understanding of the implications of a dog bite. In Lusaka, a dog bite usually evokes panic and small fights between the dog owner and the victim's family sometimes ensue. The victim's family always insists upon seeing the valid rabies certificate of the dog. If the certificate is not valid, the victim will usually demand compensation in the form of money from the owner. Victims do not seem to worry so much about post-exposure treatment.

The Veterinary Authorities in such cases usually intervene by doing the following :

   a) Confirm validity of the rabies vaccination certificate

   b) Conduct a full physical and clinical examination of the dog

   c) If the dog is suspected to be rabid, a prompt recommendation to post-mortem is made

   d) If the dog is sound, it is observed for ten days after which a final decision is made

   e) Advice about rabies and how to avoid it is given to both families.

2 ANIMAL RABIES.

Rabies control is usually carried out through the immunisation of animals, particularly cats and dogs. The law states that every pet owner must have his dog or cat vaccinated against rabies once it is three months of age. It further states that vaccination must continue at the rate of at least once each year.

Using Lusaka district to represent the current control strategies of the country, there are mainly two ways employed by the Veterinary authorities:

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[7] Department of Animal Production & Health - P.O Box 30041 – Lusaka - ZAMBIA

1) Pet owners bring their pets for vaccination at one of the various clinics in the city. At these clinics they are told when to give the first, second and other booster vaccines. The current average fee for an anti-rabies vaccination including certification is Kw. 1500 (approximately $1.00). Statistically, over 50% of pet owners are aware of the fact that they have to have their pets vaccinated. The problem we normally encounter is that the lack of knowledge of when to start and when to give boosters.

2) Conducting of mass rabies vaccination campaigns. This is carried out in most districts of Zambia at least once per year. In Lusaka it is usually done by targeting various townships. The procedure is :

   a)   The township is identified; dissemination of information through Public Address systems, i.e., radio and print media, is vigorously carried out a week before the vaccination day.

   b)   On the vaccination day, rabies vaccination teams are stationed at various pre-arranged sites, e.g., market, schools, etc., where people will have been told to bring their animals for vaccination. Usually, the turn out is high. However, most of the dogs presented may be categorised as not previously vaccinated (10%), vaccinated but no valid certificate (80%) or underage, i.e., small puppies (10%).

During these mass vaccination campaigns, pet owners are always reminded of the seriousness of rabies; usually, the response is favourable.

3 FUNDING ALLOCATED TO RABIES CONTROL.

Rabies control has always been well funded. Under the Agriculture Sector Investment Programme there has been an allocation for disease control all the way down to the district. Specific allocations for the last two years under the programme for Lusaka District, for example, are as follows :

	Kw	$
1995	2030670	1353
1996	1920000	1280

Of this amount, over 60% is allocated for rabies control. However, during a serious outbreak, funds for rabies control are made available either through the Permanent Secretary's or the Director's Office.

4 ROLE OF DONOR ORGANISATIONS, ETC.

These organisations have not done enough in terms of supporting rabies control. Reasons for this could be:

   a) Lack of proper information about the seriousness of rabies as a zoonotic disease

   b) For commercial companies, lack of funds is also a constraint.

5 THE USE OF DOG POPULATION REDUCTION.

Two methods of dog de-population are currently used, shooting and neutering.

1) **Shooting** is usually carried out after a mass vaccination campaign in specific areas. After vaccination, a follow-up team usually revisits the area to vaccinate those dogs which for some reason were not vaccinated. If for unclear reason the owner is unable to have the animal vaccinated, the animal is shot.

2) **Neutering** is a method which veterinarians recommend to pet owners as a way of dog population control. When pet owners enquire how to prevent their pets from having too many litters, they readily welcome the idea of neutering. Neutering fees are spaying - dogs Kw. 30000 ($22), cats Kw. 20000 ($15); castration - dogs Kw. 25000 ($18), cats Kw. 15000 ($11).

Several rabies outbreaks continue to be reported, for example from Lusaka in Lusaka Province, Livingstone in Southern Province, Mongu in Western Province, Kasama in Northern Province and Kapiri Mposhi in Central Province. In Lusaka district, 13/16 suspects were positive in 1993, 7/11 in 1994, 40/52 in 1995 and 14/36 in 1996.

6 TYPES OF VACCINE

Three types of vaccine are used, Rabisin (Rhone Merieux), Rabvac Tm3 (Solvay) and locally produced Balmoral vaccine.

7 RABIES DIAGNOSIS AND RESEARCH AT CVRI –MATERIALS AND COSTS

Based on 260 samples/year and Kw 1362 = 1 US$

Reagents		US$
FAT conjugate	100mls	367
Glycerol	2000mls	15
PBS buffer salts	3500gm	121
Ethanol	4000mls	118
Teepol (for cleaning)	24000mls	132
Biodan	5000mls	52
Acetone	5000mls	51
	Total	856

Equipment		US$
Spot slides (glass)	260	51
Coverslips (glass)	260	135
Wash bottles	5	7
Moist chamber	5	7
Cotton wool	2600gm	20
Needles G26	260	36
Syringes (1ml)	260	101
Mice pellets	260Kg	44
Gloves	260pr	151
Face masks	260	284
Filter paper	260	60
	Total	896

Rabies Research (Dog Ecology Study)	Km^2	US$
Chipata	600	147
Kasama	800	195
Solwezi	600	147
Mansa	800	195
Mongu	600	147
Ndola	300	73
Kabwe	150	37
Livingstone	500	121
Lusaka	radius 60	73
	Total	1135

Subsistence (5 nights/district, 8 districts)

		US$
1 Veterinarian	40 nights x 29	1160
2 Technicians	80 nights x 22	1760
1 Driver	40 nights x 15	600
	Total	3520

Total cost Reagents and Equipment   =
   $1752

Total cost Research, Dog Ecology Study =
   $4655

RABIES IN MALAWI

Sheik Ndaomba[8]

1 INTRODUCTION.

Malawi is a small landlocked country with a land area of approximately 9.4 million hectares, of which 5.7 million hectares are regarded as suitable for farming. The human population is now estimated at 11 million, with a density of 97-176/km^2, thus making Malawi one of the most densely populated countries in the region. Agriculture is the backbone of the economy, contributing about 35% of GNP, of which livestock farming contributes about 7%.

The estimated livestock populations are shown in Table 1.

Table 1 : Estimated livestock populations of Malawi

Cattle	800 000
Goats	900 000
Sheep	100 000
Pigs	250 000
Poultry	3 000 000
Dogs	250 000 - 500 000

The livestock industry in Malawi is severely constrained by diseases. The most important of these are East coast fever, trypanosomiasis, blackwater and tuberculosis in cattle, Newcastle disease and Gumboro disease in poultry, African swine fever in pigs and rabies in dogs.

Rabies is endemic throughout Malawi. Many species are affected but dogs are the most frequent victims. In addition, dogs play a major role in transmission of the disease to humans. However, hyenas, jackals and civets also have been reported to transmit the disease to humans. The animals diagnosed positive for rabies during 1995 and 1996 are summarised in Table 2.

2 RABIES CONTROL PROGRAMMES.

In the past, the Department of Veterinary Services had one rabies control team in each of the three regions. The teams were mandated to control the disease throughout the region by mass vaccination of dogs and the elimination of strays. The dedicated teams instituted this exercise and included promotion of public awareness on the radio. From 1983, however, the Ministry of Agriculture including the Veterinary Department were reorganised into eight Agricultural Development Divisions. The three regional rabies control teams were thus disbanded. Under the new arrangement, each Agricultural Development Division (DVO) is responsible not only for rabies control but also for other diseases in the Division. The result has been that rabies no longer receives adequate financial and human re-

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8 Ministry of Agriculture - Department of Veterinary Services - P.O. Box 2096 - Lilongwe, - MALAWI

source support. Of late, rabies cases have been on the increase in the country and vaccination coverage has been inadequate.

Thus, during 1990 - 1995 when the average number of humans seeking treatment each year was 4000, the number of dogs vaccinated per annum was 50000 (10 - 20% of the dog population) and a further 2000-4000 dogs were shot. The human incidents were caused by dogs (84%), cattle (7%), cats (2%), jackals (2%), hyenas (1%) and others (4%).

Table 2 : Rabies positive animals in Malawi, 1995 - 1996

Species	1995	1996
Dog	129	156
Cat	0	4
Cattle	5	6
Sheep	1	2
Goat	1	1
Guineapig	0	2
Total Domestic animals	**136**	**171**
Jackal	1	0
Rabbit	0	2
Shrew	0	1
Total wildlife animals	**1**	**3**
Total animals	**137**	**174**

3 HUMAN RABIES.

The number of human deaths per annum now averages 30-40 and the number of people seeking post-exposure treatment is about 5000. The most frequent source of infection is a dog bite. All persons seeking post-exposure treatment must report to the Veterinary Department before they can be treated at the hospital.

4 NEW EFFORTS IN RABIES CONTROL.

The numbers of dogs cited in this report are an extreme under-estimate of the true populations. It is vital that a national study of dog ecology be undertaken, but the main limiting factor is the unavailability of funds.

Rabies control project under CESTAS - EU funded.

Recently, a new project funded by the EU to operate only in Lilongwe Agricultural Department district was launched. The major objective of the project is to develop a system whereby sufficient financial and technical resources to control rabies will be made available to the Malawi government. The target will be to vaccinate at least 80% of the dog population and to increase public awareness so that the dangers of rabies can be brought to an acceptable level. These efforts will later spread to other ADDs, eventually to cover the whole country.

RABIES IN MOZAMBIQUE

Fernando Rodrigues[9]

1 INTRODUCTION.

The rabies situation in Mozambique is characterised by the occurrence of human and animal cases throughout the country. Dogs are the species most affected and are also responsible for transmission of the disease to humans. There have been no reports of rabies in the wildlife of Mozambique.

2 HUMAN RABIES.

Human rabies is still a serious problem in Mozambique, although some provinces appear to be less affected than others. The number of human cases during 1991-1996 are summarised in Table 1. The situation continues to be of concern since there has been no decrease in the number of cases over the past four years and, particularly in the rural areas, under-reporting is still a problem.

Table 1 : Distribution of human rabies by province, 1991-1996

Province	1991	1992	1993	1994	1995	1996	Total
Maputo	0	1	0	0	0	0	1
Gaza	1	0	0	0	0	1	2
I'bane	4	0	1	0	1	0	6
Sofala	5	2	0	1	3	0	11
Manica	5	9	2	3	6	6	31
Tete	0	0	3	1	0	1	5
Zambéz.	0	9	0	0	1	3	13
Nampula	3	21	3	2	4	5	38
C.Delga.	0	0	0	0	2	0	2
Niassa	0	0	0	0	0	1	1
Totals	**18**	**42**	**9**	**7**	**17**	**17**	**110**

3 METHODS OF DIAGNOSIS AND REPORTING.

Human rabies diagnosis is carried out at the National Veterinary Research Institute (INIVE), which is the Central Veterinary Laboratory. There are a further three laboratories in the provinces able to diagnose rabies, but by Sellar's staining method only. Nevertheless, very few specimens from hospitals are sent to the Laboratory. Therefore, most of the human cases are diagnosed on clinical signs and

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[9] Direccao Nacional De Pecuaria - P.O. Box 1406 – Maputo - MOZAMBIQUE

history of the person bitten. The Ministry of Health issues weekly bulletins in which rabies, as well as other diseases, is reported.

4 ANIMAL RABIES CONTROL.

The budget provided for all animal health activities does not specify the amount allocated exclusively for rabies control. The control actions are run mainly by two institutions, the National Directorate of Livestock and the National Veterinary Research Institute. The National Directorate is responsible for animal vaccination campaigns and observation of suspected animals as well as the collection and sending of suspected samples to the laboratory. The INIVE is responsible for vaccine production and laboratory diagnosis.

Funds for animal health activities disbursed since 1991 are shown in Table 2. Despite the fact that rabies represents a threat to Public Health, priority is given to the control of tick-borne diseases and trypanosomiasis. Since the human death toll from rabies is less than that from tuberculosis, malaria, etc., priority is also given to these diseases.

Table 2 : Expenditure (US$) for animal health activities, 1991-1995

1991	1992	1993	1994	1995	Total
402408	454826	299418	207747	181246	1545645

5 DIAGNOSIS AND RESEARCH.

Although all four diagnostic laboratories use Sellar's staining as a method of diagnosis, only the Central Veterinary Laboratory in Maputo also uses FAT and the mouse test. The number of animal cases confirmed during 1991 - 1995 is shown in Table 3.

Table 3 : Laboratory confirmed animal rabies cases, 1991-1995

1991	1992	1993	1994	1995	Total
12	18	14	21	9	74

6 ROLE OF DONOR ORGANIZATIONS, PROJECTS, COMMERCIAL COMPANIES, NGOS.

In 1990, a $150000 project for rabies control purchased and adapted two vehicles for the capture of stray dogs, rehabilitated one kennel compound and paid for the production of posters, pamphlets and announcements via mass media for public education. The one-day vaccination campaigns conducted during 1995 and 1996 in Maputo city, with the participation of the veterinary students, were supported by the Netherlands embassy. These funds were also used for public education, transport and subsistence for vaccinators. WHO assisted the Ministry of Health in the purchase of human rabies vaccine and the vaccination of veterinary students was part of the 1996 Rhone-Merieux campaign.

7 STRAY DOG POPULATION REDUCTION.

Unrestricted dogs constitute a public health hazard, mainly in the cities, where the dog population density is higher than in rural areas. The capture and killing of stray dogs is limited to the cities of Maputo and Beira. The operation is not carried out on a programme basis but upon request from residents only.

8 ANIMAL AND HUMAN VACCINATION.

Vaccine used for animal vaccination is produced at INIVE and is prepared on embryonated eggs. In addition, in 1993, 1994 and 1995, 32000, 45000 and 3200 doses respectively of an inactivated cell-culture vaccine were imported. The quantities of vaccine used by the Ministry of Agriculture and Fisheries is summarised in Table 4.

Table 4 : Vaccine doses distributed during 1991-1995

	1991	1992	1993	1994	1995	Total
Doses	29211	20138	54399	8491	25692	137931

Most animals were vaccinated in the cities of Maputo and Beira as a result of participation of private practitioners. In those two cities it is estimated that over 20% of the vaccinated cats, dogs and domesticated monkeys were vaccinated by private practitioners.

For human vaccination or post-exposure treatment, imported diploid cell vaccine is used and, for example, in 1993 the Ministry of Health imported 3000 doses. Sometimes, due to lack of government financial resources for vaccine acquisition, persons bitten by suspected rabid animals are forced to go to private clinics or to obtain the vaccine themselves from neighbouring countries. The number of persons vaccinated against rabies by the Ministry of Health during 1991-1995 is shown in Table 5.

Table 5 : Number of persons vaccinated in Maputo City, 1991 - 1995

	1991	1992	1993	1994	1995	Total
Bitten	826	834	881	950	938	4429
Vaccinated	93	185	178	215	43	714
% Vacc.	11.3	22.2	20.2	22.6	4.6	16.1

RABIES IN SUDAN

Ali Hassan Ahmed[10]

1 INTRODUCTION.

The Democratic Republic of Sudan extends over parts of Central, East and North Africa. The country can be divided into four geographic zones: the desert, the savannah, the subtropical and tropical. There are corresponding differences in livestock densities and methods of animal husbandry. The great majority of livestock lives in pasture grasslands and smaller herds are raised in irrigation scheme areas. Different health problems therefore prevail in the different environments. The country's animal wealth constitutes an important sector of its' economy and in this respect it is the richest Afro-Arab country. The 1994-1995 animal census estimated a wealth consisting of 30770000 cattle, 37145000 sheep, 33319000 goats, 2903000 camels and 4000000 donkeys and horses, with 71866 dogs and cats in Khartoum State. Wildlife is also a major national wealth. However, while both domestic and wildlife animals receive great attention in the Sudan, dogs and cats receive very little. This attitude allows dogs and cats to live wherever they can obtain food and shelter. Stray dogs and cats therefore live and breed freely in or near restaurants, public gardens, hospitals, hostels and slaughterhouses. In addition to causing nuisance to the public, dogs and cats form an important link in the cycle of several zoonotic diseases, including rabies.

Rabies was first reported in Sudan in 1904. In 1911 the public and official authorities recognised that the disease was endemic and hence rabies control ordinances were issued, revised in 1930 and amended in 1952. The problem of rabies in the capital city of Khartoum can be illustrated by the fact that in recent years (1971-1996) the National Public Health and Central Veterinary Laboratories have confirmed as rabies 10-20% of samples submitted from suspected animals. The Director of Public Health in Khartoum has on many occasions (the latest being in 1995) advised the Governor to declare that a rabies enzootic is present within the Province. The number of reported dog bite incidents in the city during the preceding six months was 7680. Vaccination campaigns gave only temporary relief from epidemics, since although thousands of dogs and cats were either vaccinated or destroyed, a build-up of new generations of dogs appeared whenever the campaign was not maintained, leading to epidemics which recurred every few years.

2 HUMAN RABIES.

In addition to measures of prevention and control of the disease in dogs, post-exposure wound treatment and vaccination is the principal approach to rabies prevention and control in humans. Imported Vero cell and duck embryo vaccines are available from private drug stores and although apart from allergy and low grade fever no serious reactions have been reported, they are very expensive, each costing about 15000 Sudanese pounds per course.

The major vaccine in use (since 1924), however, is a locally produced Semple vaccine prepared from the brains of 6-12 month old male goats inoculated with the Pasteur strain, inactivated by the addition of 1:4000 ß-propiolactone and diluted to give a final brain concentration of 5%. Before use, tests in-

[10] C/o Dr Abdulla Latif - Department of Parasitology - Faculty of Veterinary Science - University of Khartoum - P.O. Box 32 – Khartoum – SUDAN

clude sterility tests for bacteria and fungi, mouse inoculation tests for the presence of toxicity and live virus and potency tests. Minor paralytic reactions have been reported annually, but only 5 of 33444 persons (1 in 6688) have been reported to have serious paralytic reactions leading to death during the past five years. In 1982, four people were reported to have received the local vaccine for 10 days, following which the treatment was stopped as the biting dogs were still alive. Two of the patients died showing typical rabies symptoms and the other two became permanently paraplegic. It was later established that the batch of vaccine used contained live virus which had resisted inactivation; no further cases of this kind have occurred since 1982.

Table 1 : Human rabies cases and nervous tissue vaccinations (x1000), 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Cases	NA	200	20	20	75	0	40	10	10	0	13	13	5	12	5	0
Deaths	NA	20	10	10	20	0	40	10	10	0	9	10	3	9	2	0
Vaccinated	12	18	5	15	10	11	15	18	15	15	13	17	32	31	8.7	7.8

NA = Not Available

The rabies unit is often faced with problems of vaccine storage because of the lack of cold chain facilities. Difficulties in the transportation of vaccine to remote areas are also encountered. The numbers of persons receiving nervous tissue vaccine in Sudan since 1981, the numbers of human rabies cases and the number of human deaths from rabies are summarised in Table 1.

3 ANIMAL RABIES.

Dogs are the most important reservoir of infection and vector of the disease in Sudan. Since, like cats, they are left to scavenge for food in the vicinity of garbage tips and dumping areas where goats also roam, goats frequently become dog rabies victims. Rabies infected goat bites are the second most important source of human infection.

Diagnosis.

History of a biting incident and further clinical signs are taken as a strong suspicion of rabies. This suspicion may be confirmed by laboratory tests. Histopathological tests using haematoxylin and eosin (H & E) staining used for the detection of Negri bodies is the most commonly used technique but FAT, introduced within the past five years, is sometimes used for diagnosis of specimens sent from hospitals in the Khartoum area. Although technical staff are available and are trained in FAT techniques, the reagents needed are not available from within the country and thus have to be imported. Attempts to diagnose rabies in humans by laboratory tests have been made, but clinical signs and a history of having been bitten by a suspect rabid animal continue to be the most frequently used diagnostic method.

Most animal brain samples are sent in formalin either to the National Health or the Central Veterinary Laboratories for histochemical staining. Since there are no cold chain facilities for countrywide sample despatch, FAT is performed only on unfixed specimens if these originate from close to the central laboratory. However, the number of samples submitted to the Laboratory is low, mainly due to the lack of facilities. The number of cases confirmed during 1982 -1996 is summarised in Table 2.

Table 2 : Suspect cases of rabies in domestic animals in Sudan, 1982-1996

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Dogs and cats	138	90	55	50	52	102	70	70	158	118	10	159	335	169	84
Goats, cattle sheep	10	8	18	10	20	5	5	5	48	55	11	3	4	3	1
Horses, donkeys	2	0	2	4	0	6	2	2	34	19	1	2	1	2	1
Total	150	98	75	64	72	113	77	77	240	182	22	164	340	174	86

4 PREVENTION AND CONTROL.

Two classical approaches, the destruction of stray dogs and the vaccination of owned dogs, are used. Unfortunately, these control methods are not used continuously. However, periodic campaigns (every two or three years) are mounted, primarily in the capital city of Khartoum, which is inhabited by approximately five million people.

Stray dog destruction campaigns involve shooting, poisoning or trapping and the use of dog catchers has been tried. These campaigns are usually successful, for example, in 1982 a total of 11888 dogs were destroyed in Khartoum area (4042 dogs), Khartoum North area (3197 dogs) and Omdurman area (4649 dogs). This represents an average daily dog destruction of 263 dogs. Animal vaccination including owned dogs was carried out at the Khartoum Veterinary Hospital during 1982 - 1990. A total of 13788 animals in Khartoum (10335) Omdurman (1906), Khartoum North (2800) and East Nile (1300) were vaccinated during this period.

Thus, 13788 dogs were vaccinated during this 11 year period, compared with 11888 dogs destroyed during a 45 day period in 1982. This indicates that rabies control relies primarily on the destruction of stray and neglected dogs rather than on vaccination. It also implies that there are far more stray than owned dogs.

When anti-rabies campaigns were undertaken in the previous years, several thousand dogs were vaccinated and the owners were charged only a minimal price for the purpose. At other times of the year the vaccines are sold at higher prices, but they are not always freely available. Other domestic animal species are not vaccinated in the Sudan.

RABIES IN ZIMBABWE

Spencer Javangwe[11]

1 INTRODUCTION.

Human and animal rabies continued to be a problem in Zimbabwe during 1995 and 1996. Dog bites accounted for eight of the nine human deaths during the period, the other one was due to a jackal bite. Dogs and jackals were the principal vectors, with cattle being the main non-vector species.

2 HUMAN RABIES.

Of the nine cases that occurred in 1995 and 1996, six were confirmed by FAT on brain material and two by FAT on skin biopsies. In 1995 one case was confirmed by serology. Three of the cases also received post-exposure treatment. Details of the nine cases are given in Table 1.

One human rabies case, a nine year old boy bitten on the neck by a suspect rabid dog, survived the disease. The dog was killed but was not submitted for diagnosis. The boy received rabies vaccine at 1, 7, and 21 days following the bite. At 15 days he started to show symptoms of fever and complained of headache and stiff neck; five days later he was comatose. Skin biopsy, corneal smears and saliva taken eight days after the start of the symptoms were negative by FAT or mouse inoculation. Serum taken 32 days afterwards was tested for neutralising antibody at the CVL in Harare and was found to have a titre of 345 IU/ml. CSF taken two months after the first symptoms had a neutralising titre of 23.8 IU/ml. No virus was isolated from the CSF. On the basis of the serological tests a diagnosis of rabies was made. (At the CVL, vaccinal titres in humans rarely exceed 20 IU/ml). The patient remained comatose for over a month after which he began to respond to stimuli. Artificial ventilation was stopped soon after this. However, he remained in a semi-vegetative state and died of secondary complications several months later.

Another human case, a 24-year old woman bitten on the hands and legs by a jackal, succumbed to the disease despite receiving the recommended post-exposure treatment. The wounds were treated with soap and water and mercurochrome. She received vaccine on days 0, 3, 7 and 14. She developed symptoms of rabies 19 days post-exposure, with headache, anxiety and shoulder pains. Later she developed paralysis of the left arm, nystagmus and stiff neck; she lapsed into coma ten days after the start of symptoms and died seven days later. Diagnosis was confirmed by FAT on brain material. She did not receive immunoglobulin at the start of PET, but was given it eight days after the onset of symptoms. She also received a fifth dose of vaccine on day 30, during the clinical phase. The vaccine used throughout was within the manufacturer's expiry date.

The number of laboratory confirmed human rabies cases in Zimbabwe has been increasing since 1992 (Figure 1). The vaccine used is of cell culture origin. In 1995, 27950 doses were imported (14700 doses in 1996) but no data are available on the number of patients treated.

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[11] Central Veterinary Laboratory – P.O. Box CY 551 – Causeway – Harare - ZIMBABWE

Table 1 : Confirmed human rabies cases 1995 and 1996

Origin	Death date	Age	Sex	Vector spe- cies	Contact method	Incubation period
Muzarabani	14.3.95	12	M	Dog	Bite	27days
Nkayi	16.9.95	11	M	Dog	Bite	4 months
Gokwe		9	M	Dog	Bite	15 days
Karoi	17.2.96	24	F	Jackal	Bite	19 days
Bindura	28.3.96	12	F	Dog	Bite	45 days
Gokwe	22.10.96	10	M	Dog	Bite	36 days
Gokwe	13.11.96	12	M	Dog	Bite	2 months?
Gokwe	3.11.96	36	M	Dog	Bite	
Mutasa	20.10.96	6	M	Dog	Bite	

Figure 1 : Human rabies cases between 1987 and 1996
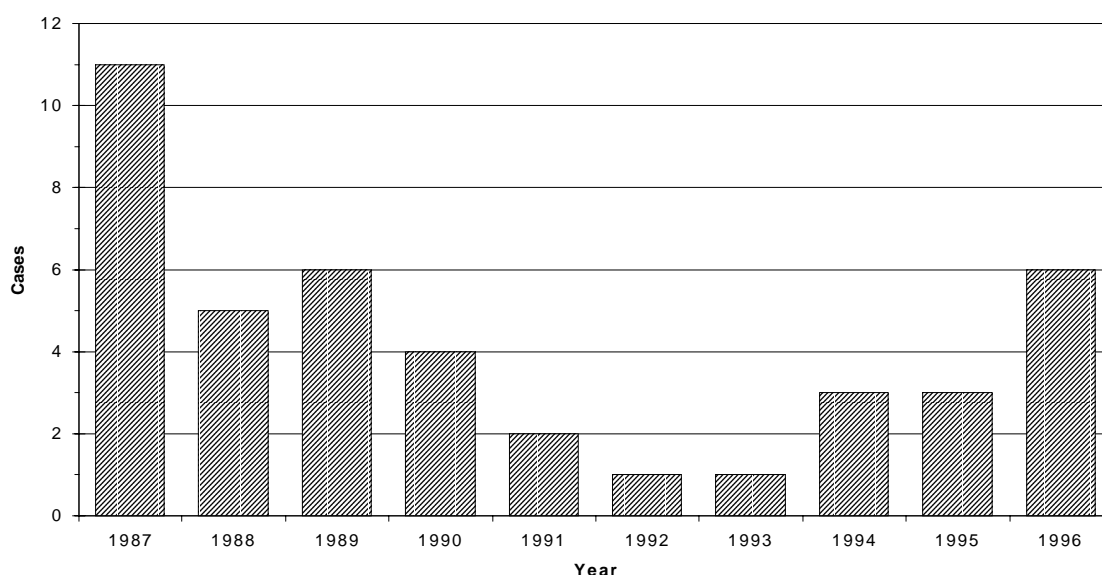
3 ANIMAL RABIES.

Samples for rabies are despatched in a special rabies box to the rabies section of the Central Veteri-
nary Laboratory (CVL) by the fastest means. If they are sent on a Friday, the sender alerts the CVL of
the mode of transportation and the estimated time of arrival. At the CVL samples are processed on the
day of arrival and the results are made available the same day. The tests used are FAT, histology and
mouse inoculation. During weekdays the rabies section informs Head Office of the results and Head
Office then passes them to the Provincial Veterinary Officer (PVO) from where the samples originated.
The PVO then passes the information to the relevant parties. During weekends, the rabies section
passes the results directly to the sender, if possible by telephone. A telephone line is dedicated to
rabies diagnosis and reporting and there is a special rabies officer to co-ordinate all rabies diagnosis
and surveillance. In addition, a weekly report containing details of all rabies specimens is sent to Head
Office and all government veterinary offices. The CVL has been compiling from submitted data the
quarterly SEARG rabies bulletin since July 1995. Laboratory confirmed animal cases are summarised
in Table 2.

Table 2 : Laboratory confirmed animal rabies cases in Zimbabwe, 1995 and 1996

Domestic animals			Wildlife animals		
	1995	**1996**		**1995**	**1996**
Dog	221	149	Jackal	278	144
Cat	17	9	Mongoose	1	2
Cow	118	105	Civet	6	5
Sheep	2	3	Aardwolf	4	0
Goat	24	30	Honey badger	6	3
Donkey	9	12	Hyena	1	1
Pig	1	3	Wildcat	0	2
Total	**392**	**311**	Skunk	1	0
			Serval	1	4
			Eland	1	0
			Total	**299**	**161**

Grand total (1995+1996) : 691+472=1163 animals

4 ANIMAL RABIES CONTROL.

4.1 Regulations.

The Animal Health (Rabies) Regulation, 1966, requires that the owner of a dog must have the dog vaccinated within one month of attaining the age of three months, followed by a second vaccination at 12-15 months of age and thereafter within every three years. If a dog of uncertain vaccination history is acquired, the owner must have it vaccinated within seven days and again after six months and within every three years thereafter.

In the Animal Health (General) Regulations, rabies is a notifiable disease and as such it must be reported to the Department of Veterinary Services. An Animal Health (Rabies Area) order may be issued by the Director of Veterinary Services in the event of an outbreak, declaring such an area a Rabies Area. This allows the Department to carry out measures necessary to contain the outbreak, such as tie-up orders and the shooting of stray dogs.

Animal Health (Import) Regulations 1989 requires that a veterinary import permit is obtained before a dog is brought into the country. Requirements for import are as follows :

The dog must originate from an area free from movement restrictions imposed for the control of rabies.

The animal has a valid vaccination certificate indicating that vaccination was carried out not less than 30 days previously and not more than 1 year before movement in the case of primary vaccination.

The animal has been re-vaccinated for rabies not less than 30 days but not more than 3 years before movement in the case of dogs. In the case of cats the period after re-vaccination is not less than 30 days but not more than one year.

If the dog is under 3 months of age its dam has to have been vaccinated against rabies at least 30 days but not more than 1 year before birth.

These requirements are standardised for countries in the Southern African Development Community (SADC). City by-laws require that a dog must be vaccinated against rabies before a dog licence is issued and all dogs within urban areas must be licensed.

4.2 Vaccination strategies.

Government Veterinary Officers as well as private veterinary surgeries carry out vaccinations on any day during working hours. In addition, Friday afternoons have been set aside for rabies vaccinations at Government veterinary offices.

Annual vaccination campaigns are carried out at dip-tanks in the communal farming areas. Similar mass vaccination campaigns are carried out at designated shopping centres in urban areas.

At every vaccination, every dog receives an ear tattoo bearing the year's unit number, first in the left ear and then in the right ear. A fee of Z$3.00 is charged if a vaccination certificate is required.

In the event of an outbreak an area may be gazetted a Rabies Area and a vaccination campaign mounted.

4.3 Reporting of human contacts.

All dog bites must be reported to veterinary staff who will check the vaccination status of the dog. If the vaccination status of the dog is not known or if the dog is not vaccinated, the dog is detained for at least 10 days in which signs of the disease should appear if infected. In the meantime, the person who was bitten is referred to the hospital for treatment. The veterinary department will inform the hospital on the rabies status of the dog for follow-up with prophylactic measures.

4.4 Animal vaccinations.

The vaccine used in dogs is an inactivated cell culture vaccine. A total of 355,281 doses of vaccine were administered in 1995 and in 1996, 353,267 doses (Table 3;Figure 2)

Most vaccinations were administered in Manicaland and Masvingo. In 1995 these two provinces accounted for 39% of dog cases and in 1996, 47% of the dog cases were in these two provinces.

Table 3 : Dog rabies vaccination for 1995 and 1996.

Province	1995	1996
Manicaland	68535	69491
Mashonaland Central	41939	31198
Mashonaland East	43037	30750
Mashonaland West	28319	30710
Matebeleland North	25946	40085
Matebeleland South	34610	30422
Midlands	43853	28100
Masvingo	69042	88511
Total	**355281**	**353267**

4.5 Use of dog population reduction.

If an area is designated a Rabies Area in terms of the Animal Health (Rabies Area) order, a tie-up order may be gazetted. A vaccination campaign is then mounted. Each dog that is vaccinated is then marked by paint. All unvaccinated dogs are then shot.

In addition there are city council by-laws which are aimed at controlling the dog population. These are as follows:

No person shall keep

more than two dogs on a single property measuring less than 2000 square metres

more than four dogs on any other single property.

Only licensed breeders can keep an unspayed bitch

No person may keep a dog unless it is licensed

Stray dogs may be captured by the council and destroyed if they are found to be ownerless, or if they are not claimed and cannot be disposed of in other ways.

The Society for Prevention of cruelly to Animals (SPCA) plays a major role in controlling the dog population. In addition to educating the public on dog population control, the Society undertakes to spay dogs for a minimal charge or free for those who cannot afford to go to a private veterinarian.

Figure 2 : Dog rabies cases and dog vaccination between 1987 and 1996
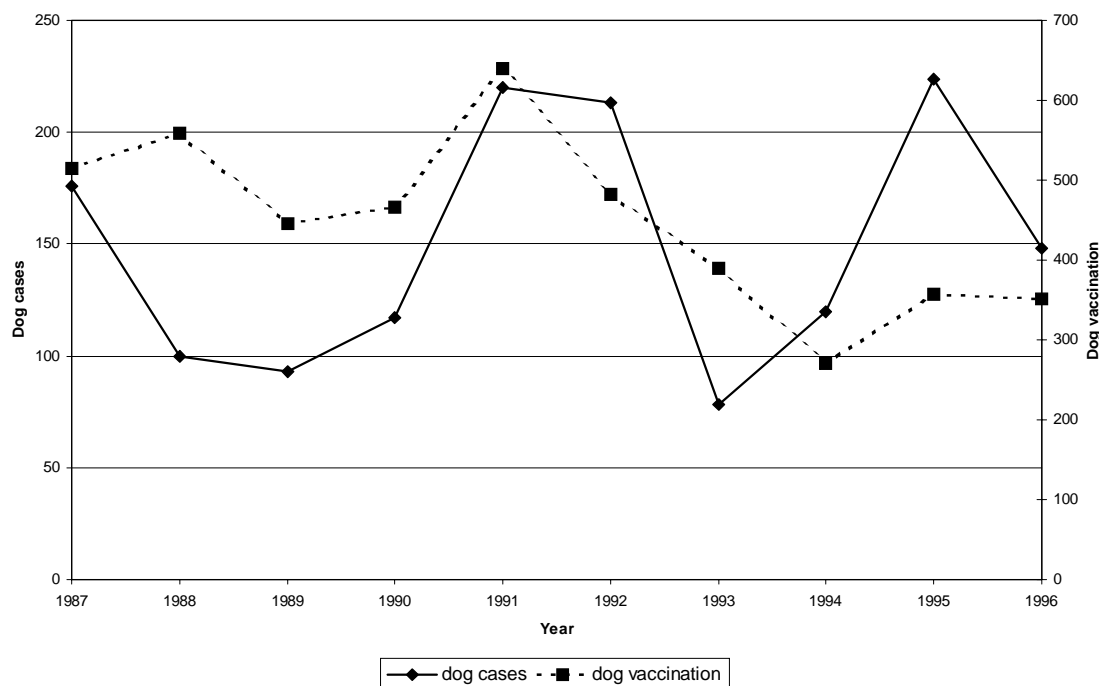
5 FUNDING AND RESEARCH ACTIVITIES

There is a general fund for all animal disease control which includes rabies. Thus to quantify in monetary terms the funding allocated to rabies control is difficult. However, in 1996 a total of 500000 doses of vaccine was bought at a cost of Z$1196000

Diagnosis of rabies is given a high priority at the Central Veterinary Laboratory, with diagnosis being a seven day a week service to the public.

Research funding from the Government is low. Over the past two years Virbac, a French company, has provided funding for specific trials involving oral rabies vaccination of jackals.

RABIES IN SWAZILAND

Roland X. Dlamini[12]

1 INTRODUCTION.

The Kingdom of Swaziland suffered a major rabies wave that started in 1992 and appears to have ended in 1996. During this wave the disease was evenly distributed throughout the country. Co-operation amongst various government departments (including the Police, Health Information and Veterinary Services), private sector and international organisations avoided an otherwise explosive situation during the wave.

2 HUMAN RABIES.

According to scanty medical records, during the past three years only two people died from clinically diagnosed rabies. Both patients were boys under the age of six years. They had earlier been presented to a hospital with dog bite wounds and, as far as the disease was concerned, they were inadequately treated. There were other unconfirmed reports of people that died from rabies during this period, some of whom died under the hands of traditional and/or spiritual healers. In the same three year period more than 100 patients received post-exposure rabies vaccination. There is apparently a lack of accurate records, if any, with regard to human rabies cases in Swaziland.

3 ANIMAL RABIES.

Dogs were the principal vectors of rabies during the period 1994-1996; other animals, such as cattle and goats, were merely victims (Table 1). During this period, one cat was also confirmed rabid. Two wild animals, a mongoose and a rodent, were taken to the Laboratory for FAT and were found negative.

Table 1 : Laboratory confirmed animal rabies cases, 1994-1996

|	1994	1995	1996	Total
Canine	22	48	20	90
Feline	1	0	0	1
Bovine	1	9	5	15
Caprine	1	8	3	12
Other	1	0	0	1
Total	**26**	**65**	**28**	**119**

Source : Manzini Veterinary Investigation Laboratory

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[12] Ministry of Agriculture - P.O. Box 162 – Mbambane - SWAZILAND

Dogs accounted for 75.6% of all laboratory confirmed cases (Figure 1) and more than 50% of all confirmed cases were dogs under six months of age. Comparatively speaking, these immature small dogs exposed more people to rabies than the mature, fierce looking dogs which were generally killed at the first signs of rabies.

Figure 1 : Species distribution of rabies cases
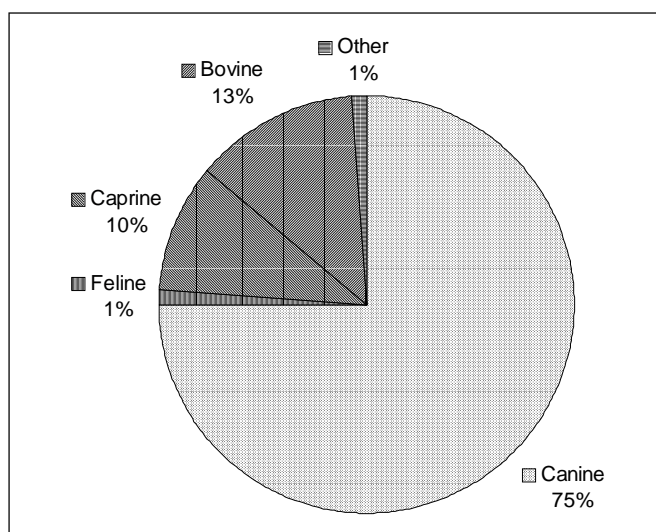
A few cases were picked up from apparently normal dogs presented at clinics and during vaccination campaigns. One dog drank, ate and behaved normally but with occasional fit-like signs during the course of the disease and then died suddenly on the sixth day. One clinically normal bitch had a litter of six puppies that died of rabies at the age of five weeks. A few dogs that died acutely were also found rabid. From such cases it may be concluded that many more cases were missed. Modern means of transport helped to spread the disease, especially when dogs were moved during the incubation period. Cases occurred randomly through the years and there was no specific monthly pattern (Figure 2).

Figure 2 : Monthly distribution of animal rabies cases
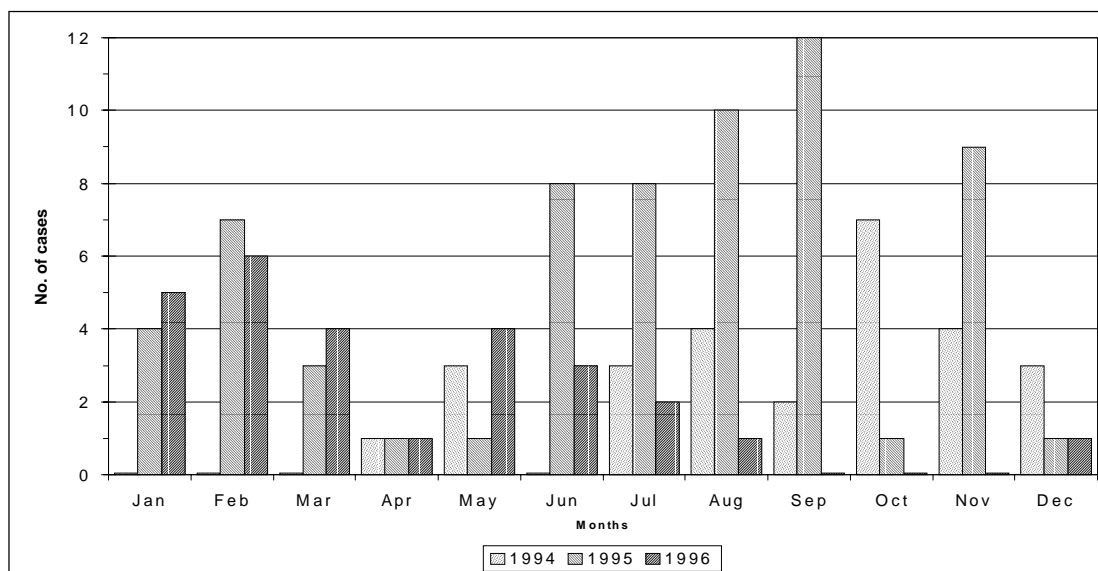
4 RABIES CONTROL.

In Swaziland there is a statutory requirement for annual vaccination of all dogs. In the past three years these vaccination campaigns managed to cover a high percentage of dogs (Table 2). The Stock Diseases Act of 1965 stipulates that in the case of an outbreak infected areas should be declared rabies guard areas. In such areas, a tie-up order is enforced. Vaccination campaigns are then conducted,

following which dogs that are not vaccinated and/or not tied up are destroyed. In the past three years more than 1500 dogs have been shot.

In 1995 the Swaziland Veterinary Association, in collaboration with the Government, embarked on rabies mass public education. International organisations such as WHO assisted in financing seminars on the disease. These seminars were attended by medical doctors, nurses, veterinarians, veterinary technicians and other interested parties. Resource persons included local veterinarians and rabies experts from neighbouring South Africa. A video of real cases of rabies was shown during the seminars, but to medical and veterinary staff only; for mass publication a video specially produced in South Africa for viewing by non-professionals was used. The latter video was also shown on national television at prime time (after the evening news) and was repeated in response to public demand.

Table 2 : Rabies dog vaccination coverage, 1994-1996

	1994	1995	1996
Population	72932	78885	78885 (1995 figure)
Vaccinated	53038	72545	69604
Percentage	72.7	92.0	88.2

Schools and communities, especially in affected areas, were one of the prime targets of this educational programme and the print media also assisted in improving awareness during this period. Radio programmes assisted in reaching the rural populace. These awareness campaigns resulted in a sharp increase in the demand for post-exposure vaccines, particularly for health workers. There was also a sharp increase in the number of samples taken to the Laboratory. Dog bite victims were referred from medical clinics/hospitals to the Veterinary Department to investigate whether the animals involved were indeed rabies suspects; this cut down costs of unnecessary post-exposure vaccine and also helped the Veterinary Department to get some of the cases it would have otherwise missed.

RABIES IN LESOTHO

Koenane Moshoeshoe[13]

1 INTRODUCTION.

The first reported cases of rabies in Lesotho were in 1981 in dogs illegally imported from an endemic rabies area of South Africa. Shortly afterwards, sporadic cases of rabies in animals were confirmed at our diagnostic laboratory. Within two years the number of laboratory and/or clinically confirmed cases had escalated to reach 0.04% of the estimated population of 100000 dogs. The Government then embarked upon a national pet animal vaccination campaign to control rabies. As wildlife rabies is unknown in Lesotho, dog and cat owners were targeted and required to pay a minimal fee for the vaccine. The response, however, was not very good since the coverage reached less than 20% of the dog population.

2 HUMAN RABIES.

During 1984, 18 human deaths were confirmed on clinical grounds, following bites from suspected rabid dogs. In response to this death toll, free dog rabies vaccination was offered and since that time the incidence has been very low (Table 1). No laboratory facilities for the diagnosis of rabies are available within the Ministry of Health and all cases are diagnosed on clinical grounds in the hospitals. Reports of such cases are always available from the statistical unit of the Ministry of Health.

Table 1 : Human rabies morbidity and mortality in Lesotho, 1984-1996

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total
Morbidity	0	1	0	3	0	0	0	0	0	0	0	1	1	6
Mortality	18	4	0	1	0	1	0	0	0	0	0	2	0	26

3 ANIMAL RABIES.

Current trends are basically dependent upon the control measures which are conducted by the Animal Health Department and the rabies incidence has decreased considerably in recent years. When free vaccination campaigns were started, the aim was to vaccinate 70% of the national dog population. The campaigns were conducted from district to district using teams of Auxiliary Animal Health Personnel and all ten districts were covered. We are indebted to the South Africans for providing 50% of the vaccine used in Lesotho.

The campaigns were such a success that we reached the target of 70% coverage. However, in recent years and for a variety of reasons we are obtaining a statistically low response of animals vaccinated. Animal owners claim that, post-vaccination, animals die and they allege that it is because of the vaccine. An educational programme by holding meetings at villages and schools to show the importance

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of the disease has been embarked upon; videos of rabid animals and informative pamphlets have been distributed and it is hoped that the response will improve.

Campaigns were initially conducted during the winter months, taking advantage of the cold weather in order to keep a free cold chain for the vaccine, but this is the time when viral diseases such as canine distemper and parvovirus are rife among the dog population. This may be why vaccination was reputed to be associated with death of the dogs. A more recent system involves running clinics in the districts, where District Veterinary Officers organise their own programmes and run clinics in various areas with their own staff. This system is slightly more expensive to run, since it needs well maintained cold chain equipment to protect the vaccine. When the animals have been vaccinated the owners are issued with a certificate.

FAT is the test used for rabies confirmation in suspect animals at the Animal Disease Diagnostic Laboratory. Since we continue to work with South Africa in animal disease diagnostics, brain tissue is sent to the Onderstepoort Veterinary Institute for comparative diagnosis.

At present, we have no rabies research programmes. The main objective of the Department of Veterinary Services is to combat rabies by annual dog and cat vaccination campaigns. Inactivated cell culture vaccines are used. The vaccination figures for 1987-1996 are shown in Table 2.

Table 2 : Dogs and cats vaccinated in Lesotho, 1987-1996

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
126400	119879	78974	87685	74850	85894	56885	27780	56594	66113

Rabies control is of high priority in Lesotho, although the budget for all animal disease control is limited. At present, funding from donor organisations for research and development. is urgently needed.
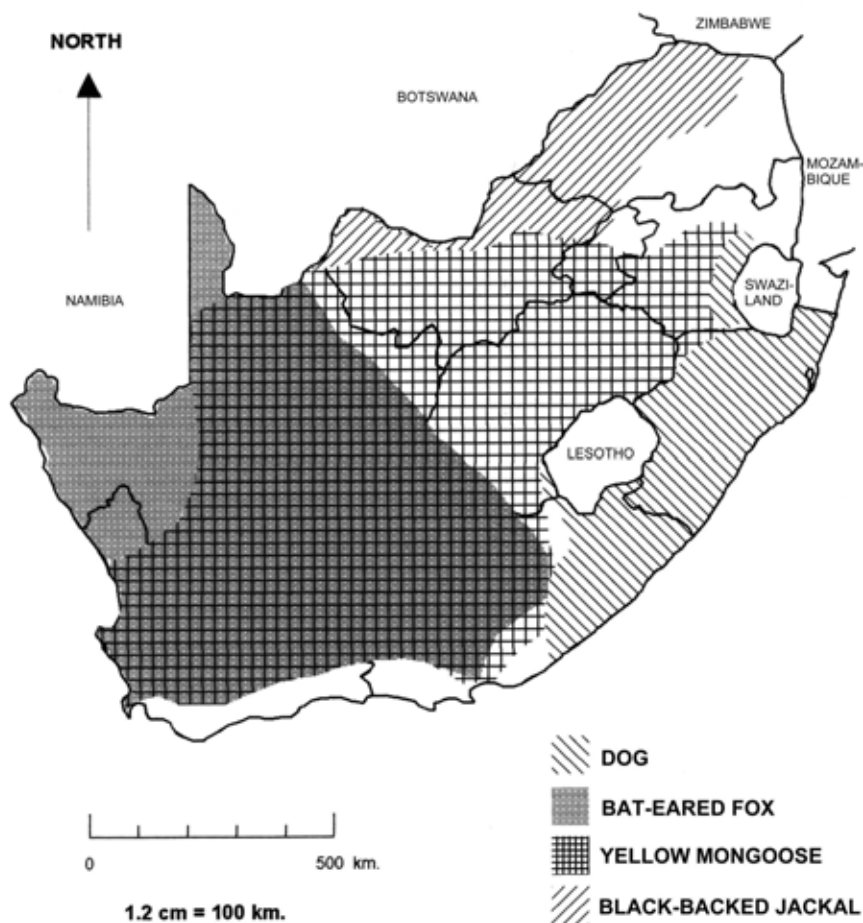
RABIES IN SOUTH AFRICA

George Bishop[14]

1 INTRODUCTION.

Although rabies has probably been present in South Africa for much longer than a century, the disease was first confirmed in 1928. Rabies is endemic throughout the country and Figure 1 is a semi-diagrammatic illustration showing the four principle rabies vectors, viz. the domestic dog, black-backed jackal, yellow mongoose and the bat-eared fox.

Figure 1 : Distribution of rabies in the Republic of South Africa, the main vectors

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2 HUMAN RABIES.

Over the last approximately 20 years, nearly all human rabies fatalities have been attributable to dog bites and dog vaccination remains a very high priority in the prevention of human rabies. However, the influence of the Kwazulu-Natal (KZN) Rabies Action Group (RAG) may have had some effect in reducing the number of human rabies cases from 26 in 1995 to 11 in 1996. A new rabies action policy and improved protocols for pre- and post-exposure treatment of humans were designed for use in this Province by RAG.

3 ANIMAL RABIES.

In 1995, the highest number of animal rabies cases ever recorded in South Africa (793) was reported (Table 1). This dramatic increase was largely attributable to the escalation in the number of dogs diagnosed rabid (340 in 1994, 377 in 1995) in Kwazulu-Natal; this number was paralleled by an increase in the number of human deaths due to rabies from 18 in 1994, to 26 in 1995.

In contrast to 1995, the number of animal and human deaths dropped markedly during 1996, although the distribution of outbreaks does not dramatically reflect the 37% decrease (see Figure 2 and Figure 3) in the overall numbers. Fewer yellow mongoose and black-backed jackal cases were recorded in 1996 compared with the previous year and this may have been due to the very dry conditions which prevailed on the central plateau and the northern regions of South Africa in 1995.

Figure 2 : Rabies cases in South Africa in 1995, all species.
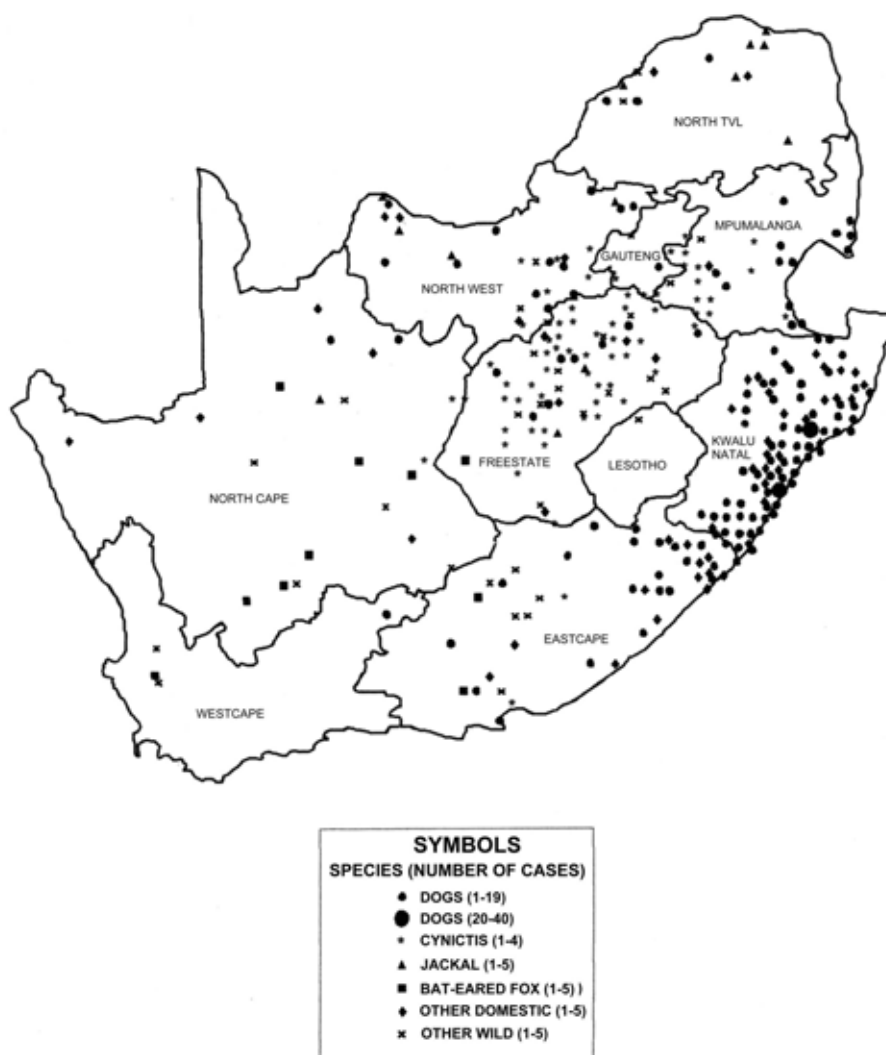
These drought conditions led to animals congregating at water points, thus increasing the chances of rabies spread. The widespread and heavy rains which fell in these areas during 1996 led to improved water availability (with less spread of rabies because of reduced animal densities at water points) and increased ground cover, making the detection of rabid wild animals more difficult. A similar argument can be held for the bat-eared fox where, in contrast to the jackal and yellow mongoose, there was actually an increase in the number of these animals found to be rabid during 1996. The drought continued throughout the years 1995 and 1996 in the western areas of the country where the bat-eared fox is widely distributed.

Figure 3 : Rabies cases in South Africa in 1996, all species.
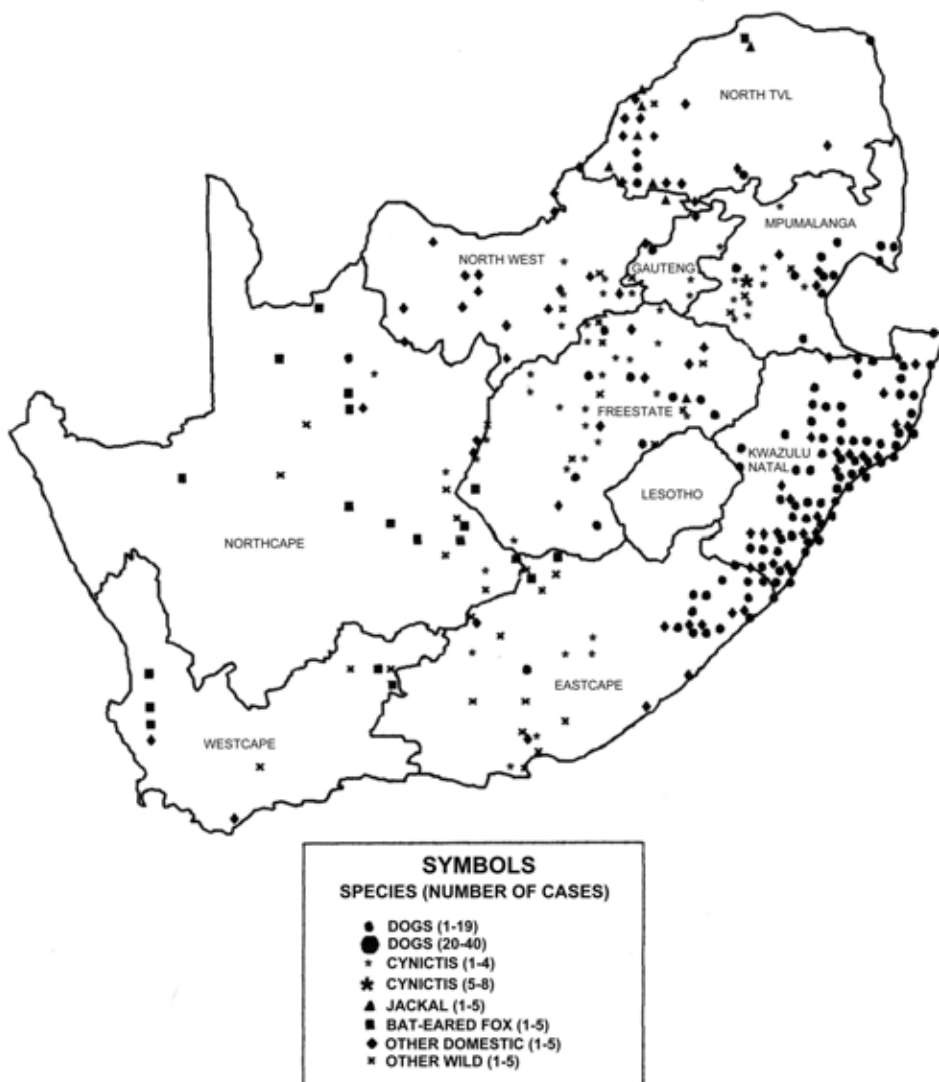
Rabies diagnostic tests are performed at three laboratories in South Africa, viz. the OIE Rabies Reference Laboratory at Onderstepoort in Gauteng, at Allerton Provincial veterinary laboratory in KZN and at the Veterinary Laboratory in Umtata, Eastern Cape. During 1995-1996 these three rabies units diagnosed 566, 629 and 99 rabies cases respectively. As an adjunct to diagnosis at one of these laboratories (Onderstepoort), since 1990 selected isolates have been further examined with a discriminatory panel of monoclonal antibodies. One outcome of this work is that during 1995 and 1996 three isolates, all from cats showing typical signs of rabies, were found to be of Mokola virus. These are the first isolates made of this virus in South Africa since 1970.

In addition, the use of monoclonal antibodies as a means of differentiating the canid from the viverrid strains of Lyssavirus type 1 is of great importance when designing vaccination strategies to combat rabies in South Africa. The detection of a canid strain in a dog population results in a far more vigorous and widespread vaccination campaign than is the case when a viverrid strain is isolated, since experience has shown that viverrid strains are not readily transmitted from canid to canid. It therefore follows

that the finding of a viverrid strain in a dog usually leads to a more localised and less vigorous vaccination campaign reaction on the part of the veterinary authorities.

Table 1 : Animal Rabies in South Africa, 1995-1996

Domestic animals			Wildlife animals		
	1995	**1996**		**1995**	**1996**
Dog	470	257	Jackal	15	9
Cat	19	11	Bat eared fox	11	22
Cattle	125	79	Cape fox	3	0
Sheep	6	2	African wildcat	3	5
Goat	8	9	Yellow mongoose	94	69
Equine	5	0	Water mongoose	2	5
Pig	0	3	Slender mongoose	4	5
Total	**633**	**361**	Small grey mongoose	1	2
			Unidentified mongoose	3	0
			Civet	0	1
			Suricate	13	11
			Small spotted genet	2	1
			Hyrax	0	1
			Serval	2	0
			Aardwolf	3	3
			Badger	1	0
			Ground squirrel	0	2
			Striped polecat	1	0
			Lion	0	1
			Impala	1	0
			Kudu	1	2
			Duiker	0	1
			Total	**160**	**140**

Grand total (1995+1996) : 793+501=1294 animals

Since 1980 the highest number of rabid dogs have consistently been found in KZN, as can be seen in Figure 4. The number of rabies cases which have been documented in this Province since 1976, along with the number of vaccine doses administered to dogs are shown in Figure 5. Over this entire period, dogs have represented 88% of all rabies cases (Figure 6). The number of vaccine doses used over the past 10 years has varied between 300 and 400 thousand. The proportion of dogs vaccinated has exceeded 80% in some areas, whereas in other areas considered as low-risk, dog vaccination has been less than 20%.

Figure 4 : Canine rabies in South Africa and Kwazulu-Natal
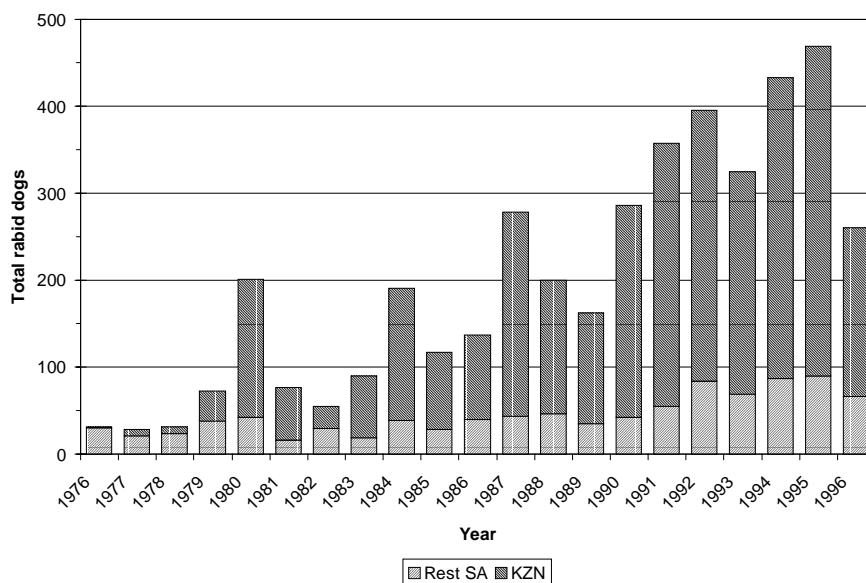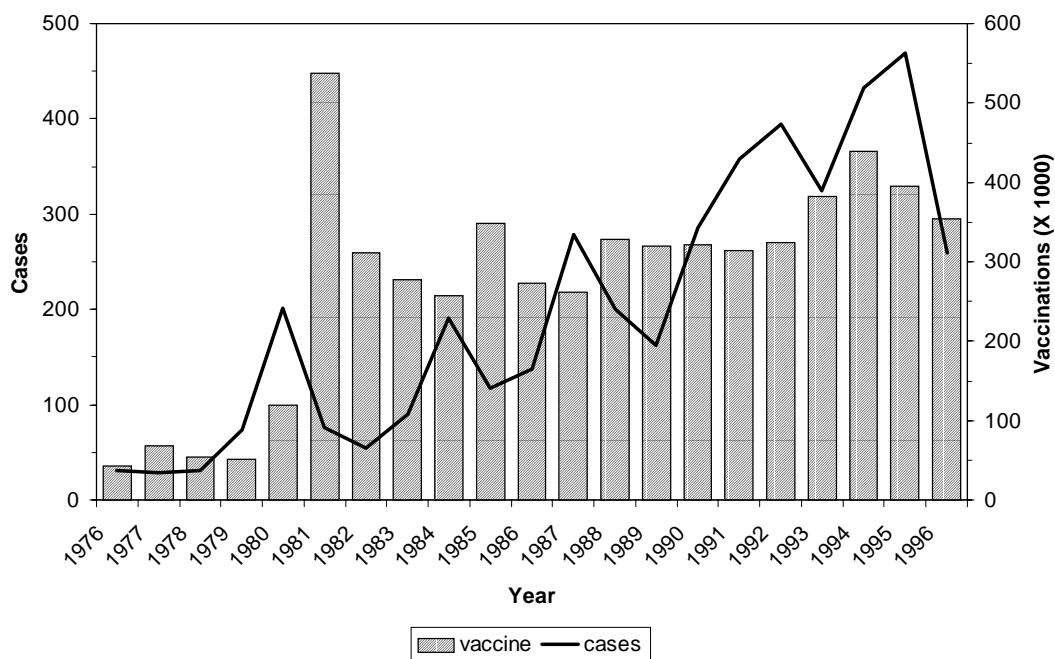

Figure 5 : Dog vaccination and rabies cases

The dramatic decrease in the prevalence of canine rabies in KZN is difficult to explain. Several factors may have played a role :

The cyclical peaks and troughs in rabies prevalence every 3 to 5 years (with corresponding troughs in the intervening years) has been very evident. The lower numbers recorded during 1996 may reflect a trough.

Canine rabies in KZN is influenced by many socio-political factors. There was a marked decrease in violence and civil unrest from mid-1995 onwards. In times of instability and inter-group friction, the vaccination of dogs receives a very low priority rating.

Veterinary control, including rabies vaccination strategies, has improved considerably since the amalgamation of the Natal and Kwazulu Veterinary Departments into a single Directorate at the end of 1994. This led, in turn, to improved co-ordination of effort and a reduction in the number

of administrative (magisterial) districts from 66 to 49. Previously, many Kwazulu districts were further sub-divided into many smaller and separate geographical areas. In practice the number of districts has been more than halved.

A new vaccination strategy and policy were introduced and implemented during 1994. The KZN Veterinary Directorate concentrated its efforts on vaccinating dogs in the rural and peri-urban areas, particularly in those parts of the Province which were identified as rabies "hot-spots". Thus, although our figures reflect a reduction in the number of doses administered in the dog population, the vaccination was probably more effective in controlling rabies. Private practitioners have taken over the responsibility of inoculating urban (city and town) dogs.

We do not believe that the apparent reduction in rabies prevalence can be attributed to poorer surveillance during 1996, since this would have had to occur with both Health and Veterinary Authorities simultaneously. We believe, rather, that there has been a real and genuine lowering of canine rabies in KZN which in turn has resulted in fewer human rabies victims.

Figure 6 : Natal rabies cases 1961-1996
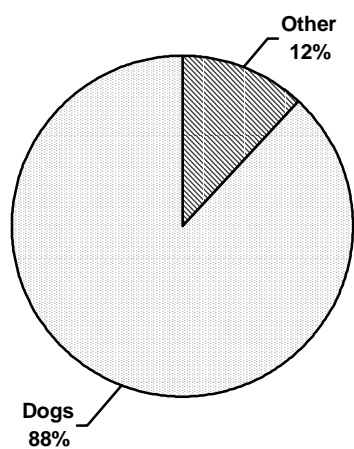
TOTAL of 3990 cases
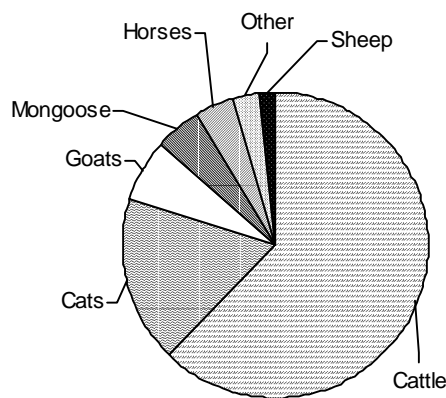
479 Other cases

"Humans not included"

DISCUSSION OF PAPERS

1) Eritrea

- Is it compulsory or voluntary for owners to report suspect dogs?
  It is voluntary, but if in a town and the dog is not reported, police will collect dogs.

- Who does human rabies diagnosis?
  It is done by the Public Health Laboratory Service.

- What were the ages of the human victims which you described?
  These are unknown by me.

- You describe vaccination of 2000 of a population of 5000 dogs, why was the figure so low, was it because of unavailability of vaccine?
  Most of the vaccinations were carried out in towns, vaccination was less satisfactory in rural areas.

- Are the figures accurate?
  Regional centres collect the figures and they are reasonably accurate.

2) Ethiopia

- Who is policing vaccination - is it for humans or for animals?
  Both - at the National Veterinary Institute vaccination is included in our programme.

- When the Ministry of Health takes over, will the Ministry of Agriculture produce animal vaccines and the Ministry of Health produce vaccines for humans?
  If we prevent dog rabies, we'll reduce the need for human vaccines - we'll see how it goes.

- Is the plan to produce sufficient vaccine for all dogs in the country?
  Yes, we hope to have enough capacity. Our current plan is to know how many doses are needed and for the Ministry of Health to produce them, so that vaccine is available upon request.

- Can the Ministry produce enough and if not where does it come from and what is the cover?
  We do not have enough but we will try to produce more.

- What is the scale of doses?
  As far as I know the Ministry of Agriculture orders 15,000 doses, but probably one million are needed. We could have had more but it was not ordered and the vaccine is also now old.

- Should you not do a cost-effective analysis of in-house vaccine production?
  Yes, but the country now has an expensive factory.

- Is vaccination by private practitioners allowed and if so, how is it controlled? Do you vaccinate in rural areas?
  At the moment we have very few private veterinarians and most vaccinations are done in the urban areas.

3) Rwanda

- Has the country infrastructure recovered, do you, for example, have constant electricity?
  At present we wait for samples to come to the Laboratory but we are able to collect when necessary. Electricity is sometimes a problem, but not often.

4) Uganda

- Are the figures accurate?
  We do not have the control that we had in the past so reports are fewer. We have innumerable islands where communications are not as good as on the mainland so yes, we do have some problems.

5) Kenya

- Were you involved with the Nairobi campaign and do you know the results?
  Coverage is not known as we do not know the number of dogs in the area, but we did carry out some publicity beforehand. Nairobi is a complex area and during the school term there is no-one to bring in dogs, so the numbers were low. Its a problem of logistics.

- How do you go about handling a dog-bite case and do you give PET?
  All suspect rabid dogs are killed and the heads should be sent to the Laboratory, although not all come in. PET is the responsibility of the Ministry of Health. Some patients go to private hospitals and may not inform the Veterinary Department. Treatment may be twice as expensive in private hospitals. In some parts of western Kenya where dog bites are common, an incident may be reported to both the veterinary department and the medical centre; the dog owner pays for the vaccination. We are trying to develop a system whereby the dog owner is responsible for the costs of patient treatment. Cases of human rabies used to be submitted to Kabete.

6) Zambia

- As a comment, a round of ammunition is more expensive than a dose of vaccine, but what is the age range of the dogs which you vaccinate?
  Ten to 25 months.

- What percentage of your cases are in wildlife?
  We do not have any wildlife cases.

- How do you allocate imported vaccine?
  Locally produced lamb brain vaccine is usually used.

- You only treat humans after the Laboratory result is obtained?
  I recommend PET for all human cases but if the dog is available then yes, we commence treatment when we know the result.

- As a further comment (from Dr. de Balogh), when I was in Zambia there was no government PET available so patients went private.

7) Malawi : No questions.

8) Mozambique

- Does the Ministry of Health have a policy on how to handle victims of dog bites?
  Yes, the Ministry indicates where the dog is and we take measures to capture the dog and retain it for ten days.

- Every dog?
  Yes, every dog.

9) Zimbabwe

- To what extent were practitioners able to prove ante-mortem cases?
  About 50% - it is easier to do for cultural reasons.

- There was a decrease in the number of cases in 1992 - what happened?
  In the 1980s there was greater awareness of the disease but in the 1990s patients turned up at the hospitals but went away as there was no treatment available; there were clinically confirmed cases but we had trouble getting specimens.

10) Swaziland

- Is vaccination confined to dogs taken to the dip-tanks?
  No, the vaccination teams move from homestead to homestead. In the cities they report to main offices for counting - the figures are reliable.

- How do you manage such a high percentage of vaccinations?
  It is structure and strategy, everyone has to report to the Chief - but we are a small country so it is not difficult.

- What further can you say about the case of six puppies which died but the bitch survived?
  In some cases we have had to treat 9 or 10 people exposed to a single puppy.

- Comment (by Dr. Wandeler): The dam may be protected by cellular immunity but there is not much antibody passed to the puppies; transfer of antibody in milk is too poor to protect puppies.

- Comment (by Dr. Fekadu): At the CDC Atlanta, some dogs recovered showing high serum and CSF antibody titres, but the puppies were not protected.

- Why do you still have such a lot of dog rabies despite high vaccine coverage? Is coverage not as good as claimed, is the vaccine out-of-date, is there a cold-chain problem?
  It is probably because of a very high dog population turnover.

11) Lesotho

- At the last meeting (1995) no rabies was reported in Lesotho for the previous three years but now you have reported human cases, is this the total?
  We now report cases from all areas.

- What are the morbidity figures?
  These are cases which were diagnosed on clinical grounds alone.

12) South Africa

- Why do you show on your map one mongoose case in Lesotho?
  Apologies, this was a cartographic error.

- Can you explain what is meant by viverrid virus in dogs - do you have rabies in monkeys?
  The viverrid viruses are mostly of mongoose origin, which occasionally spill-over into other species; we have had no reports of rabies in vervet monkeys.

- Can you be more specific about control strategies when you find a viverrid virus in a canine - do you wait until you get a result?
  Yes, but we can get a result in a couple of hours.

- Dog cases in places other than Kwazulu-Natal, are they dog-to-dog transmission?
  We have little dog-to-dog transmission in places other than Kwazulu-Natal, but we do have the possibility of other canid transmission, for example, from jackal and bat-eared fox and of course we do have some viverrid-to-dog transmission cases.

- In areas where you vaccinate 88% of dogs, do you win?
  Even if you vaccinate 120% of the dogs, you don't get on top of it unless you vaccinate three or four times!

GENERAL DISCUSSION

A number of topics were proposed for round table discussion, some of which were postponed until later discussion sessions, whilst others were dealt with in depth:

1) **Presenting data :** Data presentation varies so much from country to country, how can we obtain more reliable data? What we need is improved surveillance to understand the pattern of disease. Most data presented is collected from clinics or from wherever diagnosis is carried out. Some useful data can be collected from these places since post-mortem results yield positive data, but when it comes to special cases good data is often lacking.

- **Dr. Perry** : There are two issues here, the standard of reporting is still disappointingly haphazard. Also, the use of active surveillance, as in Machakos, rather than passive surveillance, as reported by most countries, makes a dramatic difference but requires special funding.

- **Dr. McDermott** : Active surveillance needs to be designed to show what should be done to attract funds. You must do vaccinations properly - target the vaccinations.

- **Dr: Wandeler** : I would like to see some active surveillance promoted and not just wait for samples to arrive at the Laboratory; Zimbabwe does it beautifully. You can have different tiers of surveillance, you need targeted active surveillance and can use the data for many years. Public education is important.

2) **Collaboration between Veterinary and Medical Professions :** One paper dealt with co-operation between veterinarians and physicians - we need to have a better system of knowing who does what.

- **Dr. Ndaomba** : Who does the policing of, for example, how many dogs/household; one of the problems is that we do not know how many dogs we have but this information is needed in order to put proper measures into place.

- **Dr. Perry** : The issues are slightly different. Throughout our region most countries are strapped for cash and it is difficult to cross-administer disease. How do Uganda and South Africa do this - do you have special individuals?

- **Dr. Bishop** : Yes, you do have to have individuals who are enthusiastic and almost specifically interested in rabies. If you can focus on needs, then you can cross administrative boundaries. Another view is that we are looking at reactivity to the laws that are in place.

- **Dr. Wandeler** : How do you get veterinarians and physicians to talk to each other? There are certain constraints, priorities are different and it takes a lot of time and effort to get people to change.

- **Dr. Bishop** : Getting the right people is important. Maybe its having the right structure - as was established by the WHO. The trend of public health is to move towards public education of why they need to look after the animals.

- **Dr. Kaboyo** : I am the only veterinarian in the Ministry of Public Health in Uganda. Help is not the need of the medical profession alone. We now need a much stronger structure of co-operation between veterinary and public heath bodies - many physicians have never seen a case of rabies and they need education in this matter - they know all about malaria, AIDS, Ebola etc. There must be a veterinarian in the battleground, good will is not enough.

3) The link between dogs and vaccine availability :

- **Dr. McDermott** : There is at present no link between the number of dogs and amount of vaccine available. When vaccine is purchased, some areas get too little and some get too much. We need a better system of targeting, especially in countries where funding is limited - we should target and explore routes of going back several times to vaccinate 'hot-spots' and do less where there is no rabies.

- **Dr. Perry** : Yes, we should, although targeting is not a new phenomenon. You must have a good surveillance system in place before you can target.

Human rabies : Opportunities for improved surveillance and control

HUMAN RABIES DIAGNOSIS AND REPORTING : CAN WE DO BETTER?

Alexander I. Wandeler[15]

World-wide an estimated 30000 to 60000 people die of rabies every year. Almost all human rabies deaths and the vast majority of treatments after bite exposures occur in developing countries (Acha and Arambulo, 1985), in areas where dog rabies is prevalent (Baer and Wandeler, 1987). The highest figures come from South and Southeast Asia, where the annual exposure to dog bites is between 0.1 and 1 percent of the population. Not all biting dogs are infected with rabies, and not all bites by rabid dogs lead to clinical rabies in the bite victim. Still, up to 4 human rabies deaths per 100000 inhabitants are recorded in some areas (Wandeler et al., 1988; 1993).

The figures for African countries are considerably lower (WHO, 1983; World Survey of Rabies; SEARG country reports). This low incidence of human rabies infection could have a number of causes such as a lower prevalence in the animal reservoir, superior avoidance of infectious contacts, or better access to proper post-exposure prophylaxis. However, there is also the suspicion that the figures do not always reflect the true prevalence of human rabies. Rabies deaths escape registration for the following reasons :

> ➢ the proper diagnosis is not made,

> ➢ causes of death are not differentiated sufficiently, for example recorded as "natural cause" if it is not an accident or homicide,

> ➢ causes of death are recorded locally, but not transmitted to a central registry,

> ➢ causes of death are not recorded at all.

1 DIAGNOSIS.

A patient with a rapidly progressing neurologic disorder may be admitted to a hospital, if time, logistics and economic circumstances permit. The hospital is not only the place where palliative care could be provided, it is also the institution where case histories should be recorded and professional diagnostic efforts must be conducted. However, recognising the inevitable outcome of the illness, a family may also choose to keep the poor victim in its familiar surroundings at home. In that case the cause of death may never find its way into official statistics.

For the hospital patient with an acute neurological disorder, a diagnosis may be based on clinical observations and patient history and it may include results of laboratory tests. The clinical symptoms of rabies in humans include phobic spasms (hydrophobia), inspiratory spasms, agitation and confusion alternating with lucid periods, and increasing autonomic dysfunctions. The symptoms are quite variable (Fishbein, 1991; Warrell and Warrell, 1988). Some authors distinguish between encephalitic (furious) and paralytic manifestations. Death usually occurs within a few days after the onset of symptoms. If such symptoms concur with a history of an animal bite in recent weeks or months, then the clinical diagnosis of rabies is justified. However, the typical history and symptoms are not always present and clinical diagnosis can be difficult. All rapidly progressing disorders of the central nervous system are suspicious and should, if no other etiology is obvious, be submitted for laboratory investigations (WHO, 1992).

Intra-vitam laboratory confirmations are not totally reliable. Viral antigen can sometimes be detected with immunofluorescence in frozen sections of small biopsies of well-innervated skin, less frequently in impression smears of cornea. Saliva samples may yield infectious virus. Such investigations require easy access to laboratories that are properly equipped.

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Ideally, every suspected rabies death should be confirmed by a laboratory examination. The laboratory diagnostician would prefer receiving whole brains or well identifiable parts such as brain stem and hippocampus. If a necropsy cannot be performed, it might still be feasible to recover a small brain using "biopsy" technology after the death of the patient. The tissues should be submitted frozen or refrigerated for diagnosis by immunofluorescence and virus isolation. Small pieces of brain and biopsy material may also be transported at ambient temperature in buffered glycerol saline. One must keep in mind that antigenicity and infectivity of rabies virus is not preserved indefinitely in glycerol. It is a recommended practice to conserve a part of the specimen in formalin and to submit this along with the frozen, refrigerated, or glycerol preserved material. The formalin fixed brain tissue can be used for histology and immunohistochemical procedures, if the other material has deteriorated during transport. Negri bodies in neurones can be detected in histological sections of about 80% of all rabies infected brains. Considerably more sensitive is immunohistochemistry (Bourgon and Charlton, 1987; Feiden et al., 1988), but this requires a specialised laboratory. Molecular techniques such as PCR are presently not recommended for routine laboratory diagnosis of rabies.

To recover post mortem brain tissue from all suspect cases is not possible. It is probably fair to assume that for the vast majority of rabies casualties in Africa, no material is ever submitted to a diagnostic laboratory. There are too many cultural and logistic barriers. This points to the importance of making a diagnosis on grounds of the case history and clinical symptoms.

2 SURVEILLANCE, REPORTING AND RECORDING.

The problem of rabies surveillance has numerous aspects. Questions of appropriate sampling, methods of diagnosis based on clinical symptoms or laboratory findings, logistics of submission to diagnostic laboratories and of data management and analysis need to be answered. Human rabies cases and suspected cases can be recorded retrospectively by interviewing family members, physicians and public health workers. However, prevalence and incidence rates and their geographic and temporal variation cannot be efficiently studied by random sampling.

Serological surveys for rabies antibodies are not useful. Rabies antibodies are usually the result of previous vaccinations. Only in very rare instances does the presence of antibodies reflect survival of clinical or abortive infection.

It is useful to categorise rabies case in humans according to certainty of diagnosis. The following terminology is recommended (WHO, 1997) :

> ➢ Suspected: a case that is compatible with the clinical description
>
> ➢ Probable: a case that is compatible with the clinical description and a history of contact with a (suspected) rabid animal
>
> ➢ Confirmed: a case that is laboratory-confirmed.

It is obvious that the vast majority of African cases fall into categories 1 and 2. It must be suspected that a fair number of cases with unclear symptoms and histories escape the correct diagnosis.

Rabies is a notifiable disease in most countries. Cases are reported through administrative channels to a national centre, which receives, stores and evaluates data. This office reports to the Ministry of Health, and forwards data to neighbouring countries and international organisations. The processed data are important information for use in planning and management of rabies prevention programs. The rabies data analysis cannot stand alone. It must be part of general health service analysis and administration. Lippeveld et al. (1997) describe how health information systems should work, what requirements they should fulfil, what their most frequent deficiencies are and how these can be addressed. Managerial and technical guidelines are available from WHO (WHO 1983; 1990; 1992; 1997).

3 SHOULD WE DO BETTER?

"Africa is caught in a downward spiral in which the poor health of the population is undermining economic performance, and the resulting poverty means there is less and less being spent on health care" (Anonymous, 1997). Unfortunately it is difficult to contradict this pessimistic prognosis that is reinforced by daily news on self- aggrandising political leaders, intolerance, and warfare. However, pessimism is not a useful attitude if one tries to improve a situation.

Bite incidents that come to the attention of a hospital, physician, or another public health institution must be investigated. Names and addresses of all bite victims should be recorded. The investigation should also include serious non-bite exposures following WHO guidelines (1992; 1997). If the epidemiological inquiry suggests that the biting animal might have had rabies, then all victims should receive post-exposure treatment. The well-being of all recorded contacts should be checked at timely intervals. This suggestion sounds straight forward. However, what does a physician or a nurse do who has insufficient resources, limited amounts of vaccine, no antiserum or immunoglobulin, and a number of other problems at hand?

The next immediate question is, why do we bother about rabies at all, when AIDS, malaria, tuberculosis, malnutrition, etc., are much more prevalent, and urgently require more attention. A number of arguments speak for investing at least some resources into the rabies problem. The number of people exposed to suspected rabid animals is high. In theory all people seriously exposed should receive post-exposure treatment. Proper post-exposure treatment is expensive. These costs should not be overlooked (Bögel and Motschwiller, 1986; Bögel and Meslin, 1990). It is imperative to have data on post-exposure treatments and human rabies cases for substantiating that favourable cost-benefit ratios justify rabies control programs. Last, but not least, international organisations such as WHO and OIE dedicate some attention to rabies problems. Data and facts are required in order to receive support. In today's world of diminishing resources it is imperative to have relevant, complete and timely information for attracting sponsor support.

The frequency of exposure and post-exposure treatment and incidence and/or prevalence rates of human rabies are essential components for health care and disease control planning.

4 CAN WE DO BETTER?

There are a number of different aspects to this question. The answer to the technical aspects is "yes". The components of good surveillance encompass public education, community participation, case recognition (diagnosis) and case registration in central morbidity and mortality statistics. There are numerous guidelines available on how these components should be addressed. However, their execution is constrained by cultural, economical and logistical factors. Implementation aspects reduce the answer to the title question to a "maybe".

There are ways to overcome some of the constraints. "Verbal autopsies" have worked fairly well in Africa (Asuzu et al., 1996). The technique can be used for establishing causes of mortality. One has to keep in mind that random sampling is probably not useful for assessing human rabies mortality rates. This would require exceedingly large sample sizes. The minimum number of suspected and probable cases should be estimated by special inquiries. By interviewing town and hospital officials, public health workers, healers, etc. one obtains the location of families, households, foci, etc., that experienced a possible rabies death within the past twelve months. Interviews are then conducted in these places in order to substantiate the diagnosis. One has to keep in mind that such inquiries must be conducted in ways that respect privacy rights.

Exposures to potentially rabid animals are much more frequent than actual human rabies deaths. The frequency of bite incidents and the procedures used for treating animal bites can easily be obtained by using established questionnaire survey methods (WHO, 1983; De Balogh et al., 1993). Questionnaire surveys for collecting information on rabies epidemiology may well be adequate thesis projects for students of epidemiology and public health.

It is certainly a basic demand that rabies prophylaxis, surveillance and control are incorporated into general health services. Public health education must be provided in parallel with the delivery of these services. With respect to rabies, improvement of public awareness of the following appears to be important :

> rabies as a cause of death

> epidemiology, rabies transmission, principal hosts, clinical signs in animals

> prophylaxis and post-exposure treatment

> necessity to report to government authorities

The rabies situation in Africa can and should be improved despite the fact that it may not be considered first priority. If information on rabies is provided in conjunction with health education in general, then we may be able to reduce the frequency of exposures, improve proper therapeutic behaviour

after exposure, and ameliorate reporting to health authorities. This will in turn facilitate the planning of rabies control programmes and assist the application for funding. The article (Anonymous, 1997) from which the pessimistic forecast was quoted above ends with the following statement: ... 'given political will and true commitment of countries across the Region, there is no reason why these goals should not be reached, and the deteriorating health situation in Africa reversed.'

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INTRADERMAL APPLICATION OF MODERN (CELL-CULTURE AND EMBRYONATING EGG) RABIES VACCINES FOR HUMAN RABIES POST-EXPOSURE TREATMENT
(SUMMARY)

F.X. Meslin[16]

1 INTRODUCTION.

In developing countries, where more than 99% of all human rabies deaths occur, nervous tissue anti-rabies vaccines are still the most widely used because of their relatively low cost and despite their variable potency and the risk of neurological complications. The supplies of modern and safe vaccines for many developing countries are grossly inadequate whereas the demand for affordable and safe human post-exposure treatment (PET) is increasing in the developing world. Although the costs of modern vaccines are decreasing, the current price of a full intramuscular vaccine treatment is far beyond what an average family in Africa or Asia can afford.

Multi-site intradermal administration of small doses of cell culture rabies vaccines which have been shown to protect humans bitten by proven rabid animals and to reduce the costs of PET by 60%, is an effective way of decreasing the cost of these much more potent, safe modern vaccines, and of increasing the neutralising antibody response. In many developing countries, however, rabies vaccines are being given intradermally under inappropriate conditions and according to regimens whose efficacy is unproven.

A WHO Expert Committee held in 1991 recommended intradermal application of modern rabies vaccines. This recommendation was re-assessed in January 1992 and re-evaluated by 2 WHO consultations in 1995 and 1996. A WHO document entitled «WHO recommendations on rabies post-exposure treatment and the correct technique of intradermal immunisation against rabies» was published in 1996. This document (WHO/EMC/ZOO.96.6) updates and supersedes the recommendations of the 8th report of the Expert Committee on Rabies published in 1992 (TRS 824) on PET.

2 RECOMMENDED INTRADERMAL REGIMENS.

An "ideal" vaccine regimen for PET should require a minimum quantity of vaccine, few visits to the clinic and rapid induction of immunity. These features need to be combined to produce an economical, efficient, safe regimen.

The TRC 222011 and the 804011 regimens have fulfilled these requirements. They have been used in restricted areas, mainly by experienced personnel. From 1985 to 1994 however approximately 70 000 TRC intradermal regimens where given in Thailand with more than 29 000 in category 3 exposure.

The 2-site intradermal method (222011) for use with purified vero cell rabies vaccine (PVRV), with purified chick embryo cell vaccine (PCECV) and purified duck embryo vaccine (PDEV) consists of injecting one intradermal dose at each of 2 sites on day 0,3,7 and a single site on day 28 and 90; the intradermal dose per site is one fifth of the volume after reconstitution of a single immunising intramuscular dose, i.e. the intradermal dose is 0.1 ml/site for PVRV; and the intradermal dose is 0.2 ml/site for PCEC and PDEV. PDEV should become available in 0.5 ml after reconstitution in 1998.

The 8-site (804011) regimen for use with human diploid cell (HDC) and PCEC vaccines where intramuscular dose is 1ml consists of injecting on the first day, 1 ml of vaccine divided between 8 intradermal sites (deltoids, anterior thighs, supra scapular and lower quadrant of the abdo-

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men); and on day 7, 4 x 0.1 ml intradermal injections (deltoids and thighs), and single 0.1 ml intradermal boosters on days 28 and 90.

3 WHO GUIDELINES.

WHO has recently published precise instructions on the currently recognised methods of intradermal vaccination, to make optimum use of restricted resources, and on precautions to be taken to prevent vaccine contamination from multidose vials, as well as viral cross-infection. The guidelines also provide new information on the use of immunoglobulin and other aspects of rabies PET.

These guidelines provide up-dated knowledge of the correct methods of using modern tissue culture and embryonating egg vaccines intradermally which is very poor in tropical areas with endemic dog rabies, where exposure to rabid animals is frequent, vaccine is scarce, there is little money and no RIG available. Under these conditions the WHO document aims at preventing the use of a variety of untested, potentially dangerous intradermal regimens which are being used in some places. As mentioned before the only regimens which have been demonstrated to be immunogenic today are the 222011 and the 804011

The volume of the standard intramuscular dose varies between different products, and some producers are in the process of changing from a 1 ml to an 0.5 ml ampoule. Attention should therefore be paid to the volume of the product after reconstitution.

These guidelines should be suitable for distribution to large and small clinics and rural health centres and to government organisations deciding on vaccine policies.

4 FUTURE RESEARCH.

There is a need for (a) new intradermal vaccine regimen(s) using products formulated in 0.5 ml vials. Immunogenicity studies in non-exposed volunteers must identify a satisfactory regimen before efficacy is tested in patients needing PET.

-The immunogenicity of a regimen beginning with 4-site intradermal injections (0.1 ml/site), e.g. 40202 (days 0-7-28) using the entire 0.5 ml vial on day 0 should be studied.

-The effect of smaller doses (0.05 ml/site) in 8 sites, still using one 0.5 ml vial on day 0, could be investigated. The 8-site intradermal PET regimen has only been tested with HDCV and PCEC in 1 ml vials.

-The value of giving a final injection on day 90 should be tested.

5 CONCLUSIONS.

Implementing intradermal methods for PET would increase the use of PET globally. It was emphasised that these regimens are of comparable immunogenicity to the intramuscular regimen and very much more effective and safer than vaccines of nervous tissue origin. There is no contraindication to the use of an intradermal regimen.

The decision to implement economical intradermal PET rests with government agencies which select policies for rabies prophylaxis in their own countries. Dissemination of information from such an authority by instruction of physicians, nurses and other health care workers is very important. Local or regional advisers, who could be contacted easily to give practical advice, would enhance the acceptance of the new methods.

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RABIES POLICY AND POST-EXPOSURE PROTO-COLS IN SOUTH AFRICA.

A. Robinson[17]

1 INTRODUCTION.

In South Africa, KwaZulu-Natal Province is the focus of a serious canine rabies problem and only timely and correct preventive management of patients and animals will significantly decrease the current rabies mortality. Until recently there has been a variety of confusing rabies policies in circulation, which has led to an urgent need for a single, user-friendly up-to-date policy for the Province.

The KwaZulu-Natal Province Rabies Policy

The aim of the policy is to eradicate rabies from the Province by providing a clear, statutory framework wherein both the public and health care professionals are educated about rabies control measures, correct human post-exposure treatment is given at every point of first clinical contact and the correct management of suspect rabid animals is carried out.

Policy objectives are realised by the establishment of effective Rabies Action Groups (RAGs) in every region of the Province. These groups comprise medical, veterinary, education, police, local authority and district officers and/or any other officers with rabies control capabilities.

2 GENERAL PRINCIPLES OF RABIES TREATMENT AT PRIMARY HEALTH CARE CENTRES.

Since arrangements for the provision of rabies treatment may vary in different provinces and may be changed from time to time, it is important to be familiar with local practices. If rabies vaccine and immunoglobulin are not kept at the local clinic/centre, one must find out from the pharmacist at the referral hospital what the correct procedure is: whether it will be supplied on demand, or whether patients should be referred to another facility for treatment. Information, including a contact telephone number, should be recorded.

2.1 Pre-exposure prophylaxis.

People who have occupational risk of exposure to infection, such as veterinary officials and staff of animal welfare organisations, should be given preventive pre-exposure immunisation, at the expense of either their employers or of themselves. One dose of vaccine is administered intramuscularly on days 0, 7 and 28. A single booster is given every 2-3 years, and such pre-immunised individuals are given only two boosters after a specific incident of exposure to infection, as described below.

2.2 Post-exposure prophylactic treatment.

Post-exposure treatment is aimed at preventing infection from becoming established in a person who has been bitten by a rabid animal by cleaning the wound and immunising the patient. Anti-rabies immunoglobulin is used to provide immediate passive protection and active immunity is stimulated by administering a course of vaccination. There is no effective treatment once patients develop clinical symptoms of the disease.

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2.3 Determining the risk of exposure to infection.

It is the duty of the local veterinary official (State Veterinarian or Animal Health Inspector, or private veterinary practitioners under contract in certain parts of KwaZulu-Natal) to investigate the circumstances under which the potential exposure occurred, if necessary to kill the animal involved, to take and submit specimens for laboratory examination to confirm a diagnosis of rabies and to report the findings to the medical personnel responsible for treating the patient.

If the animal to which a patient has been exposed has not been tested at a veterinary laboratory and confirmed as having rabies, but has made an unprovoked attack, or exhibited abnormal behaviour (not necessarily furious), or has not been vaccinated against rabies, or is of unknown vaccination status, or has no known owner and has not been caught and killed for examination, or if the specimens taken for examination are unsuitable (decomposed for example), then it must be presumed that the animal has rabies.

In certain circumstances veterinary officials may rule that a cat or a dog which has attacked a patient but appears to be healthy (particularly if it has been previously vaccinated against rabies and/or is in an area where rabies is not known to be active) can be confined and kept under observation for 10 days. However, sick animals should be killed for examination if a suspicion of rabies exists.

If it is known, or presumed on the basis of the above criteria, that the animal involved has rabies, then the risk to the patient and the correct course of action to be followed must be assessed according to the following Table :

Table 1 : Categories of risk from a rabies exposure

Risk category	Type of exposure	Action to be taken
I	Touching/feeding animal Licking of intact skin	Nil if history reliable
II	Nibbling of uncovered skin Superficial scratch, no bleeding Licking of broken skin	Administer vaccine without anti-rabies immuno-globulin Stop vaccination if animal negative in laboratory tests, or remains healthy after 10 days observation (dog or cat)
III	Bite/scratches which penetrate the skin and draw blood Licking of mucous membranes	Apply wound treatment Administer antitetanus and antibiotic treatment Administer anti-rabies immunoglobulin and vaccine Stop vaccination if animal rabies negative in laboratory tests, or remains healthy after 10 days observation (dog or cat)

2.4 Wound treatment.

Apply wound treatment as soon as possible after a person has been bitten by an animal, whether or not immunoglobulin and vaccine is available.

Cleanse and flush the wound thoroughly with copious soapy or clean water, or a surgical preparation, e.g. 1 in 20 dilution of 5% chlorhexidine or quaternary ammonium compound (Cetrimide) in water.

Apply disinfectant - tincture of iodine, povidone or aqueous iodine (Betadine, Zepharin) or 70 % alcohol.

Avoid suturing if possible.

Administer tetanus toxoid adsorbed vaccine (0.5ml intramuscularly).

Administer antibiotic as considered necessary, for example phenoxymethylpenicillin Pen VK) 500mg (children 25mg/kg) every 6 hours for 5 days.

Administer anti-rabies immunoglobulin as described below.

2.5 Human anti-rabies immunoglobulin.

This is supplied in 2ml ampoules (containing 300IU antibody), and the dosage is 20IU/kg body weight. To determine the correct dose, use the formula Body weight x 0.13 dose in ml. The dosage must never be exceeded. The immunoglobulin must be administered on day 0 only, that is, the day on which the treatment is started. Infiltrate all of the dose of immunoglobulin into the depth of and around the wound if anatomically possible; otherwise administer the remains of the dose by deep intramuscular injection into the buttock.

2.6 Vaccines.

Rabies vaccines registered for use in South Africa are purified, inactivated, safe and effective, and can be used in pregnant women and infants. The volume of a dose of rabies vaccine may vary (0.5-1.0ml) with different manufacturers, but all vaccines conform to a fixed potency standard; that is, they contain a set amount of virus antigen and can be used interchangeably. Cold chain practices must be observed in the handling and storage of rabies vaccine and immunoglobulin, and vaccine must be used on the day on which it is reconstituted.

2.7 Immunisation schedules.

One dose of vaccine is administered intramuscularly (into the deltoid in adults, and anterolateral thigh in infants - never into the buttock) on days 0, 3, 7, 14 and 30 (plus day 90 if immunoglobulin has been given on day 0). The complete course of treatment therefore involves either 5 or 6 doses of vaccine. The first dose of vaccine should be doubled (one dose into each deltoid) if the start of treatment has been delayed for 48 hours or more after the exposure to infection occurred, or if the patient is immunocompromised (has HIV for instance), or is malnourished, or suffers from chronic disease (tuberculosis, cirrhosis), or is taking anti-malarials (chloroquine).

Any person who has received a full course of preventive pre-exposure immunisation, or post-exposure treatment within the previous five years, and has been exposed to infection, should receive only a single dose of vaccine intramuscularly on day 0 plus a second dose ±3 days later. No immunoglobulin must be given - this interferes with the rapid antibody response which occurs in people who have been previously immunised.

2.8 Notification of rabies treatment.

Rabies is a notifiable disease, and after a course of treatment for exposure to the disease has been completed the incident should be reported on the prescribed form (currently GW17/7).

2.9 Rabies information hot-line telephone service.

Primary health care workers should not deviate from any of the above recommendations or dosage schedules, but in KwaZulu-Natal anybody, including members of the public, can obtain advice on various aspects of the disease at one of the rabies information hot-line telephone numbers. After proper consultation with an expert on a hot-line, medical staff at referral centres may use reduced dosage schedules of vaccination and a non-intramuscular route of administration, but only in certain unusual circumstances.

3 MANAGEMENT OF THE HUMAN CONTACT. (see Appendix 1 for flow diagram).

In every dog bite incident, the possibility of rabies must be assessed and the dog must be assumed rabid until proven otherwise. If the suspect animal cannot be caught, found, is unidentifiable or if its brain is damaged and unsuitable for examination, it must be assumed that the bite was from a rabid animal.

a) A thorough history of the contact circumstances must be recorded by:

   i) completing the suspect rabid animal incident report form (Appendix 3) and the treatment report on a person exposed to rabies form (Appendix 4)

   ii) assessing the likelihood of rabies as high or low by completing rabies evaluation report (Appendix 2). If the likelihood of rabies is assessed as high, rabies treatment must commence immediately.

b) Examine the patient and categorise the exposure according to Table 1:

c) Wound management.

   i) Thoroughly clean the wound by one of the following methods:

   (1) Soap and water for 5 minutes

   (2) 40 - 70% Alcohol

   (3) Povidone iodine (Betadine)

   (4) Aqueous iodine 0,01% (Zepharin)

   (5) Quaternary Ammonium Compound (Cetrimide)

   ii) No primary suture of wound. Sensible haemostasis but no compressive dressing - the wound must be allowed to drain.

   iii) Administer tetanus toxoid.

d) Vaccine therapy

Table 2 : Treatment of Patient

Within 48 hrs of attack / exposure	48 hrs or more after attack / exposure	Previously immunised patient	Immuno compromised patient
Single dose* on day 0,3,7,14, 28 (90)**	Double dose* on day 0 Single dose on day 3, 7,14, 28	Vaccination within 5 years Single dose on day 0 and 3 only No R.I.G.	If patient HIV positive; malnourished; chronic disease (e.g. T.B.) on anti-malarial Rx: treat same as if 48 hour or more after exposure

*intra muscular injection into deltoid in adults or anterior thigh for infants, not gluteal.

** if RIG on day 0

e) Human anti-rabies immunoglobulin (R.I.G.): each 2 ml ampoule contains 150 iu/ml = 300 iu/ampoule:

NB : R.I.G. must always be given at same time as vaccine (always after the first dose of vaccine) but omitted if vaccine was administered more than 14 days previously.

DOSE : 20 iu per kg body weight.

ROUTE : Half of the dose i/m into the gluteus muscle

Half of the dose infiltrated into and around the wound site if clinically   possible (if not, inject the remainder into the gluteus muscle)

When presented with a patient (clinically or telephonically), complete the following questionnaire (Table 3) to guide your management:

Table 3 : Guide to management of the human contact

#	Question	YES	NO	??	#	Question	YES	NO	??
1	Was the dog apparently healthy when the exposure occurred?		▨	▨	14	Any change in behaviour?	▨		▨
2	Is the dog at present still in good health?		▨	▨	15	Was the dog thin and apparently starving?	▨		▨
3	Is the owner of the dog known?		▨	▨	16	Was the dog making abnormal sounds?	▨		▨
4	Are the present whereabouts of the dog known?		▨	▨	17	Did the dog appear to be unable to swallow?	▨		▨
5	Has the dog been vaccinated against rabies?		▨	▨	18	Did the dog react abnormally to stimulation or being approached?	▨		▨
6	Was the dog defending the owner's property/territory?		▨	▨	19	Was the dog snapping at (imaginary) flies?	▨		▨
7	Was the dog provoked to bite or snap?		▨	▨	20	Did the dog have a slack lower jaw?	▨		▨
8	Has the dog been destroyed?	▨		▨	21	Did the dog have a "vacant look" in its eyes?	▨		▨
9	Was the dog's brain removed for examination?	▨		▨	22	Was the dog salivating?	▨		▨
10	Was the dog attacked by resident dogs on the property?	▨		▨	23	Did the dog stagger or appear inco-ordinated or lame?	▨		▨
11	Was the dog a stray?	▨		▨	24	Was the dog biting itself or foreign objects?	▨		▨
12	Was the dog abnormal in any of the ways referred to below?	▨		▨	25	Is rabies prevalent now in the area where the bite took place?	▨		▨
13	Was the dog obviously sick?	▨		▨	26	Was the dog involved in a fight during the past 4 months?	▨		▨

If any shaded block is marked:

Start treatment immediately

Report incident to Veterinary Dept or Health Authority or SA Police Services in the area of jurisdiction **who must report back to you within 48 hours** (see Appendix 3).

LIKELIHOOD OF RABIES ASSESSED AS: | **HIGH** | **LOW**

SIGNATURE OF PATIENT/GUARDIAN.
DATE:

Y	Y	M	M	D	D

4 MANAGEMENT OF THE SUSPECT RABID ANIMAL INVOLVED IN HUMAN EXPOSURE. (see

Appendix 1 for flow diagram)

IMPORTANT: management of the biting animal must never delay the appropriate treatment of the human contact. In KwaZulu-Natal, more than 95% of rabid animals are either dogs or cats.

Contact at least one of the following immediately and ensure that action has been taken within 48 hours:

> State Veterinary Services

> Local Health Authority

> Police

Immediate action to be taken by the persons contacted above:

> Safely and humanely contain or confine the suspect animal ensuring no risk of further human exposure.

> If the animal shows any clinical suspicion of rabies it must be destroyed forthwith without damaging the brain. The entire animal should be sent to the veterinary surgeon.

> The brain must be sent for diagnostic evaluation.

> Appropriate outbreak investigation must be conducted in the area where the exposure occurred by the State Veterinary Services or the Local Health Authority

5 ANIMAL RABIES PRE-EXPOSURE PROPHYLAXIX.

All dogs 3 months and older must be immunised and thereafter all dogs must be immunised annually (see Appendix 1: Veterinary Control of Canine Rabies in KwaZulu-Natal).

Legal requirements

It will be the responsibility of each dog owner to ensure valid immunisation of their animals. The clinician responsible for managing post exposure treatment will submit form "GW17/7" to the health authority on completion of treatment.

6 VETERINARY CONTROL OF CANINE RABIES IN KWAZULU NATAL.

The Animal Diseases Act 35 of 1984 and the Regulations (No. R. 2026 of 26 September 1986) declare the Province of KwaZulu-Natal to be a rabies controlled area. This requires all dogs and cats over 3 months of age to be immunised against rabies. Immunisation is to be repeated at 12 months of age and thereafter to be boosted annually.

Certification of rabies inoculations is required with the name and address of the inoculator, name and address of owner, the name and description of each animal, the remedy name, the batch number and the date of immunisation to be recorded. It is accepted that a bitch / queen inoculated in the 12 months prior to parturition will transfer valid maternal immunity to her offspring, and this immunity is considered protective up to 3 months of age. These regulations concur with municipal by-laws and international movement regulations.

6.1 Travel within KwaZulu-Natal.

The owner must be in possession of a valid certificate when pets are moved between local authority areas. Movement within local authority areas (i.e. within the municipal area where the animal is resident) may occur without the certificate, although the certificate must be presented to a State Veterinarian, police officer, or authorised person within 24 hours upon request. Puppies and kittens under 3 months of age may travel with proof of the mother's inoculations.

6.2 Travel to other provinces of South Africa (includes ex-TBVC areas).

The owner must be in possession of a valid certificate. An uninoculated animal over the age of 3 months may be inoculated and allowed to move immediately. Animals under 3 months of age may travel with proof of the mother's inoculations. Should such proof be unavailable, the animal may only move at 3 months of age and after inoculation.

6.3 Travel To Neighbouring Countries : Malawi, Zimbabwe, Namibia, Swaziland, Lesotho, Botswana.

The animals must have received valid inoculations more than 30 days and not more than 12 months prior to departure. Animals must be accompanied by an official Health Certificate completed and signed by the attending veterinarian and stamped and counter-signed by the State Veterinarian. The Health Certificate is only valid for 7 days. The inoculation certificates must also accompany the animal. Animals under 3 months of age may travel with proof of the mother's inoculations. Although the old pink State inoculation certificate is no longer in print, it may be used as proof of inoculation, in which case the State Veterinarian must also sign the reverse side of this certificate.

6.4 Travel to countries elsewhere in the world.

For countries that issue an import permit, this permit must be obtained by the owner from the relevant embassy / consulate, and be presented to the State Veterinarian prior to a Health Certificate being issued. Further information can be obtained from the Directorate of Animal Health: Import and Export Control.

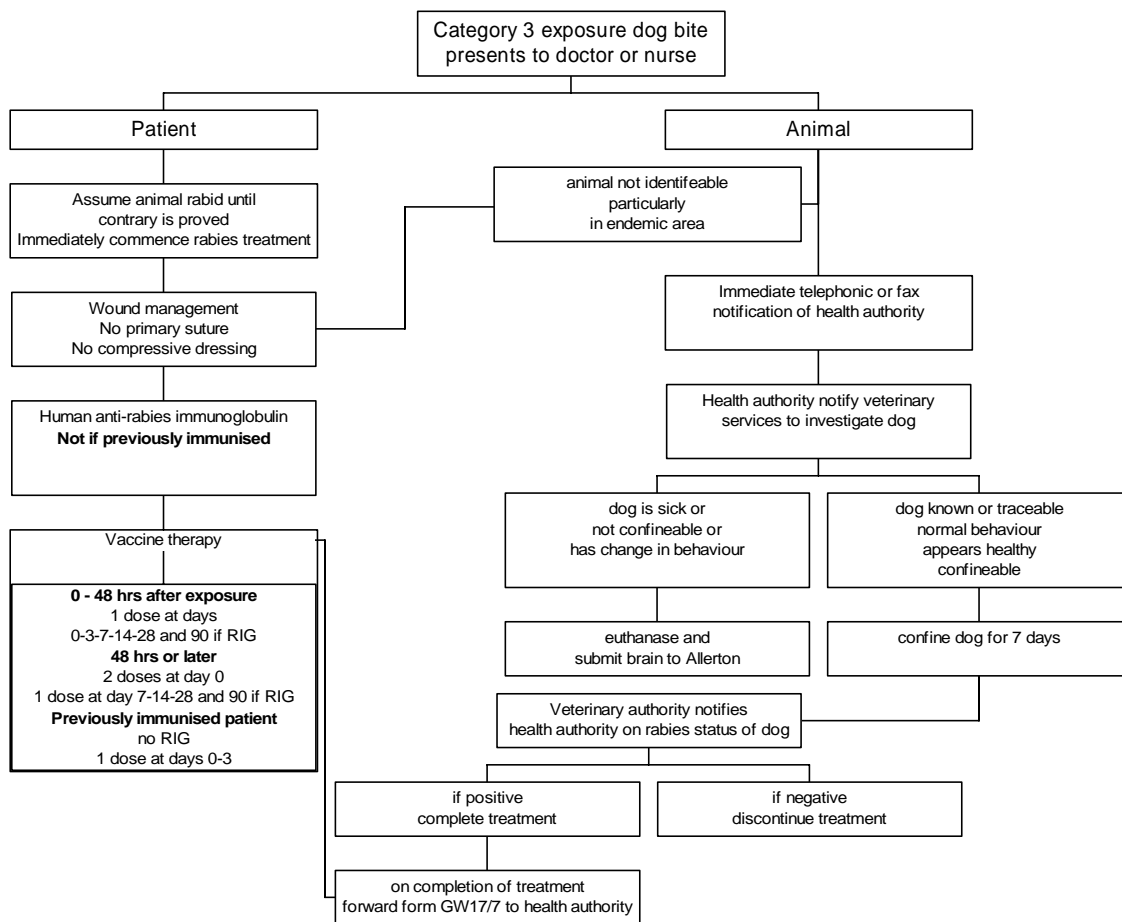## 6.5 Animals entering KwaZulu-Natal from other provinces of RSA.

Animals over the age of 3 months may be inoculated at the point of departure and then move directly to KwaZulu-Natal accompanied by the necessary certification. Puppies and kittens under 3 months of age may travel with proof of the mother's inoculations. If no such proof exists, the young animal may be moved with a letter from a State Veterinarian or attending veterinarian in the province of origin to the owner stating that the animal must be inoculated in KwaZulu-Natal immediately on reaching 3 months of age.

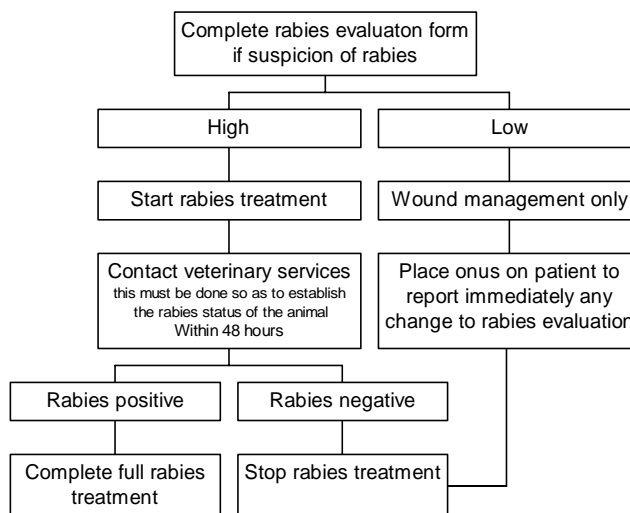## 6.6 Animals entering KwaZulu-Natal from other countries.

These owners must communicate directly the Directorate of Animal Health: Import and Export Control. (P/Bag X138, PRETORIA, 0001; Telephone 012 - 319 6000; Fax 012 - 329 0499) to ensure current import requirements are met.

In all the above, the term 'inoculate' or 'inoculation' refers specifically to rabies inoculation / vaccination.

APPENDIX 1 : SUMMARY OF HUMAN AND ANIMAL MANAGEMENT.

```
              ┌─────────────────────────────────┐
              │ Category 3 exposure dog bite     │
              │ presents to doctor or nurse      │
              └─────────────────────────────────┘
```

Patient

Assume animal rabid until
contrary is proved
Immediately commence rabies treatment

Wound management
No primary suture
No compressive dressing

Human anti-rabies immunoglobulin
Not if previously immunised

Vaccine therapy

0 - 48 hrs after exposure
1 dose at days
0-3-7-14-28 and 90 if RIG
48 hrs or later
2 doses at day 0
1 dose at day 7-14-28 and 90 if RIG
Previously immunised patient
no RIG
1 dose at days 0-3

Animal

animal not identifeable
particularly
in endemic area

Immediate telephonic or fax
notification of health authority

Health authority notify veterinary
services to investigate dog

dog is sick or
not confineable or
has change in behaviour

dog known or traceable
normal behaviour
appears healthy
confineable

euthanase and
submit brain to Allerton

confine dog for 7 days

Veterinary authority notifies
health authority on rabies status of dog

if positive
complete treatment

if negative
discontinue treatment

on completion of treatment
forward form GW17/7 to health authority

APPENDIX 2 : RABIES EVALUATION/CLINICAL ACTION GUIDE.

Complete rabies evaluaton form
if suspicion of rabies

High

Low

Start rabies treatment

Wound management only

Contact veterinary services
this must be done so as to establish
the rabies status of the animal
Within 48 hours

Place onus on patient to
report immediately any
change to rabies evaluation

Rabies positive

Rabies negative

Complete full rabies
treatment

Stop rabies treatment

APPENDIX 3

KWAZULU-NATAL DEPARTMENT OF HEALTH   FORM NO. GW ??/?

SUSPECT ANIMAL INCIDENT REPORT
TO BE COMPLETED IN FULL ON INTERVIEWING THE PATIENT/GUARDIAN
SUSPECT ANIMAL'S HEALTH STATUS TO BE ESTABLISHED WITHIN 48 HOURS

PATIENT DETAILS

NAME: _____

CONTACT ADDRESS _____

AGE: | 0 - 1 | 2 - 5 | 6 - 12 | 13 - 45 | 45 + | TEL. HOME: _____   TEL. WORK: _____

CATEGORY OF EXPOSURE: | 1 | 2 | 3 | DATE OF EXPOSURE: [ ][ ][ ][ ][ ][ ]
                                                            Y   M   D

RABIES POST-EXPOSURE TREATMENT GIVEN | YES | NO | TETANUS TOXOID GIVEN: | Y | N | ?? |

ANIMAL DETAILS

ANIMAL TYPE INVOLVED: | DOG | CAT | OTHER (specify)

BREED: _____   AGE: | PUPPY | JUVENILE | ADULT | SEX: | MALE | FEMALE |

COLOUR: _____   SIZE: | LARGE | MEDIUM | SMALL | HAIR: | LONG | SHORT |

OTHER RELEVANT INFORMATION   (DISTICTIVE MARKINGS): _____

OTHER ANIMALS BITTEN: _____   HAD THEY BEEN VACCINATED AGAINST RABIES? | Y | N | ?? |

SUSPICION OF RABIES: | HIGH | LOW | (SEE EVALUATION QUESTIONNAIRE OVERLEAF)

OWNER'S NAME: _____

ADDRESS: _____

_____   TEL. WORK: _____   TEL. HOME: _____

RABIES CERTIFICATE: | YES | NO | DATE: [ ][ ][ ][ ][ ]   BATCH: [_____]
                                            Y   M   D

ATTENDING CLINICIAN DETAILS

NAME OF DOCTOR/NURSE: _____   TEL (W): _____   TEL (H): _____

PLACE OF TREATMENT _____

ADDRESS: _____

SIGNATURE _____   DATE: [ ][ ][ ][ ][ ][ ]
                                          Y   M   D

INVESTIGATION REPORT

INVESTIGATED BY: _____   DEPT _____

DATE	ACTION

SIGNATURE _____   DATE: [ ][ ][ ][ ][ ][ ]
                                          Y   M   D

APPENDIX 4

KWAZULU-NATAL DEPARTMENT OF HEALTH

TREATMENT REPORT ON A PERSON EXPOSED TO RABIES

ON COMPLETION OF TREATMENT, THE RESPONSIBLE DOCTOR MUST SUBMIT THIS FORM TO:

THE REGIONAL DIRECTOR, DEPT OF HEALTH, P/BAG X 54316, DURBAN, 4000.

PERSON REQUIRING TREATMENT

FULL NAME _____ HOSPITAL/CLINIC NO: _____ .

RESIDENTIAL ADDRESS _____

_____

TELEPHONE NO: _____ AGE: ☐☐ MASS (KGS): ☐☐☐

INCIDENT

DATE OF EXPOSURE: ☐☐☐☐☐   ANIMAL TYPE INVOLVED: | DOG | OTHER (specify) |
  Y   M   D

EXACT GEOGRAPHICAL LOCATION OF INCIDENT: _____

CATEGORY OF EXPOSURE: | 1 | 2 | 3 | SITE OF WOUNDS: mark diagram overleaf

ANIMAL SPECIMEN SUBMITTED? _____ IF YES, CASE NO: _____ RABIES | POSITIVE | | NEGATIVE |

TREATMENT ADMINISTERED

A. RABIES IMMUNOGLOBULIN (RIG): AMOUNT: _____ DATE: ☐☐☐☐☐
  Y   M   D

B. RABIES VACCINE:

1. PREVIOUSLY IMMUNISED PERSON:

DAY 0 ☐☐☐☐☐   DAY 3 ☐☐☐☐☐
  Y   M   D   Y   M   D

2. NON-IMMUNISED PERSON:

DAY 0 ☐☐☐☐☐   DAY 3 ☐☐☐☐☐   DAY 7 ☐☐☐☐☐
  Y   M   D   Y   M   D   Y   M   D

DAY 14 ☐☐☐☐☐   DAY 28 ☐☐☐☐☐   * DAY 90 ☐☐☐☐☐
  Y   M   D   Y   M   D   Y   M   D

* ONLY IF R.I.G. HAS BEEN GIVEN

DOCTOR WHO TREATED CASE

TEL. NO: _____   DATE: ☐☐☐☐☐
  Y   M   D

FULL NAME _____

ADDRESS: _____ .

_____ .

SIGNATURE: _____ DESIGNATION: _____

22 AUG 1996 C:\RABIES\RAG

HUMAN RABIES SURVEILLANCE AND CONTROL IN ETHIOPIA

Makonnen Fekadu[18]

1 INTRODUCTION.

Politically and historically, Ethiopia is highly distinctive among African countries because it has existed as a nation in some form for more than two thousand years. Within the country, rabies has been known for centuries as a "Mad Dog Disease". In other countries where canine rabies is endemic the rate of human cases is about 1 per 100,000 population, with some of the higher rates reported in India (25,000-50,000 cases, or 25 to 50 per 100,000 people). In Ethiopia, the incidence of human rabies, as in many developing countries, closely parallels the incidence of rabies in dogs and, to a much lesser extent, wildlife; about 98% of human cases are due to dogs, much of the remainder to other domestic animals. In a recent survey in Addis Ababa and its environs, only a small proportion of the total cases, less than 2%, was due to wildlife. At present, the institute that is carrying out diagnosis and vaccine production is the Ethiopian Health and Nutrition research Institute (EHNRI).

2 RABIES SURVEILLANCE IN ADDIS ABABA.

In 1992/1993 human rabies in Addis Ababa, the capital city of Ethiopia, was surveyed and 464 rabies cases were identified. Of these, 52 (11%) were diagnosed at EHNRI and then reported to the WHO in the annual World Survey of Rabies. The remaining 412 cases (89%) were not reported to the Veterinary Public Health Division of WHO but to another division within the WHO by the Ethiopian Ministry of Health. Most of these cases were diagnosed by clinical observation of classical signs of rabies such as hydrophobia, paresthesia at the site of the bite, difficulty swallowing water and a history of a bite by a known or suspected rabid animal. Approximately 50% of the cases were adults (between 15 and 44 years of age) and approximately 60% were males. Over 98% of cases had a history of a bite by a rabid or suspected rabid dog.

The 1992/1993 Addis Ababa data on human rabies cases was extrapolated to estimate the actual magnitude of human rabies throughout Ethiopia by using an assumption that there is a uniform distribution of dog rabies and of human exposure and cases throughout the country. Thus, with an estimated 1993 population of 2.5 million in Addis Ababa and an estimated countrywide population of 55 million people, we estimate that approximately 10,000 persons die of rabies in Ethiopia each year, and that more than 40,000 persons may require human rabies post-exposure treatment (PET). Although the EHNRI distributes about 6,000 doses of Fermi vaccine, it was estimated at only approximately 13% of the total amount required. From these figures we estimate the incidence of human rabies in Ethiopia to be one of the highest in the world, at 18.6 cases per 100,000 people.

Since 1995 we have again collected data on human rabies in Addis Ababa and its environs (a cordon of about 80 to 100 km radius around the city) and we have reviewed records of patients referred with a diagnosis of rabies to the EHNRI and the rabies reference hospitals in Addis Ababa. Demographic, clinical and animal-type information was collected on standard questionnaire forms. We have identified 275 human rabies cases of which 268 (97.5%) were due to dog bite (the remaining cases were caused by foxes and viverrids (civet)). Of the 275 cases, 13% were bitten on the head, 34% on the upper extremities (hand and arm), 3% on the trunk and 46% on the legs.

The mean incubation periods ranged between 15 and 365 days, the shortest being in two eight and thirteen year old boys bitten on the face and the longest also being in one eight year old boy bitten on the leg. Forty percent of the victims were children under fifteen and of the cases bitten on the face, 61% were also children under the age of fifteen. An additional 17% were between fifteen and twenty five, giving a total of 78% of the victims being under twenty five. Of the remainder, 12% were over forty

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[18] Division of Viral and Rickettsial Diseases - 1600 Clifton Road NE - Atlanta, GA 30329-4018 – USA

years of age. The most unusual cases observed were two of human to human transmission of rabies and one due to exposure to a rabid bovine.

Our findings confirm that rabies is indeed a major problem and continues to exact a tremendous toll on the meagre public health resources of the country.

3 PREVENTION AND CONTROL EFFORTS.

The prevention efforts will entail the immediate institution of 25,OOO doses of cell culture vaccine for human rabies post-exposure treatment (PET) kindly donated by Pasteur Merieux and training and technology transfer for host country vaccine production and utilisation. EHNRI has ample space and trainable personnel to be able to produce adequate and of acceptable quality of human and animal vaccines, with limited amount of short term expertise support for transfer of technology.

4 CONTROL.

As evident during the last 50 years in the industrialised world and recently in parts of Latin America (e.g., Uruguay) and south-east Asia (e.g., Thailand), human and animal rabies prevention in major urban areas is achievable. The expected impact and long-term plan of this project is to establish vaccine production capability to not only meet the national needs of Ethiopia but also to provide a model to supply other African countries in the region

5 OBJECTIVES.

Implement hospital-based human rabies prevention in Addis Ababa using cell culture vaccine.

Establish cell culture and rabies vaccine production capability in Ethiopia and train personnel in phases of production and quality control assessment of rabies vaccines for humans and animals.

Employ a distribution system to assure that requirements for human post exposure vaccine are met throughout Ethiopia.

Organise and conduct rabies immunisation programmes in dog populations in Addis Ababa and evaluate the impact of these campaigns on subsequent human PET and human rabies cases.

Expand the urban prevention plan to rural areas.

THE SURVEILLANCE AND MANAGEMENT OF BITE WOUNDS IN MACHAKOS DISTRICT, KENYA

B. M. Nzioka[19], P. M. Kitala[20], C. N. Matere[2] and M. N. Kyule[2]

1 BACKGROUND.

Rabies has been a major public health problem in Machakos District for over forty years. The problem persisted in Machakos District even when the disease was well controlled in the rest of the country in the 1960s and early 1970s. There has been a dramatic increase in the number of people seeking post-exposure treatment (PET) in the Machakos General Hospital starting from the early 1980s. To date, there has been no reversal of the upward trend. The domestic dog has been the most important animal species responsible for most of the human animal-bites warranting PET.

2 MATERIALS AND METHODS.

Data collection : The data were obtained from records kept at the Machakos General Hospital covering the period 1992-1995. Information on each bite victim included date bitten, date reported, age, sex, biting animal, owner of biting animal, vaccinal status of biting animal, location of biting incident (by division) and the treatment given.

3 RESULTS.

3.1 Number of human animal-bites reported.

A total of 1487 human animal-bites were reported for the period, corresponding to an average rate of 372 cases per year (1 case per day). The highest number of bite cases reported on a single day was 10. Most of the bite cases (488) were reported in 1993 but the numbers dropped in the two subsequent years to a low of 243 in 1995 (Figure 1).

Distribution of the bite cases by month of the year for the four years is shown in Figure 2. The highest number of cases reported were in the months of January, February and March, followed by a sudden drop to 85 cases in April. After April, the reported bite cases oscillated monthly with decreasing amplitude to 99 cases in December.

3.2 Species distribution of the biting animals.

Of the 1487 bite cases reported, 95% were due to dogs. Table 1 shows the distribution of bites by the species of biting animal.

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[19] Public Hospital Officer - Machakos General Hospital - P.O. Box 19 – Machakos – KENYA

[20] University of Nairobi, Faculty of Veterinary Medicine, Department of Public Health, Pharmacology and Toxicology, P.O. Box 29053, Nairobi - KENYA

3.3 Distribution of animal-bite cases by Division.

The majority (77%) of the 1,487 human animal-bite cases were from three Divisions (Central, Mbooni and Mwala) of the ten Divisions making up Machakos District. The three Divisions are within a radius of 50 km from the Machakos General Hospital. The distribution of the bite cases by Division is shown in Table 2.

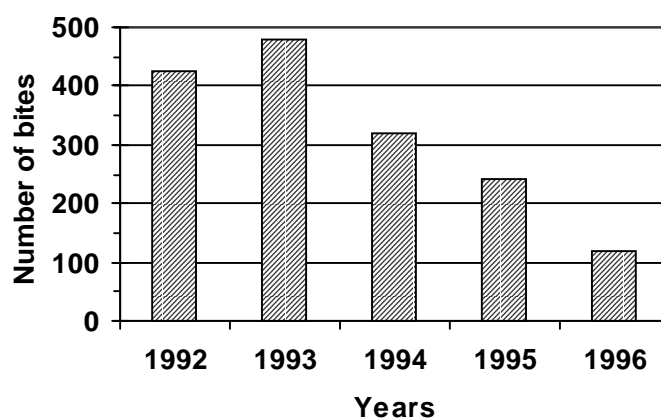**Figure 1 : Human animal-bites reported to the Machakos General Hospital, Machakos district, Kenya, 1992-1996**

Table 1 : Distribution of human animal-bites by species of biting animal.

Species	Number of animal-bite cases
Dog	1412
Cat	54
Donkey	6
Jackal	6
Leopard	3
Rat	2
Snake	2
Cattle	1
Honey badger	1
Total	**1487**

Source: Machakos General Hospital Reports, 1992-1995.

Figure 2 : Monthly distribution of human animal-bites reported to the Machakos General Hospital, Machakos district, Kenya, 1992-1995
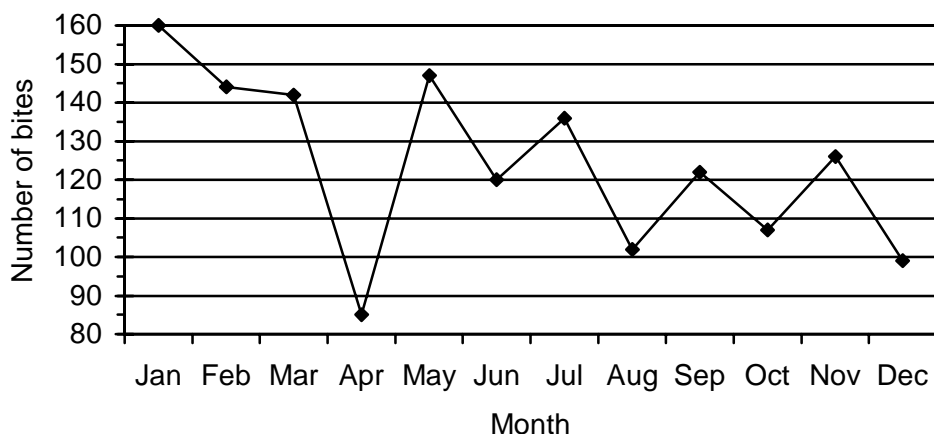
Table 2 : Distribution of human animal-bites in Machakos District.

Division	Number of animal-bite cases
Central	449
Kangundo	28
Kathiani	62
Kibwezi	45
Kilome	124
Masinga	18
Mbooni	339
Mwala	333
Wote	32
Yatta	29
Outside Machakos	8
Total	**1487**

Source: Machakos General Hospital Reports, 1992-1995.

3.4 Age and sex distribution of human animal-bite cases.

A high proportion (59.4%) of the bite cases belonged to the age-group 15 years and below. As shown in Figure 3, the cases declined with advancing age. Men and boys made up 55% of the animal-bite cases.

Figure 3 : Distribution of human animal-bites by age reported to the Machakos General Hospital, Machakos district, Kenya, 1992-1995
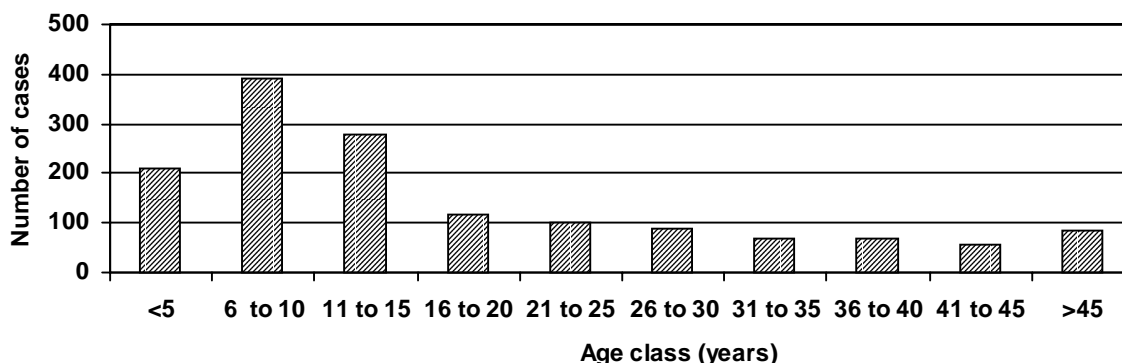
3.5 Biting-animal ownership and their vaccination status.

Of the 1412 human dog-bite cases, 499 (35.3%) were bitten by dogs whose owners could not be established. Of 913 people bitten by dogs whose vaccination status was determined, only 213 (23%) were bitten by reportedly vaccinated dogs.

3.6 Post-exposure treatment (PET).

The human diploid cell vaccine (Institute Merieux, Lyon, France) and the purified Vero-cell rabies vaccine (Pasteur Merieux, Lyon, France) are the main vaccines used for PET at the Machakos General Hospital; another is Rabipur-PCEC, the purified chick embryo cell vaccine by Hoechst, India.

Of the 499 people bitten by dogs whose vaccination status could not be identified, 469 (94%) received PET while only 684/913 (75%) of those bitten by dogs with known vaccination status received PET. The difference was significant (p<0.05), those bitten by a dog whose vaccination status could not be identified were five times more likely to receive PET relative to those bitten by dogs with known vaccination status. The remaining 259 bite victims received tetanus toxoid (TT) and other measures for wound treatment.

Of the 700 people bitten by reportedly unvaccinated dogs, 649 (93%) received PET whilst only 37 of 213 (17.4%) of the victims of vaccinated dogs received PET. Again, the difference was significant (p<0.05) - a person bitten by an unvaccinated dog was 61 times more likely to receive PET relative to those bitten by vaccinated dogs. The vaccination regimen at the Machakos General Hospital is 0.4ml, 0.1ml and 0.1ml on days 0, 7 and 14 respectively.

3.7 Time interval between biting incident and PET administration.

The time interval between biting incident and PET administration ranged from 0 - 246 days (mean = 4.85 days, std 11 days). Figure 4 shows the reporting pattern of the 1487 bite victims. Most of them (55.8%) reported within 2 days of the biting incident.

Of the 1479 biting incidents which occurred within the district (8 incidents occurred outside the district) 715 of 1231 (58.1%) occurring within a radius of 50km of Machakos General Hospital were reported within 2 days of the incident while 111 of 248 (44.8%) of the biting incidents occurring outside this radius of Machakos General Hospital were reported within two days. Thus a person bitten within a radius of 50km from the hospital was 1.7 times more likely to report within 2 days of the incident.

Figure 4 : Distribution of human animal-bites by time interval in days between a bite incident and seeking of post exposure treatment reported to the Machakos General Hospital, Machakos district, Kenya, 1992-1995
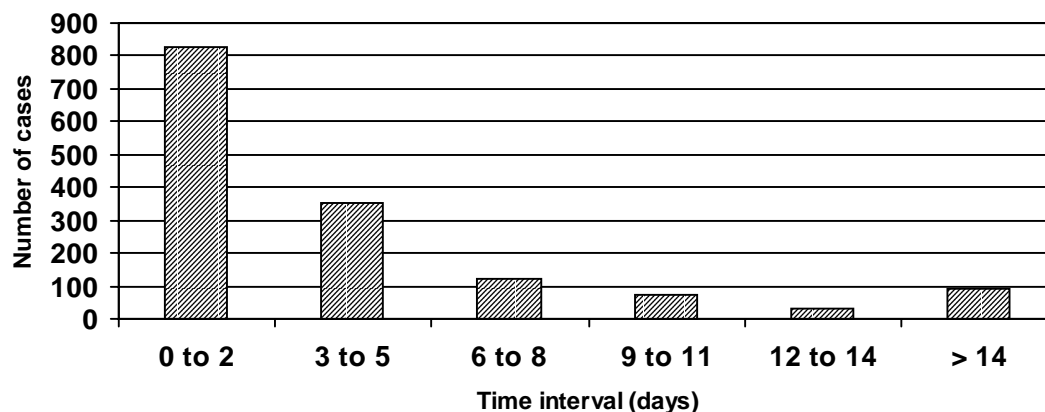
4 DISCUSSION.

Rabies continues to be a major public health problem in Machakos District as evidenced by the high number of people seeking PET after animal bites. The figures are only an indication of the extent of the animal-bite problem in the district as most people seek PET from private practitioners. The demand for PET at the Machakos General Hospital far outstrips the supply of human rabies vaccine at the hospital. It is suspected that most people do not seek PET due to the high costs of transport and PET vaccine. Indeed, a study carried out in the district (Kitala et al., 1994) revealed that about 35% of human animal-bite cases did not seek PET due to the costs involved. There is a need to look for less expensive and more efficacious vaccination regimens in terms of the number of clinic visits a bite victim has to make and also the amount of vaccine given.

The dog is the most important species contributing to 95% of the human animal-bites reported. The low proportion (23%) of bites occasioned by reportedly vaccinated dogs reflects the low vaccination rate of the Machakos dog population. The low vaccination rate of biting dogs is consistent with 33% vaccination rate estimated for dogs more than 3 months old for the district (Kitala et al., 1993).

In conclusion, there is a need for greater co-operation between the Ministry of Health and the Veterinary Department in tackling the rabies menace in the district. Public awareness of rabies in Machakos District is high and a well-planned rabies control programme in the district is likely to get maximum public support.

IMPROVING HUMAN RABIES SURVEILLANCE AT DISTRICT LEVEL IN UGANDA.

R. Winyi Kaboyo[21]

1 INTRODUCTION.

Disease surveillance data at national level are generated from the systematic collection, collation and analysis of disease data originating from the lower health units in the districts. In the case of rabies, the District Medical Offices (DMOs) and District Hospitals are the major sources of data on which national statistics on rabies are based. Since data is as good as its origin, deliberate efforts were made by the Veterinary Public Health Division (VPH) Ministry of Health (MOH) to improve rabies surveillance at district level. This was done to improve the overall quality and hence usefulness of data at the National level.

2 PROBLEMS OF REPORTING.

In order to improve rabies reporting by the districts, the following problems had to be addressed :

Reports of suspected rabies in humans were not forthcoming from about 80% of the districts in the country.

There was no common format for reporting, consequently it was difficult to analyse and compare data from one district to another.

There was often disparity in data available at the district and those at the MOH Headquarters concerning the same district.

Data form some government and private hospitals was not reported to DMOs or anywhere else.

At times however, data from government and private hospitals were reported directly to the MOH Headquarters, by-passing the DMO. This practice was the main cause of the problem in data disparity above.

The overall effect was gross under-reporting of the rabies problem countrywide, leading to the relaxation of control efforts.

3 OBJECTIVES.

The main objectives of the initiative to improve rabies surveillance in the districts were :

To improve the descriptive epidemiology of animal-bite victims suspected of exposure to rabies. The following variables, age, sex, geographical location, seasonal and temporal trends, were to be documented for each victim in order to identify the risk factors for rabies exposure in each district.

To identify the source of exposure to rabies and inform the veterinary services accordingly. This would foster intersectorial collaboration between MOH and that of Ministry of Agriculture, Animal Industry and Fisheries (MAAI&F).

To improve district and national planning in the provision of logistics for rabies prevention and control e.g. human doses required per annum.

To identify and focus health education programmes to the group at highest risk to rabies exposure.

4 STRATEGIES.

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[21] Assistant Commissioner - Veterinary Public Health - P.O. Box 8 – Entebbe - UGANDA

To harmonise and encourage reporting by all the districts, the following strategies were adopted :

Report forms specific for rabies were designed and availed freely to all DMOs and hospitals treating suspected rabies victims. The forms, 8/90, 2/92 have since been amended to 10/96 and to reflect the Post-Exposure Treatment (PET) regimen currently in use (Figure 2).

A district reporting system has been established with minor variations in ten districts where the Multi-Sectorial Approach (MSA) is being implemented (Figure 3).

A district reporting system is discussed and approved during joint workshops of the Technical Committee on Rabies Control (TECOR), the District Veterinary and Medical Staff, Local Administration, Law Enforcement Officers, Youth and Women's groups and Local Councillors (LCs) who are locally elected leaders in a given district.

Guidelines for Post-Exposure Prophylaxis were worked out and availed to health and veterinary workers in the districts. Large posters (45x60 cm) were made for health units to provide a quick reference for nurses, clinical officers and physicians on how to handle an animal-bite victim suspected of rabies exposure. (Figure 1)

To sustain the enthusiasm of the reporting officers and regularly check on the accuracy and quality of the reports, there is information feed-back between VPH division and the DMOs and Medical Superintendents. The feed-back can be in form of :

A written compliment or a request for clarification on a given report from the reporting officer.

Discussing the reports usually at the time they are hand-delivered when the district or hospital is making a fresh requisition for human anti-rabies vaccines.

Regularly updating the DMOs and hospitals involved in rabies treatments on the national situation.

Notification of clinical rabies and resultant deaths to the Health Management Information System Unit of the MOH.

5 RESULTS.

The strategies undertaken to improve rabies surveillance have resulted in better understanding of the rabies epidemiology in the country.

In particular, data from the reporting centres are now more regular, detailed and accurate, thus enabling the identification of the most important risk factors for the disease. On the other hand, through the same surveillance system, some peculiar circumstances concerning rabies have been reported e.g. human to human bites that could possibly result in exposure to rabies. The rabies prevention and control efforts are now better planned at district and national level. The number of vaccine doses required and where they are needed can be determined with reasonable accuracy.

The scope for inter-sectorial collaboration between the health sector and the veterinary services has been enhanced. There is regular exchange of information and data on animal rabies sources of exposure as well as on rabies prevention and control efforts each sector is undertaking.

6 CONSTRAINTS.

The following constraints have been identified :

There are still some reporting centres that do not use the format provided. Others do not complete the forms properly, leaving out information on important variables.

In most centres forms are filled at the time of post-exposure treatment, when vaccines (ARV) are not available and no records are kept.

Patients are usually referred to other centres with ARV where they would be treated and recorded, however, this is not always the case as patients sometimes end up staying at home without visiting any other rabies treatment centre.

The available resources in terms of funds and logistics e.g. computer facility for the VPH Division to supervise, monitor and process data as quickly as possible are not adequate.

7 CONCLUSION.

Health workers should be sensitised and provided with a stable supply of human ARV. These measures will enable them to take rabies seriously and respond appropriately to save human lives.

There is need to make deliberate efforts to enhance Multi-Sectorial collaboration between field veterinary staff, local leaders and health workers in order to improve rabies surveillance at district level, this collaboration should be extended to National level.

Figure 1 : Rabies post exposure treatment guidelines.
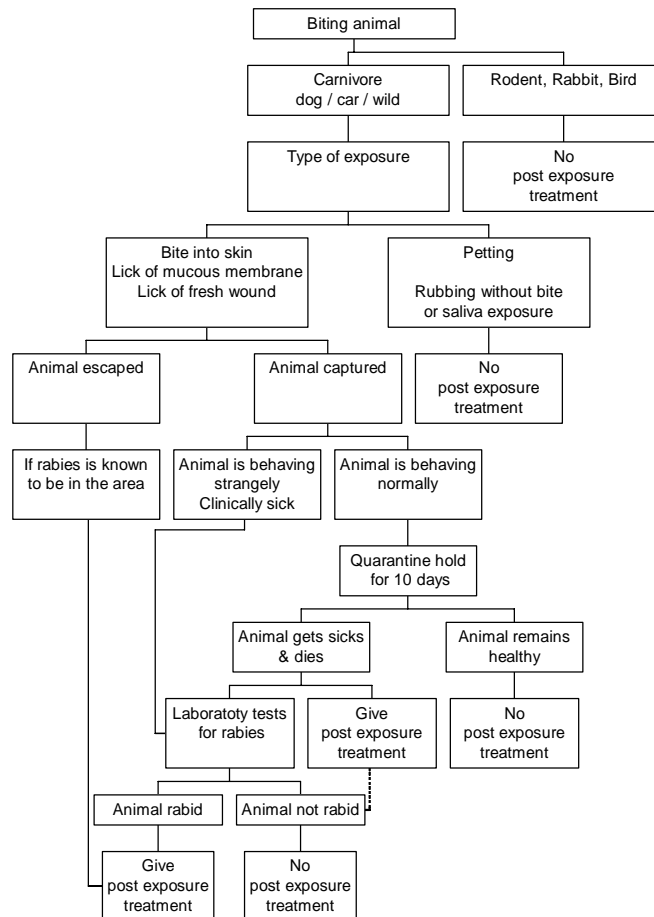
Figure 2 : Report form version 10/96

Ministry of Health – UGANDA

Reported rabies cases

From : M/Superintendent : _____ HOSPITAL _____ MONTH _____ YEAR _____

DMO : _____ DISTRICT _____ NAME OF REPORTING OFFICER _____

TO ACHS/VETERINARY PUBLIC HEALTH (VPH)

DATE	NAME	AGE	SEX	VILLAGE	SUB-COUNTY	2-1-1 TREATMENT SCHEDULE					BITING ANIMAL	ANIMAL KILLED / ESCAPED	PROGNOSIS (OUTCOME) PATIENT DEAD / ALIVE	COMMENT
						VACCINE DOSES								
						DAY 1		DAY 7	DAY 21	SERA				
						1ST	2ND	3RD	4TH					

Figure 3 : District human rabies reporting system

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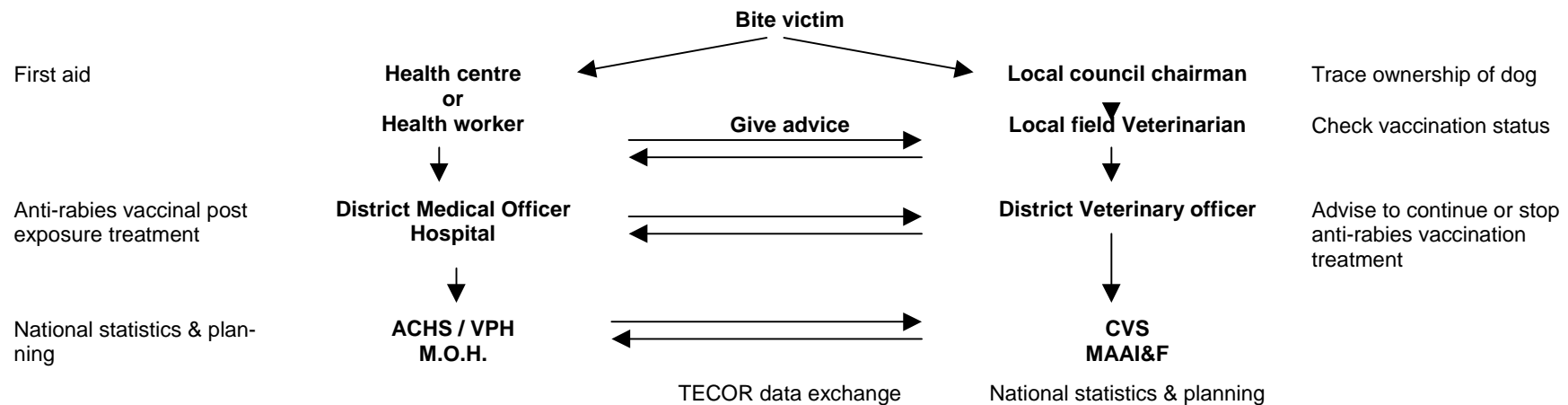
THE MANAGEMENT OF CLINICAL HUMAN RABIES EXPERIENCES FROM KWAZULU-NATAL

J.D. Godlonton[22]

Since about 1980 a change became apparent in the incidence of human and animal rabies in Kwazulu-Natal (Figure 1). The explanation for this change lies in a significant escalation in civil unrest, urban and rural violence and the resultant total breakdown in those services which would normally have controlled human and animal rabies.

Figure 1 : Human and animal rabies cases in Kwazulu-Natal, 1976 – 1996.
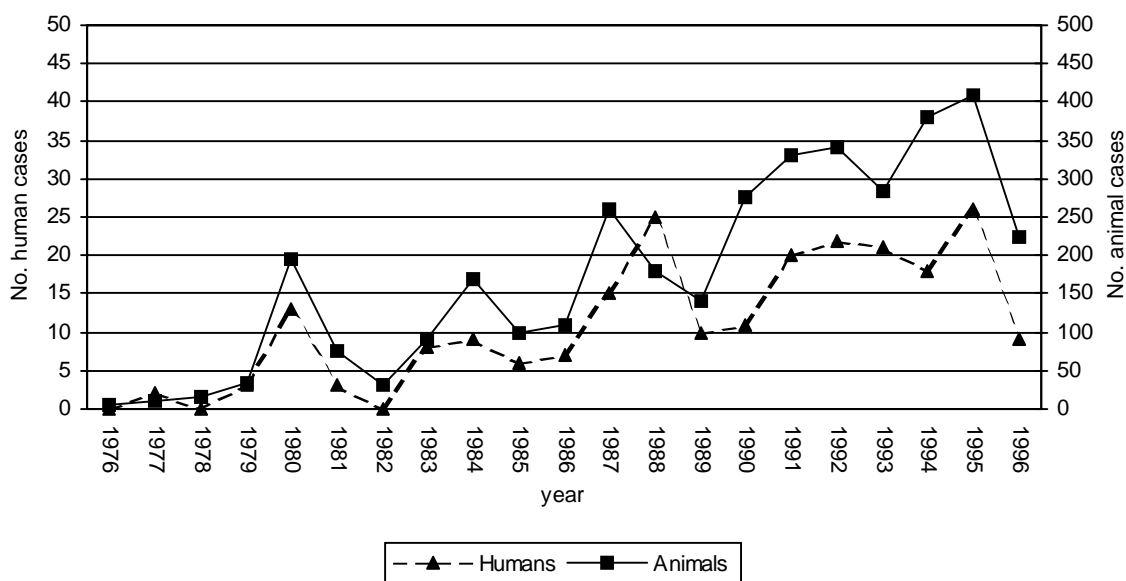
Table 1 : Human and animal rabies cases, 1991 to 1996.

Rabies (notified) : Kwazulu-Natal statistics.			
Year	Total cases	Children (<13 years)	Animals
1991	20	12	330
1992	22	18	341
1993	21	13	284
1994	18	12	386
1995	26	20	412
1996	9	7	217

The increased incidence of human rabies in Kwazulu-Natal highlighted a number of important clinical and logistical points.

1) **Children :** 13 and under were the most frequent victims. They were most often bitten between midday on Friday and Monday morning (when no facilities were available). Bites to the head and face were common.

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2) **Incubation periods** were variable (30 – 60 days) with an average of 40 days, following a pattern of prolongation for "distant" bites and shorter for severe head and neck bites. The shortest was 11 days for an adult bitten on the hand.

3) **Clinical presentation** In the majority of children clinical diagnosis was easy with advanced signs – anxiety, hallucinations, lucidity / confusion, phagophobia (hydrophobia) before coma and demise. Parasthesiae at bite sties was infrequent in children, much more common in adults. History of dog bite was positive in over 70% but less commonly remembered in children. The average survival time after admission was 30 hours. All patients dying of rabies at rabies Edendale Hospital represented the furious or encephalic form and we have as yet not seen rabies presenting as a flaccid paralysis (Guillian-Barre syndrome).

Two atypical rabies patients (Figure 2) illustrate a number of important points and these include : late and inadequate immunisation does not prevent rabies. It may predispose to a prolongated survival time. The difficulty of ante-mortem diagnosis confirmation is also illustrated.

Figure 2 : Sequence of events leading to the death of two rabid children.

Patient 1 : 7 year old girl	
Time	
Day 0	Dog bite, face, arm
Day 12	1ml HDCV IM
Day 19	1ml HDCV IM
Day 27	**Onset** Admitted to hospital
Day 30	**Coma**
Day 33	RIG 200 IU
Day 40	CSF : IF 1/2048, negative on culture Saliva : negative on culture
Day 46	CSF : IF 1/8096, negative on culture Saliva : positive PCR
Day 81	Mother removed patient
Day 91	**Death** No PM

Patient 2 : 13 year old boy		
Time		
Day 0	Dog bite : arm, shoulder	
Day 4	0.2 ml HDCV ID	Admitted to Nqutu hospital
Day 7	0.2 ml HDCV ID	
Day 11	0.2 ml HDCV ID	
Day 18	0.2 ml HDCV ID	Discharged from Nqutu hospital
Day 32	**Onset**	Re-admitted to Nqutu hospital
Day 34	**Coma**	
Day 47	Biopsy, saliva, conj. smears negative FAT	Transferred to PMB hospital
Day 57	CSF, IF 1/256 CSF, saliva negative on culture	
Day 60		Removed from PMB hospital by parents
Day 72	CSF, IF 1/512 CSF, saliva negative on culture	Re-admitted to Nqutu hospital
Day 77	**Death** Brain positive	

4) **Management :**

    a) <u>General points :</u> As the number of patients increased and with it therapeutic futility, a number of therapies were attempted – large doses of steroids, intrathecal (CSF) immunoglobulin, interferon and mechanical ventilation. This is an alarming aspect for the physician and the family who are understandably reluctant to accept the absolute futility of treating the illness. Detailed counselling is mandatory.

    b) <u>Specific</u>   sedation (dormicum), fluids IV/Ngt

5) **Differential diagnosis.** In most instances in children, the illness was so far advanced that the clinical diagnosis was easy. Whenever rabies was considered as the possible diagnosis, it was the correct diagnosis, when it was not considered typhoid fever acute toxic psychosis, encephalitis, atropine poisoning, meningitis and behavioural disorders including bewitchment were considered.

6) **Diagnostic confirmation**

    a) Attempts at <u>ante-mortem</u> diagnosis were very disappointing and included serum, saliva, corneal scraping and hair follicle biopsy. CSF immunofluorescence was positive in those who had a prolonged survival rate.

    b) <u>Post mortem</u>. In all cases where rabies was considered possible clinically, histological confirmation was obtained. In most instances the specimen was obtained by supra-orbital Tru-cut biopsy. This latter procedure proved useful as a time saving expedient and was invaluable where post-mortem refusal existed.

Important points

❖ Over 95% of patients who died of rabies had presented to a facility which could and should have been able to treat correctly or refer for correct treatment soon after being bitten (48 hours).

❖ Human rabies is the end stage of a disease not the beginning of an illness.

❖ The disease is preventable, the end stage has no cure.

❖ A misconception exists that rabies vaccine and immunoglobulins have serious and unpleasant side effects.

❖ Wild animals kept as pets are seldom immunised.

❖ Puppies are a transmission risk factor either not immunised or immuno-incompetent.

❖ The effectiveness of post-exposure prophylaxis improves with its closeness to exposure.

❖ The problem of late presentation management needs to be addressed and answers to the following questions are required :

    ➢ How long after a suspect bite is it still reasonable to give a vaccine and/or immunoglobulin

    ➢ If only vaccine is used on late bites, what dose should be used?

❖ There is an enormous disparity between the number of patients receiving vaccine and immunoglobulin and the number of dogs being identified, incarcerated, euthanased and identified positive or negative. Therefore maybe hundreds, if not thousands, of patients are receiving unnecessary rabies therapy.

DISCUSSION OF PAPERS

1) Dr. A. I. Wandeler: Human rabies and reporting: can we do better?

- **Dr. Godlonton:** Is reporting to government departments necessary to improving public awareness of rabies?
  In South Africa, central government figures for 1994 recorded three rabies deaths and seven survivals and yet in Kwazulu/Natal alone there were 18 deaths. Similarly, in 1995 government recorded three deaths and five survivals, whilst there were 25 deaths in Kwazulu/Natal alone. There are many rabies deaths which remain undiagnosed. For example, people with furious rabies will be taken to traditional healers and die without a death from rabies being recorded. Education is an important aspect of gaining better information of human cases. Diagnosticians can have an important influence on meaningful reporting. Increasing the dialogue between veterinary and health divisions is important in improving reporting.

- **Dr. King**: It was mentioned that there were lots of reports of deaths occurring at home. Is there any suggestion of human to human transmission?
  There is no direct evidence. However, I am convinced that it is possible. High virus titres can be recorded in saliva and it is feasible that transmission can occur.

- **Dr. Godlonton**: Recently Dr. Makonnen Fekadu reported possible human to human transmission in two cases in Ethiopia.

2) Dr. F.-X. Meslin: WHO recommendations on human rabies and PET

- **Dr. King**: Are the changes to WHO recommendations alterations to the Eighth Report published in 1992?
  Yes.

- **Dr. King**: Recently, gluteal-region vaccinations were carried out in a Kenyan hospital; I have also heard reports of and have seen a case of severe reaction to intradermal vaccination - are these unusual?
  Gluteal route vaccination is not recommended by the WHO. Only 3 - 14% of vaccinees are reported to give some adverse reactions, ranging from mild to severe, to intradermal vaccination.

- **Dr. Godlonton**: Can you clarify whether a 90-day post-exposure vaccination is required when rabies immunoglobulin (RIG) has not been administered?
  The 90-day regimen has been obsolete for several years and is not required, regardless of RIG administration.

- **Dr. Bingham**: Since 0.8ml of vaccine is needed for the eight site intradermal schedule and as the vaccine is supplied in 10ml and 5ml vials, vaccine may be wasted. Is it possible to reconstitute the vaccine and store it for later use?
  There is an internationally agreed standard that reconstituted vaccines without preservatives, as are the majority of human rabies vaccines, should be used within 3 - 6 hours of reconstitution. The intradermal schedule should be applied in clinics with a high rate of patients presenting for PET, so that vaccine is not wasted.

- **Dr. Bingham**: Is it possible for manufacturers to produce vials of smaller volume, e.g., of 0.1ml? *That is a question for the manufacturers.*

- **Dr. Perry**: Is the cost-effectiveness comparison between intradermal and intramuscular vaccination schedules, as presented by Dr. Meslin, artificial?
  It does not take into account the wastage of vaccine using intradermal vaccination. I agree with the statement and will return to the issue during the main discussion.

3) Dr. A. Robinson: Rabies policy and post-exposure protocols in South Africa

- **Dr. Perry**: Who will pay for the system - the patient? Has the increased budgetary allocation required to cover the policy caused problems?
  Patients admitted to State hospitals will only be charged the normal, nominal admission costs. Patients at private hospitals will be expected to cover the cost of the PET vaccination schedule. The cost is absorbed in the overall health care budget. If the policy becomes more widely implemented and is adopted at national level, then extra funds will follow.

- **Dr. Kaboyo**: If an animal bites a human, but its rabies status has yet to be proven, when is the patient notified as a rabies case?
  The notification is made at the end of the PET. Only patients which die of rabies are notifiable.

- **Dr. Godlonton**: It should be noted that a dog bite notification form does exist. Therefore, as well as rabies being notifiable, all reported dog bite patients should also be recorded.

- **Dr. Kaboyo**: This suggests that if patients receives PET, they should be recorded.
  I agree with that statement and would argue that a simplification of health department structure would be beneficial in this respect.

4) Dr. Makonnen Fekadu: Human rabies surveillance and management of bite wounds.

- **Dr. Moshoeshoe**: It is of concern that intradermal PET is being centralised in the capital, why are there no rural schemes?
  Centralisation is necessary until the efficacy of the intradermal schedule has been assessed. Once this has been shown, it should be possible to train people and pass on the expertise to regional hospitals.

- **Dr. Rutebarika**: What is the length of time between receiving laboratory results of suspected rabid dogs and starting PET?
  If at the central hospital, then as little as half an hour. The reference veterinary laboratory is next to the central hospital.

- **Dr. Rutebarika**: If you are not at the central hospital?
  PET will not be started until a definite rabies-positive result for the dog has been received. Any hospital will send the suspect dog sample to the reference laboratory.

- **Dr. de Balogh**: With reference to the 14th century Ethiopian scripts referring to the burning of a bite wound, in Mozambique and Zambia the burnt hair of the dog is applied to the bite wound.   Suspected rabid dogs are burnt in Ethiopia and inhaling the fumes is believed to confer protection against rabies.

- **Dr. Perry**: How does the proposed research by Dr. Warrell into human immunisation in Ethiopia fit in with the planned appraisal of intradermal efficacy?
  Please refer this question to Dr. Meslin.

- **Dr. Meslin**: The proposed research will look at developing a new intradermal PET schedule based on three visits. The work of Dr. Fekadu is based on already accepted schedules.

- **Dr. Fekadu**: I would suggest that the total number of visits for PET is not important compared with the cost-effectiveness of the regimen.

- **Dr. Perry**: I would argue that the imposition of multiple visits is part of the hidden cost of the treatment - for examples, loss of earnings, travel expenses - and as such is important.

- **Dr. Fekadu**: I do not fully agree. Cutting the number of visits from seven to five or three is not as significant as the actual effectiveness of the treatment.

- **Dr. Kitala**: How is the effectiveness of the treatment to be tested?
  Blood samples taken from PET patients at days 7, 14, 28, 90 and 180 will be tested using cell culture RFFIT at the CDC, Atlanta and by mouse inoculation test in Ethiopia. This should provide accurate results of immunogenicity of the intradermal routine.

5) Mr. Nzioka: The surveillance and management of bite wounds in Machakos, Kenya

- **Dr. Fekadu**: Was the immune response to intramuscular injections of 0.4ml, 0.1ml and 0.1ml at days 0, 7 and 14 respectively, examined?
No, this was not possible. However, none of the patients complained and there were no PET failures.

- **Dr. Meslin**: Of the 92 people in the study deemed to require PET, 60 received it and none died from rabies.

- **Dr. di Giulio**: How many of the 92 people were bitten by rabies-confirmed dogs?
It was not possible to get brain samples from any of the suspect dogs. However, there is a convincing story that PET did work: a rabies-suspect dog bit three children; two were given the 0.4ml, 0.1ml, 0.1ml schedule and survived; the third child did not receive PET treatment and subsequently died of rabies.

- **Dr. Meslin**: Obviously these are not trial conditions and it is difficult to make definitive statements about the effectiveness of the PET schedule. Concerning the statement by Mr. Nzioka that demand for PET exceeded vaccine availability, by how much was this?
About 75% of patients wanting PET are turned away. Patients presenting at local clinics are told to visit the general hospital, where they are often advised to buy their own vaccine.

- **Dr. Kaboyo**: Does the records of people presenting with snake bites mean that people believe that snakes can transmit rabies?
No, this is an error in the representation of the statistics.

- **Dr. de Balogh**: A general point about people's concept of rabies is that it is caused by a venom and medicine/vaccine is needed to fight the venom.

6) **Dr. Kaboyo: Human rabies at district level in Uganda.**

- **Dr. Wandeler**: I hope that there will be time later in the session to discuss many of the points raised in your presentation. A specific point is that a survey of animal bite treatments and not human rabies cases was presented. How are human cases recorded?
It is true that animal bite cases are what are actually recorded. However, the prognosis column on the form is designed to record bite injuries and can be used to include death due to rabies.

- **Dr. Wandeler**: What do you put in the prognosis column if a patient is brought late for PET and subsequently dies?
You do not put down death due to rabies.

- **Dr. Wandeler**: This is the problem with forms which look complete but the patient dies half a year later. Are these registered at follow-up?
No, but follow-up records are collected, particularly in cases where patients are known to have bitten other humans.

- **Dr. Kitala**: Is the human-to-human biting deliberate?
Yes. Patients are very sick and when they are restrained they may attempt to bite other people. There was one particular case of a rabid young boy who bit his father. The case is being followed up.

- **Dr. Fekadu**: In Ethiopia up to 1% of all PET is given following human bites.

- **Dr. Meslin** : I should like to comment on the treatment decision flow diagram presented by Dr. Kaboyo. The branch between 'suspect animal behaving strangely' and 'suspect animal behaving normally and quarantined' is a little confusing. At what stage is PET started?
In most cases the advice given is that PET is started immediately and then the decision to continue treatment will be based on future developments.

- **Dr. Meslin**: The chart seems a bit misleading. PET should appear much higher up in it. For example, if there is reason to suspect that a dog is rabid, but it is behaving normally, do you still wait ten days before starting PET?
No, but future treatment will depend on the dog's behaviour.

- **Dr. Meslin**: There should never be any delay in starting PET. Observations of dog behaviour are useful for stopping treatment if necessary, but PET should be started immediately and not be postponed for a ten-day observation period.

7) Dr. J. Godlonton: The management of clinical human rabies: the experience from Kwazulu-Natal.

- **Dr. King**: Two comments. Firstly, a patient bitten in Zambia returned to the UK, where virus was isolated from the saliva on four out of five consecutive days; for a further two days no virus was isolated and no antibody was detected; over the following four days a steeply rising antibody level was detected. Therefore, ante-mortem diagnosis can be useful, as it was in this case. Secondly, the impact of this case on the whole of the nursing staff was so traumatic that the protocol of treatment for rabies cases within the UK was reviewed.

- **Dr. Fekadu**: The detection of early IgG and IgM antibodies is possible. Also, the presentation referred to human cases showing 64 and 45 days of severe clinical signs, even though immunisation was administered. In dogs, late immunisation results in a shortening of the infection period. Are the responses of animals and humans different?
  Possibly, but during the short illness period of a rabid dog there is no intensive life-support treatment being administered. The human cases were given intensive care which may account for the extended survival time compared with rabid dogs.

- **Dr. Wandeler**: The difference between the disease in humans and in dogs is also noticeable in the appearance of the brain at post-mortem. The appearance of a brain from a human who was kept alive for an extended period will be very different from that of a dog which dies at a few days. How many of the human cases in Kwazulu-Natal do you suspect of being rabies?
  I have never seen a human case present as anything other than furious encephalitic disease.

GENERAL DISCUSSION

1) **Dr. Wandeler:** Would it be possible for Uganda to expand the level of reporting to get more information about human rabies cases and not just bite exposure?

   - **Dr. Kaboyo**: That is an aim which Uganda is slowly moving towards. Better funding is required to improve rabies diagnostic abilities. We also need to improve the level of reporting. As a starting point, the ability to identify human cases must be improved. At present, diagnosis relies on clinical signs. The system has in the past been more interested in counting how many vaccine doses have been used, rather than looking at the number of rabies cases.

2) **Dr. Meslin**: How should veterinarians and physicians share the responsibility in deciding on PET? There are at present two extreme scenarios: (1) a patient goes to a hospital and the decision whether or not to start PET will be taken by health workers with no veterinary involvement, or (2) a veterinarian will take the initiative and ensure PET is started immediately. A balance between these two extremes is required; it is not right for the veterinarian to be in total charge of the decision. A flow-chart which facilitates exchange of information between the two parties is needed.

3) **Dr. di Guilio**: Flow-charts need to be improved and standardised through gathering feed-back from all parties involved.

   - **Dr. Meslin**: This has happened to a large extent in Uganda?

     Dr. Kaboyo: Yes, since 1991. From a practical point of view, nobody has been refused PET while waiting for the outcome of a suspected rabid animal. The rationale of the flow-chart is explained in local meetings of health and veterinary workers.

   - **Dr. di Giulio**: Perhaps SEARG could work as a catalyst to help develop such flow-charts?

   - **Dr. Robinson**: There is a close similarity between the flow-charts developed in Kwazulu-Natal and Uganda, particularly with respect to management and veterinary/medical interactions. However, both systems still require improvement.

- **Dr. Wandeler**: Reference charts already exist at WHO. Why are they modified? Is it because PET is administered in schedules not recommended by WHO and too many people would require PET?

4) **Dr. Meslin**: Too much importance seems to be given to vaccination status of suspected rabid dogs. This does not follow WHO recommendations. For example, in Swaziland, biting dogs are considered normal.

5) **Dr. Dlamini**: Too many PETs would be given if you did not distinguish between those people bitten by normal healthy dogs and those in need of anti-rabies treatment. Similarly, in Malawi, vaccination is based on the vaccination status of the suspect dog.

6) **Dr. Meslin**: You can reduce vaccine wastage by improving the flow-chart.

7) **Dr. Githaiga**: What is the role of private medical practitioners? In Kenya, people will often go for PET at private clinics rather than hospitals, due to vaccine availability. This leads to a reduction in the amount of data on human cases. How do you ensure that private practitioners make this important data available?

8) **Dr. Meslin**: Regulations are not the complete answer in ensuring this.

9) **Dr. Kitala:** How much vaccine does Rhône Poulenc sell in this country?

- Rhône Poulenc Representative: 20,000 doses in the private sector, 4-6000 doses in the public sector.

10) **Dr. Meslin**: It is difficult to get complete information from the private sector, even in Switzerland!

11) **Dr. Cleaveland**: How late is too late? It is a common problem in Tanzania that patients present with bite wounds often months after the incident. How long after being bitten is it acceptable to start?

- **Dr. Godlonton**: It is common for patients to come to hospital several weeks after being bitten because the animal had been only suspected of having rabies. RIG should only be administered if the wound is still treatable as on day 0. Therefore, the answer is about 72hours after being bitten, although Dr Swanepoel believes up to 7 days. Vaccine should be administered at any stage. Heightened vaccine therapy should be administered on the first day of presentation.

- **Dr. Wandeler**: Regrettably, I must contradict Dr. Godlonton. The course of rabies pathogenesis suggests that during the incubation period the virus is located in the muscle fibres. The virus migrates from the cells via the motor end plates to enter the nervous system. RIG cannot penetrate cells but can prevent movement from muscles to motor end plates.

- **Dr. Meslin**: The WHO recommends that PET should never be withheld, regardless of the length of delay between being bitten and presenting at hospital. Full treatment, including RIG, should always be given,

- **Dr. Godlonton**: Should the vaccine dose be increased for late bite management?

- **Dr. Meslin**: No, this advice was abandoned in 1989/90 as there was no supporting evidence.

12) **Dr. Perry**: Referring to the point about intradermal and intramuscular cost differences, the comparison presented by Dr. Meslin was artificial because vaccine reconstituted for the intradermal route cannot be kept for longer than a few hours.

- **Dr. Meslin**: The intradermal route should be used in clinics with a high turnover rate of patients, so that vaccine is not wasted. On average, a full PET using the intradermal route will use two 0.5ml vials of vaccine, compared to five vials used for the full intramuscular course of treatment.

- **Dr. Perry**: Thank you for the clarification. It is important to realise that there is not a simple comparison of the volume of vaccine injected. Also, there are hidden costs associated with the intradermal route, such as the training required for health workers, which was a point raised by Dr. Robinson. Finally, if manufacturers produce vials of one tenth of the volume, they will not be sold for one tenth of the price.

Rabies in humans and animals at the wildlife/domestic carnivore interface

RABIES AS A THREAT TO THE ENDANGERED ETHIOPIAN WOLF (*CANIS SIMENSIS*)

Karen Laurenson[23], Fekadu Shiferaw[24] and Claudio Sillero-Zubiri[25]

1 INTRODUCTION.

As a species becomes more rare and thus more endangered, its remaining individuals are likely to become confined to a few small and fragmented populations. Such small populations are vulnerable to epidemics of disease and, virtually by definition, small populations are unable to support in the long term species-specific pathogens that are a major threat to their viability (Dobson and Miller, 1989). Thus generalist pathogens such as rabies, which can infect a wide range of species, pose the greatest threat to endangered species. In recent years it has become apparent that rabies can be a real threat to endangered species, with mortality in African wild dogs (Alexander *et al.*, 1993; Gascoyne *et al.*, 1993) and Blandford's foxes (Macdonald 1993) which survive in small fragmented populations. This has given a new dimension to concerns about rabies as a conservation issue.

The Ethiopian wolf is endemic to Ethiopia and is the world's most endangered canid. Less than 400 individuals now survive in six fragmented populations in the afroalpine highlands of Ethiopia and only two of these populations may be viable in the long term. The species is ultimately threatened by habitat loss as expanding human populations push into afroalpine habitat. Nevertheless, canid diseases, particularly rabies, are the most immediate threat to the largest remaining population in the Bale Mountains National Park and may also be threatening other populations. This paper briefly outlines the problem that rabies has posed to the critically endangered Ethiopian wolf, presents data on the incidence of rabies and the size and dynamics of the dog population around the park and outlines the future actions that will be taken.

1.1 Background to the problem.

The Bale Mountains National Park (BMNP) lies in the south-eastern highlands of Ethiopia and includes some 1000 km^2 of land over 3000 m, being thus the largest area of afroalpine habitat on the continent (Hillman 1986). The local communities who live around the area are Muslim agropastoralists who rely on cultivating barley and their herds of cattle and sheep for their livelihood. Some 2500 people live inside that park, some on a seasonal basis, and are accompanied by their domestic animals, including domestic dogs. These dogs can come into contact with Ethiopian wolves and hybridisation has occurred (Gotelli *et al.*, 1994).

The BMNP harbours the largest wolf population with the two areas of prime habitat separated by some 15 km of lower quality habitat (Figure 1). This population declined from its apparent peak in the 1980s of some 500 individuals, to some 120-160 animals in 1995 (Figure 2). In 1990 and again in 1991/1992, one of us (CSZ) found that many wolves had disappeared and observed others dead or dying (Table 1). Clinical signs included ataxia, anorexia and convulsions (Sillero-Zubiri *et al.*, 1996). Within 3 months in 1990, 12 of 23 known individuals on the Sanetti plateau in the north west of the park died or disappeared. Over five months in 1991-1992, 41 of 53 known wolves in five packs died or disappeared in the Web valley in the north east of the park. Three of the six Web Valley packs were decimated and eventually disintegrated. Close correlation between rates of known mortality and unaccounted wolf disappearance was evidence that missing wolves died of similar causes to the ones found dead. Hybrid wolf/dogs survived better than pure wolves, but we do not know whether this can be explained by better resistance to rabies or to a lower chance of exposure. Rabies Serotype 1 virus of canid origin was isolated from three brain samples collected from wolves.

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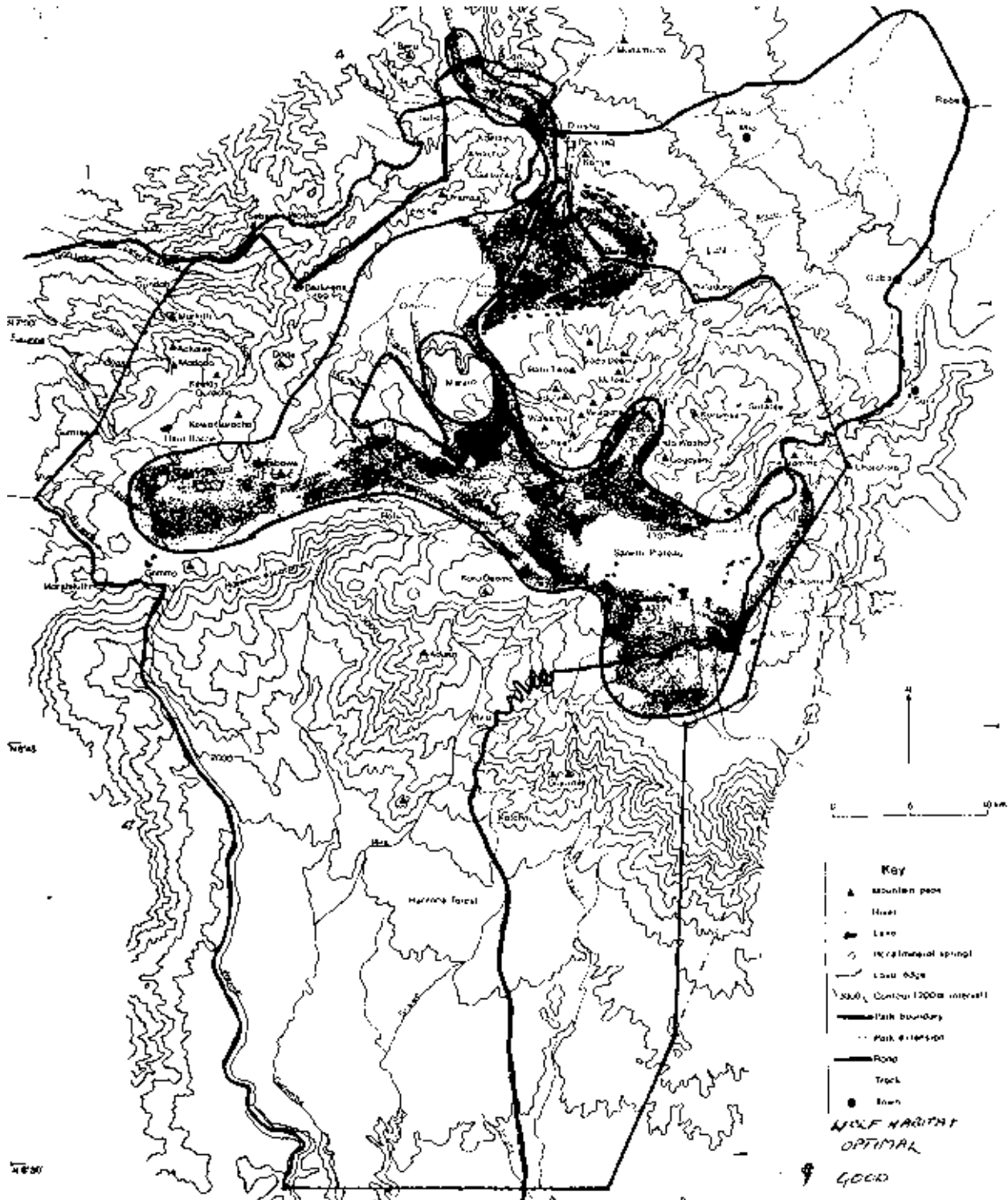**Figure 1 : Ethiopian wolf habitat, Bale mountains National Park**

Table 1 : Rabies in the Ethiopian Wolf Population Bale Mountains National Park*

| metapopulations	Year	Mortality	
Web Valley	1991/92	41/61	77%
Sanetti Plateau	1990	12 /23	52%

Survivors: Wolves 1/16
Hybrids   3/3 (Fisher Exact Probability=0.004)
Rabies virus (Serotype 1 canid origin) isolated from three wolf brains tested.
* Source: Sillero-Zubiri, King and Macdonald., 1996, J. of Wildlife Diseases 32:80-86.

Between 1992 and 1995, the wolf population declined further (Figure 2). Anecdotal reports from local communities revealed a widespread epidemic in domestic dogs inside the park in 1993, with clinical signs consistent with infection from canine distemper virus. A limited serological survey of survivors and other dogs revealed seropositivity in dogs born before the epidemic, but no evidence of antibodies to CDV in dogs born since 1993. Whether this epidemic affected sympatric Ethiopian wolves is un-known, as no monitoring was carried out at that time.

Figure 2 : Ethiopian wolf monitoring index, Sanetti plateau, Bale Mountains National Park
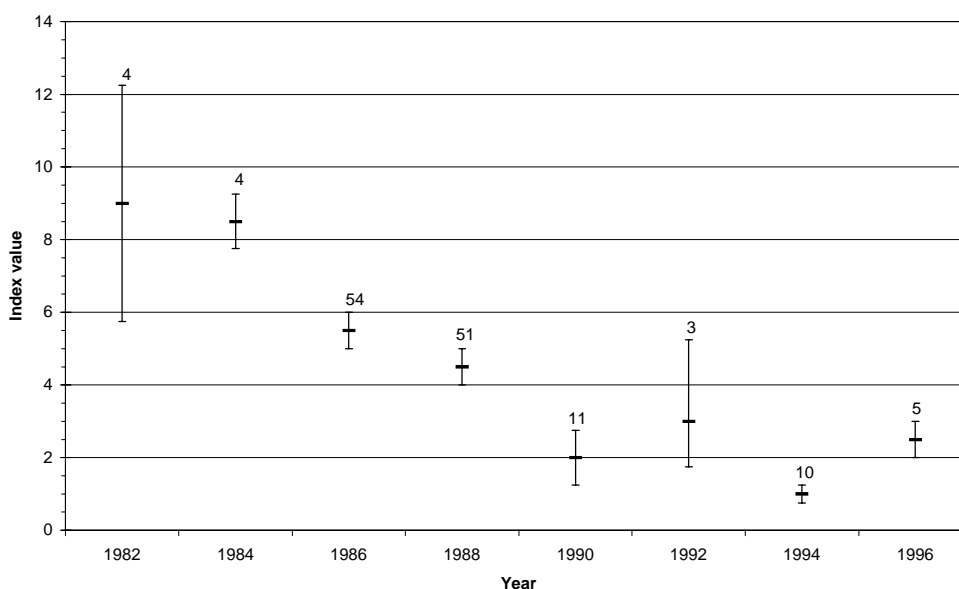
2 METHODS.

Questionnaire surveys were used to estimate both the incidence of rabies and the demographic char-acteristics of local rural and urban dog populations. In three towns (Dinsho, Goba, Robe) and three rural areas around Dinsho, 30-70 households were sampled randomly. If dogs were owned by the household, a more extensive questionnaire was carried out to estimate the number of dogs owned, their age, sex, reason for ownership etc. The size of all households was established and details of rabies cases that interviewees had seen or heard about were collected. Further details were collected from owners of all dogs vaccinated in a trial vaccination programme in two areas.

Dog population sizes in each area were estimated from the dog : human ratio, a technique adopted in several studies (Wandeler *et al.*, 1988; Brooks 1990: Matter 1991; Cleaveland 1996). Human popula-tion estimates for 1996 in each warida in the region, broken down into rural and urban areas, were obtained from local administrative offices. Estimates of the number of households in each kabele, or the population size, were obtained from the chairman or other official of each kabele studied. Some difficulty was encountered in obtaining these figures and their accuracy may be suspect; estimates of the town population sizes varied between sources.

Population age structures were determined for urban and rural dog populations, by plotting $\log_e$ (pro-portion in age class) by age class. The reciprocal slope of these plots, $1/b$, calculated by Microstat 3, gave a measure of the birth interval, which in a population with a stable age distribution is equivalent

to life expectancy. Population growth was estimated from questionnaire data as follows, where N_{96} = present dog population size of sampled households, n_n = number of dogs acquired in previous year and n_d= number of dogs died or lost in previous year:

$$\text{Change in population} = \frac{n_d - n_n}{N_{96} - n_n + n_d}$$

3 RESULTS AND DISCUSSION.

3.1 Rabies epidemiology.

There were no recent records of confirmed rabies cases in any species in the area. However, this in no way reflects the true picture of rabies incidence, for two reasons. First, few sick dogs were taken to the veterinary clinic and local people thought that they could recognise the clinical signs of rabies and tried to kill animals with clinical signs as soon as possible. Second, if cases were presented to clinics, there were few storage facilities for samples and the diagnostic laboratory was over 400 km away. Veterinarians usually made a diagnosis on clinical grounds and arranged to have the animals destroyed.

However, interviews with local residents and personal observations suggested that rabies was endemic in the Bale region (Table 2). These data suggest that the incidence of rabies in dogs, livestock and humans is very high in the area adjacent to the BMNP, with a conservative estimated annual incidence of 0.83-2.25 humans and 1199-2123 dogs per 100000. Livestock losses were estimated to be up to 1 cattle death per 12 households per year, equivalent to US $7.5 per household per year, a significant proportion of the GNP.

Table 2 : Estimated incidence of unconfirmed canine and human rabies cases, Bale Region.

Area	Estimated incidence of canine rabies /100000/year		Estimated incidence of human rabies /100000/year	
	Most conservative estimate	Least conservative estimate	Most conservative estimate	Least conservative estimate
Urban	2123	5613	0.87	3.51
Rural	1199	2167	2.25	45.0

(Most conservative estimates of incidence in dogs were calculated from the total number of rabies cases reported in last year, but using only one case each month. Least conservative estimates included reports of more than one case per month, but excluded replicated reports where possible. For humans, most conservative estimates are based on the assumption that all cases in last 3 years were reported and maximum population estimate. Least conservative estimates use minimum population estimates and only cases reported in last year).

Incidence comparison is difficult because reported WHO (1992) figures refer only to confirmed cases. The most accurate comparison is probably the incidence of human rabies, as such cases are noteworthy in the community and are generally diagnosed on clinical grounds by trained personnel. On this basis, the incidence of rabies in the Bale Region is as severe as any region in the world, being comparable to that in the Indian subcontinent and higher than in most other parts of Africa.

Older inhabitants (> 50 years) were asked if the incidence of rabies had changed over their lifetime. Of 12 such interviewees, 83% thought that rabies was now more common. Accounting for the reason behind this increase, five respondents suggested that human and thus dog numbers had increased, four suggested that dogs were not as well cared for now, one person said that the dogs did not get enough food and so could not fight off diseases and one suggested that there were now more common jackals and that they were the rabies reservoir. In addition, one person added that the spatial demographics of the human and thus dog population had changed, as well as increased, so that there was now more contact between dogs. Three respondents did not know why rabies might have increased.

Unconfirmed rabies infections were reported as the most common cause of mortality in dogs, accounting for an estimated 20% of dog deaths overall, where deaths due to poisoning in dog control

campaigns were included. Excluding this cause of mortality, rabies accounted for 25.5% of dog deaths.

Rabies was well know by community members, with 93% (n=227) reporting that they were aware of rabies as a public health and economic problem. Indeed, 67% of owners cited rabies transmission as the major disadvantage of owning a dog. Significantly more people in rural than urban areas had seen animals with the disease (Fisher exact probability, p=0.04). Of 25 people questioned in more detail, 19 (76%) could describe accurately the clinical signs associated with rabies and knew that there might be both 'mad' and 'dumb' forms of the disease.

Approximately 85% of interviewees, including owners and non-owners of dogs, thought it would be good to try to control rabies in the areas by dog vaccination, although many people did not know that vaccination was a rabies control method before being interviewed, nor understood how vaccination worked either in humans or animals. Six respondents raised the issue of wildlife reservoirs for rabies in the area, because they had seen some wild species, particularly common jackals and genets or mongooses, with symptoms of rabies. They asked how rabies in these wild species could be controlled, as, in their understanding, controlling the disease in dogs would not completely protect their cattle.

3.2 Dog demography.

There were significantly more dogs per household and dogs per human in rural areas around Dinsho than in the urban centres of Dinsho, Robe and Goba, with rural dog density averaging 16.0 dogs per km^2 and urban dog densities at 290 per km^2 (Table 3). However the dog:human ratios were lower in rural than in urban areas at 1:4.6 and 1:14.3 respectively. In addition, an estimated 125-175 dogs live inside the park in Ethiopian wolf habitat for at least part of the year.

Dog populations were male biased in urban areas and in high density rural areas, but less biased in the lower density rural areas (Table 3). Male bias was achieved by leaving female pups out in the countryside at 4-6 weeks of age. These pups either starved to death or were eaten by predators. Occasionally they would be rescued and taken into someone's home.

Table 3 : Demographic characteristics of dog population of Bale region, Ethiopia

Landuse	Dog density(km^{-2})	Dog/human	Sex ratio(M/F)	Annual change in size of dog population
	Mean *(range)*	Mean *(range)*	Mean *(range)*	Mean *(range)*
Urban	290 *(230 – 380)*	1:14.3 *(1:10.8-1:16.7)*	0.83:0.17 *(1:0.22 - 1:0.16)*	+7.7 *(-17 - +40)*
Rural	16 *(10.3 - 23.7)*	1:4.6 *(1:4.1 - 1:4.8)*	0.63:0.37 *(1:0.82 - 1:0.33)*	+7.5 *(+2.1-+17.6)*

The dynamics of the dog populations varied between different areas with negative population growth or no growth in urban areas such as Robe (0%) and Goba (-17%) where dog control programmes had been carried out within the year previous to the survey. In contrast, the dog population in Dinsho had increased markedly (40%) in the previous year and the rural populations had, on average, increased by 7.5%. This level of increase would lead to a doubling of the population in approximately 10 years.

The median age of both rural and urban dog populations was 2 years (Figure 3) although the turnover rate (the percentage of the population less than 1 year old) in the rural population was slightly higher (26%) than in the urban dog population (18%). The average life expectancy of the rural dogs was 2.8 years, whereas that of urban dogs was 2.7 years.

4 CONCLUSION AND ACTION PLAN.

Dog density in the Bale region is high in both urban and rural areas, well above the apparent threshold for rabies endemicity (Cleaveland and Dye, 1996). Anecdotal reports suggest that its prevalence has increased from epidemicity to endemicity over the last 40-50 years, with an increase in the number of people and their dogs. The human population has also expanded into areas of prime wolf habitat and it is likely that for wildlife in the Bale region and Ethiopian wolves in particular, rabies is a human-associated problem that is increasing. The high rate of mixing of the dog population, at least on the north-western side of the park, and the degree of overlap and contact between domestic dogs and wolves, means that the probability of rabies and other canid diseases invading the Ethiopian wolf population is significant.

Preliminary models to examine the consequences of periodic disease outbreaks for the persistence of Ethiopian wolf populations were constructed (Mace and Sillero-Zubiri 1997). These suggested that the Bale Mountains' wolf populations was very likely to become extinct within 50 years when rabies epidemics occurred at a frequency of 1 every 7 years on average. With a lower frequency of rabies epidemics, the wolf population was less likely to become extinct, although extinction was again almost certain when canine distemper epidemics were introduced.

Figure 3 : Age structure of domestic dog population, Bale region
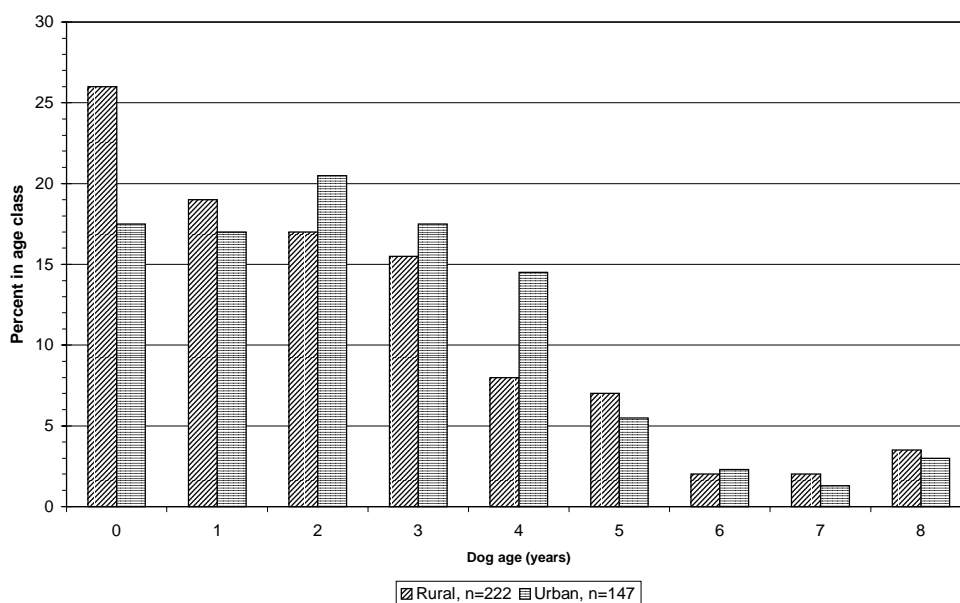
Thus rabies and other canid diseases should be perceived as a real threat to the continued existence of the Bale Mountains Ethiopian wolf population and of the species generally. Management of canid diseases must be included as an important part of any action to help conserve this endangered species. The Ethiopian Wildlife Conservation Organisation and the IUCN Canid Specialist Group therefore decided on a short and long term strategy to ameliorate the situation (IUCN Ethiopian Wolf Action Plan 1997; Laurenson and Sillero-Zubiri, 1997). In the short term, vaccination of domestic dogs inside and immediately adjacent to Ethiopian wolf habitat was recommended to give the existing population an improved chance of recovery. In the longer term, it was recommended that both disease and dog control should be improved by:

> an owner education programme to encourage responsible dog ownership

> a large scale rabies vaccination programme that would both benefit the local community and conservation objectives

> a programme to improve dog population control.

In addition, it was recommended that the following should be investigated:

the threat that canid disease posed to other wolf populations should be investigated

the role of wildlife in the persistence of these generalist canid pathogens, particularly rabies and canine distemper

the role of vaccination of rabies and other canid viruses on dog population dynamics.

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RABIES SURVEILLANCE IN WILDLIFE POPULATIONS AT THE WILDLIFE/DOMESTIC ANIMAL INTERFACE; A CASE STUDY IN KIBWEZI, KENYA

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1 INTRODUCTION.

Dog rabies has been the dominant type of rabies observed in Kenya since the first case was diagnosed in 1912. However, there has been a low but consistent number of positive cases from wildlife species over the years (Kariuki *et al.*, 1985; Binepal *et al.*, 1991). Although rabies (and canine distemper) have been suspected to be the major killers of the endangered wild dog in the Maasai Mara (Alexander *et al.*, 1993), surveillance for the disease in wildlife has never been well developed.

A wildlife reservoir of rabies has been suspected to be the cause of the persistence of rabies in localities in Kenya even during periods when the disease was well controlled in the rest of the country. Kibwezi Division in Makueni District (formerly under Machakos District) has reported a consistently high number of rabies cases even in the early 1970's , a period when rabies was best controlled in Kenya. The role that wildlife played in the maintenance of the disease at that time has always been suspected but never seriously studied, and this study was established with the aim of investigating its present role.

Because the study was limited in time and resources we relied on quick, cheap and robust surveillance methods. We used four different methods. The first method was to continue an active surveillance method established by Kitala *et al.* (1994) in this area and specifically note all reported wildlife cases captured by that programme. Secondly, to maximise the number of wildlife samples for rabies diagnosis, we collected animals killed by vehicles along the Nairobi-Mombasa highway. The third method was to conduct a survey of randomly selected households to establish the presence and relative abundance of wildlife in the study area and their contacts with humans and domestic animals. This also allowed for information on the wildlife species observed to be in closest contact with dogs. Finally, we trapped wildlife near homesteads to further determine which wildlife species had close contact with dogs and humans and to obtain samples from these for rabies diagnosis.

2 MATERIALS AND METHODS.

2.1 Study area.

The study was conducted in Kibwezi Division of Makueni District. Kibwezi Division covers approximately 3400 km^2 and lies between longitudes 37°55" and 38°5" East and between latitudes 0°20" and 0°30" South. The elevation averages approximately 900m above sea level. The area has a bi-modal pattern of rainfall with most rain falling in the months of March - April and November - December. Annual rainfall usually ranges between 500-1000 mm. The primary vegetation consists of wooded bushland with baobab trees being a common and noticeable feature. The population density is 49 people per km^2 (1989 census). Most people live on small holdings of about 5 - 10 hectares (Jaetzold and Schmidt, 1983). The principal livestock species raised are goats, sheep, zebu cattle and local free-ranging chickens. The average herd size of grazing livestock is between 5 and 10 livestock units per household. The principal crops grown are millet, sorghum and maize. There is a large sisal estate in

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the area but none is grown by the smallholders. Tobacco and cotton are grown for local consumption. The dog density in the area is 10 dogs per km^2 with 35% of the households having at least one dog and an average of 2.12 dogs per dog owning household (Kitala *et al.*, 1994).

The area borders the Chyulu National Reserve to the west, Tsavo West National Park to the south, and Tsavo East National Park to the south-west across a tributary of Athi river. Thus, the division is surrounded on 3 sides by wildlife reserves. Formerly, Kibwezi Division was largely unsettled and wildlife roamed freely in the area. But in the last 20 years, many new human settlements have been established and the larger wildlife species have almost been completely displaced. However, small wild carnivora still remain and there are quite large populations of genets, various mongoose species and the African civet. Occasionally, large wild animals migrate through the area as they move between the parks adjacent to the area.

This study was conducted in four sub-locations, Mukaange, Utithi, Mbui Nzau, and Mikuyuni. These sub-locations were chosen because of their proximity to the Nairobi - Mombasa highway, so that information gathered in the questionnaire would approximate the wildlife population from which road-kill carcasses were collected.

2.2 Retrieval of samples from households and road kills.

Four rabies workers were locally recruited in consultation with community leaders. Each worker was vaccinated against rabies (Vero - Rab, Rhone-Merieux) and given training on obtaining and recording information on suspected rabies cases in humans and animals. The rabies workers were given forms to record all wildlife killed in homesteads and to submit samples collected for rabies testing.

The rabies workers patrolled the Mombasa - Nairobi highway daily between 6.00 am and 7.00 am to collect heads of any animals killed by vehicles over the previous 24 hours. A 30 km section of road between Mbui Nzau and Machinery markets was checked each day. In cases where heads were crushed completely an attempt was made to collect brain or spinal cord material and place them in transport media from WHO kits. Intact heads were collected in polythene bags and stored in a freezer at the Kibwezi veterinary office until they could be transported to the Veterinary Research Laboratory, Kabete, for diagnosis by FAT.

2.3 Household questionnaire survey.

In each sub-location, a list of all the households was compiled through village elders (each sub-location is divided into villages, whose number differ per sub-location, each headed by a village elder). These village lists were combined and 50 households were randomly selected from each of the sub-locations for inclusion in the survey. At each selected household, the household head or other adult present was interviewed. In most households, children, who were usually with dogs and thus observed most wildlife contacts, were also present and were questioned on the presence and relative frequency of encounters with different wildlife species. The questionnaire consisted of a Table of different wildlife species with their Kikamba names and indicating the frequency of sightings, estimated number seen and the time-of-day and the season most frequently seen.

2.4 Wildlife trapping.

Ten of the surveyed households in each sub-location were randomly selected for live trapping of wildlife. Cage traps, made according to specification given by National Live TrapR (Wildlife restraint series, 1991) were used. The dimensions were determined by the general sizes of the animals expected to be trapped. All traps used were 100 x 40 x 40 cm. Traps were set for 3 to 4 nights on each selected household. Initially, the number of traps varied between 1 and 3. With experience it was found that one trap per household was adequate after trapping success was found not to vary with number of traps per household. The location of the trap was varied on different nights with the trap usually in close proximity (not more than 300 m) to the homesteads. Initial trappings were most successful when the owner advised on the trap locations. Thus, in subsequent trappings householders determined the trap locations, usually on paths leading to the homestead. This maximised the trapping of animals that were most likely to contact domestic animals and humans. Different baits were used initially, but it quickly became evident that most species trapped were small carnivores, attracted by chickens in the homesteads. Thus, fresh pieces of chicken were used as bait for most trappings.

Once trapped, the animals were anaesthetised using ketamine (Ketaset, Fort Dodge USA) alone or in combination with xylazine (RompunR , Bayer, Leverkusen, Germany). The doses were varied to determine the most suitable regime for each species using guideline reference values given by the Wildlife Restraint Series (1991) (Miscellaneous small mammals, Ketamine HCl (Ketaset, Fort Dodge USA) 2.5-5 mg/kg). After anaesthesia the animals were bled and their body measurements taken, and then euthanazed with 150 mg pentobarbitone sodium (J. M. Loveridge plc Southampton, England). Initially, every 3rd animal trapped was to be released after marking to estimate a rate of recapture but this was later abandoned due to low trapping successes. The head was either carried whole in ice to the laboratory or a brain sample taken using the straw method and samples placed in WHO kits for sample transportation under room temperature.

3 RESULTS.

3.1 Active surveillance in households.

Samples from all animal species were collected as part of an active surveillance programme over a 9 month period. Wildlife constituted 15% (9 of 57) of the samples. The species of wildlife involved were the genet (*Genetta genetta*), common mongoose (*Herpestes* sp.), bushbaby (*Galago senegalensis*), jackal (unspecified sp), honeybadger (*Mellivora capensis*), canerat (*Lophiomys imhause*) and porcupine (*Hystrix galeata*). Each species was represented by one or two samples. None of these samples tested positive for rabies by FAT.

3.2 Retrieval of samples from road-kills.

A total of 151 wildlife carcasses were found on the section of road surveyed over the 9 month period of the study. Of these, 66 yielded brain samples which could be submitted for rabies diagnosis. Three of these samples were positive under FAT. Fifteen different wildlife species were identified among the 151 wildlife carcasses found.

3.3 Household questionnaire survey.

The white tailed mongoose (*Ischeumia albicauda*), the common mongoose, the squirrel (*Paraxerus* sp.) and the genet were the most common species of wildlife sighted by people in the study area. Domestic cats (*Felis catus*) which had gone wild were also very commonly sighted. Larger carnivores like jackals, hyenas, lions and leopards were said to be only rarely sighted though there were reports of occasional movement of these animals from the surrounding National Parks and Reserves. The civet (*Viverra civetta*) had a frequency of sighting intermediate between that of the small and the large carnivores.

3.4 Wildlife behaviour patterns.

The white tailed mongoose, civet, genet, hyena (unspecified sp), and lion (*Panthera leo*) were all considered to be nocturnal. Most respondents said they saw the leopard (*Panthera pardus*) and the squirrel only during the day while the common mongoose, caracal and wild cats were generally thought to be seen at any time of day or night. Only the hyena and the lion were thought by the majority of respondents to be sighted on a seasonal basis with the majority of people saying that they sighted them during the wet season. Other species were sighted year round (Table 1).

A total of 114 households (56% of all households) reported sighting animals with "abnormal" behaviour. The white tailed mongoose was the most common species reported as exhibiting abnormal behaviour, with 80% of households reporting encounters with a white tailed mongoose showing at least one category of abnormal behaviour. The majority of these reports described aggressive behaviour towards people. Only 7 (6.7%) of all animals showing abnormal behaviour had signs of mania, a category of behaviour that could be closely associated with the furious type of rabies. Of these, 3 were white tailed mongoose.

Table 1 : Summary of frequency, time and season of sighting of wildlife species observed in 200 randomly selected homesteads in Kibwezi Division, Makueni District, Kenya, June 1995

Species	Frequency of sighting [a]	Mainly seen at [b]	Main season[c]
White tailed mongoose	High	Night	All
Common mongoose	High	Any	All
Squirrel	High	Day	All
Civet	Low	Night	All
Genet	High	Night	All
Hyena	Low	Night	Seasonal
Jackal	Low	Night	All
Lion	Low	Night	Seasonal
Leopard	Low	Day	Any
Caracal	High	Any	Any
Wildcat	Low	Any	Any

[a] High if more than 50% of the respondents said they saw the animal either daily or weekly

[b] A specific time is listed if more than 50% of the respondents felt that the animal was seen during a particular time that was considered to be the main time the animal was seen

[c] If 50% said they saw the animal in a particular season that animal was considered to be seasonal

3.5 Wildlife/ domestic animal contact.

Seventy-one percent (143 of 202) of the households reported having heard or witnessed dogs fighting with unspecified wild animal species. Seventy percent of these reported having heard these fights at least weekly. The majority of the respondents could not positively identify the species of wildlife that fought with their dogs though many assumed that it was the white tailed mongoose or the honey-badger, which are known to frequent the households and are naturally aggressive.

3.6 Wildlife trapping.

A total of 23 animals were trapped in 21 households from 79 attempts. Twenty four trapping attempts were made in Utithi sub-location, 21 in Mukaange and 24 in Mbuinzau and Mikuyuni combined. Nine animals were trapped in Utithi, 5 in Mukaange and 9 in Mikuyuni and Mbuinzau combined. This gives a trap success rate of 9%. Eleven of the animals were white tailed mongoose, 11 were genet and 1 was a common mongoose. All were FAT negative.

4 DISCUSSION.

Retrieval of samples from households using the active surveillance method

The number of samples collected from wildlife in the active surveillance programme was small and in our opinion this type of active surveillance in communities would need to be supplemented with other methods for a satisfactory estimation of rabies incidence in wildlife populations. However, the method can provide specific evidence of rabies transmission between wildlife and human and animal populations, particularly if outbreaks of rabies occur and has shown efficacy as a system for monitoring dog rabies (Kitala *et al.*, 1994). Thus any wildlife cases uncovered would be secondary to this primary benefit. Parameter estimates of importance in this respect would be the relative timing of increased case reports in domestic animal and wildlife populations and the average number of secondary contacts made by an initial rabid wild or domestic animal and other animals.

4.1 Retrieval of samples from road-kills.

The number of wildlife samples collected from road-killed animals indicates that along a busy highway, this could be a useful method for relatively easily obtaining wildlife species for disease surveillance. The yield of samples obtained during the study period varied mainly by the availability of bicycles and time of day the road was searched. To cover sufficient distances bicycles were essential. Bicycles allow increased distances to be covered while allowing for closer investigation of road-sides as well as the main road surface. We found that the time in the morning when the workers went out determined the state in which the carcasses would be found. Most animals are hit on the road at night. When workers began searching between 5.30 and 6.00 am the number of carcasses from which brain material could be recovered for rabies diagnosis was much higher than when they began searching at 7.00am or later. This is because many vehicles drive after first light and completely crush carcasses killed during the previous night and early morning.

This form of opportunistic sample collection is very well suited for assessing trends in disease incidence over time, in agreement with findings from elsewhere (Woolf *et al.*, 1986). We think it would be very well suited to monitoring both endemic and epidemic rabies and to estimate the relative timing of the percentage of rabies (or other disease) positives in different wild and domestic animal species, a potential indicator of the inter-species transmission of rabies.

4.2 Household questionnaire survey.

4.2.1 Frequency of sighting of wildlife.

Although somewhat subjective, the questionnaire method of estimating relative density of animals appeared to us to provide a useful indicator of the relative abundance of species of animals difficult to count due to their size and behaviour patterns. The species of wildlife trapped on homesteads corresponded well with those species said to be most commonly sighted by local people.

By this method it was also possible to identify the species of wildlife in closest contact with the domestic dogs and thus indicate the most likely species which could act as a reservoir of rabies given the right conditions (as for example for jackal rabies in Zimbabwe (Bingham (1997) in this volume)). Based on this study, the species of wildlife with greatest potential to act as reservoirs include white tailed mongoose, the common mongoose and the genet. These species are also in closest contact with the dogs and occur in population densities which might support transmission. However, more detailed ecological studies of these species would be required to estimate parameters for rabies transmission modelling.

From a more general wildlife conservation and management perspective, household questionnaires also provide other benefits. They could be particularly useful in initiating dialogue between communities and wildlife personnel. They provide information for wildlife staff to understand community perceptions of wildlife in their area and can be an important guide for community discussion and education efforts.

4.2.2 Wildlife behaviour patterns.

The questionnaire also provide useful information on the common patterns of behaviour of wildlife in closest contact with domestic animal and human populations. Because the observations are subjective, we have used them as relative rather than absolute indices. From their responses, it was convincing to us that local people observed wildlife closely and did notice the behaviour of wildlife. We see two potential applications for this local knowledge. The first is to help refine the design of ecological studies relative to rabies transmission and the second is to help in the assessment of post-exposure rabies treatment based on the contact species usual behaviour pattern.

While local knowledge of wildlife behaviour could be informative, most people were not experts and would invariably use their observation of the behaviour of domestic animals as a basis of comparison for wildlife behaviour. Thus, when they described a wild animal's behaviour as "abnormal" this was usually relative to behaviour of their dogs. However, they did note species-to-species differences, identifying white-tailed mongooses and honey badgers as particularly aggressive species.

Local residents also concurred on the hunting behaviour of wildlife species most likely to contact them. This further points to the white tailed mongoose and other small carnivores which hunt for chickens in

the households as species which come into constant contact with domestic dogs. The frequent fights between these carnivores and the dog probably provide more-than-sufficient contact for rabies transmission between dogs and these species.

4.3 Wildlife trapping.

Wildlife trapping was a very labour intensive exercise that yielded only modest results. The success rate of trapping depended on the position of the trap and the bait used. The paths leading to the homestead were found to be good locations to position traps. After trying out different types of meat from butcheries, it was found that pieces of freshly killed chicken were most preferred by the white tailed mongoose and the genet. It would be possible to use traps to estimate the population of wildlife in the area using capture - mark - release-recapture methods but based on our experience this would need to be done in a relatively small area for a sufficient length of time. Initially, we attempted to mark and release animals that had been trapped. Three animals, one white tailed mongoose and 2 genets, were marked by tattoos and with transponders but none were re-trapped. The low success rate of trapping, within the resource and time limitations faced, made us abandon attempts to estimate population sizes.

The types of bait used need further refining depending on the species one is interested in. Chicken meat was continued as the bait throughout this trapping study because it gave good results in trapping the white tailed mongoose and the genet but apparently it is not ideal for other species, as none other were trapped. A few attempts to use maize grains to attract squirrels were unsuccessful (a guinea fowl was caught instead). Also the type of trap used was probably not ideal for trapping squirrels. Local people are quite successful (P.M. Kitala, personal communication) in trapping squirrels but we had insufficient time to pursue this.

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DOMESTIC DOG VACCINATION STRATEGIES AROUND THE MASAI MARA NATIONAL RESERVE, KENYA

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ABSTRACT

The feasibility of controlling rabies in a rural, domestic dog population thorough mass immunisation was investigated in a study area bordering the Masai Mara National Reserve, Kenya. A comparison was made of the effectiveness - in terms of population coverage and time requirements - of two vaccination strategies: central-point and door-to-door. Based on an initial mapping exercise the study area was divided into two Sections (1 and 2) which contained comparable numbers of Masai homesteads (71 in Section 1 and 84 in Section 2). In Section 1, the vaccination campaign was conducted at each homestead. In Section 2, the campaign was associated with the annual cattle vaccination programme and owners were instructed to bring their dogs to centralised livestock immunisation points. For both strategies, vaccination was preceded by intensive publicity. In total, there were 629 domestic dogs recorded, 539 of which were old enough for rabies vaccination. Significantly greater vaccination coverage was achieved with the door to door campaign (64.5%, 189 out of 293) than the central point programme (4.3%, 48 out of 336; P < 0.001). For both strategies there was no significant variation in vaccination coverage by either age or sex of dog. In Section 2, vaccination coverage was negatively correlated with the distance from the central point; a 1 km increase in distance from the immunisation point resulted in a 95.3% reduction in coverage. The average man-minutes per vaccinated dog was also lower with the door-to-door strategy (81 minutes per vaccinated dog) compared to the central point campaign (300 minutes per vaccinated dog). The results of a follow-up survey conducted one year after the vaccination campaigns indicated that 29% of the dog population had not been reported at the time of vaccination campaigns. Adjusting for this initial under-reporting the levels of vaccination coverage were estimated as 39% and 8.6% for the door-to-door and central point strategies, respectively. The implications of the study findings for the long-term control of rabies in Masai Mara region are discussed. On a more general level, the results question the usefulness of conducting annual mass immunisations campaigns in low density rural dog populations, and possible alternative rabies control strategies are considered.

1 INTRODUCTION.

The domestic dog population adjacent to the Masai Mara National Reserve (MMNR), Kenya, is a potential source of rabies infection to the human, domestic livestock and wildlife populations (Alexander et al 1993). Other viral pathogens maintained in domestic dog populations, most notably canine distemper virus (CDV), may also have serious conservation implications if they cross into wildlife populations. Vaccinating dogs against rabies, and other canine diseases, may therefore be considered both a human and veterinary public health intervention, with possible wildlife conservation benefits. Given the importance of rabies control in the Masai Mara region, a joint research initiative between the Kenya Wildlife Service (KWS) and Kenya Agricultural Research Institute (KARI) in collaboration with the Narok District Veterinary Services (NDVS) was established to assess the accessibility to mass vaccination of the domestic dog population adjacent to the MMNR.

The area adjacent to the MMNR is a rural setting with a widely distributed human and associated domestic dog population. Domestic dog vaccination forms part of the annual cattle immunisation programme conducted by the NDVS. Cattle are vaccinated against major livestock infections (including rinderpest, foot-and-mouth disease and contagious bovine pleuropneumonia) at designated cattle crushes. Rabies vaccination should be made available for any owners bringing their dogs to these vaccination points. However, there are no available records of the number of doses administered in

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the region and anecdotal reports suggest that the rabies vaccine is not always available during NDVS immunisation campaigns.

Mass vaccination of domestic dog populations is recommended by the WHO as the main approach to rabies control (WHO 1992). The two main delivery strategies for domestic dog parenteral vaccination may be broadly termed as (1) a central-point campaign, in which dog owners are encouraged to bring their dogs for vaccination at certain designated sites, and (2) a door-to-door campaign, in which vaccination teams visit individual dog owners' residences to immunise animals. Centralised vaccination campaigns have been shown to be effective within high dog density, urban settings (Beran 1985; Ben Osman and Haddad 1988; Belotto 1988; Chomel *et al* 1988 and De Balogh, Wandeler and Meslin 1993) and also more sparsely populated rural communities in Mexico (Fishbein et al 1992). Intensive door-to-door regimens have been implemented in areas where the central-point campaign has been shown to be ineffective (Beran et al 1972, Beran and Frith 1988, Perry et al 1995) or as an emergency response to a rabies outbreak (Beran 1985; Kloeck 1997). Combination of the two strategies has also been advocated, with door-to-door visits supplementing mass vaccination at designated immunisation points (Bögel and Joshi 1990, Fishbein et al 1992). However, the number of studies which critically examine the performance of the different strategies within a particular setting is very limited. The main exception is the work of Fishbein et al (1992), in which the effectiveness of door-to-door and centralised vaccination campaigns were compared in similar rural communities in Mexico. The strategies achieved comparable levels of vaccination coverage, but fewer resources and time were required with the centralised strategy. A centralised system, linking dog rabies vaccination to cattle immunisation programmes, is the traditional form of rabies vaccination, not only in the Masai Mara region, but throughout rural areas of Kenya. The effectiveness of this centralised system in terms of vaccination coverage has never been examined in Kenya.

The study described here compared the door-to-door and central point vaccination strategies in a rural, East African domestic dog population. The vaccination coverage achieved with each strategy, the reason for not vaccinating dogs, and the total time required to conduct all aspects of the two campaigns were recorded. The effects of under-reporting dog numbers on vaccination coverage are discussed. The data collected were used to provide a quantitative description of the logistics of the different parenteral vaccination strategies. The results provide essential knowledge for the planning of effective long-term rabies control programmes within the region. The implications for rabies control in other rural communities within sub-Saharan Africa are also discussed.

2 METHODS.

2.1 Study area.

The vaccination campaigns were conducted within approximately 5 km of the perimeter of the MMNR, from east of the Mara River to the Tanzania border. The study site covered approximately 450 km^2 and included the full extent of the MMNR perimeter within Narok District. The study area was chosen based on the results of an earlier, more extensive mapping exercise in which the location of each Masai homestead, known as a manyatta, was recorded using a hand held ground positioning system (GPS, Trimble, Pathfinder®), giving an accuracy of ± 0.1 km. An external antenna placed on the bonnet of the project vehicle was used to record a location every 200 m in order to map roads and tracks within the area. The position of cattle vaccination crushes was also recorded.

Human settlements were distributed throughout the study area, but fell within six main localities, known as Mara Rianta (MR), Olore Orok (OO), Talek (TA, which includes Ilban), Sekanani (SK, which includes Iljora), Megwara-Ololaimutia (MO) and Olngainet (NG). The area comprised land from two Group Ranches, with the more eastern settlements of MR, OO and TA being part of the Koiyagi Group Ranch and SK, MO and NG lying within the boundaries of Siana Group Ranch. The study area is shown in Figure 1.

Figure 1 : The study area adjacent to the Maasai Mara National Reserve, Kenya.
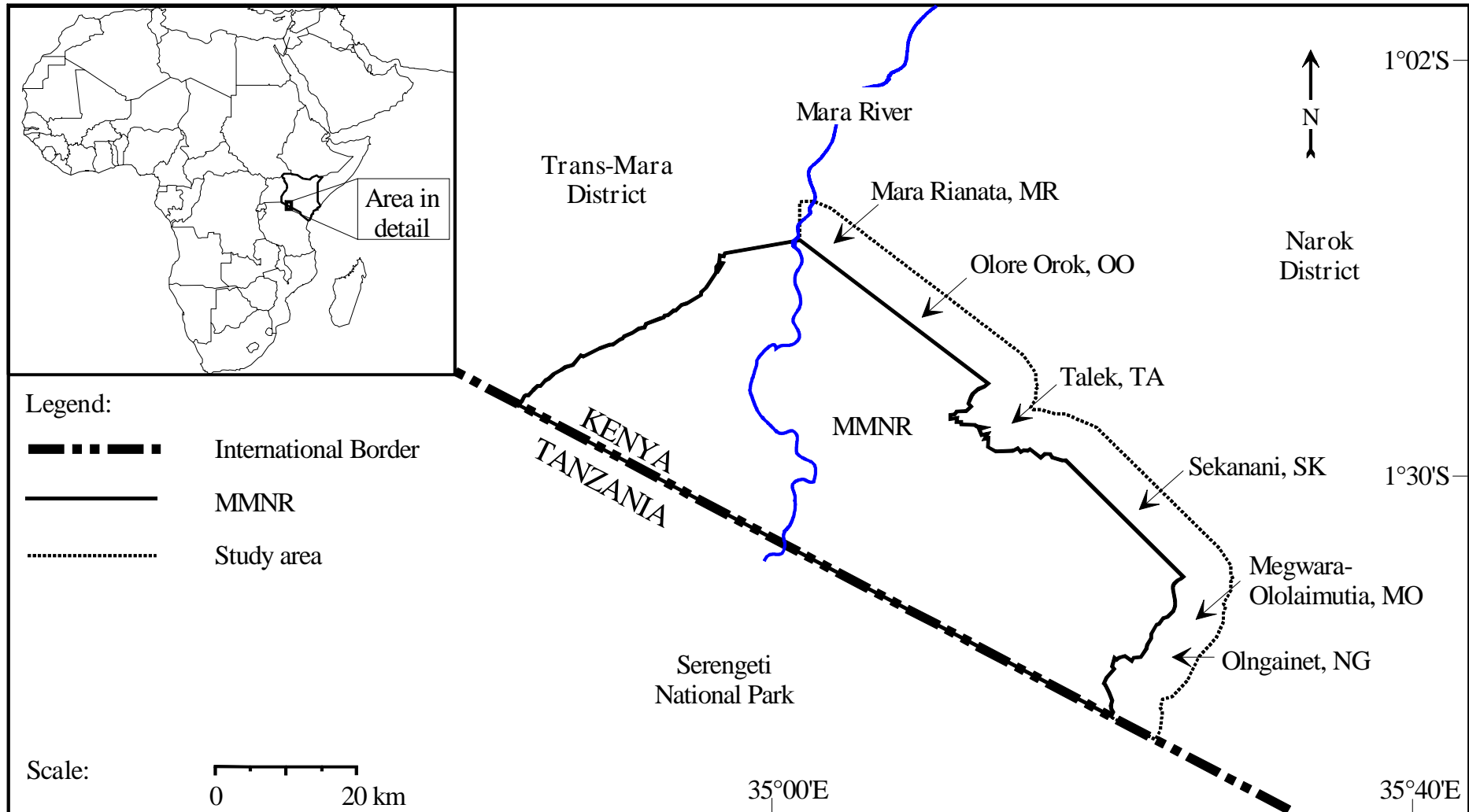
2.2 Vaccination trial study design.

An initial systematic dog population survey was conducted prior to the vaccination campaigns. Moving from east to west, from MR to MO, every fourth manyatta in the study area was visited and the questionnaire surveys conducted to gain basic dog population data. At each manyatta the questionnaire survey was conducted by the local Livestock Officer (JOK), in the local language, Ki-Maa. The results were used to gauge the expected size of the dog population, which is an essential pre-requisite to planning any vaccination campaign.

The study area was divided into two Sections (1 and 2) with one vaccination strategy assigned to each. Sections 1 and 2 were selected to contain comparable number of manyattas, total number of dogs and dogs of vaccinable age (i.e. ≥0.25 years). For convenience dogs < 0.25 years will be refereed to as "juveniles" and those ≥0.25 years as "adults".

Section 1 comprised all the settlements at SK, MO and NG, and forms part of the Siana Group Ranch. Section 2 encompassed the manyattas at MR, OO and TA which lie between the Mara and Talek Rivers and are part of the Koiyagi Group Ranch. Door-to-door vaccination was conducted in Section 1 and the centralised campaign in Section 2. The assignment of the strategies to the Sections was dictated by the timing of the NDVS centralised cattle campaign in the study area. The vaccination programmes in both Section 1 and 2 were preceded by intensive advertisement campaigns informing the local community of the programme schedule and that there would be no charge for the dog vaccines. The amount of time spent on pre-campaign publicity was similar in both Sections.

2.2.1 Door-to-door vaccination campaign.

Between July and August 1995, all manyattas located at Section 1 were visited. All available adult dogs were given two 1 ml intra-muscular injections, in different sites, against rabies virus (Rabisin®, Rhône Mérieux, batch: 40C021) and CDV, canine adenovirus, canine parvovirus and leptospirosis (Tetradog®, Rhône Mérieux, batch: L 04376). The vaccination procedure followed the manufacturer's recommendations. An electronic transponder was also inserted into each vaccinated dog and questionnaires were completed at each manyatta visited.

2.2.2 Centralised vaccination campaign.

In Section 2, the dog vaccination campaign was linked to the cattle immunisation programme conducted by the NDVS as part of the Ministry of Agriculture, Livestock and Marketing annual nation-wide programme. Cattle vaccinations were scheduled to take place at 12 cattle crushes, three government owned and nine private, situated close to the main areas of human settlement. The local community was informed to bring dogs along with cattle for vaccination at the designated immunisation points.

Dogs brought to the cattle crushes were vaccinated (same routine as described in above), fitted with an electronic transponder and their details were recorded on the relevant questionnaire form. People who arrived with only their cattle were asked why they had not brought their dogs for vaccination.

2.3 Adjustment for under-reporting.

Approximately one year after the vaccination campaigns a follow-up study was conducted. Dog demographic data were collected, from which it was possible to calculate the number of dogs alive at the time of the vaccination campaigns which were had not been initially reported. Based on the level of under-reporting, correction factors were calculated for the total population (C) and also for dogs ≥1 year of age ($C_{\geq 1}$). To quantify the effects of under-reporting on the performance of the two delivery strategies, the correction factors were used to adjust the recorded levels of vaccination coverage achieved in Section 1 and 2.

The adjusted vaccination coverage was calculated for the total dog population and also dogs ≥1 year of age because the level of under-reporting in dogs ≥1 year of age was much less than younger dogs.

2.4 Previous vaccination coverage.

The level of vaccination coverage in the study area prior to the current study was estimated from the questionnaire surveys conducted at manyattas. For each dog the interviewee was asked if it had ever been previously vaccinated against rabies and if so when was it last immunised.

2.5 Vaccination time.

All the dog vaccination work was conducted by a four-man team, consisting of PGC, the local Live-stock Health Officer (JOK), a driver of the project vehicle, and a KWS ranger. The total time spent each day of the vaccination campaigns was recorded and used to calculated the average number of man-minutes per dog vaccinated for each strategy. The times were calculated for a four man-vaccination team and included the time spent conducting the advertisements campaigns and travelling between homesteads (for the door-to-door campaign), and to and from vaccination points (for the centralised campaign). The results were compared with published results from other vaccination campaigns.

2.6 Spatial variation in vaccination coverage.

To quantify the average rate of decline in vaccination coverage with increasing distance from the central vaccination points a weighted regression was performed. The combined data from all vaccination points were used to give an average vaccination coverage per 0.5 km radius from the central point.

A similar analysis was performed for vaccination results in Section 1. The proportion vaccinated in each 0.5 km strip from the main roads was used as the response variable, and distance from the main roads as the explanatory variable.

3 RESULTS.

3.1 Domestic dog population.

At the 71 manyattas visited in Section 1 a total of 293 dogs were recorded. Sixty three (21.5%) of the recorded dogs were juveniles and excluded from vaccination. The average number of dogs per manyatta was 4.13 (s.e. 0.434), with a mean of 3.24 (s.e. 0.348) adult dogs. Eight other dogs, all adults, not resident at manyattas, were also recorded in Section 1. Six dogs were owned by local shop keepers at MO, and two by foreign missionaries at SK.

Questionnaire details were recorded at 95.2% (n = 80) of the 84 manyattas located in Section 2. Details were not recorded at four (4.8%) manyattas, all located at TA, either because there were no residents present at the time of the visit (n = 2, 50%) or there was a limited amount of available time needed to reach relatively remote locations (n = 2, 50%). There was an average of 4.00 (s.e. 0.403) dogs per manyatta, with 320 dogs reported at the 80 manyattas visited. A total of 25 dogs (7.8%) were juveniles, giving an average of 3.69 (s.e. 0.364) adult dogs. A further four dogs, all greater than two months of age, were reported to be kept by one local shopkeeper at the TA shopping centre.

There was no significant difference between Section 1 and 2 in either the mean total number of dogs per manyatta (χ^2 = 0.046, d.f. = 1, NS, scaling parameter = 3.247) or adult dogs per manyatta (χ^2 =0.786, d.f. = 1, NS, scaling parameter = 2.773).

3.2 Previous vaccination coverage.

Only one dog in Section 1, a dog owned by foreign missionaries at SK, was reported as ever having received a rabies vaccination. The dog was last vaccinated, outside the study area, in May 1994. There were no previously vaccinated dogs reported at any of the manyattas.

In Section 2, owners indicated that 15 dogs, all at TA, had previously received anti-rabies vaccination. Dogs owned by a shop keeper at TA, accounted for 20% (n = 3) of previously vaccinated animals. For two of the shop dogs, the owner could not remember the year of the last vaccination, while the third animal was indicated as last being vaccinated in 1994. Of the 12 previously immunised dogs kept at manyattas, two were last vaccinated in 1989, four in 1990 and six in 1993.

In the whole study area, therefore, only 2.6% (n = 16) of the total 625 dogs recorded had previously received anti-rabies vaccination. Of these 16 dogs, only two had been inoculated within the past year and eight within the last three years. Manyatta dogs were significantly less likely to have been vaccinated than those dogs not resident at manyattas (χ^2 = 15.43, d.f. = 1, P < 0.001).
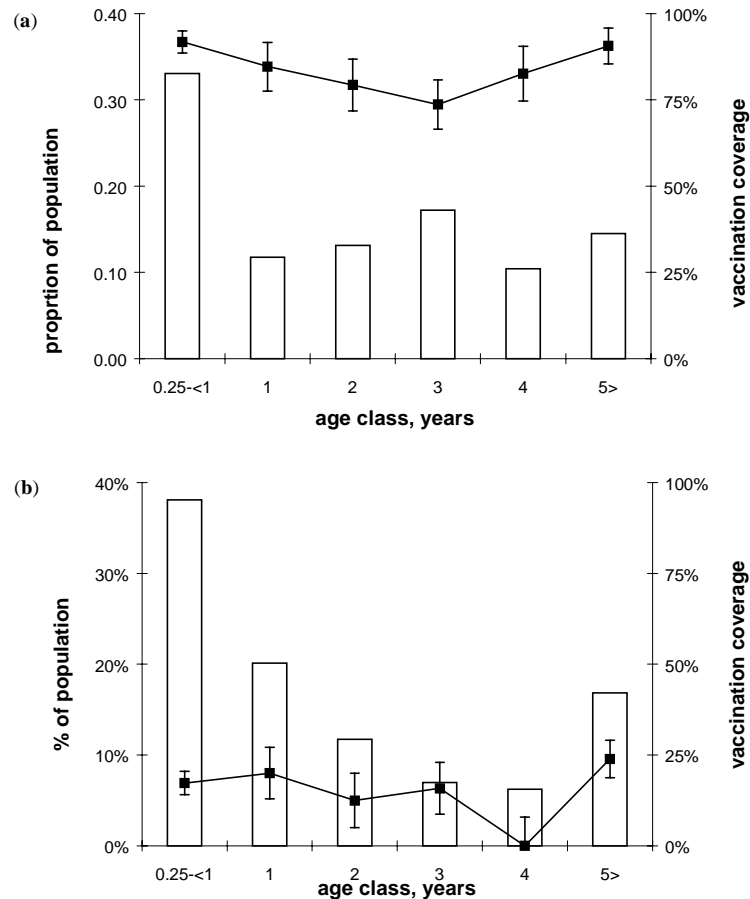
3.3 Vaccination coverage.

The vaccination coverage results are only given for dog kept at manyattas, as other dogs (i.e. ones by shop keepers and missionaries) form a very small percentage (0.02%) of the total dog population.

3.3.1 Door-to-door vaccination.

In Section 1, the overall coverage of adult dogs was 82.2% (189 out of a possible 230), while the total population coverage was 64.5% (189 out of a total of 293).

There was no significant difference in vaccination coverage with age (χ^2 = 10.69, d.f. = 11, NS), sex (χ^2 = 0.581, d.f. = 1, NS) or between localities (χ^2 = 2.907, d.f. = 3, NS). Figure 2a shows the age-specific vaccination coverage for adult dogs assigned to yearly age classes.

Figure 2 : Age-specific vaccination coverage for: (a) the door-to-door campaign in Section 1, (b) the centralised campaign in Section 2. The vaccination coverage (■), with standard error bars, for a particular age class (empty bars) of the adult population, is shown.

3.3.2 Centralised vaccination campaign.

A total of 48 dogs were brought for vaccination at the designated vaccination points. The overall level of vaccination coverage in Section 2 was estimated as 15.5% (48 out of a possible 309) of adult dogs, and 14.3% (48 out of a total of 336) of the total dog population. These estimates assume that the four manyattas not visited at TA each had an average number of total and adult dogs per manyatta.

Of the dogs old enough for immunisation there was no significant variation in the vaccination coverage with either age (χ^2 = 15.48, d.f. = 10, NS) or sex (χ^2 = 0.1268, d.f. = 1, NS). However, a significantly greater proportion of dogs was vaccinated in OO than TA, which in turn had a significantly greater vaccination coverage than MR. Figure 2b shows the age-specific vaccination coverage for adult dogs assigned to yearly age classes.

3.4 Reason for failure to vaccinate.

With the door-to-door strategy the inability to catch and restrain dogs was the main reason for not vaccinating, accounting for 51.2% (n = 21) of all 43 unsuccessful vaccination attempts. The second most important reason, constituting 39% (16 out of 41) of failures, was the absence of the dog. Only three dogs (7.3%) were not vaccinated because the owner refused permission, and vaccination was not administered to one dog (2.4%) because of its poor physical condition. A summary of unsuccessful vaccination attempts is shown in Figure 3.

The people attending the fixed point vaccination reported 15 dogs which had not been brought for vaccination. In all cases, the owner indicated that they were unable to control the dog sufficiently to bring it to the vaccination point.

Figure 3 : Reasons for not vaccinating dogs at the door-to-door campaign. The proportion of unsuccessful vaccination attempts are shown with s.e. bars for only those dogs recorded at manyattas in Section 1 (empty bars).
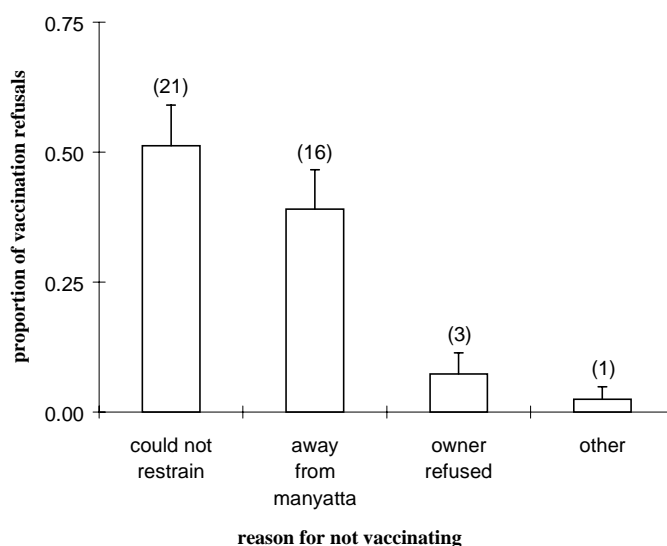

3.5 Spatial distribution.

3.5.1 Distance from major roads.

The spatial distribution of the manyattas and dogs from the main roads in Section 1 is shown in Figure 4a. In SK and MO all manyattas were situated within 2 km of the roads, with the settlements at NG

located between 5 and 6 km from the main road passing through MO. Overall, in Section 1, approximately 70% of all manyattas and dogs were located within 1 km of the main roads. There was no significant variation in the vaccination coverage with distance from the road (χ^2 = 1.534, d.f. = 1, P > 0.05).

Figure 4 : Spatial distribution of manyattas (■), total dogs (O), and adult dogs (□) from the main roads in (a) Section 1 and (b) Section 2 and (c) the study area. For Section 1, the cumulative proportion of adult dogs which were vaccinated ( ) in the door-to-door campaign, is also shown.
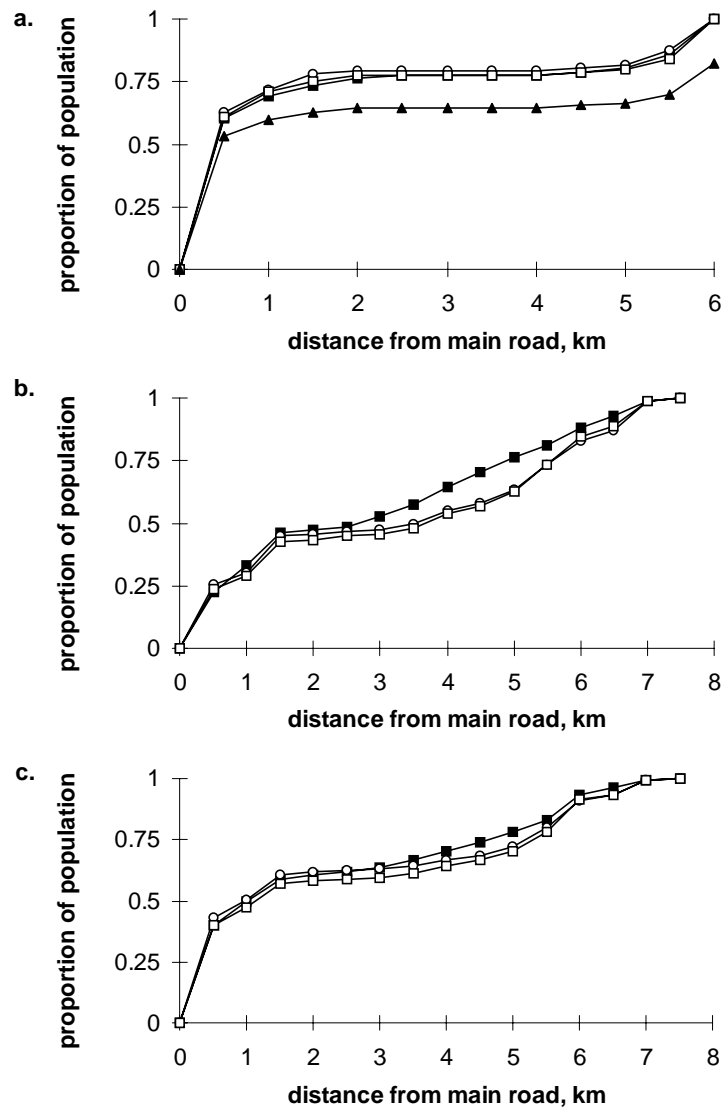
The cumulative proportion of manyattas, dogs and adult dogs as a function of the distance from the main roads is also shown for Section 2 (Figure 4b) and the Section 1 and 2 combined (Figure 4c). Approximately 60% of the total manyatta dog population in the study fall within 1.5 km of the major roads within the area.
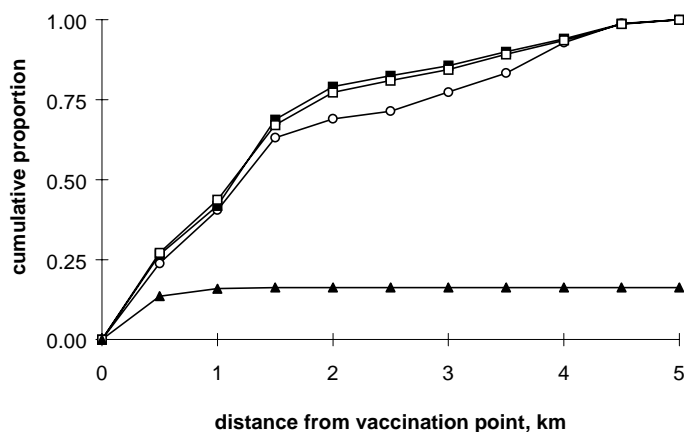
3.5.2 Distance from central vaccination points.

The spatial distribution of human settlements from the fixed vaccination points in Section 2 is shown in Figure 5. All manyattas were located within 5 km of a vaccination point, with over 75% of homesteads falling within a 2 km radius. Unfortunately, it was not possible to record the position for all cattle crushes in Section 1.

Of the 48 centralised vaccinations, 83.3% (n = 40) were from manyattas located within 0.5 km of the designated vaccination points, and the furthest distance that a dog was brought for vaccination was 1.5 km.

Figure 5 : Spatial distribution of manyattas (■), dogs (O), and dogs of three months of age or greater (□) from the vaccination points used in the centralised campaign in Section 2. The cumulative proportion of adult dogs which were vaccinated ( ) in the centralised campaign is also shown.

The sharp fall-off in vaccination coverage with distance from centre point is displayed in Figure 6, in which the results from all 12 vaccination stations are combined. The results of the regression analysis (χ^2 = 99.33, d.f. = 1, P < 0.001) give an estimated exponential rate of decrease of -3.061 (s.e. 0.5473) ln coverage per km. The exponential rate is equivalent to a 95.3% reduction in vaccination coverage per km increase in distance form the vaccination point.

Figure 6 : Decrease in vaccination coverage with increasing distance from the centralised vaccination points. The data from all twelve vaccination points were combined. The coverage (■), and s.e. bars for each 0.5 km radius from the vaccination point is shown together with the exponential fitted line (——).
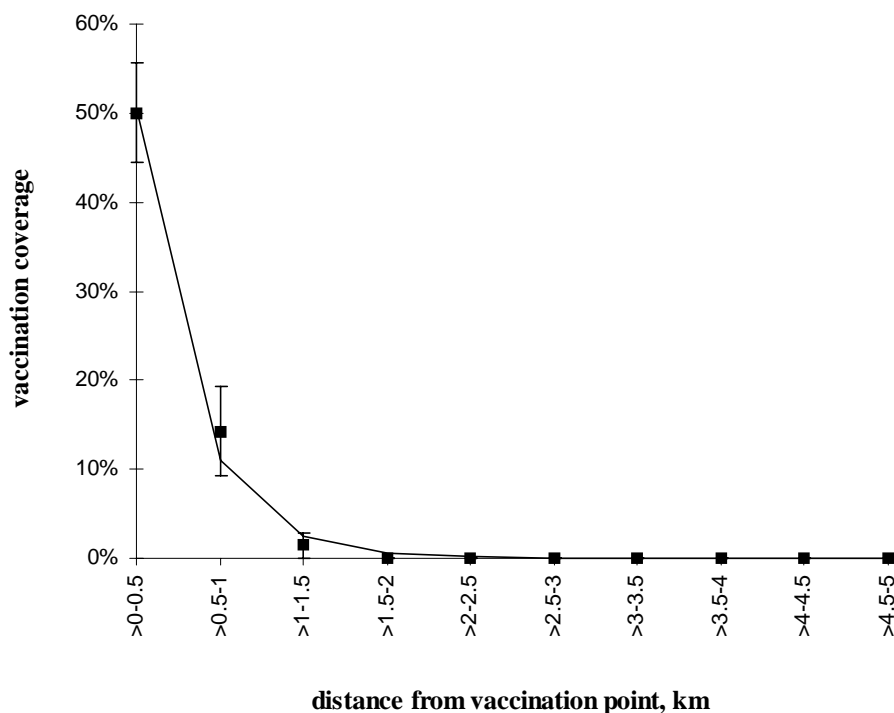
3.6 Vaccination time.

The average number of man-minutes required to vaccinate a dog in the door-to-door and centralised campaigns are shown in Table 1. The average time per vaccinated dog was less with the door-to-door strategy in Section 1 (81 man-minutes per dog) compared to that achieved using the centralised campaign (300 man-minutes per dog).

Table 1 : Average man-minutes per vaccinated dog in Section 1 and 2 using the door-to-door and centralised strategies.

	Section 1 Door-to-Door	Section 2 Centralized
Total dogs vaccinated	195	48
Total man-hours	264	240
Average man-minutes per vaccinated dog	81	300

3.7 Correction for under-reporting.

In the 1996 follow-up survey a total of 121 dogs (80 in Section 1 and 41 from Section 2) were classed as having being under-reported during the 1995 vaccination campaigns. The follow-up survey was conducted at a sub-set of 101 manyattas in the study area. The number of dogs at these manyattas in 1995 was 419, comprising 256 in Section 1 and 163 in Section 2. The level of under-reporting in Section 1 (31.3%, 80 out of 256) and Section 2 (25.1%, 41 out of 163) was not significantly different (Yates corrected $\chi^2 = 0.8$, d.f. = 1, P > 0.05).

The correction factor C = 1.652 was used to adjust the total population size for Sections 1 and 2 in 1995. The age-specific correction factor $C_{\geq 1} = 1.127$ was used to adjust for under reporting in dogs ≥ 1 year of age.

The adjusted and unadjusted levels of overall vaccination coverage achieved during the door-to-door and centralised campaigns are shown in Table 2.

Table 2 : Vaccination coverage of manyatta dogs in Section 1, following the door-to-door campaign, and Section 2, following the centralized campaign, with and without adjusting for under-reporting. The numbers in brackets refer to dogs ≥1 year

	Section 1	Section 2
Total manyatta dogs estimated	293 (157)	336 (200)
Adjusted total	484 (177)	555 (225)
Vaccination strategy	door-to-door	Centralised
Number vaccinated	189 (122)	48 (30)
Unadjusted coverage (%)	64.5 (77.7)	14.3 (15.0)
Adjusted coverage (%)	39.0 (68.9)	8.6 (13.3)

The adjustment reduces the vaccination overall coverage to 39.2% and 8.7% for Section 1 and 2, respectively. As the majority of the under-reporting was of animals less than one year of age in 1995, the adjustment has a much smaller effect on vaccination coverage in dogs ≥ 1 year of age.

The total population vaccination coverage using the door-to-door strategy was significantly greater than that achieved with the centralised campaign before (Yates corrected $\chi^2 = 165.97$, d.f. = 1, P<0.001, odds ratio 10.90, 95% c.i. 7.27–16.40) and after (Yates corrected $\chi^2 = 133.99$, d.f. = 1, P<0.001, odds ratio 6.77, 95% c.i. 4.72–9.73) adjusting for under-reporting.

4 DISCUSSION.

The results clearly demonstrate the ineffectiveness of the traditional centralised vaccination strategy. Not only was the coverage achieved in Section 2 during the centralised campaign greatly below the WHO recommended level of 70% (WHO 1987, Coleman and Dye 1996), but the proportion of dogs reported as having ever been previously vaccinated was also extremely low. The inappropriateness of the strategy for this particular rural community was further illustrated by the rapid fall-off in coverage with distance from vaccination points. Although about 60% of the dog population were kept at manyattas at least 1 km from the vaccinations points, only one dog from these homesteads was brought for vaccination during the whole 10 days of the centralised campaign. The difficulty of bringing dogs which are unused to being restrained over long distances is a possible reason for failure of the centralised campaign to reach a larger segment of the dog population.

From the comparison of the different vaccination strategies in the study area, it is clear that the door-to-door campaign in Section 1 was more effective than the centralised program in Section 2. The effectiveness was shown both in terms of vaccination coverage and average time required to vaccinate a dog. The 81 man-minutes per vaccinated dog estimated for the door-to-door strategy was considerably lower than that calculated for the centralised strategy (300 man-minutes per vaccinated dog), but were much higher than those reported for other vaccination campaigns (Chomel et al 1988, Fishbein et al 1992, De Balogh, Wandeler and Meslin 1993). The door-to-door time requirements in Section 1 were twice that of the next highest record of 40 man-minutes per vaccinated animal, reported for a centralised campaign with intensive public education, conducted in rural Mexico (Fishbein et al 1992). The other four estimates – two for centralised campaigns in urban areas of Peru and Zambia, a door-to-door campaign and centralised program, again in rural Mexico – were considerably lower than recorded in Section 1, ranging between 10-–13.1 man-minutes per vaccinated dog, (Chomel et al 1988, Fishbein et al 1992, De Balogh, Wandeler and Meslin 1993). However, it should be noted that these previous studies do not clearly state which aspects of the vaccination campaigns were included in the calculations of the total time components.

The level of vaccination coverage achieved, with and without adjusting for under-reporting, was significantly greater using the door-to-door strategy compared to the centralised campaign. The effectiveness of a vaccination strategy is largely dictated by the association between the dog and human population. Masai dogs are classed as "working dogs" according to WHO guidelines (WHO/WSPA 1990), as they are used for guarding livestock at night and, to a lesser extent, herding during the day. Although each dog is owned by a specific household the level of restriction and supervision imposed on the dog population is very low, and dogs will tend to rely on food resources scavenged from several households often at different manyattas. Dogs which are unrestricted and semi-dependent on their owners are classed as "neighbourhood dogs" (WHO/WSPA 1990). The human to dog relationship, particularly unfamiliarity with the handling of dogs, is important in understanding the deficiencies of the different vaccination strategies.

The results from door-to-door vaccination in Section 1, showed that the inability to restrain a dog was the main reason for not vaccinating animals. The difficulty in catching and holding dogs was also a major contributor to the high number of man-minutes required per vaccinated dog. Similarly, to bring a dog for vaccination at a central vaccination point requires a level of dog supervision of which most dog owners were incapable. As dogs are unaccustomed to being leashed, the degree of effort and supervision required with the centralised strategy increases with distance from the vaccination point, which accounts for the spatially heterogeneous pattern in dog vaccination coverage achieved in Section 2.

Previous studies of the vaccination coverage achieved with different administration strategies have produced variable results. Centralised campaigns have been shown to achieve in excess of 70% vaccination coverage in urban and rural dog populations of Africa (De Balogh, Wandeler and Meslin 1993, Cleaveland pers. comm.) and other developing countries (Belotto 1988, Chomel et al 1988), while they have failed to realise adequate coverage in urban Ecuador (19% coverage) and urban (23% coverage) and rural (10% coverage) Philippines (Beran et al 1972, Beran and Frith 1988). Where the centralised scheme has been shown to be inadequate, household vaccination has often proved successful in reaching at least 80% population immunity. The variable results illustrate that the requirements of an effective vaccination campaign are dependent on the specifics of the target dog population.

It has been noted that the size of the domestic dog population, and thus the task of effective vaccine delivery, is often underestimated in developing countries (Perry 1995). The average number of dogs per manyatta recorded in the study area was greater than earlier estimates of 2.65–3.24 for Masai dog

populations in Kenya and Tanzania (Alexander et al 1993, Cleaveland 1996). The high level of under-reporting may partly explain this. The results show the importance of correctly estimating the size of the target population. The loose human to dog relationship may also be a reason for the under-reporting. As many young dogs are given to neighbours, die or are destroyed, the perception of how many dogs belong to a manyatta at a given time may exclude a proportion of the younger segment of the population. Under-reporting of very young dogs has also been recorded in similar rural dog populations in Tanzania (Cleaveland pers. comm.). Education programs and regularly repeated vaccination campaigns should help to gain a greater knowledge of the target dog population, through familiarising the local community with the type of information required by the vaccination workers. The regular implementation of vaccination campaigns should also result in local dog owners becoming more accustomed, and more able, to handle and restrain their dogs sufficiently to enable parenteral immunisation. It may also be possible to refine the questionnaire so as have specific questions aimed at estimating the true number of very young dogs at each manyatta.

Adjusting for initial under-reporting alters the estimated total vaccination coverage achieved using the different vaccination strategies. However, the comparative performance of the two strategies remains similar, and the vaccination coverage achieved in dogs of one year of age or greater was not greatly altered, as the majority of under-reporting (92.7%) was for dogs less than one year of age. The results indicate that door-to-door vaccination reached almost 70% of the older ($\geq$1 year) dog population. Hence, it seems reasonable to assume that if all adult dogs are reported, then a 70% coverage in these dogs could be achieved using the door-to-door strategy. The proportion of the population which are juveniles places an upper limit on the overall population vaccination coverage which can be achieved.

An advantage of the door-to-door strategy noted in other rural areas is that the vaccination is able to be conducted at a time when the dogs are at the homestead (Fishbein et al 1992). This is a consideration for dogs which are used for herding. In the case of the Masai communities, vaccinating at a manyatta soon after dawn is the most likely time to ensure all dogs are at or close to a manyatta, as the livestock have yet to moved out to pasture. However, vaccination was conducted throughout the day in this study and the results suggest that the proportion of dogs which were not vaccinated because they were away herding livestock is of secondary importance compared to the inability to restrain the animal.

A more important consideration of the logistics of door-to-door vaccination is the distance involved in visiting each manyatta. For example, if large scale mass vaccination were carried out in boundary zones around the MMNR, the area encompassed rapidly becomes very large with increasing distance form the MMNR (Table 3). The travel-time involved in visiting all manyattas would be expected to rise non-linearly with increasing vaccination area.

Table 3 : Area encompassed by a vaccination zone of a given maximum distance from the MMNR. The results were calculated using the distance operator function in geographical information system IDRISI®.

Maximum distance from MMNR boundary (km)	Area of vaccination zone (km^2)
5	630
10	1270
15	2000
20	2800
25	3700
30	4600

As all manyattas were visited in Section 1, the door-to-door strategy resulted in a spatially homogenous vaccination coverage. In planning future door-to-door campaigns, the distribution of human settlements with respect to the main roads may be taken into consideration. For example, concentrating vaccination effort at those manyattas easily accessible from the main roads may result in adequate vaccination coverage while reducing the overall time taken to conduct a campaign.

The type of campaign strategy was the major factor related to the success of canine vaccination. Domestic dogs of either sex and all ages were equally likely to be vaccinated, using either strategy. The

two sections of the study area were well matched in terms of dog population ecology, and so provided similar settings in which to test the effectiveness of the different vaccination strategies.

Intensive education and promotional campaigns are important in over-coming the apprehensions of a community to dog vaccination, as well as raising the level of awareness about rabies control. Future vaccination work in the area, particularly if it includes the involvement of the KWS, should include community education as a priority to overcome the mistrust of the vaccination work in the areas around MR and OO. The value of such educational publicity has been most clearly demonstrated in successful mass vaccination programs conducted in Kwazulu-Natal Province, South Africa. However, it should be noted that intensive pre-campaign publicity was not necessary to achieve high levels of vaccination coverage in rural areas of Mexico (Fishbein et al 1992). Again, the data demonstrate that the requirements of a successful vaccination programme are specific to a given dog population, and cannot be uncritically applied from one situation to another (Bachmann 1993).

This study has only addressed vaccination efficiency in terms of coverage and time taken to vaccinate dogs; the cost associated with the different strategies has not been considered. An economic appraisal of the cost-effectiveness of the different strategies should also be conducted, and it is planned to carry out such a study in the near future.

The response to the different vaccination strategies in Sections 1 and 2 allow several conclusions to be drawn.

> The level of coverage achieved in the past using the traditional centralised campaign was very low, and unlikely to have been sufficient to control rabies

> The door-to-door strategy enables a greater level of vaccination coverage to be achieved than using the traditional centralised campaign. Any large scale mass vaccination campaign in the area should, therefore, employ a door-to-door strategy.

> The human to dog relationship is an important consideration for effective implementation of canine vaccination campaigns, both in terms of restraining dogs for vaccination and estimating the level of vaccination coverage.

> The time requirements for the door-to-door strategy, a combination of travel time and time dedicated to catching and restraining dogs, are considerable and should not be underestimated when planning larger scale campaigns.

However, different approaches to rabies control other than regular door-to-door mass vaccination should also be considered. The dog population density in the study area, even after correcting for under-reporting, was below the density estimated from empirical and theoretical studies necessary to maintain rabies (5 dog/km^2; Cleaveland and Dye 1995) If rabies is not maintained in the dog population but only periodically enters from elsewhere, a one-off mass vaccination followed by the establishment of an active surveillance system and rapid vaccination response to any reported outbreaks may be a viable control strategy. Such a system would require an effective surveillance system to monitor reports of any suspected rabies cases in dogs, wildlife and humans. The use of community based surveillance systems, involving co-operation between the medical and veterinary sectors is being developed elsewhere in Africa and may be applicable to the study region (see Kaboyo this volume). From a public health perspective, ensuring the local clinics have vaccine for human PET is essential. Within the study area there were clinics located at MR, SK and MG, none of which had any anti-rabies vaccines.

On a more general level, the study has highlighted how the success of a given vaccination strategy in one situation is no guarantee of being effective in a different setting. Consideration of the dog ecology within an area is an essential pre-requisite to designing an effective vaccination strategy (WHO 1987). Analysis of the spatial aspects of different vaccination strategies, which has not been addressed in previous studies, provides a concise description of the deficiencies of the centralised campaign and a possible means of efficiently targeting the door-to-door strategy over larger areas. Finally, the study has attempted to quantify the components of the different vaccination strategies to help improve future rabies control programs in the area. A similar analytical approach may be helpful in other areas where traditional vaccination strategies have failed.

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TARGETING RABIES CONTROL IN THE SERENGETI : THE RATIONALE AND DESIGN OF A DOMESTIC DOG VACCINATION CAMPAIGN

Magai Kaare[31] and Sarah Cleaveland[32,33]

1 INTRODUCTION.

In view of the increasing incidence of rabies in Africa, attention has been focused on the need to target rabies control programmes in order to optimise vaccination coverage and the cost-effectiveness of control. Given the limited resources generally available for rabies control, these factors are likely to be critical in determining the efficacy and sustainability of rabies control programmes in Africa.

Perry and McDermott (1995) identified several key components in designing effective strategies for rabies control and these have been used as the basis for designing a targeted strategy in the Serengeti ecosystem.

2 TARGET SPECIES.

In Serengeti, rabies impinges on both human health and wildlife conservation and any rabies control strategy needs to address both issues. Although many mammalian species may be infected with the rabies virus, not all act as reservoirs. Throughout the world, rabies tends to occur as a single virus strain maintained by a single principal host species. One approach to controlling rabies is therefore to determine which species act as reservoir hosts and to target control measures accordingly. The validity of this approach has been demonstrated by the oral rabies vaccination programme in Switzerland, whereby control of rabies in the maintenance host (red fox) resulted in its disappearance from all species, not only foxes (Wandeler *et al*, 1988).

Cleaveland and Dye (1995) outlined the evidence that domestic dogs are the most likely reservoir for rabies in the Serengeti, based on old and new case-surveillance data and the identification of a single canid-associated isolate from domestic dogs, livestock and wildlife. However, there are clearly caveats to any conclusion based on limited samples and on case surveillance data, particularly in National Parks where carcass survival is low and transport and communication systems are limited. Inevitable biases include the predominance of conspicuous species among animals reported sick and a high proportion of nocturnal species among the road-kill carcasses collected (Table 1). The difficulties of retrieving diagnostic material in even well-studied populations were demonstrated in 1994 during a canine distemper epidemic in lions, in which only 23 carcasses were retrieved of an estimated 1,000 individuals that died of the disease (Roelke-Parker *et al.*, 1996).

A further question concerns bat-eared fox rabies in the Serengeti. Although rabies tends to occur as short-lived epidemics in Serengeti bat-eared fox populations (Maas, 1993), the disease has been confirmed in bat-eared foxes in each of the past three years (1994, 1995 and 1996) in widely-separated areas of the park. This, together with the fact that rabies may be maintained in bat-eared foxes in the Western Cape area of South Africa (King *et al.*, 1994), raises questions about the possibility of disease maintenance in metapopulations within the park.

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3 TARGET POPULATIONS.

In order to address the question of target populations, preliminary dog ecology studies were carried out in areas to the west (Serengeti District in the Mara region) and east (Ngorongoro District) of the Serengeti National Park, which identified key differences in dog populations that have important implications for rabies control (Table 2). For microparasite infections, which require close contact for transmission, there is thought to be a threshold density, below which the probability of contact between susceptible and infectious individuals is too low to ensure transmission (Anderson and May, 1991). Consistent with this, dog rabies appears to persist only in higher-density populations of Serengeti District (> 5 dogs/km^2) but not in lower-density dog populations of Ngorongoro District (<1dog/km^2) or in wildlife (Cleaveland and Dye, 1995). The preliminary conclusion is, therefore, that it is the domestic dog population to the west of the park that is the more likely reservoir for rabies in the area.

Without an immediate solution to the practical difficulties of disease surveillance in the Serengeti, we are attempting to test our preliminary conclusions through mass vaccination of domestic dogs. This study has been designed to test two principal hypotheses:

that rabies is maintained only in higher-density domestic dog reservoir populations to the west of Serengeti National Park ;

that, while rabies appears to persist in this population, a vaccination coverage of 70%, should be sufficient to control the disease, based on empirical (Beran, 1991) and theoretical studies (Coleman and Dye, 1996).

Table 1 : Samples submitted for rabies diagnosis, 1992 - 1996

Species	No submitted	No. showing neurological signs	Road kills	Rabies positive
Domestic dog	29	29	0	14
Cow	2	2	0	2
Goat	2	1	0	2
Total domestic	**33**	**32**	**0**	**18**
Bat-eared fox	8	6	2	3
Golden jackal	1	0	1	0
Black-backed jackal	6	0	2	0
Spotted hyaena	11	0	8	0
Striped hyaena	1	0	1	0
Aardwolf	1	1	0	0
Lion	11	5	0	0
Leopard	3	0	0	0
Cheetah	1	1	0	0
Serval	2	0	2	0
White tailed mongoose	2	0	2	0
Banded mongoose	1	0	1	0
Black-tipped mongoose	1	1	0	0
Meller's mongoose	1	0	1	0
Genet	1	0	1	0
Civet	1	0	1	0
Elephant	1	1	0	0
Wildebeest	1	1	0	0
Grass rat	1	1	0	0
Total wildlife	**55**	**17**	**22**	**3**
Total	**88**	**49**	**22**	**21**

If these hypotheses are correct, vaccination of 70% of domestic dogs in the Mara region should control rabies in dogs as well as in the livestock, wildlife and human populations.

An issue of recent concern has been the age at which dogs should first be immunised. Most manufacturers recommend that rabies vaccines be given to pups at three months of age to avoid interference with maternally-derived antibodies. While this may be appropriate in industrialised countries, the same is not necessarily true elsewhere (Perry, 1996). Typical of many rural African dog populations, the Serengeti District population has a high turnover rate and low life-expectancy with up to 20% of the population under 3 months of age (Cleaveland, 1996). In such populations, vaccination of adults and juveniles alone may be insufficient to sustain population immunity. Indeed, theoretical studies based on demographic data from Serengeti District dogs indicate that the vaccination effort required to maintain adequate immunity is reduced when pups under 3 months of age are included in the programme (Coleman, 1996). Furthermore, we suspect that if vaccines are effective in young pups, cost-effectiveness may be improved through greater accessibility of this age class. This trial therefore aims to include pups in the mass vaccination programme and to compare antibody responses in young pups with and without maternal antibody under field conditions.

Table 2 : Demographic characteristics of domestic dog populations in Serengeti and Ngorongoro Districts.

District	Human : dog ratio	Density dog/km^2	Proportion population <1 year old	Life expectancy	Per capita birth rate	Pup mortality/ month (0-3 months)	Adult mortality/ month (>3 months)	Intrinsic rate of increase
Serengeti	5.2	5.7	0.37	1.9 years	0.74	0.085	0.028	0.089
Ngorongoro	10.7	0.4	0.32	2.0 years	0.65	0.106	0.019	0.053

4 DESIGN OF THE VACCINATION PROGRAMME.

4.1 Study Area.

The vaccination campaign is being conducted in a 20 km zone adjacent to the north-western border of the park (Figure 1). Control villages were selected at random in an areas to the west of this zone, between Lake Victoria and the park boundaries, where we predict that rabies will persist in the absence of vaccination.

4.2 Mass Vaccination.

Mass vaccination of dogs is conducted through fixed-point vaccination, with stations established at a central site in each village in the designated zone. The campaign is advertised in each village a few days prior to vaccination through meetings with village leaders and visits to the primary school.

Each dog is registered and data obtained on name, age and sex and is fitted with a numbered plastic collar for short-term identification and monitoring of vaccination coverage. A vaccination certificate (Tanzania Ministry of Agriculture) is issued for each animal. One ml of Nobivac Rabies (Intervet) and Nobivac Puppy DP (Intervet) is administered by sub-cutaneous injection to each dog, including puppies above 3 weeks of age. Blood samples are collected from approximately one in every five adults brought for vaccination and, where possible, every puppy under 3 months of age. Villages are visited after 28 days to re-bleed dogs for measurement of post-vaccination antibody titres in pups and adults.

4.3 Frequency of vaccination coverage.

The critical lower threshold to prevent outbreaks of dog rabies has been estimated as 55% coverage of the population (Coleman and Dye, 1996). The frequency of vaccination required to maintain vaccination coverage above this threshold was determined using birth and death rates estimated for Serengeti District dog populations (Table 2). Figure 2 shows the theoretical decline in population coverage following a single vaccination effort reaching 70% of the population. In this population, vaccination coverage falls to below 55% after 6 to 8 months, so fixed-point vaccinations will be repeated in each villages every 6 to 8 months to vaccinate susceptibles born since the previous campaign.

Figure 1 : Map of the Serengeti ecosystem showing location of villages in the vaccination zone and location of control villages
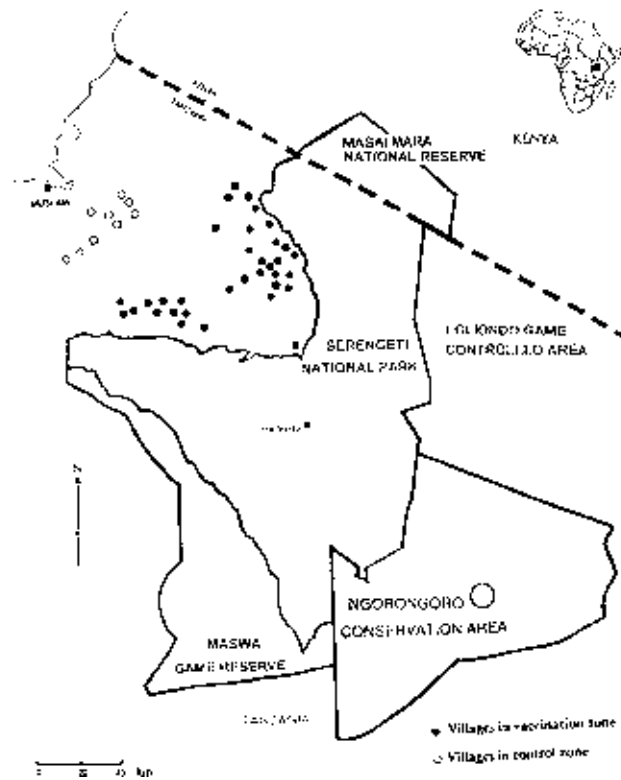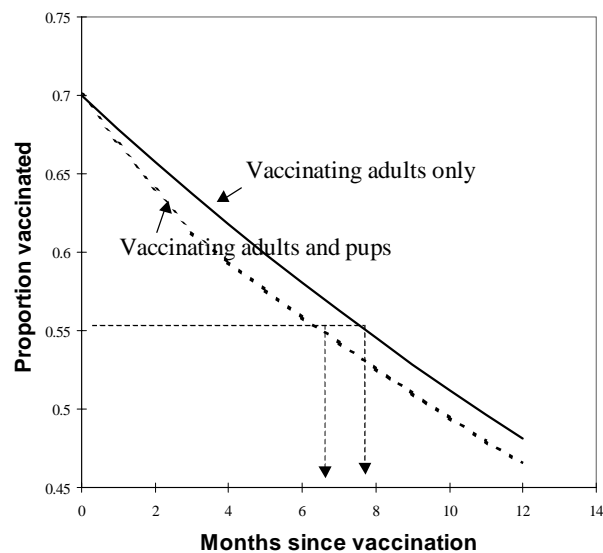

Figure 2 : Decline in population immunity following vaccination of 70% dogs

4.4 Monitoring and Disease Surveillance.

Recent work in Kenya has demonstrated the vast improvements in rabies detection rates following the implementation of active surveillance programmes (Kitala *et al.*, 1994) and this approach has been adopted to compare rabies incidence in the vaccinated and unvaccinated control populations. In addition to active surveillance, detailed longitudinal studies are being carried out of unvaccinated and vaccinated populations. Households in the longitudinal survey are visited each month to obtain data on the incidence of clinical signs in dogs, birth and death rates and causes of mortality. In addition, comparison of birth and death rates will allow us to address concerns that mass vaccination of dogs may lead to an increase in population growth, potentially exacerbating problems of disease persistence and control (Moutou, 1997).

5 SURVEILLANCE IN WILDLIFE.

Detection of rabies in wildlife is currently based on passive surveillance, with suspect cases being reported through a network of park veterinarians, rangers, scientists and tour operators. Tissue samples are collected for rabies diagnosis from all wild carnivore carcasses and from ungulates with suspected neurological disorders, as described previously (Cleaveland and Dye, 1995). Given the low detection rates of wildlife disease, however, the absence of confirmed rabies cases in wildlife provides little conclusive information. The premise of this study is that if wildlife rabies is detected after dog rabies has been controlled in the vaccination zone, rabies is unlikely to be maintained in this dog population alone and our preliminary hypothesis is incorrect.

Vaccination Coverage.

Within a week of vaccination in each village, house-to-house surveys are conducted in 10 randomly-selected villages of the vaccination zone, with questionnaires carried out in households selected by stratified random sampling. As described in detail previously (Cleaveland, 1996), household questionnaires are conducted to obtain information on dog population size, structure, birth and death rates and causes of mortality. The proportion of vaccinated dogs in households is determined from direct observation of collared animals, or in the absence of the dog, the demonstration of a vaccination certificate. The number of free-roaming dogs with and without collars is recorded during each survey. When un-collared dogs are seen, the name and owner of the dog is determined by asking villagers in an attempt to assess the proportion of ownerless dogs in the community.

6 RESULTS AND DISCUSSION.

Preliminary studies in Serengeti have suggested that a rabies vaccination strategy directed to a relatively small segment of the domestic dog population surrounding the National Park may be effective in controlling rabies in domestic dogs and wildlife in the area and the current vaccination programme has been designed to test this prediction.

Although it is too early to assess the impact of mass vaccination, our preliminary findings (5 months after the start of the programme) suggest that parenteral vaccination of dogs through fixed-point campaigns is a feasible approach to rabies control in this area, with 75.3% coverage in dogs > 3 months of age (n = 154 households). Although the overall coverage (67.8%) was slightly below the target, this was primarily due to the low turn-out of young pups (only 19.5%). Efforts are now being made to improve awareness of the need to bring pups for vaccination.

With the implementation of active surveillance measures in late 1996, an 8-fold increase in rabies submissions was recorded in domestic animals over a four-month period (4 submissions/ month) and a 9-fold increase in the number of confirmed cases (2.2/ month) when compared with figures from 1992-1995 (Cleaveland and Dye, 1995). The annual incidence of rabies in Serengeti District dogs based on confirmed cases was estimated as 84/100000 in 1996. Rabies incidence based on both confirmed and suspected cases was estimated as 204/100000 dogs. Although no human rabies cases were confirmed in 1996, the incidence of human rabies in Serengeti District was estimated at 4.8/100000 from reported clinical cases over a 6-month period.

The improved detection rates arising from active surveillance measures provide more reliable measures of incidence for monitoring the impact of vaccination during this study. However, the high costs involved raise questions about the sustainability of the approach in rural Africa.

In this study, wildlife disease monitoring is dependent upon passive surveillance and opportunistic sample collection. The sample submission rate within the Serengeti National Park remained low at an average of 1.4 wildlife submissions/month since the start of the project (compared with 1.3/month in 1992-5). Wildlife rabies was confirmed only once in 1996, in a bat-eared fox in the centre of the Serengeti National Park (Seronera).

As with active surveillance, the question of sustainability of mass dog vaccination is perhaps more critical than its feasibility. In Serengeti, we are fortunate in working in a high-profile area that attracts world-wide interest and funding. However, donor funding is usually only short-term. Budgets available for Tanzanian veterinary services are limited and funding understandably directed to the major threats to the livestock industry. Our aim is therefore to try to establish a long-term collaboration between the Ministry of Agriculture and wildlife authorities (Tanzania National Parks and the Wildlife Division) to sustain domestic dog vaccination, perhaps through utilising some of the revenues from tourism and sport-hunting, which depend on the presence of healthy predator populations. A recent precedent has been set with rinderpest control whereby the wildlife authorities have provided considerable support for regional cattle vaccination in order to prevent the entry of rinderpest into the National Park and surrounding Game Reserves. In Tanzania, there is increasing awareness that disease control is an integral part of the management of wildlife protected areas, and that close collaboration with the livestock sector is essential. Rabies affects people, livestock and wildlife and an integrated approach to its control must surely be the way forward.

ACKNOWLEDGMENTS

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JACKAL RABIES IN ZIMBABWE EPIDEMICS AND SPECIES INTERACTIONS

John Bingham[34]

1 INTRODUCTION.

Jackals account for 25% of all confirmed rabies cases in Zimbabwe. They form the second most frequently diagnosed animal with rabies, second in importance to domestic dogs. Two species of jackal occur in Zimbabwe: the side-striped jackal (*Canis adustus*) and the black-backed jackal (*C. mesomelas*).

The first cases of rabies in jackals were reported in 1952, several months after the introduction of domestic dog rabies to Zimbabwe (Foggin, 1988; Swanepoel et al., 1993). A small number of cases were reported during the following years, until 1965 when a large epidemic started in the Mashonaland East area. Since then, several distinct epidemics have been reported. Jackal rabies was reported predominantly in the commercial farming sector, with about 80% of cases from these areas. Less than 1% of cases were reported from National Parks and other protected areas.

Rabies in domestic dogs constituted approximately 46% of all laboratory-confirmed rabies cases. These cases originated predominantly in the communal areas (subsistence farming areas that comprise about 42% of the land area and settle slightly over half of the nation's population). Brooks (1990) estimated that 71% of dogs in Zimbabwe live in the communal areas and that 40% of dogs were vaccinated against rabies. Current vaccination levels are estimated to be less than 30% (Department of Veterinary Services, unpublished data).

With the expanding domestic dog population in Africa, several researchers have surmised that these populations would threaten wild animal species by, amongst other means, the introduction of diseases (Alexander et al., 1993, 1994; Cleaveland and Dye, 1995). Rabies in jackals in Zimbabwe was not reported before the introduction of rabies in domestic dogs and it is likely that the disease in jackals was introduced by dogs. In this paper I present data which examines how the epidemiology of rabies in jackals is affected by rabies in other species, particularly dogs.

2 MATERIALS AND METHODS.

Computerised records from the Rabies Unit at the Central Veterinary Laboratory, Harare, were used for this analysis. Records of all laboratory-confirmed rabies cases diagnosed from 1950 to 1996 were available.

The species of jackal case submissions was usually not indicated on submission forms, therefore jackal cases were designated to zones of species dominance. These zones were determined according to published data (Skinner and Smithers, 1990) and to sampling surveys conducted in strategic localities. Three species zones were demarcated: the *C. adustus* zone in the northern Highveld areas and the eastern fringe of Zimbabwe; the *C. mesomelas* zone in the southern, central and western areas of the country and a zone, referred to as the sympatric zone, which lies between the *C. adustus* and *C. mesomelas* zones and where both species are assumed to live in roughly equal proportions or where the relative status of the two is not known. This latter zone occupies a relatively small area where only about 4% of reported jackal cases originated. Sympatry actually occurs throughout most of the *C. mesomelas* zone, but where *C. mesomelas* makes up about 80% of jackal samples. However, most of the *C. adustus* zone does not have *C. mesomelas* and therefore most of the cases from this zone will have been *C. adustus.*

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3 RESULTS.

Between 1950 and 1996, 2050 jackal cases were reported from the *C. adustus* zone, 397 were re-ported from the *C. mesomelas* zone and 107 were reported from the sympatric zone. The disease trends in jackals within the *C. mesomelas* and sympatric zones were not clearly definable: although epidemics did occur, cases within such epidemics were diffuse and did not show any definite pattern of movement. Because of the rather imprecise nature of jackal rabies in these zones, no detailed studies on rabies in these zones will be described here.

Jackal rabies cases in the *C. adustus* zone nearly all occurred during epidemics (Figure 1), which started at a focus and had a centrifugally-moving front. Reported cases within these epidemics had high densities. These epidemics occurred in commercial farming areas: they did not progress far into neighbouring communal areas or protected (wildlife or forest) areas.

Figure 1 : Rabies cases in the *Canis adustus* zone.
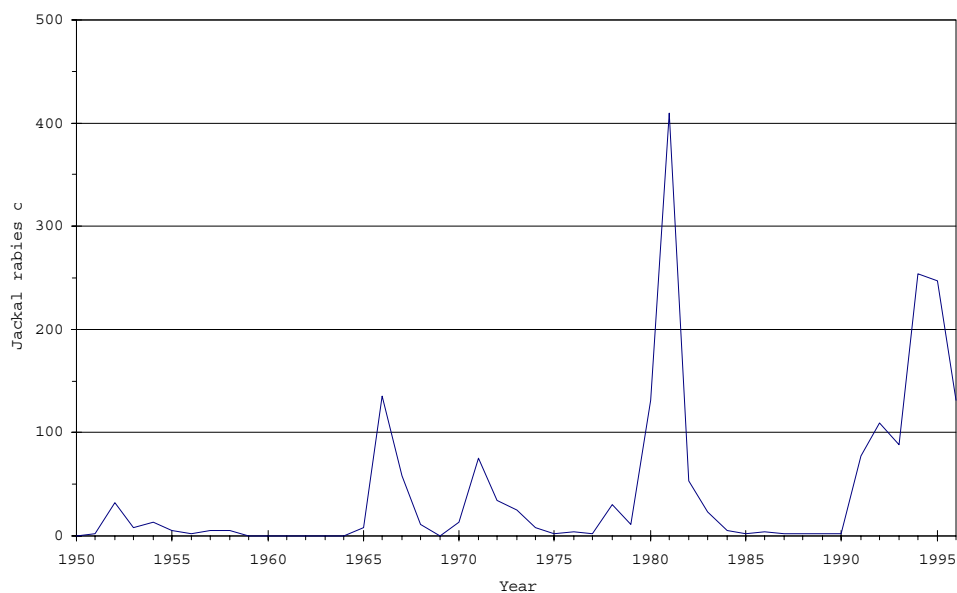
Other carnivore species apart from jackals and domestic dogs which were diagnosed with rabies within jackal rabies epidemics included African civets (*Civettictis civetta*), honey badgers (*Melivora capensis*), white-tailed mongooses (*Ichneumia albicauda*), large grey mongoose (*Herpestes ichneu-mon*), large-spotted genets (*Genetta tigrina*), aardwolves (*Proteles cristatus*) and various other spe-cies. However, none of these species were diagnosed with high frequency and they were reported after jackal cases. Therefore these species were considered to be spill-over.

Table 1 shows the number of jackal and domestic dog cases diagnosed in 2500 km2 blocks centred around towns in the *C. adustus* zone. Because they incorporate urban areas, surveillance in these blocks will probably be biased towards detection of dog cases. Despite this, the number of jackal cases far exceeded dog cases during all the jackal outbreaks. Of all jackal cases from the *C. adustus* zone up to 1996, 96.0% were preceded by at least one other jackal case within 180 days and 50 km, while 82.7% were preceded by at least one dog case and 1.1% were not preceded by cases of any species within these limits. Only 2.6% of cases were preceded by dog cases without jackal cases, while 16.0% were preceded by jackal cases without any dog cases. These data imply that jackal ra-bies in the *C. adustus* zone is self-perpetuating: jackal rabies cases are not simply spill-over from do-mestic dog rabies.

In the *C. adustus* zone a total of 13 foci which developed into epidemics were reported. Of the 13 foci, seven had dog cases occurring within a 50 km radius and 12 months before the jackal index case. Five of these foci had over five dog cases in the 50 km radius and six had over 10 cases within 100 km. In another focus where no dog cases, or cases in any other species, were reported within 50 km and 12 months, a large number of dog cases were reported between 50 to 70 km from the jackal index case.

Table 1 : The number of dog and jackal cases diagnosed in three 50 km x 50 km blocks located in the *Canis adustus* zone during epidemic periods.

Block and Period		Jackals	Dogs
Chinhoyi	1981-83	114	11
	1992-95	44	7
Mvurwi	1980-81	34	4
	1993-95	62	3
Marondera	1965-67	78	0
	1971-72	35	0
	1979-83	37	4
	1990-95	82	3

In three outbreak foci dog cases were reported within 100 km of the jackal index case, although larger numbers of jackal cases were also reported within this distance. The jackal cases and most of the dog cases were associated with separate jackal epidemics. Hence, these outbreak foci may have been initiated either by dogs straying from the other foci of jackal rabies, or from jackals dispersing from these foci.

Two instances occurred where no other carnivore cases occurred within a 50 km radius and within 12 months of the jackal index case. In the first instance low numbers of jackal and dog cases occurred although these were some distance from the focus of initiation. In the second instance no other cases were reported within a 100 km radius of an epidemic initiated near Mount Darwin in 1979. However, this was a remote area and was during a time of civil unrest, therefore the detection of cases was likely to have been poor.

4 DISCUSSION.

Are jackals a reservoir species of rabies, where a reservoir is defined as a species that is capable of independent maintenance of disease (Cleaveland and Dye, 1995)? This study indicates that *C. adustus* are capable of maintaining rabies independently of other species, and may indeed support dense epidemics. However, such maintenance has not, before the 1990s, persisted for more than 3-5 years, perhaps due to jackal population decimation that leads to decline and local extinction of the disease. Following a recovery period of up to ten years, a new epidemic starts. Epidemics in the *C. adustus* zone are not frequent, with only 13 instances recorded where new epidemics have become established. In many cases, epidemics have been preceded by rabies in domestic dogs and it is probable that domestic dogs may have initiated the epidemics in jackals.

Until the early 1950s when rabies was introduced into Zimbabwe, jackal rabies had never been reported. Following the introduction of rabies, the disease in jackals occurred mainly in large epidemics. Furthermore, jackal rabies occurred predominantly in the commercial farming areas: the natural protected areas, such as National Parks, Safari Areas and Forest Areas have had virtually no reported rabies cases. This is unlikely to be a surveillance artefact as these areas often have large numbers of biologists and tourist who would be expected to report suspect rabies cases. These points suggest that rabies is not a natural disease in jackals: it has only recently been introduced into the jackal population. The jackal/rabies parasitic relationship has evidently been unstable, a situation which is of no long-term benefit to the disease.

In the past, rabies has probably not been capable of sustaining itself in wild African canids and it currently cannot do so in natural populations. The advent of commercial farming in Zimbabwe has evidently created conditions suitable for rabies maintenance, albeit for limited periods of time. What these conditions are can only be surmised, however, they are likely to be ecological factors that have either raised the jackal population density or have changed the nature of jackals' social structure. These factors, in turn, lead to high transmission of rabies between jackals, which is necessary for the maintenance of the dense epidemics observed.

In the epidemics of the early 1980s rabies cases declined to extinction when the outbreak had reached the geographical limits of the commercial farming area. The decline in rabies incidence was presumably related to the fact that the jackal population had been decimated by the epidemic and

there were no susceptible populations remaining for the disease to spread into. Recently, a new phenomenon has been observed in the pattern of jackal rabies. During the 1990s the epidemic fronts reached the boundary of the commercial farming area, however, the annual incidence of rabies did not decline to extinction. Instead, the incidence of rabies changed to a seasonal pattern, with high incidence from January to March. These seasonal cases were dispersed and did not form the fronts which were characteristic of previous epidemics. This pattern has persisted in recent years and may indicate that *C. adustus* rabies has now become enzootic. If this is the case, the jackal/rabies parasitic relationship may be stabilising. The disease will not be so catastrophic for the jackal population but it may now be present every year. This will be confirmed in the years to come.

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DISCUSSION OF PAPERS

1) **Dr. Karen Laurenson: Rabies as a threat to the Ethiopian wolf**

- **Dr. Perry**: Do you have any evidence of rabies in the jackal, mongoose or hyaena populations in your study area?
  Local people felt that rabies was important in wildlife species in this area but whether they are rabies reservoirs or if they are infected by spill-over from dog-maintained rabies has not yet been determined.

- **Dr. Perry**: Rabies has been observed in jackals in other areas of Ethiopia but has been found to be a canid-associated strain.

- **Dr. Bingham**: As a general point, this and other studies presented have estimated dog population growth rates to be higher that human population growth rates. If we assume that dogs depend on people, why do we see these higher rates?
  There is not enough evidence to suggest that dog population growth rates are significantly greater than for the human population. Whether there is actually a real difference in these rates or whether this is an artefact needs to be resolved.

2) **Dr. J. K. Githaiga: The role of wildlife in the epidemiology of rabies in Kibwezi, Kenya**

- **Dr. Laurenson**: Did you do serology on the wildlife you trapped ?
  Not yet.

- **Dr. Cleaveland**: Did you use other methods to trap larger species?
  No, the area is densely populated so we focused on trapping small carnivores.

- **Dr. Wandeler**: The three wildlife road-kills found positive for rabies from approximately 50 samples is quite high. During outbreaks of fox and skunk rabies, the maximum percentage of road-kills positive for rabies is usually between 5 and 10%. Although, you have small numbers of positive, your data provides at least some indication that wildlife rabies could be important in the area.

- **Dr. Laurenson**: It would be very important to determine trends in the percentage positive over a longer period of time.

3) **Dr. P. Coleman: Domestic dog strategies around the Maasai Mara National Reserve**

- **Dr. Kloeck**: How and who did you use to help you catch all the dogs owned in your study?
  We used a catch pole to help but the main strategy was to train the owners to catch the dogs. All these dogs were owned and named and schoolboys were very good at catching dogs.

4) **Dr. M. Kaare: Rabies control in the Serengeti: the rationale for a targeted strategy**

- **Dr. Kaboyo**: How do you best target your rabies control strategies?
  We target livestock to control wildlife rabies by controlling transmission from livestock to wildlife.

5) **Dr. J. Bingham: Jackal rabies and dog rabies in Zimbabwe: epidemics and species interactions**

- **Dr. Bishop**: Was the monoclonal typing the same for jackals and dogs?
  We have made limited studies and with the Weybridge panel there has been no difference between them.

- **Dr. Godlonton**: Was there a correlation between the numbers of animal and human cases?
  From the 1960s to 1980s, yes, but not in the 1990s. During the 1990s, despite increased cases of animal rabies there has actually been a decline in human rabies, probably due to improved human health services.

- **Dr. Schumacher**: In Zimbabwe there were 300,000 dogs annually vaccinated for rabies in the 1990s. Is the decrease in dog rabies due to control by vaccination?

There is a correlation between vaccination rate and dog cases lagged by one year but not when lagged by 2 years.

- **Dr. Schumacher**: Are dogs vaccinated throughout the country?
  All dogs should be vaccinated. If there is a rabies outbreak in dogs, a vaccination campaign is mounted as well.

- **Dr. Dlamini**: Why do you not observe rabies in protected areas?
  Probably because of the low density of potential reservoirs. I believe that the surveillance in these areas is reasonably good.

GENERAL DISCUSSION

1) **Dr. Rodrigues**: Zimbabwe has jackal rabies quite close to the Mozambique border. How do we sample to see if we have a jackal rabies problem?

   - **Dr. Bingham**: *There are differences between the two countries. There is probably a different land use system in Mozambique versus Zimbabwe. We probably have better surveillance in Zimbabwe but this is probably not of major importance. Dog rabies is needed to initiate jackal rabies so dog rabies surveillance will be important. There seems to be more dog rabies around the border.*

2) **Dr. Fekadu**: Is the distribution of jackals associated with food sources?

   - **Dr. Bingham**: *No, in our situation it is related more to ecology. Dogs can easily outcompete jackals in the communal areas but dog densities are much lower in the commercial areas.*

3) **Dr. Pipekamp**: In the northern part of South Africa we see jackal rabies first followed by cases of rabid cattle and dogs. Why is the pattern different in Zimbabwe?

   - **Dr. Bingham**: *I think what you have observed is correct and is also the pattern we see in the extreme south of Zimbabwe with rabies in the black-backed jackal. There we see the same pattern with jackal rabies first followed by cattle and other species including the occasional dog having rabies much later.*

4) **Dr. Dlamini** : In urban areas, are dogs and jackals of equal important in transmitting rabies?

   - **Dr. Bingham**: *We have mainly had problems with jackals that stray into towns although we did have a problem with dog rabies in Mutare. In most large towns and cities we have a relatively low dog density.*

5) **Dr. Kaboyo**: Is 70% the vaccination coverage target in Tanzania?

   - **Dr. Kaare**: *Yes, that is correct.*

6) **Dr. Cleaveland**: What is the state of oral rabies vaccination trials for jackals in Zimbabwe?

   - **Dr. Bingham**: *They have not yet been implemented. In preliminary efficacy trials, 3 of 5 jackals were protected with a 7 log dose of SAG2, close to an EL50. The vaccine has also been shown to be safe in all main non-target species in the jackal-rabies area. The main problem I see is the stability of the vaccine, particularly when exposed to bright sunlight and high temperatures. The vaccine is not efficacious after 24 hours in bright sunlight but if covered would be fine after 3 nights during the winter. In our bait uptake trials there was reasonable uptake within 3 nights but I think we will need to distribute the baits by foot and by bicycle. I don't know yet whether an oral vaccination program for jackals will be implemented.*

Open session

RABIES IN EASTERN AND SOUTHERN AFRICA: EPIDEMIOLOGICAL PATTERNS

Arthur King[35]

1 INTRODUCTION.

For those of you who are familiar with this subject, let me apologise if I become boring but please stay with me because there may be a twist in the tail. For those of you attending your first meeting of our group, since this is the only presentation which deals with antigenic variation let me begin by defining what we mean by epidemiological patterns and then go on to describe the significance of different rabies viruses and why these differences may be important in the determination of control strategies.

Briefly, the rabies virus genome contains five genes, each of which codes for a protein of the virion. The virion nucleocapsid core is formed from the RNA and three of the proteins - N (nucleoprotein), NS (non-structural but this is a misnomer, it is a transcriptase-associated phosphoprotein) and L (large, virion associated transcriptase). The lipid containing envelope is a bilayer in which the M (matrix protein) lining is surrounded by G (glycoprotein). The G-protein spikes are anchored within this bilayer. The G and N are the two most extensively studied proteins. The G protein possesses the biological and immunological functions of cell surface receptors and antibody binding sites and monoclonal antibodies (Mabs) prepared against the amino acid region of the ectodomain G protein (Mab-Gs) can be used to distinguish viruses, one from another, although the neutralisation techniques required for this purpose are time consuming and results are not easy to interpret. The N protein is abundantly produced in virus infection, thus allowing detection by FAT in diagnostic tests and easy virus identification by monoclonal antibody anti-nucleocapsid (Mab-N) tests. Since the amino acid sequences of the N proteins display a high degree of homology, a panel of Mab-Ns which can detect the different reaction patterns of different viruses helps to identify the presence of these different viruses in different geographical locations. These "epidemiological patterns" can be useful in the determination of control strategies.

Similarly, analyses using molecular methods have played a major role in viral epidemiology by discriminating between virus variants. For example, analyses of the N gene of different viruses are particularly useful for the detection of changes which have taken place over relatively long evolutionary periods. The two techniques - Mab and molecular - are not mutually exclusive, rather they can be used in harness, routine use of a panel of Mab-Ns being used as a rapid indicator of those variants which may be worth further investigation by the "fine tuning" of molecular techniques.

2 RABIES SEROTYPES AND GENOTYPES.

Modern classification of the genus Lyssavirus defines the existence of four serotypes and six genotypes. Serotypes 1 - 4 were recognised by classical cross-protection tests in mice and they are now known as serotype/genotype 1 (Rabies), serotype/genotype 2 (Lagos bat), serotype/genotype 3 (Mokola) and serotype/genotype 4 (Duvenhage) viruses. Genotypes 5 and 6 have not been serotyped by classical cross-protection tests in mice but they are known respectively as European Bat Lyssavirus (EBL) 1, found predominantly in serotine bats of Europe and EBL 2, found predominantly in *Myotis* spp. of European bats. Recently, Lyssavirus infections have been responsible for the deaths of flying foxes and a human in Australia, but the serotype/genotype of these viruses has yet to be finally determined.

Although the vast majority of rabies viruses are of serotype/genotype 1 and have been isolated from most parts of the world, serotypes/genotypes 2 - 4 viruses have been isolated only in Africa. Two countries, Zimbabwe and South Africa, have isolated representatives of all four serotype viruses but many other African countries are not equipped to use discriminatory techniques and it is almost certain that Mokola and Lagos bat viruses in particular are more broadly distributed than has been reported.

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3 VIRUS COMPARTMENTATION.

Mab reaction pattern analyses of isolates from a rabies endemic area confirm surveillance observations of compartmentation of the disease in one major host species, with occasional "spill-over" to other species within the same area. The reason for such single species involvement is not clearly understood, although adaptability of a particular virus to another species and amount of virus secreted in the saliva of the recipient host may play a role. For example, in the European situation where the virus is almost exquisitely adapted to foxes, a fox may infect a dog and that dog may die of the disease after secreting low levels of virus in its saliva, but there is no evidence that the fox virus can set up a dog-to-dog cycle of infection. Similarly, in the African situation, Mokola virus and Lagos bat virus have been isolated from cats and dogs, but there is no evidence to suggest that these viruses are able to cycle in cats and dogs. Nevertheless, it should be remembered that these viruses, although sometimes called rabies-related viruses and given individual names other than rabies, do cause a disease and death in species other than the host species which is often indistinguishable on clinical grounds from the disease caused by serotype/genotype 1 rabies viruses.

4 MAB-N PANELS.

Despite the relative ease with which Mab-N analyses can be conducted, it is impractical to examine hundreds of viruses with hundreds of Mab-Ns. It is therefore more usual to construct a Mab-N panel of limited size based either on results gained with experience (omitting those which have no discriminating ability) or by the preparation of Mab-Ns against specific regions of the N protein gene.

5 EPIDEMIOLOGICAL PATTERNS.

Whichever way the panel is prepared, the number of different reaction patterns that can be obtained from terrestrial animal and in particularly canid isolates is relatively few. For example, using a panel of 17 Mab-Ns to examine 417 isolates from the major terrestrial rabies enzootic areas of Canada and the USA, only five distinct reaction patterns were determined (Smith and Baer, 1988). This is not to say that no useful information was elicited, far from it, the results confirmed for examples surveillance observations that red fox rabies in New York State originated from rabies in arctic foxes of Alaska and the North West Territories and that raccoon rabies of the mid-Atlantic States had its origins in an earlier outbreak of raccoon rabies in South-eastern USA. When the same panel was used to examine 106 isolates from five bat species, however, no fewer than 14 reaction patterns were observed, including seven variants from within a single bat species. The reason for such virus diversity in bats as opposed to that in terrestrial animals is not easy to explain but bats are the only mammals that can fly, some species being able to travel vast distances, some species hibernate and in some areas different bat species are known to share roosts and these may be factors which contribute to virus diversity within a single species.

Whereas in North America there are several rabies reservoir species (skunk, raccoon, red fox, grey fox and possibly coyote) and the disease has been continuously present, at least in some areas, since the late 1700s/early 1800s, in Europe canine rabies had virtually disappeared by the turn of this century, only to be replaced by fox rabies which spread from the Russo-Polish border during the second world war. There have been few studies of changes in the virus responsible for this epidemic and although some have shown minor antigenic changes, there has been no adaptation to other terrestrial animal reservoir hosts, as shown by the fact that when fox rabies is eradicated no other rabies cases are found. Although rabies in European bats is a relatively recently reported phenomenon (but almost 500 cases reported since 1953), it is probable that, as in the USA, it had been present but was undetected for many years. However, rabies in European bats is so easily distinguishable by Mab-N analysis from that in American bats that the two major groups - EBL 1 and EBL 2 - are classified as genotype 5 and genotype 6 respectively; each group displays a high degree of homogeneity. However, by using the "fine-tuning" of molecular techniques each group can be subdivided and it is possible to speculate that each of the four subdivisions is of different geographical origin (Amengual et al., 1997). So few isolations of the African rabies-related viruses Lagos bat and Mokola have been made that although five reaction patterns for the former and three reaction patterns for the latter have been reported (King 1991) there is insufficient evidence to make assumptions regarding the extent to which these viruses may vary. To date no comprehensive molecular analyses of these viruses have been made, although the prototype strains have been sequenced.

Although it has been postulated that rabies has been present in Africa for more than 4000 years, its recorded history in sub-Saharan Africa covers only the past century or so. As far as one can ascertain from the outcome of SEARG meetings, dog rabies predominates to the north and central Africa, but further south the disease becomes increasingly important in wildlife species. This may be a reporting artefact since in general disease surveillance in southern Africa is of a higher order than in the North, but it is certain that as human (and dog) populations expand there is greater potential for the spread of rabies into wildlife species. Only since the discovery in 1956 of Lagos bat virus in Nigeria has any study of African rabies viruses been attempted and not until 1982 was it shown that rabies viruses with differing Mab-N and Mab-G reaction patterns were present in African terrestrial animals. Most subsequent studies suffer from being carried out by different workers using different Mab-N panels and relatively few specimens, but one general conclusion that can be made from these studies is that most rabies viruses isolated from canids show only minor variation. As might be assumed from the foregoing, some further discrimination has been made with fine-tuning molecular techniques and indeed several authors have attempted to associate the origins of some variants with rabies viruses of the Middle East, Europe, southern USA, South America and Asia. The assumption has been made that most of these canid variants are associated with the disease in dogs transported by man during his explorations of the world.

The remarkably homogeneous reaction patterns of African canid virus isolates (no more than five variants were found by Smith *et al.*, 1993) is not maintained when rabies viruses from viverrids of southern Africa are examined. Foggin (1988) was the first to show that the Mab-N and Mab-G antigenic patterns which were obtained from three slender mongooses of Zimbabwe were quite distinct from those obtained from dogs and jackals in that country. Unfortunately the dissipation of the epizootic in mongooses was a factor which prevented further exploration of the phenomenon. Further work by a number of authors (King 1992; King *et al.*, 1993, 1994; Tremlett *et al.*, 1994) clearly demonstrated that rabies viruses from South Africa, Namibia and Botswana could be divided into at least two antigenic groups, those associated with canids (mainly dogs, black-backed jackals and bat-eared foxes) and those associated with viverrids, which include a number of mongoose species, suricates, genets and civets. These studies also showed that spill-over of one virus type, for example a viverrid virus into a canid, was not uncommon and indeed, almost all of the rabid domestic and wild cats subsequently examined were infected with a virus of viverrid origin; the reverse scenario has been less frequently observed.

A remarkable feature of the disease in viverrids is the high degree of heterogeneity of reaction patterns. Indeed, in one study of 83 isolates from South Africa (King *et al.*, 1993) no fewer than 22 reaction patterns were found, 21 of which were clearly associated with viverrid-type virus. These results can be directly compared with the five reaction patterns obtained by Smith *et al.*, (1993) albeit with a different Mab-N panel, from 100 African viruses but which included only viruses from three yellow mongooses and 45 isolates from unspecified species. The 21 reaction patterns associated with viverrid virus infection could be subdivided into five groups. Later nucleotide sequence work carried out by Professor L. Nel at the University of Pretoria confirmed that canid and viverrid isolates differ clearly from each other and that the five subgroups of viverrid viruses were associated geographically with distinct and different geographical localities. Since there are no topographical or other barriers to prevent mixing of mongoose populations and consequently rabies viruses it is contended that the current picture represents independent evolution over a considerable period of time of rabies virus in viverrids (Thomson, 1995).

A more recent, as yet unpublished study of South African viruses, using many of those previously tested and some new ones, but with a completely new panel of Mab-Ns prepared and supplied by Dr. A. Wandeler of Agriculture Canada, has thrown up a further intriguing possibility - the "twist in the tail" mentioned at the beginning of this presentation. The results of the study, summarised in Figure 1, indicate that with this panel there are two canid groups and three viverrid groups of viruses. Group V3 is composed of 20 viruses, 18 of which were isolated from viverrids. Only one of the 24 yellow mongoose viruses tested fell within the V3 group, as did 4 of 13 suricates, 2 of 5 galerella and 4 of 7 atillax (water mongooses) viruses. Interestingly, the viruses from all of the seven small-spotted genets fell within the V3 group, as did both ground squirrel viruses; one of the latter viruses came from a map reference identical to that of one of the genets. In 1927 Cluver reported that "in South Africa from 1916 onwards the occurrence of rabies was suspected with increasing frequency in viverrids, particularly yellow mongooses and in small-spotted genets". Today, genets are much more rarely sighted in South Africa and the number of submissions from this species to the Laboratory at Onderstepoort has fallen dramatically in recent years (C. D. Meredith, pers. comm.). It is possible that the rabies virus in genets

also evolved within that species and it is also possible that the decline in genet numbers is partially as a result of the disease.

Figure 1 :
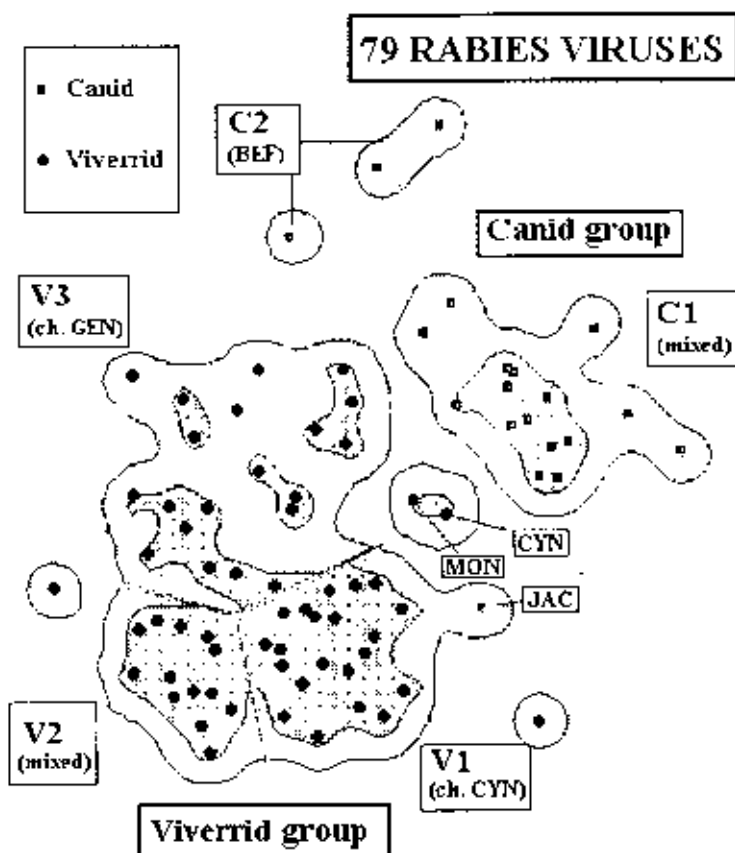
6 THE VALUE OF ANTIGENIC ANALYSES IN CONTROL STRATEGIES.

One might argue that its all very well to discover from which continent this or that virus originated, but is there any value in continuing this type of work, particularly when resources are minimal and there are more pressing problems related to human death and animal vaccination campaigns. It is reasonable to assume that antigenic variation in canids will be of little public health significance, particularly as current human and animal vaccines are protective against these variants. Nevertheless, as we have heard from George Bishop earlier at this meeting, when a canid virus is isolated from a dog in a previously canid virus free area, every attempt is made to control the disease in that area by vaccination campaigns. If the virus turns out to be one of viverrid origin, only a watchful eye is kept on the situation, since so far it appears that viverrid viruses do not cause cycles of infection in dogs. But there are also other advantages. At present, the reservoir species of Mokola virus is unknown, but since the introduction of a discriminatory Mab-N panel to Onderstepoort, several isolations of Mokola virus have been made from cats apparently suffering from typical furious rabies. This is a worrying development since Mokola is a virus against which current vaccines give very little protection. Further, although viverrid type virus has on occasion been isolated from cattle and sheep, the number of cases is insignificant as a proportion of the estimated 9 million cattle and 30 million sheep of South Africa. However, in both cattle and sheep, in experiments using high titre mongoose viral suspensions a high proportion of animals failed to develop rabies within two months but those animals which did die, particularly sheep, either died acutely or became paralysed without showing any other obvious clinical signs. Should such cases occur in the field, a rabies diagnosis probably would not be made (King *et al.*, 1994).

We now know that rabies in southern Africa is a more complicated disease than has been reported from other parts of the world. In order to understand the importance of these complications we need to examine the reaction patterns of more viruses from more species, taken from throughout the SEARG

region. Perhaps we can establish a laboratory centre which will be responsible for the collection, testing and storage of these viruses.

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THE EPIDEMIOLOGY OF RABIES IN MACHAKOS DISTRICT, KENYA

Kitala P.M.[36] and McDermott J.J.[34]

1 INTRODUCTION.

Kenya has experienced several rabies outbreaks since the first rabies case was confirmed in a dog in the outskirts of Nairobi in 1912 (Hudson, 1944). Dog vaccinations, started in the late 1950s in conjunction with dog movement restrictions, appeared to have effectively controlled the disease so that by the early 1970s it was virtually eliminated in most parts of the country (Kariuki and Ngulo, 1985). However, between 1974 and the early 1980s, rabies had spread to most parts of the country including those areas which had previously been declared rabies-free (Kariuki and Ngulo, 1985; Kariuki, 1988).

The rabies problem in Kenya has been particularly serious in Machakos District, where the disease has been endemic since the mid 1950s, even persisting during the 1960s and early 1970s when rabies was controlled in the rest of the country (Kariuki, 1988). During the period 1983-1992, Machakos District accounted for 29% (623/2149) of the confirmed animal rabies cases countrywide (Chong, 1993). Despite the once-a-year dog vaccination campaigns coupled with the destruction of unconfined dogs applied by government veterinary staff, there remained a large and relatively uncontrolled dog population (both rural and peri-urban) in the district and the proportion of dogs immunised was insufficient to control canine rabies. In the period 1981-1990, 8027 people were officially reported to have been bitten by dogs in the district out of which 4947 received post-exposure treatment and 22 died of rabies (records of the Machakos District General Hospital). During the same period, 505 animal rabies cases were confirmed (records of the Machakos District Veterinary Department). These officially reported cases should only be considered as an indication of the rabies situation in the district rather than a precise record, as the majority of cases go unreported (Kitala *et al.*, 1994)

In response to this situation, a one-year community-based active surveillance project for rabies was conducted in six randomly selected rural and peri-urban areas in Machakos District. The objectives of this project were to estimate the incidence of human and animal rabies in the district and to collect data on dog ecology and demography considered necessary for proper planning and implementation of a rabies control programme (Beran and Frith, 1988; Wandeler *et al.*, 1988; WHO 1988; WHO/WSPA 1990). We have previously reported on the dog ecology and demographic results (Kitala and McDermott, 1995). In this paper we describe the distribution of animal and human cases recorded as rabies suspects and their clinical and laboratory follow-up.

2 MATERIALS AND METHODS.

2.1 Study area and data collection.

The 6 study areas were described and mapped in Kitala *et al.* (1993). Briefly, the study areas were selected by a stratified random sample with six of ten divisions and one sublocation per division selected. A list of households for each study sublocation was compiled with the assistance of the local chief and administrator. The households were re-ordered by random selection and visited in order until 25 dog-owning households had been interviewed. After consulting with local leaders, a rabies worker per sublocation was recruited. Public meetings were also held to describe study objectives, encourage reporting of all animal-bites, suspected rabies cases including animals found dead and to answer any questions.

After an initial training programme on rabies and aspects of data collection, the rabies workers actively followed-up all animal-bites and suspected rabies cases for one year. The data were recorded in stan-

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dard forms according to WHO (1992). Rabies suspect animals were categorised into primary and secondary cases. Primary suspects were animals showing signs consistent with rabies but for which the exposing animal was unknown while secondary suspects were animals exposed by the primary suspects. A human rabies suspect was any man exposed to a rabies suspect animal. The rabies workers not only collected intact heads of rabies suspect animals but also collected heads from any animal found dead (mostly road-kills). The workers were visited at monthly intervals to assess their data collection, to collect specimens for rabies diagnosis and to provide results of previous diagnoses (note that due to delays in rabies testing all human suspects were actively encouraged to seek post-exposure vaccine). Rabies was diagnosed at the Central Veterinary Laboratory in Kabete using the fluorescent antibody test (FAT) according to the method described by Kissling (1975).

3 RESULTS.

3.1 Active surveillance for animal-bite and rabies cases.

A total of 277 animal rabies suspects, 194 primary and 83 secondary, were reported. Of the 194 primary suspects, 179 (92%) were dogs. Dogs also accounted for the majority (80% (66/83)) of secondary suspects. Table 1 shows the distribution of the primary and secondary animal rabies suspects by species and sublocation. Of the 66 dogs secondarily exposed, 63 (95%) were bitten by other dogs. Using dog population estimates for the study area, this converts to a dog-to-dog exposure rate of 1230/100000 dogs. The number of exposed animals per rabies suspect dog ranged from 1-8 animals (mean= 1.8) and 14 dogs confirmed positive exposed 30 dogs. Of the 83 exposed animals, 55% (46/83) were alive at the end of the follow-up period and a further 30% (25/83) experienced an event directly related to the exposure including: death due to bite wounds (8), sold (3), killed by their owners (9), and death due to confirmed rabies (5) (Table 2). Of the 30 dogs exposed to the 14 confirmed rabid dogs, 18 were alive at the last follow-up date, 3 were killed by their owners, 5 died of the bite wounds, 1 disappeared, and 3 died of other causes. There were 92 human cases of animal-bite reported (89 bitten by dogs) equivalent to an annual incidence of animal-bites of humans of 234/100000 people.

3.2 Rabies diagnosis.

Table 1 : Distribution of primary/secondary rabies suspects by species and sublocation in Machakos District, Kenya, 1992-1993.

Species	Sublocation						Total
	Ikombe	Kikambuani	Mikuyuni	Muvau	Ngoni	Sultan Hamud	
Dog	85/18	13/2	19/5	21/9	16/7	25/25	**179/66**
Cat	1/0	0/0	10/0	1/0	0/0	1/0	**4/0**
Honey Badger	1/0	0/0	5/0	0/0	0/0	0/0	**6/0**
Squirrel	1/0	0/0	0/0	1/0	0/0	0/0	**2/0**
Rabbit	0/0	0/0	0/0	0/0	1/0	0/0	**1/0**
Cattle	0/0	0/6	0/1	0/0	0/0	0/2	**0/9**
Sheep	0/1	0/0	0/0	0/0	0/0	0/0	**0/1**
Goat	1/0	0/2	0/2	0/2	0/0	0/1	**1/7**
Donkey	1/0	0/0	0/0	0/0	0/0	0/0	**1/0**
Total	**90/19**	**13/10**	**25/8**	**23/11**	**17/7**	**26/28**	**194/83**

There were 130 specimens examined for evidence of rabies. 96 were from rabies suspect animals of which 49 (51%) were positive and 34 were from animals found dead (mostly road-kills along the Mombasa-Nairobi road) of which 5 (15%) were positive. Dogs accounted for 81% (44/54) of the confirmed

rabid animals for an annual confirmed dog rabies incidence of 900 cases /100000 dogs. The distribution of the specimens testing positive by species and sublocation is shown in Table 3. One human death due to rabies was recorded providing a point estimate of 25 deaths per million inhabitants.

Table 2 : Follow-up results of animals exposed to animals with rabid signs in Machakos District, Kenya, 1992-1993.

	Species				
Follow-up results	**Cattle**	**Dog**	**Goat**	**Sheep**	**Total**
Died of bite wounds		7		1	**8**
Sold	3				**3**
Disappeared		2	2		**4**
Killed by owner		8	1		**9**
Died of confirmed rabies	1	4			**5**
Died of other causes		8			**8**
Alive	5	37	4		**46**
Total	**9**	**66**	**7**	**1**	**83**

3.3 Clinical signs.

The clinical signs manifested by 87 primary animal rabies suspects (clinical signs of 9 secondarily exposed animals were not recorded) submitted for diagnosis and the number confirmed is summarised in Table 4. The most frequently reported clinical signs were aggressive behaviour (characterised by biting incidents), random walking and drooling of saliva. An animal was classified as being aggressive if it attempted to bite at any time in the course of clinical disease. There was a strong positive association between aggressive behaviour and a positive FAT result (OR = 3) and also between drooling of saliva and a positive FAT result (OR = 6). No association was found between paralysis and a positive FAT result ($p = 0.7432$).

Table 3 : Distribution of specimens testing positive over total specimens tested for rabies virus on FAT by species and sublocation in Machakos District, Kenya, 1992-1993.

	Sublocation						
Species	**Ikombe**	**Kikambuani**	**Mikuyuni**	**Muvau**	**Ngoni**	**Sultan Hamud**	**Total**
Dog	17/41	1/2	7/12	3/5	7/11	9/16	**44/87**
Cat	0/1	0/0	0/1	1/1	0/0	1/1	**2/4**
Honey Badger	0/1	0/0	1/5	0/0	0/0	0/1	**1/7**
Squirrel	0/0	0/0	1/5	2/4	0/2	1/6	**4/17**
Rabbit	0/0	0/0	1/5	0/0	0/1	0/0	**1/6**
Cattle	0/0	0/0	0/0	0/0	0/0	1/1	**1/1**
Sheep	0/0	0/0	0/0	0/0	0/0	1/2	**1/2**
Dik Dik	0/0	0/0	0/0	0/0	0/1	0/1	**0/2**
Stone Hyrax	0/0	0/0	0/1	0/0	0/0	0/1	**0/2**
Mon-goose	0/0	0/0	0/0	0/0	0/1	0/0	**0/1**
Vervet Monkey	0/0	0/0	0/1	0/0	0/0	0/0	**0/1**
Total	**17/43**	**1/2**	**10/30**	**6/10**	**7/16**	**13/29**	**54/130**

3.4 Seasonal variation in the incidence of rabies suspects.

Although rabies suspect animals were reported throughout the year, distinct peaks were observed in the months of June, September and November. The main June peak was preceded by a peak in the number of litters born to 128 bitches followed in the study sites (Figure 1). The pattern of confirmed rabies mirrored that of suspect cases (Figure 1) indicating that specimen collection and diagnostic methods were probably consistent throughout the year.

Figure 1 : Temporal relationship between suspected and confirmed rabies cases and dog fecundity in Machakos District, Kenya, 1992-93.
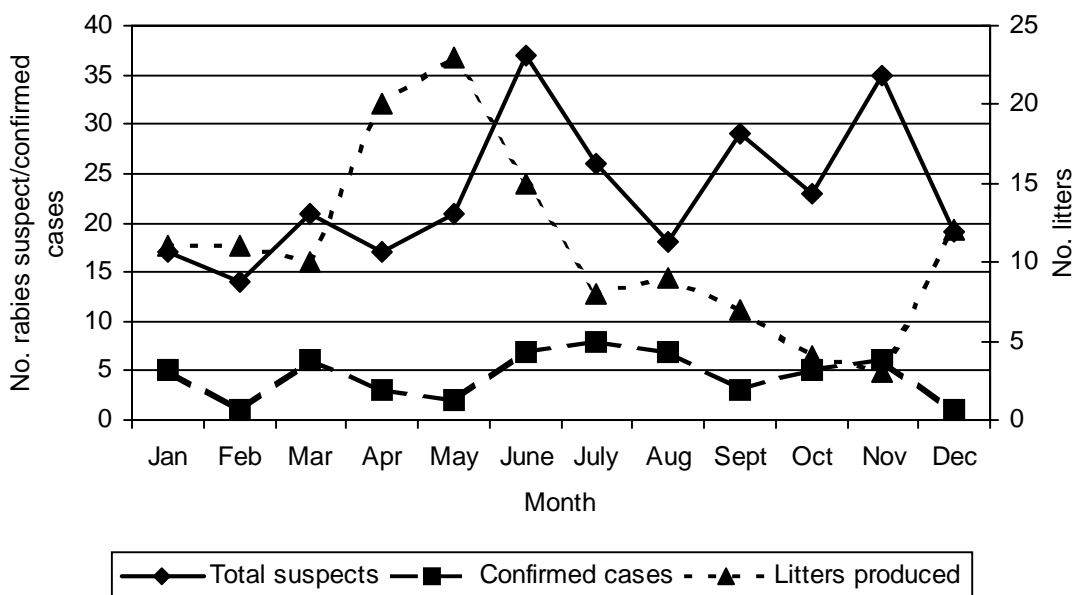
3.5 Sex and age structure of the rabies suspect dogs.

The male : female ratio of 238 rabies suspect dogs was 1:0.72 and the mean age for the 125 rabies suspect dogs with known ages was 2.9 years. The majority (65%) of the suspects were at least one year of age, with 10% being less that or equal to 3 months old (Figure 2). The mean age of 16 confirmed rabid dogs was also 2.9 years; 9 of the dogs (56%) were a year old and above and 2 (13%) were three months old and below (Figure 2).

Figure 2 : Age distribution of suspected and confirmed cases of rabies in Machakos District, Kenya, 1992-93.
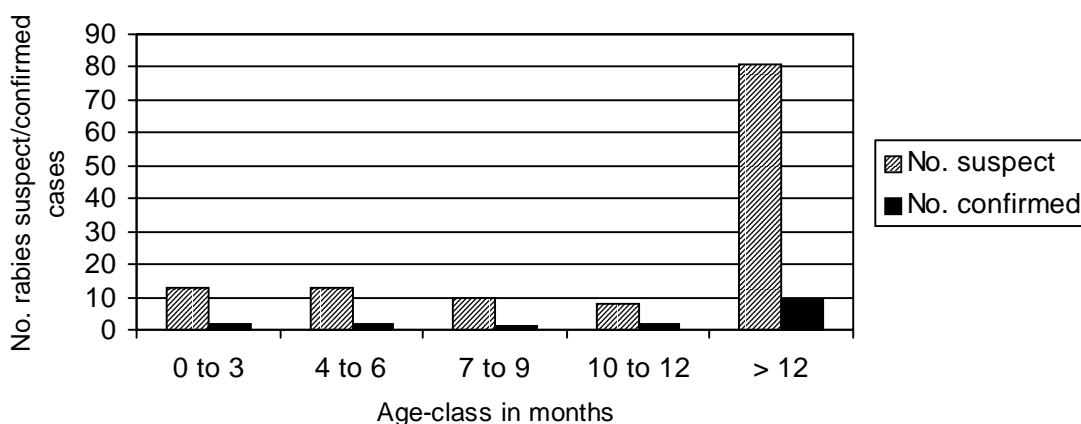
3.6 Ownership and vaccination status of the rabies suspect dogs.

The owners of 46% of 179 rabies suspect dogs could not be identified. There was a strong negative association between a positive test result and the ownership status of a rabies suspect dog (OR = 4). A small proportion (14%) of 96 rabies suspect dogs whose owners were identified, reported that their dogs had been vaccinated against rabies. Two of 16 dogs reportedly vaccinated tested positive on FAT; one had reportedly been vaccinated three years earlier and the other 3 days prior to developing rabid signs.

Table 4 : Proportion of 87 animal rabies suspects submitted for diagnosis which were FAT positive by clinical signs reported in Machakos District, Kenya, 1992-1993.

Clinical Sign	Number submitted	Number positive	Proportion positive
Aggression	52	32	0.62
Random walking	48	32	0.67
Drooling of saliva	57	37	0.65
Sudden change in behaviour	29	8	0.28
Paralysis	16	7	0.44
Hyperaemic eyes	8	5	0.62
Depraved appetite	6	1	0.17

4 DISCUSSION.

The results of this active surveillance project in Machakos District demonstrate the central role that dogs play in the maintenance and transmission of rabies in the district. The vast majority of the rabies suspect animals (92%) and confirmed rabid animals (81%) were dogs. In addition, 97% (89/92) of cases of animal-bites of humans were also due to dogs. These results are consistent with what has been observed in many countries in Africa, in which dogs consistently account for over 80 to 90% of confirmed cases (Tierkel, 1975; Acha, 1981; Bogel *et al.*, 1982; WHO, 1992). The annual incidence rate of 900 confirmed rabies cases/100000 dogs in Machakos estimated in this study is much higher than annual incidence rates (per 100000 dogs) of dog rabies in some African countries/regions including: Natal, South Africa (11.8), Zimbabwe (11), Zambia (3.3), Malawi (12.8), Lesotho (1.5), Madagascar (4.7), Kenya (3-8), Tanzania (1-6), and Serengeti, Tanzania (8-16) (Gascoyne, 1994). Since not all cases had samples submitted the true rate may actually be higher. Estimates from passive recording systems in the other countries are likely to suffer even more from under-reporting. Kitala *et al.* (1994) estimated that active surveillance in Machakos uncovered approximately 40 times more cases than passive reporting. This improved reporting underscores the importance of developing public participation in any rabies control programme.

The high incidence of rabies in Machakos is probably a function of high dog density, minimal dog control and low vaccination rate of dogs (Kitala *et al.*, 1993). In previous dog ecology and demographic studies in Machakos, Kitala *et al.* (1993) found that the majority of dogs (81%) were never restricted at any time and spent most of their time scavenging for food, that reported vaccination cover of the dog population was less than 33% of dogs over 3 months of age and that dog densities were quite high, ranging from 6 to 110 dogs km^{-2}. These are far below WHO (1992) control targets.

The proportion of submitted samples positive for rabies (51%) is comparable to estimates from other African countries. It is similar to a proportion positive of 49% reported for specimens submitted by non private practitioners in the Natal area of South Africa but is higher than the proportion of 42% reported for specimens submitted by private practitioners from the same area (Kretzmann, 1993). Foggin (1988) reports a positivity proportion of 36% for Zimbabwe and positivity proportions of 50 and 58% have been reported for Swaziland and Kenya respectively (Dlamini, 1995; Chong, 1993). The proportion of submitted samples testing positive will be largely linked to the true incidence of rabies in a given area, so that in high incidence areas such as Machakos, a high proportion of samples tested will be positive since there is a high prior probability that dogs exhibiting nervous signs have rabies.

Given this high proportion of rabies suspects testing positive and the long lag between human exposure and FAT diagnosis, the clinical signs of the rabies suspect animal and the details of the exposure incident are used to guide post-exposure treatment decisions. However, the clinical signs associated with rabies are not pathognomonic and can be mistaken for canine distemper and many other patho-

logical conditions (Fekadu, 1993). The greatest problem in relying on clinical signs to guide post-exposure treatment decisions is that some rabid dogs may die without showing any signs of illness while others develop dumb rabies, which can easily be misdiagnosed (Fekadu, 1988). In this study, a high proportion (52/87; 60%) of specimens submitted for diagnosis were from animals manifesting signs suggestive of the furious form of rabies (aggression and random walking) and only a small proportion (16/87; 18%) manifested signs indicative of the dumb form of the disease (paralysis). Any dog that attempted to bite at any stage during the clinical course was automatically categorised as aggressive by the rabies workers, because biting rabid dogs pose the greatest threat to man. Different diagnostic methods may account for the variations in the proportions of furious and dumb rabies reported in various studies. The proportions in this study are lower than some reports from elsewhere in Africa (Boulger and Hardy, 1960; Minor, 1977) but similar to others (Ryeyemamu et al., 1973; Barnard, 1979; Okolo, 1986; Foggin, 1988). Kappus (1976) found aggression in only 26% of rabid dogs in a study in the USA. The high proportion of submitted samples positive in this study indicates that the furious form of rabies is well known to the people of Machakos. The dumb form may be less well known.

Although rabies-suspect and confirmed cases were reported throughout the year in Machakos, distinct peaks were observed in the dry months of June through to November. Similar patterns have also been observed in Botswana (Sehularo, 1995), Kwazulu Natal in South Africa (Bishop, 1995), Ghana (Addy, 1985), and in Nigeria (Fagbami et al., 1981), where peak rabies incidence coincided with the dry season of the year. Bigler et al.(1973) found that rabies in the USA occurred throughout the year but peak incidence was associated with the breeding season for dogs. This pattern is likely due to the increased movements of and contacts between dogs looking for mates. In Machakos, this will be exacerbated since dogs are rarely restricted in their movement, and there is only minimal effort to control dog breeding through castration of male dogs and spaying of females (Kitala et al., 1993). Coordinating rabies control programmes with this seasonal peak may increase efficiency. We plan to investigate this in subsequent transmission models.

The sex structure of rabies cases is similar to that of the overall Machakos dog population (M:F ratio of 1:0.72 for rabies suspect dogs versus 1:0.67 for all dogs (Kitala et al., 1993)). However, rabies suspects were comparatively older than the overall population. The majority (65%) of the rabies suspect dogs and 56% of the confirmed rabid dogs were at least one year of age (compared to 50% of the general population). Only 10% of the rabies suspects and 13% of the confirmed cases were 3 months or younger (versus 26% of the general population). This older age distribution of rabies cases was also noted by Foggin (1988) in Zimbabwe (76% of confirmed rabies cases were in dogs greater than one year of age and only 4% were under 3 months of age). Brooks (1990), also in Zimbabwe, noted a large proportion of older dogs with rabies (66%) but 20% of his confirmed rabies cases were in dogs 3 months of age or younger. We expect younger dogs to have a lower incidence of rabies, since they are less mobile and thus should have less contacts with other dogs. However, despite this lower risk of younger dogs, we and others have argued (Kitala and McDermott, 1995; Perry and McDermott, 1995) that the rapid turnover of dog populations necessitates more frequent vaccination and vaccination of younger dogs than the current practice of annual vaccination of dogs older than 3 months of age.

The owners of 46% of the rabies suspect dogs could not be determined, despite our previous observations (Kitala et al., 1993) that the ownership of virtually all dogs in Machakos under normal circumstances can be determined. Two factors may be important. The first is that rabies infection destroys the usually very strong territorial instincts of dogs making them wander far from home. Of rabies suspect dogs diagnosed by FAT, dogs whose owners could not be traced were 4 times more likely to be confirmed rabid. In addition, fear of prosecution and/or paying for the post-exposure expenses of exposed humans would almost certainly cause dog owners to deny owning a dog suspected of being rabid. Foggin (1988) and Kretzmann (1993) report a much higher proportion (66%) of ownerless rabid dogs in Zimbabwe and Natal, South Africa respectively. We suspect that the active follow-up of rabies suspect cases by community rabies workers in Machakos may have contributed to the higher success rate in identifying dog owners in this study.

In summary, the results of the active surveillance for rabies provides a significantly higher estimate of the incidence of animal rabies than traditional passive surveillance. The dog appears to be both the principal reservoir and transmitter of the disease to both man and his other domestic animals. The economic losses due to rabies in Machakos are substantial in terms of direct costs of post-exposure treatment of humans, deaths of other domestic animals after a suspected exposure to rabies, and the uncostable loss of human lives due to the disease. The unacceptably high incidence of rabies in Machakos is mainly a function of high dog density, minimal dog control and the low vaccination coverage of the dog population. The current rabies control programme is clearly ineffective and needs to be revised if rabies is to be controlled. Fortunately, public awareness of rabies in Machakos is high and a

well planned rabies control programme is likely to receive good community cooperation. This planning process needs to consider both our rabies epidemiology and dog ecology findings but also the logistics of mobilizing community participation. Pilot control programmes thus developed should then be assessed in field trials with communities as the unit of observation.

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RABIES CONTROL IN MPUMALANGA, SOUTH AFRICA

P.E. Kloeck.[37]

Mpumalanga with its capital Nelspruit occupies 6 % of the surface area of South Africa. Approximately 3 million people or 7 % of South Africa's population live in this Province. Its diversified economy is supported principally by manufacturing, mining, electricity generation, tourism, agriculture and forestry.

The Province encompasses the area between Witbank in the west and Komatipoort in the east. On its southern borders lie the Free State and KwaZulu-Natal and to the north, the Northern Province. It is bordered by Gauteng in the west and Swaziland and Mozambique in the east. Spectacular natural beauty, a temperate climate and a rich array of natural features is one of the reasons why the Province is a prime destination for foreign and domestic tourists.

Agriculture in the Province is characterised by a dichotomy of highly sophisticated and fully commercialised farming practices in some areas and subsistence livestock and emerging crop farming in others.

The population is very unevenly distributed with roughly half of the population living in the former homelands of KaNgwane and KwanNdebele. The socio-economic conditions and quality of life in some of the more densely populated areas in the Province are conducive to the endemicity of canine rabies virus.

Figure 1 :
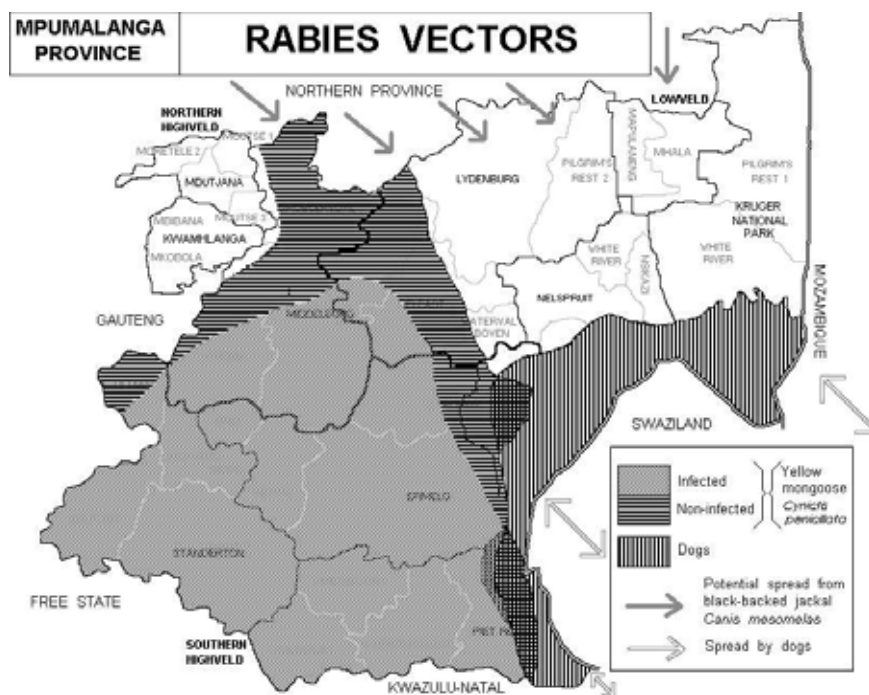
Mpumalanga has a unique blend of urban and sylvatic rabies. The diversity of species involvement here, is as wide or wider than most areas in the rest of South Africa.

Historical evidence exists that the earliest records of rabies in Mpumalanga were eleven unconfirmed human cases that occurred between 1916 and 1927 in the former Southern Transvaal (Mpumalanga -

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Southern Highveld), Free State and Northern Cape (Swanepoel *et al.*, 1993). The disease was confirmed in humans by Herzenburg (1928).
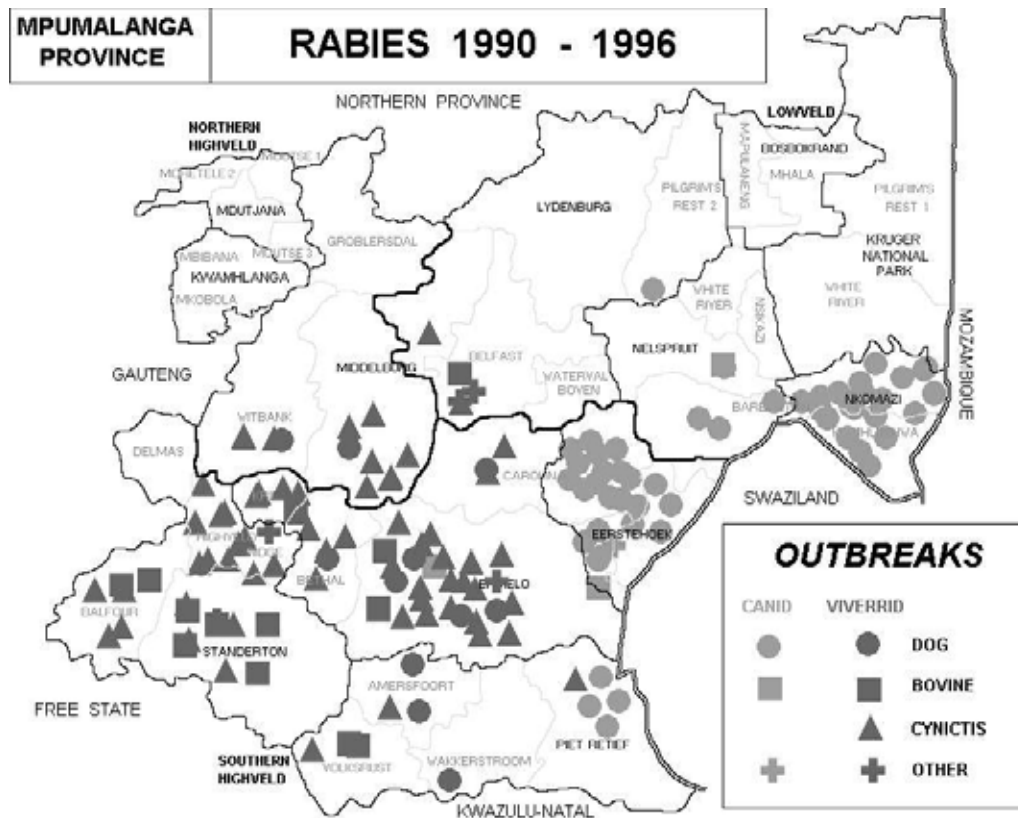
Figure 2 :

1 VIVERRID RABIES.

In Mpumalanga sylvatic rabies, independent of the canine cycle is found in the yellow mongoose (*Cynictis penicillata*). It can safely be assumed that viverrid rabies virus has been endemic for centuries in the highveld area of the province (southern and south-western territory). Rabies has been consistently diagnosed in wild viverrids, especially the yellow mongoose with occasional spill over into domestic and other animals.

The yellow mongoose is diurnal and its role as a maintenance host for rabies virus is facilitated by the fact that it lives in colonies of 10 or more individuals. It is often found together with ground squirrels in warrens. Another inhabitant of squirrel warrens is the suricate (*Suricata suricatta*), a viverrid occurring in migratory groups of up to 30 individuals. Suricates periodically evict yellow mongoose from warrens which they may then occupy for several days before moving on. In Mpumalanga the suricate is the second most commonly infected mongoose although the incidence rate is low.

Outbreaks in viverrids have occurred in a cyclical pattern over decades and no clear picture materialises from the data available in our province other than to point out that increases in viverrid rabies diagnoses appear to coincide with dry seasonal spells. It is indeed strange that not a single case of rabies was reported in sheep in an area where sheep outnumber cattle by three to one. Both species being naturally inquisitive, one would have expected several confirmations. Bovines remain the most important domestic victim species.

2 CANINE RABIES.

Canine rabies in Mpumalanga probably originated from the well documented epizootic in 1947 that spread from Angola through Namibia, Botswana, Northern Province and reached the Lowveld in 1950 (Mansvelt 1956).

Sporadic outbreaks of canine rabies have since then regularly been confirmed in the Nkomazi State Veterinary area in the eastern extreme of the province, adjacent to Swaziland and Mozambique. Canine rabies in this area has been self-limiting largely owing to the geographical landscape and physical barriers. The Northern Drakensberg, Crocodile River and Norex fence between South Africa and Mozambique present natural barriers that are extremely difficult to transgress. It is interesting to note that the Kruger National Park, an area of some 2000000 ha and directly adjacent to our borders has never recorded a case of rabies in wildlife, although approximately 36 stray dogs have been shot within the confines of the Reserve and 4 dogs have been confirmed positive for rabies in the last 18 years (Bengis). This again confirms the theory that rabies can only persist in wildlife if the vector population density is sufficient to ensure contact between individuals of its own species. It is therefore fairly obvious that wildlife vectors within this reserve are still living in harmony with the environment and themselves.

Jackals, especially the black-backed jackal, are regularly exterminated in the urban and tribal areas adjacent to this reserve as well as in forest habitats to the west. Black-backed jackals are also regularly exterminated in the sheep farming areas of the highveld. Jackals have therefore not played a role in rabies in Mpumalanga, but we remain cautious however because of the real threat of jackal rabies to our north-west.

A disturbing development in 1994 was the appearance of canine rabies in the Piet Retief State Veterinary area adjacent to KwaZulu-Natal. Within six months, five cases were diagnosed in an area covering 15000 km². Rabies was confirmed in dogs in remote areas almost 150 km apart.

This possibly indicated a northern spread from KwaZulu-Natal and possible westwards from Swaziland. The regional director of Veterinary Services launched an intensive rabies vaccination campaign in all the towns and farms in the infected area as well as a 25 km wide barrier zone along the KwaZulu-Natal and Swaziland borders. This appeared to have halted the spread temporarily. Strict vigilance and early response to primary outbreaks will have to be maintained in this area in the future.

It is perhaps important to note that limited direct contact occurred between humans and dogs belonging to the communities where canine rabies virus poses a threat and those areas where viverrid rabies is indigenous and endemic. However this is all rapidly changing and far greater interaction between communities and their livestock is busy taking place.

Since 1990 there has been a gradual increase in the number of confirmed cases in all species but more particularly in dogs. In the Eerstehoek State Veterinary area canine rabies had only ever been diagnosed in two dogs and one bovine. The first confirmed case in a dog occurred in 1986. It was not until 1995, almost ten years later that canine rabies was again diagnosed. Normal control procedures were implemented as those outbreaks fell within or directly adjacent to the area declared a national rabies controlled area.

In 1995, seven cases were confirmed in dogs in Badplaas within a 6 month period. One can speculate that the origin was either a northern spread from KwaZulu-Natal or directly between Swaziland and Mpumalanga. Normal control procedures were implemented but failed to impact on the disease and six months later another 6 cases were confirmed in the same area. The socio-political status and living conditions of the populace within which these cases had been confirmed were conducive to the establishment of street virus within this community's dogs. Moreover several very large informal settlements and villages nearby were also at risk. The human to dog ratio was 5:1 and all the ingredients were present for an explosive situation. The epidemiological distribution indicated secondary and possibly tertiary outbreaks and it was therefore essential that immediate and appropriate measures had to be taken to halt the spread effectively.

The biological distinction between canid and viverrid rabies viruses has important implications for rabies control in Mpumalanga. The virus responsible for rabies in the yellow mongoose does not appear to propagate in domestic dogs and visa versa. Experimentally, captive mongooses inoculated with a virus of mongoose origin developed typical rabies, while very few of the mongooses inoculated with a virus of canine origin developed the disease. Those that did, died very acutely.

The canine rabies virus was spreading westwards and if it became established in the highveld area, we would have enormous problems. Firstly, every outbreak would have to be typed. Where the canine rabies strain is confirmed, our directorate mounts a massive vaccination campaign at enormous costs because dogs and cats in all towns and villages are included in the vaccination campaign, whilst if the viverrid strain is diagnosed in canines, vaccination coverage is not that stringent and the infected farm and a 15 km radius is normally vaccinated. More recently only adjacent farms are vaccinated.

The explosive outbreak in the Eerstehoek State Veterinary area and the urgency to avoid further spread to the west where canine and viverrid areas would overlap gave rise to the Badplaas Rabies Tie-Up Order Campaign.

3 RABIES TIE-UP ORDER CAMPAIGN, BADPLAAS, 2-7 SEPTEMBER 1996

Figure 3 :
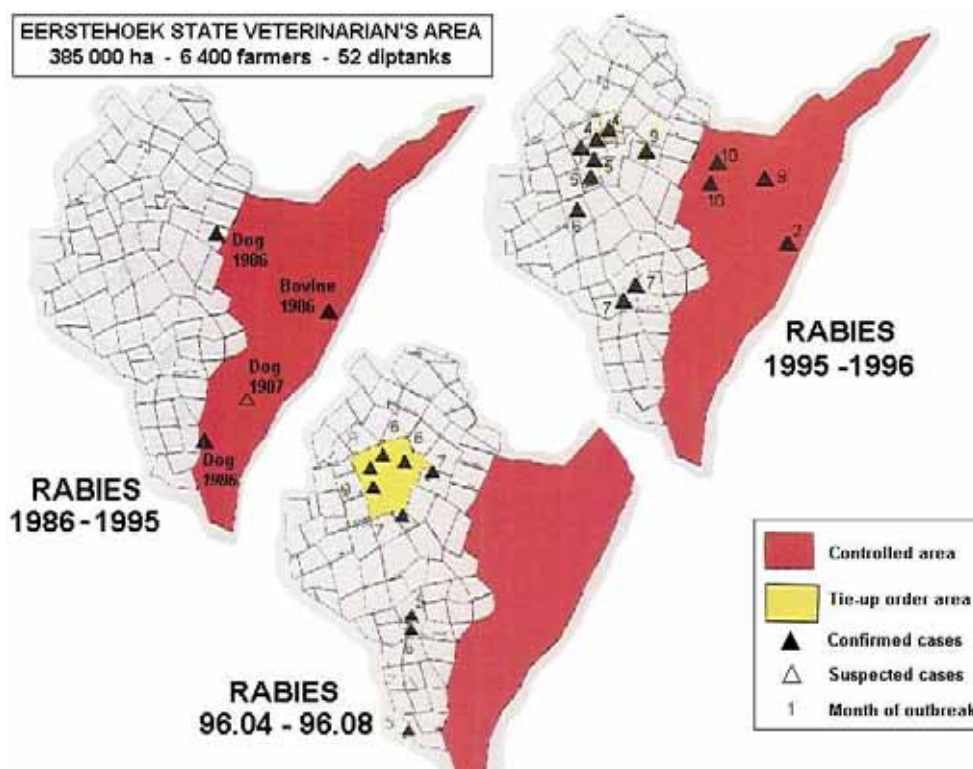
The Eerstehoek State Veterinarian's area covers approximately 385 000 hectares and has a human population of approximately 250 000 people.

Between 1986 and 1995, only three rabies cases were diagnosed in this area (2 canine and 1 bovine). In March 1995 and over the next 6 months, 7 cases were confirmed in Badplaas in an area of ± 18000 hectares with a human population of ± 5400 people. Extension and vaccination campaigns were initiated. Routine principles of quarantine and euthanasia of contact animals were practised. Approximately 68 % of the canine population was vaccinated and vaccinations were repeated in April 1996. Despite the relatively high vaccination cover, the situation deteriorated and between June and August 1996 a further 6 cases were confirmed in "stray" dogs.

Despite steadily increasing control efforts being applied with an increasing level of sophistication, conventional methods had failed to curb the incidence of rabies in this area.

In view of the serious and rapid acceleration in the number of confirmed cases and the potential spread of rabies from Badplaas it was deemed prudent to take immediate drastic action. A decision was taken to issue a tie-up order in terms of the Animal Diseases Act (Act 35 of 1984) and to eliminate all unrestrained dogs. The order was applicable to all residents in Badplaas and the surrounding area. The measures included confining dogs to an enclosed area or securing and keeping all dogs under restraint for a 6 day period.

The purpose of the measures were to endeavour to immunise every dog on every farm, small holding and homestead against rabies. In addition and possibly even more important was the identification and removal of all unvaccinated and free roaming dogs.

Whilst the Act only required the announcement of control measures by publication in both official languages in a local newspaper, it was decided to engage in consultation with all communities to enable the directorate to render extension, create awareness, rally support and gain full co-operation of all participants. A Provincial Veterinary division comprising the former KaNgwane and KwaNdebele

homelands and ex-RSA personnel had amalgamated to form a new team. It is possibly relevant to mention that South Africa had only recently come through a period of transition. Given the political and socio-economic problems of our past and the lack of trust and suspicion of our true motives, by the vast majority of the community affected by this order, the strict regulations imposed in an area where no human deaths as a result of rabies had ever been recorded, might have appeared extreme. Team spirit, line of command, mutual acceptance and respect, cameradie, training and exposure to new procedures and the desire and commitment to launch a rabies drive were just some of the issues being put to the test. It was most important to our Directorate to mount an effective and successful campaign. We operate in an area where foot-and-mouth disease, African swine fever and most of the other OIE list A and B diseases occur and it is very likely that we will rely on full support and involvement of communities in the future.

Consequently, wide liaison took place. The objectives of the order and campaign were announced by means of various articles in four newspapers in three different languages. In addition several broadcasts on two radio stations were announced. Posters were put up in three languages. Pamphlets were distributed via the post office and extension and audio visual material delivered at every school in the defined area. The day the campaign was mounted, a megaphone erected on to a vehicle was used to reinforce all previous awareness efforts.

TABLE 1

INSTITUTION	CONTACT PERSON (capacity)	PROCEDURES	RESULT
Magistrate, Carolina	Mr De Welsen (Magistrate)	Information, extension	Consent
SA Police Services, Badplaas	Inspector Kriel (station commander)	Information, extension	Consent
Transitional Local Council, Badplaas	Mr EP Nkosi (chairman)	Information, extension with video show and talk on meeting, request to support	Written consent
Tribal Council Embhuleni	Chief CM Dlamini	Information, extension with video show and talk on meeting, request to support	Written consent
Community Reconstruction and Development Committee, Badplaas	Mr CF Ziervogel (chairman)	Pamphlets distributed and read at meeting	Written consent
Badplaas Farmers' Association	Mr J Middel (chairman)	Information, extension with video show and talk on meeting, request to support	Written consent
Dept. of Health, Welfare and Gender Affairs	Mr MD Nkosi (Chief Environmental Health Officer)	Information, invitation to observe	Consent
Society for the Prevention of Cruelty towards Animals	Nelspuit Branch	Fax of notification Invitation to observe	No reaction

The defined area was divided into 40 blocks, according to housing, population and accessibility. Each block was further subdivided into between 1 and 20 farms, small holdings, etc.

Blocks 1-18 were made up of 247 farms, plots and small holdings. Blocks 19 and 20 was a well planned town with 60 houses while blocks 21-40 was a dense informal urban area with 591 houses and approximately 3 500 people.

Maps of the entire defined vaccination zone were prepared from aerial photographs, the town planning division and field observations and they were distributed to relevant teams. Access roads, homesteads, informal housing, names of owners, etc., where available, were provided.

14 officials in seven teams of two were deployed from a temporary operational office set up in the centre of the area. This was essential to ensure that the campaign could be executed within a minimum period, because many of the dogs in the defined area were dependent to varying extents on free ranging to forage for food and that it was unlikely that the community would restrain animals for more than a week. Logistical backup, including vaccine, syringes, needles, spraypaint, coolers, dry ice, ammunition, rifles, sampling gear, administration material, etc. were provided by the local State Veterinarian.

The morning prior to the campaign an orientation and training session was convened to familiarise all participants with the objectives, legislation, field and administrative procedures, discipline, etc.

The object of this campaign was to get to every home and every dog in the area.

The following procedures were strictly adhered to:

Every home in a block was visited systematically.

The officer identified himself, his directorate and his mission.

The dwelling and owner was identified and recorded.

The number of dogs was determined and recorded.

The number of dogs vaccinated during previous campaigns was verified and recorded.

All dogs were vaccinated.

Vaccination certificates were issued.

Vaccinated dogs were spray painted different colours in different blocks.

Information pamphlets applicable in any two of the three local languages were distributed.

Additional extension and information was delivered.

Owners were requested to keep dogs secured or restrained for the duration of the campaign.

Vaccination reports were completed.

Homes where owners or dogs were absent, were recorded.

Absent dogs/owners were followed up and vaccinated.

The area was patrolled and maintained by day and night to determine compliance by owners and the number of unvaccinated dogs, identified by paint or absence there of. Furthermore we attempted to determine the relative distance that dogs roamed to forage.

4 RESULT OF THE TIE UP ORDER AND ELIMINATION OF UNVACCINATED DOGS.

898 homes were visited

983 dogs were counted (This differed slightly from the estimated figure of 1177 based on a ratio of 1,3 dogs/home)

DOGS PER HOME

In blocks 1-20 the mean number of dogs per home was 1.81

In blocks 21-40 the mean was 0.72

In blocks 1-20, 23 % of the homes had no dogs

In blocks 21-40, 61 % of the homes had no dogs

This implies that at homes with dogs the mean number of dogs per home were 2,35 and 1,84 respectively.

4.1 Retention of vaccination certificates.

5 months after the 1996 annual rabies vaccination campaign only 52 % of the certificates were presented as evidence of previous vaccination.

4.2 Unrestrained dogs.

A total of 60 dogs were encountered unrestrained. In blocks 1-20, 8.3 % were unrestrained, while in block 20-40, 3.3 % were unrestrained.

Most of these were eventually restrained and vaccinated.

4.3 Dogs vaccinated.

960/983 dogs were vaccinated during the campaign. Of the 23 unvaccinated dogs, 13 were unweaned puppies and 10 were unrestrained or unmanageable. All ten dogs were destroyed.

Vaccination coverage was therefore 98.7 %.

5 EXPENDITURE.

The total cost of the campaign was R14931.21 (approximately 2 pounds sterling per dog). In terms of the experience gained and results achieved, we are of the opinion that the campaign was cost effective.

6 CONCLUSION.

While it is perhaps premature to speculate on the success of the campaign, it deserves mentioning that within 16 months of the end of the campaign, no positive cases of rabies have been recorded in the defined area.

The problem area was timeously identified and even though the target area was small, relative to the province, this exercise serves to demonstrate that where true commitment and effort are brought to bare on a rabies situation, remarkable results can be achieved within a very short period.

Whilst control of canid rabies by parenteral vaccination is relatively simple, we believe that a concerted effort directed at the few focal high risk areas, will rid our province of canine rabies.

The control of viverrid rabies presents a far more complex and different problem. This underlying reservoir of rabies virus in the yellow mongoose constitutes a continuing threat to livestock and man. The control of rabies in Mpumalanga will require better surveillance, an understanding of the virus, regular virus typing in overlapping areas and a thorough knowledge of the species involved.

ACKNOLEDGEMENTS:

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CLINICAL OBSERVATIONS ON CATTLE RABIES IN KIAMBU DISTRICT, KENYA.

Dr. A. Gitau-Thaiyah[38]

1 BACKGROUND.

The ambulatory Veterinary clinic of the Faculty Of Veterinary medicine, University of Nairobi covers an area 50 sq. kilometres round Nairobi and Kiambu Districts. This is a high potential area about 8000 ft. above sea level. The main economic activity in this area is dairy production with an average of 254000 head of dairy cattle. These animals are the ones accessible to the clinic.

Rabies is one of the diseases encountered in the clinic with the earliest case being reported in the early seventies. This study thus involves the cases attended in the clinic together with those reported by the Veterinary Laboratories, Kabete.

2 MATERIALS AND METHODS.

Data on confirmed cases of rabies was obtained from the clinical records of the University Veterinary Clinic and from the Veterinary Laboratories, Kabete. Only FAT positive cases are included in this study.

3 RESULTS.

Table 1 shows the actual recorded cases of rabies in the period 1992-1996

Table 1 : Cases of rabies confirmed by FAT per Division (1992 - 1996).

Division	1992	1993	1994	1995	1996
Kikuyu	10(7)	0	0	6(5)	0
Limuru	0	0	9(8)	1	6
Kiambu	1	0	0	1	0
Gatundu	3	1	1	0	0
Kiambaa	0	0	0	2	1
Matathia	0	0	0	0	1
Others	0	0	0	0	0
Total	**14**	**1**	**10**	**10**	**8**

These results show that the cases of rabies are sporadic. However, three outbreaks are recorded in the above table and are shown in Table 2.

In the first outbreak of 1992, the owner gave a history of having dipped his animals two days earlier using Triatix[R] (Amitraz, Cooper (k)Ltd) and the animals had been attended by an animal health assistant previously. On examination, the two animals affected had a fever of 40°C, drooling of saliva, dyspnoea with inspiratory crackles, subcutaneous emphysema over the chest and shoulder regions and firm, mucoid faeces. The diagnosis reached was poisoning by Amitraz and the animal was treated with Atropine sulphate at 2.5 mg/Kg b.wt.

Table 2: Outbreaks of rabies during this period and the duration lasted.

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Year	Division	Herd No.	Total dead	Duration
1992	Kikuyu	29	7.+	1 month
1994	Limuru	118	8+	1 month
1995	Kikuyu	7	5#	2 weeks

+ No record of dog bites.   # Bitten by same dog

Other cases then followed and had additional signs of continuous bellowing and violence on other animals and objects. These animals were kept under observation until death when FAT was done on the brain. The duration of this disease outbreak was one month and all surviving animals were treated with a dose of anti-rabies vaccine, Rabisin R (Rhône Méreux, France).

The second outbreak was uneventful except for the lack detection of bite wounds on the dead animals. The third outbreak, however, was caused by one rabid dog that traversed a distance of two kilometres biting anything in it's pathway including humans. Three of the cases were on one farm and two on another farm. The dog and the cattle involved were all positive for rabies. On the second farm, however, one of the affected cows was treated immediately by washing the wounds with soap and 5% Lugols iodine and vaccinating it with Rabisin vaccine. This animal survived.

Table 3 : Frequency of occurrence of the clinical signs:

Hyper salivation	33(76.7%)
Bellowing	18(41.8%)
Swaying of hindquarters	4(12.1%)
Violence	3(6.9%)
Pica	2(4.6%)
Yawning	1(2.3%)
Tenesmus	1(2.3%).

Table 3 shows that drooling of saliva and bellowing rank the highest in the clinical signs usually encountered. Also in my experience about half the animals encountered are able to drink water and feed right to the end while the other half are unable to do so.

4 CONCLUSION AND DISCUSSION.

Rabies is endemic in Kenya (Karuiki, 1988) and the occurrence of three outbreaks during this period was unusual as most cases of rabies are sporadic (Blood and Radostits, 1989). The dog and to minor extent the cat are the main source animals for livestock infection. However wild animals such as the fox, skunk, wolf, mongoose and squirrel may also be a source (Blood and Radostits, 1989; Lord *et al.*, 1975; Westergaard, 1982). Among farm animals cattle are most commonly affected. The incubation period is normally about three weeks, but varies from two weeks to several months in most species (Blood and Radostits, 1989).

In the first outbreak both the furious and paralytic forms of the disease were encountered while in the other outbreaks the disease was entirely furious. In the furious form of the disease the animal has a tense alert appearance, is hypersensitive to sound and movement and may show violence to other animals and objects. It has a continuous loud bellowing with a hoarse voice, drooling of saliva and increased sexual excitement. The course is 1-6 days but severe signs may be evident for 24-48 hrs, followed by collapse in a paralysed state and death. In the paralytic form, the animal shows drooling of saliva, voiceless bellows (yawning), knuckling of hind fetlocks, sagging and swaying of hindquarters while walking, deviation or flaccidity of the tail to one side, decreased sensation especially over hindquarters, tenesmus with anal paralysis which causes the animal to suck in and blow out air, recumbency with penile paralysis in the bull, pica and death within 48 hrs. of recumbency (Blood and Radostits, 1989; Baer, 1975) . These signs of rabies have an apparent geographical distribution with a preponderance of cases in the Americas being paralytic, while in India and Africa most of the cases are furious.

The misdiagnosis in the first outbreak is also important as most veterinarians get infected while examining the animals mouth and in the process some also get bitten.

In the first two outbreaks (1992 and 1994), we were unable to detect any bite wounds after a thorough post mortem and it is possible that there was another route of infection. Overall, the incidence appears quite low and this could be due to human and dog consumption of meat from rabid animals, poor reporting of cases, misdiagnosis and poor submission of samples.

Finally, there is a great need to educate farmers and animal health assistants on the disease of rabies as these two are at most risk from animal rabies.

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SAFETY OF THE ORAL RABIES VACCINE SAG2 AND EFFICACY OF ITS DELIVERY SYSTEM DBL2 IN INDIGENOUS DOGS

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ABSTRACT

In three experiments in indigenous dogs, the innocuity of SAG2 and the efficacy of the oral rabies vaccine/bait combination for dogs, DBL2 /SAG2 (Rabidog ® SAG2), was confirmed. No sign of pathogenicity could be attributed to vaccine virus even in very young individuals afflicted with various diseases. No indication for persistence, latency or dissemination was found in any of the dogs inoculated *per os* or by the intramuscular route with concentrated vaccine suspension. Excretion of input virus was detected in saliva following vaccine ingestion. Rabidog ® SAG2 was shown to be well accepted by indigenous dogs over 6 weeks of age and protected the majority of vaccinated individuals against lethal challenge. Not in all cases could protection be correlated to the presence of virus neutralising antibodies. With the completion of these trials, SAG2 has complied with all of the requirements for oral dog rabies vaccines established by the World Health Organization's expert committee on oral rabies vaccination of dogs and is soon to be used in field trials in different parts of the world.

1 INTRODUCTION.

In more than two thirds of the 60 countries of the southern hemisphere reporting to the World Health Organization (WHO) on rabies in 1994, canine rabies was still widespread and represented a significant threat to the human population (WHO, 1996). The prevention of human rabies by means of parenteral rabies vaccination of dogs has for many years been one approach to rabies control promoted by the WHO, however, application in various countries have revealed the insufficiencies of this method (Meslin and Stoehr, 1997). As dog accessibility to parenteral vaccination was often reported to be a major obstacle for successful dog rabies control, WHO co-ordinated studies on oral vaccination of dogs (OVD) and the development of safer and effective vaccines and baits (WHO, 1988; WHO,1989; WHO,1992; WHO,1993; WHO,1994; WHO,1995) from 1988 onwards.

The natural double mutant SAG2, selected by means of monoclonal antibodies from the 1st generation

rabies vaccine strain SAD$_{Berne}$ (Lafay *et al.*, 1994) was, in compliance with WHO recommendations, safety-tested in over 30 warm-blooded species, including some considered particularly susceptible, such as rodents and non-human primates (Follmann *et al.*, 1996; Fekadu *et al.*, 1996; Masson *et al.*, 1996; Bingham *et al.*,1997; Bingham *et al.*,1998). No sign of pathogenicity, persistence, latency or excretion was detectable. Following these results and the demonstration of good *per os* immunogenicity in captive foxes (Aubert , unpublished data), as well as efficacy in oral fox rabies control programs in Europe (Masson *et al.*,1996), the use of SAG2 for dogs was contemplated.

Following the initial demonstration of oral short-term immunogenicity in dogs at concentrations as little as 10^7 PFU/ml of SAG2 vaccine suspension (Aubert, unpublished data), it was shown, that SAG2 also conferred long-term protection to laboratory dogs when administered *per os* at concentrations of $10^{7.5}$ and $10^{8.5}$ MICLD$_{50}$, corresponding to 10^8, respectively 10^9 PFU or TCID$_{50}$ (Fekadu *et al.*, 1996). In

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response to administration of vaccine either in form of vaccine suspension or as a liquid filled cylindrical polymer bait, significant virus neutralising antibodies titres were detectable as early as 14 days after vaccination. Dogs continued to seroconvert gradually until the challenge on day 180. Although not all vaccinated animals exhibited antibody titres considered sufficient for protection upon challenge, all survived an homologous street rabies virus infection which killed all unvaccinated control animals.

These results suggested that SAG2 could be developed into an effective and relatively economic oral dog rabies vaccine, thus responding to two of the selection criteria for vaccines adapted for use in dog rabies control programs. However, since the route of vaccine administration requires so far the use of live virus particles, which in the case of SAG2 possess an envelope, thermal stability might be a problem in the elevated temperatures commonly prevailing in countries with a canine rabies problem. The solution proposed was to incorporate the vaccine in freeze-dried form into a bait. It was hypothesised that during consumption, the vaccine would be reconstituted in the dogs saliva and immunise as a result of contact with the oral and pharyngeal mucosa. A small scale test in laboratory beagles using the prototype bait (DBL2) charged with 10^8 respectively 10^9 $TCID_{50}$ of SAG2 was conducted to confirm this hypothesis (Aubert, unpublished data). It resulted in the protection of 3 out of 4 laboratory beagles in both groups in spite of the fact that none of the dogs exhibited any detectable humoral response prior to challenge to which all controls succumbed (Schumacher and Aubert, 1995). Although promising, the small number of dogs and the undetectable serological response demanded further investigation.

It had been observed previously, that in response to parenteral rabies vaccination, indigenous owned Tunisian dogs developed lower neutralising antibody titres than owned dogs in Europe who in return responded weaker than laboratory dogs (Blancou *et al.*,1986). We therefore became interested in conducting several trials under experimental conditions reflecting more closely the situation encountered in the field during rabies mass vaccination campaigns of dogs.

One efficacy and two safety experiment were carried out in indigenous dogs, results of which are presented below. All experiments included at least some dogs under 3 months of age most of which where afflicted with one or several relatively ubiquitous health conditions such as infestation with internal and external parasites or malnutrition. It was assumed that the induction of a protection against rabies virus in these animals was more difficult to obtain than in their counterparts held under laboratory conditions but in case of a positive outcome, these results would be more relevant for the field. Likewise it was assumed, that any residual pathogenic potential should be revealed more readily in these animals, especially if the less than ideal health status would result in some kind of immune impairment or, as might be suggested by the slowly increasing serological responses over six months observed in laboratory beagles (Fekadu *et al.*,1996), the SAG2 vaccine strain persists in the vaccinee for a certain time.

2 MATERIAL AND METHODS.

2.1 Animals.

Safety of SAG2 in indigenous Tunisian dogs (IRVT) : 8 adult dogs, 3 juveniles and 10 puppies were obtained from dog owners living in the vicinity of Tunis. Upon arrival at the IRVT they were identified with numbered collars and photographs, examined by a certified veterinarian and vaccinated against distemper, hepatitis, leptospirosis and parvovirosis (Tetradog, Mérial, Lyon, France). The dogs were caged separately in the animal facility of the Institut de la Recherche Vétérinaire de Tunis (IRVT), fed daily with commercial dried dog food and given access to water several times per day. Serum samples taken before the beginning of the experiment were negative for rabies virus neutralising antibodies. All but 5 dogs, and especially the puppies, were massively infested with fleas and 5 of 9 stool samples (puppies and aggressive adults not tested), contained eggs of *Ancylostoma*. By day 90, 9 of 14 stool samples were positive for *Ancylostoma* or *Toxocara canis* or both.

Safety of SAG2 in indigenous South-African puppies (OVI) : 25 puppies aged 5 to 7 weeks were obtained from private sources within a range of 100km from Onderstepoort. Their health status was judged reasonable, although large burdens of internal and external parasites were found. Upon arrival at the Onderstepoort Veterinary Institute (OVI) they were dewormed and dipped but not vaccinated against common puppy diseases. Eleven puppies contracted a parvovirus infection to which 4 of them succumbed. No further clinical complications occurred during the trial period in any of the remaining 21 puppies participating in the study. According to their owners, none of the animals had ever been vac-

cinated against rabies, a claim which is plausible considering the age of the puppies and which was confirmed by the absence of detectable rabies antibodies in serum samples. The animals were housed in 3 groups of 5 and 1 of 6 individuals. At the time of inoculation they were 7 to 10 weeks old.

Efficacy of SAG2/DBL2 in Tunisian indigenous dogs (IRVT) : 6 adult dogs (older than 1 year), 3 juveniles (3 months to 1 year) and a litter of 5 puppies (body weight of all dogs ranging from 0.7 to 18.5 kg) were acquired from similar source as mentioned for the safety trial conducted at the IRVT. According to their owners, neither the adult or juvenile dogs, nor the mother of the puppies had ever been vaccinated against rabies. In order to avoid a decrease in sample size due to common infectious diseases, all dogs were vaccinated against distemper, hepatitis, leptospirosis and parvovirosis (Tetradog, Mérial, Lyon, France). They were not treated against any internal and external parasitic diseases with which most of them were afflicted. Only 1 adult animal was certified by a veterinarian to be in good health. The same housing conditions as mentioned above applied. At the beginning of the experiment, 4 puppies had to be exchanged against four older individuals from the control group because they refused to take baits in the presence of the scientific team.

2.2 Vaccine characteristics, handling and titration.

Safety of SAG2 in indigenous Tunisian dogs (IRVT) : Concentrated SAG2 suspension (batch S2/5) with an indicated titer of $10^{9.4 \pm 0.42}$ $TCID_{50}$ per ml (Virbac Laboratories, Carros-Cedex, France) was shipped on dry ice to the IRVT, where the vaccine was received frozen and stored at -80°C until further use. The day of the experiment, the vaccine was thawed under running water and placed in a cooler where it remained for the entire period of the manipulation. Upon completion of the inoculation, two samples of 1ml were send to Virbac for titration. The titer obtained was $10^{9.49 \pm 0.14}$ $TCID_{50}$ per ml.

Safety of SAG2 in South African puppies (OVI) : The same protocol was followed for concentrated SAG2 suspension send to the OVI. The titer indicated for this vaccine batch (S2/14) by the Virbac Laboratories and confirmed by the OVI was 10^9 $TCID_{50}$ per ml.

2.3 Vaccine presentation (DBL2).

Efficacy of DBL2 in indigenous Tunisian dogs (IRVT): SAG2 suspension batch S2/14 (Virbac Laboratories, Carros-Cedex, France) was mixed with a specifically designed, proprietary freeze-drying exipient and portioned into thermoformed molds before undergoing a freeze-drying cycle. The resulting cubes were coated with a 2-3 mm thick layer of bait matrix similar to that normally used to cast the oral fox bait Rabigen ® SAG2 (Virbac Laboratories, Carros-Cedex, France) which had been modified by incorporation of an attractant for dogs. The finished baits were packaged and stored at +4°C until the refrigerated transport to the IRVT, where they were kept at +4°C until the start of the experiment. The titer per dose determined before shipment and immediately after the oral vaccination of the dogs was $10^{8.3}$ $TCID_{50}$.

2.4 Vaccination.

Safety of SAG2 in indigenous Tunisian dogs (IRVT): At the beginning of the experiment (J0), all 21 dogs of the vaccination group received 1 ml of SAG2 suspension which was instilled onto the tongue with a 2 ml disposable syringe.

Safety of SAG2 in indigenous South-African puppies (OVI): 10 puppies received an injection of 1ml of concentrated SAG2 suspension ($10^9 TCID_{50}$/ml) into the muscles of one hind leg whereas in 10 others, 1 ml of suspension was deposited into the oral cavity with a disposable syringe. One unvaccinated contact control was housed together with five puppies vaccinated orally, the other dogs were kept in groups of five individuals.

Efficacy of DBL2 in indigenous Tunisian dogs (IRVT): On day 0 of the experiment, 7 previously weighed DBL2 baits were placed individually in front of 7 dogs from whom food and water was withheld since the morning. They were given 15 minutes to consume the bait at the end of which the leftover baits were collected and weighed and compared to the initial weight. Seven unvaccinated dogs were kept as control animals.

2.5 Sample collection and analysis.

Safety of SAG2 in indigenous Tunisian dogs (IRVT): Sterile blood samples were obtained from all but one dog on day -1 (day before vaccination) and at monthly intervals thereafter until day 180. The blood was allowed to clot at room temperature for approximately two hours. Following low speed cen- trifugation, the sera were sampled and stored at -20°C and send out for analysis by the FAVN-test (Aubert *et al.*,1997). Unfortunately, one shipment of samples did not arrive at its destination in a condi- tion allowing analysis.

Saliva was collected from all dogs 6 hours and 3 days after inoculation, using the Salivette saliva col- lection system (Sarstedt, Molsheim, Germany) (Aubert *et al.*,1991). However, the samples were lost during transport or arrived at their destination in such a state that it was pointless to carry out an analysis .

Safety of SAG2 in indigenous South-African puppies (OVI): Blood samples were collected before vac- cination (day 0) and 7, 14, 30, 60, 90 and 120 days after vaccination respectively. They were kept at room temperature until a clot was clearly visible and subsequently centrifuged at 1000g. The serum was collected and stored at -20°C until analysis by the FAVN-test (Aubert *et al.*, 1997). Saliva was collected on cotton swabs or salivettes (Sarstedt, Monsheim, Germany) 1 hour after vaccination and daily for 7 days thereafter. Cotton swabs and salivettes were weighed before and after saliva collection and the quantity of diluent to be added to reach a 1/10 dilution was calculated. They were centrifuged for 30 minutes at 1500g. 0.03 ml of the filtrate was immediately inoculated in to suckling mice and N2a cell culture (Barrat *et al.*, 1988), the rest stored at -70°C.

Efficacy of DBL2 in indigenous Tunisian dogs (IRVT): Serum samples were obtained by the method mentioned above on days 0, 7, 14, 21 and 33 before challenge and on days 7 and 160 after challenge. They were send to the CNEVA-Nancy and neutralising antibody titres were determined by the FAVN- test (Aubert *et al.*, 1997).

2.6 Challenge.

Efficacy of DBL2 in indigenous Tunisian dogs (IRVT): 33 days after consumption of a single bait, all 14 (vaccinated and unvaccinated) dogs were inoculated into the temporal muscle with 1 ml of the Tuni- sian street rabies virus strain « Ariana 1991 Référence 1009 », which was originally isolated from the salivary glands of a rabid dog. The day of challenge, one ampoule was thawed under running water and diluted 1:50 to contain approximately $10^5 MICLD_{50}$ per ml. The viral suspension was kept on ice in a cooler throughout the experiment at the end of which 0.03ml of dilution $10^{-3.7}$ to $10^{-6.7}$ were injected intracerebrally into adult White Swiss mice. Since all mice survived, the titre could not be confirmed.

2.7 Clinical observation.

The dogs of all three experiments were observed for clinical signs suggestive of rabies such as apa- thy, depression, anorexia, hydrophobia, agitation, paralysis, neurological anomaly, coma and death. The observation periods ranged from 90 to 180 days for the Tunisian safety trial to 120 days for the South-African puppies. The dogs of the efficacy experiment were observed for 33 days before and 160 days after challenge.

2.8 Post mortem examination.

Following euthanasia of the South African puppies, the detection of rabies virus was attempted in brains, salivary glands and tonsils by MIT (Atanasiu, 1975) or inoculation into N2a cells (Barrat *et al.*, 1988). Brains were also examined for rabies virus antigen by FAT (Dean and Abelseth, 1996). In Tuni- sian dogs, brain samples, salivary glands and sub-maxillary as well as parotideal lymph nodes were tested for rabies antigen by the FAT (Dean and Abelseth, 1996) and homogenates of brain additionally inoculated into N2a tissue cultures (Barrat *et al.*, 1988). The brains of the Tunisian dogs undergoing challenge were examined for the presence of rabies antigen by FAT (Dean and Abelseth, 1996) either after their death or following euthanasia of those, who survived until the end of the experiment.

3 RESULTS.

3.1 Safety of SAG2 in indigenous Tunisian dogs (IRVT).

None of the 21 indigenous Tunisian dogs inoculated *per os* with SAG2 suspension ($10^{9.4}$ TCID$_{50}$) exhibited clinical signs indicative of rabies during the observation period. Six puppies and one juvenile died within 24 days of vaccination, however, of causes unrelated to the SAG2 vaccine administration. No animal had detectable levels of serum-neutralising antibody titres prior to vaccination. Due to the loss of serum samples during transport, no other serological data are available until day 150 of the experiment. On day 90, all except 5 dogs surviving to this point were euthanased. Of the remaining animals, one juvenile and one puppy (at time of inoculation) still had a serum-neutralising antibody titre exceeding 0.5IU/ml on day 150 and 180, while three other puppies were sero-negative (Table 1). No rabies virus antigen could be detected in brains samples and salivary glands collected post mortem from animals found dead during the experiment or euthanased on day 90 or 180.

Table 1 : Rabies virus neutralising antibody titres determined by FAVN-test in Tunisian dogs vaccinated per os with SAG2 suspension

Dog ID	Age at start	Rabies virus neutralising antibody titre in IU/ml			
		day - 1	day 90	day 150	day 180
21	adult	• 0.02	euthanased		
23	adult	• 0.02	euthanased		
24	adult	0.06	euthanased		
25	adult	0.08	euthanased		
26	adult	• 0.02	euthanased		
27	juvenile	• 0.02	euthanased		
28	adult	• 0.02	euthanased		
29	adult	• 0.02	euthanased		
30	adult	• 0.02	euthanased		
32	juvenile	• 0.02	-	**1.66**	**3.79**
33	puppy	• 0.02	-	**0.55**	**0.95**
41	puppy	• 0.02	-	0.02	0.02
43	puppy	• 0.02	-	0.02	0.02
44	puppy	• 0.02	-	0.02	0.02

The positivity-threshold of the FAVN-test is situated at 0.5 IU/ml, positive values are marked **in bold;** data of dogs dying between day 2 and 24 after vaccination of causes unrelated to rabies not shown; no data available for day 30, 60, 90, and 120 due to loss of samples.

3.2 Safety of SAG2 in indigenous South-African puppies (OVI).

20 indigenous South-African puppies, inoculated either *per os* or by the intra-muscular route with concentrated SAG2 suspension (10^9 TCID$_{50}$), did not develop clinical signs during an observation period lasting 120 days. One hour after vaccination, live virus was recovered from the saliva of 8 of the 10 puppies inoculated by the oral route, as well as from 7 of 10 puppies to whom the vaccine had been injected. Attempts to isolate virus from saliva later in the experiment were unsuccessful. No virus was found in the saliva of the unvaccinated contact control puppy which was housed together with 5 orally vaccinated dogs. In view of the unexpected detection of vaccine virus in the saliva of dogs inoculated by the intramuscular route, a confirmation was attempted in 4 additional, 10 week old puppies which were vaccinated by the intramuscular route with the previously used vaccine preparation. Two additional puppies received vaccine *per os*. Contrary to the first trial, gloves were changed between inoculations and the puppies wore Elizabethan collars to prevent licking of the injection sites and of each other. Any shared equipment was removed from the pens prior to the experiment and dogs were observed for one hour after inoculation. No situation potentially leading to cross-contamination occurred. In this second experiment, no vaccine virus was detected, except in one dog 1 hour after *per os* inoculation. A separate trial aiming at testing of the sensitivity of the saliva collection and processing technique found that the minimum viral concentration required for a positive outcome was $10^{0.78}$ TCID$_{50}$/ml.

It was thus concluded that : the saliva collection and processing technique was sufficiently specific and sensitive, the presence of virus in parenterally inoculated dogs was most likely of accidental nature, and following oral administration of concentrated vaccine suspension, SAG2 virus was detectable in saliva of puppies for about one hour.

Serum samples of all 21 dogs were free of detectable serum-neutralising antibody titres prior to inoculation. Within 7 days, high titres of rabies virus neutralising antibody were detectable in 17 of 20 vaccinated dogs (mean i.m. : 3.31 ± 2.6 IU/ml ; mean oral : 0.91 ± 0.7 IU/ml), while one animal which had been retained as a contact control remained negative (1.05). On day 30 and 60 respectively, the humoral response in both groups reached its highest value (mean i.m. : 23.48 ± 12.1 IU/ml ; mean oral : 7.77 ± 4.2 IU/ml), and declined thereafter (Table 2). By day 120, titres in 7 of 10 orally inoculated dogs had fallen to pretrial values, compared to none in dogs vaccinated by the intramuscular route (mean i.m. : 7.70 ± 3.0 IU/ml ; mean oral : 4.82 ± 4.9 IU/ml). Titres in the group inoculated intramuscularly were consistently higher throughout the experiment but the difference was not statistically significant.

No virus was isolated from and no antigen was detected in brain samples, salivary glands or tonsils collected from euthanased dogs upon completion of the experiment, including those of the contact control animal.

3.3 Efficacy of DBL2 in indigenous Tunisian dogs (IRVT).

Of the seven indigenous Tunisian dogs to whom one DBL2 vaccine bait ($10^{8.3}$ TCID$_{50}$) was presented « free-choice », all interacted in at least three of the following ways with the bait : observing (7/7), smelling and licking (5/7), chewing (7/7) and swallowing (7/7). Even though the DBL2-bait is rather small (dimensions 1.5 x 3 x 2.5 cm), none was swallowed intact. Instead, dogs investigated the bait carefully and eventually pieces were bitten of and chewed slowly. The contact with the central core appeared to be particularly interesting and provoked licking as a result of which the central unit disintegrated in saliva. Six of 7 baits were consumed entirely. The one puppy remaining in the vaccination group left three quarters of its bait untouched after tampering with it for five minutes. The average time until total consumption of baits by the other animals was 2.25 minutes, with 4 animals finishing the bait within 1 minute or less, and two others after 3 minutes and 30 seconds and 6 minutes respectively.

Only two of seven dogs consuming a bait developed a significant rabies virus neutralising antibody response until day 14 after vaccination, while all others remained sero-negative prior to challenge (Table 3).

Table 2 : Neutralising antibody titres in puppies following inoculation with SAG2 suspension

Dog ID	Route of inoculation	Rabies virus neutralising antibody titre						
		day 0	day 7	day 14	Day 30	day 60	Day 90	day 120
1	i.m.	0	**10.45**	**4.65**	**18.15**	**18.15**	**7.92**	**6.01**
2	i.m.	0	**3.46**	**4.56**	**31.54**	**10.45**	**13.77**	**4.56**
3	i.m.	0	**2.00**	**13.77**	**8.15**	**18.15**	**10.45**	**7.92**
4	i.m.	0	**2.00**	**6.01**	**8.15**	**18.15**	**23.93**	**13.77**
5	i.m.	0	**2.00**	**2.62**	**23.93**	**30.80**	**13.77**	**10.45**
6	i.m.	0	**0.50**	**3.46**	**8.15**	**30.80**	**13.77**	**3.46**
7	i.m.	0	**2.62**	**13.77**	**40.64**	**13.77**	**18.15**	**7.92**
8	i.m.	0	**2.00**	**10.45**	**23.93**	**13.77**	**7.92**	**4.56**
9	i.m.	0	**3.46**	**4.56**	**31.54**	**7.92**	**10.45**	**7.92**
10	i.m.	0	**4.56**	**4.56**	**40.64**	**40.64**	**40.64**	**10.45**
Mean		0	**3.31**	**6.83**	**23.48**	**20.26**	**16.01**	**7.70**
(± standard deviation)			(2.6)	(4.0)	(12.1)	(9.9)	(9.4)	(3.0)
11	oral	0	0.13	**2.62**	**2.62**	**3.46**	**3.08**	**2.62**
12	oral	0	**1.51**	**4.56**	**7.92**	**7.92**	**7.92**	**13.77**
13	oral	0	0.87	**7.92**	**18.15**	**10.45**	**7.92**	**6.01**
14	oral	0	0.66	**7.92**	**7.92**	**7.92**	**6.01**	**6.01**
15	oral	0	**1.15**	**4.46**	**4.56**	**13.77**	**7.06**	**2.62**
16	oral	0	**2.62**	**4.56**	**4.56**	**6.01**	**0.66**	0.29
17	oral	0	**1.15**	**3.46**	**4.56**	**2.00**	**0.50**	0.22
18	oral	0	0.66	**6.01**	**6.01**	**13.77**	**4.56**	**13.77**
19	oral	0	0.12	**0.66**	**0.65**	**1.99**	0.13	0.29
20	oral	0	0.22	**4.56**	**10.45**	**10.45**	**10.45**	**2.62**
Mean		0	**0.91**	**4.68**	**6.74**	**7.77**	**4.83**	**4.82**
(± standard deviation)			(0.7)	(2.1)	(4.6)	(4.2)	(3.4)	(4.9)
21	none	0	0	0	0	0	0	0

VNA titres are listed as the reciprocal of the highest serum dilution resulting in a 50% reduction in infectious foci correlated to the WHO standard serum (0.5IU) in the FAVN-test. Positive values **in bold.**

On the day of challenge (day 33), only one vaccinated animal still had antibodies above 0.5IU, the level considered to reliably confer protection against an otherwise fatal street rabies virus challenge. Seven days after challenge, 4 of 7 vaccinated dogs, including the two previously sero-positive animals, had significant titres, while three others never sero-converted. In the vaccination group, all dogs with and one dogs without detectable antibody titres survived the challenge. Although on day 0, no evidence of previous contact with rabies virus antigen could be detected in any of the 14 dogs, one animal of the control group also expressed significant titres (by day 7) which remained elevated throughout the experiment. This dog, which was retrospectively eliminated from the experiment, and one other control without a detectable humoral response at any time, survived the challenge. The etiology of rabies could be confirmed in all dogs dead during the experiment by post mortem analysis of brain material. The brain of survivors, euthanased on day 160 following challenge, was in contrast, free of rabies antigen or rabies virus. These results have recently been submitted for publication (Hammami *et al.*, 1998).

Table 3 : Rabies virus neutralising antibody titres detected by FAVN-test and mortality due to challenge in Tunisian dogs vaccinated per os with DBL2/SAG2

| Dog ID (age) | Treat-ment | Rabies virus neutralising antibody titre in IU/ml | | | | | | |
		D 0	D 7	D 14	D 21	D 33	D 7 after challenge	D160 after challenge
8 (P)	DBL2	0.14	-	-	≤ 0.06	≤ 0.06	**5**	**0.55**
9 (A)	DBL2	0.14	-	-	≤ 0.06	0 .06	≤ 0.08	dead
10 (A)	DBL2	no serum	-	-	≤ 0.06	0.06	≤ 0.06	dead
11 (A)	DBL2	≤ 0.04	-	-.	≤ 0.06	0.02	**0.95**	0.18
12 (A)	DBL2	0.06	0.06	**1.26**	**1.66**	**1.56**	**6.59**	**0.32**
13 (J)	DBL2	≤ 0.04	-	-.	≤ 0.06	0.08	≤ 0.11	≤ 0.04
14 (A)	DBL2	0.08	0.06	**0.55**	0.24	0.18	**1.66**	0.24
1 (P)	none	≤ 0.06	≤ 0.06	≤ 0.06	≤ 0.06	≤ 0.06	≤ 0.06	dead
2 (P)	none	≤ 0.06	≤ 0.06	≤ 0.06	≤ 0.06	≤ 0.06	≤ 0.06	dead
3 (P)	none	0.14	-	-	≤ 0.06	0.14	0.11	dead
4 (J)	none	0.06	-	-	≤ 0.06	0.24	0.18	≤ 0.04
5 (J)	none	0.11	-	-	≤ 0.06	0.24	≤ 0.14	dead
6 (P)	none	≤ 0.04	-	-	≤ 0.06	≤ 0.03	≤ 0.06	dead
7 (A) excluded	none	0.03	**0.95**	**0.55**	**0.72**	**0.72**	**2.18**	**0.55**

The positivity-threshold of the FAVN-test is situated at 0.5 IU/ml, positive values are marked **in bold**
 - : serum not tested ; age : P = puppy < 3 months, J = Juvenile (3 months to 1 year), A = Adult (> 1 year)

4 DISCUSSION.

Two safety and one efficacy experiments using the live modified rabies vaccine strain SAG2 and its bait DBL2 (Rabidog ® SAG2) were conducted in dogs of varying ages, origin and health status by two laboratories situated in countries considering the use of oral dog vaccination as an adjunct to paren-teral dog rabies control. Test subjects were recruited from the local dog populations, vaccinated against major dog diseases or treated against parasites and housed for the purpose and duration of the trial in closed animal facilities. Recruitment of sero-negative dogs from endemic rabies areas was a problem, since not all previously vaccinated dogs exhibited detectable levels of virus neutralising antibodies and not in all cases was the information given by the owner reliable. However, following vaccination, previously exposed dogs showed a classical anamnestic humoral response and were thus distinguishable from naive animals. One control animal of the efficacy trial displayed a response of such a pattern and was in retrospective excluded from the experiment. Also problematic was the housing of animals afflicted with various diseases in closed premises and decimation of test subject occurred prior and during experiments due to stress, husbandry problems or infectious diseases other than rabies. Not in all cases was the infrastructure for sample treatment available which in one case led to the loss of samples.

In spite of difficult working conditions, where some variables where uncontrollable, the safety and effi-cacy result obtained in indigenous dogs and especially puppies are considered conclusive. The results described in this document largely confirm those obtained in controlled laboratory environments as discussed below.

Regardless of the vaccine presentation, dog characteristics, route of inoculation (oral or intramuscu-lar), duration of the observation period or site of testing, adverse effects attributable to the vaccine were not observed in any of the 48 dogs enrolled in the 3 studies. Although 6 puppies and 1 juvenile dog died after vaccination in the Tunisian safety experiment, rabies was excluded as a cause of mor-tality on the basis of negative FAT diagnosis on tissues of predilection.

The absence of clinical signs in the South African puppies inoculated with concentrated SAG2 vaccine by the intramuscular route confirm unpublished results by Fekadu et al., who inoculated adult labora-

tory beagles according to the APHIS/USDA safety protocol for rabies vaccines in order to determine the fate of the vaccine virus. In short, 5 unvaccinated, seronegative beagles where inoculated by the intramuscular route with concentrated SAG2 vaccine suspension ($10^{8.5}$ MICLD$_{50}$), while in 5 additional animals, a major nerve (brachial plexus) and its surrounding tissue was infiltrated. One animal of each group were sacrificed on days 3, 7, 10, 15, 25, and 35 after vaccination respectively and a tissue suspension of regional lymph nodes, brain, tonsils, salivary glands, and kidneys were injected into suckling mice. None of the 10 dogs showed clinical signs until scheduled time of sacrifice and no virus was detected by Suckling Mouse Inoculation Test or inoculation of mouse neuroblastoma cells. Attempts to isolate virus from saliva swabs collected at 1, 7 and 24 hours after vaccine administration showed no virus present in any swab. Rabies virus neutralising antibody was detected in dogs that were injected intraneuronally in the brachial plexus and surrounding tissues as early as 7 days after inoculation, whereas those administered orally had seroconverted by day 15.

Clinical and histopathological results of these two studies show absence of pathogenicity, viral dissemination, persistence and latency, at least in the tissues examined, thus confirming the safety of SAG2 for the dog, including puppies. For the first time however, vaccine virus was recovered from the saliva of a significant number of dogs 1 hour after oral vaccination. The detection of virus in saliva samples of dogs vaccinated by the intramuscular route is, following results obtained in a more strictly controlled study, most likely due to accidental cross-contamination. There have been two previous reports of presence of rabies virus in saliva swabs of orally vaccinated animals, one in a jackal and one in a mongoose (Bingham *et al.*, 1997; Bingham *et al.*, 1998) which could clearly be identified as SAG2. Virus isolation has generally been difficult to come by, indicating that virus concentrations might be generally low, even shortly after oral inoculation, and saliva collection and treatment techniques may be insufficiently sensitive. The method used by the OVI (Bingham, unpublished data) with a detection-sensitivity of less than 10 particles per ml of saliva appears to be an exception which might explain the high number of positive virus isolations observed in orally vaccinated puppies. In these dogs, the presence of vaccine virus in the saliva was expected for at least a brief period after oral inoculation until most viral particles were flushed away by saliva and swallowed. Our findings confirm this view, however, since 10 times more vaccine was used in this experiment than what is proposed for Rabidog ® SAG2, it is likely that under field conditions, significantly lower amounts of vaccine virus might be present in the saliva of few dogs for a only a short period of time. Based on our findings we conclude, that the risk of horizontal transmission of SAG2 vaccine virus by a freshly immunised dog are minimal even during the first hour following bait consumption. To get a more specific risk estimation it may be interesting to investigate this question on saliva samples collected from laboratory dogs ingesting vaccinal bait. The use of puppies in comparison to adult dogs might be advisable since the high frequency of virus detection might be linked to the young age of the test subjects.

The safety of the live modified rabies vaccine strain SAG2 in indigenous dogs in particular and canine and other mammal species in general has been extensively documented here and elsewhere (Follmann *et al.*, 1996; Fekadu *et al.*, 1996; Masson *et al.*, 1996; Bingham *et al.*,1997; Bingham *et al.*,1998). An important precondition, however for the use of this vaccine in oral mass vaccination campaigns is the availability of a vaccine presentation well accepted by the target species and suitable to deliver the vaccine to the immunogenic sites in the oral cavity of dogs. The freeze-dried prototype bait DBL2 proposed as the vaccine delivery system of SAG2 for this purpose has specifically been designed for dogs. It consists of a porous centre in which the vaccine is homogeneously dispersed and a water-resistant coat which is aromatized with a flavour-combination selected by two-choice-tests in laboratory dogs (Schumacher, unpublished data). In order to decrease chances of human contamination in the field, the bait contains no permanent vaccine container. The DBL2-bait is smaller in size compared to others (Linhart *et al.*, 1977), thus facilitating seizing and manipulation of the bait by dogs of different sizes. At the same time it is bulky enough to not be swallowed intact. The bait coating is only 2-3 mm thick and represents a small fraction compared to the vaccine containing core, which is believed to favour the contact between the vaccine and the oral mucosa. The lyophilised bait matrix apparently stimulates investigative behaviour in dogs and readily disintegrates in saliva, thus allowing most likely the reconstitution of sufficient concentrations of vaccine virus for immunisation. The attractivity of the bait has previously been demonstrated for laboratory and indigenous dogs, with rates of acceptance comparable to those observed with chicken heads, the most attractive bait available (Ben Youssef *et al.*, 1998). However, as experienced in Tunisian dogs, puppies may be wary of the presence of strangers and refuse baits.

As described in this document, consumption of DBL2 baits charged with $10^{8.3}$ TCID$_{50}$ of SAG2 vaccine resulted in protection of 71% of indigenous dogs against a street virus challenge to which 5 of 6 controls succumbed. These results are comparable to those obtained in the small scale study described

elsewhere, where 3 out of 4 laboratory beagles vaccinated with a DBL2 containing $10^{8.0}$ $TCID_{50}$ or 10^9 $TCID_{50}$ survived a challenge that killed the two unvaccinated controls (Schumacher and Aubert, 1995). However, results of a recently completed larger experiment comparing the efficacy of the SAG2/DBL2 combination (Rabidog ® SAG2) with an adaptation of the liquid vaccine delivery system for foxes (Rabigen ® SAG2) indicate that one DBL2-bait containing 10^7 to $10^{7.5}$ $TCID_{50}$ might be sufficient to confer protection to adult laboratory beagles (Rupprecht, pers. communication). Taken together, these results suggest that Rabidog ® SAG2 in its present form is efficacious in dogs in general but that, similar to what has been described for parenteral rabies vaccines (Blancou *et al.*, 1986), higher vaccine concentrations may be required for indigenous dogs. The cause for the weaker response of indigenous dogs is unknown although infestation with internal parasites and the vaccination against other canine diseases shortly before the beginning of the experiment as well as mechanical interference by bait material with vaccine contact in the oral cavity may contribute.

It has long been recognised in rabies, that the glycoprotein of the viral envelope induces virus neutralising antibodies which, in return, are the main mediators of protection against challenge (Wiktor *et al.*, 1973). It is interesting to note, that in the Tunisian efficacy experiment, only 2 out of 7 indigenous dogs, developed detectable VNA-titers until the day of challenge. Nevertheless, 5 animals survived the infection which killed 5 of 6 unvaccinated controls. From the anamnestic humoral response observed 7 days after challenge it can be deduced that at least 4 of the 5 survivors receiving SAG2 had been exposed to the vaccine virus. While there is little doubt about the specificity of protection, VNA titres must have been either to low for detection by the antibody titration method used or the protective immune response induced was not VNA. It could be hypothesised that these observation are due to some kind of reduced immunological sensitivity possibly due to exposure of the Tunisian dogs to a multitude of antigens such as those of internal and external parasites and the vaccinations received shortly before oral vaccination. The search of specific answers to those questions was beyond the scope of this experiment. However, since protection without the presence of VNA was also observed in varying degrees in all other experiments were SAG2 vaccine was administered *per os*, it is likely that the phenomenon is characteristic for the oral route. According to our results, it is observed more readily when vaccine is administered by bait, in indigenous dogs, in young individuals, at lower vaccine concentrations and with shorter observation periods (see also tables 1, 2 and 3). Common to all these situations, although for different reason, are elevated antigen requirements. While protection against rabies in absence of virus neutralising antibodies clearly defies conventional views, it has been shown previously in the context of oral vaccination (Fekadu *et al.*, 1996; Black and Lawson, 1980; Kieny *et al.*, 1988; Artois *et al.*, 1993) and we have accumulated sufficient evidence to conclude that the SAG2/DBL2 oral rabies vaccine/bait combination (Rabidog ® SAG2) is efficacious in indigenous and laboratory dogs.

5 CONCLUSION.

Working under conditions such as described in this publication is difficult and the outcome of the experiments is often unpredictable. The confirmation of the experiments in indigenous dogs by data obtained in a controlled laboratory environment is determining for success or failure of such tests. Using this comparative approach, we were able to accumulate evidence for the safety of SAG2 in dogs, including puppies and demonstrated the suitability of the SAG2/DBL2 oral vaccination system for indigenous dogs. Rabidog ® SAG2 has thus fulfilled all of the World Health Organization's requirements for oral canine vaccines and should soon be released for field testing.

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LIVE RECOMBINANT RACCOON POX-RABIES VACCINES FOR THE CAT

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1 INTRODUCTION.

Rabies virus, a Lyssa virus in the family *Rhabdoviridae*, is a negative-strand RNA virus that produces five proteins during cytoplasmic replication. Of the five proteins, the virion spike glycoprotein (RG) plays a crucial role in the induction of protective virus neutralising antibodies (VNAS) and stimulation of T lymphocytes (2-5). The raccoon poxvirus (RCINV) recombinant, RCN-RG which expresses the rabies glycoprotein G of the challenge virus Standard (CVS) strain of rabies virus, specifically induces rabies VNAs and protection against lethal rabies challenge in several different animal species (6 –7).

We report here the induction and detection of rabies VNAs in raccoon pox-rabies recombinant vaccines-immunised cats, indicating no apparent transmission of the recombinant viruses to in-contact non-vaccinated controls. Although we were unable to challenge vaccinated specific pathogen-free (SPF) cats against rabies because of containment restrictions, high rabies virus neutralising antibodies were induced and challenge with virulent feline panleukopenia virus (FPV) showed that immunised cats were fully protected.

2 MATERIALS AND METHODS.

2.1 Cells acid viruses.

RCNV(8) - RCN-RG(6 – 7) - RCN-RG/FPV-VP2(9 – 19) and the USDA National Veterinary Services FPV challenge standard (10) were propagated in either Crandell feline kidney (CrFK), Norden Laboratory Feline Kidney (NLFK), CV- 1 monkey kidney, or thimidine kinase (TK) minus rat-2 cells grown and maintained in Eagle minimal essential medium (MEM).

2.2 Animals.

Specific-pathogen-free cats, 5 -12 months old (Liberty Laboratories) were kept in biohazard level-2 filter isolation units, approved by the Biohazard Committee, Institutional Animal Care and Use Committee and RDNA Committee of the New York State College of Veterinary Medicine at Cornell University.

2.3 Animals inoculated with RCN-RG.

Eight cats were inoculated orally with 10^8 RCNRG while 2 cats served as in-contact unvaccinated controls.

2.4 Animals inoculated with RCN-RGIFPV-'*T2.

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Cats were divided into two groups, 8 were vaccinated subcutaneously with 10^7 PFU of purified RCN-RG/FPV-VP2 and boosted on day 26 and day 34; two cats received phosphate buttered saline (PBS). Sixteen days after the last booster (day 50 after primary immunisation), the 10 cats were challenged perorallv with $10^{4.5}$ $TCID_{50}$ of virulent FPV according to USDA procedure (10). The cats were clinically observed for any untoward effects of immunisation and challenge.

2.5 Rabies virus neutralisation tests.

The rabies neutralising antibody titres were determined by the rapid focus immunofluorescent inhibition test (RFFIT), and were expressed in international units (IU).

2.6 Feline panleukopenia virus neutralisation tests.

For FPV VNA determinations, sera were assayed essentially as described before (9 – 20). Briefly this was done by first seeding 10^4 CrFK cells in 0.1 ml MEM onto 8-chamber LabTek slides (Nunc, Inc., Naperville, IL) and incubating the cells at 37° C for two hours. During the first hour, 2 fold serial dilutions of each serum are prepared and mixed with FPV, and then the mixture was incubated at 37° C for 1 hour. After incubation, the individual mixtures were added to separate chambers on the slide and the slides were incubated 37° C in an atmosphere of 5% CO_2, for 3 to 4 days. The infected monolayers were fixed with methanol, stained with May-Grunwald Giemsa stain and then examined by light microscopy for FPV intranuclear inclusion bodies. The reciprocal of the highest serum dilution that showed no detectable FPV inclusions was the VNA titre.

3 RESULTS.

3.1 Animals inoculated with RCN-G.

All 8 cats inoculated with RCNPG developed high rabies virus neutralising (VN) antibody titres after a single oral inoculation (Table 1). Rabies VN antibody were still detectable at high levels 85 days post inoculation. RCN-RG virus did not spread from inoculated cats, as shown by the absence of antibody to RCNV and rabies virus in in-contact control cats.

3.2 Animals inoculated with RCN-RG/FPV-VP2.

Table 2 shows rabies VNA titres in the sera of vaccinated and unvaccinated cats. Vaccinated cats were positive for rabies VNAs on day 26 and extremely high antibody were noted following a booster. 'VNA titres of sera from individual cats rose to ≥8 and ≥16 IU rabies virus by 50. Unvaccinated cats were rabies VNA negative throughout the experiment.

Eight cats vaccinated with purified RCN-RG/TPV-VP2 showed a titre of 1.00 on day 26 after primary vaccination against FPV (data not shown). Following recombinant virus booster on day 26 and 34 after the primary vaccination, we noted FPV VNA titres of 7000 by day 43 and >10000 by day 50. In-contact unvaccinated cats showed no detectable FPV virus VNA (data not shown). After challenge the VNAs in the unvaccinated cats rose to 500 by day 60 (data not shown). All vaccinated cats were solidly protected against FPV virulent virus challenge (data not shown).

Table 1 : Rabies (IU) and raccoon poxvirus (NT) neutralising antibodies in specific-pathogen-free cats orally inoculated with 10^8 PFU of RCNRG.

CAT	Virus neutralising antibody titre							
	0		14		28		85	
	IU	NT	IU	NT	IU	NT	IU	NT
Vaccinated								
413	0.00	0.00	0.70	0.60	2.80	1.20	2.10	1.35
471	0.00	0.00	0.56	0.60	1.28	1.05	2.80	0.90
364	0.00	0.00	2.80	1.65	14.00	1.80	6.25	1.95
623	0.00	0.00	2.50	1.80	14.00	1.65	13.00	1.80
621	0.00	0.00	.56	1.35	2.80	1.50	0.25	1.65
546	0.00	0.00	2.80	1.50	2.80	1.65	2.80	1.65
535	0.00	0.00	1.25	1.35	2.80	1.50	12.00	1.80
983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Incontact unvaccinated controls								
442	0.00	0.00	0.00	0.00	0.00	0.00	00.00	0.00
481	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rabies neutralising antibodies international units (IU) were determined by the rapid fluorescent focus inhibition test (RFFIT). Raccoon poxvirus (NT) antibodies were determined by 50% plaque reduction tests.

RCNRG = raccoon poxvirus-rabies glycoprotein recombinant,

Table 2 : Rabies virus neutralising antibodies in sera of cats vaccinated with (RCN-FPV-VP2/RG and boosted on days 26 and 34.

Animal No.	Days after primary vaccination				
	0	26	43	50	57
Vaccinated					
A983	≥0.0625[*]	1	4	≥8	≥8
A954	≥0.0625	2	≥8	≥8	≥8
A962	≥0.0625	2	4	≥8	≥8
A931	≥0.1250	≥8	≥8	≥8	≥8
A964	≥0.1250	4	≥16	≥16	≥16
A982	≥0.1250	1	≥16	≥16	≥16
A955	≥0.1250	1	≥16	≥16	≥16
A963	≥0.1250	≥8	≥16	≥16	≥16
Unvaccinated					
A981	≥0.0625	≥0.0625	≥0.0625	≥0.0625	≥0.0625
A932	≥0.1250	≥0.1250	≥0.1250	≥0.1250	≥0.1250

' International Units : 1 IU equals a 1:32 dilution of standard antiserum against rabies virus (18)

4 DISCUSSION.

Rabies vaccines are used for both pre- and post exposure vaccination in humans, and either pre-exposure vaccination in animals or revaccination of previously vaccinated exposed animals. Humoral neutralising antibody has been shown to play an important role in protection against rabies (11).

Fekadu *et al.* (12) have shown that the protective humoral rabies virus neutralising antibodies are directed against rabies G glycoprotein and that the rabies N protein may be important for the induction of cell-mediated immune response against rabies virus infection. Because rabies virus is highly fatal, post exposure vaccination should produce 95 – 100% seroconversion within 2 weeks. Historically in humans, using conventional inactivated vaccines, this was achieved by multiple intraperitoneal booster vaccinations. It is evident from this study that a single oral vaccination with the recombinant vaccines will be sufficient to produce seroconversion. One tenth of an international unit of rabies antibody is required for solid protection against peripheral rabies challenge (13 – 14).

The finding that recombinant raccoon poxvirus products can be delivered orally opens possibilities of vaccinating wildlife against a host of diseases through baits. Successful bait vaccination against rabies in foxes using a vaccinia virus recombinant (20) was demonstrated in France, in Belgium and in Canada (16). The antirabies vaccinating activity of the vaccinia recombinant was also demonstrated in raccoons (15) and skunks (17). In addition to being safe, raccoon poxvirus and recombined virus products in raccoon poxvirus appear to be suitable for feline immunisation.

Acknowledgements

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THE IMPORTANCE OF DOG DEMOGRAPHY TO THE CONTROL OF RABIES

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ABSTRACT

Dog population dynamics have a major impact upon the effectiveness of rabies control strategies. Mathematical models that describe host population biology are useful tools to quantify likely effects and help in the planning of rabies interventions. Two examples are presented as potential control strategies (lowering the age at first vaccination and dog culling), whose likely benefits are evaluated in the context of two East African dog populations.

1 INTRODUCTION.

Domestic dogs are the main reservoir of rabies throughout the developing world. As such, understanding domestic dog ecology has been recognised as central to the design of effective rabies control programmes (Beran 1982, 1985; Beran and Frith 1988; Kitala and McDermott 1995; Wandeler 1985; Wandeler *et al* 1993; WHO 1987; WHO/WSPA 1990). Standard procedures for collecting and applying such ecological information were developed by the WHO in the 1980s (WHO 1987 and 1992; WHO/WSPA 1990). The methods for data collection, based on questionnaire surveys and mark recapture techniques (Beck 1973), were designed to estimate population size, density and demographic parameters. The guidelines also stressed the importance of understanding the relationship of dogs to human society (Beran 1985; Beran and Firth 1988; Wandeler *et al* 1988), and a system of classifying dog populations based on the level of dependence on owners was introduced (WHO 1987). The guidelines recommended that the planning of rabies control should include an assessment of the different sections of the dog population in terms of accessibility to vaccination and the appropriateness of culling measures (WHO 1987, 1992). The dog population data also provides the baseline information needed to evaluate the success of a given intervention.

A large body of dog demographic data has subsequently been collected from a variety of developing country settings. However, it may be argued that where dog ecological data are available it has not been utilised to its full extent (Cleaveland 1996; Perry 1993, 1995). The demographic pattern emerging from dog populations of developing countries shows consistently high population turn-over rates. Both Cleaveland (1996) and Perry (1995) have argued that for such populations annual vaccination would be insufficient to maintain the critical vaccination coverage of 70% (WHO 1987) yet national control programmes still tend to be implemented on a yearly basis. Similarly, the age distribution of many dog populations indicates a large proportion < 3 months of age. Targeting of these young dogs in mass immunisation campaigns has been advocated as a means of maximising vaccination coverage given limited resources (Perry 1995).

Any assessment of the likely impact of a domestic dog rabies control intervention should take into considerations the underlying host population dynamics. Construction of simple mathematical models which capture these dynamics and act as a framework on which intervention effects may be simulated are a useful tool in disease control planning. To illustrate this, I shall consider two questions:

can the effectiveness of annual mass vaccination be improved by including dogs < 3 months of age?

is culling likely to be an effective rabies control strategy? For both questions I will use data from rural East African dog populations to construct a theoretical framework in which the likely effects may be quantified.

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1.1 Lowering the age at first vaccination.

Mass vaccination is recommended by WHO as the principle rabies control strategy (WHO 1992). Modern, inactivated, tissue-culture vaccines are safe and highly immunogenic, providing long-lasting protection (Aubert 1992). However, most vaccine manufacturers recommend that for dogs born of immunised bitches the minimum age of vaccination should be 3 months, so that vaccine-induced active immunity is not affected by the presence of maternally derived antibodies. Perry (1995) argues that given the rapid recruitment of new-born susceptibles, loss of immunes through death and vaccination programmes that are repeated, at best, annually, it is necessary to immunise even the youngest dogs in order to sustain sufficient levels of population immunity. It has been proposed that effort should be placed into developing a new vaccine that can protect against rabies even in the presence of maternally derived antibodies.

To see if there are any beneficial effects of including these younger dogs in the vaccination programmes we can construct a population model in which vaccination is assumed to be conducted on an annual basis. We can compare two vaccination strategies by simulating the effects of vaccinating a constant fraction of the population each year. For example with an annual vaccination coverage of 40%, then with the currently used strategy in Africa the vaccination effort would be confined to dogs ≥3 months of age, with the new strategy the 40% would be distributed equally across all age classes including dogs < 3 months. With the latter routine it is assumed that vaccination works equally well in dogs of all ages.

To understand how immunisation works at the population level we introduce a concept know as the basic reproduction number of infection, or R_0 (see Anderson and May 1991). The parameter R_0 for rabies is simply the number of secondary rabid cases which would directly result from one rabid dog entering a fully susceptible dog population. If the average number of secondary cases were more than one (i.e. $R_0 > 1$) there would be an epidemic of rabies and the disease would spread through the population. If the average number of cases were less than one (i.e. $R_0 < 1$) then there would be no epidemic and the rabies could not spread through the host population. Mass immunisation prevents an outbreak by effectively lowering the average number of secondary infections to less than one. For mass vaccination to reduce the average probability to less than one of a rabid meeting a susceptible dog and passing on the virus, the fraction of the population which must be vaccinated needs to be above a critical threshold. The critical proportion of the population, referred to here as p, which needs to be kept immune to control and eventually eradicate rabies is defined as

Equation 1 : $p > 1 - \dfrac{1}{R_0}$

Empirical (see Beran 1991) and theoretical (Coleman and Dye 1996) evidence suggests that a 70% vaccination coverage is likely to be effective in controlling domestic dog rabies.

Mass vaccinations of domestic dog populations are usually conducted in what is know as a "pulse", that is, over a short period of time a large fraction of a dog population vaccinated. However, immediately after the vaccination pulse the population immunity will start to decrease as new susceptibles (births) enter the population and vaccinated (i.e. immune) animals leave the population (deaths). There may also be some loss of immunity at an individual dog level, but with modern tissue culture vaccines we would expect the rate of loss of vaccine immunity to be much slower compared to death and birth rates (Aubert 1992). Following a one-off mass vaccination, the fraction of the population which are immune will continue to decrease eventually passing the threshold critical level p. This is why vaccination pulses need to be repeated at regular intervals. Ideally, a vaccination programme should aim to maintain the population immunity above the threshold p throughout the period between vaccination pulses.

By taking a population perspective we see that births may be regarded as an input of new susceptibles, while deaths will result in a loss of vaccinated animals. For dog populations in developing countries:

Birth rate > Death rate >> Rate of loss of vaccine induced immunity.

When the birth rate is greater than the death rate the population will grow. Studies from Africa have documented dog population growth rates of between 4.7–10% per annum which have tended to ex-

ceed the human population growth rates in the study areas (Brooks 1990, Cleaveland 1996, Kitala and McDermott 1995).

Despite the widespread acceptance that dog population studies are essential for the design and evaluation of rabies control programmes, there are still many African countries for which basic dog ecology data are not available. The work conducted by Cleaveland (1996) in the Serengeti region of Tanzania is one of the few studies to compile longitudinal demographic data. Cleaveland gives the survival schedule, the probability of surviving, l, from birth to age x years, for the Serengeti District dog population (Figure 1). The population was estimated to be growing at a an annual instantaneous rate, r, of 0.06 per year. With the lx schedule and r estimate we can calculate the stable age distribution, that is the proportion of animals held in each age class, from the expression :

Equation 2 : $S_x = l_x e^{-rx}$

where Sx is the number of animals of age x relative to the number of new-borns in the population.

Figure 1 : Survival schedule (lx) for the Serengeti District dog population. The data were taken from Cleaveland 1996.
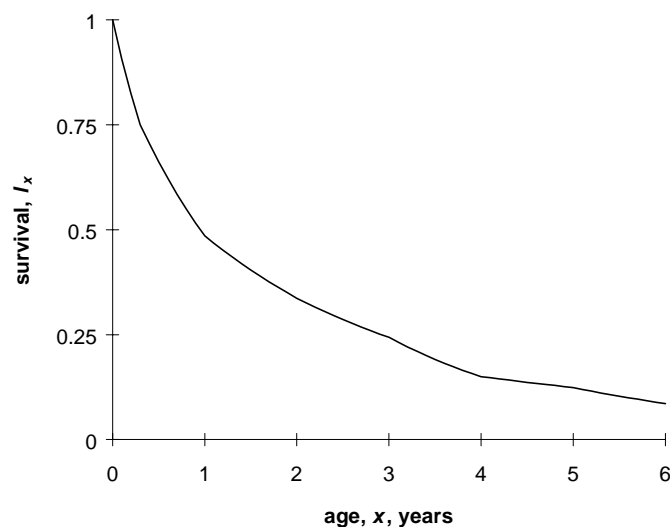

The stable age distribution is shown in Figure 2. With the survival rate, age distribution and growth rate we can model the population immunity following a constant coverage applied at annual pulse vaccinations according to the two strategies outlined above. It was assumed that the probability of being vaccinated at any one pulse was independent of vaccination history. Published experimental data of the survival rate of vaccinated dogs challenged with live rabies virus were used to estimate a rate of loss of vaccine induced immunity of approximately 3% per year (Sikes *et al* 1971; Lawson and Crawley 1972;Larghi *et al* 1979; Percausta *et al* 1982;Blancou, Aubert and Perrin 1985; Ganiere *et al* 1985; Jayakumar, Ramadass and Raghavan 1989; Jayakumar and Ramadass 1991).

Figure 2 : Stable age distribution for Serengeti District dog population calculated using Equation 2. The shaded area refers to dogs < 3 months of age.
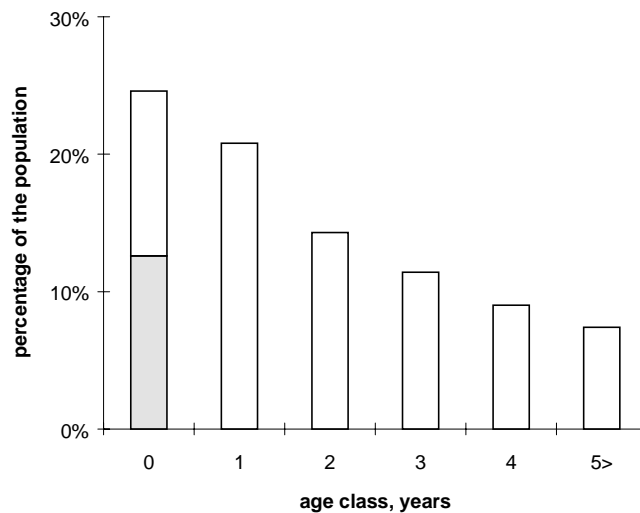

Following regular vaccination a stable state is approached at which the population immunity varies between a maximum, immediately following vaccination, and a minimum level, immediately prior to the next vaccination pulse. An example of the simulation of population immunity through time is shown in Figure 3.

Figure 3 : Changes in the level of population immunity with an annual pulse vaccination of 40% coverage. The arrows on the x-axis indicate when the pulse vaccination is conducted.
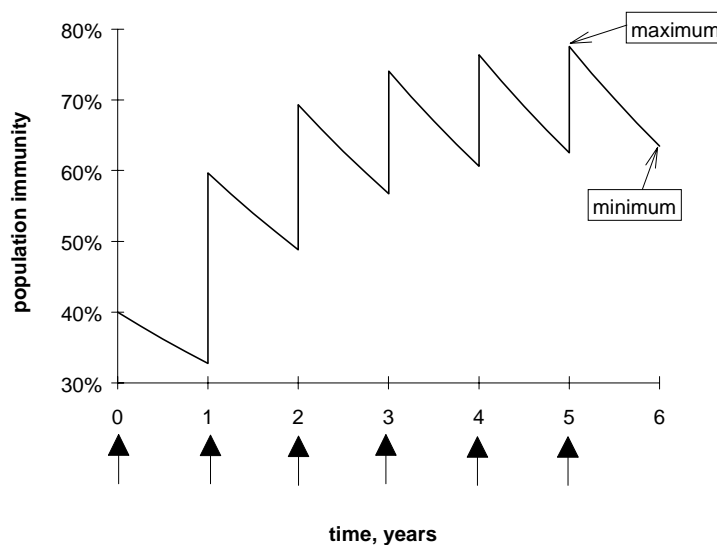

These stable state maximum and minimum conditions for the two different strategies may be compared (Figure 4). We are more interested in the minimum level, as epidemic theory suggests that we want to maintain the population immunity above some threshold value, p. The percentage reduction in annual vaccination effort, using the new compared to the old strategy, required to maintained the minimum level of population immunity above a given threshold is shown in Figure 5. It can been seen that to keep the minimum population immunity above a threshold of approximately 19% it is beneficial to include the younger dogs. The benefits of including dogs < 3 months of age increase with higher minimum threshold levels.

Figure 4 : Stable state maximum and minimum levels of population immunity when vaccination is confined to dogs ≥3 months of age (- - - - -) or all age classes (_____).
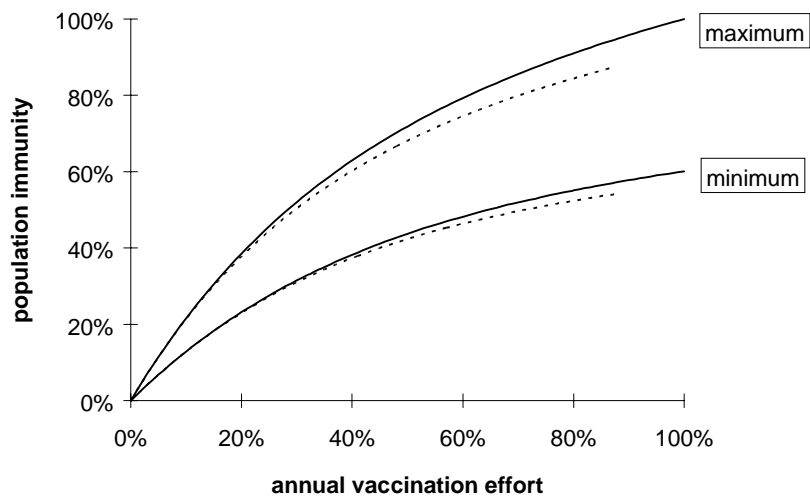
The modelling exercise suggests that being able to include the younger dogs in the vaccination pro-grammes would be beneficial in Serengeti District. The exact level of benefit gained from including the younger dogs is dependent on the demography of the host population.

Figure 5 : The saving in vaccination effort, achieved using the new strategy, required to keep the minimum population immunity above a given level.
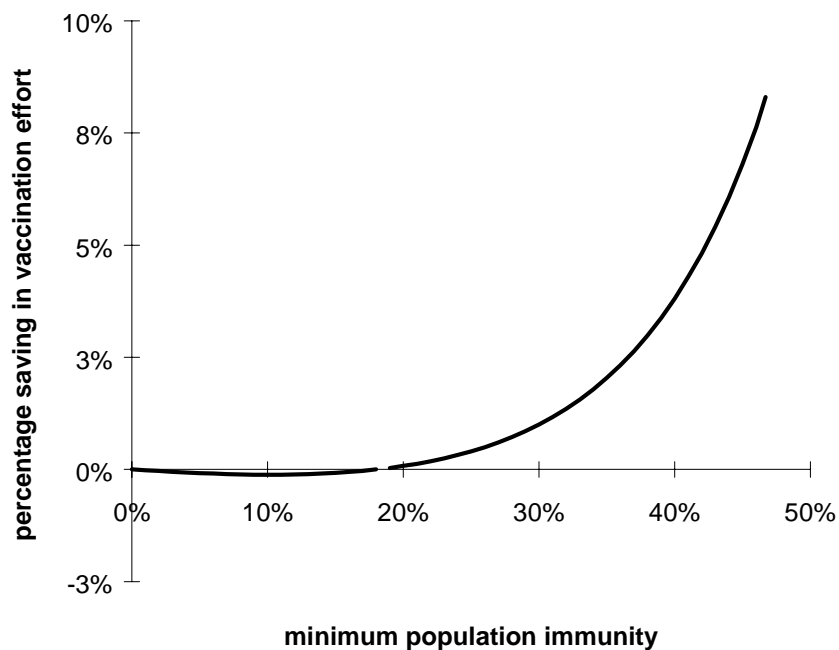
1.2 Culling.

Population control measures operate on birth rates and/or death rates. The principle of culling is to increase mortality rates so that the population density is lowered and the probability of contact be-tween infectious animals and susceptible animals is also reduced. However, both birth rates and death rates may be density dependent processes (Wandeler 1985). The effects of altering either or both rates may therefore be non-linear and difficult to intuitively predict. Construction of a mathematical model which describes the host population dynamics is useful in predicting the likely outcome of

population control measures. To make accurate predictions requires a detailed description of the dog population biology. Ideally, data would be available not only for age-specific mortality and fecundity rates but also for how the magnitude of these rates varies with population density. Such data are very scarce for developing dog populations.

Preliminary analysis of longitudinal survival data collected from a rural domestic dog population adjacent to the Masai Mara National Reserve (MMNR), Kenya, suggests that age-dependent density dependence survival is operating. Masai families live in homesteads known as manyattas, with several families occupying one manyatta. The data show a significant negative correlation between survival over the first 3 months of life and the total number of dogs in the manyatta. This density dependent effect is not seen in older dogs. The relationship is shown in Figure 6.

What are the consequences of this relationship for culling as a control strategy in dog population adjacent to the MMNR? Culling off unrestricted dogs tends to be introduced as an emergency measure during an outbreak, and is used in conjunction with mass vaccination to control rabies (e.g. Wells 1954; Waltner-Toews *et al.*1993). In the dog population adjacent to the MMNR, culling would be expected to increase the death rate in dogs ≥ 3 months of age, as these animals tend to be less restricted than the younger dogs. The average number of dogs per manyatta would therefore be reduced, and the relationship shown in Figure 6 suggests that this would lead to an increased survival of younger dogs. This change in survival equates to an increased rate of recruitment of susceptible into the population, which will dilute any population immunity established through immunisation. The control measure could, therefore, have the perverse effect of actual perpetuation of an outbreak.

This is a simplified example of the importance of density dependent processes, and a more detailed population model would need to be constructed to actually quantify the impact of culling on the epidemiology of rabies.

Figure 6 : Age-specific density dependent survival. The data for dogs < 3 months of age (■) and ≥ 3 months (O). The fitted lines for the young (--——) and old (- - - - -) ages classes are also shown.
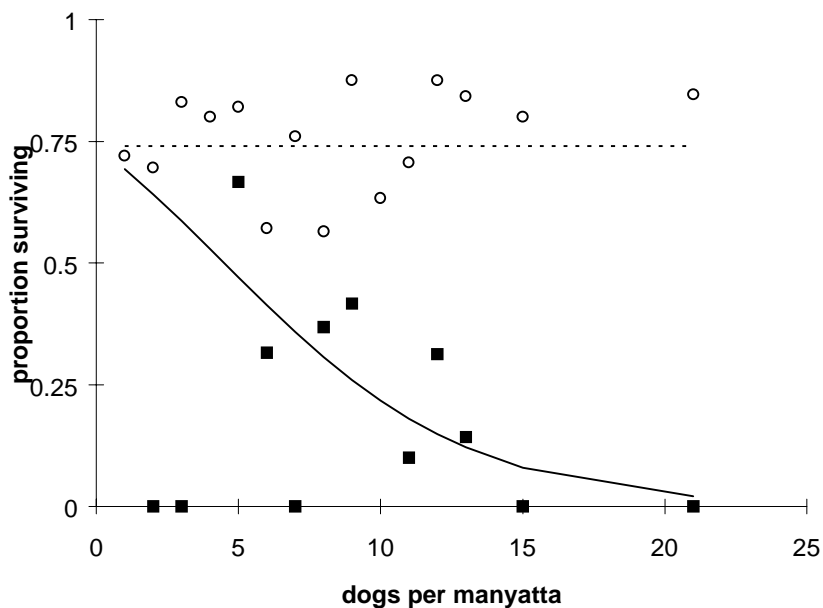
2 CONCLUSION.

This short discussion has illustrated the importance of understanding dog population ecology in the planning and assessment of rabies control strategies. By capturing some essential elements of the domestic dog population biology in a simple analytical framework it is possible to quantify the likely impact of an intervention, and also asses how the effectiveness will vary with differences in host demography.

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DISCUSSION OF PRESENTATIONS

1) Dr. A. King: Rabies in eastern and southern Africa: epidemiological patterns

- **Dr. Bishop**: Against which strains will current post-exposure vaccines work?
  The only virus against which current vaccines do not work is Mokola virus and therefore monoclonal antibodies are useful in typing the virus to indicate what action to take. Three more Mokola viruses have been found since using the current panel in South Africa, all from cats showing typical rabies signs.

- **Dr. Wandeler**: We should promote the isolation and storage of viruses, especially those isolates from unusual situations, such as very young pups with rabies so that they can then be typed for analysis.

2) Dr. P. Kitala : The epidemiology of rabies in Machakos, Kenya

- **Dr.Meslin**: It would seem that one of the conclusions of your talk is that rabies is a very important public health problem in Machakos, although only one human case was identified, which equates to an incidence of 25 per million people. Is there any information for the entire Machakos district?
  This result is only from a sample of the population. There is some other data from hospitals, although this will still be an underestimation as many people will never go to hospital and will die at home.

- **Dr. Wandeler**: Yesterday we also had similarly high incidence of human rabies reported from Ethiopia, and these are equivalent to those from Asia. Perhaps this is the real scale of the problem. I am, however, a bit uneasy about some of the dog figures reported as they would appear to represent little dog to dog transmission. I wonder if there is another underlying problem, such as a wildlife reservoir?
  Our workers were told to get any animals they could, without bias or discrimination, but we recorded little evidence of a wildlife problem.

- **Dr. Wandeler**: Yes, but it is dogs that transmit rabies to humans and therefore samples and diagnosis are more likely.

- **Dr. McDermott**: What is the reproductive ratio in this study and how does it compare with other areas?
  The reproductive ratio is between 1.7 and 2.2 in other studies and may be 2.4 in Machakos.

- **Dr. Ndaomba**: How did you recognise dogs in the follow-up visits?
  We recruited local workers and then dogs were visited every month or twice a month to get accurate details.
  Are you sure that there was no chance that you were told that it was another dog that had rabies when you followed-up?
  No, we could identify dogs by their age, sex, colour, name etc.

3) Dr. P. Kloeck: Rabies control in Mpumalanga, South Africa.

- **Dr. Dlamini**: In the north-east of Swaziland we have no rabies, but there is a high incidence in the south of the country which borders KwaZulu/Natal. When vaccination is being carried out in this area, owners of hunting dogs and greyhounds, who don't like having their dogs vaccinated, move over the border to South Africa to avoid vaccination. We should co-ordinate vaccination campaigns on both sides of the border to counteract this problem.

- **Dr. Mutemwa**: Do you have plans to control rabies in mongooses and blackbacked jackals?
  Jackals are not at present a problem in this area, but are a threat to the north. We have no means to control rabies in mongooses. In the past we used to gas colonies, but within a year the populations had recovered and so the policy was abandoned

- **Dr. Perry**: How much did the programme cost?
  $3.50 per dog.

- **Dr. Perry**: How does that compare with Kwazulu-Natal and does it include the cost of publicity and adverts?
  The budget of 40,000 Rand for publicity went a long way and is included in this costing, but the cost of salaries is not included.

- **Dr. Ndaomba**: What proportion of the department's budget is that?
  Very small. We did it as a test case to see if we could get support from the community and then apply for funds elsewhere in the future. Most of the budget goes into Foot and Mouth disease, African Swine Fever and African Horse Sickness. We made a 15 minute long video for children and it has been very successful and has also been used in Swaziland. If anyone wants one we have 200 copies left.

4) Dr. A. Thaiya: Clinical observations on cattle rabies in the Kiambu District of Kenya.

- **Dr. Kloeck**: In South Africa, in areas of jackal rabies, we often see hydrophilia in cattle. They tend to congregate at drinking points and try to drink. The animal opens its mouth, puts it in the trough and tries to suck, but unsuccessfully. In some cases, however, animals continue to eat and drink throughout.

- **Dr. Cleaveland**: In the first outbreak in cattle, I understand that no bites were found but there were 20 cases. Is there any possibility of cattle-to-cattle transmission?
  There were 10 cases in one month but we suspected a rabid dog, although we did wonder if they could have got it through water troughs.

- **Dr. Kaboyo**: In Uganda, a farmer was using a dog to herd his cattle. The dog was very active and aggressive and bit some cattle whilst working, and the farmer thought it was doing a good job. However, the dog was rabid and he lost over 10 cows. The lack of awareness and education is really a big problem.

- **Dr. King**: Are there mongooses in the area?
  No, there are few little wildlife, but we do think there are some mongooses but they are nocturnal and thus seldom reported.

- **Dr. Kitala**: In one outbreak, 8/29 cattle died. On questioning, the herdsman reported that he had seen a rabid dog one month before.

- **Dr. Wandeler**: What was the incubation period in most cases?
  About a month. When foxes or jackals bite cattle, a 6 month to 1 year incubation period is more common.

- **Dr. Kloeck**: Do they generally vaccinate cattle, as this has been done in South Africa with good results?
  No, only in particular herds if there is a problem.

5) Dr. Carolin Schumacher: Oral rabies vaccines for dogs: research update

- **Dr. Kaboyo**: You said that the bait should be as unattractive as possible, but the one you produced looked like chocolate! It is a problem of industrially produced baits and therefore we need to educate people not to eat these baits.

- **Dr. Kaboyo**: You did the field trials in Tunisia, but you should also do them in a tropical environment, where there's lots of rains and heat?
  It is very hot in Tunisia, but we will extend trials.

- **Dr. Wandeler**: Surely it is possible to make the bait less attractive?
  We really did try many colours and shapes, but there are lots of limitations with productions, colours, attractants and this was the best we could do.

- **Dr. Robinson**: What about something that looks like a faecal pellet?
  Yes, but they are too bulky and difficult to pack.

6) Dr. C. Ngichabe: Recombinant raccoon pox rabies vaccines for cats.

- Do you get in PBL in natural infections in racoons?
  We didn't check but were told this happened.

- What was the rationale behind the different times to challenge?
  This was a short experiment and we didn't have time to replicate.

7) Dr. P. Coleman: Dog population reduction in rabies control: does it work?

- **Dr. Wandeler**: This is a very important contribution - culling can be counterproductive and expensive.

- **Dr. Schumacher**: If you use the vaccination regime of vaccinating dogs under 3 months of age, vaccination coverage is increased by 10%. In the field, the dog population turnover and puppy mortality is high. Many of these vaccinated puppies would therefore die, so would the increased coverage of 10% be cancelled out due to this high mortality?
  Yes, but for optimal coverage of 70%, we should vaccinate dogs with the greatest life expectancy. In this study, puppy life expectancy is still greater than older dogs; dogs aged 1,2 or 3 live longest. There is high mortality in pups, but those that survive do so for a long time.

- **Dr. Perry**: What is the relative importance of puppies as a source of infection; it could be very important?
  Dr. Kitala's data showed that most cases in dogs are from those aged more than one year. Only 10% occurs in dogs of less than 3 months, but this age group have more contact with children and other people generally.

- **Dr. Wandeler**: In some areas, there are lots of cases in juveniles.

- **Dr. McDermott**: At the last SEARG meeting, it was clear that the available vaccine can be used in dogs less than 3 months of age. Are you talking about a new vaccination strategy rather than a new vaccine?

- **Dr. Wandeler**: Some live attenuated vaccines are pathogenic in pups and are still available, therefore only killed vaccines should be used in pups. The amount of maternal antibody is essentially negligible.

- **Dr. Schumacher**: Can you really vaccinate these puppies? Their immune system is not as well developed. Also, if they are parasitised or sick, it reduces the immune response. Are there any data to support the effective vaccination of pups of this age?

- **Dr. Wandeler**: It is not possible to get an immune response from 100% of pups, but a good proportion do respond. Immunity may not be as long lasting. In Tunisia, the SAD vaccine wasn't very effective in the laboratory, but in the field all pups sero-converted. Indeed, some parasite load can help the immune system to develop and be able to respond and so many pups are not immunocompromised.

- **KSPCA**: The welfare organisations are against culling. In Nairobi during rabies control programmes, people hide their dogs as they think they will be poisoned, which has happened previously. Indiscriminate culling decreases vaccination coverage.

- **Dr. Wandeler**: Yes we need co-operation between agencies and co-ordination between NGOs and government.

- **KSPCA**: Last time, the vets poisoned the dogs just after the vaccination campaign! This arose from a communication problem between the central agency, which had been informed, and the district, who were not told.

- **Dr. Githaiga**: What is the effect of mortality from other diseases?
  Should we be promoting a primary health scheme for dogs? *Yes if dogs live longer, loss of the percentage which is immune is lower.*

- **Dr. Wandeler**: This is a weakness in the model because it assumes a stable population and no epidemics of canine distemper or adenoviruses. There was no significant difference in the age structure of the population over the 3 years of study in the Tanzanian project, but yes, you are right, this is a problem.

- **Dr. Wandeler**: In Tunisia there was a stable age structure for a number of years, but then CDV came in and disrupted it.

- **Dr. Bingham**: What is the effect of culling pups; should we encourage this?
  It would decrease the susceptibles and people would want their dogs to live longer. Therefore we should encourage dog owners to decrease litter sizes.

- **Dr. Kitala**: In some areas culling is not possible as demand is greater than supply.

- **KSPCA**: There are 20-30 pups in the KSPCA at any time and it takes a long time to house them to homes with a good standard of care. We should encourage pup culling as soon as they are born.

GENERAL DISCUSSION

- **Dr. Wandeler**: The typing of strains, storage of isolates and appropriate laboratory submissions are very important. Is this something that SEARG should take over and organise? Can all countries permanently store frozen or freeze dried samples?

- **Dr. Perry**: This is a difficult issue; who wants the information and why. We now have an increased understanding of the types of strain, but does this have much effect on control? I don't think so. So, if someone wants to improve our knowledge they need to help provide the mechanisms and incentives for the submission and storage of samples.

- **Dr. Wandeler**: There are two reasons to type strains, first scientific reasons and second for surveillance. If odd cases occur, for example in geographically isolated areas or somewhere it was not expected, it might be possible to trace the source and change the control strategy from typing.

- **Dr. Perry**: Yes but that is part of better surveillance.

- **Dr. Wandeler**: Who will give away their viruses: I am against robbing "intellectual property" and so this should be a collaborative effort. My laboratory would help where possible, but only to be altruistic.

- **Dr. Perry**: Yes, some countries have bad experiences of this situation.

- **Dr. King**: Obviously I am very keen to look at differences in viruses. We will not understand rabies unless we keep looking at the viruses and how they move within regions. It would be ideal to have a regional centre and for one country or laboratory to offer this service to the rest of the region. Thus if any country can get viruses to them, the laboratory will type them. BUT, the virus belongs to the people who isolated it and therefore is not public property. Owners should be consulted before any publication.

- **Dr. Meslin**: Should we have surveillance at the sub-regional level and ask one centre to do this and publish the results in the quarterly bulletin? The quarterly bulletin, however, is not fully operational - it is difficult enough to do, so do we really have the capacity to organise a virus centre?

- **Dr. Wandeler**: OK, so the initiative is with the collector of the samples to approach a laboratory and ask them to help with isolation. This should be done in particular from cases with a strange history, such as the lack of a bite wound, puppies from healthy females etc.

- **Dr. Kaboyo**: Can we have a list of the Centres with this capability and who are willing and have the budget to do this. At the moment we do not know which laboratories can do this.

- **Dr. Meslin**: This is part of surveillance. I think we have to define our priorities and I don't think that this is a priority as it doesn't really affect control.

- **Dr. Wandeler**: I think its very important and affects control strategies.

- **Dr. King**: We need to ask WHO to inject some money!

- **Dr. Wandeler**: We need surveillance for planning and evaluating control programmes. How can we improve surveillance?

- **Dr. Meslin**: The basis of surveillance is a good laboratory, good sample collection and people to provide the motivation for this. The techniques are now available to get samples to the laboratory without a cold chain. But it seems that logistics i.e. transport of samples is the biggest problem.

- **Dr. Perry**: We shouldn't concentrate on the technical aspects which are well understood. The infrastructure i.e. the collecting system is the limiting factor, as well as information collation and return of information to the collector of the samples. However, there are examples from this meeting where these problems have been overcome.

- **Dr. King**: I was appointed roving technical expert at the first SEARG meeting and I have found a lot of variation in the standard of diagnosis. Even the poorer laboratories do not need much input to improve their diagnosis, but they do not see that there is a technical problem in their region. It is no good getting a result if it is the wrong result. Often the problem is easy and cheap to solve. I am very happy to come and help but I need to be asked to come.

- **Dr. Kimanzi**: This is a problem of not prioritising rabies as a disease. The reality is that some laboratories are not up to standard.

- **Dr. King**: Yes, but SEARG is here to solve these problems and this will addressed again this afternoon.

SEARG business meeting

PERSPECTIVES ON THE FUTURE OF SEARG

B.D. Perry [49]

1 WHERE ARE THE STRENGTHS OF SEARG?

❖ We are all a nice bunch of people!

➢ Mixture of front line (country level diagnosis and control), applied research (regional), molecular technology and vaccine development (predominantly in ARIs)

❖ Relatively limited geographical spread

❖ Relative informality of group

❖ Ability to assemble a group of active rabies control and research workers at regular intervals

➢ Functionality of the group

▪ Low soporific index (Godlonton, 1997, pers. comm.)

▪ Proceedings publication index = 100%

➢ Ability to fund; can it be sustained?

❖ Demonstrated response to tackling identified problem areas, for example :

➢ Virus characterisation (SEARG, 1992)

All regions, e.g. King *et. al.*

➢ Vaccination coverage levels (SEARG, 1992)

e.g. Kenya (Coleman; Kitala); Tanzania (Kaare)

➢ Dog population dynamics (SEARG, 1993)

e.g. Ethiopia (Laurenson); Kenya (Kitala; Coleman); Tanzania (Kaare); Zimbabwe (Butler)

➢ Data gathering, handling and decision support (SEARG, 1995)

e.g. Uganda (Kaboyo and Rutebarika); South Africa (Robinson)

2 WHAT ARE THE WEAKNESSES OF SEARG?

❖ Strong influence on research, but weak influence on rabies control programmes.

❖ Inadequate spread of disciplines

❖ Focus on technical aspects, no economic impact research

❖ Not backed up by funding avenues

3 SO WHERE DO WE GO FROM HERE?

❖ Maintain strength as broad research forum

➢ Meeting at two yearly interval

❖ Develop a focussed proposal for action, with clearly attainable products over a defined time

➢ Potential subjects :

▪ Diagnostic capabilities enhancement

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- Surveillance and reporting strategy
- Intersectorial rabies control programmes
- Strengthening of delivery of veterinary services to control diseases of public health concern

❖ Repository of rabies viruses?

❖ Maintain geographical focus?

  ➢ For : logistics / funding

  ➢ Against : demand exists in other regions

❖ Incorporate into existing WHO/FAO programmes?

❖ Strengthen involvement of medics, community health workers, etc …

❖ Next meeting : WHERE? WHAT FOCUS?

THE VIEWPOINT OF
A DIRECTOR OF VETERINARY SERVICES.

J. K. Kajume[50]

Ladies and gentlemen,

Let me take this opportunity to thank SEARG and WHO for facilitating this forum which by itself is a step forward in the epidemiology and control of rabies in this region.

The country reports already presented in this meeting tend to indicate that the rabies control performance in some countries has not showed significant increase over the last few years whereas in others there is tremendous achievement recorded. In nearly all cases there is need to step up effort in the surveillance and control of rabies. Even in countries where significant breakthrough has been made, there is still a lot that remains to be done.

The question now is : how do we move forward from where we are, with particular reference to Kenya, the course of action will be focused along the following guidelines :

1) Intensify campaigns to educate communities on :

    a) Dangers of rabies

    b) The responsibilities / obligations of dog owners.

    It is envisaged that the campaigns will be planned and executed through the agricultural extension service which is being put in place.

2) Private sector participation.

    For a long time, the control of rabies in Kenya has been the domain of the government. In this regard, the government has spent a substantial amount of resources in vaccination campaigns and other control measures. In the on-going service restructuring process, the private sector (mainly private veterinarians, dog owners, NGOs, etc…) will play a more participatory role than before. The government will however continue to ensure that the appropriate regulatory mechanism is in place.

3) Pressure on local authorities.

    The local authorities have to a large extent neglected their role in the control of rabies. Many stray dogs are a common feature in our urban centres today, the main attractant being uncollected garbage. The rabies threat posed by these dogs cannot be ignored. It is therefore of utmost importance that the local authorities be sensitised on the need to keep our urban centres clean and enforce by-laws which govern the keeping of dogs and cats in towns and cities.

4) Step up collaborative effort.

    The relevant players in the field of rabies control who include veterinary authority, health authority, Kenya wildlife service, local authorities, KSPCA and other NGOs have to work more closely.

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5) Surveillance and research work.

There is need to intensify research and surveillance work focusing on better control options, more effective and appropriate vaccine, control or eradication in reservoirs, etc … In addition monitoring of rabies control performance needs to be strengthened.

6) Countries to borrow a leaf from one another.

Through enhanced regional co-operation countries can borrow a leaf from sister countries which have recorded successful performance in rabies control.

7) Campaign for more resources. The veterinary and other relevant authorities have to campaign for more resources to facilitate better control and surveillance. Needless to say that the effort to control rabies in our region is seriously hampered by insufficient supportive resources.

Conclusion.

Rabies is still a threat in our region and calls for more concerted effort in its control. In this regard, there is urgent need to enlist participation, support and collaboration of communities, private sector and other relevant players in the epidemiology and control of rabies. It is through this approach that further achievement can be made. A conclusion question is : can we set a vision for year 2020?

THE VIEWPOINT OF
A DIRECTOR OF MEDICAL SERVICES

J. A. Nyamongo[51]

Rabies is a disease with a high mortality if untreated. It is rarely taught in detail in medical schools, more often than not it is mentioned in passing or as a differential diagnosis. This is probably because there is little to offer. However, this is not entirely true as mortality rates can be drastically reduced with post-exposure treatment using Rabies immunoglobulins and anti-rabies vaccine.

To understand the issues, I present two scenarios :

1) Many clinicians go for many years before they encounter a case of rabies. When they do, it is often puzzling and the patient may go for some days without a definitive diagnosis. All of a sudden someone mentions a history of animal bite or the nurse notices signs of hydrophobia then with a bang the diagnosis is brought home to the doctor. The full realisation of what he is dealing with then hits him. Initially it is exotic and exciting but as it dawns on him, he gets confused. What do I tell the patient and the relatives?. Then the problems of education and counselling come in.

2) An individual is bitten by an animal in a remote area. He goes for one or two days without bothering then in passing he mentions to a colleague about this bite. The colleague vaguely tells him of a rumour he heard of someone who was similarly bitten and died a horrible death. The individual now gets into a state of panic. He sets off the next morning to the nearest health facility to seek help. At the facility he explains his problem, for a solution he is referred to the District Hospital several kilometres away. The search for funds for his fare takes another one or two days. Eventually he is on the queue at the hospital and gets to see the doctor. He is lucky. Yes we can help you the doctor says, you will receive an injection today, another one the day after tomorrow, a week from now, two weeks and a month from now. This is all confusing to the rural man, besides there are no funds . In any case he is not unwell. The individual goes and is lost to follow-up.

I have presented the two scenarios to show you some of the issues in rabies.

1 ISSUES OF DIAGNOSIS.

Diagnosis is often made clinically through the presentation of a classical history and symptoms and signs. But in other cases it may go undiagnosed especially if the presentation is not classical.

There is, therefore, need to raise the index of suspicion of rabies among clinicians. Information of the possible existence of animal rabies in an area should be communicated to the health facilities.

Ante-mortem laboratory confirmation of rabies is difficult mainly for three reasons :

1) Problems of obtaining appropriate samples

2) Logistics of transporting these samples to the central diagnostic laboratory

3) The turn around time before results are obtained

51

2 POST EXPOSURE TREATMENT.

As has been shown, appropriate and timely post-exposure treatment can greatly reduce mortality. However two things need to be done to increase the effectiveness even further :

1) Reduce the cost of treatment
2) Improve the treatment regimens to increase patient compliance

3 DATA.

The two scenarios I have just presented show how circumstances conspire to ensure that data on human rabies is incomplete in most cases. This means effective strategies to combat the disease cannot be formulated.

Rabies is one area where there is need for effective collaboration between the Veterinary and Medical departments to combat a disease. People must be made to understand that in protecting their animals from rabies they are protecting themselves.

DISCUSSION OF PRESENTATIONS

Dr. Robinson: The strength of SEARG lies in its independence and I propose that it is unfettered by the institutionalisation which would come with official FAO or WHO status.

Dr. Injairu: I would like to know how much SEARG can influence the activities of veterinary departments, since SEARG does not have its own resources.

Dr. King: There are recommendations for closer co-operation between the veterinary and medical profession. SEARG can ensure that a copy of the Proceedings is sent to the CVO and CMO to encourage dialogue.

Dr. Perry: That is the minimum that could be done. Perhaps SEARG could play some further role. It is possible that SEARG has not been disseminating information adequately and I suggest that we should consider publication of second editions of Proceedings, for example.

Dr. Godlonton: Regarding the involvement of medics, I have been in a minority position during this meeting and, as such, have expressed some strong views. I would like more medics to be involved to provide support for views on issues such as the management of rabies cases and ante-mortem diagnosis.

Dr. Kitala: The health sector has been invited to this meeting, but it appears that there is still considerable apathy.

Dr. King: Are we aiming at the wrong level? Perhaps the SEARG meetings should be directed at practitioners instead of Ministry officials.

Dr. Meslin: If the medical profession is to be involved, the programme must be tailored so that it is not boring for physicians. Our experience from Zimbabwe suggests that medics were not involved or interested in the predominantly veterinary context of the programme.

Dr. Wandeler: I support what Dr. Meslin has just said. We should invite medics to talk to us, rather than just to attend the meeting.

Dr. Kajume: A problem arises because rabies is spread from animals to humans, not vice versa. Perhaps this is what creates apathy from the medical profession.

Dr. Nyamongo: There is a lack of interest because the disease is not taught in medical school and only seen rarely. Perhaps clinicians feel that they have little to offer.

Dr. Kaboyo: SEARG needs to be more inclusive with a broader remit to include other health workers, not just physicians. For example, it is often nurses who are the first to deal with a bite injury and doctors only become involved when the clinical disease is apparent i.e. when it is too late.

Dr. Robinson: I support the involvement of community health workers. I use the example of a recent dysentery epidemic in South Africa, where the problem was successfully tackled through involving workers from many different sectors, not just the medical field.

Dr. de Balogh: There is often not enough commitment from Governments for rabies control programmes. Perhaps we need to invite decision-makers to SEARG meetings.

Dr. Ndaomba: Firstly, the WHO region office in Brazzaville has no involvement in zoonoses, which may be one reason why there is little interest from medical health colleagues on rabies. Secondly, there is the need to enhance diagnostic capacity.

Dr. Kaboyo: Using Uganda as an example, collaboration between the Ministry of Health and Department of Veterinary Services seems to be working through the appointment of a veterinarian in the Ministry of Health. There is now a proposal to have two more vets appointed. This approach is definitely worth trying, but it needs the backing of the veterinary profession and a clear idea of what needs to be done. That is, the job description needs to be well described and the mandate clearly defined. Having a clear job description will avoid undue conflicts.

Dr. Ahmed: Physicians are playing a significant role. For example, I am a veterinarian, but am overseeing the human vaccine production unit. In Sudan, there is a committee for rabies control involving veterinary public health, physicians and the Ministry of the Interior.

Dr. Perry: I would like to follow up on Dr. Meslin's suggestion for SEARG to monitor proposals for WHO funding, such as those for diagnostic capability enhancement. I must emphasise that these proposals must come from countries or individuals. SEARG cannot come up with proposals itself. This leads on to the question of what is SEARG? Should it be an informal group with no clear structure, or should we develop a structure?

Dr. Meslin: The WHO could support some small-scale projects, but SEARG could also attract other sources of funding.

Dr. de Balogh: Should we look at the example and experiences of Latin America, which has seen some success with rabies control?

Dr. King: I would like to return to the question of a repository for rabies viruses in the region. In my opinion, the best place for a repository is at Onderstepoort. Should this be the preliminary site? Could we ask Dr. Thomson to make some sort of facility available? Could the WHO consider supporting such a venture?

Dr. Meslin: The WHO would be more interested in field programmes.

Dr. Wandeler: Onderstepoort is already the OIE reference laboratory. Why not make it an OIE/SEARG reference laboratory? The initiative must still come from the researcher in the field.

Dr. King: I agree, but pointers would be helpful.

Dr. Kitala: How should SEARG co-ordinate submission or screening of research proposals to WHO. We would need to have a permanent secretary for SEARG.

Dr. Perry: If we want to take advantage of WHO interest between meetings, we need some more permanent secretariat-type activity to link users and resource people. This would be separate from the organization of the next meeting.

There was a consensus that this should be implemented.

Dr. Kinyili: What about the financial considerations and implications?

Dr. Perry: It depends on who is appointed, but yes, there are financial implications.

Dr. Kinyili: Can we identify an institution, not a person, so that it can be sustained more easily?

Dr. King: I would volunteer, but the UK is a long way from the SEARG region. I therefore suggest that we ask George Bishop.

Dr. Bishop: I agree to become the permanent Secretary.

Dr. Kitala: We should discuss the location of the next SEARG meeting.

Dr. Perry: There are a few criteria:

- The chosen country must be within the region
- The country must be willing to host the meeting
- There should be a rabies problem in the country
- The country is actively doing something in the region.

Proposals followed to consider Ethiopia, Malawi, Mozambique and Uganda as possible hosts for the next meeting.

Dr. Zewde: On behalf of Ethiopia, we would have to inform the Director of Veterinary Services

Dr. Ndaomba: On behalf of Malawi, we strongly support the suggestion and have experience from previously hosting other Conferences. Hosting the meeting in Malawi would really help rabies control in the country.

Dr. Rodrigues: On behalf of Mozambique, we are prepared to host the meeting following endorsement from the authorities.

Dr. Kaboyo: On behalf of Uganda, we would welcome members and we feel that we have something to offer as Uganda is in an improving situation. Official endorsement would be needed.

Dr. Kinyili: I think Mozambique is ideal as it was previously going to host the meeting.

Dr. Godlonton: Surely the committee should make the decision. Delegates should give the committee the mandate to make the decision.

Dr. Perry: We need clarification of the committee. In the past, the committee was elected on the basis of a venue. Would the current committee be acceptable - that is Dr. Kitala, Dr. Perry, Dr. Bingham and Dr. Bishop?

Dr. Fekadu: I suggest the country is elected on the basis of issues to be discussed at the next meeting. For example, human rabies is a problem that has not been addressed and this is a huge problem in Ethiopia. The organizing committee should make the decision and then inform the members.

Dr. Perry: We need a time frame for the decision-making process.

Dr. Meslin: I agree with Dr. Fekadu on the top priorities for the next meeting.

Dr. Kitala: I would like to express many thanks to all the participants and look forward to renewing acquaintances in two years' time.

Note: At the social gathering later in the day, UGANDA was chosen by the committee to be the next venue in 1999

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