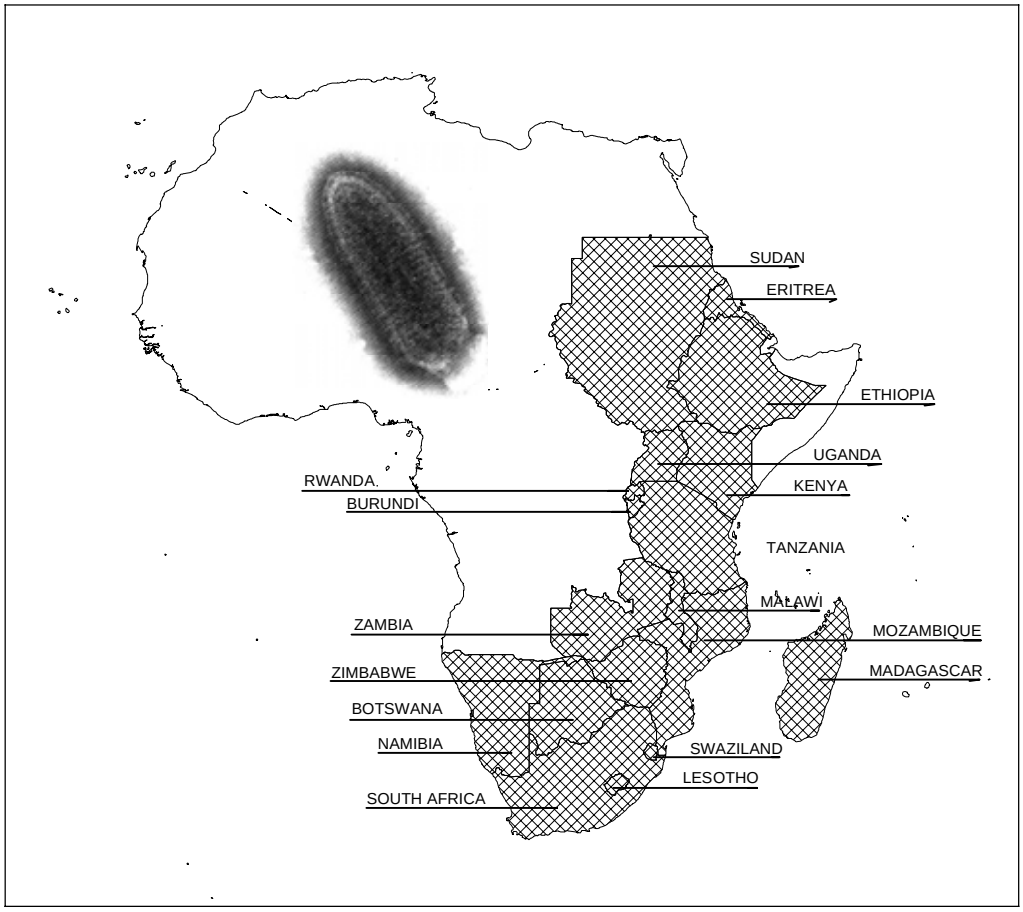
W. H. O.

PROCEEDINGS OF THE SOUTHERN AND EASTERN AFRICAN RABIES GROUP / WORLD HEALTH ORGANIZATION MEETING



LILONGWE, MALAWI – 18-22 JUNE 2001

ÉDITIONS FONDATION MARCEL MÉRIEUX
17, rue Bourgelat, 69002 Lyon - France

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Official opening

OPENING SPEECH

Arthur King[1]

Mr. Chairman, Ladies and Gentleman,

May I welcome you all to this, the sixth meeting of the Southern and Eastern African Rabies Group in this, the tenth year of our operation. At the end of each meeting there is intense competition to host the next meeting and we are delighted that on this occasion Malawi was chosen. Sadly, Sheik Ndaomba, who had attended many of our meetings and was instrumental in bringing us to Malawi, passed away in February last year and I would ask you to stand in silence for a minute while we remember with gratitude the life of Sheik and convey to his family our condolences.

Our first meeting was held in Lusaka, Zambia, in 1992. It was a gathering of scientists and administrators with an interest in rabies, aiming to establish the true extent of rabies in the ten countries that attended. We did not anticipate meeting again, but what we found convinced us that the disease was far more prevalent than anticipated, so we established the Group and held further meetings in Southern Africa. Since then we have grown like topsy and now cover 18 countries, an area 10% larger than that of the USA and with 25 million more people. In addition to more countries, we now try to attract a Vet and a Medic from each country and are permanently linked to WHO.

We are a voluntary group, with no governmental backing and no resources. Therefore, we have to raise funds for each meeting and we are indebted to WHO, our principle backer, to commercial companies including Chiron-Behring, Biovacc, Merial, Intervet and Virbac and to other donors such as the Wellcome Foundation and the Chief Scientist's Group in the U.K.. Special mention must be made of the Chiron Award, which is of $3000 to be presented at each biennial meeting to enable the continuation of existing projects or the establishment of new projects. Applications for the Award will be judged by an expert panel and the winner will be notified accordingly. Another special mention should be made of the generous gift by Merial of a CD-ROM devoted to rabies for each delegate. Part of our work is to disseminate knowledge of the disease and I shall be giving a presentation of how the CD-ROM can be used to best effect later in the programme.

In addition to these donors we are aided by the contributions of rabies experts from many countries. We will be privileged in the day or two ahead to have presentations from some of the worlds leading rabiologists from Africa, North and South America, Europe and Australia.

Of course, we cannot hold a meeting without the considerable support of the host nation. Here, Gift Wanda has been "our man in Malawi" and has worked diligently to organize transport to and from the airport, negotiated favourable terms with the hotel, organized the training course which took place at the Central Veterinary Laboratory yesterday and carried out a host of other tasks. He could not have done this work without the support of his Director, Danny Chinombo who, in addition to arranging a cocktail party for us all tonight, has kindly agreed to act as Chairman of the Malawi meeting.

This meeting would not have been possible were it not for the efforts of our Secretary, George Bishop. It is he who has picked up the pieces of the early disasters with travel arrangements and has done so much to ensure that we have a successful meeting. George is a tough cookie from South Africa and if you have any problems I'm sure he'll be willing to help you. Our Programme Manager is Alex Wandeler and he has put together a scientific programme that we hope you all find instructive and intriguing. Finally of our Group, our IT specialist is Jacques Barrat. Jacques is a very quiet man, for a Frenchman, but he will be running the overhead projector, the slide projector and the LCD projector and he will help all those presenters who need these facilities.

[1] Formerly, Central Veterinary Laboratory, Weybridge, Surrey KT15 3NB, UNITED KINGDOM

We hope that you have an enjoyable and memorable meeting. It has been made possible by all the donors, contributors and workers I have mentioned to you and I hope that you will show your appreciation of them by joining me in a generous round of applause.

Towards the end of the programme we will have a session devoted to Quo Vadis, meaning where do we go from here? After ten years of work it is right that we should review progress and, where necessary, make changes.

This Group belongs to you, the national representatives. Are you satisfied with your achievements? What more can you do? Should we continue to meet? Should we broaden our horizons and invite more countries? Every meeting takes a huge amount of fund-raising – could your country do more to contribute to your financial support?

These are just a few questions, which I hope you will consider before the Quo Vadis debate, and your contribution to this debate is crucial to the future of SEARG.

Now, it is my great pleasure to hand you over to Danny Chinombo, our Meeting Chairman.

OPENING SPEECH

E.S. Malindi

I am greatly honoured to request you, Honourable Minister, to officially open this year's Southern and Eastern African Rabies Group (SEARG) meeting taking place here in Malawi, but before I do so, allow me please to say a few words.

SEARG is a grouping of eighteen member countries, which includes Malawi. The venue for the group's meeting rotates within member countries. Malawi was chosen to host this year's meeting at the last meeting in Entebbe, Uganda in 1999. Since the group inception in 1992, five meetings have been held as follows: two meetings in South Africa (1993), one in Zimbabwe (1995), one in Kenya (1997) and one in Uganda (1999). At the end of each meeting, Proceedings are compiled for future reference.

As you might be aware, Honourable Minister, rabies is a serious global problem and is a well known public health concern not only in Malawi, but throughout the world as can be deduced from the attendance at this meeting. The control of this deadly disease in developing countries poses a lot of logistical challenges. It is the task of this gathering to tackle some of such challenges.

With these few remarks, Honourable Minister, it is my humble duty to request you to officially open the meeting.

Thank you.

OPENING SPEECH

L.K. Mangulama
Honourable Minister of Agriculture and Irrigation.

It is my honour and privilege to welcome you all to this 6th Southern and Eastern African Rabies Group (SEARG) Conference in Malawi.

I am pleased that at the last meeting that took place in Entebbe, Uganda in 1999, Malawi was unanimously chosen to host this 6th Conference. Let me assure you that despite the heavy schedule ahead of you this week, you will discover that Malawi is indeed the warm heart of Africa.

I am informed that SEARG was founded in 1992 at a gathering of rabies scientists, diagnosticians and policy makers in Lusaka, Zambia. I am also informed that SEARG has an overall noble objective of constantly sharing scientific advances in rabies with a view to harmonise control strategies of this deadly disease. I commend the Group for this great initiative.

Distinguished guests, Ladies and Gentlemen, we are all fully aware that rabies is a serious global problem posing a permanent threat to human population in many parts of the world. Crude estimates of deaths caused by rabies, especially in densely populated countries in Africa and Asia, are alarming and call for seriousness in coming up with strategies to control the disease.

In Malawi, rabies is endemic throughout the country. About 200 cases are confirmed in animals each year, but the real incidence is probably several times higher than this. Most of the cases occur in dogs and a few in cattle, goats and other domestic animals. Less than 5% of the cases occur in jackals and hyenas. Dogs are most commonly the source of infection for animals and man. Occasional returns show that there about 10 human cases recorded each year and there are a few more cases occurring in the rural areas, which go unreported.

The main method of control employed in Malawi includes destruction of infected animals and vaccination. The main constraint to control is that of logistics rather than technical, as it has been virtually impossible to achieve at least 80% vaccination coverage in the high-risk dog populations as recommended due to inadequate vaccine and information on dog ecology.

In Malawi, the reality is that vaccination is not compulsory and the general public have in recent years, due to economic reforms, been asked to pay partly for the vaccine. I am challenging this gathering to seriously reconsider the cost sharing approach and make appropriate recommendations to government and donor agencies if we are to combat this zoonosis.

Distinguished guests, Ladies and Gentlemen, I have noted this year's theme, "Rabies – a pending crisis in the new millennium?" with a great curiosity. If you scientists allow whatever amount of this disease to spill over to the next millennium, posterity will judge us accordingly. I, therefore, think that the initiative to form this Group is not only commendable, but a giant step towards combating this most dreaded disease and assuring future generations that their ancestors were doing something about the disease.

Distinguished guests, Ladies and Gentlemen, I am reliably informed that adequate control of rabies lies in a scientifically acceptable vaccination coverage (at least 80%) of dogs and cats and control of their populations. I also note that the biggest challenges are in the areas of development of thermostable vaccines, enforcement of laws and regulations pertaining to rabies control and the introduction of cost recovery or cost sharing schemes in the control of the disease. I hope these areas will be fully tackled and practical and tangible recommendations drawn.

Distinguished guests, Ladies and Gentlemen, allow me to thank all those who have made this conference a success. Your close affiliation with SEARG/WHO will always be recommendable.

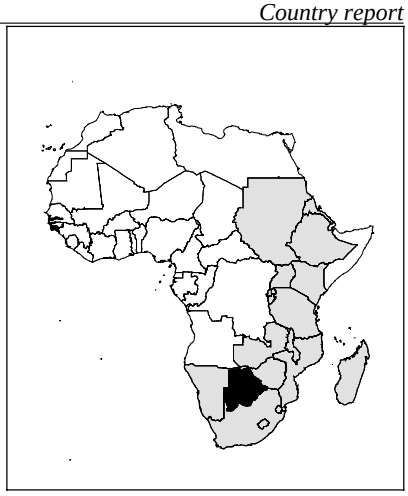
Last, but by no means least, let me thank both the local and international SEARG/WHO organizing committees for the tireless efforts in making it possible for the conference to take place. I also wish to thank all delegates for the time to prepare their contributions to this conference.

I wish you all very fruitful deliberations.

With these few remarks I declare this conference officially open.

Thank you for your attention.

Country reports



RABIES IN BOTSWANA

Joint report by
Botswana Ministries of Agriculture and Health

1 INTRODUCTION.

Rabies is a viral (rhabdovirus) acute infectious disease of all warm-blooded animals including man. It is invariably fatal and is usually transmitted by a bite from an infected animal. It occurs in most parts of the world with only a few countries free from the disease and these include Japan, Australia, New Zealand, UK, and Iceland etc.

Rabies manifests itself in most cases by a change in animal behaviour; the friendly dog may become irritable, the wild cat may become affectionate. Wild animals enter villages and even houses apparently without fear. In so-called "furious rabies" the animal is restless, runs wildly about, and may bite without warning and chew and swallow wood, stones and soil. In "dumb rabies" the animal becomes progressively paralysed but may bite if provoked. Inability to swallow causes drooling of saliva and the animals fear water (hydrophobia). Finally the animal may go into convulsions followed by coma and death.

Rabies is tentatively diagnosed from the field on the basis of history and clinical signs, and confirmed by the Fluorescent Antibody Test (FAT) and Mouse Inoculation Test (MIT) in the laboratory. Animals suspected to have died of rabies but are negative on FAT are further subjected to the MIT.

Where a suspect animal is unavailable for sampling (e.g. killed, burned and buried by farmers), but history is indicative of rabies, "Rabies Notification" is made and all procedures that normally apply to rabies positive animals are evoked.

2 RABIES IN ANIMALS.

2.1 Epidemiology of animals rabies in Botswana.

There are two interrelated cycles, urban and sylvatic, in which rabies is maintained. The urban cycle is predominantly dependent on domesticated and stray dogs and cats. The sylvatic cycle poses a different problem. Rabies outbreaks have been recorded for ages and seem to centre on certain vectors, usually one, two or more carnivorous species in each particular location. In Botswana the black-backed jackal and the mongoose act as the main reservoirs in the sylvatic cycle, domestic animals such as cattle, sheep, goats, dogs and cats due to their close proximity to man are the main risk for transmission of the disease to man.

In Botswana rabies is commonly confirmed in cattle, sheep and goats in 74% of total cases, domestic dogs and cats contribute 13%, wildlife represents 11% and other species 2%. The disease is endemic in the country and causes economic losses to farmers.

Of major concern are the human exposures to rabies. These are in the form of bites from dogs, cats and wildlife and also contact with livestock at cattle posts where people may handle and even eat

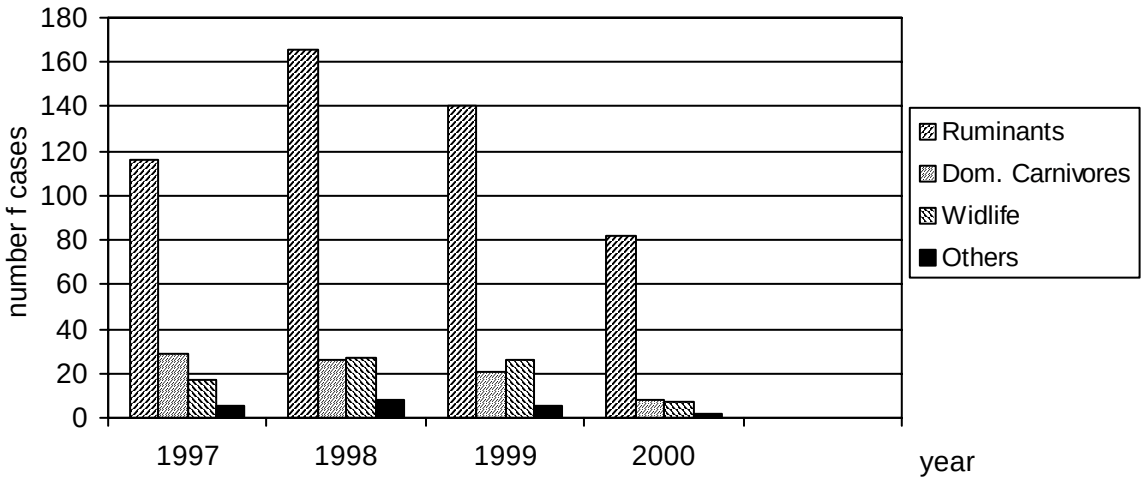
meat from atypically rabid animals. The Government spends P1.1 million (161700 US$) each year in controlling this disease.

2.2 Temporal distribution of rabies.

Table 1: Distribution of rabies cases by species (1997-2000).

Species	1997	1998	1999	2000	Total	Rel. freq. (%)
Bovine	63	115	55	49	282	41.17
Caprine	50	50	59	33	192	28.03
Ovine	3	1	26	0	30	4.38
Dog	28	24	18	8	78	11.39
Domestic cat	1	2	3	0	6	0.88
Horse	2	1	2	0	5	0.73
Donkey	3	7	3	2	15	2.19
Wildlife	17	27	26	7	77	11.24
Total	167	227	192	99	685	

Figure 1: Confirmed rabies cases by group of species (1997-2000).



2.3 Spatial distribution of rabies.

The disease occurs throughout the country, following the geographical distribution of hosts.

2.4 Rabies control in Botswana.

Due to the public health and economic importance of rabies, the government of Botswana has in place a rabies control program to prevent the spread of the disease between man and animals. The following activities are carried out for this purpose:

The government protects the public by carrying out:

- Vaccinations against rabies for all dogs and cats above the age of three months and every 12 months thereafter. This is compulsory and done at no cost to pet-owners.
- Diagnostic services of the disease in animals and man.
- Public education about the disease.
- Population control of the reservoir in the wild.

- Undertaking movement control of dogs and cats; permits are required for all the movements.
- Destroying all stray dogs and cats during "tie-up" order declared following each annual vaccination campaign.
- Destroying stray and unvaccinated dogs.

3 RABIES IN HUMANS.

Rabies is one of 15 diseases notified weekly in health service statistics in Botswana. Rabies figures fall into two categories;

- rabies exposures – reported when specific treatment with anti-rabies vaccine has been started following a bite or other relevant exposure from an animal suspected to have rabies or verified by the veterinary laboratory to have rabies. (It is important to note that patients will be treated as human exposures if the animal has no valid vaccination certificate or whose vaccination status is uncertain (in the case of domestic animals such as dogs), or any bites from a wild animal. The expectation is that such reports should be nullified if the animal is subsequently shown not to have rabies.
- cases - are reported as human rabies if the characteristic clinical symptoms and/or laboratory verification through the identification of intracytoplasmic virus or fluorescent antibody staining of tissue from the patient is carried out.

  For the notification of rabies deaths a post-mortem or ante-mortem laboratory diagnosis should be obtained.

Cases of human rabies are rare in Botswana. This may be attributed to the effective control of rabies in domestic animals by the veterinary services, and the wide availability in all health facilities of anti-rabies vaccine. Two cases were reported in 1999 however.

Table 2: Human rabies statistics.

1999	Exposures	1199
	Cases	2
	Deaths	2
2000	Exposures	1425
	Cases	0
	Deaths	0

Source: Health Statistics 1999, 2000. Annual Bulletins of notifiable Diseases. Central Statistics Office.

Guidelines for the clinical management and prevention of rabies are given in the Botswana Treatment Guide (National Standing Committee on Drugs, Ministry of Health, 1992). This guide is currently under revision and will be replaced by a new edition of the guide.

3.1 Prevention of human rabies.

This has two main components.

1. Veterinary control measures: - control of rabies in domestic dogs and epidemiological surveillance of the wildlife population.
2. Standard treatment of all bites in health facilities
   - Thorough cleansing and flushing of animal bites and scratches with soap and water, administration of tetanus toxoid and antibiotics if indicated. Health facility staff are instructed not to suture such bites.
   - Specific treatment using post-exposure prophylaxis using anti-rabies human diploid vaccine. This vaccine is available at all health posts, clinics and hospitals in Botswana.

The following summary guidelines are given:

Table 3: Post-exposure rabies prophylaxis.

Animal and its condition	Treatment in the case of	
	Bite	**Licking**
Healthy – vaccinated (with valid certificate)	None	None
Healthy – not vaccinated	Vaccine	None
Unknown or escaped	Vaccine	Vaccine
Rabid or suspected	Vaccine	Vaccine

Schedule for post-exposure prophylaxis:

Staff members are instructed to follow the instructions on the vaccine leaflet. The general schedule is as follows: 1 dose of vaccine on Days 0, 3, 7 and day 14. If animals are certified as healthy after 10 days, no further vaccination is necessary. When this information is not available patients go on to receive further doses on days 30 and 90.

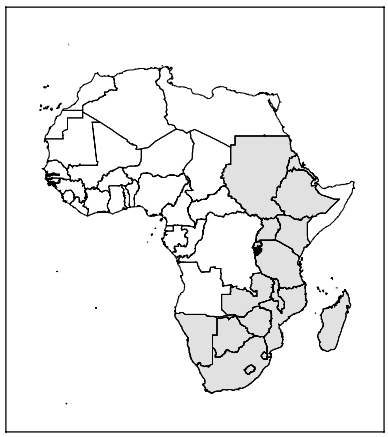
Staff are also required to do the following:

- Report any animal bite to the veterinary officer
- Provide proof that the animal has a valid vaccination certificate
- If the animal has no valid vaccination certificate, a request for detention and observation of the animal is submitted to the veterinary officer.

Suspect animals, which die or are killed, should have their brains undergo veterinary laboratory examination for rabies.

4 CONCLUSION.

Rabies is a fatal zoonotic disease and as such it needs to be tackled on both the animal and human health fronts. The current trend in Botswana, where the disease occurrence in livestock is very high is worrisome and calls for more applied research to understand its epidemiology: given the relatively low and declining prevalence in domestic carnivores (urban reservoirs), is it being spread to livestock by wildlife reservoirs or not? If it is, what intervention measures can be deployed, oral vaccines for wildlife?



RABIES IN BURUNDI IN 1999 AND 2000

S. Masabo[1] and D. Siniremera[2]

INTRODUCTION.

Rabies cannot be considered as a calamity in our country. It is a zoonosis that has been fought vigorously from the colonial era until today. It is usually transmitted by dogs, jackals and monkeys.

According to recorded statistics for the past two years, 90 positive cases were diagnosed by the National Veterinarian Laboratory of Bujumbura from the Burundian territory. An anti-rabies vaccination campaign is organised annually throughout the country, especially in the capital city Bujumbura and its outskirts where a big concentration of dogs is found.

1 VACCINATION OF PETS.

1.1 Vaccinated pets in Bujumbura.

In 1999, approximately 1057 dogs, 35 cats and 10 monkeys were vaccinated. In 2000, the number of vaccinated dogs was lower, i.e. 1007 dogs, whereas 30 cats and 12 monkeys were vaccinated.

1.2 Vaccinated pets upcountry.

In 1999, 772 dogs were vaccinated and 753 dogs in 2000 were vaccinated.

Note: The numbers of monkeys and cats which were vaccinated outside the Bujumbura City Center is insignificant (unknown).

Therefore, 2962 anti-rabies vaccines were imported and sold in Burundi in 1999, and 2052 vaccines in the year 2000.

The imported vaccines are Rabdomum, Dohyvac, Rabisin and Rabivac.

2 CONCLUSION AND STRATEGY.

Every pet suffering from rabies is immediately killed.

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[1] Ministry of Agriculture and Livestock – Bujumbura - BURUNDI

[2] Public Health Ministry – Bujumbura - BURUNDI

Domestic animals, except dogs and cats, which are suspected of having or being infected with rabies, are put under quarantine. Suspected or infected animals are those that have been bitten or licked by rabies-infected animals.

Dogs and cats which are either bitten or rolled by a rabid animal or which have been in contact with it must be immediately killed except dogs and cats which have been preventively vaccinated for more than 30 days and less than a year. They are also put under quarantine for a period of at least 15 days. If quarantine is not possible or the pet fled, administration authorities decide that the animal be killed on the spot.

Herbivores and pigs, which are part of a herd in which one or more animals have been bitten, are put under observation for 15 days. During this observation period, the pets' owner is not entitled to kill the animals.

Anti-rabies vaccination is compulsory for dogs and cats.

As soon as a single case of rabies is recorded in an administrative area, officials are entitled to compel the isolation of all dogs and cats in a determined area for at least 2 months under the advice of the veterinarian.

On highways, in public places or places open to the public, in fields, in the bush or forests, dogs must be attached or kept on leashes.

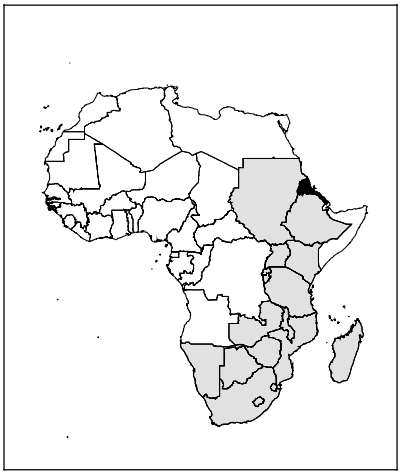
Stray dogs and cats are killed without delay, and no indemnity is given for the death of such animals. If dogs or cats bite people and if rabies is likely, those animals are kept under observation by veterinary services until the diagnosis is made. It is forbidden to unleash the animals, and people who are either bitten or licked by rabid or suspected animals must seek medical advice without delay.

If the observation of the animal is not possible or a positive diagnosis is made, the bitten person is given 7 anti-rabies vaccine doses according to protocol D1-D2-D3-D7-D15-D30-D60, with local treatment of injuries in case of bites.

Thirty-one cases of human rabies have been reported in 1999 and 11 cases in 2000. These data are an underestimate as no diagnosis is done for cases occurring in villages.

ACKNOWLEDGEMENT

We would like to thank the Burundi government for allowing us to participate, the Malawi government for hosting the meeting and the organising committee for making the meeting a success.



RABIES IN ERITREA

T. Tekleghiorghis[1], T. Yosief[1]

1 INTRODUCTION.

Eritrea is strategically located in the north-eastern part of the African continent. It is bound to the east by the Red Sea with about 1000 km of coastline, by the Sudan to the west and north, by Ethiopia to the south, and by Djibouti to its south-eastern extreme. It has an area of about 124500 km^2 and a population estimated between 3 to 3.5 million, which is growing at about 2.9% per annum.

The country is administratively divided into six regions. Population density is high in the central highlands but low in the lowlands.

The Veterinary Services Division carries out all animal health activities in the country.

2 ANIMAL RABIES.

Rabies is among the most important zoonotic diseases (brucellosis, tuberculosis, anthrax, echinococcosis, etc.,) in the country. It is endemic in the urban areas where it is maintained in a dog-to-dog cycle, hence is of the urban type. To some extent, there could be a limited role of wild carnivores in maintaining rabies virus infection but this has not been studied.

2.1 Methods of diagnosis.

Fluorescent antibody test (FAT) has been used as a routine test in the Central Veterinary Laboratory (CVL) since 1996, using the Centocor FITC conjugate. The Mouse Inoculation Test has also been used for negative results. Standard operating procedures are essentially similar to those described by D. J. Dean *et al.* and H. Koprowski, (1996) Laboratory Techniques in Rabies, WHO, Geneva.

Table 1: FAT confirmed rabies cases in domestic species of animals in Eritrea 1996-2000.

Year	Brain samples tested	Brain samples positive	Percent positive
1996	44	34	77.3
1997	31	13	41.9
1998	18	6	33.3
1999	17	10	58.8
2000	5	1	20.0
Total	115	64	55.6

[1] Veterinary Services Division, P.O.BOX 1162, Asmara- ERITREA

Figure 1: Rabies samples tested by FAT.

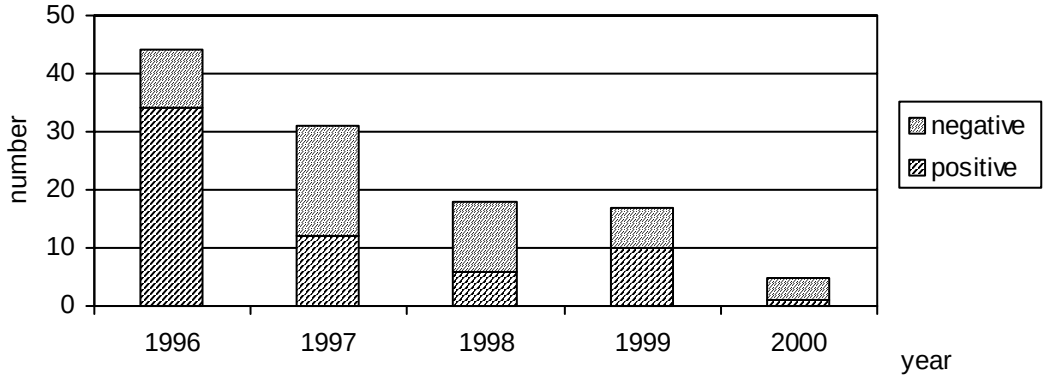


Table 2: Frequency of infection with rabies virus in domestic species of animals in Eritrea 1996-2000.

Species	Total No. of cases	No. of positive cases	Frequency of infection (%)
Dogs	86	48	55.8
Cats	2	1	
Cattle	23	10	43.5
Donkeys	3	3	
Goats	1	1	
Total	115	63	54.8

2.2 Rabies control strategies.

In Eritrea the following control strategies are practised:

- Elimination of stray dogs.
- Immunisation of dogs, cats and other domestic animals at risk.
- Laboratory diagnosis to confirm clinical cases
- Public awareness to cooperate in the control programmes.

Table 3: Vaccinated and destroyed dogs, 1997-2000.

Year	Vaccinated dogs	Destroyed dogs
1997	17077	-
1998	3109	1797
1999	4717	2266
2000	8012	2076
Total	32915	6139

The type of vaccine used in animals was Rabisin.

The pattern of dog-mediated rabies cases has been reduced when observed from 1996 to 2000. This clearly shows that the pre-exposure vaccination and dog elimination programme was effective.

3 HUMAN RABIES.

Liaison between the medics and veterinarians concerning rabies disease is very loose and the situation of human rabies is not clearly known. There are human rabies cases in most of the regions of the

country, but not properly reported. The number of bitten persons was recorded for those animal rabies specimens brought to the Central Veterinary Laboratory only.

Table 4: Number of persons bitten by rabid dogs, 1996-2000.

Year	Bitten persons
1996	45
1997	35
1998	6
1999	14
2000	1
Total	101

Source: Central Veterinary Laboratory

Table 5: Human rabies cases in Eritrea, 1998-2000.

Year	Age Group	Cases	
		OPD	IPD
1998	≥ 5	16	9
	< 5	1	1
1999	≥ 5	14	1
	< 5	1	0
2000	≥ 5	16	4
Total		48	15

Source: Ministry of Health

The human diploid cell culture vaccine (IMOVAX, Pasteur Mérieux) is used as a pre-exposure vaccination and post-exposure treatment for humans.

4 FUNDING.

No earmarked budget has been allocated for rabies control. All vaccine, diagnostic reagents and other costs are covered by the Government budget on a cost recovery base.

ACKNOWLEDGEMENT.

To the Director, Veterinary Services of Eritrea and SEARG for organizing this meeting.

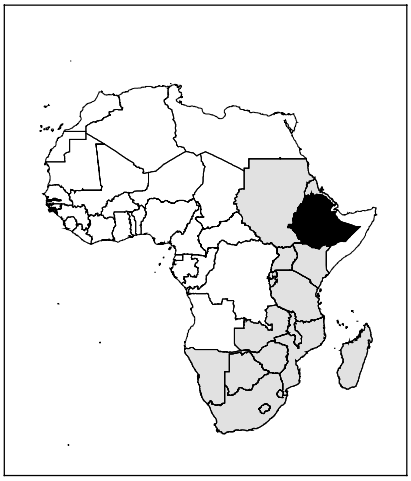
REFERENCES.

MESLIN F.X., KAPLAN M. M., KOPROWSKI H. – 1996 - Laboratory Techniques in Rabies, 4th edition, W.H.O., Geneva

Proceedings of the Southern And Eastern African Rabies Group / World Health Organization Meeting, 1999

Annual Reports of Veterinary Services Division, 1996-2000

RABIES IN ETHIOPIA



Eshetu Yimer Ahmed[1]

1 INTRODUCTION.

Rabies in Ethiopia had been recognized as an important disease for many centuries. The treatments recommended for people bitten by rabid animals have been described in many Ethiopian medical books since the early 17th century. The occurrence of rabies outbreaks in dogs in Addis Ababa was reported as early as 1903.

In Ethiopia rabies is primarily a disease of dogs although other domestic animals like cats, cattle and sheep are also involved. Natural infection occurs in almost all domestic animals, however, dogs are the main sources for human infection. During the last 5 years (1996-2000), 91.6% of the fatal human rabies cases were attributed to dog bites. This report describes the prevalence of rabies in Ethiopia during these years.

2 ANIMAL RABIES.

Although rabies is mainly a disease of carnivores, especially both domestic and wild canine species, almost all mammals including man are also susceptible to the disease. The total number and the different species of animals observed and examined for rabies is given in Tables 1 and 2.

During the years (1996-2000) a total of 7749 animals were observed and examined for rabies and 1228 (15.85%) of them found to be positive. Dogs accounted for 95.47% of the total animals examined of which 14.68% were found to be positive for rabies, accounting to 88.44% of the total positive animal rabies cases. This indicated that dogs are the principal vectors of rabies and major source of infection for humans, followed by cats that represent 2.85% of the rabies positive animals.

2.1 Rabies in dogs.

Rabies in dogs is well established in Ethiopia. From a total of 1437 brain samples of dogs examined during the period 1996-2000, 1086 (75.57%) were positive for rabies (Table 3). Dogs accounted for 95.5% of the total animal species examined and represented 88.44% of the total laboratory confirmed positive rabies cases. In fact the actual number of positive rabies cases is expected to be higher when compared for example to the large number of stray dogs roaming around in the streets of Addis Ababa. Moreover, dogs contributed to 91.6% of the fatal human rabies cases and 91.6% of the human rabies post exposure cases that necessitated post exposure anti rabies treatments.

[1] Ethiopian Health and Nutrition Research Institute - P.O.Box 1242/5654 - Addis Ababa - ETHIOPIA

Table 1: Different species of animals examined from 1996 to 2000.

Animal species	No of animals examined	Number positive	Percent positive	Percentage of total examined
Dog	7398	1086	14.68	95.47
Cat	221	71	32.13	2.85
Cattle	52	39	75.00	0.70
Sheep	11	7	63.6	0.10
Goat	5	3	60	0.10
Donkey	7	6	85.7	0.10
Horse	1	-	-	0.01
Hyena	8	7	87.5	0.10
Monkey	29	2	6.9	0.40
Fox	5	2	40	0.10
Mongoose	2	1	50	0.02
Rabbit	1	-	-	0.01
Cerval cat	1	1	100	0.01
Cheetah	1	1	100	0.01
Civet cat	1	-	-	0.01
Rat	2	-	-	0.02
Human	4	2	50	0.01
TOTAL	7749	1228	15.85	100.0

Table 2: Animals examined for rabies in five years.

Year	Total number of animals tested	Number positive	Percent positive
1995/1996	1597	168	10.52
1996/1997	1610	237	11.72
1997/1998	2061	379	18.39
1998/1999	1310	267	20.38
1999/2000	1171	177	15.12
TOTAL	7749	1228	15.85

Table 3: Percent distribution of dogs positive for rabies and positive brain samples.

Year	No of dogs examined	% positive	Total brain examined	No.(%) positive brain
1995/1996	1546	9.7	240	150(62.5)
1996/1997	1549	13.6	290	210(72.41)
1997/1998	1922	17.01	394	327(82.99)
1998/1999	1254	19.14	304	240(78.95)
1999/2000	1127	14.11	209	159(76.08)

2.2 Cats.

Cats are the second most important sources of rabies for humans next to dogs in Ethiopia. Cats accounted for 2.85% (Table 1) of the total animal species examined and contributed to 2.73% of humans that took anti rabies post-exposure treatments.

2.3 Other domestic animals.

The occurrence of rabies in the various animal species in Ethiopia is summarized in Table 2. Cattle represent the highest rabies cases (3.18%) followed by sheep, goats and donkeys.

2.4 Wild animals.

Hyena, jackals, mongooses and the cerval cat were included among the wild animal species examined during the period.

3 HUMAN RABIES.

During the period 1996-2000 a total of 153 fatal human rabies cases were recorded and 79.74% (Table 5) these cases came from Addis Ababa and its surroundings. Diagnosis of human rabies was based on history of animal bites and clinical signs and symptoms.

Man contracts rabies as a result of the bites of rabid animal spcies (domestic or wild). Hence, due to the uncontrolled rabies in domestic animals especially in the canine population in Ethiopia, the risk of rabies infection to humans is quite high. To that effect post-exposure anti rabies treatment was given to 9593 people (Table 4).

Table 4: Post exposure anti rabies treatment and fatal human rabies cases.

Year	Post-exposure treatment	Human rabies cases
1995/1996	1752	23
1996/1997	2429	47
1997/1998	2620	33
1998/1999	1252	17
1999/2000	1540	33
Total	9593	153

Table 5: Fatal human rabies cases in Addis Ababa and other regions

Year	Addis Ababa and its surroundings	Others	Total
1995/1996	23 (100.0%)	- -	23
1996/1997	30 (63.8%)	17 (36.2%)	47
1997/1998	29 (87.9%)	4 (12.1%)	33
1998/1999	12 (70.6%)	5 (29.4%)	17
1999/2000	28 (84.8%)	5 (15.2%)	33
Total	122 (79.74%)	31 (20.26%)	153

Table 6: Age distribution of fatal human rabies cases

Year	Age group				Total
	1-14	15-49	50+	Unknown	
1995/1996	8	11	4	-	23
1996/1997	23	22	2	-	47
1997/1998	13	9	8	3	33
1998/1999	5	7	5	-	17
1999/2000	15	11	7	-	33
Total	64	60	26	-	153
Percentage	41.83	39.22	16.99	1.96	

Children aged 1 – 14 years were affected by rabies at a slightly higher rate than the adults aged 15 – 49 (Table 6).

The above figures, although an underestimate of the actual situation for the whole country, gives an idea of the gravity of the problem. Report of the Ministry of Health, Epidemiology Division in 1977 suggested that the total number of rabies cases in humans in Ethiopia might reach more than 1000 each year. On the other hand Fekadu (1997) estimated that approximately 10000 people die of rabies annually in Ethiopia.

4 VACCINE PRODUCTION.

The Ethiopian Health and Nutrition Research Institute (EHNRI) is the only institution in the country that is engaged in the diagnosis of rabies. The method of rabies diagnosis being employed currently at the institute is the Fluorescent Antibody Test (FAT), advises people bitten by rabid or suspected rabid animals on post exposure anti rabies treatments and produces the Fermi Type nervous tissue vaccine destined for use both in humans and animals.

The vaccine prepared for animals is a 20% suspension of phenolized adult sheep brain infected with fixed rabies virus while the human anti-rabies vaccine is a 5% suspension. During the last 5 years a total of 40774.11 doses of human anti rabies vaccine and 95160 doses of animal vaccine were produced (Table 7).

The distribution of anti rabies vaccine both for animals and humans use by regions is given in Table 8 and 9. The data on the distribution of vaccine indicated that rabies is present in every corner of the country.

Table 7: Human and animal anti-rabies vaccine production.

Year	Human vaccine doses	Animal vaccine doses
1995/1996	8931.76	16920
1996/1997	8814.12	18620
1997/1998	5962.35	18000
1998/1999	7490.59	21800
1999/2000	9575.29	19820
Total	40774.11	95160

Table 8: Human anti-rabies vaccine distribution by region (doses).

	Tigray	Amhara	Oromia	Somali	Harari	Bensha Ngul	SNNP	Dira Dawa	Addis Ababa
1995/1996	341.18	122.35	1802.35	125.88	-	23.53	696.47	64.71	1017.64
1996/1997	270.59	47.06	1171.76	143.53	12.94	5.88	647.06	100.0	1458.82
1997/1998	364.71	64.71	2102.35	91.76	-	11.76	552.94	117.65	830.59
1998/1999	305.88	129.41	1988.24	52.94	-	23.53	614.12	295.29	411.76
1999/2000	494.12	100.00	2205.88	92.94	-	-	687.06	195.29	270.59

Table 9: Animal anti-rabies vaccine distribution by region (doses).

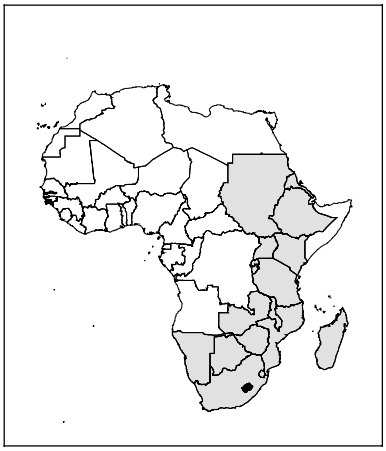
	Tigray	Amhara	Oromia	SNNP	Dira Dawa	Harari	Addis Ababa
1995/1996	940	340	1260	180	200	-	13700
1996/1997	2100	40	2280	680	1300	-	12080
1997/1998	1000	60	2400	60	1800	-	12400
1998/1999	2000	-	3780	460	600	-	14300
1999/2000	2000	1000	3100	560	600	500	11860

5 CONTROL.

Rabies is a disease that posed major public health hazard in Ethiopia. Canine rabies has been successfully controlled in many European countries as evidenced by the rarity of human rabies cases. However there is no coordinated activity to control rabies in the country. There is fragmented activity, which is not sufficient to control the disease. These included vaccinations of dogs especially in cities and towns although not organized regularly, destruction of stray dogs and utilization of post exposure anti-rabies treatments.

RABIES IN LESOTHO BETWEEN 1999- 2000

The Department of Livestock Services,
Veterinary Services Division



1 GEOGRAPHICAL LOCATION.

Lesotho is situated in the Southern African region. It has an area of 30000 km^2, divided into 10 districts. One third is arable land and the rest of the country is mountainous, with the highest peak of 3600 meters above sea level. This mountainous area is used for livestock production. The climate is subtropical. The country is surrounded entirely by the Republic of South Africa.

2 INTRODUCTION.

Rabies in Lesotho was first introduced through illegal importation of dogs in 1981.

After that, the country had sporadic cases of rabies in animals, which were confirmed initially by Ondersterpoort Laboratory in Pretoria, but later by the laboratory in Maseru. The high incidence of rabies was becoming a threat to the nation after the loss of 18 human lives in 1984. Vaccination of domestic pets was until then voluntary and an arrangement between the pet owner and their vet. The government of Lesotho through the Department of Livestock Services had to take drastic steps of controlling the disease by vaccinating potential carrier animals, which were 100000 dogs and 20000 cats. The response was good with free vaccine for the pets, from the year 1985 to 1994 when the owners began to complain of mortality after immunization.

3 HUMAN RABIES.

Recently, the number of humans reported to have been bitten by dogs has risen, and the Veterinarians monitor all the dogs suspected to be rabid for two weeks unless the animal dies during this period. During this period the patient is referred to a health clinic or hospital where they are given post exposure anti-rabies treatment. Depending of the severity of the case, in some instances the animal is shot and specimen sent to the laboratory for confirmation. This was done at the central laboratory in Maseru until 1998 when political unrest resulted in vandalization of the laboratory. To date all specimens are sent to Onderstepoort Veterinary Institute in Pretoria.

The figure for human rabies cases is shown on Table 1.

Table 1: Human rabies cases by year.

Year	Morbidity	Mortality
1996	1	-
1997	29	-
1998	43	-
1999	14	-
2000	10	1
Total	97	1

There are still no laboratory confirmatory facilities for human cases in Lesotho; the only method is by clinical diagnosis of the patient and a history of contact with a dog that was suspected to be rabid. Coordination between the Ministry of Health and Veterinary Services is by reporting up to date statistics.

4 ANIMAL RABIES CONTROL.

The current strategy is mainly a control measure, which is done by organizing campaigns to immunize cats and dogs. The Animal Health Division conducts these campaigns at district level in the form of mobile clinics. These clinics were adopted because they suit the programs of the Veterinarians in their areas, except that they are expensive because the organizer has to maintain a cold chain to protect the vaccine, as at times the programs are conducted during warm seasons. Previously, the rabies campaigns were conducted during cold winter months as temperatures drop to 0°C or even below. The response of the pet owners used to be very impressive during early eighties, probably because of the number of rabies cases that occurred in both dogs and humans.

We are presently looking for funding to host a National Seminar for Technical and Professional personnel between the two Ministries, (Health and Agriculture) where we can set standards and formulate a policy together towards combating rabies in man and animals. Table 2 indicates the number of rabies positive cases, as well as the vaccination figures for dogs and cats:

Table 2: Rabies vaccination figures for dogs and cats.

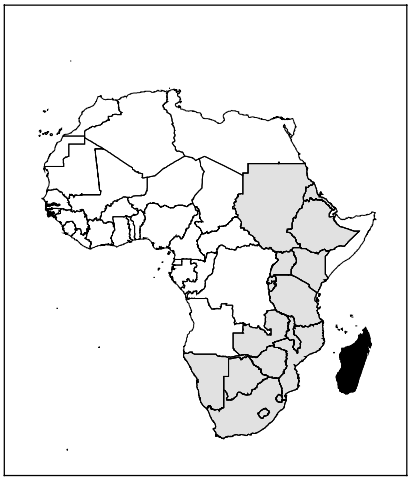
Year	Number vaccinated	Number of positive	
		Dogs	Cattle
1996	66113	-	-
1997	71304	-	-
1998	67560	2	-
1999	54754	1	1
2000	31486	2	-

There is no research on rabies except that we are beginning to monitor its incidence in districts where we feel vaccination coverage is low. In Lesotho we do not use population reduction except that we have embarked on restricting methods of importation of dogs and cats and as a result our pet population has decreased. The type of vaccine that is used to control rabies in animals is the inactivated cell culture vaccine.

ACKNOWLEDGEMENT.

Lesotho welcomes the 2001 invitation to the Southern and Eastern African Rabies Group (SEARG) in collaboration with W.H.O.

RABIES IN MADAGASCAR: 1999 - 2001



R. Razafinandrasana and C. Maharavo [1]

In absentia

1 DOG RABIES SURVEILLANCE.

Table 1: Observation of biting dogs.

Year	Number of cases
1999	1705
2000	1240
2001	1426

Table 2: Immunisation of dogs.

Year	Vaccinated dogs
1999	2371
2000	9732
2001	8750

2 LABORATORY DIAGNOSIS OF RABIES.

Table 3: Rabies cases in 1999.

Province	cattle Pos/ tested	dog Pos/ tested	goat Pos/ tested	cat Pos/ tested	man Pos/ tested	lemurid Pos/ tested	rat Pos/ tested	TOTAL
Antananarivo	7/8	25/45	0/1	3/6	1/1	0/4	0/1	36/66
Antsiranana	0	3/3	0	0	0	0	0	3/3
Fianarantsoa	0	1/3	0	0	1/1	0	0	2/4
Mahajanga	1/1	1/1	0	0	0	0	0	2/2
Toamasina	0	0	0	0	0	0/1	0	0/1
Toliara	0	1/1	0	0	0	0	0	1/1
TOTAL	8/9	31/53	0/1	3/6	2/2	0/5	0/1	43/77

[1] Ministère de l'Agriculture, de l'Elevage et de la Pêche – Direction générale de l'élevage – Antananarivo - MADAGASCAR

Table 4: Rabies cases in 2000.

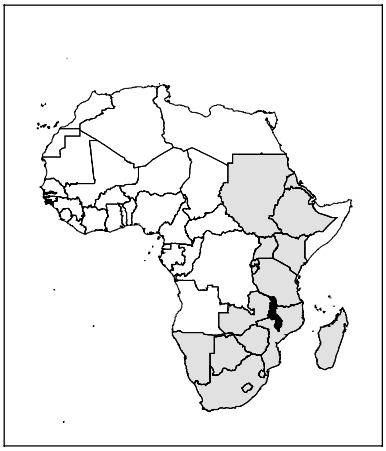
Province	cattle Pos/ tested	dog Pos/ tested	cat Pos/ tested	man Pos/ tested	lemurid Pos/ tested	TOTAL
Antananarivo	0/1	33/42	3/11	1/3	0/1	37/58
Mahajanga	0	3/4	0	0	0	3/4
TOTAL	0/1	37/47	3/12	1/3	0/1	41/64

A dog from Antananarivo could not be analysed.

Table 5: Rabies cases in 2001.

Province	cattle Pos/ tested	dog Pos/ tested	cat Pos/ tested	lemurid Pos/ tested	TOTAL
Antananarivo	1/3	76/94	3/8	0/6	80/111
Antsiranana	1/1	0	0	0	1/1
Mahajanga	1/1	0	0	0	1/1
Toliara	0	1/2	0	0	1/2
TOTAL	3/5	77/96	3/8	0/6	83/115

Three dogs from Antananarivo could not be analysed.



RABIES IN MALAWI

B. A. R. Chimera [1] and P. B. Chikungwa[2]

1 INTRODUCTION.

Malawi is a small country in the Southern African Development Coordination Region (SADC) with a human population now estimated at 11 million and a dog population of 2.5 million, although figures from the field are much lower. For the purpose of implementation of agricultural programmes the country is divided into eight Agricultural Development Divisions (ADDs), but in terms of veterinary diagnostic services the country still uses a regional system. There is one central laboratory, and two regional laboratories, one in the north and the other in the south. These handle rabies cases, when confirmation is required.

Rabies is still considered endemic in Malawi with most confirmed cases coming from urban and peri-urban areas.

2 DOG POPULATION.

The dog population across the country has remained stable (Table 1) over the last five years, despite the general feeling that the figures are on the increase.

Table 1: Dog population according to ADD: 1996 to 2000.

	Agricultural development divisions								
	Karonga	**Mzuzu**	**Kasungu**	**Salima**	**Liliongwe**	**Machinga**	**Blantyre**	**Shire valley**	
1996	14435	11000	20871	4498	53798	6763	28095	-	-
1997	15815	10194	55272	4363	58175	6139	32259	-	-
1998	16797	7976	4932	5820	74903	5305	23011	12621	151365
1999	15000	7762	30580	6012	61084	4106	28349	15164	168057
2000	9975	8000	55762	28370	72426	3100	32750	16975	227358

From the available data most dogs are located in Lilongwe, Kasungu and Blantyre ADDs and the lowest in Machinga. This may be because of the large Moslem population in the area (Figure 2).

[1] Central Veterinary Laboratory, P. O. Box 527 Lilongwe - MALAWI

[2] Karonga Agricultural Development Division, P/B 04 Karonga - MALAWI

Figure 1: Dog population trend per ADD.

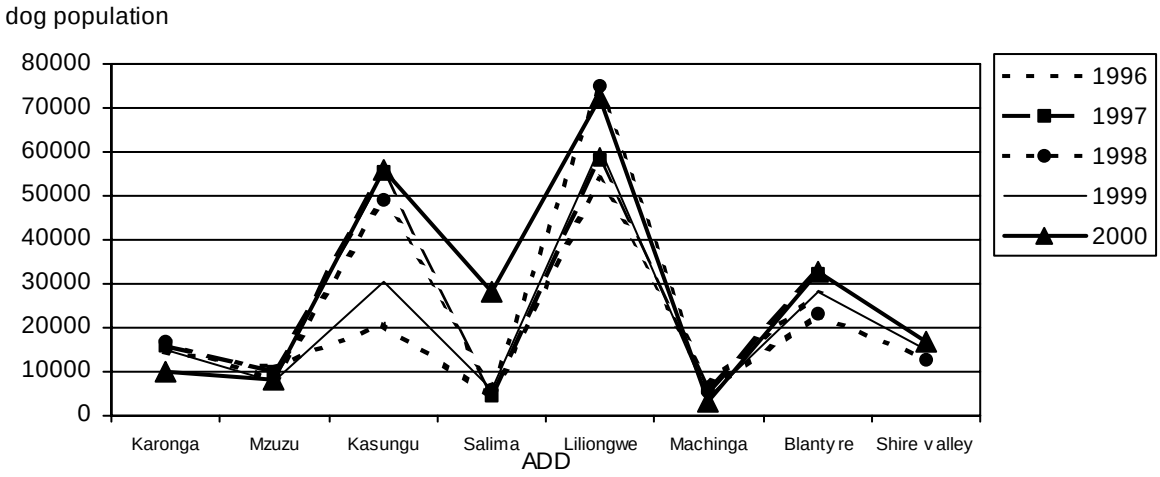
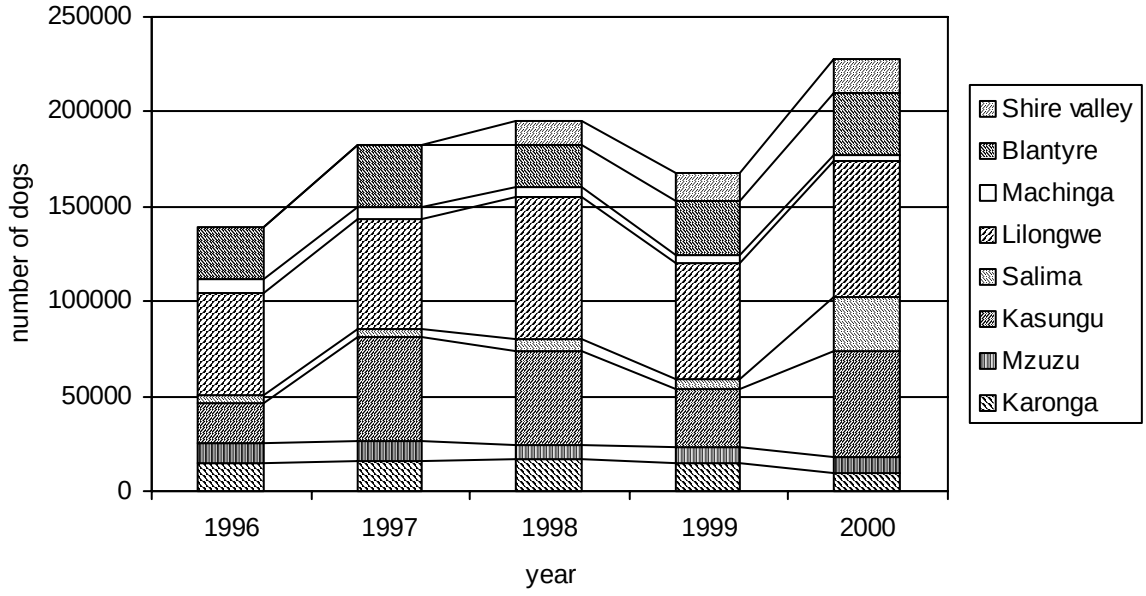


Figure 2: Total number of dogs per year per ADD.



It should be mentioned that the exact dog population is not known. Available reports indicate figures ranging from 225000 to 2500000. Hence there is need for proper study if the disease is to be controlled.

3 RABIES INCIDENCE.

Rabies in Malawi continues to occur throughout the country as indicated in monthly disease reports form ADDs and as recorded by veterinary laboratories. The disease, according to our records, occurs throughout the year, there being no seasonality.

In terms of spatial distribution most cases are reported around the cities of Blantyre and Lilongwe. This can be attributed to the obvious high dog population densities and to the availability of diagnostic facilities: two of the three major Veterinary Diagnostic laboratories are located in Lilongwe and Blantyre.

Table 2: Confirmed rabies cases at veterinary laboratories (Blantyre, Mzuzu and Central Veterinary Laboratories).

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	TOTAL
Dog	166	150	136	169	159	169	98	96	95	64	1302
Cat	3	3	0	3	3	2	3	2	3	2	24
Hyena	1	5	1	0	0	0	0		1	0	8
Jackal	5	1	2	1	2	3	0	0	0	1	15
Cattle	24	10	11	17	9	7	10	3	5	1	97
Sheep	0	0	1	0	1	0	4	0	0		6
Goat	1	3	2	7	1	1	1	4	4	2	26
Pig	0	2	1	0	1	0	0	0	0	0	4
Fungwe	0	0	2	0	0	0	0	0		0	2
Rabbit	0	0	0	0	1	0	0	0	0	0	1
Rat	0	0	0	0	0	0	1	0	0	0	1
Monkey	0	0	0	1	0	0	0	0	0	1	2
Total	200	174	156	198	177	182	117	105	108	71	1488

It is expected that the situation is the same in the rural areas as indicated by the number of dog bite reports from the field. Dog bite figures in Mzuzu ADD have remained high as shown in Table 3.

Table 3: Case study, Mzuzu ADD - 1996 - 2000

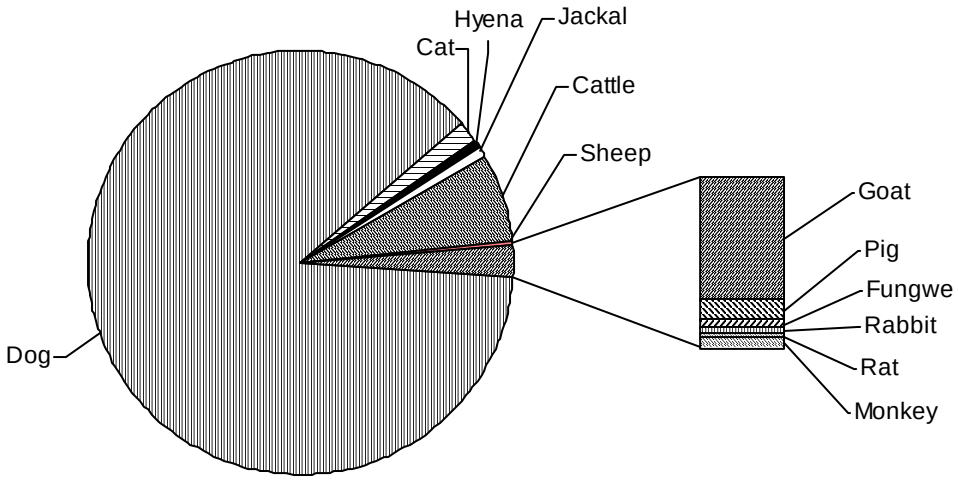
	Dog bites reported	People treated with ARV	Dogs vaccinated
1996	89	107	2220
1997	100	160	1893
1998	253	148	1527
1999	255	123	1216
2000	323	199	967

4 SPECIES INCIDENCE.

Over the past ten years dog rabies has remained a major problem in Malawi with 1302 confirmed cases, followed by cattle with 97 confirmed cases, and then goats and cats.

It is interesting to note that in 1997 a case was confirmed in a rat. Jackals do not seem to play a major role in rabies epidemiology in Malawi. (Table 2 and Figure 3).

Figure 3: Species distribution of rabies cases from 1996 to 2000.



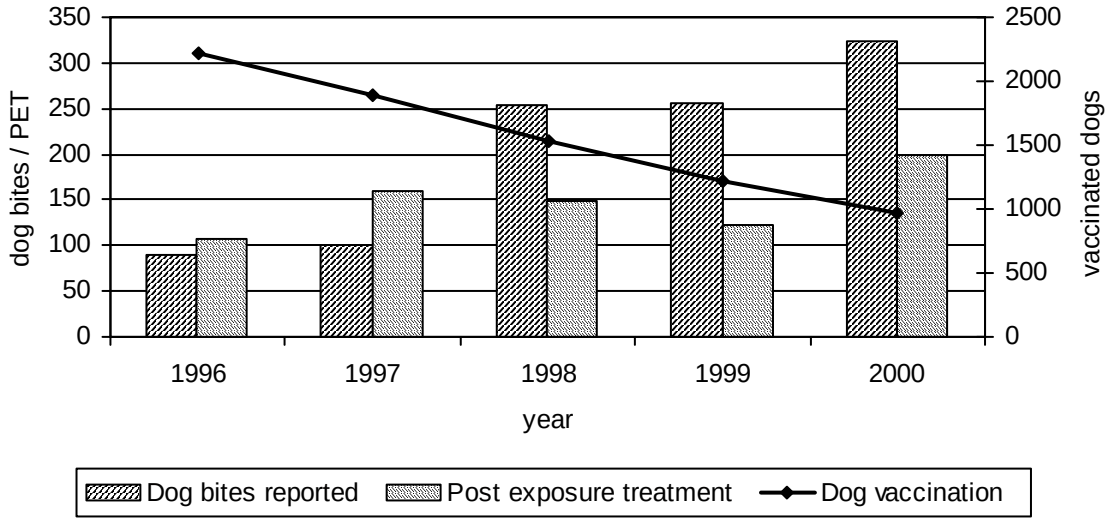
5 CONTROL OF RABIES.

As indicated earlier, laboratory rabies diagnosis is only done at three major laboratories while at ADD level it is mainly based on history and clinical picture.

Unlike in the past when there were specific projects (C.E.S.T.A.S.) and Regional Teams, control now is left to voluntary presentation of animals for vaccination. It is currently semi privatised and dogs are vaccinated at a fee.

Data from Mzuzu ADD indicate that the number of dogs vaccinated is decreasing whereas the number of dog bites is increasing (Figure 4).

Figure 4: Dog bite, PET and dog vaccination in Mzuzu ADD from 1996 to 2000.



6 CONCLUSIONS.

Dog bite cases in Malawi are considered to be indicators of the rabies situation in animals. Figure 4 shows that the number of dog bite cases is still high whereas vaccinations are almost non-existent. This scenario coupled with poor reporting, too few sample submissions, too few diagnostic facilities and absence of reliable data on dog population dynamics indicates that Malawi is heading for a rabies crisis. Therefore there is need for the country to restrategise its approach to rabies control.

REFERENCES.

EDELSTERN, R. M. – 1992 - The epidemiology and control of rabies in Malawi

CVL Annual Reports for 1991- 1995

CVL V4/Rabies Annual Reports for 1996 and1997

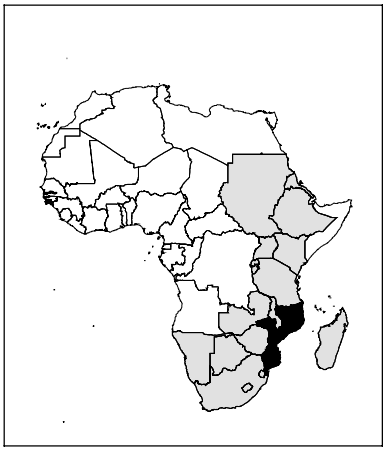
CVL V4/Rabies Quarterly Reports for 1998

CVL Rabies Reports 2000

ADD Field Reports 2000

RABIES IN MOZAMBIQUE

M. E. Pinto[1]



1 INTRODUCTION.

In Mozambique rabies occurs throughout the country affecting both human beings and animals. The disease has mainly been diagnosed in domestic animals, namely dogs, cats and cattle.

Dogs are the animals most affected and also the main species responsible for the transmission of the disease to humans.

The incidence of human as well as animal rabies differs among provinces, the Zambézia and Nampula provinces being the most affected.

In the past 4 years, the yearly rabies vaccination covered only an average of 44000 dogs (6.3%) of the estimated dog population (700000) in the country (Arnaldo Villa Nova, 1989).

2 HUMAN RABIES.

According to the Health Authorities, the number of human deaths caused by rabies is high and does not show any significant signs of decreasing during the past 3 years (Table 1).

It is also recognised that, probably some human rabies victims in remote areas are not reported to the Health Authorities because of the lack of hospitals and poor communication facilities. Thus, the number of human rabies cases may be higher than that reported.

If someone is bitten by a dog, the hospital approaches the veterinary services in order to keep the dog under observation for a period of 10 days.

Depending on the result of that observation the victim may be submitted to vaccination.

Unfortunately, because of lack of funds, the Ministry of Health (MISAU) does not provide sufficient quantity of human rabies vaccine to all hospitals especially in the remote areas.

Rehabilitation of kennels for observation of suspected animals is required to improve the capacity to better assist bitten persons and also reduce the amount of human vaccine used.

[1] National Directorate of Livestock - Animal Health Department - P.O. Box 1406 - Maputo - MOZAMBIQUE

Table 1: Distribution of human rabies in the various provinces, 1997-1999

Province	1997	1998	1999	Total
Maputo	0	0	0	0
Gaza	6	0	4	10
Inhanbane	5	2	4	11
Sofala	5	1	2	8
Manica	1	0	0	1
Tete	0	0	0	0
Zambézia	2	11	7	20
Nampula	5	8	5	18
C.Delgado	4	3	0	7
Niassa	0	0	0	0
Totals	28	25	22	75

(Gabinete de Epidemiologia – MISAU)

3 METHODS OF DIAGNOSISC AND REPORTING.

Rabies diagnosis in animals as well as in human beings is carried out at the National Veterinary Research Institute (INIVE), which is the Central Veterinary Laboratory located in Maputo, using any of three tests: FAT test, the Mouse Inoculation Test, and Seller's staining.

Other three small laboratories in different provinces have facilities to perform Seller's staining test only.

Most of the reports of human cases are based on clinical signs and history of the person bitten.

Epdemiological units in both the Ministry of Health (MISAU) and the Ministry of Agriculture and Rural Development are responsible for data gathering and issuing a periodical bulletin.

Confirmed rabies cases do not reflect the real picture in Mozambique, since most go unreported either due to the poor veterinary infrastructure or because dog owners use traditional methods for treatment and do not approach veterinary authorities.

The role of wildlife in the epidemiology of rabies is not known.

Table 2: Number of confirmed rabies cases in animals by province for the period 1997-2000.

Province	1997	1998	1999	2000	Total
Maputo	0	0	1	0	1
Gaza	13	8	11	5	37
Inhambane	0	0	0	0	0
Sofala	2	0	0	0	2
Manica	0	0	13	0	13
Tete	9	14	0	10	33
Zambézia	0	0	0	0	0
Nampula	1	2	2	5	10
C.Delgado	0	0	0	0	0
Niassa	0	0	0	0	0
Total	25	24	27	20	96

(National Directorate of Livestock (DINAP)

The spatial distribution of rabies in animals by province is not in agreement with the occurrence of human cases.

4 ROLE OF DONOR ORGANIZATIONS, PROJECTS, COMPANIES, INSTITUTIONS AND NGOS.

Students of the Veterinary Faculty participate vigorously in annual vaccination campaigns being conducted by the Provincial Veterinary Services.

Some projects run under The National Directorate of Livestock (DINAP) procure human and animal rabies vaccines; veterinary supplies and vehicles and bear all costs associated in vaccination campaigns. The projects also cover costs for educating the public via the public media or in schools.

Although the high incidence of confirmed animal rabies occurs in the provinces of Gaza, Tete, Manica and Nampula, the future campaign will take place in the provinces of Zambézia, Nampula and Sofala because of the high incidence of human rabies.

5 ANIMAL RABIES CONTROL.

The annual vaccination campaign is free of charge and it is done throughout the country by the Provincial Veterinary Services. The vaccine is imported by the National Directorate of Livestock depending on the availability of funds.

In the recent past the INIVE produced the vaccine based on embryonated eggs.

The city councils are responsible for the capture and elimination of stray dogs. However due to the lack of equipment, this activity has almost stopped across the country.

The Ministry of Agriculture and Rural Development is planning to launch an extensive educational campaign mainly in the provinces where the incidence of the disease is high to make the public aware about the seriousness of rabies and educate dog owners to vaccinate and keep their dogs in their dwellings in urban and per-urban areas.

The budget allocated to procure vaccines is scarce (8.800 USD in 2000, Table 3). This is a major problem for rabies control in Mozambique.

The National Veterinary Research Institute is responsible for vaccine production and laboratory diagnosis. However, at the present moment the vaccine is not being produced.

Table 3 shows the quantity of animal rabies vaccine imported in the past four years.

Table 3: Expenditures for rabies vaccine imported between 1997-2000.

Year	1997	1998	1999	2000	Total
Amount (USD)	3200	13408	18668	8800	44076

(DINAP)

6 ANIMAL AND HUMAN VACCINATION.

The number of doses of imported vaccine for animal use (tissue culture cells) and the number of doses distributed between 1997 and 2000 is summarised at Table 4.

Table 4: Number of doses of imported vaccine for animal use and number of doses distributed between 1997 and 2000.

Year	1997	1998	1999	2000	Total
Doses of vaccine imported	25505	32000	20000	40000	117505
Doses of vaccine distributed	54755	43154	19900	57960	175769

(DINAP)

Private veterinary practitioners in the larger urban centres conduct vaccinations of cats, dogs and monkeys.

The Ministry of Health imports human vaccines to protect people bitten by suspected rabies animals; DINAP also imports vaccine for human use to protect people who work in the laboratories, and in the capture and vaccination of dogs.

The total number of people bitten in Maputo between 1997-2000 was 5074 of which 210 received post-exposure anti-rabies treatment and were vaccinated (Table 5).

Table 5: total number of people bitten and vaccinated in Maputo between 1997 and 2000.

	1997	1998	1999	2000	Total
Persons bitten in Maputo City	1601	998	1125	1350	5074
Persons vaccinated in Maputo City	15	85	69	41	210
% of vaccinated persons	0.94	8.52	6.13	3.04	4.14

(Centro de Higiene Ambiental e Exames Médicos)

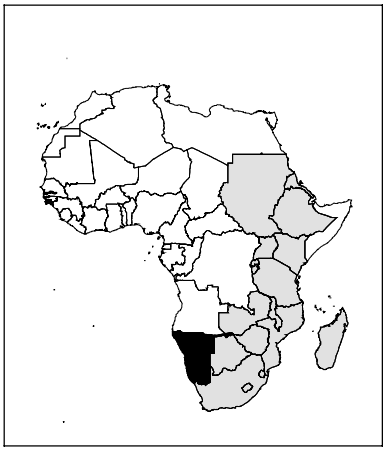
7 CONCLUSION.

In conclusion rabies is an important zoonosis in Mozambique.

The control of rabies is far from desirable and must be further improved in order to lower the risk of human fatalities.

This can only be achieved if adequate funds are allocated for procurement of vaccines, rehabilitation of kennels, public awareness and operating costs.

CONTROL OF RABIES IN NAMIBIA



F. Mettler[1], M. Uanguta[1] and O.J.B. Hűbschle [1]

Rabies has been recognised for a considerable time span in Namibia as an important infection of wildlife and livestock causing a low level of human infections (1999: 15 cases). Transmission to humans generally occurs through stray dogs and other unvaccinated dogs. This 'urban cycle' is found in the densely populated communal areas in the north of the country, where wildlife has become virtually extinct. In the farming areas of Namibia the black-backed jackal (*Canis mesomelas*) is the main transmitter of rabies, comparable with the 'sylvatic cycle' known from Europe.

Over the years this pattern remained and the intensity of outbreaks is only accentuated by seasonal changes. It has been demonstrated in the past that longer periods of drought lead to an increase of infections. A higher density of animals around watering points can explain this fact as well as the greater distance the jackals have to cover in order to secure their food.

Between March and July 1999 there was a localised outbreak of rabies in the Otjiwarongo district around the Waterberg. The farmers estimated that roughly 150 deaths in kudu antelope (*Tragelaphus strepticeros*) occurred. From 20 brain samples sent to the Central Veterinary Laboratory in Windhoek, 16 were tested positive. This started fears of a repetition of an epizootic which occurred between late 1977 and 1985, when an estimated 30 000 to 50 000 kudus, or 20 percent of the population, died of rabies in Namibia. Various observations during this epidemic strengthened the suggestion of a horizontal transmission between the kudus.

Table 1: Total of reported rabies cases in Namibia, confirmed cases in parenthesis.

	1999	2000
Domestic animals		
Canine	138 (39)	137 (61)
Feline	9 (3)	15 (6)
Bovine	168 (37)	134 (42)
Ov./Cap./Eq./camel	47 (16)	44 (14)
Wildlife animals		
Jackal	29 (19)	13 (10)
Other Carnivores*	15 (6)	20 (5)
Kudu	33 (16)	4 (2)
Other Herbivores**	7 (1)	2 (1)
Others	5 (0)	5 (0)

*Leopard (*Panthera pardus*), Wildcat (*Felis nigripes*), Bat-eared fox (*Otocyon megalotis*), Honeybadger (*Mellivora capensis*), Civet (*Viverra civetta*), Spotted hyena (*Crocuta crocuta*), Dassie (*Procavia capensis*), Ground squirrel (*Xerus inauris*).
** Oryx (*Oryx gazella*), Eland (*Taurotragus oryx*), Roan (*Hippotragus equinus*), Giraffe (*Giraffa camelopardalis*), Blesbok (*Damaliscus dorcas phillipsi*).

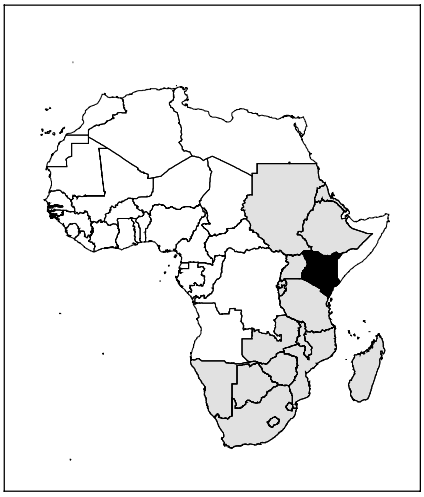
Vaccination data for the northern area of Namibia (the regions where urban rabies is prevalent) indicate an increased vaccination cover for the year 2000, which might be linked to a definite upsurge of

[1] Ministry of Agriculture, Water and Rural Development - Central Veterinary Laboratory – Private bag 13187 – Windhoek – NAMIBIA.

rabies cases during that year, this applies certainly for confirmed cases. Further, only laboratory confirmed rabies cases qualify in-contact persons for a state-sponsored vaccination. Figures provided by the local state veterinarian for the North central region indicate that during 1999, 6783 pets have been vaccinated either in veterinary clinics or during the yearly vaccination campaign where vaccination teams cover the whole rural area of the region. The percentage of stray dogs included in this figure is difficult to ascertain. During 2000, 16286 pets were vaccinated in the same area. However, according to the local state veterinary officer it appears that a considerable number of dogs still remain unvaccinated as the dogs tend to disappear once the vaccination teams reach rural villages.

Concerning the diagnosis of rabies, a centralised service stationed at the Central Veterinary Laboratory in Windhoek is adhered to. A suspected rabies specimen can be shipped from any part of the country during the afternoon to reach the laboratory the next morning, where the Fluorescent Antibody Test (FAT) for rabies will be applied. Hence without exception within 24 hours maximum the veterinarian or the animal health inspector who submitted the case will be informed by phone about the result. In positive cases with human contact a fax will be sent to ensure that a medical practitioner initiates treatment according to the post-exposure anti-rabies vaccination schedule. The government of Namibia via the Ministry of Health and Social Services provides human diploid rabies vaccine and where indicated anti-rabies immunoglobulins. In negative cases brain tissue will be examined histologically and in cases of non-suppurative encephalitis the FAT is repeated. Routine animal inoculation experiments in the case of negative FAT yet human contact have ceased and only in exceptional cases, which warrant further clarification, mouse inoculation assays are performed.

It becomes clear by following the rabies incidence in Namibia over the past years that wildlife rabies is here to stay. Efforts in the past to study the use of oral rabies vaccines for jackals provided encouraging results concerning the immunological response after vaccine provision. However the vastness of the country on the one side and the large variety of carnivorous wildlife complicate the distribution of vaccine baits considerably. A solution to this problem has certainly to wait for alternative new vaccine formulations i.e. via genetically modified organisms. It is therefore our humble opinion that before the latter can be approached a rapid field test for the identification of rabies-infected animals must be developed. Many countries in Africa lack the necessary infrastructure to ship suspected material quickly to a diagnostic centre with the consequence that numerous cases go unrecorded and preventative/curative measures are not instituted in time.



RABIES IN KENYA

Macharia M.J., Kasiiti J.L., Karuga A.K.,
Mburu J.W. and Gacheru S.G. [1]

1 INTRODUCTION.

Kenya's first report of rabies was in South Nyanza in 1902 (Hudson, 1944). The disease is a "Notifiable Disease" and it has been reported almost annually since diagnosis was confirmed for the first time in 1912 (Chong, 1993). The majority of the cases have been reported from dogs (Binepal *et.al.*, 1992).

2 HUMAN RABIES.

The incidence of human rabies in Kenya cannot be estimated accurately. In most Kenyan hospitals, a patient is suspected to have rabies only on the basis of animal-bite history and also the presenting symptoms. Since 1996 no human rabies specimen has been received at the Central Veterinary Laboratories, Kabete, where human rabies diagnosis is confirmed. The Ministry of Public Health has no data indicating the number of unconfirmed clinical cases. However, in a study carried out from 1982 to 1987 in one of Kenya's 41 Districts at that time (Kitala *et.al.*, 1993), a total of 5264 human animal bite cases and 11 human deaths from rabies were recorded. The study estimated a human dog-bite prevalence of 40 per 100000 people in 12 months. With Kenya's total human population estimated in 1999 to be 30 million, the extent of the rabies problem in humans must be immense. There is, therefore, an urgent need to strengthen the liaison between the medical and veterinary professions.

3 ANIMAL RABIES.

Up until 1976, rabies was only reported in a few Districts. For example, between 1967 and 1974 three to twelve cases were reported annually from just two Districts (Machakos and Kitui). Thereafter, the disease spread to the rest of the country (Davies, 1981) with cases diagnosed increasing from 22 in 1972 up to a peak of 290 in 1987. The increase in rabies incidence should be interpreted cautiously since it may be confounded by factors such as an increased level of surveillance and improved diagnostic capabilities (Perry, 1992). The disease still remains endemic in all Districts, with an average of 82 positive cases being diagnosed each year. It is most prevalent in dogs, followed by cattle, cats, goats, sheep, pigs, wildlife and man in decreasing order, the dog being the primary source and vector. Of the number of cases confirmed positive (n=492) at the Central Veterinary Laboratories, Kabete, from 1995 to 2000, 56% were domestic dogs, 28% were cattle, 6% were cats, 4% were equine (mainly donkey), 3% were goats and 3% were other species (Table 1).

[1] Veterinary Research Laboratories, P.O. Kabete, KENYA.

4 DIAGNOSIS.

The diagnosis of rabies is done on the basis of clinical signs observed in animals and man. Laboratory confirmation is done at the Central Veterinary Laboratories at Kabete and the Regional Veterinary Investigation Laboratories at Mariakani using brain material. Laboratory tests used are the Fluorescent Antibody Test (F.A.T.) and Mice Inoculation Test (M.I.T.) as described by King (1995). M.I.T. is carried out for all samples negative on F.A.T. Live rabies suspect animals are kept under isolation in specially built kennels at the Central Veterinary Laboratories, Kabete for observation.

5 RESULTS.

The total number of rabies cases confirmed positive in Kenya from 1995 to 2000 is summarised in Table 1. In 1999, a total of 94 cases were submitted for diagnosis as compared to 90 cases in 1998 and 110 cases in 1997. There were 41 positive canine cases out of a total of 55 canine samples received. This was followed by bovine (19/24 cases), feline (4/6 cases), equine (4/4 cases), wildlife (mongoose - 2/3 cases), and 1 positive goat. Nairobi reported the highest number of positive cases (31/43).

In the year 2000, a total of 100 cases were submitted for diagnosis. There were 28 positive canine cases out of a total of 61 canine samples received. This was followed by bovine (18/24 cases), feline (5/5 cases) and 2 positive cases from equine, goats and sheep. Again, Nairobi reported the highest number of positive cases (23/43).

The details of results of previous years is covered in reports published in the Proceedings of Southern and Eastern African Rabies Group (SEARG) meetings held in Zambia, South Africa, Zimbabwe, Kenya and Uganda.

Table 1: Positive cases according to species, 1995 – 2000.

	1995		1996		1997		1998		1999		2000	
	Pos	**Total**	**Pos**	**Total**	**Pos**	**Total**	**Pos**	**Total**	**Pos**	**Total**	**Pos**	**Total**
Dogs	77	178	53	92	35	53	42	50	41	55	28	61
Cattle	20	30	45	51	19	36	16	19	19	24	18	24
Cats	6	52	2	5	7	9	7	9	4	6	5	5
Equine	7	9	7	9	1	3	1	3	4	4	2	3
Goats	4	15	5	6	1	5	1	2	1	2	2	2
Sheep	0	4	0	0	0	1	2	2	0	0	2	2
Pigs	0	0	0	0	0	0	1	1	0	0	0	1
Wildlife	3	62	0	2	2	3	0	4	2	3	0	2
Human	0	0	0	2	0	0	0	0	0	0	0	0
Total	117	350	112	167	65	110	70	90	71	94	57	100

Pos = Positive cases

Table 2 shows origins of the specimens. Most were submitted by Veterinary Field Officers, Veterinary Investigation Laboratories and the Kenya Society for Protection and Care of Animals (K.S.P.C.A.). Of the cases indicated as submitted by farmers, most were actually submitted by veterinarians who recorded them in the owner's names or they were ownerless dogs found dead but recorded using the names of the people who sent them to the laboratories.

Table 2: Source of samples for laboratory diagnosis, 1996 – 2000.

	1995		1996		1997		1998		1999		2000	
	Pos	**Neg**	**Pos**	**Neg**	**Pos**	**Neg**	**Pos**	**Neg**	**Pos**	**Neg**	**Pos**	**Neg**
District Veterinary Office	22	35	31	20	12	9	17	0	11	4	10	8
Veterinary investigation Laboratory	18	24	30	7	18	17	18	7	11	4	19	7
K.S.P.C.A	17	16	25	15	8	5	9	3	26	6	15	11
Farmers	18	4	14	8	10	9	15	4	15	3	7	8
University of Nairobi	3	9	2	1	4	1	5	0	1	0	1	0
Private veterinarians	7	12	7	1	6	4	5	3	7	6	5	8
Researchers	31	131	3	1	6	0	1	2	0	0	0	0
Police	1	2	0	2	1	0	0	1	0	0	0	1
Total	117	233	112	55	65	45	70	20	71	23	57	43

K.S.P.C.A. = Kenya Society for Protection and Care of Animals
Pos = Positive
Neg = Negative

6 ANIMAL AND HUMAN RABIES CONTROL.

The control of rabies is through vaccination of dogs, cats and domestic animals; through destruction by baiting of stray dogs; through restriction of dog movement; and, through post-exposure immunisation of humans. Approximately 10,000 doses of human anti-rabies vaccine are used annually. Human Rabies Immunoglobulin (HRIG), though in stock, is rarely requested, most probably due to lack of public awareness (Dr. Nyamongo J.A., personal communication). There is a separate budget for animal rabies control programmes in the field (Table 3). However, there is need to also include diagnostic, epidemio-surveillance and sero-monitoring activities in the budget allocation. Table 4 shows that the actual animal vaccination figures have been declining since 1999, in proportion to the decreasing funding for rabies control (Table 3). Legislation exists and control measures are generally effective in areas where there is strict enforcement of regulations of the Rabies Act, the Rabies Ordinance and the Animal Diseases Act. Llittle is known about dog population dynamics and exact population figures and hence the percentage vaccination coverage is difficult to gauge. This is indeed a big setback in the successful control of the disease. Other setbacks include increase in the stray dog population and insufficient public awareness.

Table 3: Public funding for rabies control, 1995 – 2000.

Financial year	Total allocation Kenya Shillings (US$)
1995/1996	5100000 (63750)
1996/1997	5900000 (73750)
1997/1998	26681580 (333520)
1998/1999	27530300 (344130)
1999/2000	6833520 (85420)
2000/2001	2300000 (28750)
2001/2002	2312050 (28900)

Table 4: Actual animal vaccinations 1995 – 2000.

Year	Doses
1995	53211
1996	70553
1997	58965
1998	93612
1999	34315
2000	9993

7 DISCUSSION.

Domestic dogs remain the principal vectors for rabies (Table 1). In 1999 they accounted for 58% of all laboratory confirmed cases while in 2000 they accounted for 49% of the cases. The increasing numbers and mobility of both human and dog populations, among other factors, have accentuated the increase in rabies cases. Since the disease is widespread, the whole country is regarded as a rabies endemic area for the purposes of control.

Rabies control has not been very successful due to decreasing financial resources at the disposal of government veterinary services and the resulting competition of the scarce resources available by other disease epidemics of greater economic importance and with a potential to spread faster. However, the Government still recognizes the importance of rabies and especially the public health aspect of the disease. There is need to determine the actual incidence of rabies in animals and especially in humans. Availability of such data will influence policy and attract more interest in rabies since the strongest motivation for rabies control will come from the magnitude of the rabies burden not in animals, but in the human population (Kaboyo, 1999). It will also allow development of effective control programmes. The role of wildlife in the epidemiology of rabies is unknown since only a few cases of wild carnivora, bats and other wildlife species are received at Central Veterinary Laboratories, Kabete (Binepal *et al.*, 1992). An efficient and sustainable method to collect wildlife samples for rabies diagnosis needs to be established.

Awareness of the general public of the importance of rabies control is crucial in any rabies control/eradication programme. The Kenya Veterinary Association continues to play a significant role in publicity awareness but this is not sufficient. All stakeholders (technical and lay) must get involved. The Kenya Rabies Group needs to be revived to attract scientists and policy makers, including those from the Department of Veterinary Services and the Department of Public Health.

There is an urgent need to identify a facility to diagnose human rabies, to encourage medical doctors to confirm clinical suspicions of rabies and to make them aware that rabies control is as much a human task as it is a veterinary one, if not more. Information of all suspected human cases should be collected, collated and analysed.

A system that allows accurate collection of data on vaccine sales for both human and animal rabies control requires to be devised, involving all rabies vaccine outlets.

Rabies strains occurring in Kenya need to be typed and identified so that appropriate rabies control strategies can be adopted.

ACKNOWLEDGEMENTS.

To the Southern and Eastern African Rabies Group (SEARG/WHO) who made it possible for Dr. Macharia M.J. and Dr. Karugah A.K. to participate in this conference. To Dr. Kitala P.M. who kindly read and commented on the manuscript. To the Director of Veterinary Services, Kenya, and the Director of Medical Services, Kenya (through Dr. Nyamongo J.A.), who allowed free access and use of data and records available in their respective Departments. To the Director of Veterinary Services who granted permission for this paper to be published.

REFERENCES.

Animal Diseases Act, CAP 364, Laws of Kenya.

BINEPAL Y.S., MACHARIA M.J. AND RUNYENJE R.E.N. – 1992 - Rabies in Kenya, In: *Proceedings of the international conference on epidemiology, control and prevention of rabies in eastern and southern Africa,* Lusaka, Zambia. Edited by King, A. Lyon, France: Editions Fondation Marcel Mérieux: 14-16.

CHONG W.K.T. – 1993 - Rabies in Kenya. In: *Proceedings of the southern and eastern Africa rabies international symposium*. Pietermaritzburg, Natal, South Africa.

DAVIES F.G. – 1981 - The possible role of wildlife in the natural history of rabies in Kenya, In: *Wildlife disease research and economic development*. (L. Karstad, B. Nestel, and M. Graham eds.). Ottawa International Development Research Centre: 28-29.

Department of Veterinary Services, Kenya. Veterinary Records.

HUDSON J.R. – 1944 - A short note on the history of rabies in Kenya. *East African Medical Journal*. **21**: 622-627.

KABOYO R.W. – 1999 - Overview of Southern and Eastern African Rabies Group (SEARG) Activities 1997-1999. In: "*Proceedings of the Southern and Eastern African Rabies Group/World Health Organization meeting*". Edited by Rutebarika, C *et al.* Lyon, France: Editions Fondation Marcel Merieux: 7.

KARUGAH A.K. – 1999 - Rabies in Kenya. In: "*Proceedings of the Southern and Eastern African Rabies Group/World Health Organization meeting*". Edited by Rutebarika, C *et al.* Lyon, France: Editions Fondation Marcel Merieux: 12-14.

KING A.A. – 1995 - Diagnosis of Rabies. *Proceedings of the 3rd International Conference of the Southern and Eastern African Rabies Group*. Harare, Zimbabwe.

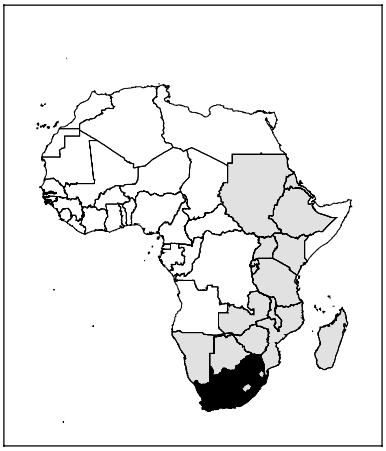
KITALA P.M., MCDERMOTT J.J., KYULE M.N. AND GATHUMA J.M. – 1993 - Features of dog ecology relevant to rabies spread in Machakos District, Kenya. *Onderstepoort Journal of Veterinary Research*, **60**: 445 - 449.

NYAMONGO J.A. Head, National Public Health Laboratory Services, Kenya.

PERRY B. – 1992 - Epidemiology of Dog rabies and its control in eastern and southern Africa. In: "*Proceedings of the international conference on epidemiology, control and prevention of rabies in eastern and southern Africa*, Lusaka, Zambie". Edited by King, A. Lyon, France: Editions Fondation Marcel Merieux: 107-121.

Rabies Act, CAP 365, Laws of Kenya.

RABIES IN SOUTH AFRICA

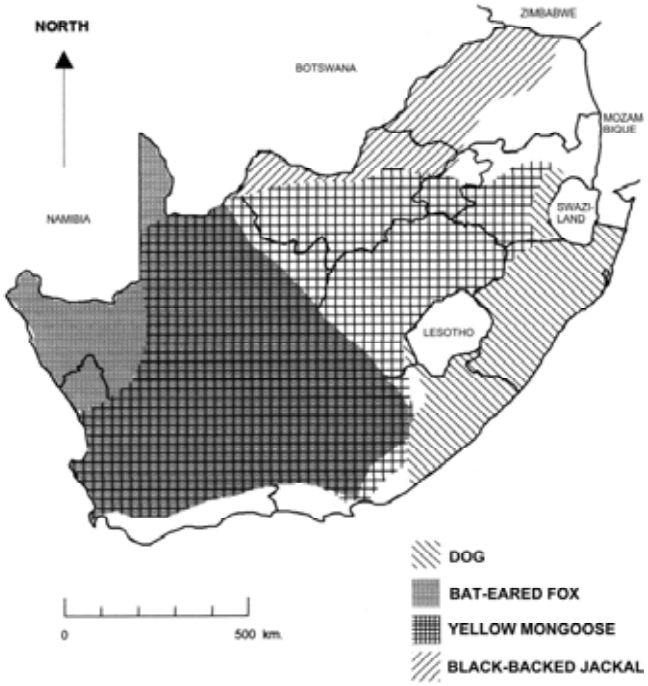


George Bishop[1]

1 INTRODUCTION.

This report, covering the two-year period 1999 to 2000, is an update of previous reports published in the Proceedings of SEARG meetings, which took place in Zambia, South Africa, Zimbabwe, Kenya and Uganda. The overall rabies situation in South Africa has changed very slightly and the disease remains endemic throughout the country. Four major vectors have been identified, namely the domestic dog, the yellow mongoose, the black-backed jackal and the bat-eared fox. Two strains of the rabies virus have been identified on the basis of monoclonal antibody typing and gene sequencing, namely the canid and herpestid (mongoose) types. Canine rabies is still largely confined to three provinces on the east coast of South Africa, namely Kwazulu-Natal, Mpumalanga and the Eastern Cape, where nearly all cases of human rabies are reported. The sylvatic form of rabies is largely dictated by the distribution of the three wild animal vectors (Figure 1).

Figure 1: Distribution of rabies in the Republic of South Africa - The main vectors.



[1] Allerton Veterinary Laboratory - Pietermaritzburg - Kwazulu-Natal - SOUTH AFRICA

2 HUMAN RABIES.

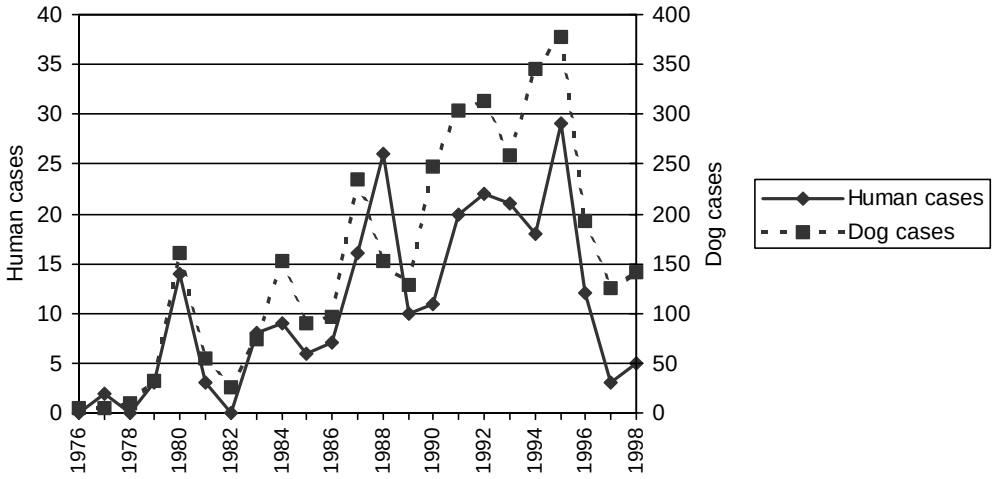
Table 1: Number of confirmed human deaths due to rabies in Kwazulu-Natal and the remainder of South Africa.

Year	Kwazulu Natal	Rest of South Africa	Total
1995	29	0	29
1996	12	2	14
1997	3	3	6
1998	5	1	6

data obtained from the National Institute for Virology, Sandringham, Gauteng, South Africa

There has been a noticeable decrease in the number of reported human deaths due to rabies since 1995 when 29 people are known to have succumbed to the disease (Table 1). This is probably mainly related to the corresponding decrease in canine rabies in the areas where this form of the disease is endemic. The close relationship between the number of dog cases and human cases is well documented in the literature and this is also seen in Figure 2. Lowered vigilance, which results in decreased surveillance, is not thought to be a major contributing factor in this improved situation since the veterinary and medical authorities operate independently of each other. The efforts of various groups of South African scientists to improve pre- and post-exposure rabies treatment protocols have also played a role in reducing the number of human deaths due to rabies.

Figure 2: Rabies in Kwazulu Natal in 1976-1998.

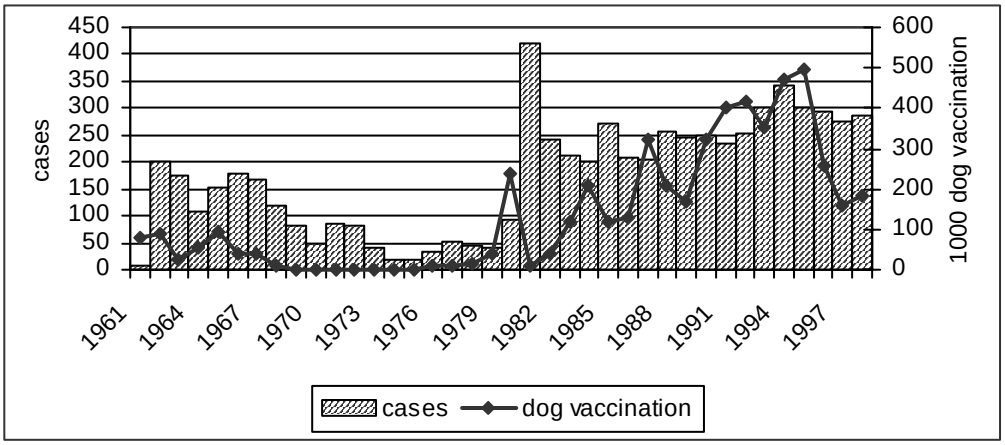


3 CONTROL OF RABIES.

The vaccination of dogs is of paramount importance in those areas where the canine form of the disease occurs. Very large and highly successful rabies campaigns were carried out in three eastern areas of Mpumalanga. High vaccination coverage (>90%) was achieved in these campaigns, which effectively eradicated the disease from that region of the Province. In one of these areas, there has not been a single case diagnosed for 18 months and this is a region where up to six outbreaks were found per month prior to the campaign. Elsewhere in South Africa, the vaccination of dogs has proved adequate, since there have been no new major outbreaks of canine rabies outside the identified endemic areas. The black-backed jackal is the major vector involved in spreading rabies to cattle in the northern regions of South Africa where farmers respond by vaccinating their herds.

The first documented case of canine rabies in Kwazulu-Natal was in 1961. The number of animal cases together with annual vaccination figures are depicted graphically in Figure 3.

Figure 3: Rabies cases in domestic animals and dog vaccinations in Kwazulu Natal 1961-1998.



The Rabies Advisory Group (RAG) comprising scientists from the Directorates of Animal Health and National Health have been advising those responsible for disease regulations on new measures that could be adopted to improve rabies control and reduce the number of deaths due to rabies in South Africa. A booklet, «Guidelines for the Medical Management of Rabies in South Africa», was published in 1997 by the South African Department of Health. Post- and pre-exposure vaccination protocols are based on those issued by the World Health Organization (WHO, 1992, WHO, 1997). The Essen regime (including the use of human anti-rabies immunoglobulin, or HRIG) is standard post-exposure procedure in South Africa. All vaccinations are given by deep intramuscular injection, as the intradermal route is deemed too difficult to implement on a wide scale. Since the WHO recently included in its recommendations the use of HRIG with the 2-1-1 protocol (WHO, 1997), Kwazulu-Natal (KZN) Province intends introducing this approach as an alternative to the 5-dose Essen protocol. This change in policy is based on the results of an unpublished survey, conducted at hospitals and clinics in KZN, which showed that patients, who were supposed to present for 5 vaccinations, averaged only 2.3 visits each. A more comprehensive update of a previously available rabies booklet is in the process of being compiled by the RAG.

A recent recommendation by the RAG that the entire South Africa be regarded as a rabies endemic country for the purpose of control was adopted by the veterinary authorities. It will soon be compulsory for all dogs and cats in South Africa to be vaccinated at the age of three months and boosted within a year. Further vaccinations must then take place every three years. In certain provinces, such as Kwazulu-Natal and Mpumalanga, the provincial veterinary directors have insisted on annual vaccinations because of the ongoing canine rabies threat and the high turn-over in the dog population.

Pilot field trials using placebo oral baits have been initiated in KZN. More than 90% of the dogs offered these baits have accepted them, most of them within 3 seconds. Baits containing SAG2 vaccine will be used in more extensive trials which will start within a few weeks.

4 ANIMAL RABIES.

The rabies cases diagnosed during 1997 and 1998 are listed in Table 2. These figures are based on dates of submission to the three laboratories which carried out this work. There was a marked increase in the number of black-backed jackal cases in 1998 compared to the previous year. The distribution of canine, other domestic animals, yellow mongoose, black-backed jackal, bat-eared fox and other wild animal rabies cases are shown in Figure 4

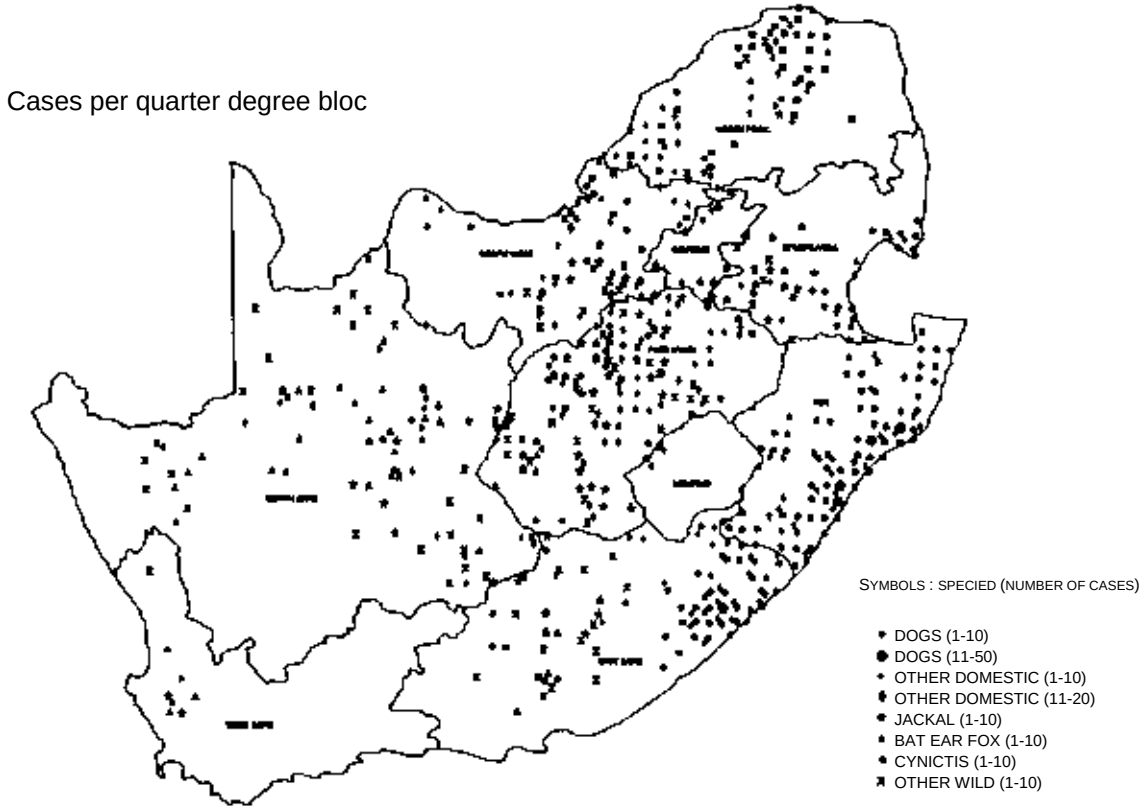
Table 2: South African animal rabies cases in 1997 and 1998.

	1997	1998
Dogs	231	210
Cattle	106	101
Cats	19	22
Donkey	1	
Goats	12	8
Horses	1	3
Pigs		1
Sheep	6	2
Aardwolf	4	7
African wild cat	1	6
Bat-eared fox	27	18
Black-backed jackal	21	49
Cape fox	3	1
Caracal		1
Civet	1	
Duiker		1
Eland	1	1
Ground squirrel		4
Hyrax	1	
Large grey mongoose	1	
Small spotted genet	2	6
Small spotted cat		1
Spotted necked otter		1
Suricate	13	16
Slender mongoose	10	11
Small grey mongoose	3	6
Striped polecat	2	
Water mongoose	1	
Wild dog	5	
Yellow mongoose	54	69
TOTAL	526	545

5 DIAGNOSTICS.

Three veterinary laboratories have carried out all animal rabies diagnostics over the past two years. The OIE Rabies Reference Laboratory at Onderstepoort has increased its diagnostic capabilities considerably and tissue culture isolations of virus are now used routinely instead of the mouse inoculation test. Furthermore, all positive cases are typed using monoclonal antibodies. Allerton Provincial Veterinary laboratory still provides a rapid diagnostic service, but the Rabies Unit at Umtata Veterinary Laboratory ceased functioning towards the end of 1998. Suspect human rabies cases are all forwarded to the centrally-placed National Institute for Virology in Gauteng Province.

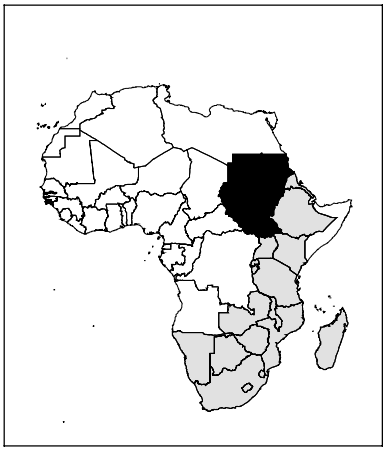
Figure 4: animal rabies cases in South Africa in 1997 and 1998 (1071 cases).



6 REFERENCES.

WHO Expert Committee on Rabies. Eighth Report. Technical Report Series 824. Geneva: World Health Organization, 1992

WHO Recommendations on Rabies Post-Exposure Treatment and the Correct Technique of Intradermal Immunization Against Rabies. WHO/EMC/ZOO.96.6. 1997



RABIES IN SUDAN

Yahia Hassan Ali[1]

1 INTRODUCTION.

Rabies is endemic in Sudan, as in most African countries. Since the first report of rabies in 1904, the disease has been reported annually. The incidence is dependent upon the control measures adopted. The estimated animal population in Sudan in 2000 was 124844000, while 91000 owned dogs and cats had been reported in animal census in Khartoum State during 2000.

Estimated animal population in Sudan 1999 – 2000.

Year	Bovine	Sheep	Goat	Camel	Total
1999	35825000	44802000	37346000	3031000	121004000
2000	37093000	46093000	38548000	3108000	124842000

2 HUMAN RABIES.

The reporting system of the Federal Ministry of Health is well organized, although in recent years after the application of Federal system, it was retarded. There is weekly, monthly, quarterly and annual reports for all in- and out-patients who reached hospitals and Health Centres in Sudan. Rabies post exposure treatment was restricted in specified Health Centres, so the records were easily collected, but recently it has become difficult. Khartoum State was and still is reporting the highest figures of human rabies post exposure treatment. This is due to the shortage of vaccine in most parts of the country. Human rabies post exposure treatment as well as deaths of the disease during 1998 – 2000 are shown in Table 1.

Table 1: Human Rabies post exposure treatment and deaths in Sudan 1998 – 2000.

Year	Khartoum		Central States		Northern States		Eastern States		Western States		Total	
	PET	Death	PET	Death	PET	Death	PET	Death	PET	Death	PET	Death
1998	6180	-	117	15	41	4	208	8	20	2	6566	29
1999	6567	6	400	5	1	-	300	2	447	7	7815*	20
2000	6149	3	950	9	128	2	388	1	1209	17	8934**	32

* includes 100 post-exposure cases were reported in the southern states
** includes 110 post-exposure cases were reported in the southern states

2.1 Rabies vaccines.

Locally produced goat brain vaccine is available, at 6 USD per course of 10 doses. Imported vaccines are duck embryo vaccine (which costs 100 USD per course of 6 doses) and tissue culture vaccine (produced on vero cells which costs 110 USD per course of 5 doses). The cost is usually paid by the

[1] Rabies Unit-Virology Dep. - Central Veterinary Research Laboratories - P.O. Box 8067 El-Amarat - Khartoum - SUDAN

exposed person, no role for NGOs in this respect. Diagnosis of human rabies is based on case history and clinical signs; laboratory confirmation is very rare.

Recent trends: Trials to produce tissue culture vaccine are on-going.

3 ANIMAL RABIES.

The incidence of rabies in Sudan depends on the control measures adopted by the Veterinary Authorities. The disease is endemic and is reported in most parts of the country. Dogs were found to be the animal species most involved in rabies epidemiology. Goats are the main victims of dog bites followed by the donkey. Data collected from all veterinary clinics are reported monthly and annually and sent to the director general of animal resources in each state and to the prime Under Secretary of animal resources in Federal Ministry of Animal Resources. The reporting is variable in the different states, some respond regularly, others do not. In general, reporting of animal rabies is considered poor, because a large number of cases are usually not reported to the veterinary authorities especially in the rural areas. A total of 588 rabies suspected animals were reported in Sudan during 1998 – 2000. Table 2 shows the suspected animal species reported.

Table 2: Reported Rabies suspected cases in Sudan 1998 – 2000.

Animal species	Years			Total
	1998	1999	2000	
Dog	71	46	107	224
Cat	7	11	17	35
Monkey	1	3	2	6
Goat	29	66	37	132
Sheep	1	2	4	7
Equine	53	21	42	116
Bovine	8	5	14	27
Camel	40	-	1	41
Total	210	154	224	588

Diagnosis.

Rabies laboratory diagnosis is carried out in the Central Veterinary Research Laboratory (rabies unit). Samples are sent on ice or formalin. A few samples are tested in the National Health Laboratory. The techniques applied are Fluorescent Antibody Test and histopathology. Table 3 shows the results of tested samples.

Table 3: Results of Rabies Laboratory Diagnosis in Sudan 1998 – 2000.

Species	1998	1999	2000	
Dog	5	4	9	Positive
	10	9	10	Negative
Cat	4	5	7	Positive
	6	6	1	Negative
Monkey	1	-	-	Positive
	-	1	-	Negative
Goat	6	11	9	Positive
	8	5	6	Negative
Sheep	-	1	1	Positive
	-	1	1	Negative
Equine	1	4	3	Positive
	3	2	4	Negative
Bovine	2	6	5	Positive
	2	1	3	Negative
Camel	2	-	1	Positive
	-	-	-	Negative
Fox	-	-	-	Positive
	-	1	-	Negative
Total	21	31	35	Positive
	29	26	25	Negative

4 RABIES CONTROL STRATEGY.

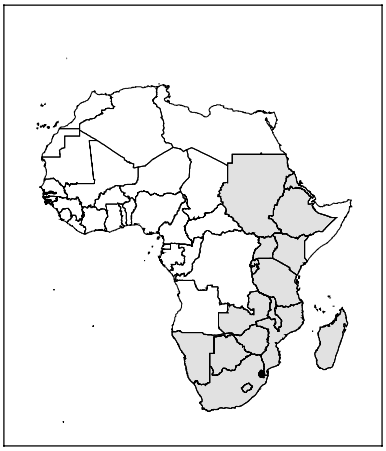
Rabies control programs are planned annually in each province, state and in the Federal Ministry of Animal Resources. Although there are annual funds for control programs, it was noticed that in the recent years the control programs were not applied efficiently. The main steps carried out in rabies control programs are vaccination of susceptible animals and destruction of stray and unvaccinated ones. The figures of vaccinated and destroyed animals in Sudan during 1998 – 2000 are summarized in Table 4.

Table 4: Rabies Control Measures in Sudan 1998 – 2000.

Year	Animals vaccinated	Animals destroyed
1998	2302	9722
1999	843	223
2000	2946	4249

The routinely applied dog destruction policy in Sudan is found to be more efficient than vaccination alone. Almost 90% of dogs are kept outdoors and no attention is paid by their owners to vaccinate them. In Khartoum State the number of owned dogs reported during the animal census adopted during the year 2000 were 91000, while only 2946 animals were vaccinated during the same year. The collaboration between animal resources, health and police authorities is continuous at the Federal level through the National Committee of rabies. The situation in the different states is variable and should be strengthened to aid in rabies control strategies.

As rabies laboratory diagnosis is centralized in the Central Veterinary Research Laboratory, the supplement by recent diagnostic tools is on going. The same is proposed for the regional veterinary diagnostic laboratories. Production of tissue culture rabies vaccine for animals is under investigation. The available vaccine for animals currently is tissue culture vaccine that costs about 0.75 USD per dose.



RABIES IN SWAZILAND

R. X. Dlamini[1]

1 INTRODUCTION.

In the Stock Diseases Act no. 7 of 1965, rabies is the second scheduled disease, after foot and mouth disease. This act stipulates that all dogs should be vaccinated annually and the Veterinary department conducts these annual vaccination campaigns in September. Under this act, a single laboratory confirmed rabies case is an outbreak, irrespective of the species affected. In such a case dip tank areas which fall within a radius of approximately 6km are declared rabies guard areas. Every owner of a dog or cat in a guard area is required to present his pet for inoculation at designated vaccination centres. Failure to comply with the above regulations is an offence and is liable on conviction to a fine not exceeding E 300 (26.25 US$) and in default of payment, to imprisonment for a period not exceeding three months. A government veterinary officer may destroy a dog or cat in any of the rabies guard areas if in his opinion such a dog or cat has not been confined so as to prevent it from escaping from such guard areas. In pursuance of this, the officer may ask for the assistance of the Royal Swaziland Police.

2 ANIMAL RABIES.

Despite good legislation and availability of funds to purchase vaccines, cases of rabies have continued to occur since 1992 and dogs are still the principal vectors (Table 1). In the late 1980s rabies was almost eradicated, then the veterinary staff was motivated. Social and economic changes in the beginning of the 1990s eroded that motivation. Vaccination campaigns became less vigorous, especially in outbreak areas and even today this is still the situation. Since 1998 Government requires that the Tender Board approve rabies vaccine purchasing orders and this takes too long. As a result, since then the Veterinary department has failed to do the annual vaccination campaigns in September. This further de-motivated the staff and confused pet owners and vaccination coverage dropped dramatically (Figure 1).

Table 1: Vaccination coverage and Laboratory confirmed animal rabies cases, 1992- 2000.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
Vaccination coverage (%)	70.5	72.6	78.7	91.7	70.8	63.2	1	48	1	55.2
Canine	17	14	22	48	20	19	14	19	57	230
Feline	0	0	1	0	0	2	0	0	0	3
Bovine	0	0	1	9	5	0	1	2	2	20
Caprine	0	0	1	8	3	2	0	0	2	16
Other	0	0	1	0	0	0	0	0	0	1
Total	17	14	26	65	28	23	15	21	61	270

[1] Veterinary department – Manzini - SWAZILAND

The disease is evenly distributed throughout the country, affecting all four regions (Table2). Also there seems to be no seasonal pattern or any other pattern in the occurrence of the disease. However most of the cases seem to occur in high-density areas. This may be due to a high dog population density and/or the fact that veterinary field officers tend to concentrate on dip tank areas (Rural).

Figure 1: Dog vaccination and rabies cases, 1992 – 2000.

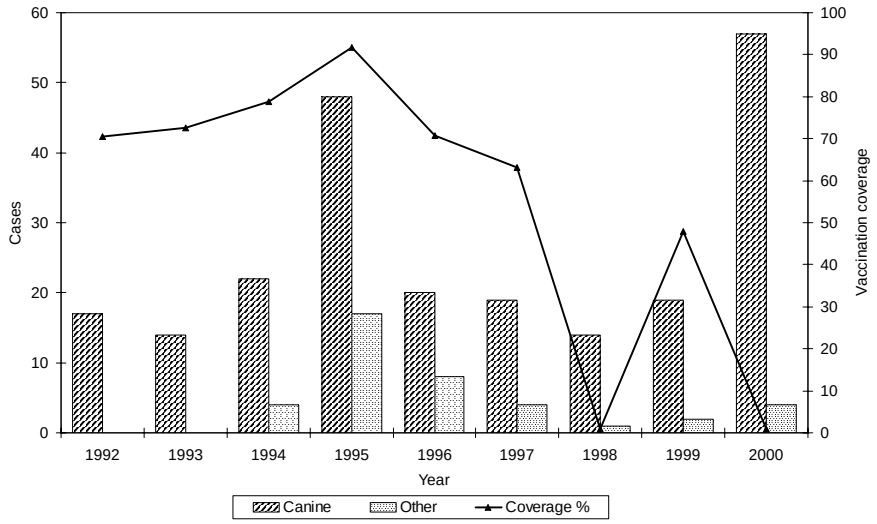


Table 2: Distribution of laboratory confirmed rabies cases by region and month (Jan 1999- Dec 2000).

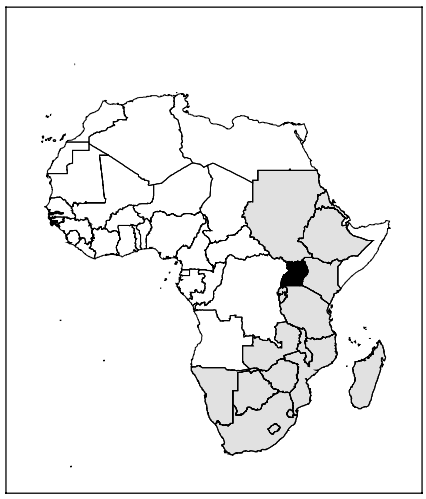
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
MZ	1	4	3	4	2	4	5	7	2	0	4	1	37
HH	0	0	4	1	0	3	0	0	1	0	1	0	10
SH	4	1	4	0	2	1	0	1	0	1	0	0	14
LB	0	1	1	0	0	0	1	4	5	3	4	1	20
Tot	5	6	12	5	4	8	6	12	8	4	9	2	81

3 HUMAN RABIES.

Medical records are still scanty. Doctors and nurses are terrified of the disease and they would rather not deal with suspected rabies cases. Pathologists refuse to take samples for laboratory diagnosis. Between 1998 and 2000 four human cases were reported, diagnosed clinically only. Government hospitals used 2400 and 3500 doses of human rabies vaccines in 1998 and 1999 respectively.

4 CONCLUSION.

Government's failure to purchase vaccine on time and the lack of motivation/ incentives for veterinary staff should be addressed by the veterinary department. Acquired immunodeficiency syndrome (AIDS) and foot and mouth disease (FMD), Cholera and other diseases overshadowed the importance of rabies. Awareness campaigns should be conducted especially for the health workers. A cost-effective method of identifying vaccinated dogs should be devised and/or adopted. An appropriate post graduate course on zoonosis should be offered for both medical and veterinary doctors, maybe in one of the regional universities.



RABIES IN UGANDA

C. S. Rutebarika[1]

1 INTRODUCTION.

This report covers the period of 1999 and 2000 and updates the previous reports of SEARG/WHO meetings.

The overall situation has changed a little because the previous two years saw resurgence of widespread epidemics of Lumpy Skin Disease and Foot and Mouth Disease in the country. The two epidemics, spreading fast and of greater economic importance, competed more favourably for the meagre resources allocated to the department of livestock health and entomology. The disease remains endemic throughout the country.

As a result of the department spending little on dog rabies control, the Ministry of Health has spent progressively more money on ARV.

2 HUMAN RABIES

Source: Veterinary Public Health Unit / Ministry of Health.

The report for 1999 - 2001 indicates that 30 cases of rabies were recorded while a total of 9935 dog bite victims received post-exposure treatment with anti-rabies vaccine (ARV) in the various health units in the country compared to the previous 6028 cases. These cases shot up by 64.8%. This increase in rabies cases and dog bite victims is a reflection of minimal control of dog rabies by the Department of Livestock Health and Entomology.

The increased trend for the last 2 ½ years was due to reduced public health sensitisation programmes about the importance of rabies by members of the Technical Committee for Rabies control (TECOR) and reduced funding of the Department of Livestock Health and Entomology.

The dog contributed to over 95% of the rabies cases reported and there was no laboratory confirmation of any human rabies cases during this period. The collaboration between the district medical and veterinary staff has continued to grow and this has improved greatly on the reporting of bite victims and their management.

[1] Department of Livestock Health and Entomology - Entebbe - UGANDA.

Table 1: Human rabies data (1992- June 2001).

Year	No. of post exposure treatments	ARV doses (imported)	No. of rabies cases	Estimated cost (US$)
1992	766	3976	50	35000
1993	1518	5720	23	52000
1994	2614	8298	15	74700
1995	3222	13623	14	122000
1996	1698	16000	9	144000
1997	2916	16000	10	144000
1998	3112	16000	10	144000
1999	4537	10000	5	55000
2000	5398	10000	9	56000
2001	1316	4880	16	30256
Total	27097	104497	161	856956

Source: Veterinary Public Health/ Ministry of Health.

3 ANIMAL RABIES CONTROL.

Rabies remained a very serious epidemic in the country. Vaccination of dogs was insufficient, since only 77000 doses of rabies were imported. Outbreaks of other Epidemics like, FMD, Lumpy Skin Disease, Malaria and Ebola overshadowed its importance and took priority on resource allocation. Nevertheless, rabies was among the most predominantly reported diseases in the whole country.

During the period of 1999 – 2001, 1670 suspected clinical cases were reported, 72000 dogs and cats were vaccinated, and 3001 stray dogs and cats were destroyed. A policy to improve the delivery of veterinary services has been drafted and it is hoped that a review of the Laws governing the sector is to be undertaken as soon as it is approved by cabinet.

Public awareness, through a multisectoral approach (MSA), was extended to districts of Kapchorwa, Lira, Kiboga, Apac, Jinja and Kabale, although we had anticipated covering 10 districts during this period.

4 FUNDING FOR RABIES CONTROL, DIAGNOSIS AND REPORTING.

The procurement of rabies vaccine is the responsibility of Central Government (MAAIF) while implementation of vaccination campaigns is the mandate of local authorities whose funding priorities may not favour rabies control. MAAIF only procured 74000 doses of rabies vaccine, which was insufficient for the whole country.

The contribution of private veterinarians, teaching institutions and the Uganda Society for Protection and Care of Animals (USPCA) in rabies control is still minimal.

The central diagnostic laboratory has reagents and uses FAT for diagnosis. However, very few samples are being submitted to the laboratories by District Veterinary Officers (DVOs) mainly because most times, the DVOs receive information late after the offending animal has been killed and buried.

Some public awareness programmes have been funded, though inadequately. Reporting from districts remained poor during this period. This is a result of decentralisation and poor funding of MAAIF staff who can not carry out regular supervision of the district field activities.

However, the recent epidemic outbreaks of Ebola, Malaria, Foot and Mouth Disease and LSD have paved a way for negotiations between Ministry of Agriculture, Animal Industry and Fisheries and Ministry of Finance, Planning and Economic Development for a disease emergency fund from which rabies will be able to benefit. It is also hoped that the general disease reporting problems will be eased under PACE, which is about to take off.

The number of dogs and cats vaccinated since 1992 are indicated in Table 2.

Table 2: Animal Rabies data.

Year	Amount of vaccine procured	No. of Vaccinates (cats and dogs)	Estimated cost of vaccine (USD)
1992	80000	56662	25600
1993	-	24875	-
1994	100000	82306	32000
1995	90000	73906	28800
1996	400000	63390	128000
1997	-	130480	-
1998	-	69555	-
1999	-	-	-
2000	74000	72000	29600
2001	-	2000	-
Total	744000	575174	244000

Source: Livestock Health and Entomology Departmental Annual Reports, 1992-2001.

5 ROLE OF DONOR ORGANISATIONS / PROJECTS.

The last two years had no donor organisation or project facilitating rabies control.

The government has finally launched the Plan for Modernisation of Agriculture (PMA). Under PMA, there is a fund for epidemic disease and pest control and it is hoped that rabies control will be a beneficiary of this fund. PMA has extension services under the National Agricultural Advisory Services (NAADS) that will be based in the districts operating at parish level. PMA is a World Bank funded project.

Pan African Control of Epizootics (PACE) is about to begin and one of its major objectives is to establish an epidemiosurveillance network, nationally and regionally. PACE is funded by the European Union. PACE will support the diagnostic capacities of the central and district laboratories as well as the reporting network.

It is envisaged that the activities of PMA and PACE will improve rabies control, diagnosis and reporting.

6 USE OF DOG POPULATION REDUCTION.

The strategy of dog population reduction has been used mainly in urban areas and more recently when rural areas saw big populations of stray dogs left behind by displaced people during the civil strife in the North and Western parts of the country. Such populations have been reduced by poisoning, shooting and hunting.

In the last two years 2584 dogs, 417 cats, 21 jackals and 50 foxes were destroyed. The Uganda Society for the Protection and Care of Animals (USPCA) has expanded its scope of work on sterilisation of dogs and cats (both domestic and stray) in and around Kampala as a method of population reduction.

7 ANIMAL AND HUMAN VACCINATIONS.

7.1 Types of vaccines used (Human).

Vaccines currently in use are the inactivated cell culture vaccines prepared on VERO Cells (Verorab). The human diploid cell culture (HDCV) and Duck embryo vaccines were last used in 1993.

The numbers of rabies suspect victims who received post exposure treatment and amounts of vaccine imported per year are shown in Table 1 for the period of 1992-2001. The vaccines were used in all the districts of the country and were free, but due to budgetary constraints, not enough vaccines were bought.

7.2 Animal vaccines.

The vaccination returns for the year 1992 to 2001 are indicated in Table 2. A decrease in vaccine procurement is indicated in Table 2. There is urgent need to formulate a project specifically for rabies control.

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

The cases of Rabies reported in the different species of animals for the period 1992-2000 are indicated in Table 3. The Queen Elizabeth National Park had an outbreak of rabies in 2000 in which a bushbuck that died tested positive for rabies. It is suspected that hyenas, which died in the same park (QENP) around the same period, could have died of rabies. There is need for the testing of the oral bait vaccines in the national parks considering that most of National Parks have wild Canivora e.g. the jackals in Kidepo National Park are estimated at 100.

7.3 Constraints to Rabies control.

Rabies control programmes are still constrained by:
(a) Irregular and insufficient funding.
(b) Control of stray dog populations which are on the increase.
(c) Public awareness on Rabies is still insufficient.
(d) Decentralisation policy and civil service reform.
(e) Minimal role by the private sector.

The liberalisation of vaccine procurement to the private sector may ease the chronic shortage of vaccines and insufficient funding by government.

Table 3: Reported cases of Rabies in Uganda, 1992 –2001.

Species	1992	1993	1994	1995	1996	1997	1998	1999	2000
Dog	243	228	376	252	38	298	61	1,214	442
Cat	-	-	1	4	1	5	3	7	13
Cattle	1	2	-	4	1	30	5	6	8
Goat/Sheep	2	-	7	5	8	4	-	-	
Fox	-	2	-	5	8	-	-	3	3
Jackal	3	6	-	4	2	-	-		4
Monkey	-	-	1	-	3	3	-	2	-
Rabbit	-	-	-	-	2	2	-	-	-
Mongoose	-	-	-	2	-	-	-	-	-
Pigs								1	1
Leopard								1	-
Bush back									1
TOTAL	249	238	385	276	73	268	69	1234	472

Source: Livestock Health and Entomology Departmental Annual Reports, 1992-2001

Table 4: Human Rabies data (1992- 2000).

Year	Suspected rabies victims treated (ARV)	ARV doses used (imported)	No. of cases	Estimated cost (US$)
1992	766	3976	50	35000
1993	1518	5720	23	51000
1994	2614	8298	15	74700
1995	3222	13623	14	122000
1996	1698	16000	9	144000
1997	2916	16000	10	144000
1998	3112	16000	10	144000
1999	4537	10000	5	55000
2000	5398	10000	9	56000
2001*	1316	4880	16	30256
Total	27097	104497	161	855956

Source: Veterinary Public Health/ Ministry of Health.
* January-June

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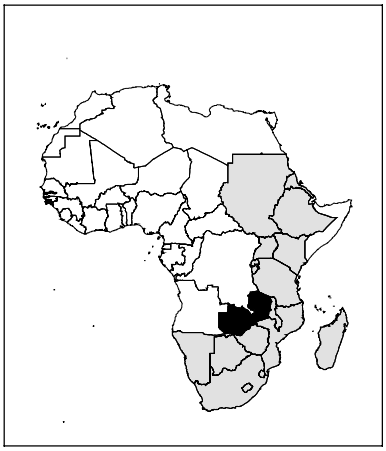


RABIES IN ZAMBIA

A. Mutemwa [1], P. Mijere[2]

1 RABIES SITUATION IN ZAMBIA.

1.1 Introduction.

Rabies is still being reported in both animals and humans in Zambia. However the cases that are reported in humans are not always confirmed.

In dogs and cats, most of the suspected cases are followed by a laboratory confirmation especially in the urban areas.

Incidences of dog bites are still very common especially in the urban areas.

1.2 Animal rabies period from 1999 to 2001.

All the nine provinces of Zambia reported rabies cases during this period. The following table shows the cases as they occurred per year per province.

Table 1: Rabies situation in Zambia provinces.

	January 1999 to December 1999								
	Central	**Copper-belt**	**Eastern**	**Luapula**	**Lusaka**	**Northern**	**North-Western**	**South-ern**	**Western**
Reports	13	3	1	7	1	3	12	6	20
Cases	49	6	1	16	+v4	19	115	17	63
Deaths	26			13	4		29	8	44
	January 2000 to April 2001								
Reports	34	6	10	2	12	0	12	22	30
Cases	154	9	55	3	+v4	0	28	81	97
Deaths	46	6	6	1	4		13	67	60

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

[2] PHO – box 70032 – Ndola - ZAMBIA

Table 2: Incidence rate of rabies by province in 1999.

Provinces	Incidence rate	Total cases	Population
Central	8.9	91	1017100
Copperbelt	4.5	77	1713317
Eastern	2.5	35	1423430
Luapula	14.7	104	708730
Lusaka	15.3	247	1615709
Northern	8.0	112	1399573
North Western	2.1	12	578653
Southern	8.0	118	1470939
Western	15.41	1191	772129
Total	8.8	1987	10699580

Table 3: Incidence rate of rabies by province in 2000.

Provinces	Incidence rate	Total cases	Population
Central	4.4	46	1042603
Copperbelt	2.5	44	1735802
Eastern	3.4	50	1477907
Luapula	1.8	13	728175
Lusaka	0.0	0	1717176
Northern	0.4	6	1399666
North Western	10.2	62	606879
Southern	2.0	29	1445041
Western	2.8	22	789898
Total	2.5	272	10943147

1.3 Data on rabies human contacts.

Table 4: Human contacts in Lusaka province.

	1999	2000	2001
People bitten by a dog	51	65	30
Recommended PET	4	3	40

The average age of people bitten was 15 years. The common body parts bitten were calf, buttocks and arms.

The total number of dogs vaccinated by the government veterinary clinics in Lusaka province yearly was: 4412 in 1999, 4288 in 2000 and 914 up to May 2001.

1.4 Human rabies in 1999 – 2000.

Table 5: Quarterly incidence of Human rabies surveillance in Zambia.

Period	OPD	Admissions			Deaths			Grand total
	Under 5	Under 5	Over 5	Total	Under 5	Over 5	Total	
1999, Q1	27	0	12	12	0	98	98	432
1999, Q2	19	3	7	10	0	5	5	106
1999, Q3	24	1	9	10	1	32	33	204
1999, Q4	20	7	12	19	0	57	57	173
2000, Q1	8	29	24	53	1	2	3	91
2000, Q2	10	1	14	15	0	9	9	64
2000, Q3	17	0	6	6	0	43	43	124
2000, Q4	1	5	11	16	2	8	10	45
2001, Q1	2	9	1	10	2	1	3	32
Total	128	55	96	151	6	255	261	1271

2 CONTROL METHODS.

2.1 Vaccination of animals.

In urban areas, routine rabies vaccinations are carried by the individual veterinary clinics both private and government.

In rural areas vaccination against rabies is solely done by government veterinary officers.

In routine rabies vaccination an average charge of K5000, i.e. 1.5 USD, is usually passed on to the dog owners.

However, when there is a rabies outbreak, mass rabies vaccinations are carried out free of charge by the government. During this time tie up orders are usually enforced.

Types of vaccine used in Zambia.

The rabies vaccine used are either locally produced (CVRI RABIES VACCINES) or imported (RABISIN - MERIAL).

Different batches have been used: in 1999 batches 80 W 652, 80C 711 and 80 W 423; in 2000 batches L 70401, L 61748 and L 60636; in 2001 batches L 70401 and L 76493.

Local vaccine is produced at Central Veterinary Research Institute by the vaccine production section. Importation of vaccine is also going on. This is mainly by the livestock services co-operative Society. However importation of vaccine requires that the importer obtains the import permit through the office of the Director of Veterinary Services. The following table shows the amounts of doses locally produced and imported from 1999 up to date.

Table 6: Number of vaccine doses locally produced and imported from 1999 up to date.

Year	Locally produced doses	Imported doses
1999	22859	42570
2000	32050	43300
2001	15000	

2.2 Funding.

At the moment, disease control activities are jointly funded by international development agency (IDA) and by the government.

However whenever there is an outbreak, special arrangements are made through the offices of the Director and the Permanent Secretaries (PS) who almost always make sure that the funds to contain these outbreaks are made available.

2.3 Collaboration between services in case of dog bite.

Dog bite cases still involves the Medical, the Police and the Veterinary departments.

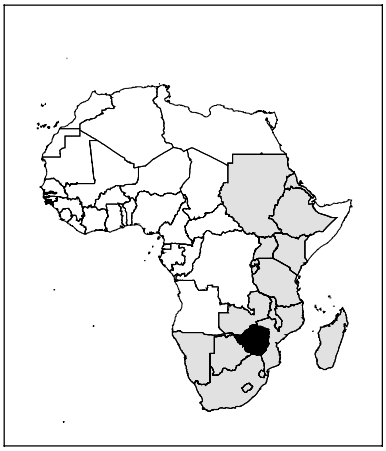
An incident of a dog bite is usually reported to the police before treatment is instituted at the clinics or hospitals. However the medics will always refer such cases to the government veterinary officers for verification of the rabies certificate, the biting circumstances and on the clinical status of the dog in regards to rabies.

The interaction however is not physical as it is always done through correspondence.

3 CONCLUSION.

Rabies still continues to be a serious zoonotic disease in Zambia. It is a notifiable disease.

However the government still needs to do more in rabies control. It also needs to do more in collection of data on human rabies and its effects.



RABIES IN ZIMBABWE

W. Shumba[1] and A. Zezai[2]

1 ANIMAL RABIES IN GENERAL.

Rabies is the concern of both the Ministry of Health and child Welfare and that of Agriculture, through the department of veterinary services. Rabies has been endemic in Zimbabwe since the 1950's after more than ten years of complete disappearance following the first confirmations in 1938.

The pattern of rabies has a lot to do with land use (see maps below). It tends to be more common in agriculturally active parts of Zimbabwe. This is particularly true for bovines and jackal cases are virtually restricted to commercial farming areas. Dog rabies cases for the period 1999 and 2000 seem to be concentrated in communal areas.

The central veterinary laboratory is crucial for the diagnosis of all rabies cases in the country, the main test being the FAT test in both human and animal specimens but complementary tests are mouse inoculation test (MIT) and histology (H&E stains) for negative samples with human contact. Not much has been done with regards to histopathological diagnosis in humans.

The dominance of dogs, jackals and bovine cases of rabies is quite striking for Zimbabwe. The geographical distribution of rabies is also important as it may be changed with the ongoing Land Reform Program in Zimbabwe. We are therefore planning to intensify education of the communities on the pending dangers of rabies in their livestock as they occupy former commercial farms for resettlement. Dog rabies, which has been mainly in rural and peri-urban areas, will now be even more spread in the majority of the country.

The primary health care approach is employed for human cases and suspected cases. At the first level of care patients have their wounds cleaned, anti-tetanus toxoid given if necessary, history taken and the patient referred to the next level if anti-rabies is indicated.

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Figure 1: Dog rabies cases 1999 – 2000.

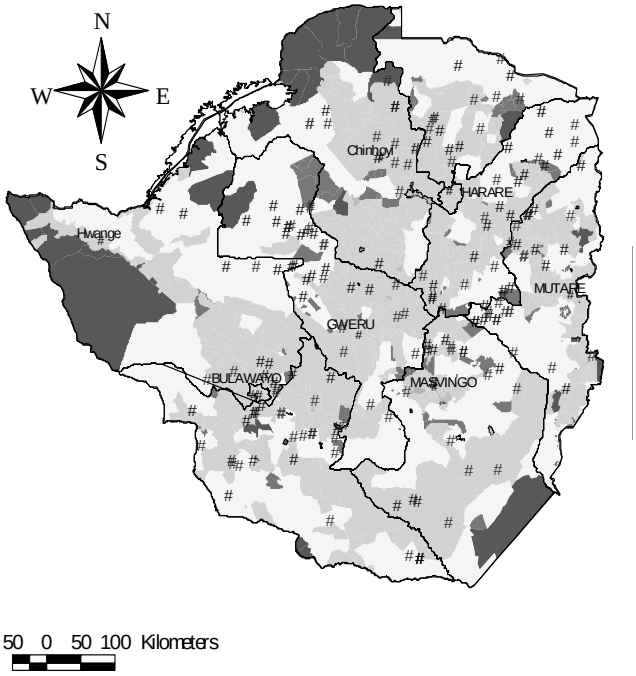


Figure 2: Bovine rabies cases 1999 and 2000.

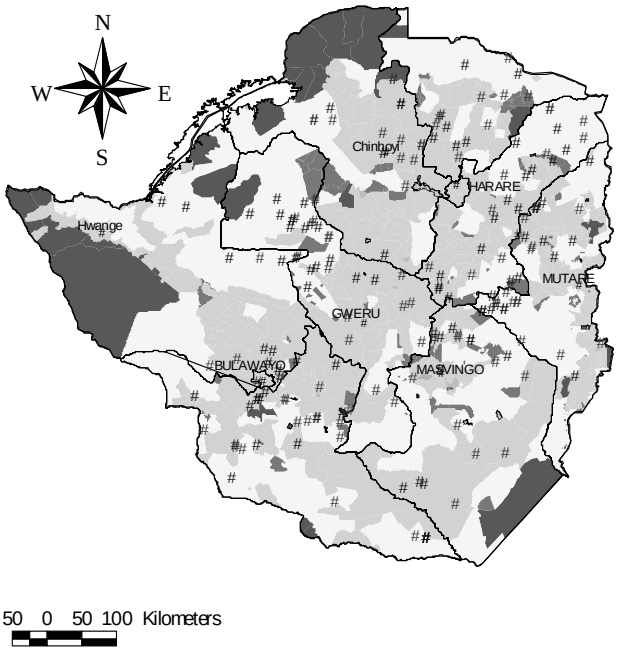
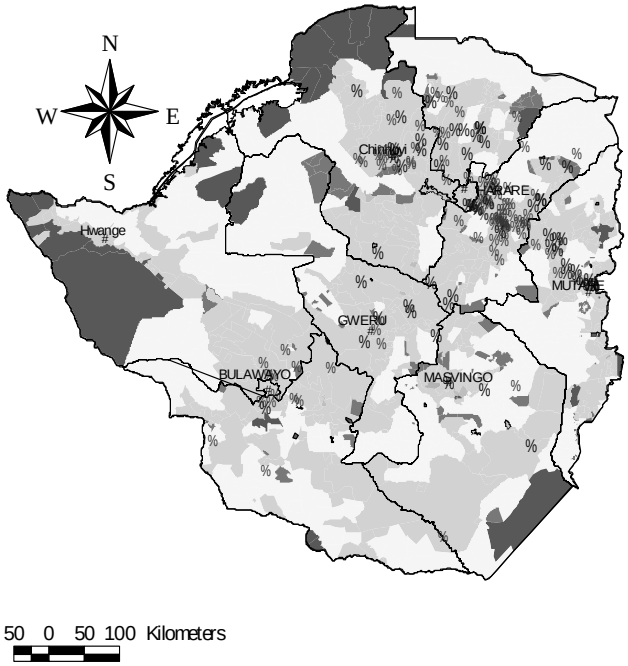


Figure 3: Jackal rabies 1999 and 2000.



Dog vaccinations are almost free to the public save for a token fee of Z$15 (0.3 US$) for the certificate.

Figure 4: Animal vaccine usage for the period 1999 – 2000.

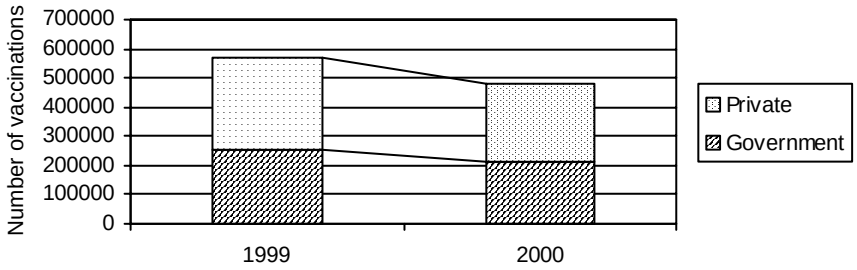


Figure 5: Dog vaccination and dog rabies cases in 1999 – 2000.

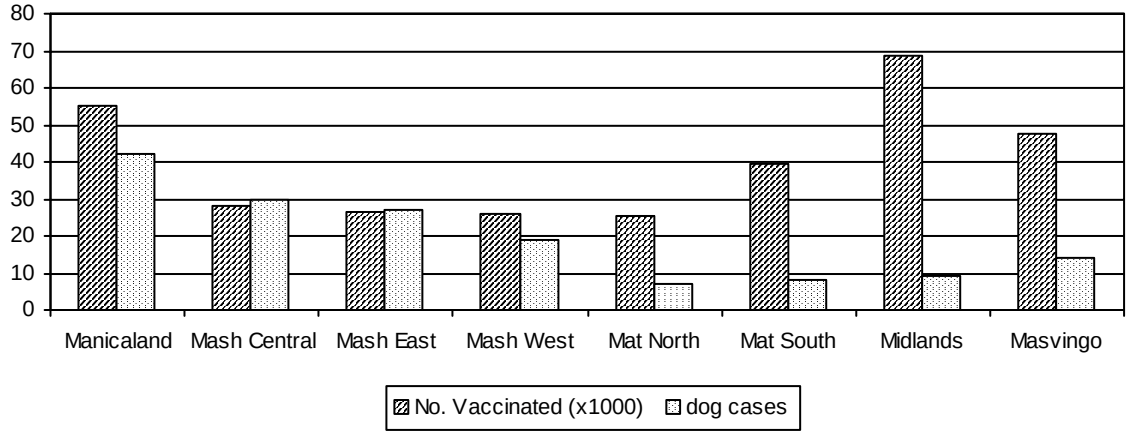


Table 1: Cases by species for the period 1999 and 2000.

Animal	1999		2000		Total	
	positives	tested	positives	tested	positive	tested
Bovine	95	218	93	182	188	400
Dog	156	243	126	196	282	439
Cat	6	18	12	24	18	42
Goat	17	19	16	22	33	41
Sheep	0	4	2	7	2	11
Jackal	94	115	61	75	155	190
Horse	3	4	2	4	5	8
Human	5	6	2	2	7	8
Donkey	5	7	4	4	9	11
Squirel	0	1	0	3	0	4
Mongoose	2	8	0	2	2	10
Honey badger	0	0	1	1	1	1
Serval	0	0	1	1	1	1
TOTALS	383	643	320	523	703	1166

NB: The percentage positivity on all specimens tested was 58% and 60% for 1999 and 2000 respectively.

Table 2: Number of dog cases confirmed positive after biting, handled or saliva coming in contact with people.

Mode of exposure	1999	2000
Bite	92/136	74/101
Handling	120/215	92/176
Saliva	13/28	15/24

The table shows the possibility of transmitting rabies to human beings through various ways. The probability of transmitting the disease is very high.

2 HUMAN RABIES POLICY IN ZIMBABWE.

Since dog and wild animal bites are considered as rabies potentially dangerous, health workers in conjunction with veterinary services department will check for the vaccination status of the dogs.

2.1 Dog/Animal bites.

For other animals like jackals and wolves it will be assumed that they are rabid.

For animals that do not usually bite people such as donkeys and cattle, each time they bite people such people are treated as having been bitten by rabid animals.

2.2 Definitions of terms.

Suspected case of rabies: anyone bitten by dogs suspected to be rabid, or any wild animal as quoted above

Human rabies case: anyone who has been in contact or bitten by animals and has signs and symptoms of rabies

2.3 Prevention of rabies in humans.

Pre-exposure: immunisations are given to vets, wildlife workers, and other animal handlers.

Post-exposure: following bites by animals suspected to be rabid, vaccinations are given.

2.4 Pre-exposure immunisation schedule.

The rabies vaccine produced on human diploid cells is used intramuscularly (3 x 0.5 ml doses on day 0, 7 and 28). After the first annual booster, another booster dose is given every 2-3 years if it is not possible to titrate the neutralising activity of the serum.

2.5 Post exposure treatment of cases.

Thorough cleaning of the wound with betadine or other antiseptic solutions is mandatory.

High risk: human rabies immunoglobulin @ 10 IU/kg once only instilled at site of injury and 10 IU/kg injected in the gluteal region once this is followed by rabies vaccine (human diploid cell) im @ 0.5 ml in each arm on day 0, then 0.5ml in one arm on day 7 and on day 21 (i.e.the 2-1-1 schedule).

Low risk: Where a domestic animal that is vaccinated against rabies is concerned or where there is no break in the skin, no immunoglobulin is given but the 2-1-1 rabies vaccination schedule is followed.

Minimal risk: discretion of health worker is used, otherwise a single dose of booster rabies vaccine will suffice.

3 ZIMBABWEAN HUMAN RABIES SITUATION 1995-2000.

Year	Suspected	Confirmed	Deaths
1995	70	7	4
1996	120	5	4
1997	199	4	1
1998	392	17	4
1999	51	6	2
2000	64	6	4

Anti-rabies vaccine consumption

Type	1999	2000
human rabies IgG	12	12
Human diploid	26 565	17 620

NB. The human diploid given includes pre-exposure and post exposure doses

4 CONTROL MEASURES.

Relationship between health and veterinary departments is excellent

Data on rabies, anthrax and other zoonotic conditions is shared weekly through weekly reports

Outbreaks are controlled as team

Stray animals are usually kept for monitoring by SPCA

Rabid animals are shot on site and brains taken for laboratory tests

DISCUSSION

Ethiopia.

Which diagnostic test for identification is used in Ethiopia?

Fluorescent antibody test is being used in Ethiopia.

Is there any evidence in Ethiopia of rabies virus excretions (after quarantine period?)

We follow WHO guidelines to quarantine the suspected rabid animal for 10 days and in the case that it stays alive no further post-exposure treatment is given to the person bitten.

Ethiopia is capable of producing human vaccine, why is this vaccine not recommended?

This vaccine is being used out of necessity and has been produced for the last 30 years to protect people. Although there is a risk of paralysis in 1/1000 persons, the country still has no other choice at this time.

Ethiopia and Botswana.

Ethiopia and Botswana use the FAT. However the number of samples submitted to the laboratory is very low. Are there any plans to increase the number of samples being sent to the laboratories?

The only diagnostic laboratory for rabies is located in Addis Ababa and most of the samples come from around the city. There are no regulations for persons to bring samples to the laboratory. The communication and transportation systems in the country are not well established in addition to funds being diverted for other diseases such as CBPP, FMD, PPR and Rinderpest.

Only positive animals were reported by Botswana. There are more samples submitted to the laboratory but have not been included into the report. In case of samples testing negative for rabies they will also be examined for TSE and Heartwater. In Botswana persons are aware about submitting samples.

Botswana.

It has been presented that in Botswana mostly rabies in ruminants is prevalent. Has the role of dogs as possible transmitters of rabies to ruminants been considered and the influence of eventual husbandry practices?

There is a need for more applied research, however the rabies cases in ruminants do not appear to be related to dog rabies cases. A wildlife reservoir is suspected but more studies are needed.

In Botswana, rabies in ruminants is very similar to what is observed in Namibia.

Are jackals being tested to investigate their relation to ruminant rabies in Botswana as it is done in Zimbabwe?

If extension officers come across dead jackals they will always send them in for testing. (Even decomposing samples have been sent in and tested positive)

Do you have any experience with tie-up orders causing opposition from animal welfare groups as it has been the case in Zimbabwe when through the Internet negative publicity has been given to the measure?

Yes, persons do not like it when animals are being shot. Nevertheless as stray dogs can be a nuisance to the public they can be supportive to the police and capture teams, especially when knowing that their children are at risk.

Are there other experiences with welfare organizations?

When the authorities in Uganda wanted to kill stray dogs in an area with rabies, the ministry received a massive number of e-mail after this news had been spread via the BBC. In this way welfare organizations can be counterproductive.

How were the rabies vaccination campaigns set up in Botswana?

First of all an awareness campaign via radio, newspaper, posters, etc. was organized. The campaign is always conducted at a national level generally during June/July for 1-2 months duration. Vaccination centers are put in villages or at cattle posts. After the central point campaign, the vaccinators will go from door to door in case the coverage has been low. Thereafter a tie-up order is given.

Eritrea.

Eritrea has presented quite a variation in the number of dogs vaccinated against rabies between the years. What could be the reason for this?

In 1996 there was a high incidence of rabies and this triggered vaccination campaigns for dogs, attaining a coverage of 40%. Thereafter, the number of cases were less, however, the availability of vaccine also decreased. This together with logistical problems led to a lower vaccination coverage in 1997 and 1998. For 2000 the vaccination coverage has increased again and the number of rabies cases reduced.

Malawi.

The histogramme presented by Malawi shows an increase in human rabies cases, why are persons not receiving adequate treatment. Has decentralization had any effect on the efficiency of rabies control?

The veterinary department only has control over the referral of a person bitten to hospital. From the hospital the responsibility lays in the hands of the medical personal. Communication between veterinary and medical staff has to be improved. The decentralization process has not been as positive as expected.

Malawi has mentioned that if nothing is done with regard to rabies control, there will be a crisis. In Zambia there is also a tendency for privatization resulting in some persons vaccinating dogs with water and charging for it.

The awareness is dropping as well as the vaccination coverage and the funds.

CESTAS project by EU was assumed to be sustainable through introducing full cost recovery but it failed for rabies control.

It was reported that a rat was found positive

Possibly it was a false positive case

Lesotho.

In Lesotho, samples are send to Onderstepoort for diagnosis, will this not result in underreporting, how are samples tested?

Any case reported will be observed for 10 days. If the dog dies, samples will be sent to Onderstepoort and the hospital notified to continue treatment. There is a very good record keeping system.

Mozambique and Malawi.

Dog-bites have been taken as indicators for rabies, however not all dog-bites result in rabies cases as shown by Mozambique where only 1.4% of persons bitten are vaccinated. Is this due to screening out or merely lack of vaccine?

Rabies in Malawi is mainly reported from urban areas. Rural areas underreport rabies. The veterinarian tries to find out if the bite was due to provocation of the animal or not. Therefore not every dog-bite is referred for PET.

For Mozambique the situation is similar. The cause of the bite is assessed and if there is any proof of vaccination.

South Africa.

Has Rabisin been licensed for ruminants?

Rabisin is licensed in South Africa to be used in ruminants, dogs, cats, sheep, horses and game animals.

What is the place of oral vaccination in the general vaccination policy

Baiting is not a "quick-fix" operation. Cost per bait is US$ 3.00. It is a good option to be used in inaccessible areas where dogs cannot be brought in for vaccination or where people are away. It should not be seen as a replacement for parenteral vaccination but as a complementary measure.

What data are there in South Africa that indicate that rabies spills over from jackals to dogs?

Evidence are the cycles in some areas. If more than 70% of dogs are vaccinated it will stop the cycle. In other areas, however, where jackals are not vaccinated, the disease keeps on popping up without going to dogs as to start a new cycle. For example, Soweto has many unvaccinated dogs and jackals nearby.

If dog and jackal rabies isolates are sequenced they are not distinguishable. This has been the case for South Africa and Zimbabwe.

The natural range of jackals is greater than that of dogs. The rabies strain in dogs is the same as in jackals.

The bat-eared fox rabies strain is distinguishable from dogs and jackals only to a minor extent.

Has there been any seroconversion studies done in South Africa?

No seroconversion studies have been done. Most of the work was done in kennels where some dogs did not seroconvert but however survived a challenge. Efficacy and innocuity studies were done in caged animals.

The bait vaccine can be expensive but can be handled by non-professionals.

KwaZulu Natal appears to be a hot-spot for rabies, why is it not controlled?

There has been an incredible success. In 1995 there were 412 animal cases in South Africa with 29 human deaths (all in Kwazulu Natal). By 1998 only 121 animal cases and 3 human deaths. Problems are due to persons having other priorities in life (e.g. money, education) and therefore it is difficult to get them motivated to have dogs vaccinated.

In RSA sylvatic rabies appears to be common, why is this not the case for Swaziland as it borders with RSA?

The situation in Swaziland is as in Kwazulu Natal where predominantly dog rabies exists and a very few cat cases.

Kenya.

Has the use of dog movement restriction been successful in Kenya?

In areas where legislation requires dogs to be confined or chained it is difficult to impose this measure. The legislation is not enforced. Some persons in rural areas have 10-15 dogs.

Dog movement restriction does not work as persons do not have the means to feed themselves and are not able to feed their dogs.

Over a 5 year period, 82 children under 12 died of rabies (72%) and 96% had been bitten by dogs. 85% of them had been bitten between Friday lunchtime and Sunday afternoon after the offices had been closed.

There could be a checklist to see if a dog can be categorized as feral or not. Does the person e.g. feed the dog, take it for vaccination, does it sleep more than 4 nights at the home?

How many human cases have been diagnosed antemortem? What percent were in children under 12 years and what percent had received PET?

As it appears, pathologists do not like to do post-mortem on rabies cases. Therefore they should be adequately immunized. In cases due to cultural beliefs it is difficult to get samples from humans. A specific method can be used by taking a sample with a straw transorbitally before the relatives refuse the post-mortem.

Swaziland.

Swaziland quotes high vaccination coverage (70-90%). How is it estimated?

Dogs are counted during livestock census and afterwards households without livestock are visited.. The reason why there still is rabies is that the turnover of the dog population is very high. A bi-annual vaccination could be looked into.

Why does Swaziland claim that no vaccinations could be done at an other time of the year? Doctors could be sensitized to treat rabid patients and receive pre-exposure to reduce risks.

When we got the vaccine for rabies, FMD was a priority at that moment. With regard to pre-exposure for medics the problem is the fast turnover of professionals in this field. Therefore it is difficult to built a strong team.

Why can rabies vaccine not be produced locally to reduce costs?

The number of dogs vaccinated locally could not sustain production and it is cheaper to import vaccine. However at present the eastern African cooperation is being revived and should cooperate on regional disease control. Nowadays quality is important.

Zambia.

The logistics of reporting dog rabies appears not to be efficient as first the person bitten needs to go to the police, then to the vet before getting treatment at the hospital. Especially for rural areas this appears to be a problem.

If a person does not report first to the police they will not receive treatment. Especially in case the dog has not been vaccinated the owner of the dog and the person bitten need to go to the police. In rural areas the community police are frequently present.

If the police are not involved there might be a some conflict occurring and sometimes persons forge vaccination certificates.

From my experience in Zambia as a district veterinarian it took a person sometimes very long to go through the whole procedure from police to vet to hospital. It does not appear to be very efficient.

The bovine cases appear to be mostly in the commercial farms. There has also been a case of a donkey chasing to bite somebody

In ruminants the choking syndrome can pose a risk to humans

In Namibia mostly in the rural densely populated areas there is a more urban type rabies cycle as in Swaziland where the dog is the main transmitter.

Uganda.

How was the experience of privatization in Uganda?

Although the decision had been taken 8 years ago, the process only started last year where 9 out of 500 veterinarians have gone private.

Bat rabies

THE BAT LYSSAVIRUSES OF AFRICA

John Bingham[1]

Two of the seven genotypes of lyssaviruses have been reported from African bats: Lagos bat virus and Duvenhage virus. This paper will focus on these two viruses. Two other lyssaviruses are also present in Africa, but have not been reported from bats. The first of these, classical rabies virus, cycles in domestic dogs throughout most of the continent and in various wild Carnivora (Canidae, Herpestidae and possibly Viverridae) in the southern regions of the continent. The second, Mokola virus has been isolated from domestic cats, a dog, shrews, a rodent and human beings. Its host species is not known and may indeed be a species, or several species, of bat, but no evidence is yet available to support this. Arthropod-borne viruses, Obodhiang and kotonkan, which are closely related to the lyssaviruses have been isolated in Africa (Bauer and Murphy, 1975; Kemp *et al.*, 1973). It is possible that these viruses are similar to the evolutionary progenitor virus of the lyssaviruses, but their correct taxonomic placement remains unclear.

1 LAGOS BAT VIRUS.

First isolated in 1956 by Boulger and Porterfield (1958) during a survey for rabies in bats, this virus was not initially recognised as being similar to rabies. It was isolated by mouse inoculation from a pool of brains and salivary glands of male fruit bats (*Eidolon helvum*) that had been collected from a tree roost on Lagos Island in Nigeria. It was not until some years later, following the isolation of Mokola virus, that this isolate was recognised as being a Rhabdovirus with serological similarities to rabies virus (Shope *et al.*, 1970).

It was next isolated in the Central African Republic in 1974, (Sureau *et al.* 1977; Sureau *et al.*, 1980) in a dwarf epauletted fruit bat (*Micropterus pusillus*).

During the years 1980 and 1981 an epizootic of Lagos bat virus occurred around Durban, in the eastern coastal region of South Africa. The host was probably the common epauletted fruit bats (*Epomophorus wahlbergi*) although only one bat was identified. The infections, of which 13 were reported, were diagnosed by the routine fluorescent antibody test for rabies, which did not distinguish the virus from rabies (Meredith and Standing, 1981). These bats were generally submitted by members of the public after being found dead or sick. Other suspected cases, for example the case of a bat that attacked and bit a motorcyclist in the face (Meredith and Standing, 1981), were assumed to have been infected with the virus but were not submitted for confirmation. The isolates were first characterised and classified by using serological tests (Crick *et al.*, 1982), and later by the use of monoclonal antibodies. One report, now considered to be incorrect, indicated that this was Mokola virus (Schneider *et al.*, 1985).

In 1985 two isolates were reported from Senegal. One was from a fruit bat (*Eidolon helvum*) but the second was, interestingly, from an insectivorous bat, *Nycteris gambiensis* (cited by Foggin, 1988; Swanepoel, 1994).

The next report of Lagos bat virus was in 1986 from a vaccinated domestic cat from Dorowa in Zimbabwe (Foggin, 1988). This cat was a routine rabies submission.

In 1990 the virus was identified in another fruit bat (*E. wahlbergi*) in Durban, South Africa.

A further case was reported from Ethiopia in a dog (Mebatsion *et al.*, 1992).

The most recent isolate was made in France in 1999. This case was in a fruit bat that had been imported from the African continent, via Belgium, as an exotic pet. It had presumably acquired the infection from Africa over four months before it died.

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To date Lagos bat virus has not been reported in a human victim or to cycle in any terrestrial mammal population.

Table 1: Isolations of Lagos bat virus.

Locality	Date	Species	Number of isolates	Reference
Lagos, Nigeria	1956	Fruit bats, (*Eidolon helvum*)	1 (pool of 6)	Boulger and Porterfield; 1958; Shope *et al.*, 1970
Bozo, Central African Republic	1974	Dwarf epauletted fruit bat(*Micropterus pusillus*)	1	Sureau *et al.*, 1977
Durban, South Africa	1980 - 1982	Fruit bats, (*Epomophorus wahlbergi*)	13	Meredith & Standing, 1981; Crick *et al.*, 1982
Senegal	1985	*Nycteris gambiensis* and *Eidolon helvum*	2 ?	Anon, 1985 (cited by Foggin, 1988)
Dorowa, Zimbabwe	1986	Domestic cat	1	Foggin, 1988
Durban, South Africa	1990	Fruit bats, (*Epomophorus wahlbergi*)	1	Swanepoel, 1994
Ethiopia	Pre 1992 (1982?)	Domestic dog	1	Mebatsion *et al.*, 1992
France (ex "Africa")	1999	African roussette fruit bat	1	Promed posting 13 August 1999

2 DUVENHAGE VIRUS.

Three isolates of Duvenhage virus have been made. The first case occurred in 1970 in a man who lived in the Warmbaths area, north of Pretoria (Meredith *et al.*, 1971). Five weeks before succumbing to the virus he had been attacked and bitten on the lip by an insectivorous bat while asleep at night. This man suffered from a disease clinically indistinguishable from rabies and after his death rabies was diagnosed histologically. Rabies fluorescent antibody tests on the original brain and on the brains of mice that died after inoculation of the virus were negative. Serological characterisation of the isolate confirmed it to be related to, but different from rabies.

In 1981 a further isolate was made in a microchiropterid bat from northern South Africa and the third isolate was found during a bat survey conducted in 1986 near Bulawayo, Zimbabwe.

It was initially thought that the European bat lyssaviruses were of the same species as Duvenhage virus as no serological differences could be distinguished between the two. However, monoclonal antibody and gene sequencing studies indicated that the groups were distinct species. Hence, early references to the European bat lyssaviruses refer to them as Duvenhage virus.

Table 2: Isolations of Duvenhage virus

Locality	Date	Species	Number of isolates	Reference
Warmbaths, South Africa	1970	Human	1	Meredith *et al.*, 1971
Louis Trichardt, South Africa	1981	Microchiropterid bat (possibly *Miniopterus schreibersii*)	1	Swanepoel, 1994
Bulawayo, Zimbabwe	1986	Bat (*Nycteris thebaica*)	1	Foggin, 1988

3 OTHER BAT LYSSAVIRUS ISOLATIONS.

In a survey of bats carried out in the late 1950s and early 1960s in South Africa one bat (*Nycteris thebaica*) collected from north-eastern South Africa was reported to be positive for rabies on the mouse inoculation test and histopathology (Onderstepoort Veterinary Institute, unpublished data; Swanepoel, 1994). No isolate was retained.

Rabies was diagnosed in a bat brain from Messina in northern South Africa in November 1992. The brain had been fixed in formalin and was tested by histological stains. No brain specimen remained after the tests, therefore this isolate was never characterised. (Onderstepoort Veterinary Institute, unpublished data)

In 1996 rabies was detected from an unidentified Zambian bat that had been found dead (Ahmadu and Zulu, 1998). The diagnosis was made by fluorescent antibody tests on the bat's brain and on the brains of mice that died after inoculation of brain suspension. No other details of this virus isolate are available.

Several surveys of bats for lyssaviruses have been made. These include the surveys described above from Onderstepoort in the early 1960s and Foggin's survey (1988) of Zimbabwean bats in the 1980, which resulted in one "rabies" and one Duvenhage isolate respectively. Another South African survey found no rabies in 530 bats using the RREID test (Oelofsen and Smith, 1993). A recent ongoing South African survey to test over 60 brains from bat museum specimens and bats submitted by the public for rehabilitation has not yielded any lyssaviruses (Onderstepoort Veterinary Institute, unpublished data).

4 DIAGNOSIS OF BAT LYSSAVIRUSES IN AFRICA.

The laboratory confirmation of non-rabies lyssaviruses has been difficult. Many standard diagnostic procedures either do not detect infection, or detect infection but do not differentiate it from rabies. Some non-rabies lyssaviruses have almost certainly gone undetected due to these diagnostic limitations.

The first isolates of Mokola virus found in Zimbabwe (Foggin, 1982, 1983) were diagnosed negative using rabies fluorescent antibody tests. Infection was detected because suspensions of the specimens were inoculated into mice, which subsequently died and displayed weakly fluorescing brain antigen on FA tests. The recognition of one Mokola isolate from Pietermaritzburg (South Africa) in 1998 followed a similar pattern. Many other non-rabies lyssavirus isolates were initially reported positive for rabies, but were only recognised as unusual following serological or antigenic characterisation, in some cases many years after their initial isolation (Meredith *et al.*, 1996; Bingham *et al.*, 2001). In some cases suspicions were aroused by the cases' unusual histories (e.g. vaccinated animals) and epidemiology (eg from areas currently free of rabies) and by the dull fluorescence on the FA test.

Solutions to the diagnostic difficulties presented by lyssaviruses can be approached in different ways. Our approach, taken at the Rabies Unit, Onderstepoort, is described as an example. We were careful to bear in mind that we did not only have to detect rabies and other known lyssaviruses, but also the possibility of unknown lyssavirus variants. Our approach was as follows:

1. The initial diagnosis was carried out using a high quality polyclonal conjugate generated against both rabies (SAD) and Mokola purified nucleocapsid proteins. The nucleocapsid protein was inoculated into goats and serum harvested when indirect FA test titres exceeded 1:30 000. After conjugation the conjugate was tested and found to detect all four African genotypes (rabies, Lagos bat, Mokola and Duvenhage) at a dilution of at least 1/500 on the direct FA test. We did not use monoclonal conjugates, as we did not have the surety that they would recognise unusual antigenic variants and mutants. For example, at least one commonly used commercial monoclonal conjugate did not detect South African herpestid genotype 1 variants.
2. Each positive isolate was then typed on a panel of 20 anti-nucleocapsid monoclonal antibodies, which had been specifically selected to recognise routine and unusual southern African variant lyssaviruses.
3. Where there was any uncertainty, either in the initial diagnosis or the typing procedure, the specimens were inoculated intracerebrally into suckling mice, which were observed for signs of infection for 2 - 28 days. The brains of any dead mice were tested on the FA test and monoclonal antibody panel.

5 EFFICACY OF RABIES VACCINES.

Lyssaviruses appear to cause diseases in people and animals that are very similar clinically and prognostically to rabies. Lagos bat virus is the only lyssavirus that has not been reported to cause human deaths, however, given its pathogenic and pathological similarity to other lyssaviruses in animal models (Murphy *et al.*, 1973a,b; Tignor *et al.*, 1973), it must be assumed to be equally fatal during human infections.

There are no commercially available vaccines against non-rabies lyssaviruses. Therefore, are the current rabies vaccines effective for other lyssaviruses? Evidence from field studies suggest that rabies vaccines are ineffective against Mokola virus and probably also ineffective against Lagos bat virus, as many of the cats diagnosed with Mokola virus and one with Lagos bat virus in South Africa and Zimbabwe were vaccinated (Von Teichman *et al.*, 1998; Foggin, 1988). Vaccination models in laboratory animals and in vitro systems suggest that rabies vaccines will be reasonable effective in protecting against Duvenhage virus, but ineffective against Lagos bat or Mokola viruses (Fekadu *et al.*, 1988; Badrane *et al.*, 2001).

6 WHAT IS THE SIGNIFICANCE OF BAT LYSSAVIRUSES IN AFRICA?

Duvenhage virus was reported to be responsible for the death of one person, while Lagos bat virus has not caused any reported human deaths. Although both viruses are likely to have caused other deaths that have not been reported, it is obvious that the public health significance of bat lyssaviruses is not great. Compared to HIV/AIDS, tuberculosis, malaria and even rabies, bat lyssaviruses must justifiably rank low in the priority of public health concerns in Africa.

Nevertheless, it is important that virologists and clinicians in Africa remain vigilant. Bat lyssaviruses are potentially fatal and anyone bitten by a bat must receive rabies treatment, unless the offending bat can be proven to be negative for lyssavirus. Even so, rabies vaccines are not optimally effective against Lagos bat virus (Badrane *et al.*, 2001). These viruses can also cause death in pets, which may transmit the virus to people. It is possible that bat lyssaviruses may establish cycles in terrestrial mammal populations. Although improbable, if such an event were to occur the importance of the virus would increase considerably as it would become more threatening to human and livestock populations.

7 IMPROVING THE UNDERSTANDING OF BAT LYSSAVIRUSES IN AFRICA.

Despite the low public health priority of bat lyssaviruses in Africa, basic research on them should continue, as this will assist in our understanding of lyssaviruses worldwide, and help us to understand how to control future infections and outbreaks. Our understanding of bat lyssavirus is hampered mainly by our lack of knowledge of their epidemiology, caused mainly by the low detection rate of the viruses.

Virus surveys should be conducted on sick or dead bats by analysis of brain specimens. It is not advisable to conduct surveys of normal healthy bats as this is unlikely to yield viruses and may be detrimental to the survival of some bat populations. Sources of bats include: sick and dead bats collected from caves and roosts, carcasses from animal rehabilitation centres, individuals submitted by members of the public and specimens from natural history museums. It is important that bat taxonomists correctly identify carcasses. All isolates must be kept for future analysis by storage of original bat brain or first passage mouse brain material and duplicate samples of the isolate must be sent to a separate reference laboratory for safe keeping.

REFERENCES.

AHMADU B. AND ZULU L. N. K. – 1998 - Rabies in a Zambian bat. *The Veterinary Record*, **143**,148.

ANON 1985 Isolation of Lagos Bat virus in West Africa. *Internal Reports of Centre Collaborateur OMS de Référence et Recherche pour les Instituts Pasteur*, Paris. Cited by Foggin 1988.

BADRANE H., BAHLOUL C., PERRIN P. AND TORDO N. – 2001 - Evidence of two lyssavirus phylogroups with district pathogenicity and immunogenicity. *Journal of Virology*, **75**, 3268-3276.

BAUER S.P. AND MURPHY F.A. – 1975 - Relationship of two arthropod-borne rhabdoviruses (Kotonkan and Obodhiang) to the rabies serogroup. *Infection and Immunity*, **12**, 1157-1172.

BINGHAM J., JAVANGWE S., SABETA C.T., WANDELER A.I. AND NEL L.H. – 2001 - Report of isolations of unusual lyssaviruses (rabies and Mokola virus) identified retrospectively from Zimbabwe. *Journal of the South African Veterinary Association*, **72**, 92-94.

BOULGER L. R. AND PORTERFIELD J. S. – 1958 - Isolation of a virus from Nigerian fruit bats, *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **52**, 421-424.

CRICK J., TIGNOR G.H. AND MORENO K. – 1982 - A new isolate of Lagos bat virus from the Republic of South Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **76**, 211-213.

FEKADU M., SHADDOCK J.H., SANDERLIN D.W. AND SMITH J.S. - 1988 - Efficacy of rabies vaccines against Duvenhage virus isolated from European house bats (*Eptesicus serotinus*), classic rabies and rabies-related viruses. *Vaccine*, **6**, 533-539.

FOGGIN C.M. – 1982 - Atypical rabies virus in cats and a dogs in Zimbabwe. *The Veterinary Record*, **110**, 338.

FOGGIN C.M. – 1983 - Mokola virus infection in cats and a dog in Zimbabwe. *The Veterinary Record*, **113**, 115.

FOGGIN C.M. - 1988 - Rabies and rabies-related viruses in Zimbabwe: historical, virological and ecological aspects. *DPhil thesis*, University of Zimbabwe

KEMP G.E., LEE V.H., MOORE D.L., SHOPE R.E., CAUSEY O.R. AND MURPHY F.A. – 1973 - Kotonkan, a new rhabdovirus related to Mokola virus of the rabies serogroup. *American Journal of Epidemiology*, **98**, 43-49.

MEBATSION T., COX J.H. AND FROST J.W. – 1992 - Isolation and characterization of 115 street rabies virus isolates from Ethiopia by using monoclonal antibodies: Identification of 2 isolates as Mokola and Lagos Bat viruses. *The Journal of Infectious Diseases*, **166**, 972-977.

MEREDITH C.D., ROSSOUW A.P. AND PRAAG KOCH H.V. – 1971 - An unusual case of human rabies thought to be of chiropteran origin. *South African Medical Journal*, **45**, 767-769.

MEREDITH C. D. AND STANDING E. – 1981 - Lagos bat virus in South Africa. *The Lancet*, 832-833.

MEREDITH C.D., NEL L.H. AND VON TEICHMAN B. F. – 1996 - Further isolation of Mokola virus in South Africa. *The Veterinary Record*, **138**, 119-120.

MURPHY F.A., BAUER S.P., HARRISON A.K. AND WINN W.C. – 1973 - Comparative pathogenesis of rabies and rabies-like viruses. Viral infection and transit from inoculation site to the central nervous system. *Laboratory Investigation*, **28**, 361-376.

MURPHY F.A., HARRISON A.K., WINN W.C. AND BAUER S. P. – 1973 - Comparative pathogenesis of rabies and rabies-like viruses. Infection of the central nervous system and centrifugal spread of virus to peripheral tissues. *Laboratory Investigation*, **29**, 1-16.

OELOFSEN M.J. AND SMITH M.S. – 1993 - Rabies and bats in a rabies-endemic area of southern Africa: application of two commercial test kits for antigen and antibody detection. *Onderstepoort Journal of Veterinary Research*, **60**, 257-260.

SCHNEIDER L.G., BARANARD B.J.H. AND SCHNEIDER H.P. - 1985 – Application of monoclonal antibodies for epidemiological investigations and oral vaccination studies. I- African viruses. *in* "Rabies in the Tropics" E. Kuwert *et al.* eds, 47-53..

SHOPE R.E., MURPHY F.A., HARRISON A.K., CAUSEY O.R., KEMP G.E., SIMPSON D.I.H. AND MOORE D.L. – 1970 - Two African viruses serologically and morphologically related to rabies virus. *Journal of Virology*, **6**, 690-692.

SUREAU P., GERMAIN M., HERVE J.P., GEOFFROY B., CORNET J.P., HEME G. AND ROBIN Y. – 1977 - Isolement du virus Lagos bat en empire Centrafricain. *Bulletin de la Societe de Pathologie Exotique*, **70**, 467-470.

SUREAU P., TIGNOR G.H. AND SMITH A.L. – 1980 - Antigenic characterization of the Bangui strain (ANCB-672d) of Lagos bat virus. *Ann.Virol.(Inst.Pasteur)*, **131E**, 25-32.

SWANEPOEL R. – 1994 - Rabies. in *Infectious Diseases of Livestock with special reference to Southern Africa*. Volume One, J. A. W. Coetzer, G. R. Thomson and R. C. Tustin, eds., Oxford, pp. 493-552.

TIGNOR G.H., SHOPE R.E., BHATT P.N. AND PERCY D. H. – 1973 - Experimental infection of dogs and monkeys with two rabies virus serogroup viruses, Lagos bat and Mokola (IbAn 27377): clinical, serologic, virologic, and fluorescent antibody studies. *Journal of Infectious Diseases*, **128**, 471-478.

VON TEICHMAN B.F., KOKER W.C.D., BOSCH S.J.E., BISHOP G.C., MEREDITH C.D. AND BINGHAM J. – 1998 - Mokola virus infection: description of recent South African cases and a review of the virus epidemiology. *Journal of the South African Veterinary Association*, **69**, 169-171.

MOKOLA VIRUS: A BRIEF REVIEW OF THE *STATUS QUO*.

L.H. Nel[1]

1 INTRODUCTION.

Mokola virus is the genotype 3 member of the Genus *Lyssavirus* within the Family *Rhabdoviridae* of which all members, whether fish, animal or plant virus, share the same very characteristic enveloped bullet-shape morphology. Like rabies virus, the prototype lyssavirus, Mokola virus causes an acute encephalomyelitic disease. Whereas rabies is probably the most important and definitive viral zoonosis worldwide, Mokola virus infection has to date been reported from the African continent only (Nel *et al.*, 2000). Two other lyssaviruses, Duvenhage and Lagos Bat virus (genotypes 4 and 2, respectively) also seems to be unique to the African continent (Swanepoel *et al.*, 1993). The remaining lyssavirus genotypes appear to be exclusive to Eurasia (genotypes 5, 6; European Bat Lyssaviruses) and to Australia (genotype 7; Australian Bat Lyssavirus, Gould *et al.*, 1998).

2 HISTORY OF MOKOLA VIRUS ISOLATIONS.

Very little is known about the epidemiology of the African rabies-related viruses. The isolation of Mokola virus has been reported rather haphazardly from only a small number of African countries where appropriate investigations have been undertaken (Figure 1). Mokola is the only lyssavirus never isolated from bats, but it has been found in a surprisingly diverse host range, considering the small number of virus isolates. The first isolation of the virus was already made in 1968, from organ pools of shrews in Nigeria (Kemp *et al.*, 1972). Thereafter the virus was isolated from man (Nigeria – 1969/71 – Familusi and Moore, 1972; Familusi *et al.*, 1972), again from shrews (Cameroon, 1974 – Le Gonidec *et al.*, 1978), from a rodent (Central African Republic, 1983 – Saluzzo *et al.*, 1984), from domestic cats and a dog (Zimbabwe, 1981/82/93 – Foggin, 1983; Bingham *et al.*, 2001) and again in 1989 from a cat in Ethiopia (Mebatsion *et al.*, 1992). All isolations of Mokola in South Africa were made from domestic cats; first in 1970 (described in Schneider *et al.*, 1985), with the next isolates only made many years later, from 1995 to 1998 (Von Teichman *et al.*, 1998; Nel *et al.*, 2000).

3 MANIFESTATION OF DISEASE.

Disease caused by Mokola virus-infection is rabies-like in clinical manifestation. In fact, it is likely to be the good rabies surveillance programme (and improved lyssavirus diagnostics) that led to the recent isolations of Mokola in South Africa, which were all made from domestic cats with suspicious rabies-like symptoms. In the two human cases reported, both young girls, the symptoms were fever and convulsion (with full recovery) in one case and drowsiness, paralysis and terminal coma in the second case (Familusi and Moore, 1972; Familusi *et al.*, 1972). One distinction between typical rabies infection and Mokola infection in domestic cats, seem to be the lack of unprovoked aggression in the latter. However, as with rabies, unusual behaviour, neurological disturbance, hypersensitivity, dehydration and salivation have been most commonly reported in the cases of Mokola infection of domestic animals (von Teichman *et al.*, 1998).

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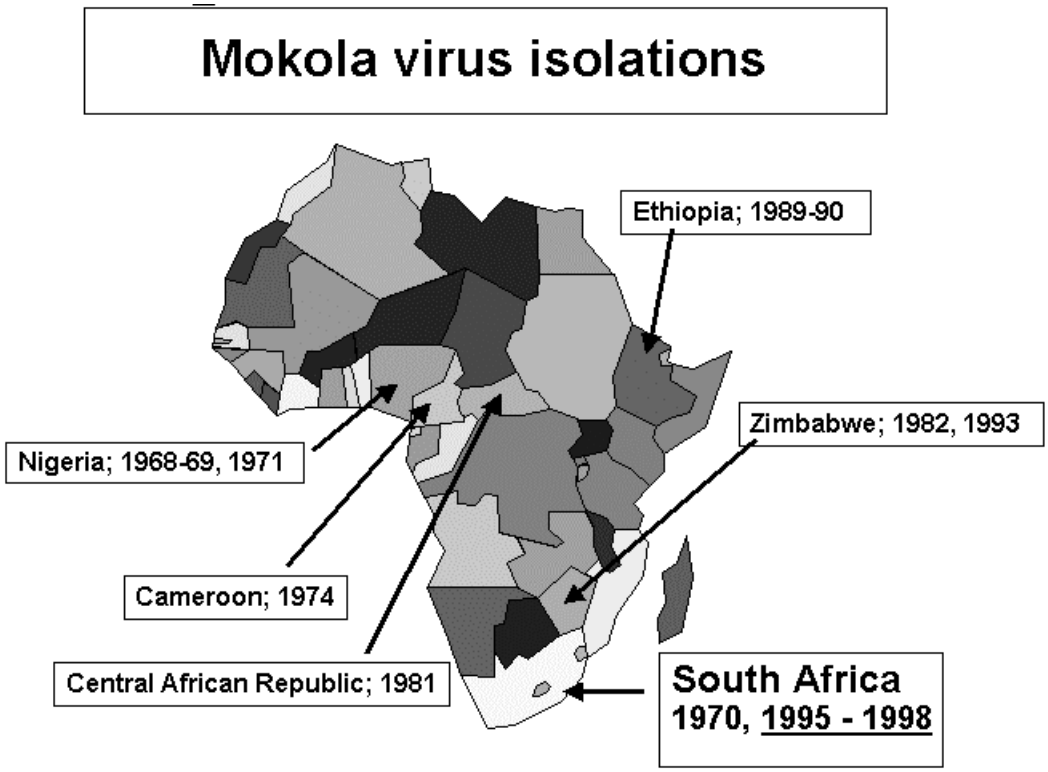
Figure 1: Geographical locations and dates of Mokola virus isolations.



4 EPIDEMIOLOGY.

Of all the lyssavirus genotypes, Mokola is genetically most distant from rabies, as demonstrated with serological studies (King and Crick, 1988) and through analyses of specific genomic nucleotide sequences (Bourhy *et al.*, 1993). When Mokola virus isolates from southern Africa were analysed genetically, they were found to display a phylogenetic clustering arrangement which were in perfect agreement with their geographical sites of isolation, with one of the clusters composed of viruses which were isolated over a time period of 28 years (Nel *et al.*, 2000; Figures 2 and 3). This striking geographical influence over Mokola virus evolution is in agreement with observations on the molecular epidemiology of classical rabies viruses associated with wildlife in southern Africa and elsewhere (Unpublished data; Nadin-Davis *et al.*, 1999).

A phylogenetic analysis of the full-length glycoprotein sequences of Mokola virus and comparison with the glycoproteins of a wide range of rabies virus isolates indicates a comparable degree of variation within the two Genotypes (not shown). The significance of the finding lies in the fact that the genetic variation among only four isolates of Mokola (3 from southern Africa and one from Ethiopia) more or less equals the variation found among the most diverse classical rabies virus isolates from various host species throughout the world.

Figure 2: Geographical locations and numbers of Mokola virus isolates from southern Africa.

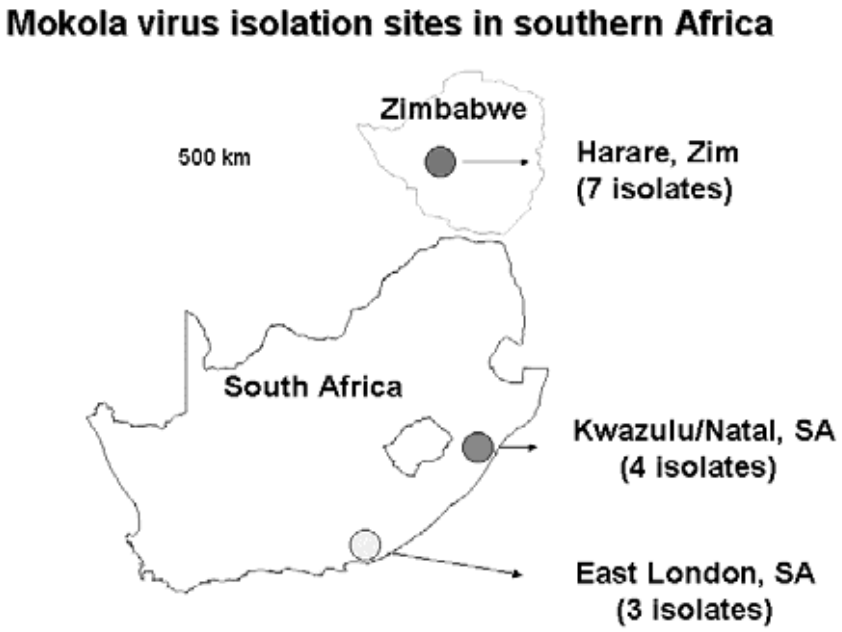
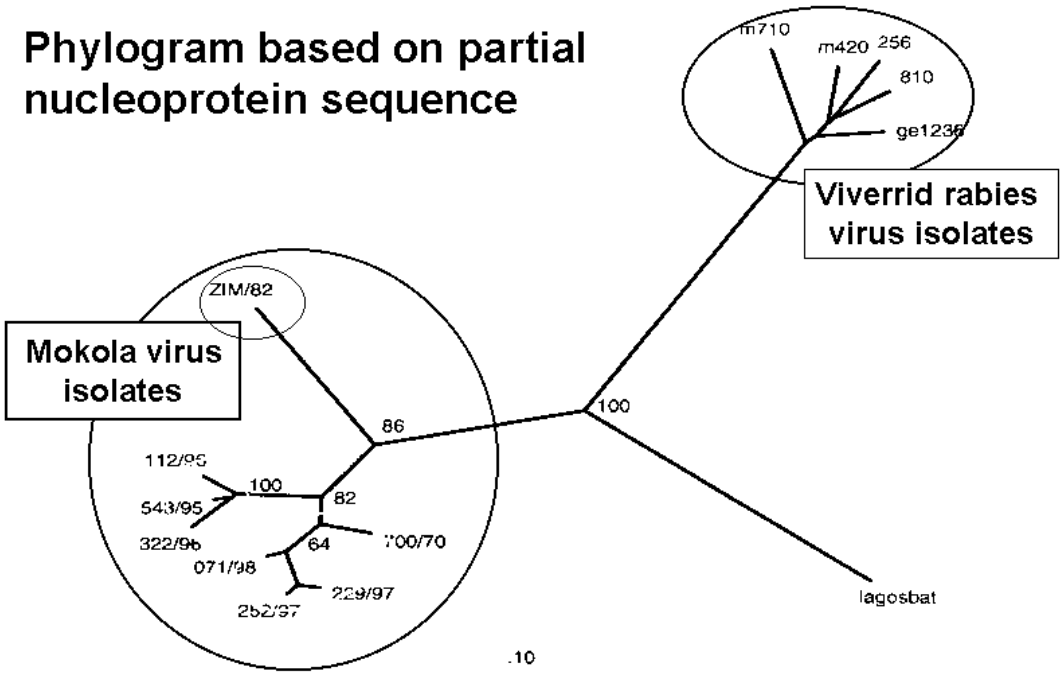


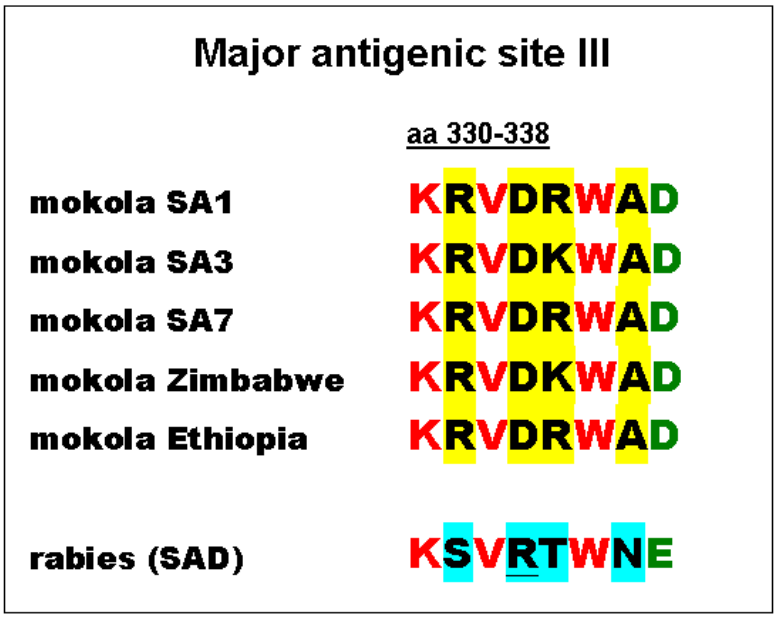
Figure 3: Phylogenetic reconstruction indicating the relationship of rabies viruses, a Mokola isolate from Zimbabwe (Zim 82), seven South African isolates of the Mokola virus and an isolate of Lagos bat virus (see Figure 2 for geographical locations). The rabies virus genotype is represented by a group of viruses isolated from Herpestid species in South Africa. The inferred phylogeny is based on sequence alignment of the N1-N2 nucleoprotein gene sequences as previously described (Nel *et al.*, 2000).



5 VACCINES.

For lyssaviruses, the trimeric transmembrane glycoprotein (G) induces neutralizing antibodies and a large variety of rabies vaccines based on the delivery of this antigen confer protection against challenge with rabies virus (e.g. Perrin *et al.*, 1985). In a comparison of the most important known antigenic domains of the G proteins of six Mokola viruses with rabies, several important dissimilarities were found. One of these was found in the antigenic domain III (Figure 4). It is well known that the context of this domain and the Arg333 specifically, determines the integrity of this antigenic site and the ability of rabies virus to produce lethal infection in mice (Dietzschold *et al.*, 1983). Variations within this domain thus affect antigenicity as well as pathogenicity. In the case of rabies virus the important sites around Arg333 are all occupied by neutral amino acids (Figure 4). However, for all five Mokola viruses analysed, this domain differs significantly with that of rabies – with aspartic acid occupying position 333 and with two basic amino acids and one aliphatic amino acid in the important surrounding sites (highlighted in Figure 4). It is thus no surprise that rabies vaccines will not protect against Mokola infection in studies with mice and it has also been shown that rabies hyper-immune human sera very poorly cross-neutralizes Mokola virus (CDC, unpublished; Bahloul *et al.*, 1998; Nel *et al.*, submitted). Failure of rabies vaccination to protect against Mokola has also been demonstrated with a dog in Zimbabwe (Foggin, 1983) and by the most recent cases of the disease in cats in South Africa - most of these animals were in fact vaccinated against rabies, as required by law for domestic animals in this part of South Africa (Von Teichman *et al.*, 1998).

Figure 4: Dissimilarities in the glycoprotein antigenic domain III of Mokola virus isolates and rabies virus. Details are described in the text.



A second antigen that may also contribute to immunity against lyssaviruses, is the nucleoprotein (N), which tightly enfolds the viral RNA in a nucleocapsid structure. Although rabies N does not elicit neutralizing antibodies, it has been found to induce protective immunity under circumstances where vaccinated animals are challenged peripherally (Dietzshold *et al.*, 1988; Dietzshold *et al.*, 1989).

Several individual research groups have experimented with the use of DNA vaccines for protection against rabies (eg. Xiang *et al*., 1994; Bahloul *et al.*, 1998; Osorio *et al*., 1999), Experimentation towards cross-reactive DNA vaccines, including the generation of chimeric lyssavirus glycoproteins (G) for rabies, Mokola and European bat lyssaviruses have also been described (Bahloul *et al*., 1998; Jallet *et al.*, 1999). We have cloned the glycoprotein and nucleoprotein (N) genes from South African

Mokola viruses, and used these in the construction of different DNA vaccines for immunization against Mokola virus (Nel *et. al.*, submitted).

Current thinking is that DNA vaccines may be most useful in combination with other vaccines (Williamson *et al.*, 2000). Priming with a DNA vaccine prior to boosting with a live recombinant vector may significantly enhance the cellular immune responses to the recombinant protein; as reported for diseases such as malaria (DNA vaccination followed by boosting with modified Vaccinia Ankara (MVA)-recobinant, Schneider *et al.*, 1998) and with Human Immunodeficiency Virus (HIV)-infection (Kent *et al.*, 1998). Expressing only the gene of interest may serve to focus the immune response on these specific proteins. As a model for the utility of DNAvaccine/live recombinant vaccine prime/boost strategy, we have investigated whether enhanced crossprotection may be achieved with DNA/recombinant lyssavirus vaccine combinations. To date we have been unable to demonstrate any stimulation of a cross-reactive immune response using a variety of such combinations (unpublished), but cross-reactive protection in mice have been achieved with vectors which express chimeric lyssavirus genes (Bahloul *et al.*, 1998; Jallet *et al.*, 1999).

6 POSTEXPOSURE TREATMENT.

For rabies, the establishment of an effective post exposure vaccination regimen has been immensely useful in protecting against the disease. It may be assumed that the same would be true for Mokola virus, provided that dedicated biologicals are developed for such application. Conjectured from our experience with pre-exposure vaccination studies, it is likely that rabies-specific post exposure biologicals will not be effective against Mokola infection. Unfortunately, the DNA vaccines for Mokola so far developed may be at a disadvantage in post exposure application, due to the relatively slow humoral antibody responses elicited by these types of vaccines under conventional administration.

7 CONCLUSION.

Mokola virus has twice been isolated from humans and once from a dog, but most isolations to date have been from rabid cats (15 isolates) or small mammals (shrews – 5 isolates, rodent – 1 isolate). The central role of domestic cats along with small mammal species in the epidemiological evidence to our disposal allures speculation that small mammals, likely prey species for cats, serve as reservoir species for Mokola virus. Strengthening an argument for the likelihood of a bat reservoir for Mokola, is the fact that bats play an important or exclusive role in the epidemiological cycles of all the other lyssaviruses. Nevertheless, a recent survey (using the fluorescent antibody assay with a broad-spectrum conjugate) of 315 bats and 133 small mammals collected throughout South Africa, failed to indicate the presence of lyssavirus-specific antigens (W Hechter, unpublished results).

Mokola virus is a potentially dangerous agent. Our poor understanding of the reservoir of Mokola, its apparently underestimated incidence, its likely wide host range, its proven zoonotic potential (Familusi *et al.*, 1972), the failure of protection by rabies vaccines and the absence of any post-exposure treatment regimen are discomforting. At risk of contracting encephalomyelitis from Mokola infection would be veterinarians, laboratory personnel (particularly those associated with rabies diagnostics) and others in regular contact with animals or samples which may expose them to Mokola virus.

However, to date the African rabies-related viruses like Mokola have mostly received attention because of scientific curiosity and interest in peculiar aspects of their epidemiology and pathogenicity (Von Teichman *et al.*, 1998; Nel, *et al.*, 2000; Foggin, 1988; CDC unpublished) or as models in molecular virology, for example in chimeric virus construction and study of defective interfering particles (Mebatsion *et al.*, 1995) or in studies of immunogenicity and in studying vaccine development (Nel *et al.*, submitted; Bahloul *et al.*, 1998). Among the lyssaviruses of Africa, with consideration of the abundance of rabies virus and the very serious problems associated with classical rabies in wildlife, domestic animals and man throughout our continent, the rabies-related viruses will probably have to remain, for the time being, mostly “of interest”.

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REFERENCES.

BAHLOUL C., JACOB Y., TORDO N. AND PERRIN P. – 1998 - DNA-based immunization for exploring the enlargement of immunological cross-reactivity against the lyssaviruses. *Vaccine,* **16**, 4, 417-425.

BOURHY H, KISSI B. AND TORDO N. – 1993 - Molecular diversity of the Lyssavirus genus. *Virology*, **194**, 70-81.

BINGHAM J., JAVANGWE S., SABETA C., WANDELER A.I. AND NEL L.H. – 2001 - Report of isolations of unusual lyssaviruses (rabies and Mokola virus) identified retrospectively form Zimbabwe. *J. South Afr. Vet. Ass.*, **72**, 2, 92-94.

DIETZSCHOLD B., LAFON M., WANG H., OTVOS L.J., CELIS E., WUNNER W.H. AND KOPROWSKI H. – 1989 - Analysis of protective immune mechanisms induced by rabies nucleoprotein, *In* Genetics and pathogenicity of negative strand viruses, edited by D Kolakofsky and BWJ Mahy. Elsevier Science Publishers BV, Amsterdam, p295-305.

DIETZSCHOLD B., WANG H., RUPPRECHT C., CELIS E., TOLLIS M., ERTE H., HEBERKATZ E. AND KOPROWSKI H. – 1987 - Induction of protective immunity against rabies by immunization with rabies virus ribonucleoprotein. *Proc Natl Acad Sci USA*, **84**, 9165-9169.

FAMILUSI J.B. AND MOORE D.L. – 1972 - Isolation of a rabies-related virus from the cerebrospinal fluid of a child with aseptic meningitis. *African Journal of Medical Science*, **3**, 93-96.

FAMILUSI J.B., OSUNKOYA B.O., MOORE D.L., KEMP G.E. AND FABIYI A. – 1972 - A fatal human infection with Mokola virus. *American Journal of Tropical Medicine and Hygiene*, **21**, 959-963.

FOGGIN C.M. – 1983 - Mokola virus infection in cats and a dog in Zimbabwe. *Veterinary Record*, **113**, 115.

FOGGIN C.M. – 1988 - Rabies and rabies-related viruses in Zimbabwe: Historical, virological and ecological aspects. *PhD thesis*, University of Zimbabwe, 261 pp.

GREGORIADIS G., SAFFIE R. AND DE ZOUZA J.B. – 1997 - Liposome mediated DNA vaccination. *FEBS letters*, **402**, 107-110.

GOULD A.R., HYATT A.D., LUNT R., KATTENBELT J.A., HENGSTBERGER S. AND BLACKSELL S.D. – 1998 - Characterization of a novel lyssavirus isolated from pteropid bats in Australia. *Virus Research*, **54**, 165-187.

JALLET C., JACOB Y., BAHLOUL C., DRINGS A., DESMEZIERES E., TORDO N. AND PERRIN P. – 1999 - Chimeric lyssavirus glycoproteins with increased immunological potential. *Virology*, **73**, 1, 225-233.

KENT S.J., ZHAO A., BEST S.J., CHANDLER J.D., BOYLE D.B. AND RAMSHAW I.A. – 1998 - Enhanced T-cell immunogenicity and protective efficacy of a human immunodeficiency virus type 1 vaccine regimen consisting of consecutive priming with DNA and boosting with recombinant fowlpox virus. *Journal of Virology*, **72**, 10180-10188.

KEMP G.E., CAUSEY O.R., MOORE D.L., ODEOLA A. AND FABIYI A. – 1972 - Mokola virus. Further studies on IbAn 27377, a new rabies-related etiologic agent of zoonosis in Nigeria. *American Journal of Tropical Medicine and Hygiene*, **21**, 356-359.

KING A. AND CRICK J. – 1988 - Rabies-related viruses. *In* "Rabies" (J B Campbell and K M Charlton, Eds), pp. 177-199, Kluwer academic publishers, Boston.

LE GONIDEC G., RICKENBACH A., ROBIN Y. AND HEME G. – 1978 - Isolement d'une souche de virus Mokola au Cameroun. *Annali di Microbiologia*, **129A**, 245-249.

MEBATSION T., COX J.H. AND FROST J.W. – 1992 - Isolation and characterization of 115 street rabies virus isolates from Ethiopia by using monoclonal antibodies: Identification of 2 isolates as Mokola and Lagos bat viruses. *Journal of Infectious Diseases*, **166**, 972-977.

MEBATSION T., SCHNELL M.J. AND CONZELMANN K.-K. – 1995 - Mokola virus glycoprotein and chimeric proteins can replace rabies virus glycoprotein in the rescue of infectious defective rabies virus particles. *Journal of Virology*, **69**, 3, 1444-1451.

NADIN-DAVIS S.A., SAMPATH M.I., CASEY G.A., TINLINE R.R. AND WANDELER A. – 1999 - Phylogeographic patterns exhibited by Ontario rabies virus variants. *Epidemiol. Infect.*, **123**, 325-336.

NEL L., JACOBS J., JAFTHA J., VON TEICHMAN B. AND BINGHAM J. – 2000 - New cases of Mokola virus infection in South Africa: A genotypic comparison of southern african virus isolates. *Virus Genes*, **20**,2, 103-106.

OSORIO J.E., TOMLINSON C.C., FRANK R.S., HAANES E.J., RUSHLOW K., HAYNES J.R. AND STINCHCOMB D.T. – 1999 - Immunization of dogs and cats with a DNA vaccine against rabies virus. *Vaccine*, **17**, 1109-1116.

PERRIN P., THIBODEAU L. AND SUREAU P. – 1985 - Rabies immunosomes (subunit vaccine) structure and immunogenicity. Pre and post exposure protection studies. *Vaccine*, **3**, 325332.

SALUZZO J.F., ROLLIN P.E., DAUGUET C., DIGOUTTE J.P. GEORGES A.J. AND SUREAU P. – 1984 - Premier isolement du virus Mokola à partir d'un rongeur (*Lophuromys sikapusi*). *Annales de l'Institut Pasteur: Virologie*, **135^{E}**, 57-66.

SCHNEIDER L.G., BARNARD B.J.H. AND SCHNEIDER H.P. – 1985 - Application of monoclonal antibodies for epidemiological investigations an oral vaccination studies. I. African viruses, *In* Rabies in the tropics, edited by E Kuwert, C Mérieux, H Koprowski and K Bögel. Berlin: Springer Verlag: 47-59.

SCHNEIDER J., GILBERT S.C., BLANCHARD T.J., HANKE T., ROBSON K.J., HANNAN C.M., BECKER M., SINDEN R., SMITH G.L. AND HILL A.V. – 1998 - Enhanced immunogenecity for CD8+ T cell induction and complete protective efficacy of malaria DNA vaccination by boosting with modified vaccinia virus Ankara. *Nature Medicine*, **4**, 4, 397-402.

SWANEPOEL R., BARNARD B.J.H., MEREDITH C.D., BISHOP G.C., BRÜCKNER G.K., FOGGIN C.M. AND HUBSCHLE O.J.B. – 1993 - Rabies in southern Africa. *Onderstepoort Journal of Veterinary Research*, **60**, 325-346.

VON TEICHMAN B.F., DE KOKER W.C., BOSCH S.J.E., BISHOP G.C., MEREDITH C.D. AND BINGHAM J. – 1998 - Mokola virus infection: description of recent South African cases and a review of virus epidemiology. *Journal of the South African Veterinary Association*, **69**, 4, 169-171.

WILLIAMSON C., MORRIS L., RYBICKI E. AND WILLIAMSON A.L. – 2000 - Designing HIV-1 subtype C vaccines for South Africa. *South African Journal of Science*, **96**, 318-324.

XIANG Z.Q., SPITALNIK S., TRAN M., WUNNER W.H., CHENG J. AND ERTL H.C.J. – 1994 - Vaccination with a plasmid vector carrying the rabies virus glycoprotein gene induces protective immunity against rabies virus. *Virology*, **199**, 132-140.

VAMPIRE BAT RABIES IN THE AMERICAS

C. Vargas[1]

Adapted from overheads.

1 VAMPIRE BAT.

Vampire bats belong to the Desmodontidae family. Three species live in tropical and sub-tropical America. The most important one is *Desmodus rotundus* a medium size bat (Figure 1). These bats feed on blood of vertebrates and are very adapted to this diet. They take nearly 15ml of blood per meal.

They live in colonies in humid caves or in splits of trees. In the colony, they show strong social links with grooming and licking behaviour, sharing alimentary resources (the individuals that have fed during the night regurgitate blood for the ones that could not feed).

Figure 1: *Desmodus rotundus*, the most common vampire bat.

2 VAMPIRE BAT RABIES.

In 1999, vampire bat rabies has been reported in 21 Latin American countries from Mexico to Argentina (Figure 2).

[1] PAHO / PANAFTOSA - 525 22nd street, NW - Washington DC - USA

Figure 2: Occurrence of vampire bat rabies in Latin America.

2.1 Animal rabies due to vampire bat.

In 1999, 6637 animal rabies cases have been reported in Latin America. Domestic animals correspond to 95% of these cases as shown in Table 1.

Table 1: Animal rabies cases in Latin America in 1999.

Domestic animals: 6333 cases	Cattle	3225
	Dog	2510
	Cat	185
	Others	413
Wildlife: 304 cases	Mongoose	154
	Bat	95
	Fox	20
	Monkey	9
	Skunk	8
	Others	11
	Unspecified	7

Among the 95 cases reported in bats in 1999 in Latin America, 45 were observed in non-vampire bats and 22 in vampire bats. The species of 28 bats have not been determined.

Table 2: Cattle rabies cases in Latin America in 1999 by sub-region.

Subregion	Cases
Brazil	2628
Central America, Caribe	209
Andine area	140
South cone	126
Mexico	108

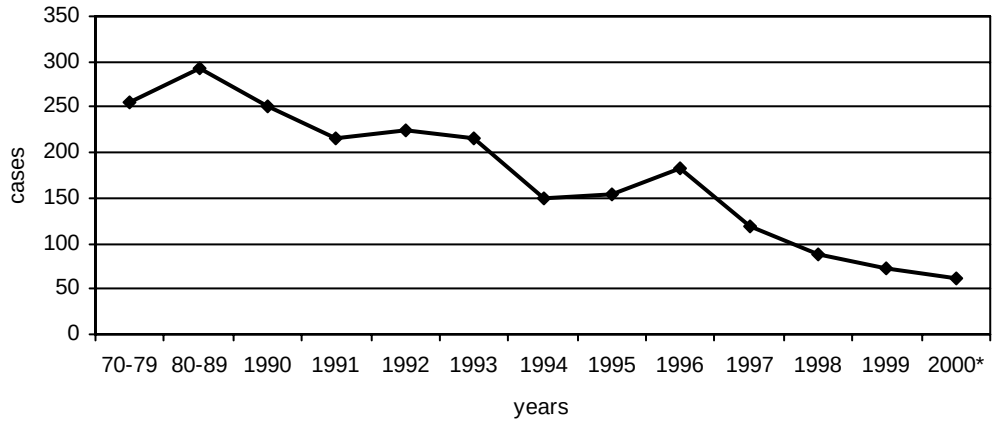
Vampire bats feed on different animals and often on cattle (Figure 3). The blood meal is not painful for the animal and it does not induce any defensive movement from the parasited animal.

Figure 3: Vampire bats feeding on cattle.

2.2 Human rabies cases due to vampire bat.

The number of rabies cases reported in man in Latin America is decreasing since the 1980s, as shown in Figure 4.

Figure 4: Evolution of human rabies cases in the Americas, 1970-2000.
Year 2000 data are provisional.



Among the 73 cases of human rabies reported in 1999, 49 were due to dogs, 14 to bats (7 vampire and 7 non specified bats), 1 to a skunk and 9 to unknown animals.

Figure 5 illustrates the localisation of human rabies cases transmitted by animals in 1999 in Mexico and Central America (panel a) and in South America (panel b). Figure 6 groups the different countries that reported bat transmitted human rabies.

Most often, in the regions where cases have been reported houses have no protection against bats. The use of mosquito net does not give any protection against vampire bats that cut it very easily.

Figure 5: Human rabies in Latin America in 1999.

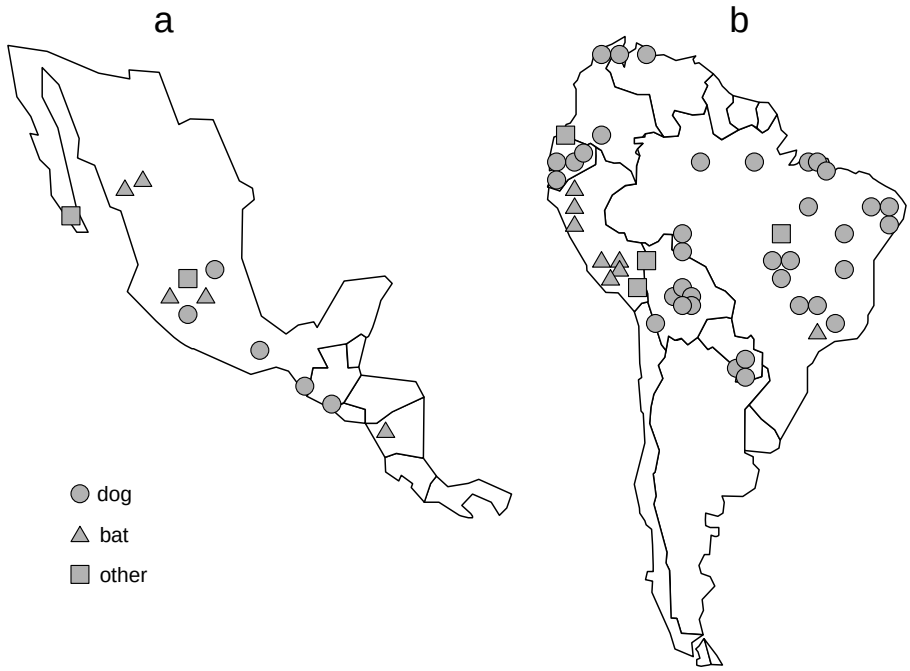


Figure 6: Countries having reported bat transmitted human rabies in 1999.

3 CONTROL OF VAMPIRE BATS.

The method used to control vampire bat rabies consists of population reduction measures. Bats are captured with nets, painted with an anticoagulant paste and then released. This method uses the fact that vampire bats live in colonies where an inter-individual licking behaviour permit the poisoning of more vampires. (Figure 7)

Figure 7: Control of vampire bat populations.

4 CONCLUSION.

The surveillance of vampire bat rabies needs to be strengthened. A more effective control of vampire bat rabies should rely on the development of more cost-effective methods and on the development of recommendations for the protection of persons at continued risk of exposure to vampire bats.

HUMAN DEATHS FROM BAT RABIES IN THE UNITED STATES

J. S. Smith[1], L. A. Orciari[1], P. A. Yager[1] and S. L. Messenger[1]

ABSTRACT.

Insectivorous bats have been incriminated in 26/29 human rabies infections acquired in the United States since 1980. This would not be an unexpected finding if typing of virus from the patients had identified variants of rabies virus associated with house bats. House bats are very common insectivorous bats that use human dwellings as roosts or hibernacula. Unexpectedly, however, virus typing in 18 of the 26 cases (69%) identified a variant of rabies virus only rarely found in house bats but common in two bat species infrequently encountered by humans, the silver-haired bat *(Lasionycteris noctivagans)* and the eastern pipistrelle bat *(Pipistrellus subflavus)*. An increased virulence for the variant was hypothesized (Morimoto *et al.*, 1996) to explain these findings, suggesting that some variants of rabies virus are more successfully transmitted by bat bites.

1 SUMMARY OF PRESENTATION.

In what has become an increasingly familiar pattern, all four of the indigenously acquired human rabies infections in the U. S. during 2000 were attributed to contact with insectivorous bats inside a home (Centers for Disease Control and Prevention, 2000b). In no case were public health officials notified of the bat contact and no patient sought post-exposure rabies prophylaxis. Exposure histories in the cases were not elicited from the patients, but from friends and family members of the patients after a laboratory diagnosis of rabies had been made.

On the surface, these cases and 22 similar cases since 1980 (Noah *et al.*, 1998) might not appear extraordinary. Rabid bats often become unable to fly, increasing the opportunity for human contact. Because bites by bats may result in an insignificant wound as compared to bites by terrestrial carnivores, the implications of a bat bite are often minimized and medical care may be thought unnecessary. Several species of insectivorous bat use houses and outbuildings as day roosts or hibernacula. Colonies of hundreds to thousands of these house bats (usually big brown *(Eptesicus fuscus)*, little brown *(Myotis lucifugus)*, or Mexican freetailed bats *(Tadarida brasiliensis)*) may exist seasonally in or close to human dwellings and are the bat species most often submitted to rabies testing laboratories (figure 1).

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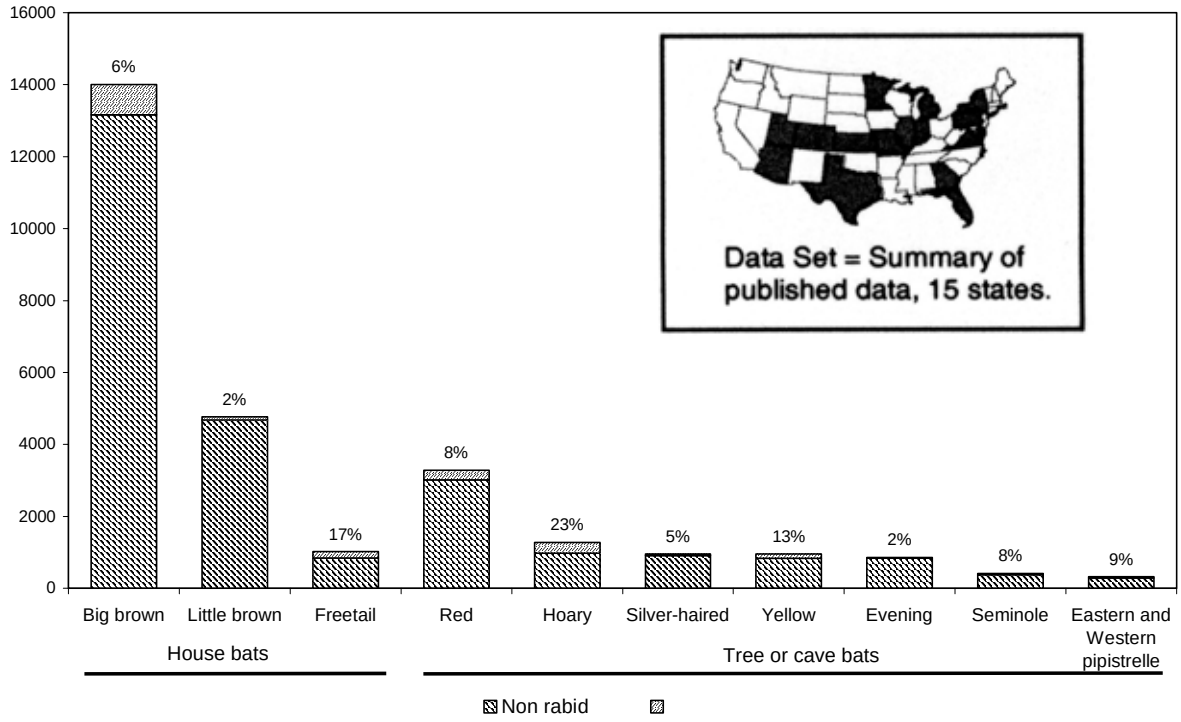
Figure 1: Insectivorous bats tested for rabies, 1697 rabid among the 25421 submitted for testing.



This simple explanation for human rabies exposure becomes more complicated, however, when virus samples from the cases are submitted for genetic typing. The virus variant identified in two of the four recent cases and 16 other human case samples (Smith *et al.*, 1995) is not commonly found in house bats. Instead, virus typing (figure 2) identified bats whose habits and roost preferences do not often bring them in contact with humans, silver-haired bats *(Lasionycteris noctivagans)* and eastern pipistrelle bats *(Pipistrellus subflavus)*. The virus lineage associated with the human cases (lineage 27 in figure 3) was associated with 43/48 samples from silver-haired and eastern pipistrelle bats, but in only minority samples from other species (8 samples representing 4 bat species). Among the explanations compatible with these typing results are two opposing hypotheses:

- **Hypothesis 1. Lineage 27 is present in the majority of human cases because it is the most common variant in bat populations.** If this hypothesis is correct, then the database used to associate lineage 27 with silver-haired and eastern pipistrelle bats (figure 3) cannot be representative of bat populations in the U.S. There is some validity to this assumption. Only a few public health laboratories identify all submitted bats to species, and even when identifications are made, samples from red bats and common house bats are not submitted to virus typing in numbers proportional to their importance in human-bat interactions. A strong bias exists for the submission of samples from less common or unusual bat species for virus typing. As more surveys include all bats, it is possible that lineage 27 will be found in a larger proportion of samples from all bat species, and/or eastern pipistrelle and silver-haired bats will be found to comprise a larger proportion of bats submitted for rabies testing because of human contact.

  Hypothesis 1 is not supported by data gathered to date. For example, almost all bats submitted to the Indiana Department of Health 1965 to present have been identified to species at Indiana State University (Whitaker and Douglas, 1987). Samples from 116 rabid bats collected during the years 1982 to 1999 were submitted for genetic typing (Messenger, Whitaker, and Smith, manuscript in preparation). Eastern pipistrelle and silver-haired bats comprised respectively 2.5% and 1.6% of 6,861 submissions and 7.3% and 1.5% of 342 rabies-positive bats. Samples from big brown and red bats were the most commonly submitted species (84% of all samples) and the bats most frequently found rabid (77% of all positive samples). Lineage 27 was associated with 11/12 eastern pipistrelle bats and 2/2 silver-haired bats, but only 1/45 big

brown bats, 1/44 red bats, and 1/2 little brown bats. The remaining Indiana bats formed discrete clusters composed primarily of samples from a single bat species.

- **Hypothesis 2. Incidence of contact with humans may be no greater for silver-haired and eastern pipistrelle bats than for other bats, but increased virulence of the lineage 27 virus allows for more successful transmission events to occur after superficial contact with a bat infected with a lineage 27 virus.** Both experimental data and epidemiologic data support hypothesis 2. The lineage 27 virus replicates well at 34°C in fibroblast and epithelial cells, characteristics that could facilitate infection after superficial contact (Morimoto *et al.*, 1996), although more experimental data are needed to confirm this observation. Certain variants associated with common bat species are under-represented in cross-species transmission events (both between bat species and from bats to humans (Smith *et al.*, 1995), suggesting that virulence is not equal among all variants.

  If hypothesis 2 is correct, then human rabies will remain rare in the United States because an unnoticed or unrecognized contact with silver-haired and eastern pipistrelle bats or with any animal infected with the variant of rabies virus they transmit should also be a rare event. Unfortunately, prevention of those few human deaths will be almost impossible because unnoticed or unrecognized animal contact will not elicit anti-rabies treatment.

Figure 2: Rabies virus variants and associated with human deaths. Unites States 1981 – 2000.

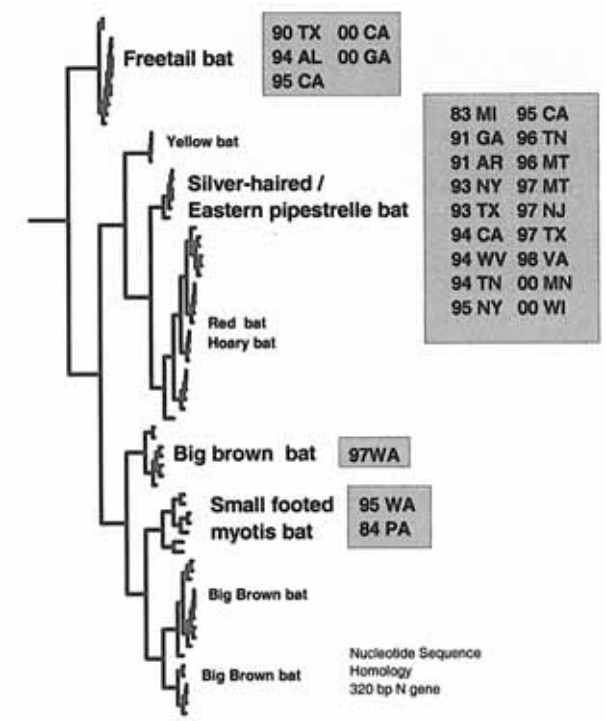
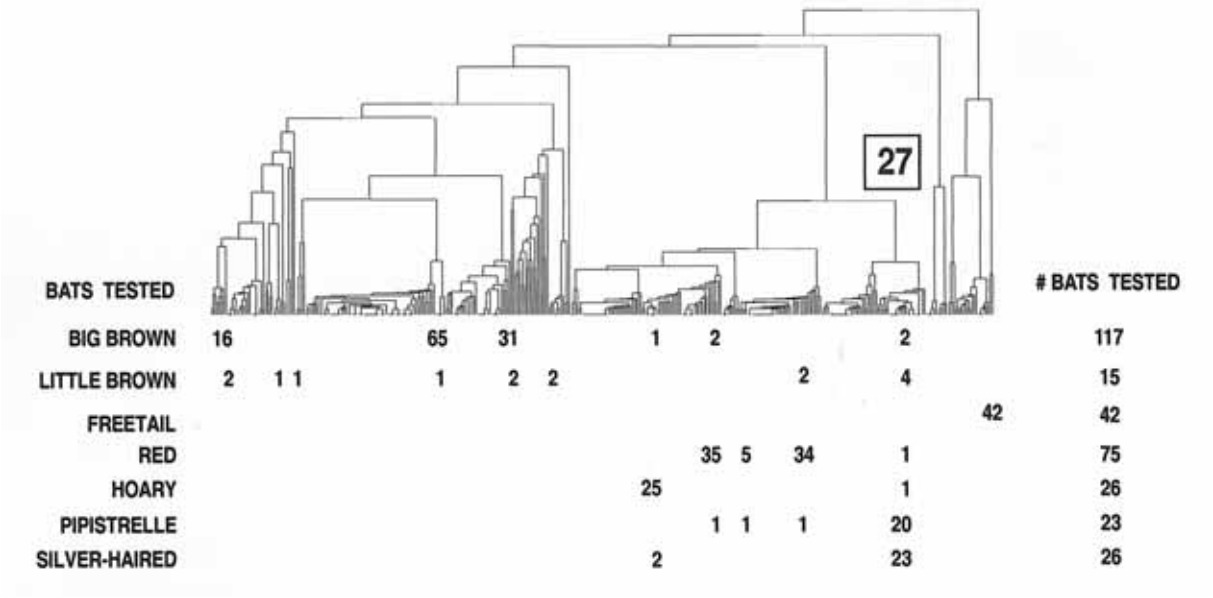


Figure 3: UPGMA tree of 383 rabies virus samples from 25 U.S. bat species. Numbers under branch clusters indicate the number of virus samples from each species found in that cluster. (not all bat species tested are identified in the figure)



REFERENCES.

CENTERS FOR DISEASE CONTROL AND PREVENTION – 2000 - Human Rabies - California, Georgia, Minnesota, New York and Wisconsin, 2000. *Morbidity and Mortality Weekly Report*, **49**, 1111-1115.

MORIMOTO K., PATEL M., CORISDEO S., HOOPER D. C., FU Z. F., RUPPRECHT C. E., KOPROWSKI H. AND DIETZSCHOLD B. – 1996 - Characterization of a unique variant of bat rabies virus responsible for newly emerging human cases in North America. *Proceedings of the National Academy of Sciences of the United States of America* **93**, 5653-5658.

NOAH D.L., DRENZEK C.L., SMITH J.S., KREBS J.W., ORCIARI L., SHADDOCK J., SANDERLIN D., WHITFIELD S., FEKADU M., OLSON J.G., RUPPRECHT C.E., CHILDS J.E. – 1998 - Epidemiology of human rabies in the United States, 1980 to 1996. *Ann Intern Med.,* **128**, 922-930.

SMITH J. S., ORCIARI L. A. AND YAGER P. A. - 1995 - Molecular epidemiology of rabies in the United States. *Seminars in Virology*, **6**, 387-400.

WHITAKER J. O. AND DOUGLAS R. G., JR. – 1987 - Bat Rabies in Indiana: 1965-1984. *Proceedings of the Indiana Academy of Science*, **95**, 571-584.

EUROPEAN BAT RABIES

Arthur King[1]

1 INTRODUCTION.

Bat species are more widely distributed than any other species (except man) and bats are the only mammals that can fly. The order Chiroptera (bats) is divided into two suborders, the Megachiroptera and the Microchiroptera. The Megachiroptera are the Old World fruit bats and flying 'foxes', the single Pteropodidae family having 42 genera and 173 species, whereas the Microchiroptera are composed of 17 families with 144 genera encompassing 813 species. Bats may be insectivorous, frugivorous, carnivorous, fish eating or flower feeding, but only the haematophagous (vampire) bats feed by imbibing blood.

Rabies and the so-called rabies-related viruses are now collectively known as lyssaviruses. However, the lyssaviruses can be distinguished by serological and molecular characterization into a number of different virus types (serotypes and genotypes) and it is now customary to refer to the serotype 1 viruses of bats of the Americas as rabies viruses, whereas all others are referred to as lyssaviruses.

Rabies in bats has a long history. Examples have been cited of human rabies due to vampire bats in the sixteenth century and of cattle rabies epizootics due to vampires in the sixteenth, eighteenth and nineteenth centuries. Nevertheless, it was not until the 1920s that rabies was discovered in insectivorous bats in Brazil and the 1930s in frugivorous and insectivorous bats in Trinidad. These latter discoveries went largely unnoticed until a young boy in Florida was bitten on the chest by an infected insectivorous bat in 1953 and this incident may be said to have sparked interest and awareness of the possibility of rabies in bats throughout other parts of the world.

2 EUROPEAN BATS.

Within the European Union, of the 31 species from three families *Rhinolophidae*, *Vespertilionidae* and *Molossidae*, all of which are insectivorous, no fewer than ten are classified as endangered, whilst a further ten species are thought to be vulnerable. Legal protection is afforded to all species in all EU countries and they are also protected in other European countries, but the level of protection varies greatly. Thus, little or no disease-related research is carried out in European bat species.

3 EUROPEAN BAT RABIES.

Although they undoubtedly were not the first European bats to be infected with rabies, during 1954-1984 fifteen cases of rabies in bats were reported from Germany (7), Yugoslavia (3), Ukraine (2) and one each from Turkey, Greece and Poland. Significantly perhaps, none of these cases were confirmed by virus isolation. Between 1985 and 1999, however, 578 cases were found in the Netherlands (238), Denmark (199), Germany (100), Poland (12), Spain (12), France (6), Switzerland, Ukraine and Czechoslovakia (two each) and Slovak Republic, Hungary and the UK (one each).

3.1 Bat species involved.

So far, nine bat species have been implicated: small numbers of *Nyctalus noctula* (5), *Rhinolophus ferrumequinum* (1), *Myotis myotis* (1), *Vespertillio murinus* (1), *Pipistrellus nathusii* (1) and *P. pipistrellus* (1); larger numbers of *Myotis daubentonii* (4), *M. dacsycneme* (8) and *Eptesicus serotinus* (426).

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Unfortunately, the species of quite a large number of bats (142) have not been determined and it is noticeable that most of these have been reported in more recent years.

From these figures and from other work it is clear that the disease is most frequently found in three species, *Eptesicus serotinus*, *Myotis daubentonii* and *M. dasycneme*. Of the five *Nyctalus noctula* bats, three were from Yugoslavia in 1955, one from Ukraine in 1985 and one from Germany in 1991.

Eptesicus serotinus bats or 'serotines', meaning of the evening, when they may be expected to feed, winter in hollow trees, buildings, caves and mines and in summer are found in urban buildings and hollow trees. Their colonies are usually small, of less than 100 members, and their food is predominantly large insects in open sheltered urban parkland areas, mostly in lowlands. Their mean home range may be up to 50km^2 and the maximum straight-line flight recorded is 7.4km.

Myotis species bats have an almost worldwide distribution. In Europe, *M. dasycneme* bats are found in Sweden, Poland, Czechoslovakia, Germany, Denmark (limited to Jutland), Netherlands and the extreme North East of France. Their habitat is riverbanks and they usually feed over waterways. They roost in buildings in summer and in caves, mines and cellars in winter. Nursery roosts and hibernacula are often 200-300km apart and they are known to migrate between neighbouring countries. *M. daubentonii* bats have a wider range than dasycnemes and are also found in Spain, Portugal, Austria, Switzerland, South Scandinavia, North Yugoslavia, Bulgaria and the UK. Their habitat is around rivers, ponds and lakes and they feed over water on emerging insects. Summer and winter roosts are often widely separated.

3.2 European bat lyssaviruses.

The European bat rabies viruses have been classified as:

Genotype 5 or European bat lyssaviruses (EBL) 1 and

Genotype 6 or EBL 2.

In my laboratory a panel of anti-nucleocapsid monoclonal antibodies (Mab-Ns) was prepared by using the prototype strains of Mokola (genotype 2), Lagos bat (genotype 3) and Duvenhage (genotype 4) viruses and representatives from Denmark of the EBL1 (genotype 5) viruses and from Finland of an EBL2 (genotype 6) virus. By using a truncated panel of these Mab-Ns (Table 1) it is a simple matter to distinguish between representatives of the six serotype/genotype viruses, including genotypes 5 and 6.

Table 1: Reaction patterns of selected Mab-Ns with genotype 1-6 viruses.

Virus Genotype	Mab-N Reference number											
	M1	**M7**	**M11**	**D1**	**D3**	**DB1**	**DB3**	**DB9**	**F1**	**L1**	**L2**	**L23**
CVS11	+					+	+					+
Lagos bat	+	+				+	+			+	+	+
Mokola	+	+	+				+		+		+	+
Duvenhage	+			+	+	+	+				+	
EBL 1	+				+	+	+	+				
EBL 2			+		+	+	+		+			
39 EBL 1s	+	V			+	+	+	+				

Mab-N origins: M = Mokola, D = Duvenhage, DB = Denmark bat, F = Finland and L = Lagos Bat viruses. * = 39 EBL 1 viruses, only some of which react with M7, indicating the presence of more than one variant in the EBL 1s.

Later work at my laboratory, carried out by Dr. T Fooks and his colleagues in collaboration with colleagues from the Institut Pasteur, Paris, sub-divided by molecular techniques the European bat viruses into EBL 1a and EBL1b and EBL2a and EBL 2b. Dr. Fooks and his colleagues also confirmed the relationships of the lyssaviruses by analysis of a 405bp sequence of the N gene (Fig. 1). The technique that they used is, of course, far more sophisticated than Mab-N studies and it not only confirmed the presence of diversity in the EBL viruses but also mapped their relationship with other lyssaviruses (Fig.1). At present only two major genotypes have been shown in the three European bat species most frequently sampled, but that is not to say that others may not be found in time. Nor does the relatively low number of bat rabies cases examined since 1985 (less than 600 in 17 years) give much indication of the extent of involvement of other species.

3.3 Clinical signs and laboratory diagnosis.

In almost all mammals, behavioural changes are one of the first signs of a lyssavirus infection and bats are no exception to this rule. To see a bat in its natural habitat during the daytime is an exceptional event and a warning that the bat may be sick, possibly infected with a lyssavirus. To date, in almost all countries to have reported rabies in European bats the disease came to light when a member of the public came into contact with an infected bat. In only two cases could the contact victim be said to have been 'attacked' and even in one of these the bat may be said to have been provoked.

When infected bats were found alive, they were sometimes described as paralysed, at times crying and quite often biting when approached. Observations by two bat workers who took a sick bat into care showed that there were strong motoric activities during the nights, followed a few days later by aggression, when the bat bit into dead objects and the cage. The bat died of a lyssavirus infection 36 days after capture, indicating an incubation period of at least 36 days, and a lyssavirus infection was confirmed by FAT.

There are no descriptions of the pathology in bat brains infected with European bat lyssaviruses, although some descriptions of the basic lesion, a non-suppurative meningoencephalitis appear to be similar to that observed in rabies infected terrestrial animals. Most reporters have limited their findings to the presence or absence of Negri bodies following FA staining, or to their size and quality of staining when they were present.

4 HUMAN RABIES CASES OF EUROPEAN BAT ORIGIN.

Fortunately, only three human deaths from European bat rabies have been reported.

The first occurred in Voroshilovgrad, Ukraine, in 1977. A 15-year-old girl was bitten on the finger during the daytime by a bat of unknown species. She was not given post-exposure treatment and she died 35 days later. A lyssavirus was isolated from her brain.

The second case occurred in Russia in 1985 after an 11 year old girl 'Yuli' was attacked and bitten on the lower lip by a bat which then flew away. The wound was treated with iodine but no other treatment was given and she died 27 days later, having for six days shown symptoms typical of a rabies virus infection. A genotype 5 virus was isolated from her brain.

The third case was a 30 year old Swiss biologist who was admitted to Helsinki University Central Hospital with ascending paralysis of the Guillain-Barré type and radiating pain in the right arm and neck. He had been bitten by bats in Malaysia over four years earlier, in Switzerland one year earlier and 51 days before the onset of symptoms. He died of rabies 20 days after hospital admission. He had never been vaccinated against rabies, received no post-exposure treatment before falling sick and a genotype 6 virus was isolated from his brain.

4.1 Do current vaccines protect against European bat rabies?

Early work suggested that, in mice, some genotype 1 vaccines did not protect against challenge from genotype 5 isolates. No comparative work has been carried out against genotype 6 viruses. However, no properly vaccinated person, nor person given proper post-exposure treatment, has died of rabies following a bite from a European bat.

4.2 Antibody production in infection.

Only a few reports of antibody production following natural infection have been made.

In one, sera from 10 apparently healthy Danish serotine bats, nine of them from a lyssavirus positive colony in south-east Jutland, the other from a bat trapped in a house where a positive bat had been diagnosed previously, revealed rabies FA titres of 100 in four bats, 10 in four bats and less than ten in two bats.

In another report, in Spain between September 1991 and September 1992 four serotine colonies were blood sampled to determine the prevalence of lyssavirus antibody. From one of the colonies in May

1989 a year-old serotine unable to fly had been found lyssavirus positive and in July 1989, of four less than one-month-old positive pups, one was found dead but the others appeared to be in good health when they were killed. In summarizing antibody production in naturally infected bats, although antibody has been found, in only one bat did the antibody level remain consistently high and from the little amount of work it is not possible to draw the conclusion that European bats may recover from infection.

5 EXPERIMENTAL STUDIES IN BATS.

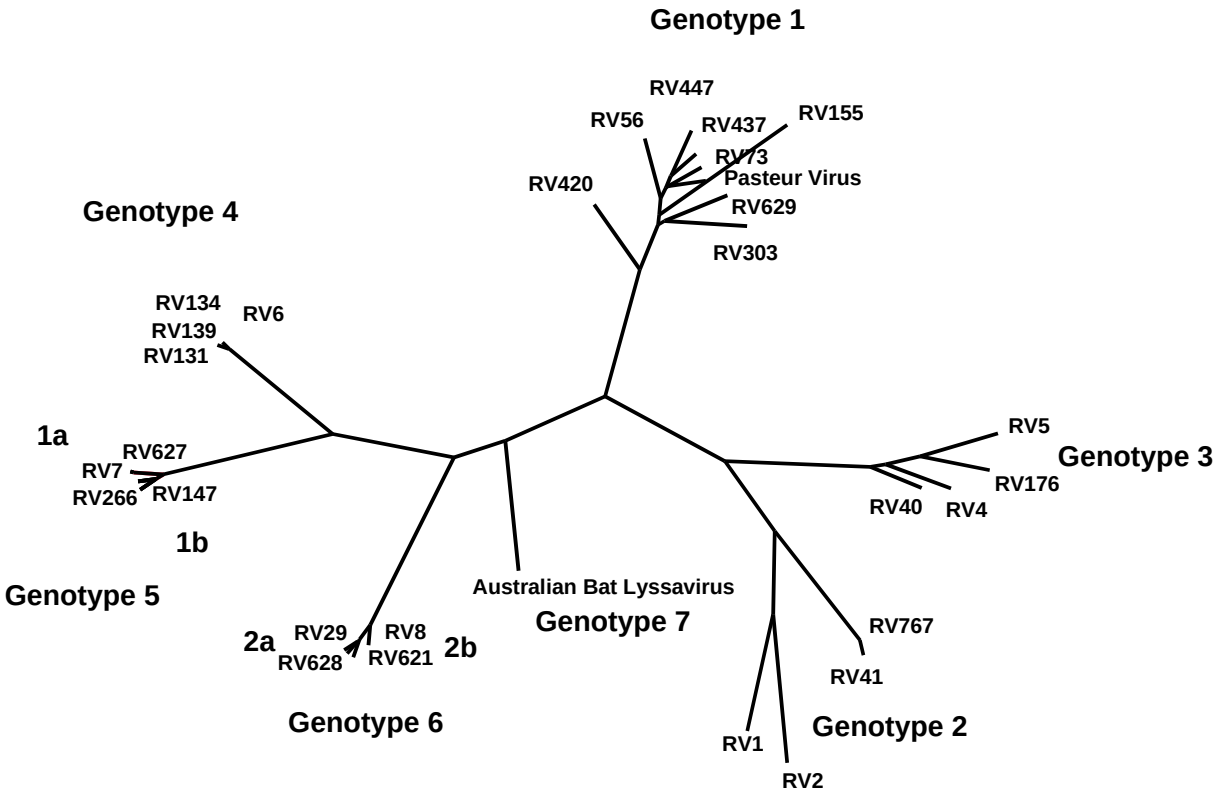
Because of the protected status of bats in Europe, only one bat-to-bat transmission study has been reported, from Russia. In 1992 two genotype 5 viruses (known as Yuli and Stade) and 'an unusual' genotype 1 virus (1150) from a *Vespertillio murinus* bat were inoculated intramuscularly into a mixed group of 100 Daubentons and 11 *M. brandtii* bats and into 15-20gm adult white mice. Results showed that bats were less susceptible than mice to the genotype 5 viruses and that incubation periods were longer. Conversely, the susceptibility of bats inoculated with the 'unusual' genotype 1 virus was higher than that of mice, although the incubation period was significantly longer. It was also noted that whereas 50% of the bats inoculated with the genotype 5 viruses showed aggressive behaviour and convulsions, all bats inoculated with the 'unusual' genotype 1 virus showed only the paralytic form of lyssavirus infection.

6 CONCLUDING REMARKS.

European bat rabies was 'discovered' nearly 50 years ago and at about the same time that insectivorous bat rabies became apparent in North America. However, there appear to be many differences in the geographical picture - in North America the disease has been reported from almost all species adequately sampled and the annual number of reported cases usually exceeds the total number so far reported in Europe. The causative viruses also are quite different and there have been many more human deaths from bat rabies in North America than there have been in Europe.

Nevertheless, far more bat rabies cases have been reported in Europe than in Africa. Is this a reflection of the true incidence of African bat rabies? To date there have been only three cases of Duvenhage (genotype 4) from a very limited geographical area, whilst the number of Lagos bat (serotype 2) virus isolates probably does not exceed 20, mainly from frugivorous bats spread over a huge geographical area but with substantial unexplained gaps. There is little doubt that the legal protection of European bats has a bearing on our lack of knowledge of the transmission mechanisms and course of disease within them. There is also little doubt that the lack of surveillance systems and diagnostic capability in Africa has a bearing on our lack of knowledge of African bat rabies *per se*. Bat rabies in Australia has only recently been discovered, although no-one claims it to be a new phenomenon. Now that western Europe is virtually freed of terrestrial animal rabies, there may well be an opportunity to turn our attention and resources to the disease in bats, so that we better understand the implications.

Figure 1: A representative tree of the lyssaviruses as established by analysis of 405bp N-gene sequences.



* Most of the information in this paper has been abstracted from the chapter King A., Haagsma J. and Kappeler A. - Lyssavirus infections in European bats - in a forthcoming book, King A.A., Aubert M.F.A. and Wandeler A. I. (eds.) Rabies in Europe and the Mediterranean Basin, to be published by CAB International in 2002. Full references to all published work in this paper will be found in the book. Thanks are due to Dr. T. Fooks of the VLA, Weybridge, for permission to reproduce Fig.1.

STUDIES WITH AUSTRALIAN BAT LYSSAVIRUS IN FLYING FOXES, AND DOMESTIC CATS AND DOGS

K.A. McColl[1], T. Chamberlain[1], R. Lunt[1], K. Newberry[1] and H.A. Westbury[1]

1 INTRODUCTION.

In 1996 and 1998, two Australian women died following infection with Australian bat lyssavirus (ABL) (Allworth *et al.*, 1996; Hanna *et al.*, 2000). As there was a clear lack of information about the pathogenesis and epidemiology of the disease caused by this virus, studies on ABL infection in flying foxes and in domestic cats and dogs were undertaken at AAHL. The aims of this work were to provide answers to some important practical questions about this recently recognized disease in order to allow the development of strategies that might help to control the disease and protect humans from exposure to the virus.

2 MATERIALS AND METHODS.

In all animal experiments, animals were held in cages in the Large Animal Facility at AAHL. All caging was in accordance with the requirements of the AAHL Animal Ethics Committee.

2.1 Virus.

ABL was isolated from a naturally infected grey-headed flying fox (*Pteropus poliocephalus*), and was passed four times intracerebrally (I/C) in mice followed by four rapid passes in mouse neuroblastoma (MNA) cells (Crick and King, 1988). Virus was then stored at –80°C in 300 µL aliquots containing 10^5 $TCID_{50}$ of virus.

2.2 Studies in flying foxes.

Two trials were conducted, both using *P. poliocephalus*.

2.2.1 Trial 1.

Wild-flying foxes were collected from around Sydney, and then transported to AAHL. Prior to experimental work, all animals were tested for the presence of antibodies to both Hendra virus (HeV, a lethal zoonotic paramyxovirus of bats; Murray *et al.*, 1995), using a virus neutralization test, and lyssaviruses, using the Rapid Fluorescent Focus Inhibition Test (RFFIT). Seven flying foxes were then inoculated intramuscularly (I/M) in the forearm with $10^{3.7}$ $TCID_{50}$ of ABL. One animal was an uninoculated control. Mice, inoculated intracerebrally (I/C) with 20-30 µL of ABL, were inoculum controls. All flying foxes were held for 2 months post inoculation (pi), and, apart from blood samples collected prior to inoculation, the only additional tissue samples examined during this experiment were those collected at necropsy. These included blood samples collected immediately prior to euthanasia, impression smears of the brain for fluorescent antibody tests (FAT), and tissue samples fixed in formalin for histopathology and immunoperoxidase examinations (IPX).

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2.2.2 Trial 2.

For the second trial, flying foxes that had been maintained in a university colony were used. They were free of antibodies to both HeV and ABL. Ten *P poliocephalus* were inoculated with 10^5 $TCID_{50}$ of ABL I/M, and one was held as an uninoculated control. Mice, inoculated I/C, were held as inoculum controls. All bats were held for 3 months pi. At necropsy, impression smears were made of the brain for FAT, and tissues were collected for virus isolation on neuroblastoma cells, histopathology and IPX.

2.3 Studies in cats.

Three mature male cats were inoculated I/M with 10^5 $TCID_{50}$ of ABL, and one was an uninoculated control. I/C-inoculated mice were used as inoculum controls. Cats were held for 3 months pi, and clinical samples, including blood and oral swabs, were collected regularly throughout this period. At necropsy, blood, cerebrospinal fluid, urine and other tissue samples were collected for serology, virus isolation on neuroblastoma cells, histopathology and IPX. Impression smears of the brain of each cat were prepared for FATs.

2.4 Studies in dogs.

Three pups (2-3 months old) were inoculated I/M with $10^{3.7}$ LD_{50} of ABL, and two with 10^5 LD_{50} of ABL. Two were held as negative controls. Two mice were inoculated I/C with ABL. Pups were held for 3 months pi, and, during this period, clinical samples, observations on behaviour, and necropsy samples were collected in the same way as was done with the cats.

3 RESULTS.

3.1 Flying foxes.

3.1.1 Trial 1.

Prior to the start of this trial, RFFITs revealed that all 15 flying foxes were negative for antibodies against lyssaviruses. However, seven of the animals were seropositive for HeV when the trial began, and, by the time the trial was terminated, a further three animals had also seroconverted (while being held at AAHL). The potential presence of HeV in this colony of flying foxes had a number of consequences for the manner in which the trial was conducted. Firstly, the entire trial was conducted under Biosecurity Level 4 conditions, and, secondly, in order to further minimize potential contact between experimentalists and HeV, only limited clinical and necropsy samples were collected from bats.

All inoculum control mice were euthanized at 9-10 dpi because they showed clinical signs consistent with lyssavirus infection. FATs on impression smears of the brains of these mice confirmed the presence of lyssavirus.

One ABL-infected bat became obtundent and developed severe muscle weakness at 27 dpi. Following euthanasia, it was confirmed to be lyssavirus-positive by FAT on brain impression smears, by histopathology and by IPX. No other animals developed clinical signs of disease, and all were seronegative at the end of the 2-month trial. Histopathological and IPX examinations of these bats revealed no significant lesions.

3.1.2 Trial 2.

Three of the 10 bats inoculated with ABL developed clinical signs consistent with a lyssavirus infection between 2-3 weeks pi. In all cases, clinical signs consisted of muscle weakness, ataxia, and paralysis or paresis of all four limbs.

The clinical diagnosis of lyssavirus infection was confirmed in all three affected animals by some, or all, of the following: histological lesions in the CNS (a non-suppurative meningoencephalomyelitis and ganglioneuritis); detection of viral antigen in the CNS by IPX or FAT; virus isolation from the brain; and, detection of virus by PCR in brain, saliva or salivary gland.

Furthermore, while none of the three clinically affected bats that were euthanized seroconverted, five of the seven ABL-infected survivors did develop anti-lyssavirus antibodies. In most cases, the titres were transient but, in one animal, the titre, after waning to below detectable levels, then vigorously rose again.

3.2 Studies in cats.

Inoculum control mice were all sick, and were euthanized at 5-8 dpi. The presence of lyssavirus was confirmed by FAT.

At the end of the three-month trial, no cats had succumbed. However, all three ABL-infected cats seroconverted between 4-14 weeks pi. In the first to seroconvert, the anti-lyssavirus titre rose steadily until approximately 2 mths pi, at which point the titre remained steady until euthanasia at 3 mths pi. In another, the titre continued to rise rapidly from 6 wks pi until euthanasia at 3 mths pi, and the last cat did not seroconvert until around 3 mths pi (just prior to euthanasia). Anti-lyssavirus Ab was found in the cerebrospinal fluid of one of these cats. There were no obvious behavioural changes or abnormal clinical signs in any of the infected cats.

Following necropsy of each cat at approximately 3 months pi, no lesions were noted in the CNS of any of the cats, FATs and IPX studies on the brains were negative for viral antigen, and attempts at virus isolation were unsuccessful.

3.3 Studies in dogs.

Inoculum control mice were all sick and euthanized at 7-8 days pi, and the presence of lyssavirus was confirmed by FAT.

At 2-3 weeks pi, three of the five ABL-infected dogs showed very mild abnormal clinical signs (paraesthesia at the site of inoculation, and hind-limb ataxia). In each case, the signs persisted for 1-2 days, after which the dogs recovered. All five dogs were euthanized at 3 mths pi. At necropsy, there were no lesions in any of the dogs, nor was ABL antigen detected in the CNS of any of them. Virus could not be isolated from any of the ABL-infected dogs.

All ABL-infected dogs seroconverted. The response was rapid and vigorous in three of the dogs, while the remaining two dogs had lower titres. Nevertheless, even these were, in general, higher than those observed in cats and bats. CSF, collected from dogs immediately prior to euthanasia, was positive for lyssavirus-specific antibody in two ABL-infected cases.

4 CONCLUSIONS.

The results of work on ABL infection in bats, cats and dogs have improved our understanding of the pathogenesis, diagnosis and the epidemiology of the disease in general, and in these species in particular. The main conclusions to be drawn from this work include:

- When flying foxes are inoculated peripherally with ABL, the proportion that develops abnormal clinical signs within three months of inoculation is relatively low.

- The FAT, which is the diagnostic procedure of choice in most laboratories, revealed only minute to small amounts of antigen in the brain of affected flying foxes, raising the real possibility of false-negative diagnoses.
- Following inoculation with ABL, some flying foxes may seroconvert in the absence of clinical signs of disease. Their titre may then wane, or it may fall and, later, experience a secondary rise. Some flying foxes show neither clinical nor serological evidence of infection following inoculation.
- Mature cats inoculated with ABL showed no clinical signs of infection, but they all seroconverted, and, in one, specific antibody was found in the CSF. Had the cats resisted infection, or would they have eventually succumbed (as happened with rabies virus-infected cats (Murphy *et al.*, 1980)?
- A number of young pups inoculated with ABL showed definite, but transient, clinical signs of disease. All seroconverted, and, in some, specific antibody was detected in the CSF.
- The clear lesson for work involving bat-derived lyssaviruses is that perhaps experimentally infected animals need to be kept for much longer than expected in order to get a true understanding of the outcome of these infections.

REFERENCES.

ALLWORTH A., MURRAY K. AND MORGAN J. – 1996 – A human case of encephalitis due to a lyssavirus recently identified in fruit bats, *Communic. Dis. Intell.*, **20**, 504.

CRICK J. AND KING A. – 1988 – Culture of rabies virus in vitro. *In*: Rabies. Campbell J.B. and Charlton K.M. (eds), Kluwer Academic Publishers, Boston, pp 47-66.

HANNA J.N., CARNEY I.K., SMITH G.A., TANNENBERG A.E.G., DEVERILL J.E., BOTHA J.A., SERAFIN I.L., HARROWER B.J., FITZPATRICK P.F. AND SEARLE J.W. – 2000 – Australian bat lyssavirus infection: a second human case, with a long incubation period, *Med. J. Aust.*, **172**, 597-599.

MURPHY F.A., BELL J.F., BAUER S.P., GARDNER J.J., MOORE G.J., HARRISON A.K. AND COE J.E. – 1980 – Experimental chronic rabies in the cat, *Lab. Investigation*, **43**, 231-241.

MURRAY K., SELLECK P., HOOPER P., HYATT A., GOULD A., GLEESON L., WESTBURY H., HILEY L., SELVEY L., RODWELL B. AND KETTERER P.J. – 1995 – A morbillivirus that caused fatal disease in horses and humans, *Science*, **268**, 94-97.

DISCUSSION

L. Nel to J. Smith: Is there any possibility of aerosol transmission or mutation to aerosol transmission from bats to humans?

There is no evidence for aerosol transmission. Most exposure has been from single bats. However, the literature states 2 cases associated to caves with thousands of free tailed bats. Surveys in terrestrial animal populations that prey on these bats have shown no evidence of transmission.

M. Letshwenyo to C. Vargas: How do you protect cattle from bat rabies? Is there any danger with regard to the contact with droppings of bats?

Cattle are protected through rabies vaccination, however not all farmers vaccinate their animals accounting for the many bovine cases in Latin America. The vaccine protects the animal against rabies not against eventual anaemia induced by the bats.

L. Nel: *For bats there has to be a bite. This is not the case with Hanta virus where the virus is transmitted through the droppings (rodent excreta)*

J. Bingham: *In Africa to have bats around the house is less dangerous than having a dog.*

J. Godlonton to J. Smith: There has been a case of a lady bitten that died after one week while she was still being treated.

In 1958 horse serum and nerve tissue vaccine could lead to failure, and not until in the 1970's were new vaccines available.

T. Fooks to L. Nel: What about route of immunization, are there works on mucosal vaccination

Non invasive administration of DNA vaccines should be the route to go even if traditional vaccines are cheaper. More generally, the non-invasive way is the route to go (looking at lipids and oral vaccines).

A. Zezai: In rural Zimbabwe there are bedbugs, can they transmit rabies?

J. Bingham*: There is no evidence. It has been studied in ticks.*

T. Mebatsion: For Mokola vaccine is an inactivated vaccine better than a DNA vaccine?

L. Nel: *The inactivated vaccine protects. Work has been done as a model to see how vaccines can support each other. In the future DNA vaccine with non-invasive administration is envisaged (effective, easy to administrate to humans).*

A. Wandeler: Jean Smith showed fantastic pictures of the jaw of a raccoon compared to a bat. How often do physicians see bites without a history of carnivore contact?

J. Godlonton: *In 40% of the cases there are no bite wounds due to prolonged incubation (1-2-years) and the person has forgotten about the exposure.*

W. Shumba to C. Vargas: Is the rural fox a potential for bat rabies? And are the governments doing something about the open houses in Latin America?

This is difficult to answer. The presented picture was taken in Peru in a very inaccessible area (2 days walking or by horse). Persons are using mosquito nets however they do not work against bat-bites. The control of bats is laborious and costly. It has to be evaluated if persons at continuous risk should receive pre-exposure prophylaxis. The government might need to come into building new type of houses. Many rabies cases do not get reported to the authorities as the nearest health center can be 2 days away and many do not recognize the risk of bats for rabies.

D. Ntebela to C. Vargas: I doubt that mosquito nets work.

In Peru it has been evaluated that mosquito nets only provide 20% reduction of risk.

T. Fooks to K. McColl: During the PCR test performed in cat and dog experiences has RNA load been quantified.

No. Due to lack of funds

J. Smith to K. McColl: From observations in the literature, defective interfering particles are suspected in case of unusual progression of virus. Was the original inoculum too small, was it amplified by passage?

Several passages of the virus have been made to clear the possibility of interfering particles. There was no evidence of defective interfering particles in the inoculum.

F. Meslin to K. McColl: Additional information has to be provided in your talk, will this be published? In Hanoi during the bat lyssavirus session in March 2001 cats and dogs were basically presented as non-susceptible species.

The publication is pending.

Rabies control

THE ELIMINATION OF RABIES IN LATIN AMERICA EXAMPLE: MEXICO

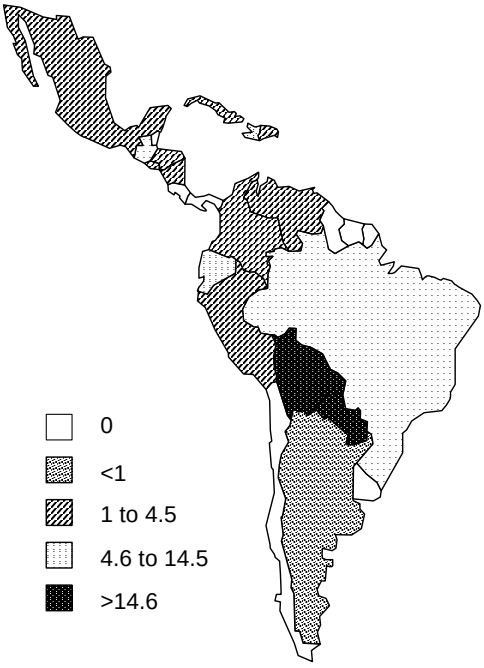
C. Vargas[1]

Adapted from overheads.

1 RABIES SITUATION IN LATIN AMERICA.

In Latin America, dog rabies is reported in most of the countries (Figure 1), rabies cases observed both in man and in dog have decreased since the beginning of the 1990s (Table 1). Most of recorded human rabies cases are due to dog bites.

Figure 1: Dog rabies cases per million people in Latin America, 1999.



In 1999, the following countries recorded dog transmitted human rabies: Bolivia (10 cases), Brazil (21), Colombia (3), Ecuador (4), Guatemala (2), Haiti (1), Mexico (3), Paraguay (3) and Venezuela (2).

On a yearly base, 730000 to 870000 people are exposed to rabies and one third of them receive post exposure treatment (Table 2). Even if the importance of dog as transmitters of rabies is decreasing, dogs remain the most important transmitting species (Figure 2). In Latin America, most human rabies cases are recorded in people under 20 years (Table 4).

[1] PAHO / PANAFTOSA - 525 22nd street, NW - Washington DC - USA

Table 1: Human and dog rabies cases in Latin America.

Years	Dog rabies cases							Human rabies cases
	Andine area	Brazil	Mexico	Caribbean	Central America	South Cone	Total	
1970-1979								255
1980-1989								293
1990	3160	823	11676	123	524	156	16462	252
1991	2251	461	7351	78	405	246	10792	215
1992	2935	699	2077	128	418	365	6622	225
1993	3147	688	1398	109	959	337	6638	216
1994	1753	672	1515	99	807	575	5421	150
1995	1756	641	1261	60	354	398	4470	154
1996	1962	1058	852	76	577	549	5074	183
1997	1217	945	521	108	538	589	3918	118
1998	690	1746	394	119	268	395	3612	89
1999	519	970	317	145	158	401	2510	73
2000*							1590	61

* provisional data

Table 2: Human contamination and post-exposure treatment in Latin America between 1995 and 1999.

	1995	1996	1997	1998	1999
Exposed people	736000	818000	821000	817000	875000
Post exposure treatments	285000	309000	307000	281000	295000
% PET	38	39	37	34	34

Table 3: Human rabies cases by type of transmitting animal, 1999.

Transmitting animal	Cases
Dog	49
Vampire bat	7
Other bat	7
Skunk	1
Unknown species	9
Total	73

Figure 2: Rabies in humans by type of transmitting animal, the Americas, 1990 – 1999.

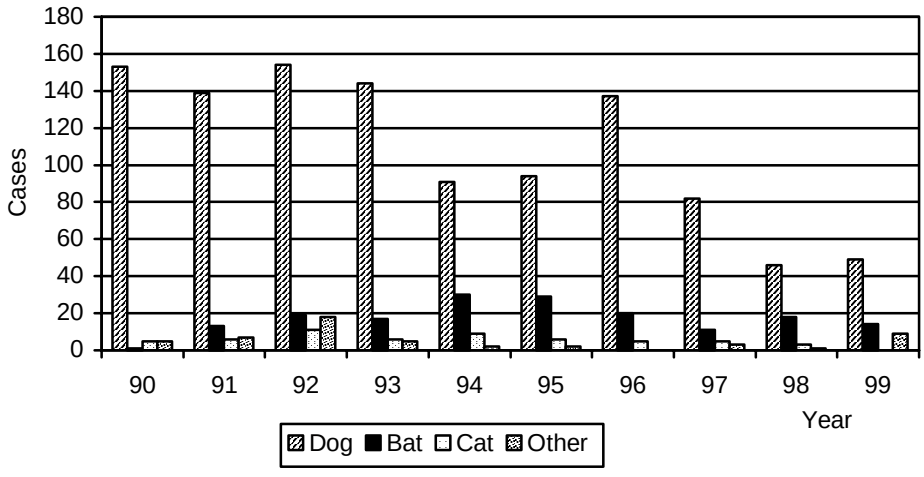


Table 4: Human rabies by age group in Latin America in 1999.

Age	Percent
≤ 10	33.3
11 to 20	20
21 to 30	8
31 to 40	14.7
41 to 50	6.7
51 to 60	6.7
> 60	10.7

Table 5: Estimated dog population and vaccination coverage in Latin America, 1998-1999.

Year	1998	1999
Estimated dog population	56796000	57614000
Vaccinated animals	37209000	37897000
Vaccination coverage	67 %	68 %

Table 6: Evolution of human and dog rabies between 1981 and 1999.

	1981	1999	Evolution
Human rabies	345	73	- 77 %
Dog rabies	19645	2510	- 87 %

The main strategies used to control dog rabies are:

- Massive dog vaccination campaigns (Table 5).
- Remedial vaccination campaigns if needed (local level).
- Permanent vaccination posts in selected public health clinics.
- Rapid control of all rabies foci.
- Improved rabies surveillance.
- Use of high potency vaccines.

2 EXAMPLE OF MEXICO.

The vaccination pressure increased regularly between 1990 and 2000 (Figure 3). The decrease of the number of dog rabies cases and of human rabies cases is clearly shown in Figure 4.

Another evolution is the decrease in the importance of dogs as animal species that transmit rabies to people: more than 95% of dogs in 1990, 40% in 1999 and 0 in 2000 (Figure 5).

Figure 3: Number of dogs vaccinated in Mexico between 1990 and 2000.

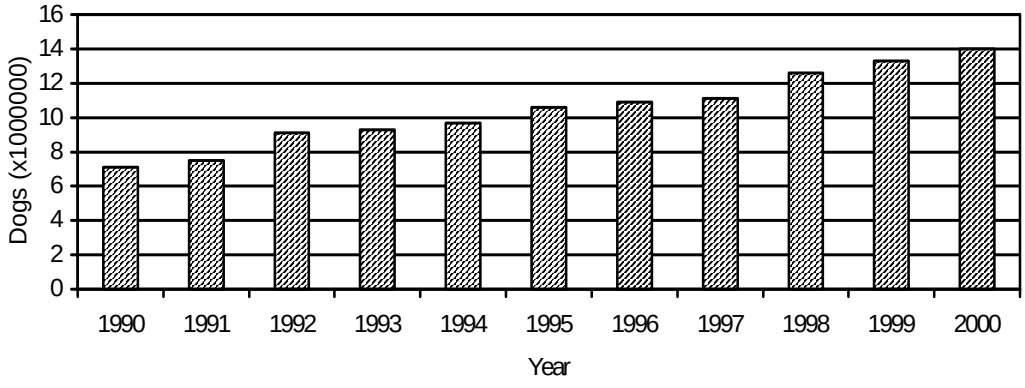


Figure 4: Cases of dog rabies and dog transmitted human rabies in Mexico, 1990-2000.

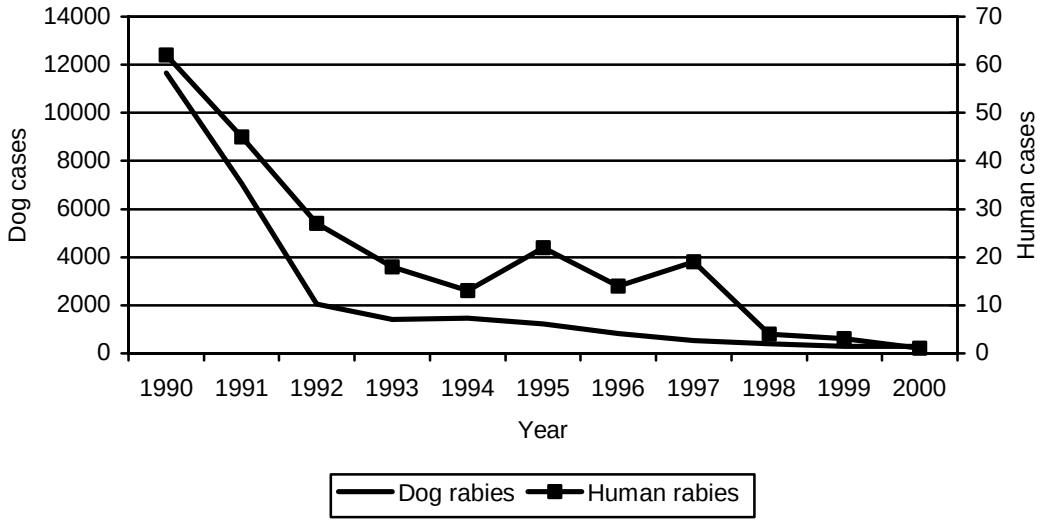
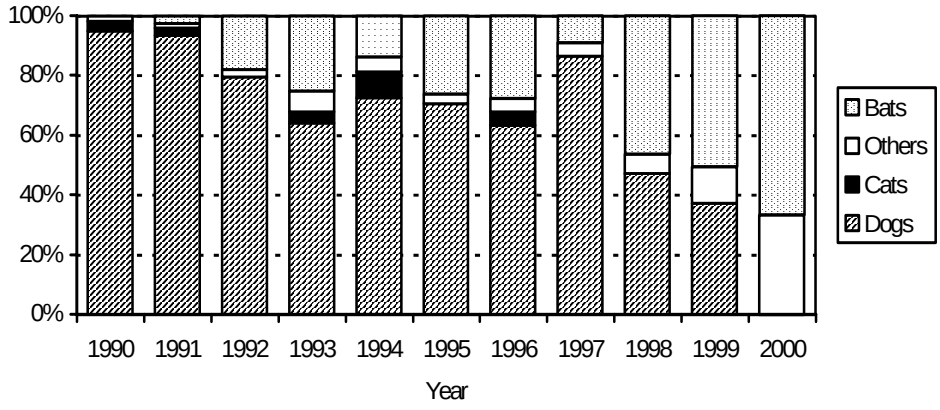


Figure 5: Distribution of human rabies by type of transmitting animal in Mexico, 1990-2000.



2.1 Factors contributing to the success of Mexico dog vaccination campaigns.

Establishment of committees with clear definition of responsibilities at each level.

Organization and execution by the local level (Figure 6).

Thoughtful campaign planning and distribution of vaccination posts.

Advertising in local and national media (Figure 7, Figure 8).

Community participation.

Availability of high potency vaccine.

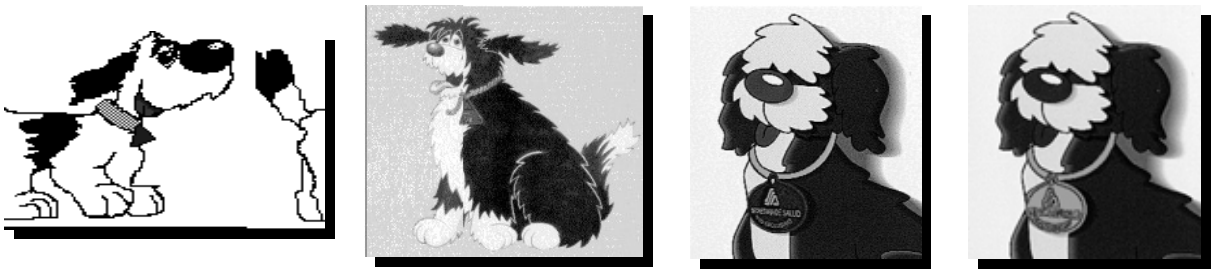
Figure 6: A vaccination point in rural area.

Figure 7: Advertising, some "carteles de campaña".

1989 **1990** **1992** **1994**

Figure 8: Advertising, "Fachas" the central character of advertising campaigns.

1997 **1998** **1999** **2000**



3 THE FUTURE.

Some lines of action should be considered to achieve human rabies elimination in Latin America:

- Sustained political and financial support for the national rabies control programs.
- Strengthening epidemiological surveillance.
  - Delimitation of areas at risk (focalization).
  - Identification of all wildlife rabies reservoirs.
- Improvement of laboratory capacity and introduction of new methods (Mabs, PCR).
- Improving treatment in persons exposed to rabies: increased coverage, harmonization of schemes for post-exposure prophylaxis, change to TC vaccines.
- Development of effective control methods of rabies in wildlife, especially in vampire bats.
- Strengthening of intersectorial coordination (particularly between health and agriculture) and community participation.

A DOG RABIES VACCINATION CAMPAIGN IN RURAL AFRICA: IMPACT ON THE INCIDENCE OF ANIMAL RABIES AND HUMAN BITE INJURIES

S. Cleaveland [1], M. Kaare [2], P. Tiringa [2] and T. Mlengeya [3].

ABSTRACT.

Despite the availability of safe and effective rabies vaccines, the incidence of dog rabies has been increasing throughout much of sub-Saharan Africa. This paper describes a vaccination strategy that has resulted in successful control of rabies in a rural African dog population. From October 1996 to February 2001, a mass rabies vaccination programme was carried out in a rural domestic dog population of northwestern Tanzania, with a dog population density of 5-10 dogs/km^2. Four central-point vaccination campaigns were conducted in 72 villages with a mean interval between campaigns of 338 days (± 24 days), 319 days (± 24 days) and 456 days (± 50 days). In randomly-selected villages vaccination coverage was estimated from household questionnaires as 64.2% (n=260), 61.3% (n=705), 64.30% (n=876) and 76.1% (n=348) following each of the four campaigns respectively. Rabies incidence data were collected by active surveillance in the vaccination zone (Serengeti District) and in an adjacent control zone (Musoma District). Following the start of dog vaccination, the incidence of dog rabies declined significantly in Serengeti District and was significantly lower than in the control zone. The reported incidence of human bite injuries from suspect rabid animals declined significantly in the vaccination zone, but remained more stable in the control zone over the same period. A dog vaccination coverage of 60%-70% has thus been sufficient to control rabies in a rural African population and has led to significantly reduced demand for human post-exposure vaccine. The number of wildlife rabies cases in the adjacent Serengeti National Park increased in 1998 but declined in 1999 and 2000.

1 INTRODUCTION.

Rabies was first confirmed in Tanzania in 1934, but the disease is widely believed to be more prevalent and widespread today than at any time in recorded history. Several factors are thought to have contributed to an increase in rabies over the past three decades, including (i) the rapid growth of human and dog populations, (ii) the increasing mobilisation of rural populations, and (iii) a decline in the infrastructure and resources available for disease control (Cleaveland, 1998). Traditional approaches to dog rabies control in Tanzania include mass vaccination, movement restriction and culling of 'stray' dogs. However, none of these approaches has been widely effective over the past 30 years. Epidemiological theory suggests that a vaccination coverage of 70% should be sufficient to prevent outbreaks of dog rabies, based on the pattern of rabies epidemics in urban dog populations (Coleman and Dye, 1996). However, in Tanzania, the proportion of vaccinated dogs falls well below this level, with vaccination coverage from 1980 to 1991 estimated as 0.6%-4.1%, using a conservative human:dog ratio of 10:1 and dog vaccination figures from the Ministry of Agriculture (1994).

In addition to population coverage, vaccination strategies also need to consider the frequency of campaigns. This is particularly important in dog populations with high birth and death rates (such as Tan-

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[3] Tanzania National Parks, P.O. Box 3134, Arusha, TANZANIA

zania), because the overall population coverage will decline rapidly after a single campaign, with the risk of outbreaks occurring between campaigns. Rabies vaccinations have traditionally been carried out annually in Tanzania. However, demographic data from rural populations indicate that more frequent campaigns (every 6-10 months) are needed to maintain population coverage above the threshold required to prevent rabies (Cleaveland, 1996).

Although several studies have reported dog vaccination coverage levels achieved through different strategies of vaccine delivery (e.g. Fishbein *et al.*, 1992; Perry *et al.*, 1995; Matter *et al.*, 2000; Kitala *et al.*, 2001), there are only few empirical data correlating vaccination coverage with rabies incidence. Vaccination of 65% of dogs in urban Peru resulted in successful control of dog rabies in Peru (Chomel *et al.*, 1988) and ERA vaccination of 30-50% of dogs in Korea led to the apparent elimination of dog rabies from 1985 to 1992 (Lee *et al.*, 2001). However, relatively high levels of coverage among household dogs in Mexico (56% - 86%) failed to prevent an outbreak of dog rabies in the late 1980s (Eng *et al.*, 1993). In Zimbabwe, vaccination of an estimated 10% to 50% of the dog population from 1986 to 1995 has been insufficient to control dog rabies (Bingham *et al.*, 1999).

A further factor that has not yet been evaluated in Tanzania is the impact of wildlife hosts on dog rabies control. Throughout the world, the pattern of rabies suggests that, despite the ability to infect multiple hosts, different strains of the rabies virus are maintained by only a single host species. If this paradigm is true for Tanzania, the current evidence suggests that the domestic dog is likely to be the principal maintenance host species in the country (Cleaveland and Dye, 1995). In this case, control of dog rabies should therefore lead to the disappearance of rabies in other mammalian hosts.

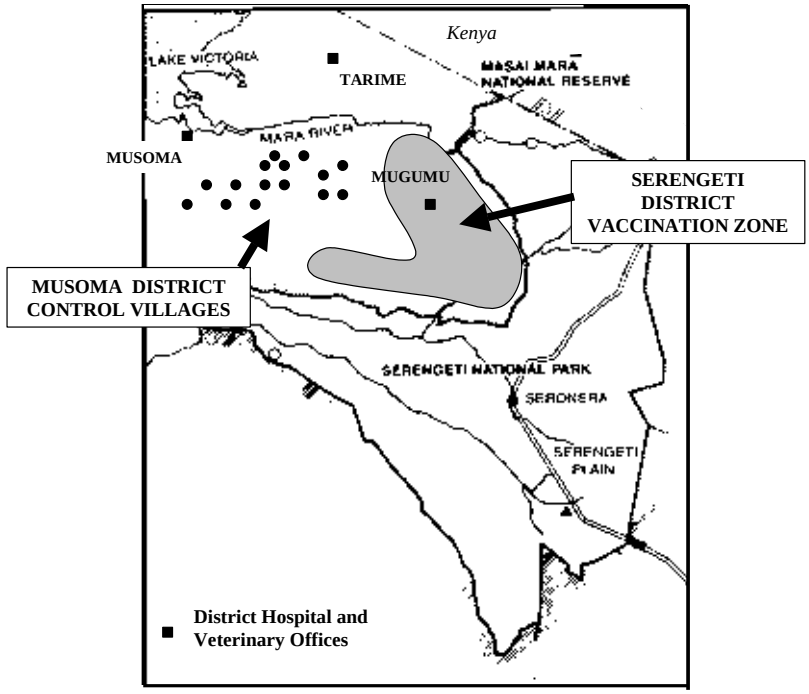
This study was set up to investigate the impact of mass dog vaccination on the incidence of dog rabies in a rural area of Tanzania, in order to determine

a) the relationship between vaccination coverage and the incidence of dog rabies;
b) the impact of mass dog vaccination on animal-bite injuries in people and demand for human post-exposure treatment and
c) the impact of dog vaccination on wildlife rabies.

2 MATERIALS AND METHODS.

2.1 Study area.

Figure 1: Location of vaccination zone in Serengeti District (shaded grey) and control villages in Musoma District (shown by black circles).



The study area was the Mara Region of Tanzania, (340-350 E, 10 30'-20 10'S). The vaccination zone comprised all villages within Serengeti District, adjacent to the Serengeti National Park (Fig. 1). The control zone comprised 10 villages selected at random within Musoma District. Both the vaccination zone and control zones were part of the Midland Zone of the Mara Region, an area of relatively homogeneous landuse, with agropastoralist production systems based on livestock and cultivation of crops, such as cassava and maize (FAO/IFAD, 1995). Within the Midland Zone, human population densities ranged between 30-50 people/km^2 (FAO/IFAD, 1995). Preliminary estimates of dog density using the human:dog ratio indicated that the density of dogs ranged from 5-10 dogs/km^2 in both Serengeti District (Cleaveland and Dye, 1996) and Musoma District (Cleaveland and Kaare, 1999). In both areas, dog rabies vaccine was available only sporadically through government veterinary services. No mass dog vaccination campaigns had been conducted in either area for at least 6 years prior to the study.

2.2 Mass dog vaccination.

A mass vaccination campaign was carried out in Serengeti District from October 1996 to February 2001 under the auspices of the Ministry of Agriculture and Cooperatives (currently Ministry of Water and Livestock Development) using a village-based strategy. One to two days prior to the vaccination date in each village, livestock officers visited the village to advertise the campaign through meetings with community leaders and at primary schools. Previous experience has suggested that children are most likely to handle dogs and bring them for vaccination (de Balogh *et al.*, 1993; Kitala *et al.*, 2001). On the day of vaccination, a team of four livestock officers set up a vaccination station at a central point within the village. Dogs brought to the vaccination station were registered with data recorded on the head of the household, name of dog, age, sex, and previous vaccination history, and for females, reproductive histories. Each dog was given 1ml Nobivac Rabies vaccine (Intervet) and 1 ml Puppy DP (Intervet) subcutaneously, with the rabies vaccine being used as solvent for the canine distemper and canine parvovirus vaccine. A vaccination certificate was given, and coloured plastic collar fitted to each vaccinated dog. Vaccination was free of charge.

The first campaign was conducted between October 1996 and March 1997. Between September 1997 and August 1998, villages were re-visited in approximately the same sequence as the first campaign with the aim of vaccinating pups born since the previous campaign and any other unvaccinated adults. Previous studies have demonstrated that the life expectancy of Serengeti District dogs (1.9 years; Cleaveland, 1996) is less than the duration of immunity afforded by the vaccine (3 years). Thus we assumed that, on average, one dose of vaccine would be sufficient to protect each dog. Although advertising for the campaign targeted unvaccinated dogs, vaccinated dogs brought to the station received booster rabies vaccinations.

A third campaign was conducted between February 1999 and September 1999 and a fourth campaign between May 2000 and February 2001, adopting the same protocol as previous campaigns.

2.3 Vaccination coverage.

Vaccination coverage was determined in each phase of the campaign by questionnaire surveys of householders in randomly-selected villages within the vaccination zone. During the first campaign, vaccination coverage was also assessed by

i. direct observation of collared dogs seen in the village during the questionnaire surveys and

ii. number of vaccine doses administered in relation to the estimated total dog population.

Questionnaires were conducted within 2 days of the vaccination campaign and households sampled by systematic stratified sampling. Households were visited within each kitongoji (administrative subdivision) and one in three households sampled systematically within each kitongoji along a transect at a random bearing from the main road. This ensured that households were visited at a range of distances from the location of the vaccination station in the village centre. To assess whether samples were representative of the village as a whole, all households were visited in two of the study villages and data were compared from households in the sampling frame and from all other households within the village. For validation of questionnaire data, data on dog ownership were also compared for households in which dogs were directly observed and those in which owners reported the number, age and sex of dogs.

The dog population size was estimated from the human:dog ratio obtained from questionnaire surveys, with the village human population based on 1988 human census data with a projected regional population growth rate of 2.9% per annum (Bureau of Statistics, 1991).

2.3.1 Incidence of dog rabies.

Although rabies is a notifiable disease in Tanzania, it is widely recognized that most cases of dog rabies are not reported to the government veterinary services. To obtain more detailed incidence data on dog rabies, community-based active surveillance measures were implemented within 15 randomly-selected villages within the vaccination zone and in each of the 10 control villages, using methodology adapted from studies in rural Kenya (Kitala *et al.*, 1994). Livestock field officers stationed in each of the monitoring villages were paid to complete monthly report forms, in which standardised information was collected from village leaders, primary school teachers and medical dispensary staff about any suspect cases of rabies in the village. In addition, a financial incentive was offered to field officers for collection of brain stem samples collected from dog carcasses, using World Health Organization collection kits (Barrat and Blancou, 1988). During the first two years of the programme, incentives were paid for all dog samples retrieved. During the third year, when rabies was reported at only very low levels, attempts were made to increase the chances of detecting cases by offering an increased incentive to be paid only when samples were confirmed rabies positive on laboratory diagnosis.

The incidence of dog rabies was recorded for each month as the number of suspect cases divided by the estimated dog population within the study villages. The dog population size was estimated from the human:dog ratio obtained from questionnaire surveys, with the village human population based on 1988 human census data with a projected regional population growth rate of 2.9% per annum (Bureau of Statistics, 1991).

2.3.2 Incidence of human bite injuries.

Animal bite injury data were collected for the vaccination and control zones from Government District Hospitals in Mugumu, Musoma and Tarime Districts. Information was obtained on the species inflicting the bite wound, the age, sex and village of origin of the victim, whether the animal was suspected of suffering from rabies and whether post-exposure rabies vaccine had been administered. Incidence data were recorded as the monthly per capita incidence of bite injuries, using human population data based on 1988 government census with a projected population growth rate of 2.9% per annum (Bureau of Statistics, 1991).

2.3.3 Wildlife rabies.

Surveillance of wildlife rabies in the Serengeti was carried out by the Tanzania National Parks Veterinary Department, using a reporting network established among park staff, scientists and tour operators. Wherever possible, brain stem samples were collected from all wild carnivore carcasses using WHO collection kits (Barrat and Blancou, 1988). Rabies diagnosis was conducted at the WHO rabies collaborating centre, Agence Française de Securité Sanitaire des Aliments, Nancy, France and at the Onderstepoort Veterinary Institute, South Africa, using immunofluorescence diagnostic tests (Kaplan and Koprowski, 1973). Animal cases were classified as suspect rabies if the reported history included abnormal behaviour in combination with neurological signs and/or unprovoked aggression.

2.3.4 Data analysis.

An autocorrelation analysis was carried out (Sokal and Rohlf, 1995), which demonstrated that the incidence data for dog rabies cases and dog bite injuries were significantly autocorrelated. To avoid biases arising from autocorrelated data and as a preliminary step in data analysis, non-parametric statistics were adopted to investigate differences between proportions (chi-squared test) and the difference between the median incidence in vaccination and control zones at different stages of the programme (Mann-Whitney U Test) (Siegel and Castellan, 1988).

3 RESULTS.

3.1 Vaccination coverage prior to start of campaign.

Vaccination coverage prior to the start of the campaign was 9.1% (total dogs=4457) in the vaccination zone, and 8.5% (total dogs=316) in the control zone.

3.2 Vaccination coverage – Questionnaire survey.

Questionnaire data were collected from 1515 households from 22 villages. Over the four campaigns, the average vaccination coverage for the entire dog population was 63.7% (n=1904), with 69.9% (n=1668) adults vaccinated and 33.4% (n=326) pups less than three months of age vaccinated. Details of vaccination coverage following each campaign is shown in Table 2.

Table 6: Summary household information from questionnaire survey conducted after each campaign.

	Campaign				Overall
	1	2	3	4	
Total dogs	315	693	861	120	1989
Total people	2048	4145	5063	724	11980
Human:dog ratio	6.50	5.98	5.88	6.03	6.02
Households sampled	226	548	674	101	1549
Dogs per household	1.39	1.26	1.28	1.19	1.28

Table 7: Vaccination coverage of the owned dog population determined from household questionnaire surveys conducted after each of the vaccination campaigns. The total number of dogs and households refers to only those households for which age classes and vaccination status of dogs was recorded and hence differs slightly from Table 1.

	Campaign				Overall
	1	2	3	4	
Households sampled	197	552	688	89	1526
Total dogs	225	702	879	98	1904
Total pups (< 3 months)	49	139	117	21	326
All dogs vaccinated	142	429	566	75	1212
Pups vaccinated	11	52	36	10	109
Overall coverage (%)	63.11	61.11	64.39	76.53	66.28
Coverage for adults/juveniles (%)	74.43	66.96	69.55	84.42	73.84
Coverage for pups (%)	22.45	37.41	30.77	47.62	33.56

3.3 Vaccination coverage - Observation of collared dogs.

Following the first campaign, observations were made of 270 dogs roaming free within three villages, of which 109 (62.1%) were wearing plastic collars that had been fitted during the vaccination campaign.

3.4 Vaccination Coverage - Number of dogs vaccinated.

The total population of owned dogs was estimated as 12,143 (95% C.I =10,766-13,512) from the human:dog ratio (Table 1) and projected human population sizes (Bureau of Statistics, 1991). During the first campaign, it became apparent that many dogs were not registered at the vaccination station, therefore the number of dogs recorded in the first campaign (5469) was considered to be an underestimate of the true number vaccinated. We therefore estimated vaccination coverage from the total

number of vaccine doses administered, assuming 2% wastage for dogs that required repeat injections due to incorrect administration (observed during subsequent campaigns). During the first campaign, a total of 7600 doses of vaccine were administered in Serengeti District, from which we estimate that a total of 7448 dogs were vaccinated, giving an estimated overall population coverage of 61.3% (55.1% – 69.2%). During the second and third campaigns, vaccines were administered only to dogs that had been registered. A total of 7552 and 6399 dogs were registered during the second and third campaigns respectively. Previous vaccination status of dogs recorded in 45 villages (n=5804 dogs) was estimated to be 27.7% overall in the second and third campaigns.

3.5 Intervals between campaigns.

The mean interval between successive campaigns in villages within the vaccination zone was 338 days (+24 d), 319 days (+24 d) and 456 days (+ 50 d).

3.6 Evaluation of sampling method.

For the two villages in which all households were sampled, the percentage of dogs vaccinated in households within the sampling frame (53.03%, n=122) was not significantly different from the percentage vaccinated in all other households in the village (54.47%, n=246). In these groups, there was no significant difference in the number of people per household ($\chi^2_5 = 1.06$, $p>0.05$), nor in the number of adult ($\chi^2_5 = 4.16$, $p>0.05$), juvenile ($\chi^2_1 = 0.70$, $p>0.05$) or pups ($\chi^2_1 = 0.69$, $p>0.05$) per household. There were also no significant differences between the number of dogs ($\chi^2_3 = 2.25$, $p>0.05$), juveniles ($\chi^2_3 = 0.14$, $p>0.05$) or pups per household ($\chi^2_1 = 0.63$, $p>0.05$) in families in which dogs were observed directly by the interviewer and those in which the number of dogs was reported by the owner.

3.7 Rabies recognition.

Rabies was confirmed by laboratory diagnosis in 68% (n=25) of the domestic dog cases reported as suspected rabies cases. Due to the relatively small number of carcasses retrieved throughout the study, incidence data are subsequently reported here in terms of reported cases.

3.8 Incidence of dog rabies.

The incidence of dog rabies is shown for the vaccination and control zones in Fig. 2. The incidence of dog rabies was significantly lower in Serengeti District in phase 2 after the first campaign (July 1997 to Jun 1998) than in phase 1 (September 1996 to June 1997) ($W_{8,25}=216.0$, $p<0.001$). In contrast, the incidence of dog rabies in Musoma District did not differ significantly between phase 1 and phase 2 ($W_{5,25}=100.0$, $p>0.05$). No cases of dog rabies were reported in any of the study villages after July 1998, while cases continued to be reported in study villages of Musoma District.

Fig. 3 gives the monthly incidence of dog rabies in the whole of Serengeti District, showing that only few cases were reported after July 1998. However, the disease was not completely eliminated with sporadic cases reported throughout that period. Due to difficulties in procurement of vaccine in early 2000, the interval between the third and fourth campaigns was longer than planned. Two cases were reported in December 2000 and a single case in February 2001. No cases have been reported since that time until the time of writing (December 2001).

Figure 2: Incidence of reported canine rabies cases monitored by active surveillance in study villages of Serengeti (vaccinated) and Musoma (unvaccinated) Districts. Active surveillance in Musoma District ended in June 1999.

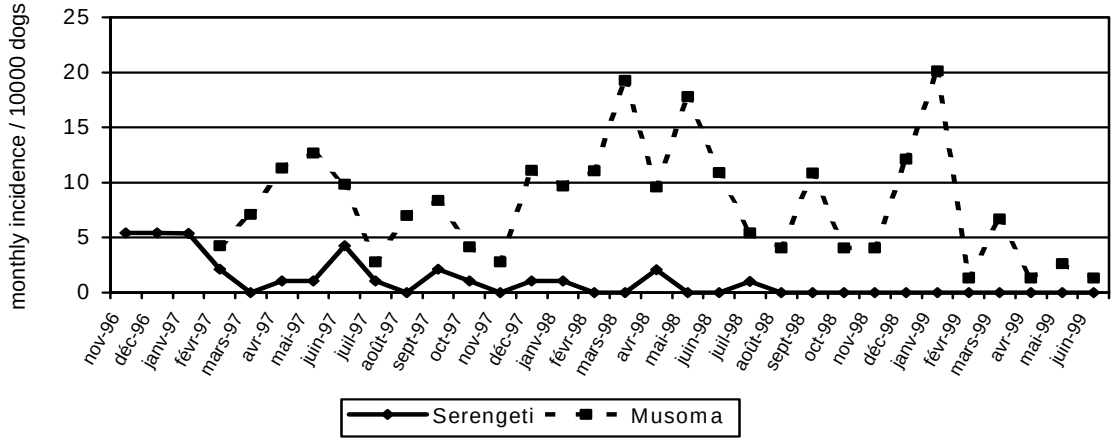
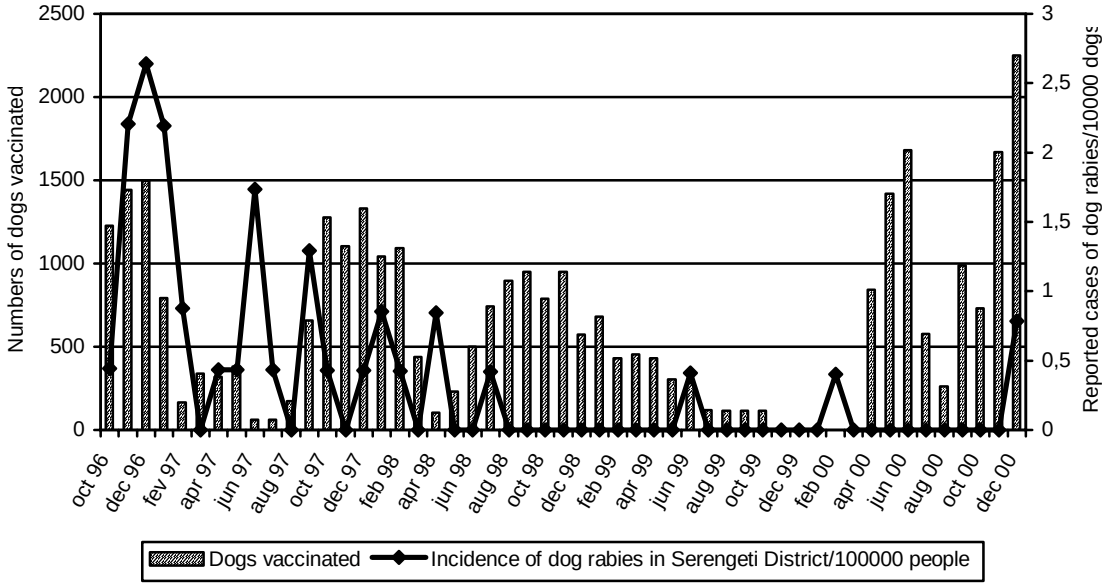


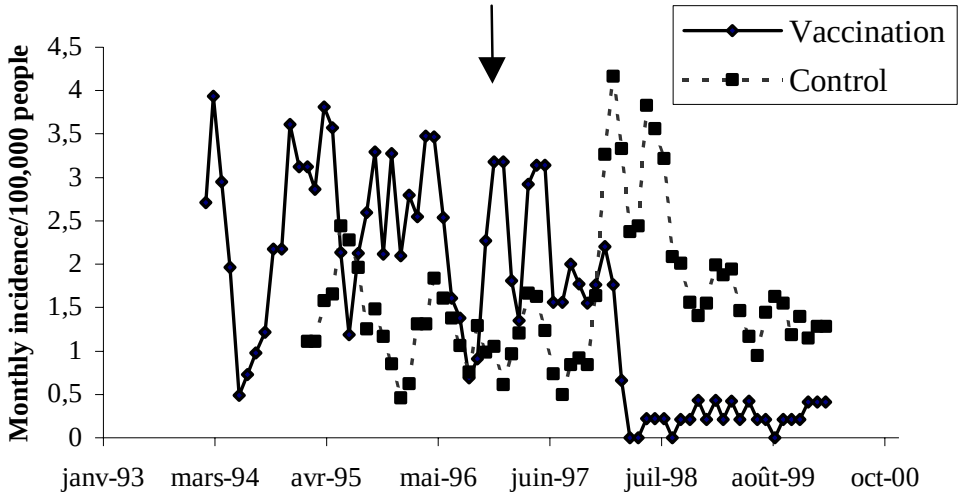
Figure 3: The monthly incidence of dog rabies (shown by the black line) in Serengeti District overall in relation to the number of dogs vaccinated (shown by the bars).



3.9 Incidence of human bite injuries.

The incidence of dog bite injuries from suspected rabid dogs (shown in Fig. 4) was significantly lower in Serengeti District after the first campaign (phase 2 - July 1997 to April 2000) than before the end of the first campaign (phase 1 - November 1993 to June 1997) ($W_{42,32}$=2144, p<0.001). Although, the incidence of suspected rabid dog bite injuries was higher in Musoma District in phase 2 than in phase 1, the difference was not significant ($W_{18,46}$=549, p>0.05).

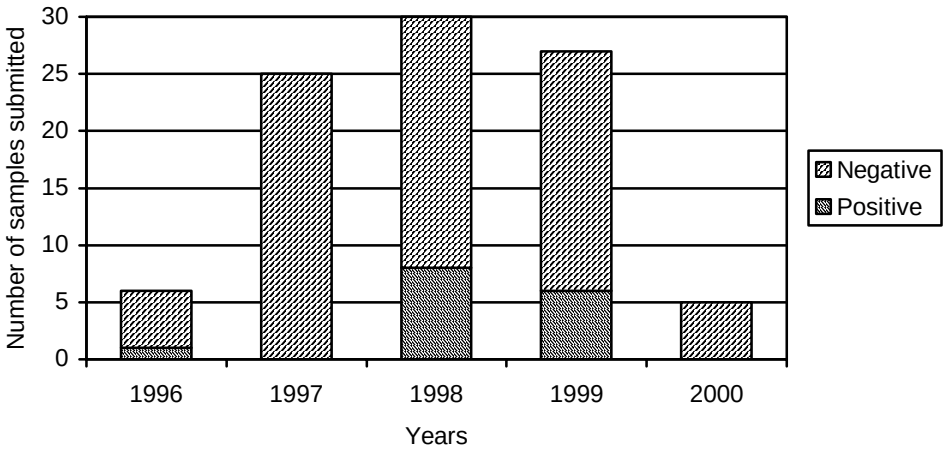
Figure 4: The incidence of human bite injuries from suspected rabid dogs in Serengeti (vaccinated) and Musoma (unvaccinated) Districts. The arrow shows the start of the dog vaccination campaign in Serengeti District.



3.10 Cases of wildlife rabies.

Between August 1996 and December 2000, samples were submitted for rabies diagnostic tests from 94 wildlife carcasses from the Serengeti National Park and surrounding areas (Figure 5).

Figure 5: Number of samples submitted for rabies diagnosis from wildlife species in the Serengeti ecosystem.



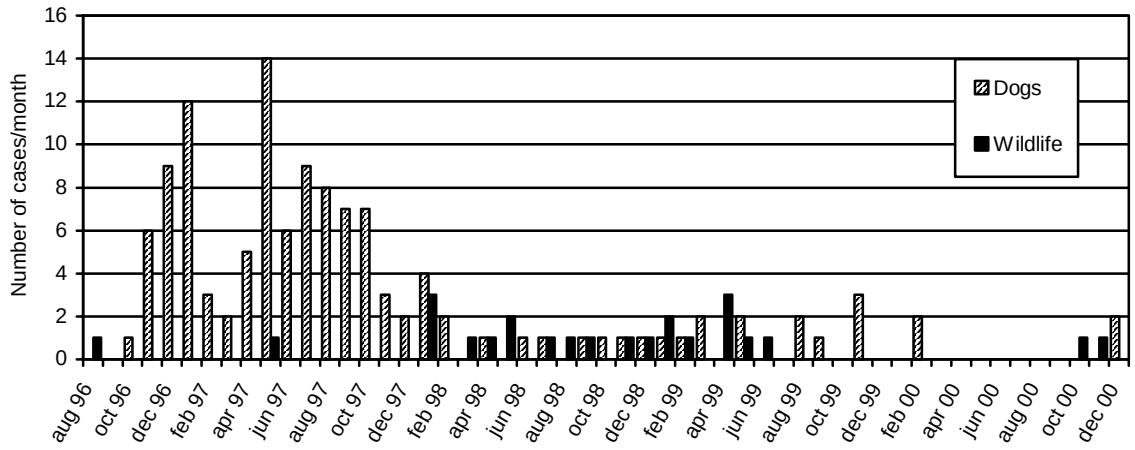
The species distribution of suspected and confirmed rabies cases is shown in Table 3. Bat-eared foxes comprised the greater proportion of confirmed wildlife rabies deaths (53.8%).

Table 8

Species	Confirmed	Unconfirmed
Bat-eared fox	7 (53.8%)	4 (36.4%)
Spotted hyena	0	4 (36.4%)
Jackal (species not specified)	2 (15.4%)	2 (18.2%)
Black-backed jackal	1 (7.7%)	0
Wild cat	1 (7.7%)	0
Aardwolf	1 (7.7%)	0
Civet	1 (7.7%)	0
White-tailed mongoose	0	1 (9.1%)
Total	13	11

The total number of reported cases increased following the first dog vaccination campaign, but declined in 1999 and 2000 (Fig. 6).

Figure 6: Monthly number of suspected rabies cases in dogs (Serengeti District) and wildlife (Serengeti National Park) reported on the basis of clinical signs.



4 DISCUSSION.

Two key conclusions arise from this study. First, control of dog rabies in some rural Africa communities is feasible through implementation of a simple central-point dog vaccination strategy. Second, vaccination of dogs not only reduces the incidence of dog rabies, but also the demand for human post-exposure treatment in these communities.

In this study, vaccination of 64% of owned dogs resulted in a significant reduction in the incidence of dog rabies. While epidemiological theory predicts that a 70% coverage should be sufficient to prevent rabies outbreaks (Coleman and Dye, 1996), this study demonstrates that vaccinating 64% of owned dogs is sufficient to control endemic disease in rural African populations, with virtual elimination of rabies in the core vaccination zone. Although a few cases were reported sporadically after the second campaign (post July 1998), these cases occurred mainly at the margins of the vaccination zone, possibly as a result of transmission from unvaccinated dogs outside the vaccinated area.

A common misperception in rural Africa is that a large proportion of the dog population comprises ownerless 'stray' dogs. In this study, we conclude that the number of ownerless dogs is relatively insignificant because estimates of vaccination coverage obtained from questionnaire data were broadly similar to those obtained for the overall population using direct observation of collars. However, it must be noted that direct observations of collared dogs were limited in terms of the number of villages sampled, the duration of the observation periods and the lack of night observation (when free-roaming dogs are more likely to be active). More robust methods (e.g. Matter *et al.*, 2001) may be needed to provide reliable estimates of the true fraction of ownerless dogs that are inaccessible for vaccination.

Nonetheless, even if a large number of ownerless dogs have been missed in our estimate of vaccination coverage, the empirical observation remains valid that vaccinating 64% of owned dogs at 10-15 month intervals resulted in control of dog rabies in these communities.

Although central-point campaigns proved to be a simple and effective strategy for vaccinating rural dogs in this part of Tanzania, care needs to be taken when extrapolating to other parts of the country and elsewhere in Africa. For example, cultural attitudes towards handling of dogs is known to affect the accessibility of dogs to parenteral central-point vaccination campaigns in Ethiopia (Karen Laurenson, pers. comm.). Similarly, dogs sampled during a previous study in Pemba, Tanzania (a predominantly Moslem community) (Cleaveland *et al.*, 1999) were more difficult to handle than dogs from the Mara Region, which is predominantly Christian. This study was carried only in village communities and it is highly likely that dog ownership and accessibility patterns will differ in large urban communities, affecting the coverage levels that can be attained using a central-point strategy. Further work may be needed to investigate the cost-effectiveness of different delivery methods (e.g. house-to-house, oral vaccination strategies) in other parts of Tanzania.

Rabies surveillance in both human and animal populations remains an enduring problem throughout much of sub-Saharan Africa, making it difficult to evaluate epidemiological trends, assess the true burden of disease or determine the impact of any control measures. Active surveillance measures introduced in selected villages in the vaccination and control zones allowed us to compare the incidence of dog rabies in the two populations with reasonable accuracy. However, due to the relatively short time-frame of the project, active surveillance measures were introduced only at the time that dog vaccination was initiated and pre-vaccination base-line data for the two zones are not available. Although active surveillance is highly effective in increasing rabies detection rates (Kitala *et al.*, 1994), these measures are expensive and require intensive input, which raises doubts about sustainability for rural Africa (Cleaveland *et al.*, 1999).

In previous studies, we have shown that animal-bite injury data provide a valuable and accessible source of epidemiological data for quantifying human rabies mortality in Tanzania (Cleaveland *et al.*, in press; Cleaveland *et al.*, this vol). Here, hospital records of bite injuries from suspected rabid animals also proved to be of great value as data from both districts were available for several years prior to the onset of dog vaccination, allowing trends to be monitored before and after the dog vaccination campaigns and incidence to be compared between vaccinated and non-vaccinated communities.

An important finding of this study was the rapid decline in demand for human post-exposure treatment (PET) vaccine within 18 months of the onset of mass dog vaccination, which has important implications for the economics of rabies control. Although this might be expected as a logical consequence of a reduction in dog rabies, use of human PET vaccine has not declined in several other countries following implementation of dog vaccination programmes. For example, in Tunisia, although the incidence of dog and human rabies declined by over 50% in the three years following the onset of large-scale dog vaccination in 1992, human PET remained at the same or slightly higher levels (data for Tunisia from Rabnet, oms.b3e.jussieur.fr/rabnet). Similarly, in Thailand, an 80% decline in the number of confirmed animal cases was reported from 1987 to 1996 following mass vaccination of dogs and cats (Mitmoonpitak *et al.*, 1998). However, over the same period, the number of people receiving PET increased from 84,178 cases in 1987 to 160,448 in 1994, stimulated by public education campaigns and greater availability of vaccine (Mitmoonpitak *et al.*, 1998). In our study, human rabies vaccine was provided by the project to district hospitals in both the vaccination and control zones from 1997 to 1999. Increased availability of vaccine might therefore explain the increase in animal-bite injuries recorded in 1997 in Musoma District, but it cannot account for the marked differences observed between the two areas after implementation of dog vaccination (Fig.4). One explanation why a decline in demand for PET was observed in our study and not in Thailand or Tunisia may be that dog rabies needs to be virtually eliminated before a reduction in demand for PET becomes apparent. Furthermore, the community needs to become aware that rabies has disappeared, which has indeed occurred very quickly in the Serengeti study. Conversely, if dog rabies is still widespread, albeit at a low incidence, the bite from any dog could still be considered a rabies risk requiring continued high usage of human PET. We suggest that there may be a threshold incidence of dog rabies incidence which must be reached before PET demand declines, and this may be a critical factor in the economic evaluation of any dog vaccination programme. Additional data from other countries and regions would be of tremendous interest in this respect.

After four years of dog vaccination campaigns in the Serengeti, the impact on wildlife remains equivocal. There was clearly no immediate decline in wildlife rabies corresponding to the decline in dog ra-

bies in 1998 and 1999. However, since June 1999 only few suspected wildlife cases have been reported and none confirmed by laboratory diagnosis. There are several interpretations that are consistent with these results:

a) wildlife rabies is maintained independently of domestic dogs (possibly within a bat-eared fox reservoir population) and cycles of dog and wildlife infection occur asynchronously;

b) wildlife rabies is driven by dog rabies, but with a lag period of 1-2 years (a pattern that is consistent with temporal trends from Zimbabwe, for example – Cleaveland and Dye, 1996);

c) wildlife cases continue to occur as a result of transmission from a reservoir population of unvaccinated dogs living adjacent to the southwestern boundaries of the park, where dog rabies is still endemic. At present, each of these scenarios remains a possibility and work is currently underway to explore this further by extending the zone of vaccination to include the entire southwestern boundary of the park over the next five years and monitoring the temporal and spatial patterns of rabies in dog and wildlife populations.

Although fewer wildlife samples were submitted in 1999 for rabies diagnosis and fewer suspected wildlife cases reported, this is unlikely to be the result of reduced disease surveillance. Indeed, wildlife disease surveillance has probably been improving progressively in the Serengeti since the establishment of the Tanzania National Parks (TANAPA) veterinary unit in 1996, with park rangers, scientists, and tour operators becoming increasingly aware of the importance of reporting suspected cases.

In summary, a central-point strategy for mass vaccination of dogs provided a simple and effective method of controlling dog rabies and led to a significant reduction in demand for human post-exposure rabies vaccine in northwestern Tanzania.

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REFERENCES.

BARRAT J. AND BLANCOU J. - 1988 - Simplified technique for the collection, storage and shipment of brain specimens for rabies diagnosis. *WHO/Rabies Research/88.27*, World Health Organization, Geneva, Switzerland.

BINGHAM J., FOGGIN C.M., WANDELER A.I. AND HILL F.W.G. - 1999 - The *epidemiology* of rabies in Zimbabwe. 1. Rabies in dogs (*Canis familiaris*). *Onderstepoort Journal of Veterinary Research*, **66**: 1-10.

BUREAU OF STATISTICS - 1991 - *Tanzania Sensa 1988*. Bureau of Statistics. President's Office, Planning Commission, Dar es Salaam, Tanzania.

CHOMEL B., CHAPPUIS G., BULLON F., CARDENAS E., DE BEUBLAIN D. T., LOMBARD M. AND GIAMBRUNO E. - 1988 - Mass vaccination campaign against rabies: are dogs correctly protected? The Peruvian experience. *Reviews of Infectious Diseases*, **10**, S697-S702.

CLEAVELAND S. - 1998 - The growing problem of rabies in Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **92**, 131-134.

CLEAVELAND S. AND DYE C. - 1995 - Rabies in the Serengeti: persistence of a microparasite infecting several host species. *Parasitology*, **111**, S33-S47.

CLEAVELAND S. AND KAARE M. - 1999 - Rabies surveillance in Tanzania. *Proceedings of the Fifth International Conference of the Southern and Eastern African Rabies Group/WHO*, 29-31 March, 1999, Entebbe, Uganda (eds. King A.A., Barrat J., and Wandeler A.I.), pp 69-78.

CLEAVELAND S., BARRAT J., CLIQUET F., BARRAT M-J., KAARE M. & ESTERHUYSEN J. - 1999 - A rabies serosurvey of domestic dogs in rural Tanzania: results of a rapid fluorescent focus inhibition test (RFFIT) and a liquid-phase blocking ELISA used in parallel. *Epidemiology and Infection*, **123**, 157-164.

CLEAVELAND S., FÈVRE E., KAARE M. AND COLEMAN P. (in press) Estimating human rabies mortality in Tanzania from dog bite injuries. *Bulletin of the World Health Organization*.

CLEAVELAND S., FÈVRE E., KAARE M. AND COLEMAN P. (this vol) Using dog bite injury data to estimate human rabies mortality in Tanzania.

COLEMAN P.G. AND DYE C. - 1996 - Immunization coverage required to prevent outbreaks of dog rabies. *Vaccine*, **14**, 185-186.

DE BALOGH K.K.I.M., WANDELER A.I., AND MESLIN F.-X. - 1993 - A dog ecology study in an urban and a semi-rural area of Zambia. *Onderstepoort Journal of Veterinary Research*, **60**,437-443.

ENG T.R., FISHBEIN D.B., TALAMANTE H.E., HALL D.B., CHAVEZ G.F., DOBBINS J.G., MURO F.J., BUSTOS J.L., DE LOS ANGELES RICARDY M., MUNGUIA A., CARRASCO J., ROBLES A.R. AND BAER G.M. - 1993 - Urban epizootic or rabies in Mexico: epidemiology and impact of animal bite injuries. *Bulletin of the World Health Organization*, **71**, 615-624.

FAO/IFAD - 1995 - Mara Region Farmers' Initiative Project, Formulation Report, 1995, FAO, Rome, pp71.

FISHBEIN D.B., FRONTINI M.G., DOBBINS J.G., COLLINS E.F., HUERTA G.Q., RODRIGUEZ J.D.G., WOOMING B., RAMOS J.G., BELOTTO A.J., TORRES J.M.B, YENNE K.M., LINHART S.B. AND BAER G.M. Prevention of canine rabies in rural Mexico – an epidemiologic study of vaccination campaigns. *American Journal of Tropical Medicine and Hygiene*, **47**: 317-327.

KAPLAN M.M. AND KOPROWSKI H. - 1973 - La rage – Techniques de Laboratoire. 3rd Ed., *Monograph Series* no. 23. Pp. 75-87. World Health Organization, Geneva, Switzerland.

KITALA, P.M., MCDERMOTT J.J., KYULE M.N, MATERE C.N. - 1994 - Investigation of rabies incidence and control by active surveillance in Machakos District, Kenya.

KITALA P.M., MCDERMOTT J., KYULE M., GATHUMA J., PERRY B. AND WANDELER A. - 2001 – Dog ecology and demographic information to support the planning of rabies control in Machakos District, Kenya.

LEE J.H., LEE M.J., LEE J.B., KIM J.S., BAE C.S. AND LEE W.C. - 2001 - Review of canine rabies prevalence under two different vaccination programmes in Korea. *Veterinary Record*, **148**, 511-512.

MATTER H.C., WANDELER A.I., NEUENSCHWANDER B.E., HARISCHANDRA L.P.A. AND MESLIN F.-X. - 2000 - Study of the dog population and the rabies control activities in the Mirigama area of Sri Lanka. *Acta Tropica*, **75**, 95-108.

MINISTRY OF AGRICULTURE AND CO-OPERATIVES - 1994 - A national rabies control programme. Ministry of Water and Livestock Development (formerly Ministry of Agriculture and Co-operatives), Dar es Salaam, Tanzania.

MITMOONPITAK C., TEPSUMETHANON V. AND WILDE H. - 1998 – Rabies in Thailand. *Epidemiology and Infection*, **120**, 165-169.

PERRY B.D., KYENDO T.M., MBUGUA S.W., PRICE J.E. AND VARMA S. - 1995 - Increasing rabies vaccination coverage in urban dog populations of high human population density suburbs – a case study in Nairobi, *Kenya. Preventive Veterinary Medicine*, **221**, 137-142.

SIEGAL S. AND CASTELLAN N.J. - 1988 - Non-Parametric Statistics for the Behavioural Sciences. 2nd Ed., McGraw-Hill, London.

SOKAL, R.R. & ROHLF, F.J. - 1995 -. Biometry: the principles and practice of statistics in biological research. (3rd ed.). New York: W.H. Freeman and Co.

RABIES IN FLORES, INDONESIA: COMPARISONS AND CONTRASTS TO RABIES CONTROL IN AFRICA.

John Bingham[1]

ABSTRACT.

Rabies was introduced to the island of Flores (East Nusa Tenggara Province, Indonesia) in 1997, by a dog transported from Buton Island to the eastern extremity of Flores. The disease subsequently spread westwards to affect the whole island, with the domestic dog being the principal host species. Rabies control was attempted almost entirely through dog population reduction, which was carried out by the communities under the encouragement and lobbying by community and religious leaders. Dog depopulation policies, as opposed to vaccination, were considered necessary because the absence of sufficient veterinary infrastructure required that control efforts had to be conducted by the communities, and not by a government authority. In contrast to the situation in Africa, rabies is likely to be easier to eradicate in Flores because it is an island with a limited and isolated dog population. Like most African countries Flores has poorly developed infrastructure to carry out rabies vaccination campaigns. For this reason it mobilised its communities into taking a very active role in the rabies eradication campaigns. This level of community participation (but not necessarily the techniques used) may be a model for rabies control programmes in Africa.

1 BACKGROUND.

In November 2000 I travelled to Indonesia, at the request of the Indonesian Government and the Office International des Epizooties to investigate an outbreak of canine rabies on the island of Flores and to make recommendations regarding its control. It was not only an interesting epidemiological study but also a study of an unfashionable method of dealing with a new rabies epidemic. The methods used by the government of Flores highlighted principles of rabies control that are often neglected by other governments around the world.

Indonesia is a large archipelago comprising several thousand islands located in Southeast Asia. It has a human population of over 200 million making it the fourth most populous nation in the world. Most of the population is Muslim although the island of Flores is predominantly Christian. Flores is located at around latitude 8° south. It is mountainous throughout its length, with peaks rising to over 2000m. It has a population of just over 1.56 million people, who live mainly around the coastal areas. The principal economic activities are agricultural. The road network is sparse due to the mountainous terrain, although the existing main roads are well maintained. Many of the more out-lying areas are accessible only on foot or with high-clearance vehicles, motorbikes or horses.

2 RABIES IN INDONESIA AND FLORES.

Rabies was first reported in Indonesia during the nineteenth century, but has remained confined to the larger islands of the west and north of the Indonesian archipelago. The domestic dog is the principal maintenance host in all areas of the country.

Rabies had never been reported from Flores or the other islands of southern and eastern Asia until 1997. In November 1997 cases suspicious of rabies in dogs and humans were reported in the eastern

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district of Flores (Flores Timur). The introduction of the disease was traced to a dog that had been transported by boat from Buton Island to the north of Flores in September 1997. From Flores Timur the disease spread to the neighbouring districts in 1999 and continued westwards in 2000. It reached the western-most district in late 2000.

Human rabies cases in Flores were recognised soon after the introduction of rabies in Flores Timur and up until November 2000 ninety-one human cases were reported.

The principle host species for rabies in Flores was, and continues to be, the domestic dog. Before the dog elimination campaigns Flores had a high dog population. There were estimated to be over 600000 dogs, with an average human-to-dog ratio of 2.5:1. Dogs are an important part of Flores society: dog meat being a major ceremonial dish, and dogs being used as currency for bride prices. They are used for hunting wild game and for protecting crops from pests. There does not appear to be a population of unowned dogs in Flores.

In all except the most recently affected district the major control method consisted of dog population reduction (Table 1), implemented soon after the detection of cases in the respective areas. The district of Manggarai, which has only recently confirmed dog cases and which has a large dog population, has started rabies control through vaccination.

Table 1: Data on control measures in Flores up until October 2000. Dog population estimates were calculated before the control measures were carried out.

	District					
	Flores timur/ Lembata	**Sikka**	**Ende**	**Ngada**	**Manggarai**	**Total**
Estimated dog population	119919	125311	69916	86823	234046	636015
Number of dogs killed: Total	90524	110427	27166	53317	1123	282557
Culling percent (percent of original population)	75.5 %	88.1 %	38.9 %	61.4 %	0.5 %	44.4 %
Number of dogs vaccinated	0	0	33208 (47.5%)	0	6500 (2.8%)	39708 (5.7%)

Culling of dogs was done mainly by the individual dog owners, but also by the Livestock Services and Police. No dogs were killed without the consent of the owner. All leadership hierarchies were consulted before the communities were asked to kill their dogs. Usually, a senior leader in the district administration led the teams, which also consisted of a livestock officer and a member of the police force. The community was informed regarding the campaigns and encouraged to participate constructively through messages via community and religious leaders.

The culling policies were extremely unpopular with the community, although resistance has been surprisingly low and co-operation good. The local and international press, the local veterinary association and international animal welfare organisations have been critical of the policies. The critical statements in the press and their contradiction of official policy have caused a great deal of confusion among the public. Some dog owners have refused to have their dogs killed. It was said that dogs were being hidden from the authorities inside houses and in the plantations. It was also stated that people may have been moving their dogs to other districts and even other islands where dog elimination policies were not enforced, in order to protect their dogs.

The effects of the dog elimination policies were evident where they had been conducted rigorously. No dogs were observed while travelling through Ngada District, although they were commonly seen along the roadside and in yards in other areas of the island.

Vaccination policies were not adopted by the districts for a combination of reasons, which were stated as follows:

- Initially rabies vaccines were not available in sufficient quantities; even three years after the start of the epidemic there was insufficient vaccine, despite donations of 146000 doses of animal vaccine. There were insufficient funds to purchase the additional required number of vaccine doses.
- As many of the dogs are not accustomed to being handled, they are difficult to catch.

- The lack of any form of transport and deficiencies of refrigeration facilities make the maintenance of cold chains for vaccine difficult.
- There are insufficient personnel with the training to vaccinate the dogs.

One acknowledged drawback of the depopulation policies is the possible increase in unauthorised dog movements, particularly to other islands in the region. There is a large amount of boat traffic between islands, which is largely not policed, although legislation does exists to control the movement of animals between islands.

There are several reasons why eradication of rabies from Flores is achievable. Firstly, Flores is a small island and is therefore protected from the large-scale replacement of dogs from surrounding areas. Secondly, the dog population is relatively small in size, which will limit its ability to support a persistent rabies cycle. Finally, there is considerable community will within the island to eradicate the disease.

3 SOME COMPARISONS BETWEEN FLORES AND AFRICA.

The epidemiology of rabies is similar between Flores and much of Africa as the vector in both is the domestic dog, with negligible numbers of unowned dogs. In controlling rabies Flores has many logistical problems similar to those found in Africa. There is insufficient vaccine and insufficient infrastructure to deliver vaccine to target dog populations.

A large continent such as Africa would have considerably more difficulty in eradicating rabies. Flores is an island with an isolated dog population. Movement of dogs onto the island is logistically difficult and therefore it is protected from large-scale dog influx. This protects the dog population from repeated introductions of rabies from other infected populations and also limits the rate at which the dog population can recover following depopulation measures. Rabies eradication through dog depopulation measures alone can conceivably be effective on Flores, but is unlikely to be effective in a continent with the size and population of Africa.

The control effort in Flores gives an example of a community-driven alternative rabies control concept that is rarely found in Africa. Although the local government of Flores played a key role in co-ordinating and monitoring the control efforts, the government itself did not implement the control procedures as it realized that this would have been beyond its ability. In contrast, rabies control in Africa has always been a government initiative, even when governments have become unable to adequately fulfil this role, due to unavailability of resources. Communities have usually been enrolled to assist in control efforts, for example, by bringing their dogs to central vaccination points, but are generally not expected to take greater initiatives in rabies control. More involved community participation in the planning and implementation of rabies control programmes is essential to achieving a more sustained and effective decline in rabies prevalence in Africa.

How can African communities effectively eliminate rabies in their dog populations? The answer is complex and will vary between different communities, but will always depend on strong and dynamic community leadership and effective local leadership structures, as was present in Flores. Governments veterinary departments and Non-Governmental Organisations must always continue to have important roles, including co-ordination of control strategies, maintenance of effective surveillance systems, ensuring that public awareness of rabies (generally as well as the immediate local situation) remains high and ensuring that bottlenecks for the distribution of vaccine into problems areas are removed. Incidentally, these roles can also benefit other areas, for example, improvement of general disease surveillance networks and raising the public awareness of other diseases.

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REFERENCE.

BINGHAM J. – 2001 - Eradication of rabies on Flores Island: Can it be done in the near future? *Fourth International Symposium on Rabies Control in Asia*, Hanoi, Viet Nam, 5-9 March 2001. Organised by Fondation Mérieux, France. (Proceedings in preparation.)

KEEPING RABIES OUT BY SURVEILLANCE STRATEGIES, VACCINATION AND SEROLOGY

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1 INTRODUCTION.

Classical rabies virus (RV) strains have a worldwide distribution except for a few island nations including the United Kingdom, New Zealand and Hawaii and the continents of Australia and Antarctica. In addition, as a result of the successful oral vaccination campaign in Western Europe, many countries are free of rabies (Rabies Bulletin Europe 2001). All mammals are susceptible to rabies, but the major hosts are wild and domestic canines and felines. Measures aimed at preventing its introduction, and establishment, have been made subject to specific legislation in the United Kingdom.

2 UNITED KINGDOM QUARANTINE LAWS.

The UK has remained rabies-free since 1922 largely due to its island status and by the strict 6-month quarantine laws. Between 1922 and 1969, 27 cases of rabies occurred in UK quarantine facilities (25 dogs, 1 cat, and 1 leopard). The last cases of animal rabies outside quarantine occurred in the UK between 1969 and 1970 (both occurred in dogs after undergoing the 6-month quarantine period). In 1971, as a direct result of these two cases a system of quarantine with rabies vaccination was introduced for all (non-commercially traded) dogs and cats being imported into the UK. In September 1998, the Advisory Group on Quarantine reviewed the UK's quarantine policy and possible alternatives (the Kennedy Committee). Following the publication of the committee's findings (The Kennedy Report, 1998) and with strong public support, additional significant changes to the UK's quarantine laws were publicly announced. The recommendation from the Kennedy Report was that quarantine for animals entering or re-entering the UK could be replaced where the animal has been vaccinated against rabies. The report also recommended tight regulation of this system with a number of safeguards to ensure that any risk of rabies entry was minimised. These included demonstration of seroconversion following vaccination, the use of microchip technology for animal identification and limitations on the countries from which the UK will receive animals. These recommendations amounted to the most progressive changes that have been made to the UK quarantine policy since the introduction of compulsory vaccination to complement the 6-month quarantine rule.

3 UNITED KINGDOM PET TRAVEL SCHEME (PETS).

The UK government aims to keep rabies out of the UK by employing stringent 6-month quarantine periods and import controls. In February 2000, the UK Pet Travel Scheme (PETS) was introduced as a pilot scheme and provided that certain conditions are met, permits for the import without quarantine of domestic cats and dogs from specific European countries and rabies-free islands and territories. The qualifying countries have been extended several times (Table 1). In August 2000, a further 15 "rabies-free islands" were declared eligible to participate in the scheme. This was followed in January 2001 when a further 13 "rabies-free islands" were included in the scheme (Table 1). From 28th February 2000 to the end of August 2001 greater than 30000 qualifying dogs and cats had participated in the scheme.

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Table 1: Countries currently included in the UK Pet Travel Scheme

Countries taking part in the scheme since February 2000 (n=22)	Additional countries included in the Pet Travel Scheme from August 2000 (n=15)	Additional countries included in the Pet Travel Scheme from January 2001 (n=13)
Andorra	Ascension Island	Antigua and Barbuda
Austria	Australia	Cayman Islands
Belgium	Barbados	Fiji
Denmark	Bermuda	French Polynesia
Finland	Cyprus	Guadalupe
France	Falkland Islands	Jamaica
Germany	Hawaii	La Reunion
Gibraltar	Japan	Martinique
Greece	Malta	Mauritius
Iceland	Montserrat	Mayotte
Italy	New Caledonia	St Kitts and Nevis
Liechtenstein	New Zealand	St Vincent
Luxembourg	St Helena	Wallis and Fortuna
Monaco	Singapore	
Netherlands	Vanuatu	
Norway		
Portugal		
San Marino		
Spain		
Sweden		
Switzerland		
The Vatican		

To qualify for the scheme, each animal is required under the PETS legislation to be fitted with a microchip then vaccinated against rabies using an inactivated vaccine. Blood taken from the vaccinated animal, normally one month post-vaccination, must then be successfully tested for RV neutralizing antibodies (titre ≥ 0.5 IU/ml) at a DEFRA (Department of the Environment, Food and Rural Affairs, formally the Ministry of Agriculture, Fisheries and Food; MAFF) recognized laboratory. Furthermore, all pet owners would have to complete a declaration that testified the animal had not been outside the qualifying countries in the six months prior to travel. The cats and dogs may not enter the UK under PETS until six months after the date that a veterinary surgeon has taken the blood sample that led to a successful test result. To avoid the need for a further blood sample and 6-month wait, booster doses must be administered as recommended by the manufacturer. Prior to re-entering the country the animal must be treated against ticks and tapeworms.

In the future the UK government is considering whether the scheme should be extended to include North America. The Kennedy report also acknowledged a potential need to import cats and dogs from North America although it was accepted that rabies is endemic in wildlife (The Kennedy Report, 1998). Specific rabies-free countries that currently import dogs and cats from North America using alternative methods to that of quarantine include Australia and New Zealand. These countries have shown that approximately 15000 dogs and cats have been imported into these rabies-free areas from the US with no incidence of reported rabies (Briggs and Schweitzer, 2001).

4 SEROLOGICAL ASSAYS FOR RABIES.

As a result of the change in policy an operational infrastructure to provide serological testing for the PETS scheme was established. This strategy was the basis to initiate a rapid screening test for RV neutralizing antibodies from animal serum. It also included the successful demonstration of proficiency in performing the rabies serology test.

The use of virus neutralisation assays for the detection of rabies antibodies have been widely used in many laboratories since the successful development of a virus neutralisation test for rabies in a murine model (Webster *et al.*, 1935). This has been superseded by tissue culture based assays, principally the rapid fluorescent focus inhibition test (RFFIT) (Debbie *et al.*, 1972; Smith *et al.*, 1973). An adaptation of this, the fluorescent antibody neutralisation test (FAVN) (Cliquet *et al.*, 1998) is now an officially accepted test prescribed by the Office International des Epizooties (OIE) for rabies antibody testing (OIE Manual, 2000). Equivalent results have been reported by comparing the antibody response to

rabies vaccination in companion animals (dogs and cats) using either the FAVN method or by RFFIT (Briggs *et al.*, 1998).

In our laboratory, the FAVN test is performed in accordance with the OIE rules as described (OIE Manual, 2000) with permissible modifications. For all tests performed at the VLA, FITC conjugated anti-rabies monoclonal immunoglobulin is used at a dilution of 1:100, as recommended by the suppliers (Centocor, USA). Under statutory guidelines, each laboratory that undertakes serological testing on serum samples within the PETS framework undergoes a bi-annual proficiency test.

The development of an OIE accepted ELISA test for the detection and quantification of rabies virus specific antibodies is underway in many laboratories. The advantages of an ELISA protocol include the decrease in the requirement for specialised high containment laboratories or dedicated laboratory equipment for handling live virus. In addition, an ELISA will accurately measure post-vaccine rabies virus-specific antibodies from vaccinated dogs and cats within hours of receiving the blood sample compared with days using conventional rabies antibody immunoassays.

5 RESULTS.

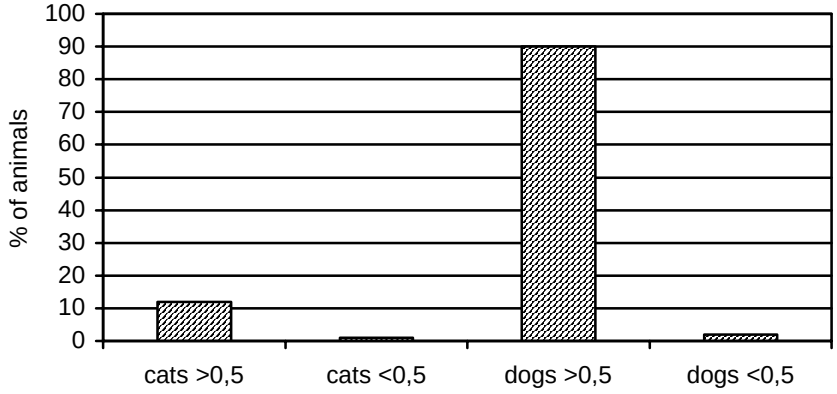
5.1 Geographical origin of the sample.

To date, the vast majority of samples submitted to our laboratory for antibody testing were sent from the UK. Of these samples the geographical spread was fairly uniform across the UK. Overseas samples were also received from Spain, Australia, Portugal, New Zealand, Cyprus and The Republic of Ireland.

5.2 Immune status of the animals following vaccination.

In a cohort of blood samples from vaccinated dogs and cats analysed between August 1999 and October 2000, seroconversion following vaccination was high (Fig 1). The majority of animals were vaccinated with either Rabisin (Merial Animal Health Ltd, UK) or Nobivac Rabies (Intervet UK, Ltd). Following vaccination against rabies 98.7% of dogs and 98.9% of cats demonstrated a detectable RV-specific neutralizing antibody titre ≥0.5 IU/ml (Fig 1). In both species, less than 1.5% of animals tested had demonstrable antibody titres below the threshold value.

Figure 1: Measurement of serological response in dogs and cats following rabies vaccination



These results compare with those previously reported from a different cohort of dog and cats from which 11% of dogs and 3% of cats had antibody titres below 0.5 IU/ml (Cliquet *et al.*, 2000). In this study, more than 50% of the dogs and cats were destined for Norway and Sweden. The discrepancy in failure results between these two cohorts is most likely to be due to the time difference between vaccination against rabies and blood sampling. For example, in Sweden the earliest time that testing for immunity can occur is four months after the last vaccination (The Kennedy Report, 1998). In con-

trast, in the UK scheme, the recommended time interval between vaccination and blood sampling is one month when antibody levels should be high. In both schemes, the level of immunity must be 0.5 IU/ml or greater.

The detection of antibody titres below the accepted threshold does not indicate that the animal is unprotected but that seroconversion has occurred between the date of vaccination and the date that the blood sample was taken. For these reasons, the primary role of the serological testing laboratory for samples from countries that participate in the UK PETS scheme is to demonstrate rabies antibody-specific seroconversion following vaccination.

6 CONCLUDING REMARKS.

A current objective for global rabies control is its elimination from regions of Asia and Africa. This ambitious goal could be achieved through the extension of the oral vaccination campaigns in other continents. Important lessons from the successful use of quarantine and vaccination from many parts of Western Europe could assist in supporting specific rabies elimination programs throughout Africa. This approach however, may be problematic as a result of campaign failures in specific regions and the risk of re-introduction of rabies in previously declared rabies-free areas. It may be possible to benchmark the rabies control efforts currently being pursued in eastern European countries. It is clear that any approach will have associated difficulties that will pose both political and economic problems.

In Africa, however, the situation is more complicated with rabies being endemic within a wide range of host species, including the domestic dog. There are additional logistical problems such as the availability and costs of vaccine, cold-chain dependency, education of the population and supporting political infrastructure and commitment.

The primary goal in Africa will involve a greater involvement of bordering countries in reducing the incidence of rabies (especially at national boundaries). In the future, the main requirement will be to harmonize the parenteral and oral vaccination campaigns (both for sylvatic and domestic animals) across Africa to create rabies-free zones followed by a legislative system to control trade and movement restrictions of animals within rabies-free areas. In addition, legislation should be in place to hold owners accountable for their animals (especially dogs). Any attempt to reduce the incidence of rabies by a single country will be frustrated by subsequent incursion of the virus from bordering states with no rabies control. Clearly co-operation between nations will be a primary goal in tackling rabies in Africa.

Appropriate contingency plans should also be co-ordinated across African countries to deal with any new rabies outbreak. Ideally, there should be less emphasis placed on the destruction of stray animals as an effective way of controlling rabies. Obviously in some circumstances the large-scale destruction of stray rabid dogs is necessary however, it is often only a short-term solution as the dog population soon recovers with larger numbers of naïve animals. Instead control measures should concentrate more on the vaccination of domestic animals (especially stray animals) followed by appropriate serological testing and ring vaccination of susceptible wildlife species.

In this way, by interrupting the chain of rabies transmission in animals the burden that rabies imposes to human health will be reduced.

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REFERENCES.

BRIGGS D.J., SMITH J.S., MUELLER F.L., SCHWENKE J., DAVIS R.D., GORDON C.R., SCHWEITZER K., ORCIARI L.A., YAGER P.A. AND RUPPRECHT C.E. – 1998 - A comparison of two serological methods for detecting the immune response after rabies vaccination in dogs and cats being exported to rabies-free areas. *Biologicals*, **26**, 347-355.

BRIGGS D.J. AND SCHWEITZER K. – 2001 - Review. Importation of dogs and cats to rabies-free areas of the world. *Vet Clin North Am Small Anim Pract.*, **31**, 573-583.

CLIQUET F., AUBERT M. AND SAGNE L. – 1998 - Development of fluorescent antibody neutralization test (FAVN test) for the quantitation of rabies-neutralizing antibody. *Journal of Immunological Methods*, **212**, 79-87.

CLIQUET F., VERDIER Y., SAGNE .L., SCHEREFFER, J.L., SELVE, M. AND AUBERT M. – 2000 - Alternative à la quarantine dans les pays ou territoires indemnes de rage: analyse des taux d'anticorps antirabiques chez les chiens et chats vaccines. *Bull. Soc. Vet. Prat. de France*, **84**, 29-39.

DEBBIE J.G., ANDRULONIS J.A. AND ABELSETH M.K. – 1972 - RABIES ANTIBODY DETERMINATION BY IMMUNOFLUORESCENCE IN TISSUE CULTURE. INFECTION AND IMMUNITY, 5, 902-904.

KENNEDY J. – 1998 - Quarantine and Rabies: A Reappraisal. Report by The Advisory Group on Quarantine to the Rt Hon Nick Brown MP, Minister of Agriculture, Fisheries and Food. London, MAFF Publications.

OIE Manual.(2000). OIE Manual of Standards for Diagnostic Tests and Vaccines, 4th edn. Rabies. Office International des Epizooties, Paris, pp. 276-291.

Rabies Bulletin Europe (1/2001). Rabies Surveillance Report. January-March 2001. 25, World Health Organization, Geneva.

SMITH J.S., YAGER P.A. AND BAER G.M. – 1973 - A rapid reproducible test for determining rabies neutralizing antibody. *Bulletin of the World Health Organization*, **48**, 535-541.

WEBSTER L.T. AND DAWSON J.R. – 1935 - Early diagnosis of rabies by mouse inoculation. Measurement of humoral immunity to rabies by mouse protection test. *Proceedings of the Society for Experimental Biology and Medicine*, **32**, 570-573.

COST AND EFFECTIVENESS OF DISEASE CONTROL FOR ENDANGERED SPECIES:

VACCINATING TARGET AND RESERVOIR HOSTS TO CONTROL RABIES IN ETHIOPIAN WOLVES

M. K. Laurenson[1,2], D.T. Haydon[1] and the Ethiopian Wolf Conservation Programme[2]

ABSTRACT.

In recent years, rabies and canine distemper virus have caused a number of population declines in endangered carnivore populations, when these pathogens have 'spilled over' from reservoir domestic dogs. Protection of these endangered species could be achieved through reducing disease incidence in the dog reservoir or by direct vaccination of the threatened species. This latter option may be the only option if a wildlife reservoir is present. In Ethiopia, vaccination of sympatric dogs has successfully reduced the threat of disease for one population of the endangered Ethiopian wolf, but this programme is both expensive and logistically difficult. In this paper we examine theoretically the relative cost and effectiveness of alternative strategies to protect different-sized Ethiopian wolf populations from rabies. A comparison of the estimated cost of these strategies for 5 wolf populations suggested that costs of dog vaccination ranged from £44273 (63400 US$) to £13149 (18830 US$) depending on the size, fragmentation and geographical location of the wolf population. The cost of directly vaccinating wolves with an oral vaccine varied from £1389 (1990 US$) to £7139 (10220 US$) and was mainly dependent on the size of the wolf population. Comparison of the cost per wolf protected suggested that dog vaccination is always more expensive than wolf vaccination, by a factor of 1.9 to 5.6. Costs of dog vaccination were particularly high in small, linear or fragmented wolf populations. Using an individual-based mathematical model of a wolf population that incorporates disease as a dynamic process, we compare reservoir dog and wolf vaccination. Results suggest that the persistence of small (<100 animals) wolf populations are improved when the incidence of rabies in dogs is reduced and that vaccination of less than 40% of wolves will have a similar effect. We suggest that further research investigating the feasibility of wolf vaccination should be pursued.

1 INTRODUCTION.

Infectious diseases can dramatically influence the dynamics of endangered populations and have attracted increased interest in recent years. Generalist pathogens that persist in another reservoir host species are of particular concern (McCallum and Dobson, 1995). As human populations expand into wildlife areas and transmission from reservoir domestic animals to wildlife becomes more common, this problem will continue to increase in future years.

Rabies is the greatest disease threat to endangered carnivores, having caused local extirpation of African wild dog populations (*Lycaon pictus*) and dramatic population declines in a number of species such as African wild dogs, Blanfords fox and Ethiopian wolves (*Canis simensis*) (Macdonald, 1993). Indeed, this disease is the most immediate threat to most of the remaining critically endangered Ethio-

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pian wolf populations (Laurenson *et al.*, 1998) and caused the death of approximately two thirds of the Bale Mountain wolf population in the early 1990s (Sillero Zubiri *et al.*, 1996).

In Ethiopia, dogs are the most likely reservoir host for rabies (Laurenson *et al.*, 1997). In this situation, prevention of outbreaks in the target endangered species, could be achieved through preventing contact between dogs and wildlife, vaccinating dogs, or vaccinating the target wildlife species (Laurenson *et al.*, 1997). Preventing contact between dogs and wildlife is essentially impossible in the rural African situation, as dogs are not restrained within houses or compounds and carnivores are notoriously adept at penetrating fences. Vaccinating dogs living in and around habitat harbouring the target species is a viable option and this strategy has been used successfully to reduce rabies incidence in dogs living in and around the Bale Mountain's Ethiopian wolf population (Laurenson and Williams, unpub). However, it can be logistically difficult. In particular the difficulty in catching some dogs means that attaining sufficient dog population vaccination coverage to induce herd immunity is a challenge. These factors also increase the time and manpower involved and thus the expense of this strategy.

With recent advances in vaccine research, vaccination of the target wildlife species is now also a potential option. Parenteral vaccines, using an inactivated virus, are available and could be used without risk in Ethiopian wolves, although their efficacy is currently unknown. Oral rabies vaccines, now used extensively in Europe and North America, might be used to protect Ethiopian wolves (Aubert *et al.*, 1994, Fearneyhough *et al.*, 1998, Robbins *et al.*, 1998). However, a preliminary investigation of the cost and effectiveness of wolf and dog vaccination is warranted before further research and development is conducted to test the efficacy and feasibility of this method.

In this paper we investigate the costs of vaccinating dog and Ethiopian wolves around five of the current wolf populations in Ethiopia and present results from a population viability model (Haydon *et al.*, in press) that detail the relative effectiveness of these approaches in protecting wolves from rabies.

2 METHODS.

2.1 Cost estimates for dogs and Ethiopian wolf vaccination.

Costs of dog and wolf vaccination were estimated for 5 of the 7 extant wolf populations, spanning the range of population sizes (250 to 20 animals). Costs were estimated for vaccinating 70% of dogs in each kabele (the local administrative unit) around each wolf population, equivalent to a band approximately 5 km wide. Overhead costs included refrigeration and administration, cost associated with travelling to each site by public transport and motorbike, and costs associated with the number of kabeles, and thus the number of dogs, vaccinated (vaccines, syringes, needles, dog catchers, certificates time and labour involved, campaign organisation and advertising)

The costs of wolf vaccination were associated with a visit to each wolf population and then finding and vaccinating each pack (consisting of 6 adults and 4 pups) at its den site. Annual overhead costs included vaccine custom clearance and storage, but were divided between all the sites. Costs associated with each site included time and travel to the site by hiring a vehicle. The cost of vaccinating each pack at the site were then estimated by including the time and cost of travelling locally by horse, number of days to find the den and administer vaccine, vaccine cost and the depreciated cost of camping equipment for each den trip. The number of packs in each wolf population was estimated using recent population estimates (Marino, under review).

2.2 Relative effectiveness of wolf vaccination and reducing incidence in reservoir dogs.

An individual-based, spatially explicit and stochastic wolf population viability model was constructed that explicitly incorporated disease as a dynamic factor. Full details of the model are available in Haydon *et al.* (in press). Different sized populations were subject to a range of conditions, including varying disease incidence in reservoir dogs and varying the proportion of wolves vaccinated. Vaccination was assumed to provide lifetime protection. A thousand simulations under each set of condition were run for 50 years and the probability of viability calculated by counting the number of populations that became extinct or survived that time.

3 RESULTS.

3.1 Relative cost of wolf and dog vaccination campaigns.

The estimated costs of protecting five of the wolf populations depended again on the distance from Addis Ababa, the number of wolf packs thought to occur and the cost of importing and storing vaccine (Table 1). These latter overhead costs were calculated as though only one population were to be vaccinated. However, should such a programme be adopted, these costs would be shared between the populations, thus considerably reducing the total cost and cost per wolf, particularly for the small wolf populations. For example, if overhead costs were shared by the seven wolf populations, then the total cost for Mt Guna would be £1215 (1740 US$) and the cost per wolf at £61 (87 US$).

The estimated cost of vaccinating dogs around these wolf populations varied from £2000 (2860 US$) to £12000 (17180 US$), depending on the size of the wolf habitat in the area, its distance from Addis Ababa and its size, shape and degree of fragmentation (Table 1).

Overall, the cost of estimating dogs was estimated to be between 1.9 and 5.6 times more expensive than direct wolf vaccination (Table 1).

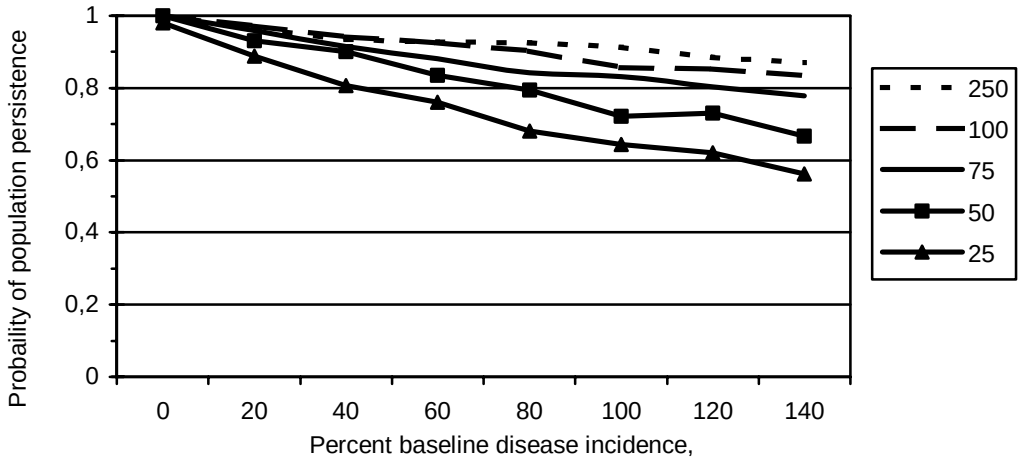
Table 1: Estimated cost of dog vaccination and oral wolf vaccination against rabies for 5 Ethiopian wolf populations. Habitat for wolves in Bale, Mt Guna and Menz essentially comprises one compact area, the Arsi habitat exists along a mountain ridge and is long and thin in shape, whereas the South Wollo habitat consists of several fragmented, linear areas.

Site (population size)	Dog vaccination		Wolf vaccination		Factor increase for dog vaccination over wolf vaccination
	Total	Cost/dog	Total	Cost/wolf	
Bale (250)	18831 US$	76 US$	10224 US$	42 US$	1.9
Arsi (80)	17497 US$	349 US$	3868 US$	73 US$	4.8
S Wollo (40)	14527 US$	362 US$	2632 US$	64 US$	5.6
Menz (25)	6119 US$	245 US$	1989 US$	66 US$	3.7
Mt. Guna (20)	6182 US$	309 US$	2107 US$	80 US$	3.9

3.2 Effectiveness of rabies control through vaccinating dogs and Ethiopian wolves.

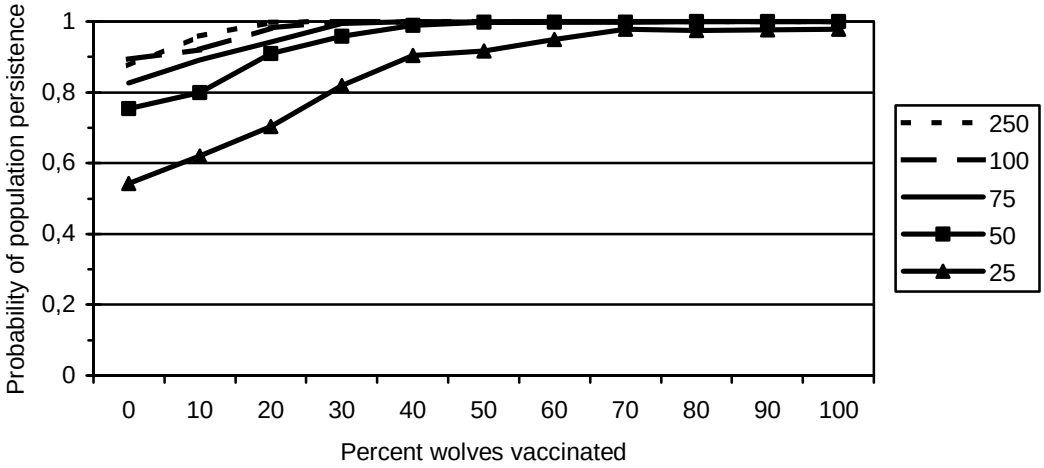
Increasing rabies incidence decreased the probability of wolf population persistence in all sized wolf populations, but the effect was particularly pronounced in populations of less than 100 animals (Figure 1). Thus if rabies could be locally eradicated in the reservoir dog population, by vaccinating approximately 70% of dogs, even the small populations were remarkably resilient. Incomplete rabies control also increased the probability of population persistence in an approximately linear fashion.

Figure 1: Effect of disease on population persistence in Ethiopian wolf populations of 25-250 animals (from Haydon *et al.*, in press).



The effect of wolf vaccination on the viability of different sized populations was also examined using this model (Figure 2). In all sized populations, vaccination of wolves increased population persistence, but in a non-linear fashion. Thus small increases in wolf vaccination coverage led to larger increases in population persistence. Vaccination of just 40% of wolves in all but the smallest population effectively removed the threat of disease to population persistence. In the smallest population (25) modelled, vaccination coverage of 60% increased the probability of persistence to over 90%.

Figure 2: Effect of vaccinating Ethiopian wolves on viability of 25-250 animals populations (from Haydon *et al.*, in press)



4 DISCUSSION.

The results presented in this paper suggest that the direct vaccination of Ethiopian wolves using oral vaccines may be cheaper and as effective as vaccinating domestic dogs, even if only a proportion of the wolf population were vaccinated. Wolf vaccination appeared to be cheaper than vaccinating dogs around all the populations where costs were estimated.

The relative increased cost per wolf protected by dog vaccination also varies with the size, shape and fragmentation of wolf populations. In a larger population such as Bale, which has a smaller circumference to area ratio, the estimated cost per wolf protected is relatively low compared to a small area such as Mt Guna. It is similarly cheaper in terms of cost per wolf to protect circular wolf populations

than linear or fragmented populations, as there is a smaller boundary along which to vaccinate. Thus the cost per wolf of vaccinating dogs around areas such as that in Arsi, a long, narrow range of mountains, is high, as were areas in South Wollo which are fragmented (Marino *et al.*, 1999).

In some areas, however, the relative increase in cost for vaccinating dogs is low, costing about 90% more in Bale than direct wolf vaccination. In such a scenario, the benefits associated with conducting such campaigns in the local community by conservation programmes, either directly for the community by reducing human and livestock losses or indirectly by creating opportunities for community public health and conservation education and dialogue, may outweigh the actual monetary costs. In other areas, however, direct protection of wolves through oral vaccination is considerably cheaper, and if limited conservation funds are available, may be the preferred option.

Estimating the financial benefits that might accrue to local communities through a reduction in human and livestock deaths associated with rabies are beyond the scope of this paper, but may be considerable. Livestock losses in the Bale area, for example, were estimated to be up to $7.5 per household per year (Laurenson *et al.*, 1997). These costs of rabies are not, however, borne by those interested in wildlife conservation, but by the local communities. Although it is clearly desirable for conservation projects to reduce these other costs, limited budgets may preclude this approach. For example, at present funds are not available for protecting northern wolf populations and this may be the priority in the short term. If local communities or government contributed to the cost of vaccination programmes then conservation programmes may be able to provide the incentive and infrastructure to reduce rabies incidence in the area.

Wolf vaccination may also be as effective in improving wolf population persistence as eradicating rabies in the local dog population. Vaccinating just 40% of wolves was sufficient to almost ensure that all but the smallest populations persisted over 50 years. In a population of 25 animals, 40% vaccination increased the probability of population persistence from about 50% to nearly 90%, a very considerable improvement. As vaccinating all the wolves in a population is likely to be impossible logistically, the finding that only a proportion of the population needs to be vaccinated to improve population persistence is reassuring.

The results presented in this paper suggest that further investigations into the feasibility of wolf vaccination should be carried out. Parenteral killed vaccines are currently available and should be safe in this species and, given the species is so closely related to domestic dogs, should be effective. However, difficulties, risks and increased costs associated in capturing the species for vaccination make this route unattractive and likely to be unfeasible. Oral rabies vaccines, particularly the vaccinia recombinant vaccination (Mackowiak *et al.*, 1999) which presents no risk of rabies infection, may be an attractive option, but research, must be conducted on baiting systems, efficacy and safety, such as that being carried out for wild dogs in South Africa (Knobel *et al.*, this volume/under review)

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REFERENCES.

AUBERT M., FLAMAND A. AND KIENY M.P. – 1994 - Will rabies soon disappear from Western Europe? *La Recherche*, **25**, 582-584

FEARNEYHOUGH M.G., WILSON P.J., CLARK K.A., SMITH D.R., JOHNSTON D.H., HICKS B.N. AND MOORE G.M. – 1998 - Results of an oral rabies vaccination program for coyotes. *JAVMA*, **212**, 4, 498-502.

HAYDON D.T., LAURENSON M.K. AND SILLERO-ZUBIRI C. In press. Integrating epidemiology into population viability analysis. *Conservation Biology*.

KNOBEL D.L., DU TOIT J.T. AND. BINGHAM J. - UNDER REVIEW. DEVELOPMENT OF A BAIT AND BAITING SYSTEM FOR THE DELIVERY OF ORAL RABIES VACCINE TO FREE-RANGING AFRICAN WILD DOGS (LYCAON PICTUS). J WILDLIFE DISEASES

LAURENSON M.K., SILLERO ZUBIRI C., THOMPSON H., SHIFERAW F., THIRGOOD S. AND MALCOLM J. – 1998 - Disease threats to endangered species; Ethiopian Wolves, domestic dogs and canine pathogens. *Animal Conservation*, **1**, 273-280.

LAURENSON M.K., SILLERO ZUBIRI C. AND SHIFERAW F. – 1998 - Rabies as a threat to the Ethiopian Wolf (*Canis simensis*). Proc. of the Southern and Eastern African Rabies Group (SEARG) meeting. (Ed. P. Kitala, B. Perry, J Barrat and A. King), Merieux, Lyon. pp.97-103.

LAURENSON M.K., SHIFERAW F. AND SILLERO-ZUBIRI C. – 1997 - Disease, domestic dogs and the Ethiopian Wolf; the current situation. *In:* The Ethiopian Wolf: An action plan for its conservation. Compiled and Edited by C. Sillero Zubiri and D.W. Macdonald. IUCN, Gland, Switzerland.

MCCALLUM H. AND DOBSON A. – 1995 - Detecting disease and parasite threats to endangered species and ecosystems. *TREE*,**10**,5, 190-194.

MACDONALD D.W. – 1993 - Rabies and wildlife: a conservation problem? *Onderstepoort J of Vet Res*, **360**, 633-634.

MACKOWIAK M., MAKI J., MOTES-KREIMEYER L., HARBIN T. AND VAN KAMPEN K. – 1999 - Vaccination of wildlife against rabies: successful use of a vectored vaccine obtained by recombinant technology. *Advances in Vet Med*, **41**, 571-583.

MARINO J., LAURENSON M.K. AND SILLERO ZUBIRI C. – 1999 - The status and threats to the Ethiopian wolf. *Report to the National Geographic Society*

MARINO J. Under Review. Endangered Ethiopian wolves persist in small isolated afroalpine enclaves *Oryx*

ROBBINS A.H., BORDEN M.D., WINDMILLER B.S., NIEZGODA M., MARCUS L.C., O'BRIEN S.M., KREINDEL S.M., MC GUILL M.W., DEMARIA A., RUPPRECHT C.E., ROWELL S. – 1998 - Prevention of the spread of rabies to wildlife by oral vaccination of raccoons in Massachusetts. *JAVMA*, **213**, 1407-1412.

SILLERO-ZUBIRI C., GOTTELLI D. AND KING A. - 1996 - Rabies and mortality in Ethiopian wolves (*Canis simensis*). *J Wildlife Diseases*, **32**, 80-86.

THE RABIES CONTROL PILOT PROJECT IN MALAWI

C.B. Chizonda[1] and M. Bacchiochi

1 INTRODUCTION.

Malawi is situated between Zambia to the West, Tanzania to the North and North East and Mozambique to the Southern part of the country. The country is divided into three political divisions - Northern, Central and Southern Regions. The country is divided in ecological zones: 8 Agricultural Development Divisions (ADDs) and 32 Rural Development Projects (RDPs).

2 RABIES IN MALAWI.

Rabies is endemic in Malawi and occurs throughout the country. It is the most feared of the zoonoses that occur in Malawi. The disease affects several species of both wild and domestic animals but it is most commonly recorded in the domestic canine population. The latter is characterised by a large stray dog component. Dogs are major transmitters of rabies to the human population.

The Department of Animal Health and Industry (DAHI) is responsible for the control of rabies.

3 PROJECT JUSTIFICATION.

Reports from the Ministry of Health and Population between 1990 and 1994 show that:

- 20316 people were bitten by dogs
- 24452 people were treated for rabies
- 213 human deaths were recorded,
- the estimated annual death toll is 30-40 people
- annual post exposure treatments exceeded 5000 people

Laboratory data collected between 1995 and 1997 show that 615 rabies cases were confirmed in the laboratory. 90% of them were from canine samples and 10% from other animals. In 1996 about 174 cases out of 349 samples were confirmed by F.A.T. Thirty five people died of rabies in Central Region alone and of this figure 24 deaths occurred in Lilongwe ADD. Mzuzu Regional Laboratory diagnosed 41 canine rabies in 1997 in only the first 10 months of the year.

Following these observations:

- It is clear that Malawi was experiencing an unprecedented number of human dog bites that had resulted in the resurgence of rabies near to epidemic proportions.
- An inter-ministerial task force for the control of rabies in Malawi (chaired by C.B. Chizonda) wwas established.
- A project proposal was prepared, but it lacked funding.
- A document was submitted to the EU, which recommended that the pilot project should be implemented jointly by the Malawi Government and an Italian NGO, CESTAS.

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4 DOG POPULATION IN MALAWI.

There was no official figure of total dog population. DAHI 's 1995 estimate was 250 000 dogs.

5 OBJECTIVES OF THE PROJECT.

The overall objectives are:

- to develop a pilot control system whereby resources and suitable techniques were made available to the GoM in order to control rabies so as to perform the relative tasks more adequately in the control of this zoonosis, (Policy defined using the lessons learned during the implementation phase)
- to reduce the human occurrence of rabies through the control of canine rabies throughout Lilongwe ADD.

The specific objectives are:

- to achieve an acceptable level of control of the rabies problem in Lilongwe ADD,
- to set up an example of effective rabies control to the other ADDS of the country.

6 ACTIVITIES OF THE PILOT PROGRAMME.

Recognising the significance of rabies as a zoonosis and in the face of the present endemic, DAHI, in collaboration with CESTAS implemented the following interim measurers (Attack Phase) throughout Lilongwe ADD.

6.1 Set up scheduled mass-vaccination campaigns throughout Lilongwe ADD.

The following activities were carried out:

- Over 100 Veterinary Assistants (VAs) were fully equipped and trained in rabies control aspects.
- Transport, vaccination equipment, cold chain, field staff uniforms and vaccines were provided by the project.
- The Central Veterinary Laboratory was provided with a new immuno-fluorescent microscope and other essential instruments for better and faster rabies diagnosis.
- Five RDPS, two ADDs (Salima and Karonga), the Veterinary Clinic, Lilongwe ADD office and the Central Veterinary Laboratory were equipped with High Frequency Radios to facilitate communication.

6.2 Perform awareness campaigns.

These campaigns have been performed in order to intensify the dissemination of information on the dangers of rabies by utilising all means of media available.

The following awareness-activities were carried out during the pilot project implementation phase:

- The famous "Chiwewe/Chimpeni" song was re-introduced and panel discussions on the national radio through the Agricultural Communication Branch (ACB) were performed with an arrangement to answer questions from the public as it is done in Aids Control Programmes.
- An attractive poster with a rabid dog showing pictorial signs was produced and placed in strategic places throughout Lilongwe ADD.
- A sensational video tape on rabies was prepared to be shown to the general public as well as the senior policy making officials of the relevant Ministries to sensitise them on the gravity of the matter.

- A series of Drama on rabies aspects were performed by a professional cultural troupe at village level to sensitise the communities involved during the mass-vaccination campaigns.
- A seminar on rabies control was conducted by DAHI at Central Veterinary Laboratory chaired by Dr. Arthur King as the rabies expert.

7 RESULTS /OUTPUTS OF THE PILOT PROJECT.

The following results and outputs were achieved during the two years project period:

- Lilongwe ADD staff (more than 100 VAs) were trained in rabies control skills and were fully equipped to carry out rabies control programmes.
- A new dog ecology questionnaire was prepared in order to achieve a more accurate dog population figure within Lilongwe ADD. The project adopted the methodology to interview about 30% of the population living in each RDP (Lilongwe West, Lilongwe East, Ntcheu, Dedza Hills and Thiwi-Lifidzi),
- Messages on the dangers of rabies were developed and disseminated to both dog owners and the general public, using the national radio, posters, leaflets and panel discussions.
- At least 80% of the dog population was vaccinated and identified through the use of appropriate dog collars and certificates of rabies vaccination. All copies of the certificates released were kept by DAHI as receipt of payment and as official documents to be re-used during further vaccination campaigns.
- A new dog population census was obtained within Lilongwe ADD through the use of questionnaires. The ADD had about 75000 dogs of which 60000 were vaccinated and identified with an appropriate coloured plastic collar.
- Ten (10) mass-vaccination campaigns were carried out in more than 400 vaccination field stations. During the campaigns about 60000 dogs were vaccinated at vaccination fee of 5 MK (0.07 US$) in rural trading centres and 1MK (0.01 US$) in rural areas. (Introduction of cost recovery concept in rabies control).
- In collaboration with the City Council of Lilongwe, the project carried out four rounds of vaccination campaigns during the two year programme period within urban and peri-urban areas of Lilongwe City. During the four rounds about 8000 dogs were vaccinated at vaccination fees of 35 Mk (0.48 US$) per dog.
- During the last mass-vaccination campaigns, the project shot about 950 stray dogs.
- More than 80000 rabies vaccine doses were delivered to the other seven ADDs in order to allow them to cope with the endemic rabies situation. This was at cost.
- The Central Veterinary Laboratory was partially equipped with a new immuno-fluorescent microscope and different essential lab instruments for rabies diagnosis.
- Ten HF Radios were installed in different strategic stations (RDP, CVL, LADD, Vet Clinic) to improve daily reporting and general communication.

All revolving funds generated from the vaccination campaigns and from the vaccines delivered to the other ADDs were utilized directly at RDP level for running costs of motorcycles and for VAs allowances.

8 SUGGESTIONS FOR THE FUTURE RABIES CONTROL PROGRAMME IN MALAWI.

- In April 1999 DAHI submitted to the EU the Financial Proposal for the “National Rabies Control Programme.”
- The new programme is planned to adopt the policy and lessons learned from the pilot project.
- The National Rabies Control Programme will be a component of the National Animal Health Programme, which is currently under study and in preparation phase.

- Recommendations drawn from the Rabies Pilot Control Project.

In December 2000 a team of evaluators from Brussels conducted, on behalf of the E.U., a technical evaluation of the Rabies Control Pilot Project and recommended the following requirements:

- To have improved and more efficient inter-ministerial collaboration and reporting of rabies data
- To respect Malawi's Laws by enforcing /observing the Legislation, which states that the notification of any human death from zoonotic disease such as rabies is mandatory.
- To establish improved reporting and communication system from peripheral centres (i.e. RDP) to the central bodies (i.e. HQs, ADD)
- To establish an improved recording system, using computers, of all diagnostic results and creation of an official database at the Central Veterinary Laboratory.
- To conduct an accurate dog population census be carried out at national level for planning purposes.
- Government resources to be allocated to allow characterisation of all areas at risk. A census will show the dog: human ratio and will allow calculations of resources required for the containment and treatment on a per inhabitant basis.
- Epidemiological risk analysis to be undertaken by Government to determine high and low risk areas and to estimate the number of dogs in each area that have to be vaccinated.
- Routine vaccination against rabies in lower epidemiological risk areas to be undertaken commercially by local privatised Veterinary Assistants but emergency outbreaks must be dealt with by Government Services according to standing regulations and all vaccinations and certificates to be closely monitored by National Authorities.

Malawi is currently revising its relevant Acts and Regulations in order to accommodate these recommendations.

BAITING FOR *LYCAON PICTUS*

D. L. Knobel[1]

Adaptated from overheads.

ABSTRACT.

The objective of the study was to develop a bait and baiting system capable of delivering one effective dose of oral rabies vaccine to each member of a free-ranging African wild dog (*Lycaon pictus*) pack. Trials were conducted between June and October 2000. The results of cafeteria-style bait preference trials testing seven candidate baits in captive wild dogs revealed a significant preference for chicken heads (June trials: $p = 0.023$, September trials: $p = 0.021$). Trials using a topical biomarker (Rhodamine B) showed that chicken head baits are sufficiently chewed 71.4% (n=7) of the time to rupture the vaccine container. Free-ranging wild dogs and young puppies (10 weeks) successfully ingested chicken head baits. Significant dominance of bait intake by a single individual was seen in four of six study packs, and in the three packs in which an alpha pair could be distinguished it was noted that the dominant feeder was an alpha animal. Pattern of bait distribution and degree of satiation had no effect on pack coverage (proportion of pack ingesting at least one bait). Pack coverage was found to be significantly related to trial number ($r = 0.71$, $p < 0.001$), with pack coverage increasing with increased exposure of the pack to the baits. During 45.9 hours of diurnal observations only two baits were lost to non-target species. A proposed baiting system for the oral vaccination of captive and free-ranging wild dogs is given, with initial exposure of packs to baits not containing vaccine ('priming') an important part of the technique.

1 OBJECTIVE.

To develop a practical bait and a baiting system capable of delivering at least one effective dose of oral rabies vaccine to each member of a free-ranging wild dog pack, with minimal exposure of non-target species.

1.1 Characteristics of an ideal bait.

- Protect the vaccine against temperature, UV light and microorganism contamination
- Highly palatable and attractive to wild dogs (adults and puppies)
- Chewed rather than swallowed whole
- Acceptable cost
- Readily available

1.2 Characteristics of an ideal baiting system:

- Suitable for deployment around the den
- Deliver at least one bait to each pack member (including puppies)
- Ensure ingestion in as short a time as possible
- Minimise uptake of baits by non-target species

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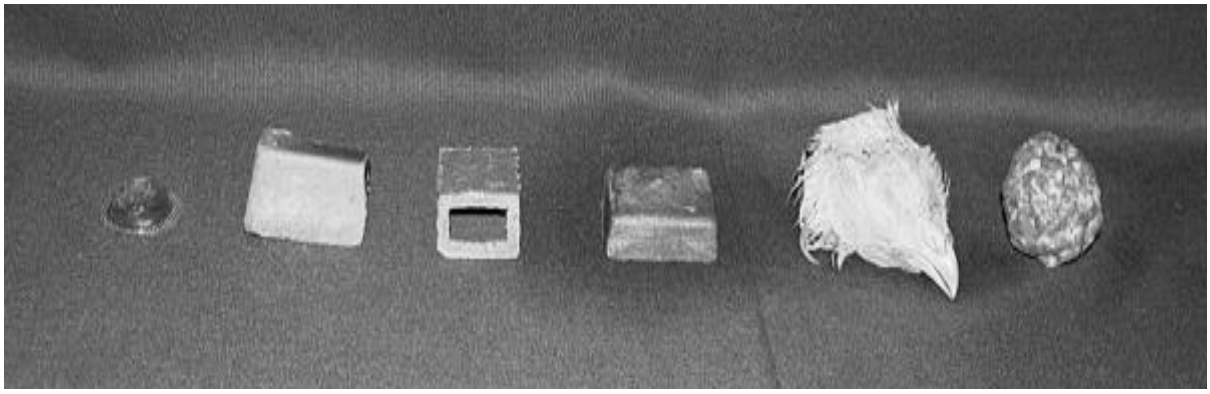
2 STUDY PACKS.

- Fourteen captive packs in De Wildt Cheetah & Wildlife Trust (9 packs) and in Rhino & Lion Nature Reserve (5 packs)
- Three free-ranging packs in Kruger National Park (KNP) (2 packs) and in Madikwe Game Reserve (1 pack)

3 BAIT PREFERENCE TRIALS.

Of seven candidate baits, five were tested in June and two were tested in September. Test were performed in captive dogs: 6 packs and 3 individuals in a cafeteria trial. Rodger's index was measured.

Figure 1: baits tested during trials.



3.1 Results.

3.1.1 Pack preference trials conducted on captive packs during June and September 2000.

Trial date	n[a]	Bait type	Preference index[b]	
			x^c	SE
June	3	Chicken head	1.000†	0.000
		Mince/chicken foot	0.453†††	0.269
		Lard/Wax (chicken)	0.223†††	0.118
		Dog food cube	0.200†††	0.195
		Lard/Wax (meat)	0.123†††	0.118
September	3	Chicken head	1.000†	0.000
		Liver flavoured block	0.537†††	0.167
		Fish flavoured block	0.473†††	0.384

[a] Number of packs of wild dogs used in a trial.
[b] Rodger's index of preference, expressed in terms of $x \pm$ SE. See text for details of calculation.
[c] Means with the same number of † are not significantly different ($\alpha = 0.05$) within a trial.

- June – Chicken heads ($p = 0.023$)
- September – Chicken heads ($p = 0.021$)

3.1.2 Individual preference trials

- RAF1 - RI chicken heads = 1
- RAF2 - RI chicken heads = 1
- RAF3 – no baits ingested

4 ATTRACTANT PREFERENCE TRIALS.

4.1 Methods.

Two candidate attractants and control studied in 4 packs with a cafeteria trial. Rodger's Index and alpha female contact time (AFCT) were measured.

4.2 Results.

- No significant difference in preference was found between either attractant and the control, using both Rodger's Index and alpha female contact time
- No attractant was therefore used in further trials

5 BIOMARKER TRIALS.

5.1 Methods.

Seven adults received 2 mls rhodamine B in vaccine capsule in chicken heads. They were then immobilized and oropharyngeal mucosa was examined for staining.

5.2 Results.

Five of the seven dogs (71.4%) showed staining. All vaccine capsules had been swallowed.

6 PUP UPTAKE TRIALS.

6.1 Methods.

Two groups of animals were studied: captive 12-week old pups (5 trials) and free-ranging 10-week old pups (6 trials). The mean proportion of baits eaten and the mean number of chews per bait were measured.

6.2 Results.

Captive pups ingested 96.7% ± 3.3% of baits. Free-ranging pups ingested 50.8% ± 10.8%. The mean number of chews for pups = 16.6 ± 2.11. The mean number of chews for adults = 11.1 ± 0.545 ($p=0.004$).

7 DOMINANCE TRIALS.

7.1 Methods.

Does one high-ranking individual dominate bait intake? Twenty five trials on 5 captive packs and 6 trials on 1 free-ranging pack have been conducted. One chicken head bait per pack member.

7.2 Results of bait intake dominance trials conducted on captive and free-ranging African wild dogs.

Pack identification		Number of trials	Significant dominance of bait intake by an individual (Y/N)a?	Status of dominant individual
Captive	DS	7	Y	Alpha male
	DM	3	Y	Unknown
	DC	5	Y	Alpha female
	DT	4	N	n/a
	DP	6	N	n/a
Free-ranging	MD	6	Y	Alpha male

a Calculated using one-way ANOVA and Student-Newman-Keuls multiple comparison procedure at $\alpha = 0.05$

8 PACK COVERAGE TRIALS.

8.1 Methods.

Pack coverage vs.: pattern of bait distribution (clumped, spaced or targeted)

degree of satiation ("Belly fullness score"= BFS)

8.2 Results.

No significant difference in pattern of bait distribution vs. pack coverage.

No significant difference in belly fullness score vs. pack coverage.

Targeted delivery method: 85.7% success with captive animals, 0% success for free-ranging animals.

Free-ranging pack: the pack coverage correlated to trial number ($r = 0.71$, $p < 0.001$)

9 NON-TARGET SPECIES TRIALS.

9.1 Methods.

Diurnal species: 46 h of observations around dens (free-ranging packs).

Nocturnal species: 20 baits placed at 4 sites in KNP during late afternoon. Sites examined 12h later & all mammalian tracks recorded.

9.2 Results.

Diurnal species: 2 chicken head baits lost, Bateleur eagle & black-backed jackal.

Nocturnal species: no baits remaining in the morning, Spotted hyaena, genet, dwarf mongoose, slender mongoose and warthog.

10 DISCUSSION.

Chicken heads as baits.

Uptake by pups.

'Priming' to increase pack coverage

'Targeted' delivery in captive packs

Ongoing research on efficacy of bait/vaccine combination, optimal vaccination schedule and effect of maternal antibodies.

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- Kruger National Park
- Madikwe Game Reserve

IS IT POSSIBLE TO VACCINATE YOUNG CANIDS AGAINST RABIES AND TO PROTECT THEM?

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1 INTRODUCTION.

Two canid species, the dog and the fox, are the most important reservoirs of rabies in terrestrial mammals. When considering human health, dogs remain the most important host and vector of rabies. They are responsible for estimated 35000 to 50000 human deaths due to rabies worldwide.

Control of the disease is generally achieved by vaccination. In countries where sylvatic rabies exists, oral vaccination campaigns conducted with safe and efficient baits make possible the eradication of the disease. In countries where canine rabies is endemic, WHO recommends mass parenteral vaccination campaigns of dogs and promotes, for dogs impossible to reach, the use of oral immunisation (WHO, 1993). WHO has made recommendations on safety of anti-rabies oral vaccines.

An important part of these populations is constituted of young animals. Vaccination schemes generally indicate that the first vaccination should not be done in dogs younger than 3 months because of the possible presence of blocking levels of maternal antibodies that might interfere with the active immunisation due to vaccination (Povey, 1997).

If the immunology of young dogs is well-known, very little is known of the immunity of the young fox. This paper gathers results obtained during studies of the response to anti-rabies vaccination of young dogs and foxes.

2 RESPONSE OF YOUNG DOGS FOLLOWING VACCINATION.

2.1 Mass parenteral vaccination campaigns in Tunisia.

2.1.1 Surveillance protocol.

This study was conducted near Tunis (Seghaier *et al.*, 1999). From 1982 till 1992 the Tunisian programme for rabies control included mass parenteral vaccination campaigns of dogs every two years. This led to a decline in animal and human rabies cases. However since 1988, the number of human rabies cases has increased and 25 human deaths occurred in 1992. Therefore, since 1992, mass parenteral vaccination campaigns were carried out every year.

A serological survey was conducted in a suburban area close to Tunis (Sanhaja) to study the ability of dogs to respond to rabies vaccination.

The vaccine used for parenteral vaccination (Rabirabta) is produced locally by the Veterinary Research Institute in suckling lambs inoculated with CVS. Brains are harvested when animals are para-

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lysed and the suspension is then inactivated with β-propiolactone and adjuvanted with aluminium hydroxide. All batches are tested for potency in Nancy.

During the study 1ml dose of vaccine was administered subcutaneously to dogs at day 0 and one year later (D365). Two different batches of vaccine titrating 8 and 8.8 IU/ml were used during the study. Blood samples were collected at day 0, 30, 210, 365 and 395 (i.e. 1 month after the second vaccination). The rabies virus neutralising antibody titres were determined by using a modified version of the rapid fluorescent focus inhibition test (RFFIT) (Smith *et al.*, 1973; Zalan *et al.*,1979).

2.1.2 The dog population.

Data related to the demography of the dogs (301 dogs at beginning of the survey) were based on owners information. Tewnty three per cent of houses have a dog (348 animals), the dog:human ratio is 1:15.6.

The average ages of dogs was 2.6 years; the annual turnover rate per year was estimated to be 37%.

Thirty six per cent of the dogs were less than 1 year old (figure 1) and 16 % of these dogs were puppies (less than 3 months). The male/female ratio is 2.03. The percentage of dogs less than 3 months old in this study is not significantly different from that reported in other parts of the world (Table 1).

Figure 1: Structure of the dog population in Sahanja.

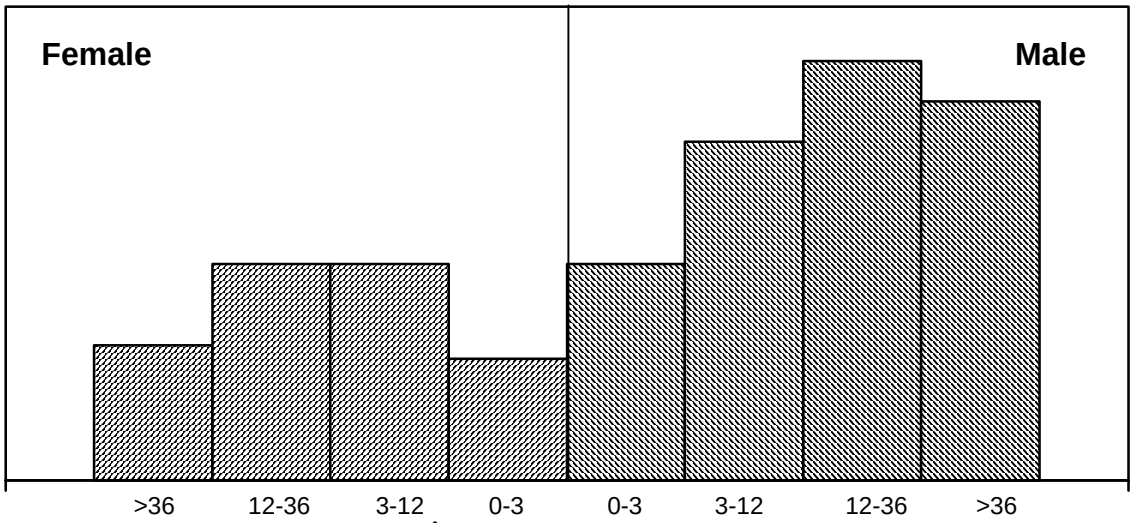


Table 1: Field data related to the proportion of owned dogs younger than 3 months.

	Study area	Percent of dogs	
		less than 3 months	1 year
Cleaveland S., 1996	Tanzania (Serengeti)	12	25
Matter *et al.*, 1998	Tunisia (El Bassatine)	7.4	30
Matter *et al.*, 1993	Turkey	7-20	
Chomel *et al.*, 1988	Peru (Lima – Calla)		38
Matter *et al.*, 2000	Sri Lanka	1.7 – 11.1	19
Matter *et al.*, 2000	Kenya (Masaï Mara)	21.5	

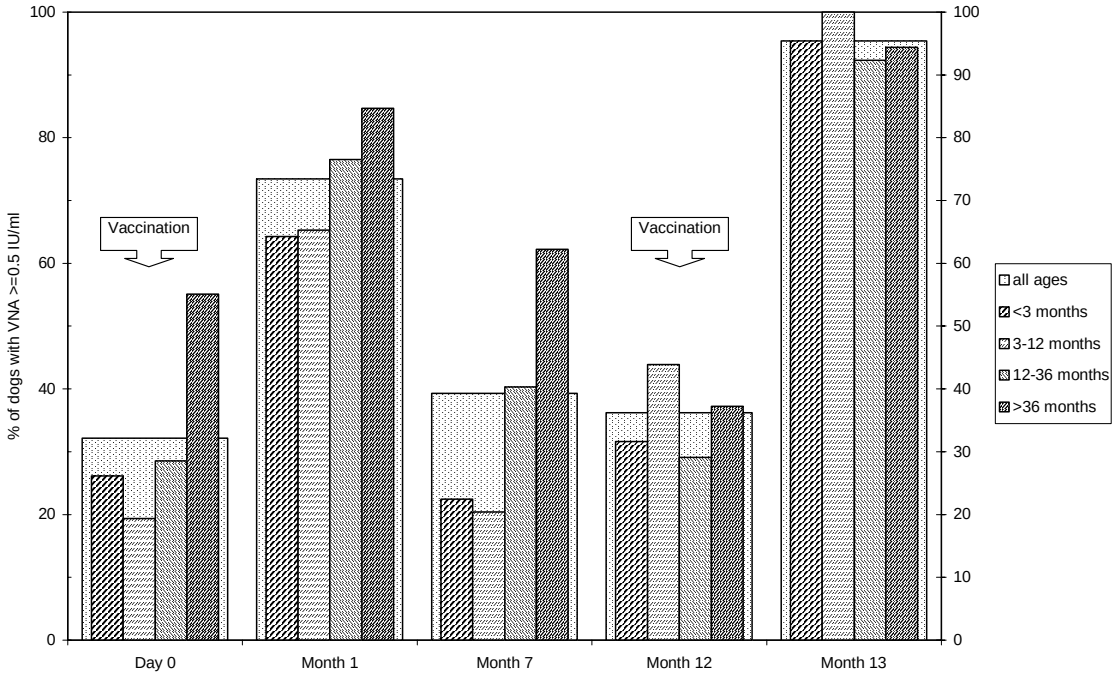
2.1.3 Serological surveillance.

All dogs were not always available during the different periods of the blood samplings. Among the 301 dogs initially included in this survey, 95%, 88%, 72%, 60% and 54% were sampled at D0, D30, D210, D365 and D395 respectively.

Figure 2 shows that one month after the vaccination, the percentage of dogs with titre ≥ 0.5 IU/mL was significantly increased in all age groups. Then it decreased during the following months. Twelve months after the first vaccination only 29 to 44% of the tested animals were ≥ 0.5 IU/mL. One month after the booster this proportion reached 92 to 100 %, depending on the age group. The percentages observed for the puppies and for the dogs younger than 1 year were not significantly different from the rest of the population all along the study.

Twenty six per cent of the puppies (n=39) had neutralising antibody titres greater or equal to 0.5 IU/mL at Day 0. These antibodies were considered of maternal origin. In figure 3 two groups of animals have been done, those having undetectable antibodies at day 0 (n=29) and those having titres of at least 0.5 IU/mL. One month after the first vaccination, puppies that showed titres ≥0.5 IU/mL at Day 0 had a significantly higher neutralising titre (t=2.68, df=23, p=0.011). Thereafter, the kinetic of rabies antibodies responses at months 7, 12 and one month after the booster were similar in the two groups.

Figure 2: Percentage of dogs within each age group with a neutralising antibody titre of at least 0.5 IU/mL.



During this survey, no dog died of rabies or showed clinical symptoms of rabies. Therefore the rabies neutralising antibodies were the result of an immunological response to vaccination and were not due to rabies infection.

2.1.4 Conclusion.

The results of this study confirm the necessity to organise yearly parenteral vaccination campaigns to maintain a minimal protection in the dog population. The serological survey of puppies showed that maternal antibodies do not seem to hamper seroconversion of puppies and the neutralising activity of their serum.

2.2 Other serological surveillance of puppies vaccinated against rabies.

Only few data have been collected on rabies vaccination protocols aiming to define the best period to vaccinate young dogs.

Chappuis (1998) vaccinated puppies born of bitches immunised with an inactivated adjuvanted antirabies vaccine (Rabisin). The vaccination was made on 14 days old animals that presented neutralising antibodies, three vaccines have been used (rabisin, two doses of a canary pox recombinant). All

the animals were challenged with New York strain at the age of 115 days. Figure 3 shows the kinetics of neutralising antibodies level of puppies after vaccination. Whatever the antibody titre at two weeks after vaccination, all animals had a low level of antibodies when challenged, the result of the challenge is given in Table 2.

The survival after challenge was correlated to the immunogenicity of the vaccine used. Although obtained with a limited number of animals these data confirm that rabies antibodies (or at least the level of these antibodies) are not the only factor that protects against rabies.

Figure 3: Kinetics of antibodies of puppies vaccinated at the age of 14 days and challenged at 115 days.

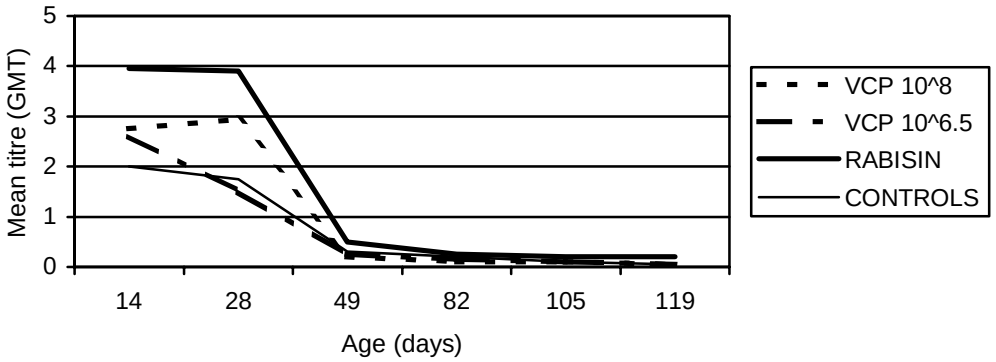


Table 2: Result of the challenge of 16 vaccinated puppies born of vaccinated bitches.

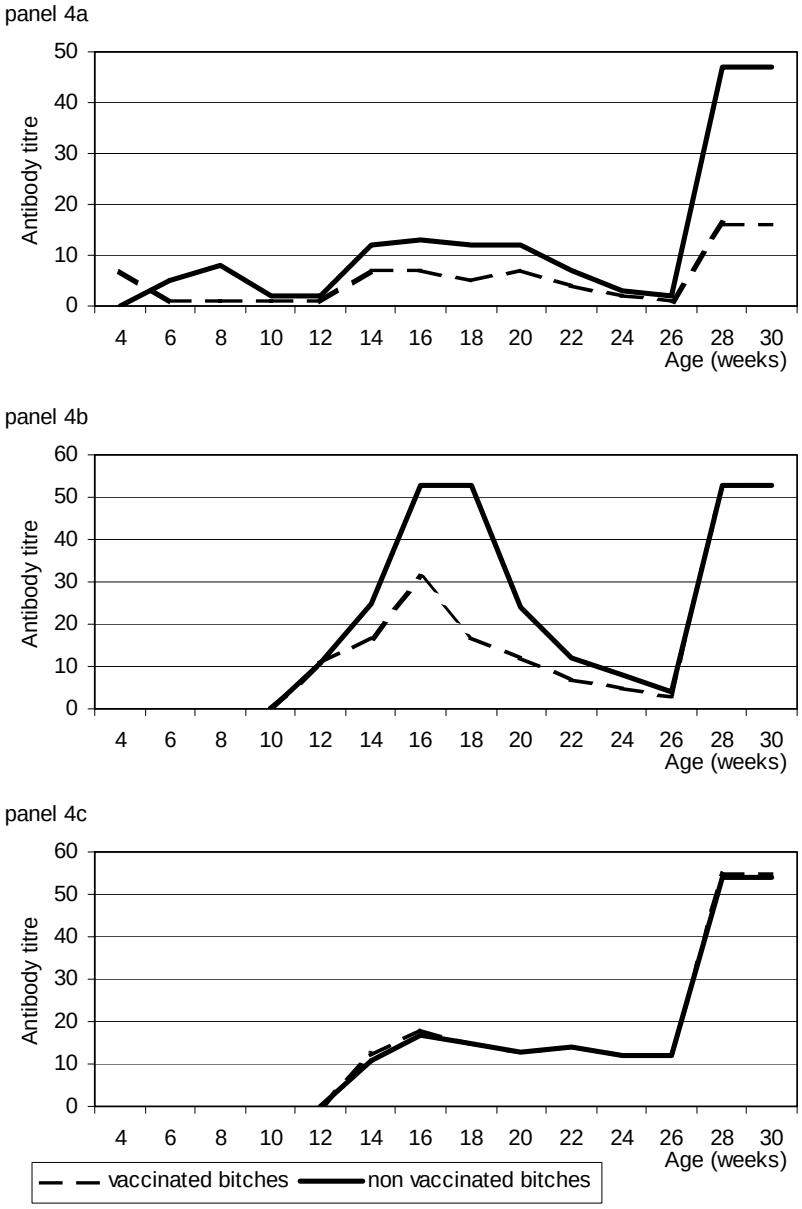
Groups of animals	Survival rate
Control group	0 out of 4
Canary pox recombinant $10^{6.5}$	2 out of 4
Canary pox recombinant 10^{8}	4 out of 4
Rabisin	4 out of 4

Aghomo *et al.* (1990) studied the response to vaccination with a Flury LEP vaccine of dogs born from vaccinated and unvaccinated bitches. The first vaccination was performed on 4, 6, 8, 10 and 12 weeks old animals, two boosters were administered at the age of 12 and 26 weeks. Figure 4 shows the observed kinetics. There is a clear interference when the first vaccination was done at 4, 6 or 8 weeks of age, puppies born of vaccinated bitches have always a lower titre than the controls born of unvaccinated bitches, even after the booster vaccinations. When the first vaccination is made on 10 weeks old animals, the interference phenomenon is less clear, puppies born of vaccinated vixens have a lower titre till the second booster. When the first vaccination is made on 12 weeks old animals, there is no difference between the two groups of animals. In this study, maternal antibodies (or the interference-inducing factor) are active up to the age of 3 months. But animals have been vaccinated with a live vaccine that may also induce cell-mediated immunity and without challenge, it is difficult to consider that the neutralising antibody level characterises the protection to infection conferred by the vaccine which is the key element in rabies control through vaccination.

A previous study on laboratory dogs demonstrated that passive antibodies of maternal origin interfere with active immunisation (Précausta *et al.*, 1985) this work compared the level and the kinetics of the humoral response in puppies born of immune and non-immune dams and vaccinated against rabies with an inactivated vaccine. The results show that puppies born of non immunised dams and vaccinated against rabies at 1 month of age responded to vaccination with neutralising titres similar to puppies vaccinated at 7 months of age. However, the antibody synthesis of immunised puppies born from dams and vaccinated at 1 month of age was inhibited by the persistence of maternal antibodies.

Similar results were recorded in a study (Van Kampen, 1999) reporting solid protection against lethal challenge of 2 week-old and 6 week-old puppies still having maternal antibodies and vaccinated with a single injection of recombinant Canary Pox rabies vaccine or vaccinia recombinant vaccine (Raboral VRG).

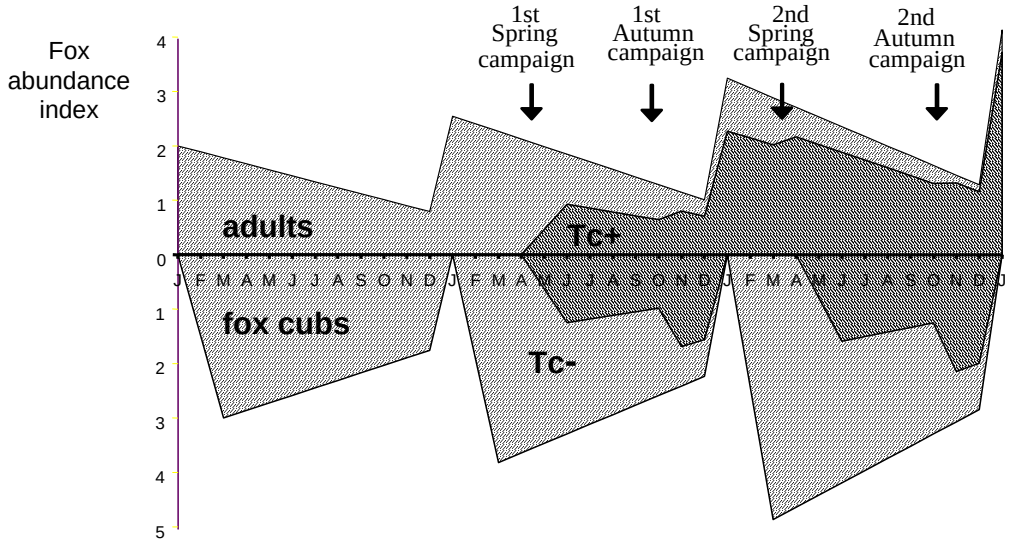
Figure 4: Kinetics of antibodies following Flury LEP vaccination of puppies born of vaccinated or unvaccinated bitches at the age of 4 weeks (panel a), 10 weeks (panel b) and 12 weeks (panel c). Boosters were administered at the age of 12 and 26 weeks.



3 ORAL VACCINATION OF YOUNG FOXES (*VULPES VULPES*).

The control of rabies in fox populations must address different problems: the increase of fox populations, the persistence of residual foci, the risk of re-infection of freed areas, the age structure of fox population. Figure 5 shows the evolution of a fox population orally vaccinated against rabies during a three year period. The impact of oral vaccination measured by the bait uptake in the adult portion of the population is clearly different from the one observed in the "cub" part. After the third campaign, 75% of adults are vaccinated and even with an increasing population, the proportion of vaccinated animals does not decrease. The observation of the "cub" part of the population shows a global increase of the population, more important than the one observed in adults. The proportion of vaccinated animals remains relatively low (20 to 50%) and constant in this group, which means that there is an increasing number of unvaccinated receptive cubs, leading to an important decrease in the impact of oral vaccination in the fox population.

Figure 5: Evolution of an infected red fox population after oral vaccination campaigns.



In spring cubs constitute two thirds of the fox population, their vaccination is then crucial to maintain the vaccination coverage. In areas that have been vaccinated several times, cubs are born from immunised vixens; maternal antibodies may hamper active immunisation of fox cubs during the spring campaigns.

Different parameters have been monitored: duration of the maternal antibodies, age of immunocompetency, protection against challenge conferred by oral vaccination. The results presented here have been obtained during a project financed by the European commission (contract FAIR CT97-3515 : *"Rabies vaccination in emergency - Wildlife vaccination rabies in difficult and emergency situations and its potential impact on the environment"*) and more precisely in the phase dealing with the study of immunisation of fox cubs with oral vaccines.

The vaccines that have been studied over the two-year experiment are the two oral vaccines that fulfil the requirements of WHO, a vaccinia recombinant expressing the glycoprotein of rabies virus (V-RG) and a double mutant from the SAD Berne strain (SAG2 vaccine).

Both experiments followed the same general protocol. The animal model used in this study was the silver fox, which belongs to the same species as the "wild" red fox, *Vulpes vulpes*. All silver fox cubs used were born in the experimental farm of our laboratory. One to 4 years old males and 2 to 9 years old females were purchased at least one month before the beginning of the reproductive activity of the vixens from the Norwegian Fur Breeder's Association (Oslo, Norway). On arrival, all animals were treated with anthelmintics (Droncit®, Bayer Pharma, France and Ivomec®, Merial SAS, France) and were vaccinated against canine distemper, viral hepatitis, parvovirus infection, infectious tracheobronchitis and leptospirosis with Canigen® CHPPi/L (Virbac, France). They were kept in individual cages, fed daily with a commercial dry food for adult dogs and water was provided *ad libitum*. All animals were observed daily.

Vixen sexual cycles were monitored using both vaginal resistivity and keratinisation of epithelial cells in vaginal smears. Once a vixen was determined receptive, a male was co-housed with it for one day. After this, detection of spermatozoa was performed by examination of vaginal smears to assess the covering. In this way it was possible to determine precisely the beginning of the gestation period and the estimated parturition time (mean gestation period is 52 days). Covered vixens were then transferred to maternity cages and pregnancy was verified 30 days later by echography and transabdominal palpation.

When cubs of the litter were 8 to 9 weeks old, the dam was removed and the cubs were re-caged usually in pairs. They were fed daily with commercial dry food for young dogs with drinking water *ad libitum*. According to their size (generally when 3 to 4 months old), young foxes were placed in individual cages. At this time they were also treated with anthelmintics (Droncit® and Ivomec®) and vaccinated with Canigen® CHPPi/L (two injections, 4 weeks apart).

3.1 Protection conferred to fox cubs by V-RG

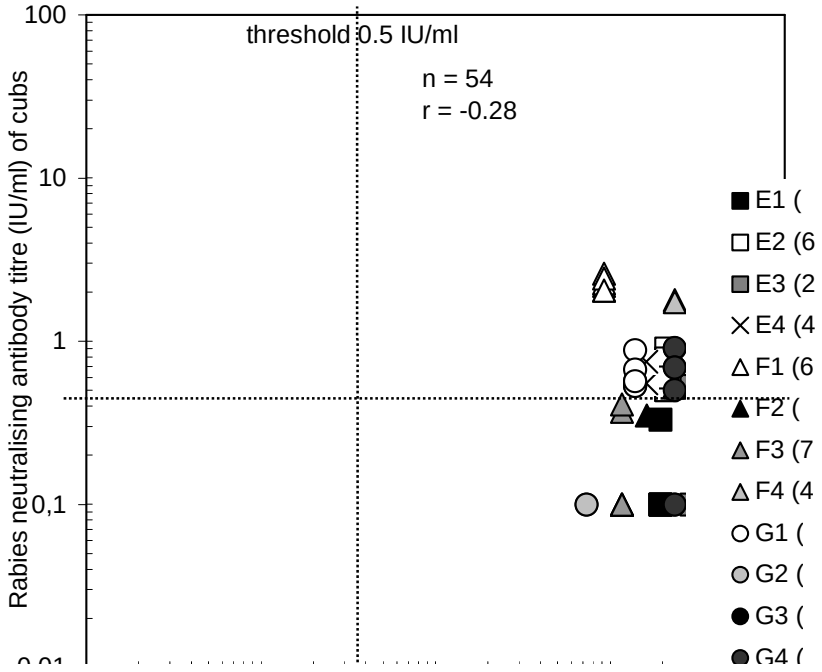
Seventeen males and 40 females were included in the protocol. Twenty one pregnant vixens were divided in six groups as shown in Table 3. Twelve vixens vaccinated with V-RG at thirty days of pregnancy and nine vixens kept as controls. In both groups, litters were divided in 3 sub-groups: cubs vaccinated when 30 days old (groups E and H), cubs vaccinated when 3 months old (groups F and J) and non-vaccinated cubs (groups G and K). Both adult and young foxes received the V-RG vaccine by direct instillation into the oral cavity (2.7 ml corresponding to the average dose of the batch used in the test). All young foxes were blood sampled when 30 days old and thereafter at 2 weeks intervals until 5 months of age. When 5 months old, cubs were challenged intramuscularly with 10^3 $MICLD_{50}$ of a street strain isolated from sub-maxillary glands of a naturally rabies infected fox.

Table 3: Groups of fox cubs vaccinated with V-RG and calendar of the experiment.

	Vixens vaccinated at 30+/-2 days of pregnancy			**Unvaccinated vixens**		
Litter codes	E1 E2 E3 E4	F1 F2 F3 F4	G1 G2 G3 G4	H1 H2 H3 H4	J1 J2 J3	K1 K2
number of cubs	5 6 2 4	6 1 7 4	5 2 4 7	7 1 6 5	6 5 2	4 6
Vaccination	D30	D90	no vaccination	D30	D90	no vaccination
Serological survey	titration of neutralising antibodies from 1 month to 5 months at 2 weeks intervals					
challenge	at 5 months of age					
end of the experiment	65 days post-challenge					

The disappearance of maternal antibodies in fox cubs born from vaccinated vixens and allocated to the groups F (vaccinated at 90 days old) and G (unvaccinated) is shown in Figure 8b; litters of group K. Individual levels of rabies neutralising antibody were highly variable.

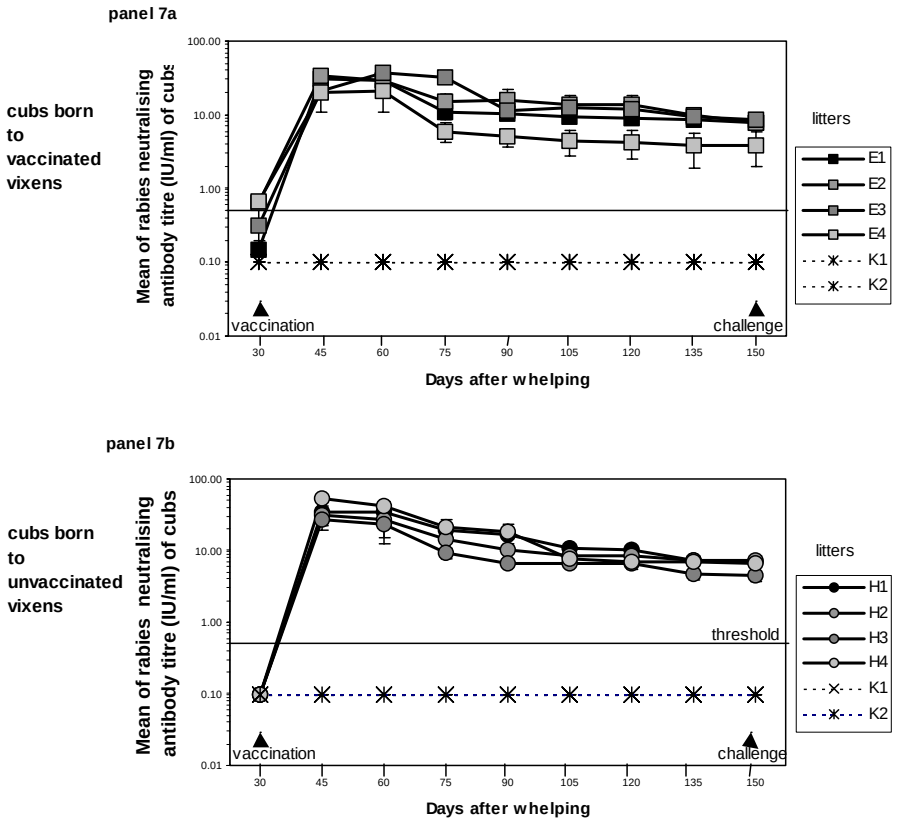
Figure 6: Distribution of the mean neutralising titre of a litter according to the neutralising titre of the vixen.



This high inter-individual variability in neonates has been already hypothesised (review by Chappuis, 1998) as a possible consequence of the rank of birth (therefore a greater possibility to consume colostrum for those born first), the size of the litter, and the rates of antibodies in vixens. In this study however, no significant correlation was found between the levels of antibodies in cubs and those of their respective mothers (Figure 6).

Figures 7 and 8 describe the kinetics of acquired humoral immunity of fox cubs born from vaccinated or non-vaccinated mothers and vaccinated at 30 days (groups E and H) and at 90 days of age (groups F and J) respectively compared to control litters (group K, unvaccinated cubs born of unvaccinated vixens). As early as fifteen days after oral administration of the vaccine, mean titres were significantly increased for all groups of cubs whatever their immune status before vaccination. Furthermore, mean antibody titres did not differ significantly during the study whether cubs were born from vaccinated vixens or from non-vaccinated vixens ($0.059 < p < 0.451$ for cubs vaccinated at 30 days of age; $0.063 < p < 0.897$ for cubs vaccinated at 90 days of age). Then mean antibody titres remained stable until at least five months of age, when all cubs were submitted to a virus challenge.

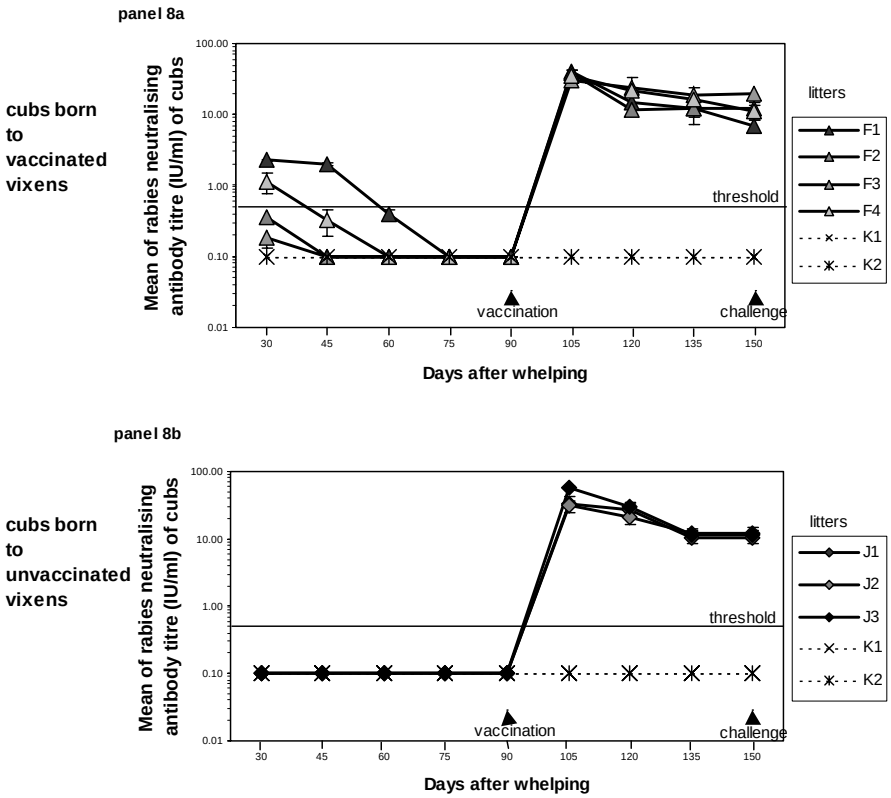
Figure 7: Kinetics of neutralising antibodies of 30 days old fox cubs orally vaccinated with V-RG. Unvaccinated litters K1 and K2 born of unvaccinated vixens were used as controls.



No significant difference was observed between mean antibody titres of fox cubs whether or not they were issued from vaccinated or non vaccinated vixens and whether they were vaccinated at 30 days or at 90 days of age ($0.144 < p < 0.935$). Following the rabies challenge, whatever the immune status of the vixens, all vaccinated young foxes ($n = 65$) resisted challenge and all unvaccinated controls ($n = 29$), except one, died of rabies.

This study demonstrated that vixens orally vaccinated with V-RG during pregnancy transfer neutralising antibodies to their offspring. However no correlation was found between titres of cubs and those of their mother, contrary to the results reported by Müller *et al.* (1999). We hypothesise that this absence of correlation may be related to individual differences in colostral absorption and difference in antibody concentration in colostrum.

Figure 8: Kinetics of neutralising antibodies of 90 days old fox cubs orally vaccinated with V-RG. Unvaccinated litters K1 and K2 born of unvaccinated vixens are used as controls.



Data showed that 1 month old and 3 months old fox cubs born from vixens not vaccinated against rabies are equally able to respond to V-RG oral vaccination. This result suggests that no additional maturation of the immune system seems to occur after 30 days of age.

The duration of passive immunity ranged between 45 and 75 days after birth (Figure 8a) was depending upon the levels of antibodies reached at 30 days of age and this period. It should be noted that the kinetics of disappearance of antibodies of maternal origin was similar for all litters.

3.2 Protection conferred to fox cubs by SAG2. (preliminary results)

This part of the programme was made during the next year and the final interpretation of the results obtained is in process. To assess the reproducibility of the results between these two sets of serological analyses, 5 sera already tested during year 1 have been retested blindly during year 2.

Thirty-one males and 70 females were included in the experiment. The general arrangement of the 27 litters (122 cubs) obtained is summarised in Table 4.

Table 4: Groups of fox cubs vaccinated with SAG2 and calendar of the experiment.

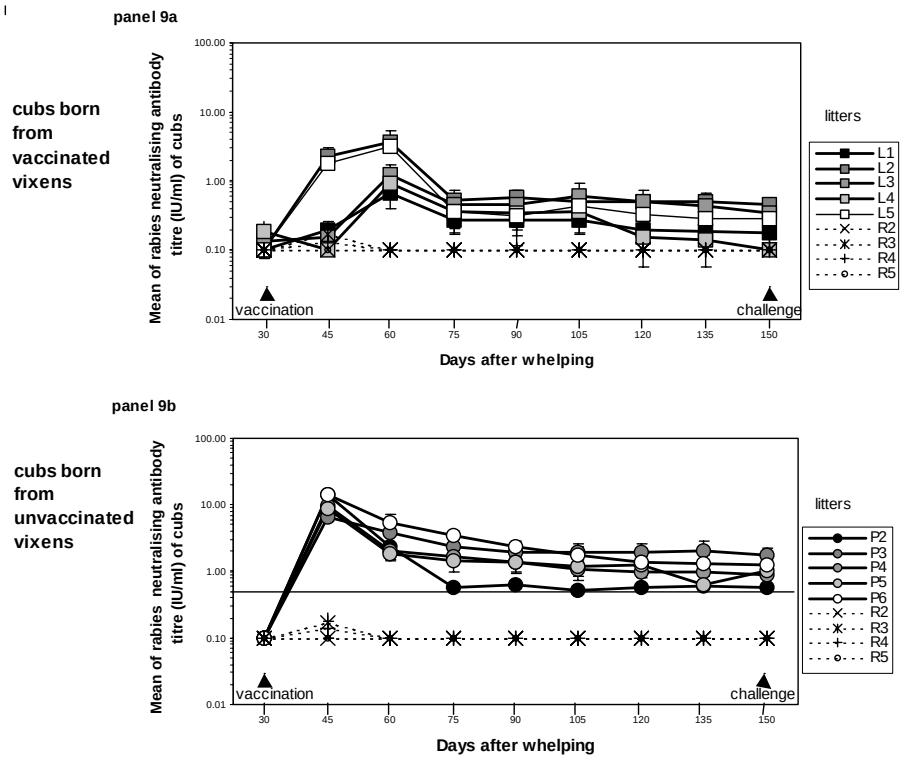
	Vixens vaccinated at 30+/-2 days of pregnancy			**Unvaccinated vixens**		
Litter codes	L1 L2 L3 L4 L5	M1 M2 M3 M4	N1 N2 N3 N4 N5	P2 P3 P4 P5 P6	Q1 Q2 Q3 Q4	R2 R3 R4 R5
number of cubs	4 1 6 7 5	5 5 4 4	5 2 5 3 5	1 4 5 5 6	5 3 3 5	5 3 3 3
Vaccination	D30	D90	no vaccination	D30	D90	no vaccination
Serological survey	titration of neutralising antibodies from 1 month to 5 months at 2 weeks intervals					
challenge	at 5 months of age					
end of the experiment	65 days post-challenge					

Serum samples collected during the previous experiment were blind tested during these tests to assess the correlation between the two groups of tests.

Maternally derived antibodies may persist for up to 70 days. As observed for V-RG, there is no correlation between the neutralising titre of the female and the one observed in the offspring. Among the 66 cubs born of vaccinated vixens, 57 had no detectable neutralising antibody 2 weeks after oral vaccination. Five of the 9 other cubs belonged to the same litter (N5), 2 to litter L4 and one to litters L3 and N1; their titres ranged between 0.29 and 0.98 IU/ml.

A clear interference exists between this passive immunity and the seroconversion of cubs vaccinated when 30 days old (Figure 9a). Cubs born of vaccinated vixens constantly show a neutralising titre lower than the one observed in litters born of unvaccinated vixens.

Figure 9: Kinetics of neutralising antibodies of 30 days old fox cubs orally vaccinated with SAG2. Unvaccinated litters R2 to R5 born of unvaccinated vixens were used as controls.

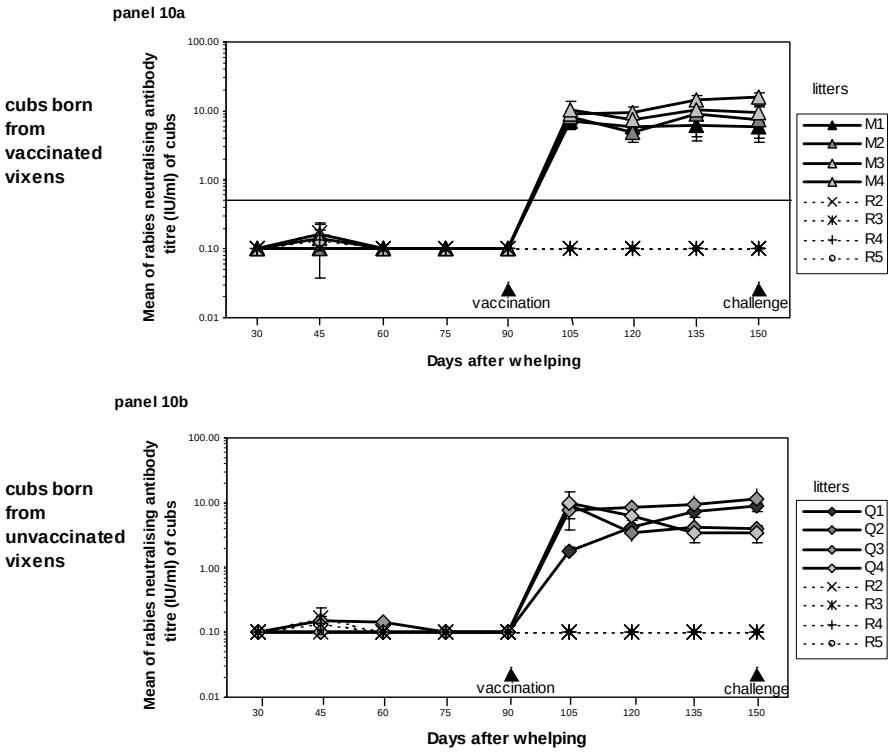


No interference was observed when vaccination is made when animals are 90 days old. Response to vaccination (increase in neutralising titre 15 days after vaccination) and kinetics of the neutralising titre are not statistically different between the two groups.

All except two vaccinated cubs resisted challenge, both belonged to the group vaccinated at the age of 30 days. One of them did not show any neutralising activity throughout the study, the other one was serologically negative except on the control performed at 60 days of age (i.e. 0.37 IU/ml, log = -0.43). But it must also be emphasised that such serological responses have also been observed in cubs that resisted challenge.

The very early ability of canids to respond to oral vaccination with the SAG2 has been observed (Schumacher *et al.*, 1997) who tested the innocuity of a highly concentrated SAG2 suspension (10^9 $TCID_{50}$) in puppies. Twenty puppies (7 to 10 weeks old) were inoculated either per os or by the intramuscular route. No animal developed clinical signs during the 120 day period of the trial. All dogs rapidly synthetised (7 days after inoculation) rabies antibodies and titres remained stable during the four months observation period (Figure 10).

Figure 10: Kinetics of neutralising antibodies of 90 days old fox cubs orally vaccinated with SAG2. Unvaccinated litters R2 to R5 born of unvaccinated vixens are used as controls.



3.3 Conclusions of the experiment.

The analysis of data collected during the second part of the experiment (SAG2 vaccine) is still in process. However some conclusions may already be drawn.

- One-month-old fox cubs are able to respond to oral vaccination with SAG2 or V-RG, this capacity may exist earlier. This is confirmed by the resistance to challenge of cubs born of unvaccinated vixens and orally vaccinated at the age of 30 days.
- When vixens are vaccinated, no correlation is observed between the neutralising titre of the vixen and that of the offspring. This passive immunity lasts less than 75 days.
- Passive immunity of maternal origin may interfere with neutralising serological response of fox cubs vaccinated at the age of 30 days with SAG2. No interference is observed with V-RG vaccine. No interference has been observed when vaccination is made at the age of 90 days.
- Cubs vaccinated with V-RG at the age of 30 days resist challenge whatever the vaccinal status of the vixen. If the vixen has been vaccinated with SAG2, one-month-old cubs vaccinated orally with SAG2 may not resist challenge.
- On a more general point of view during epidemiological studies, serological data obtained in young animals (less than 3 months) do not necessarily come from the vixen because one month old fox cubs can respond to the stimulation at least of some antigens.

4 CONCLUSION.

Domestic species are generally immuno-competent at birth. However, an additional maturation of the immune response occurs during neonatal period. The vaccination of young canids must be considered and encouraged for different reasons:

- Dog and fox populations are young populations with a rapid turnover.

- Puppies are generally confined and less mobile than adult dogs and therefore they are easier to reach and to handle.
- Puppies are in frequent contact with young children and frequently fondled by people.
- Low amounts of maternal antibodies in neonates may be insufficient to prevent a rabies infection.
- Life expectancy of live-born puppies is very low during the first three months of life.

The lack of interference between maternal antibodies against rabies and active immunisation conferred by vaccination have been observed in young dogs vaccinated with inactivated vaccines given parenterally and in young foxes vaccinated orally with V-RG vaccine.

When annual mass vaccination campaigns of dogs are planned with inactivated vaccines given parenterally puppies must be included whatever the immune status of the bitch. This measure should contribute to a decrease in rabies infections in children. It should be outlined that WHO do not recommend the use of live attenuated vaccines that may be pathogenic in puppies.

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REFERENCES.

AGHOMO H.O., ODUYE O.O. AND RUPPRECHT C.E. – 1990 - The serological response of young dogs to the Flury LEP strain of rabies virus vaccine. *Veterinary Research Communications*; **14**, 415-425.

BLASCO E., LAMBOT M., BARRAT J., CLIQUET F., BROCHIER B., RENDER C., KRAFFT N., BAILLY J., MUNIER M., PASTORET P.P., AUBERT M.F.A. – 2001 - Kinetics of humoral immune response after rabies VR-G oral vaccination of captive fox cubs (*Vulpes vulpes*) with or without maternally derived antibodies against the vaccine. *Vaccine,* **19**, 32, 4805-4815.

CHAPPUIS G. - 1998 - Neonatal immunity and immunisation in early age: lessons from veterinary medicine. *Vaccine*; **16**, 1468-1472.

CHOMEL B., CHAPPUIS G., BULLON F., CARDENAS E., DE BEUBLAIN T.D., LOMBARD M., GIAMBRUNO E. – 1988 – Mass vaccination campaign against rabies : are dogs correctly protected? The Peruvian experience. *Rev. Infect. Dis.*, **10,** 4, S697-S702.

CLEAVELAND S. – 1996 – The epidemiology of rabies and canine distemper in the Serengeti, Tanzania. PhD thesis, Univ. London, 1-262.

MATTER H., SCHUMACHER C.L., KHARMACHI H., HAMMAMI S., TLATLI A., JEMLI J., MRABET L., MESLIN F.X., AUBERT M.F.A., NEUENSCHWANDER B.E. *ET AL.* – 1998 – Field evaluation of two bait delivery systems for the oral immunization of dogs against rabies in Tunisia. *Vaccine*, **16**, 7, 657-665.

MATTER H., WANDELER A.I., NEUENSCHWANDER B.E., HARISCHANDRA L.P.A. AND MESLIN F.X. – 2000 – Study of the dog population in the Mirigama area of Sri Lanka. *Acta trop.*, **75**, 95-108

MÜLLER TH., SCHUSTER R., WERIZEL U., VOS A., SELHORST TH. AND NEUBERT A. – 1999 - Maternal immunity and the immune response of fox cubs (*Vulpes vulpes*) to oral vaccination against rabies. Abstract. The 10th Annual rabies in the Americas Meetings. San Diego, CA, USA, 14-19 November; 83.

POVEY R.C. AND CARMAN S. – 1997 - Technical basis of vaccination. Veterinary Vaccinology. Amsterdam: Elsevier Science BV, 853 pp.

PRÉCAUSTA P., SOULEBOT J.P., CHAPPUIS G., BRUN A., BUGAND M. AND PETERMANN H.G. – 1985 - Nil cell inactivated tissue culture vaccine against rabies. Immunization of Carnivores. *In* Rabies in the Tropics, Kuwert E., Mérieux, C., Koprowski H. and Bögel K. eds. Berlin, Springer Verlag 1985: 227-240.

SCHUMACHER C.L., HAMMAMI S., CHAPARRO F., BISHOP G., VON TEICHMAN F.B., AUBERT M.F.A., BINGHAM J., CLIQUET F. AND AUBERT A. – 1997 - Safety of the oral rabies vaccine SAG2 and efficacy of its delivery system DBL2 in indigenous dogs. *In* Proceedings of the SEARG meeting. Nairobi (Kenya), 163-174.

SEGHAIER C., CLIQUET F., HAMMAMI S., AOUINA T., TLATLI A. AND AUBERT M. - 1999 - Rabies mass vaccination campaigns in Tunisia : are vaccinated dogs correctly immunized ? *Am J Trop Med Hyg*, **61**, 879-884.

SMITH J.S., YAEGER P.A. AND BAER G.M. - 1973 - A rapid reproducible test for determining rabies neutralising antibody. *Bull World Health Organisation*, **48**, 535-541.

VAN KAMPEN K.R. – 1999 - Rabies vaccines. Rabies : Guidelines for Medical Professionals. Trenton : Veterinary Learning Systems, 88 p.

ZALAN E., WILSON C. AND PUKITIS D. – 1979 - A microtest for the quantitation of rabies virus neutralizing antibodies. *J Biol Stand*, **7**, 213-220.

ORAL VACCINATION WITH SAG 2 BAITS AND INTERNATIONAL RABIES CONTROL

O. Segal[1]

The situation of rabies in the world is constantly evolving. It differs greatly from one continent to another.

- In North America, the incriminated species are the raccoon, skunk, fox and coyote populations.
- In Latin America, Asia and Africa, dogs are an important reservoir of rabies, transmitting the disease by bite to humans and farm animals, mainly cattle.
- In Europe, adaptation of rabies to the fox allowed the virus to invade many countries.

The development of an oral rabies vaccine for dogs was encouraged by the success obtained with oral vaccination of foxes in Europe with Virbac vaccine.

The vaccine strain, called SAG2, has successfully passed the efficacy and safety requirements of the World Health Organization.

It is a live, attenuated, pure virus produced on cell culture.

It has been selected with monoclonal antibodies from the first oral vaccine used in Switzerland: SAD Bern. SAD Bern still has some residual pathogenicity in mice due to the presence of an arginine in position 333 of the glycoprotein. The codon coding for this amino acid was changed from AGA (initial code for arginine) to GAA. These two changes of nucleotides make it virtually impossible for SAG2 to revert to the vaccinal parent strain.

This mutation leads to the replacement of arginine by a glutamic acid. It is responsible for the loss of pathogenicity of SAG2 when administered to adult mice by the IC route.

SAG 2 is efficacious and safe for foxes, jackals, dogs, coyotes, skunks and raccoons.

The safety of SAG2 was then tested on more than 30 target and non-target species including baboons, the most sensitive non-human primates for rabies. This led to the signature of a “Memorandum of Understanding” between W.H.O. and Virbac aimed at the development of oral vaccination of dogs in needing countries.

Rabidog®, the dog-specific bait, was developed in collaboration with the French National Centre for Scientific Research, the Centres for Disease Control, the A.F.S.S.A. and the Allerton Provincial Veterinary Laboratory.

The liver flavour of the bait is very attractive. The vaccine is lyophilised, allowing conservation in hot climates.

The coating is very thin, thus allowing the dog’s saliva to reconstitute the liquid vaccine within seconds, to put it in contact with oral mucosa and tonsils.

The shape of the bait allows excellent prehension by dogs of all breeds and sizes.

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The first oral vaccination of dogs started in Eastern South Africa southwest of Durban and close to the border of KwaZulu Natal and the Eastern Cape Province.

No death or illness in dogs or in non-target species could be attributed to the use of the vaccine.

86% of the dog owners preferred oral vaccination to the parenteral route.

95% thought that using baits to inoculate dogs was a good idea that would work well.

75% maintained they would allow the Veterinary Department to offer baits to their dogs while they were absent.

A one-year monitoring of rabies outbreaks showed no rabies cases in the areas of the field trial.

As an adjunct to parenteral vaccination, SAG 2 vaccines, successfully used in Europe (France, Switzerland) and in South Africa, increases vaccination coverage by reaching otherwise inaccessible animals.

SOME OBSERVATIONS ON RABIES EPIDEMIOLOGY AND CONTROL

A.I. Wandeler[1]

This short review is dedicated to the memory of George Bishop.

1 THE GOALS OF RABIES CONTROL.

Rabies is a zoonosis with distinctive clinical and epidemiological features. A variety of different Lyssavirus genotypes and variants circulate in populations of different mammalian species. The genus Lyssavirus contains the virus species (serotypes, genotypes) rabies virus, Lagos bat virus, Mokola virus, Duvenhage virus, the European bat Lyssaviruses I and II, and the Australian bat Lyssaviruses. All Lyssaviruses may cause clinical rabies and the methods routinely used in diagnostic laboratories do not readily discriminate between the different virus species. Bats are recognized as principal hosts of different Lyssaviruses in Africa, Australia, Europe, and in the Americas. Small to medium-sized species of *Carnivora*, including domestic dogs, are the principal hosts for genotype-1 rabies in Africa, Asia, Europe, and in the Americas.

Though one might consider other goals of rabies control, the primary objectives are protecting human health and preventing economic losses (Wandeler, 2000). The occurrence of rabies in humans and domestic animals can be controlled by prophylactic vaccination and post exposure treatment, by reducing the risk of exposure, or conclusively, by disease elimination in the principal host species. The easiest way to reduce the incidence of human infection is by prophylactic immunization of those domestic animals, which are the most common source of human exposure. It is a considerably more challenging task to eliminate rabies in its principal host populations.

2 EPIDEMIOLOGY AND CONTROL IN EUROPE.

Large parts of Europe became free from rabies at the beginning of the twentieth century for reasons that are not entirely clear. A new epizootic in foxes emerged in Eastern Europe during World War II. The disease advanced rather regularly at a pace of twenty to fifty kilometres per year toward the west and southwest. As long as the epizootic was expanding, it had the following characteristics: A very high case density (up to 5/km^2/year) in newly affected areas, a very high proportion of rabid foxes, with initial outbreaks lasting for about one year, followed by an oscillating prevalence over many years. For reasons not fully understood, the epizootic front came to a standstill in the middle of France and in northern Italy. Analyses of epidemiological data and laboratory observations suggested that the recent European rabies epizootic is propagated and maintained by a single species, the red fox (*Vulpes vulpes*) (Wandeler *et al.*, 1974; Toma and Andral, 1977). Other species are frequently infected with the European fox rabies virus, but, none of them appear to be capable of maintaining independent transmission cycles. Jean Blancou and his team at the “Laboratoire d’Etudes et de Recherches sur la Rage et la Pathologie des Animaux Sauvages” in Nancy, France, established the susceptibility and the rate and magnitude of virus excretion for many European species. They found that the red fox has indeed the highest susceptibility to the European fox virus. However, when inoculated with a North African dog rabies virus, red foxes may develop immunity, rather than disease. Rabid foxes also excrete more virus in their saliva than do other rabid animals. From these observations the French team developed the concept of viral biotypes. A particular biotype is a virus variant adapted to a particular principal host species by particularly high pathogenicity for this species, by a high rate of excretion, and by low immunogenicity (Blancou, 1988). We must keep in mind that the pathogenicity/susceptibility, susceptibility/excretion, immunogenicity/survival triad does not cover all virus adaptations necessary for sur-

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vival in a species with a habitat dependent population density, turnover and structure, and specific patterns of behaviour and social interactions (Wandeler, 1991a).

The history of control of fox rabies in Europe is complex. Certainly, public health education and improving post-exposure prophylaxis kept the number of human cases low. For a while it was controversial, if prophylactic vaccination of dogs and cats would be beneficial. Nevertheless, once this was universally accepted and dog vaccination became compulsory in many jurisdictions, the number of human exposures was reduced significantly. Assuming that red fox populations are the substrate maintaining the rabies epizootic in Europe, most control efforts were directed against this species. It is debatable if the attempts to curb fox populations had a significant impact on incidence and spread of the disease, except in a few locations, such as the Danish peninsula. The introduction of oral rabies immunization for foxes, first applied in Switzerland in 1978 (Wandeler, 1991b), brought a gradual change in rabies control strategies (Aubert *et al.*, 1994). Oral immunization of foxes resulted in the disappearance of the disease from large parts of Western Europe in all species, except bats.

Different rabies epizootics persist in bat populations. Two distinct Lyssavirus species are observed in European bats. European Bat Lyssavirus type I is circulating in *Eptesicus serotinus* populations, while type II is seen primarily in *Myotis* species. These viruses are rarely transmitted to terrestrial mammals, though a few human cases have been recorded.

3 EPIDEMIOLOGY AND CONTROL IN NORTH AMERICA.

Dog rabies was common in North America at the beginning of the twentieth century, but then disappeared from Canada and the USA, possibly due to dog vaccination (Beran, 1991) and stricter regulations on dog ownership. Wildlife rabies rapidly replaced dog rabies after 1950. The wildlife rabies situation in North America is far more complex than in Europe. Distinct virus variants circulate in different species, such as striped skunk, red fox, and raccoon. An even higher diversity of genotype 1 rabies viruses is found in North American bats. In Canada alone, 11 distinct rabies virus variants are recognized with monoclonal antibodies. Several variants occur in a single species, and geographical distributions of variants are overlapping.

Experimental evidence that red foxes are highly susceptible to the viruses isolated from foxes predates comparable European findings (Sikes, 1962). Similarly, Parker and Wilsnack (1966) demonstrated that striped skunks (*Mephitis mephitis*) are highly susceptible to viruses circulating in skunk populations. These findings support the interpretation of viral host-adaptation and the biotype definition given above. However, other observations do not. A significant deviation from the high susceptibility pattern is exemplified by raccoon rabies. To achieve 80% mortality in raccoons one has to inoculate over $10^6 TCID_{50}$ by the intramuscular route. In stark contrast, red foxes need less then 10 $TCID_{50}$ for a lethal infection. One may speculate that not every encounter between a rabid and an uninfected raccoon results in disease transmission, and that the low susceptibility is keeping the transmission rate in balance with the behavioural ecology and population biology of this species, while the biotype concept stipulates that a virus well adapted to its host species achieves a high efficiency of transmission and high lethality and does therefore not generate any substantial herd immunity. This is not necessarily true in all situations. Everard and co-workers documented a correlation between the number of diagnosed rabies cases in mongooses (*Herpestes auropunctatus*) and the prevalence of rabies antibodies in this species on the island of Grenada (Everard and Everard, 1985). One may speculate that the observed patterns of susceptible-infected-immune permits the persistence of the association in these island host populations of limited size.

Rabies control efforts unfolded in a similar pattern as seen in Europe. However, when it came to controlling wildlife rabies with oral vaccines, one had to deal not only with foxes, but also with other principal hosts. So far, only a few of the North American wildlife rabies control problems have been addressed. The first wildlife vaccination project on this continent was initiated in the Province of Ontario, Canada, in 1989 (MacInnes *et al.*, 2001). For several decades fox rabies has been prevalent in southern Ontario. Up to 25% of the annually diagnosed cases was found in striped skunks (Charlton *et al.* 1991). A study in molecular epidemiology indicated that the same genetic variants occurred in foxes and in skunks in relatively small geographical clusters (Nadin-Davis *et al.*, 1993), indicating that there is frequent transmission from one species to the other and no epidemiological sequestration. Rabies control efforts by oral immunization were restricted to foxes, since the attenuated live vaccine ERA does not immunize any other Ontario wildlife by the oral route. Though diagnosed cases of rabies in foxes disappeared almost completely from the treated area, rabies in skunks persists in a few loca-

tions. This may indicate among other things that the surveillance for fox rabies is insufficient, or that a skunk population under specific ecological conditions is capable of maintaining an epizootic of a virus that was considered to be adapted to foxes.

4 DOG RABIES.

One can differentiate between areas in which dogs are the main hosts and areas where rabies is maintained by wild animals. The latter situation is found in America north of Mexico, in Europe, and in parts of southern Africa. In these areas, a majority of the rabies cases reported are in wild animals and usually only 0.1-5% in dogs. The factors that may produce the low prevalence of rabies in dogs are: most dogs are restricted in their movements; they are kept indoors or in enclosures and leashed when outside; dog vaccination is strongly recommended and practiced, or is even compulsory. It may also be that virus strains adapted to wild species are not very well suited for propagation within dog populations. In large parts of Asia, Africa, and Latin America, the bulk of diagnosed rabies cases is seen in dogs (Fekadu, 1991). Even though dog rabies is often termed "urban rabies", it is clearly a rural problem in many developing countries. Dogs are kept and/or tolerated at very high numbers in most human societies. Their abundance is not explained by their limited economic usefulness. Cultural practices determine the level of supervision of their social interactions and access to resources (food, water, shelter, mates). It is assumed that high density dog populations permit the occurrence of enzootic canine rabies, but this is not very well documented. Despite the easy access to dog populations for data collection, not much is known about dog rabies epidemiology. From published information, one gets the impression that dog rabies is highly enzootic with only moderate fluctuations in prevalence. This picture is only partially correct however, since epizootic patterns have also been described. Rabies in many dog populations appears to rank high as a cause of adult dog deaths. In some areas, rabies in dogs may not be independent of rabies in jackals, mongooses, or other wildlife, yet there are also situations where a dog population alone can maintain endemic rabies.

Virus variants from areas with predominant dog rabies are all very similar when analysed with monoclonal antibodies (Wandeler, 1991a). This may indicate functional constraints in their adaptation to the species, but more likely it is a reflection of common ancestry. Smith *et al.* (1992) have analysed the genetic relatedness of rabies virus isolates using N-gene sequence data. They concluded that the similarity of many dog rabies virus variants from around the World is most likely the result of the introduction of European dogs and their viruses in colonial periods.

Successful attempts at the control of rabies have generally occurred where both vaccination and dog control (destruction, confinement, breeding restrictions) have been accomplished simultaneously. Rabies control in areas with canine rabies is usually not a simple application of regulations on dog ownership. Enforcement of such regulations is impeded by a number of ecological and cultural constraints, but well planned and executed campaigns can reduce the incidence in dogs drastically and may even eliminate the disease in areas where it is not maintained by wildlife.

5 THE SITUATION IN SOUTHERN AND EASTERN AFRICA.

Rabies was present in the Mediterranean Basin, and herewith in North Africa, in early historic times. Reports of the disease in sub-Saharan Africa before 1900 are contradictory. Nevertheless, the diversity of African Lyssaviruses indicates the antiquity of their presence on the continent (Shope, 1982). At present, dog rabies is widespread throughout Africa. The states of southern and eastern Africa are not exempt, as the country reports to the SEARG meetings clearly document. Jackal rabies epizootic cycles are recognized in Namibia, Botswana, northern South Africa and Zimbabwe. The viruses found in jackals are identical to the prevalent dog rabies variants. There is some controversy over whether jackal rabies epizootics are the consequence of the disease occurring in dogs, or vice versa (Bingham *et al.*, 1999). Canine rabies viruses from Ethiopia are antigenically different from those from Tanzania, and Tanzanian viruses are distinct from South African dog viruses. Some isolates from Zimbabwe look more like those from Tanzania, while others resemble the South African ones. More important, all isolates from domestic and wildlife species examined so far are identical to the dog and jackal viruses of their area, indicating considerable spillover or shared responsibilities for maintaining the epizootic. There is a significant exception: Mongooses, particularly the yellow (*Cynictis penicillata*) and the slender mongoose (*Galerella sanguinea*) are the principal host species for the mongoose rabies variants around most of the southern African subcontinent (King *et al.*, 1994; Von Teichman *et al.*,1995). Since

the surveillance is somewhat superficial and the number of analysed isolates is relatively small, it would not be surprising to find viruses of non-canid origin in a much wider area.

6 CONCLUSIONS.

The rabies epizootic in Western Europe in the twentieth century appeared to be dependent on a single species, the red fox *Vulpes vulpes*. The epidemiological pattern could easily be explained (and modelled) by fox population biology and ecology, by its very high susceptibility, high lethality, and high rate of excretion. The success of European control campaigns confirmed the integral role of foxes. The interpretation of the European observations cannot be generalized however, since the situation on other continents is different. This being the case, a number of conclusions and recommendations can be made:

1) Attempts to elucidate local epidemiological patterns should be made. Good surveillance is a prerequisite. Molecular and antigenic analyses are useful. There are two caveats for the latter: biased sampling, and tools not discriminating between viruses circulating in specific hosts, may both lead to erroneous conclusions.

2) Epidemiological knowledge should be considered in planning control strategies. Dog rabies can be eliminated, if there is no other species permitting the virus to circulate in its populations. Even if there is such a wildlife "reservoir", it is still crucial to achieve and maintain a high vaccination coverage in dogs in order to reduce the risk of disease transmission to humans.

BIBLIOGRAPHY.

AUBERT M.F.A., MASSON E., ARTOIS M. AND BARRAT J. – 1994 - Oral wildlife rabies vaccination field trials in Europe, with recent emphasis on France. *In* Lyssaviruses, Rupprecht CE, Dietzschold B, Koprowski H (eds). Berlin: Springer, 219-243.

BERAN G.W. – 1991 - Urban rabies. *In* The Natural History of Rabies, Baer GM (ed.), 2nd Edition. Boca Raton, CRC Press, 427-443.

BINGHAM J., FOGGIN C.M., WANDELER A.I., HILL F.W.G. – 1999 - The epidemiology of rabies in Zimbabwe. 1. Rabies in dogs (*Canis familiaris*). 2. Rabies in jackals (*Canis adustus* and *Canis mesomelas*). *Onderstepoort J Vet Res*, **66**, 1-10, 11-23.

BLANCOU J. – 1988 - Ecology and epidemiology of fox rabies. *Rev Infect Dis*, **10**, Supplement 4, S606-S609.

CHARLTON K.M., WEBSTER W.A., CASEY G.A. – 1991 - Skunk rabies. *In* The Natural History of Rabies, Baer G.M. (ed.), 2nd Edition. Boca Raton, CRC Press, 307-324.

EVERARD C.O.R., EVERARD J.D. – 1985 - Mongoose rabies in Grenada. *In* Population Dynamics of Rabies in Wildlife, Bacon P.J. (ed.). London: Academic Press, 43-69.

FEKADU M. – 1991 - Canine rabies. *In* The Natural History of Rabies, Baer G.M. (ed), 2nd Edition. Boca Raton: CRC Press, 367-387.

KING A.A., MEREDITH C.D., THOMSON G.R. – 1994 - The biology of southern African lyssavirus variants. *In* Lyssaviruses Rupprecht C., Dietzschold B., Koprowski H. (eds.),Berlin: Springer-Verlag, 267-295.

MACINNES C.D., SMITH S.M., TINLINE R.R., AYERS N.R., BACHMANN P., BALL D.G.A., CALDER L.A., CROSGREY S.J., FIELDING C., HAUSCHILDT P., HONIG J.M., JOHNSTON D.H., LAWSON K.F., NUNAN C.P., PEDDE M.A., POND B., STEWARD R.B., VOIGT D.R. – 2001 - Elimination of rabies from red foxes in Eastern Ontario. *J Wildl Dis*, **37**, 119-132.

NADIN-DAVIS S.A., CASEY G.A., WANDELER A.I. – 1993 - Identification of regional variants of the rabies virus within the Canadian province of Ontario. *J Gen Virol*, **74**, 829-837.

PARKER R.L., WILSNACK R.E. – 1966 - Pathogenesis of skunk rabies virus: quantitation in skunks and foxes. *Am. J. Vet. Res.*, **27**, 33-38.

SHOPE R.E. – 1982 - Rabies-related viruses. *Yale J Biol Med*, **55**, 271-275.

SIKES R.K. – 1962 - Pathogenesis of rabies in wildlife. I. Comparative effect of va-rying doses of rabies virus inoculated into foxes and skunks. *Am J Vet Res*, **23**, 1041-1047.

SMITH J.S., ORCIARI L.A., YAGER P.A., SEIDEL H.D., WARNER C.K. – 1992 - Epidemiologic and historical relationships among 87 rabies virus isolates as determined by limited sequence analysis. *J Infect Dis*, **166**, 296-307.

TOMA B., ANDRAL L. – 1977 - Epidemiology of fox rabies. *Adv Virus Res*, **21**, 1-36.

VON TEICHMAN B.F., THOMSON G.R., MEREDITH C.D., NEL L.H. – 1995 - Molecular epidemiology of rabies virus in South Africa: evidence for two distinct virus groups. *J Gen Virol*, **76**, 73-82.

WANDELER A.I. -1991a - Carnivore rabies: ecological and evolutionary aspects. *Hystrix (n.s.)*, **3**, 121-135.

WANDELER A.I. - 1991b - Oral immunization of wildlife. *In* Natural History of Rabies, Baer G.M. (ed.):. Boca Raton: CRC Press, 485-503.

WANDELER A.I. – 2000 - Oral immunization against rabies: afterthoughts and foresight. *Schweiz Arch Tierheilk*, **142**, 455-462.

WANDELER A.I., WACHENDÖRFER G., FÖRSTER U., KREKEL H., SCHALE W., MÜLLER J., STECK F. – 1974 - Rabies in wild carnivores in Central Europe. I. Epidemiological studies. *Zbl Vet Med B*, **21**, 735 - 756.

DISCUSSION

T. Mebatsion to K. Laurenson: Your conclusions of the cultural study in Ethiopia are mainly contributable to poverty and uneducation more than to differences in religion. Education is the most important for controlling rabies.

The big problem is the lack of resources. "Quick-fix" education for Christian communities and much more education is needed for Muslim communities. Different attitudes can be changed in the long-term.

A. Zezai to S. Cleaveland: Vaccination will result in a longer life of the vaccinated dog, are there any confounders involved?

I agree that there might be confounders. If the dog has been given a collar and a certificate, the owner will take better care of this animal. The causes of death vary among the regions. The Masai puppies receive milk and eat blood and meat (and are sometimes eaten by leopard) while other puppies suffer from malnutrition.

R. Winyi Kaboyo to C. Vargas: Due to the lack of funds and resources there has been little success in mass vaccination campaigns in Africa. What is the cost of the vaccination programme presented?

It is not only money that plays a role in rabies control or the control of any disease. In Latin America once the campaign starts and has a success for 1-2 years, the next government will feel the pressure to continue. It is important to have a good infrastructure (e.g. laboratories and trained people for diagnosis)

R. Winyi Kaboyo to J. Bingham: In Flores many dogs were killed, but this is however not recommendable.

Dog rabies vaccination is not very expensive. The most expensive part is to get the vaccine applied. In Western countries the task has been transferred to the private practitioner.

S. Cleaveland: *The vaccine costs 0.40 USD per dog, while the total cost is 1.10 US$ per dog (all included).*

P. Mejere to A. Chizonda: How many cases of human rabies are now in the Lilongwe area?

There is no information from Ministry of Health available, this is a problem.

W. Shumba: *Apparently Ministry of Health has no data on human cases and nobody from MOH has come to this meeting.*

R. Winyi Kaboyo to A. Chizonda: Is the project sustainable with MKw 35 (0.47US$) per dog vaccinated? The best way to obtain data from MOH is to get data on treatments in hospitals. Before getting more vaccine they have to show how it has been spend.

The idea was that veterinary assistants should be privatized and take over the job. The government should only come in emergency situations. The amount is adequate for Lilongwe but in rural areas only 1-5 MKw can be charged.

K. de Balogh to A. Chizonda: Where the different education methods used during the campaign assessed?

The song combined with the drama were very effective especially for children.

D. Ntebela to A. Chizonda: Why has privatization been introduced? There is a worry that neither the government nor the public will be able to support the programme.

Formerly the Malawi government provided free services to the farmers. Now this task has been reduced to merely giving advice as the government has no money to undertake activities.

D. Ntebela to T. Fooks: What control measures have been taken to avoid the introduction of rabies via the Channel tunnel?

There have been different groups assessing the risk of rabies coming via the tunnel. Everything that could be done was actually done. Poisoning was only indicated in the contingency plan but is never expected to be used.

T. Mebatsion to K. Laurenson: Congratulations for the data presented. Is the live-vaccine safe to be given to this endangered species?

One could be hesitant to apply live-vaccine but this is not the case with recombinant vaccine as it is also being used in other parts of the world. Parenteral vaccination could be an option however darting and capture can give problems in this endangered species.

L. Nel to T. Mebatsion: P-protein that binds to LC8 was not deleted or replaced?

It was deleted but did not change the structure. The final titre (??) was indistinguishable from the parent virus.

L. Nel to T. Mebatsion: Did you consider to switch parts around?

If G-protein was to be moved to the 3' end, attenuation or high immunogenic virus could not easily be acceptable for authorities. SAG2 has residual pathogenicity for suckling mice. There is a danger due to the high prevalence of HIV in Africa that this safety is not acceptable.

F. Kumba to O. Segal: What is the cost of the product and the conditions for storage especially taking the heat of Africa into consideration.

The cost is 1.00 USD depending on the quantity and the location of manufacture (locally produced is eventually cheaper). As it is lyophilized, it can stand heat up to 45°C and the shelf-life is 2 years at 4°C. The fox bait still contained a liquid vaccine that had to be kept at –20°C.

R. Winyi Kaboyo to J. Barrat: All dogs should be vaccinated on a yearly basis whatever their age. Some vaccines indicate an immunogenicity for 3 years.

We have seen that dog populations are young populations. Then yearly vaccinations are recommended due to the rapid turn-over of the population to maintain a sufficient percentage of protected animals. In fox populations, when rabies is endemic, the live expectancy of a fox is 2 years and rabies kill up to 80% of animals, so once again there is a very young population that become rapidly sensitive to rabies after the end of vaccination campaigns.

W. Shumba to O. Segal: Why not also target for all the canid species?

Initially the target species was the fox. Virbac also got involved in other species projects such as dogs, African wild-dog and raccoons and skunks with the CDC.

A. Wandeler: *The vaccine is the same for all the species however the vehicle needs to be species specific as well as ecology specific in order to be effective.*

Miscellaneous

RABIES DATA MANAGEMENT SYSTEMS IN W.H.O.

F.X. Meslin[1]

WHO has developed two systems that are currently working in parallel: the report of the World Survey of Rabies (WSR) and RABNET.

1 THE WORLD SURVEY OF RABIES.

The WSR has existed for more than 30 years already (WRS for the year 1998 was the 33rd issue). It is produced on paper from data collected through the WRS questionnaire. The WSR questionnaire is sent by fax, mail (surface or electronic) to all W.H.O. member states (191 countries) and territories.

The questionnaire contains 65 questions grouped in four categories (human and animal cases – human and animal vaccines – human prevention and treatment as well as animal rabies measures in place – rabies diagnostic techniques used) and covers a calendar year. Data is collected from the questionnaire after verification. As the return rate does not exceed 40 to 45% (in spite of reminders), additional basic information (such as presence/absence of rabies) is added to the database from other sources (e.g. the OIE animal health yearbook, the annual rabies report from the Pan-American Health Organisation and WHO meeting reports…). In that way the geographical coverage for a given year can be extended to about 140 countries and territories.

Data are processed, Tables and introduction summary are prepared and the WRS report dispatched by mail to all WHO members States. This takes at least 18 months sometimes two years. The major reasons for this delay are that:

(1) national data often do not become available within a year after the year covered by the WSR questionnaire, and

(2) the slow influx of replies that necessitate reminders on our part.

2 RABNET.

The second system named RABNET (web address: http://oms.b3e.jussieu.fr/rabnet/), which was put into place three years ago, is web based. It uses the same questions as the WSR entered in an electronic data entry form. RABNET can be accessed through the web for two distinct purposes: data access and processing and also for direct data entry. For the latter a password is required that can be obtained from W.H.O. upon request at address Rabnet@who.int or aph@who.int. When consulting data graphs, charts and maps can be generated by the system for a given country, region or for the world for a given year. Available rabies data from 1998 onwards have been entered into RABNET database. As only about 60 countries are entering data through RABNET using the electronic data entry form the geographical coverage is currently improved by entering data from the WSR questionnaires received from those countries only providing data using the WSR questionnaire. This increases the relevance of RABNET when the system is consulted as more countries are present, although it does not improve the topicality of those data as filled WSR questionnaires usually do become available late.

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3 FUTURE OF THE 2 SYSTEMS.

Through promoting RABNET at meetings, visits, etc, it is hoped to rapidly increase the number of countries entering data through the web directly into the system.

RABNET data management and processing will be improved to deliver better charts, graphs and maps and decrease the time currently required for consulting or entering data into the system.

Eventually the WSR report and the WSR questionnaire will be phased out.

USING DOG BITE INJURY DATA TO ESTIMATE HUMAN RABIES MORTALITY IN TANZANIA

Sarah Cleaveland[1], Eric M. Fèvre[2], Magai Kaare[3], Paul G. Coleman[4]

SUMMARY.

It is widely recognised that, in many parts of the world, official reports greatly underestimate the true number of human rabies deaths. In this paper, data on bite injuries from suspected rabid dogs were used to make quantitative predictions about the magnitude of under-reporting in Tanzania. A series of probability steps was used to calculate the likelihood of a person developing rabies after the bite of a suspected rabid dog, incorporating field data on the incidence of animal-bite injuries, the accuracy of rabies recognition, distribution of bite wounds, and post-exposure treatment. Predicted human rabies mortality was estimated to be:

(a) 1499 deaths per year (95% CI 891 – 2,238), equivalent to an annual incidence of 4.9 (2.9 – 7.2) deaths/100000, when using active surveillance bite-incidence data and

(b) 193 deaths per year (32 - 409), which corresponds to an annual incidence of 0.62 (0.1-1.32) deaths/100000, when using national bite statistics. Official figures for the same period recorded an annual mean of 10.8 (7.7 – 14.0) rabies deaths per year.

These data suggest that rabies in Tanzania is a much more significant public health problem than widely recognised, with up to 100-fold under-reporting of human cases. Dog bite injuries are an accessible source of epidemiological data that may be used to estimate the public health burden of rabies and to monitor epidemiological trends in developing countries.

1 INTRODUCTION.

In global terms, rabies is considered to be a relatively insignificant human disease, accounting for only 1% of infectious disease deaths (Meslin *et al.*, 1994). However, it is widely recognised that, in many parts of the world, official reports greatly underestimate the true number of human rabies deaths. The problem is important because a lack of awareness of the magnitude of the rabies problem and a lack of data on epidemiological trends have been major factors hampering the development of disease control initiatives in Africa.

Inconsistencies in the reported incidence of human rabies are widespread. For example, the 1996 World Survey of Rabies (WHO, 1998) recorded a total of 30209 cases world-wide, of which 238 were from Africa and 32772 from Asia. In Ethiopia, 464 human cases were reported in Addis Ababa alone between 1992 and 1993 (Fekadu, 1997), whereas in the entire country, only 26 cases were officially reported to the World Health Organization (WHO) in 1992 (WHO, 1994) and 35 in 1993 (WHO, 1996).

Several explanations for under-reporting have been proposed:

- patients with clinical rabies may stay at home or seek treatment from local healers;
- most cases do not undergo laboratory confirmation;

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- causes of death may be recorded locally but are not transmitted to central authorities;
- a small proportion of deaths may go unrecognised by medical staff;
- cases may be perceived as 'bewitchment' requiring exorcism rather than medical treatment (Fekadu, 1982, Warrell and Warrell, 1988; Fishbein, 1991; Meslin *et al.*, 1994; Wandeler, 1997; Godlonton, this volume).

Attempts to estimate the true scale of human rabies mortality have been carried out for only a few countries, such as India (WHO, 1998) and Ethiopia (Fekadu, 1997), and these are generally considered to be well-informed guesses. Here, we describe an approach to estimating human rabies mortality in Tanzania, using empirical data on the incidence and distribution of dog bite injuries, the accuracy of rabies recognition and levels of post-exposure treatment.

The fear of developing rabies provides a powerful incentive for people to report animal bite injuries to hospitals, particularly when human post-exposure treatment (PET) is available (Cleaveland *et al.*, 1999; Kitala *et al.*, 2000). Records of bite injuries from rabid animals may thus provide an accessible source of rabies epidemiological data, which, in Tanzania, are routinely reported from district hospitals to central authorities.

One of the principal factors influencing the outcome of a rabid dog bite is the location of the bite on the body, with bites to the head, face and neck carrying a much higher risk than bites to the foot or leg (Babès, 1912; Baltazard and Ghodssi, 1954; Baltazard and Bahmanyar, 1955; Shah and Jaswal, 1976; Sitthi-Amorn *et al.*, 1987; Fishbein, 1991). Here, we use the site of injuries on the body to predict the outcome of the bite of a rabid dog.

2 METHODS.

The calculation of the predicted number of human rabies deaths in Tanzania is based on a series of probability steps shown in Fig. 1.

The starting point for the calculation was the incidence of bite wounds from suspected rabid dogs, obtained from two sources:

- villages within the Mara Region, Tanzania, in which active disease surveillance measures had been implemented (Cleaveland *et al.*, 1999) and
- official reports of human bite injuries from the Ministry of Agriculture and Co-operatives, Tanzania (1997). For the same period, official data on human deaths were obtained from the Ministry of Health (1997).

The probability of dying of rabies following a bite from a suspected rabid dog, P_{Death}, from the probability tree was calculated as:

$$P_{Death} = P_1 \times \left[\left(P_2 \times P_6 \right) + \left(P_3 \times P_7 \right) + \left(P_4 \times P_8 \right) + \left(P_5 \times P_9 \right) \right] \times \left(1 - P_{10} \right)$$

P_1, the rabies recognition probability, was determined from data collected in the active surveillance studies on the proportion of suspect animal rabies cases that were subsequently confirmed by laboratory diagnosis using immunofluorescence diagnostic tests (Kaplan and Koprowski, 1973). Animal cases were classified as suspect if the animal was reported as suspect on submission of the sample.

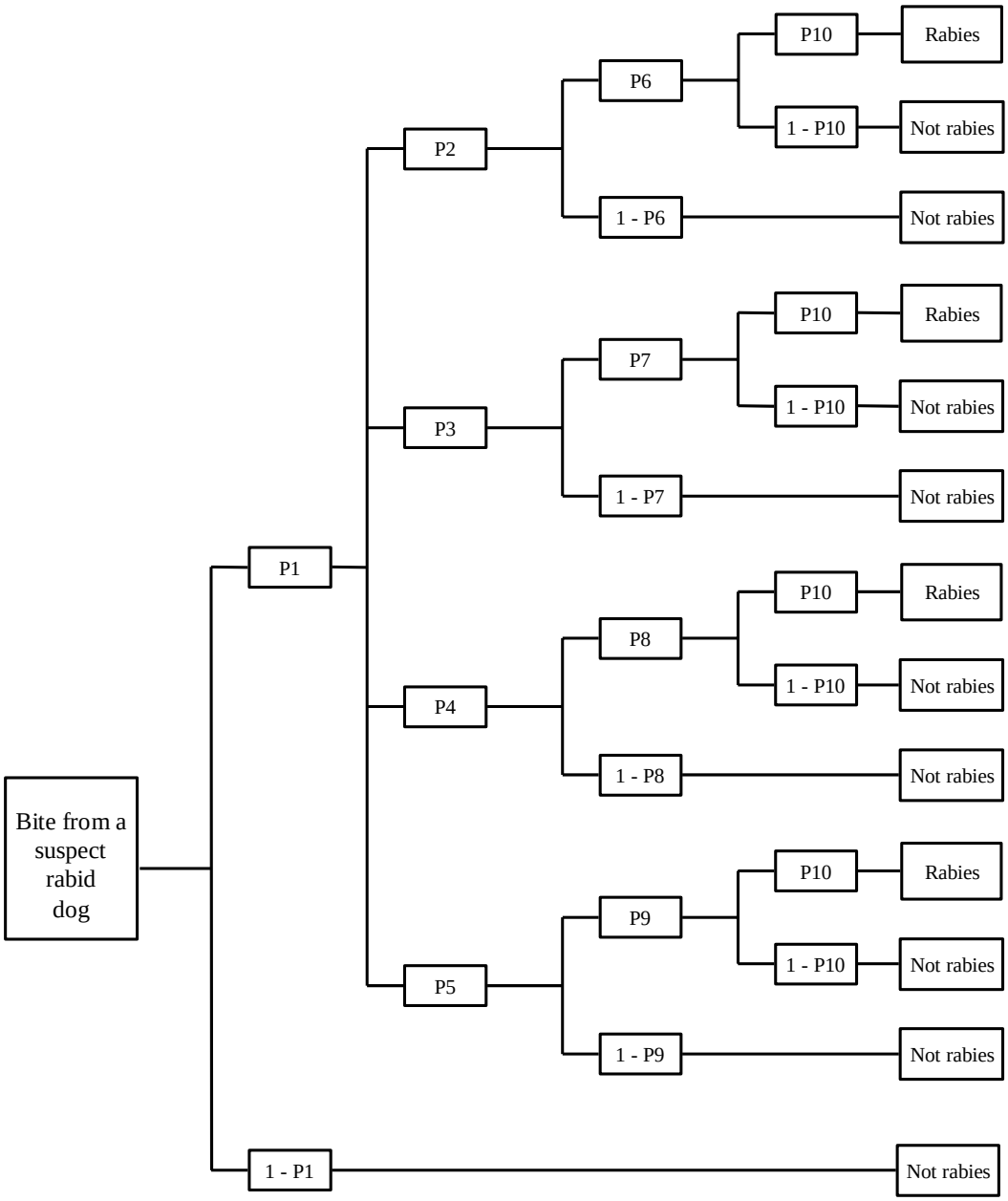
The proportion of bites on the head, neck, arm and leg (P_2-P_5), were obtained from Mara Region government hospital records (1993-1998). For patients bitten at multiple sites, the bite wound was classified according to the site of highest risk.

The proportion of people bitten on the head, neck, arm and leg developing rabies (P_6-P_9), was guided by data from published literature, which indicated that, if left untreated, 30-60% of people bitten on the head, face or neck would develop rabies, whereas the expected mortality following bites to the hand was 15-40%, and 0-10% following bites to the trunk and leg (Babès 1912; Fishbein, 1991).

The proportion of bite victims receiving post-exposure treatment (P_{10}), was determined from hospital records within the Mara Region from 1993 to 1997. Data from 1998 and 1999 were excluded from the analysis because additional human vaccine was provided by research projects and was thus not representative of the situation in Tanzania as a whole. To be conservative in our estimate of human

deaths, we assumed that any patient receiving PET would not develop rabies, regardless of the number of vaccine doses received or the interval between the bite injury and start of treatment.

Figure 7: Decision tree for determining probability of rabies death following the bite of a suspect rabid dog. Probabilities $P_1 \ldots P_{10}$ are defined in Table 1.



To estimate the population at risk when calculating incidence figures, population projections were estimated from 1988 government census data and published population growth rates (Bureau of Statistics, 1988).

If the incidence of suspected rabid dog bites per 100000 per year is i and the population at risk is Q, then the total number of deaths due to rabies per year is simply calculated as $\frac{(i \times Q \times P_{Death})}{100000}$.

The total number of rabies deaths per year was calculated using projected 1998 population figures (i.e. Q=30.9 million). We estimated confidence limits for the total number of deaths due to rabies by attaching probability distributions to the input parameters (i and P_1 ... P_{10}, see Table 1) and running Monte Carlo simulations using Palisade @RISK software (Windows Version 1.0, Palisade 1997) for

3000 iterations. At each iteration, the value of each input parameter was chosen at random from within the defined probability distribution. The mean and range within which 95% of the total rabies mortality estimates fell were recorded using the suspected rabid dog bite incidence values from both the national statistics and active surveillance study.

3 RESULTS.

3.1 Incidence of dog bite injuries.

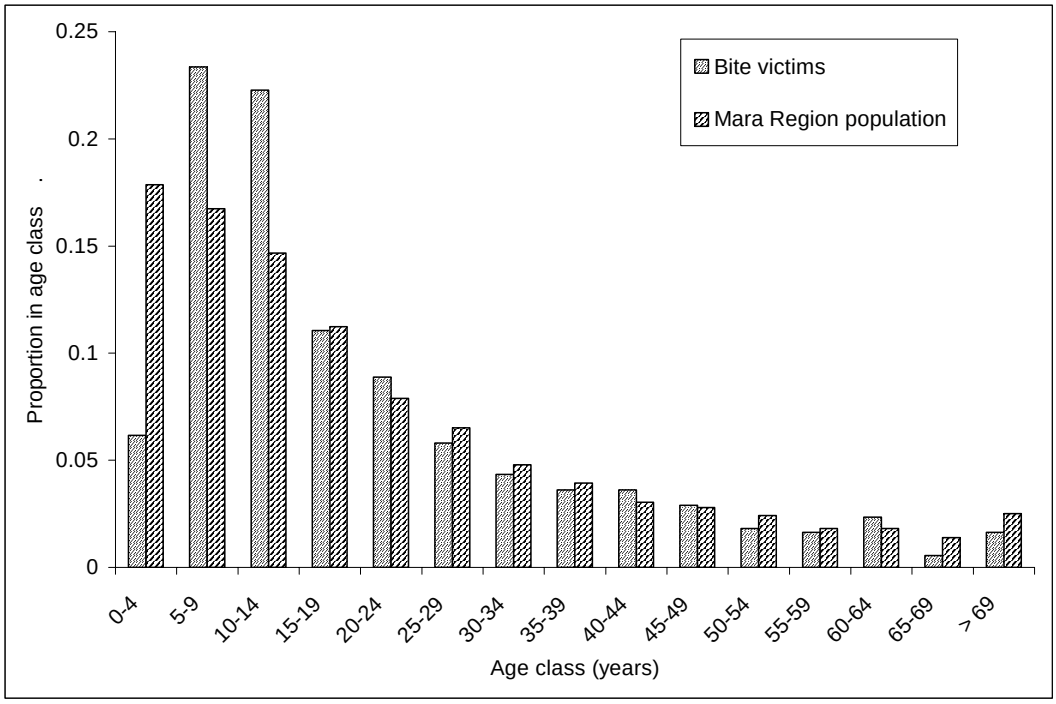
3.1.1 National statistics.

Between 1990 and 1996 a total of 23709 bite injuries were reported from suspect rabid animals in Tanzania, giving a mean of 3387 (1779 – 4994) cases per year. The mean annual bite incidence was 12.5 (6.7-18.3) cases /100000.

3.1.2 Mara region.

Within the Mara region, the vast majority of bites reported to district hospitals were inflicted by dogs (96.6%, n=964). Where the status of the dog was recorded, 685/914 dogs (74.9%) were classified as suspect rabies cases. The age distribution of bite victims differed significantly from the Mara Region population as a whole (χ^2 = 103.4, d.f. = 14, p<0.001) with a greater proportion of children in the 5-15 year age classes bitten by suspect rabid dogs (Fig. 2). Within the active surveillance area, which covered a total human population of 81725, an average of 84.9 (41.0 – 128.9) suspected rabid dog bites per year were recorded, corresponding to an annual incidence of 103.9 (50.1 – 157.7) bite injuries/100000.

Figure 8: Age distribution of patients bitten by suspect rabid dogs (n = 615) in relation to the Mara Region population as a whole (n= 970942).



Rabies recognition probability (P_1).

Within the active surveillance areas, 25 samples were submitted for laboratory diagnosis from dogs defined as suspect rabies cases. Of these, 17 (68.0%) were confirmed positive by immunofluorescence (FAT).

Distribution of bite injuries (P_2-P_5).

Bite injuries were reported more frequently on the head and hands, and less frequently on the legs of people bitten by suspect rabid dogs than those bitten by non-suspect rabid dogs (χ^2 = 32.7, df=3, p<0.001). For this analysis, we therefore used the distribution of bite injuries from suspect rabid dogs only, which is shown in Table 1.

Table 9: Probability distributions of parameters used in the Monte Carlo simulations.

Variable	Estimate
A. Suspected Rabid Dog Bite Incidence, I	
National incidence of suspected rabid dog bites per 100000 per year	Triangular: min=6.7, mode= 12.5, max=18.3
Number of bites injuries per year in active surveillance areas, N	Poisson: mean=84.9
Average population at risk in active surveillance areas, R	Point estimate: 81725
[2]The annual incidence per 100000 of suspected rabid dog bites in the active surveillance area is calculated as 100000xN/R	

Variable	Estimate
B. Probability Tree Parameters, P1..P10	
P1 Suspected rabid dog being rabid	Binomial: p=0.680, n=25
P2 Bite injury to the head	Point estimate: 0.070 (22/315)
P3 Bite injury to the arms	Point estimate: 0.384 (121/315)
P4 Bite injury to the trunk	Point estimate: 0.060 (19/315)
P5 Bite injury to the legs	Point estimate: 0.486 (153/315)
P6 Developing rabies following bite injury to the head	Triangular: min=0.3, mode=0.45, max=0.6
P7 Developing rabies following bite injury to the arms	Triangular: min=0.275, mode=0.15, max=0.4
P8 Developing rabies following bite injury to the trunk	Triangular: min=0.05, mode=0.0, max=0.1
P9 Developing rabies following bite injury to the leg	Triangular: min=0.05, mode=0.0, max=0.1
P10 Probability of receiving PET if bitten by a suspected rabid dog	Binomial: p=0.563 n=487

Post-exposure treatment (P_{10}).

At least one dose of post-exposure rabies vaccine was given to 274/487 (56.3%) patients reporting with bites from suspect rabid dogs. The interval between bite injury and presentation for treatment ranged from 0 to171 days (median = 3 days).

Human rabies deaths.

From 1990-1996, the mean number of officially reported rabies deaths was 10.8 (7.7 – 14.0) per year, corresponding to an average incidence of 0.041 (0.028 – 0.053) deaths/100,000 per year.

Predicted Human rabies deaths.

Extrapolating bite incidence data from active surveillance areas to the whole of Tanzania, 1499 (891 – 2238) human rabies deaths were predicted per year, equivalent to an annual incidence of 4.9 (2.88-

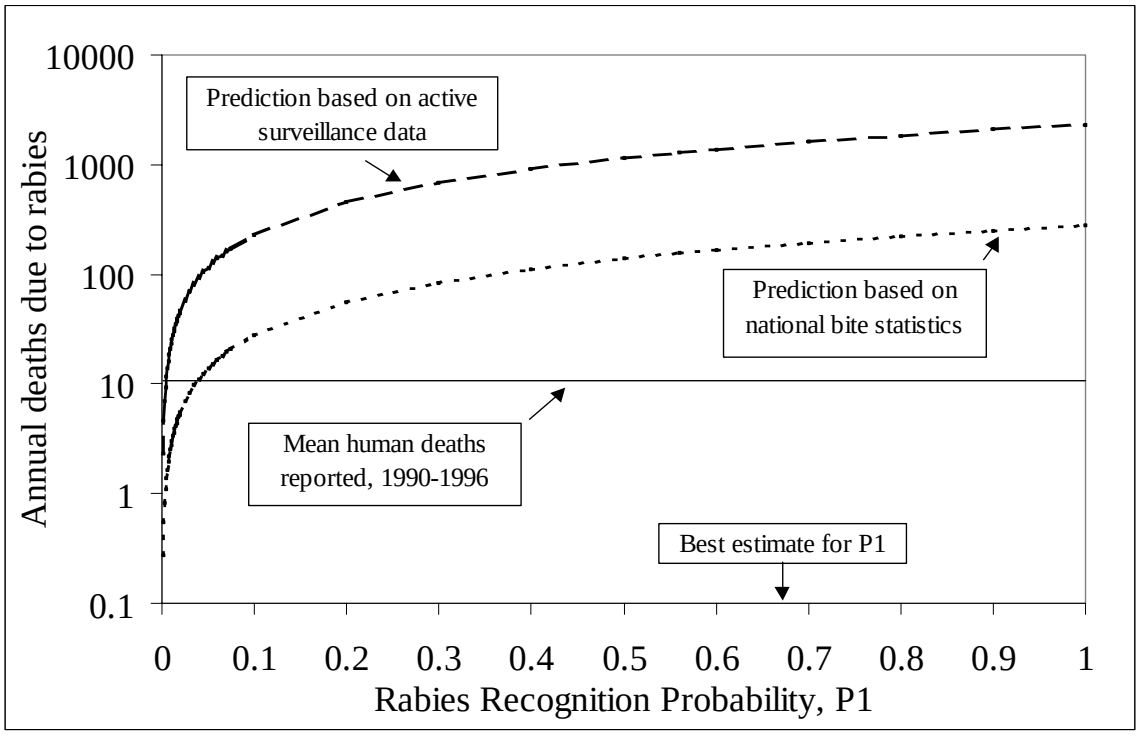
7.24) deaths/100000. The value of P1 for which the estimated number of deaths was equal to the official number recorded was 0.006 (0.003-0.010) (Fig. 3). The distribution of predicted deaths by age class is shown in Table 2. Predicted rabies deaths were highest in the 5-15 year age classes.

Table 10: Age distribution of predicted rabies deaths using active surveillance and official bite-incidence data.

Age class	Predicted rabies mortality using active surveillance bite incidence data Deaths/100,000	Predicted rabies mortality using official national bite incidence data Deaths/100,000
0 – 4 years	3.23 (2.01-4.73)	0.42 (0.07-0.87)
5 – 9 years	7.23 (4.44-10.63)	0.93 (0.16-1.97)
10 – 14 years	7.36 (4.24-11.34)	0.95 (0.16-2.05)
> 15 years	3.92 (2.30-5.98)	0.50 (0.08-1.08)
ALL	4.85 (2.88-7.24)	0.62 (0.10-1.32)

Using national bite statistics, the estimated annual mortality due to rabies was 193 deaths (32 - 409). This is equivalent to an annual incidence of 0.62 (0.1-1.32) deaths/100,000. The value of P_1 for which the estimated number of deaths was equal to the mean official number recorded was 0.119 (0.019 – 0.26) (Fig. 3).

Figure 9: Predicted annual human rabies deaths in Tanzania in relation to rabies recognition probability, P_1, and the actual number of deaths officially recorded.



4 DISCUSSION.

The results of this study highlight two key issues. First, rabies is a significant public health problem in Tanzania, with the predicted incidence of human rabies using active surveillance bite-incidence data (4.9 deaths/100000) up to 100 times greater than officially recorded. Second, dog bite records provide an accessible and valuable source of epidemiological data that have generally been under-exploited.

Although these estimates of human mortality are much higher than incidence figures derived from government data, the predicted incidence is similar to that reported by Kitala *et al.* (2.5 rabies deaths/100000) during active-surveillance studies in Machakos District, Kenya (Kitala *et al.*, 2000).

The validity of these indirect estimates of human rabies mortality depends upon two key assumptions. The first assumption, which applies to both estimates, is that the proportion of untreated people dying in Tanzania following a bite to the head, hand, trunk and limbs is similar to that reported in Europe and Asia previously. The second assumption, which applies only to estimates from active surveillance studies, is that data from the Mara Region is representative of Tanzania as a whole. Regarding the development of clinical rabies, factors such as wound severity, the proportion of rabid dogs excreting virus, and virus pathogenicity have the potential to influence the outcome of exposure (Fishbein, 1991). As hospital records in this study provided insufficient data on severity of wounds, we assumed here that all reported bites involved penetration of the skin, and were not superficial scratches or licks, which would carry a lower risk. With respect to salivary virus excretion, field data are very limited. However, salivary gland samples collected from four rabid dogs in this study were all antigen positive on FAT. While it is not possible to determine if virus strain differences influence the proportion of humans who develop rabies after exposure, there is currently no evidence that the Africa-1b 'canid' strain of rabies isolated from Tanzanian dogs (Bourhy *et al.*, 1993) is less pathogenic than other dog isolates.

We clearly need to be cautious about extrapolating Mara region animal-bite incidence data to the whole of Tanzania. Although rabies is reported throughout the country, patterns of infection are likely to vary between regions. Cultural and religious factors may influence patterns of dog ownership and knowledge of rabies, which may in turn affect patterns of disease, recognition of rabies in local communities, and the probability of seeking PET at hospitals (Laurenson *et al.*, this volume(a); Godlonton, this volume). Nonetheless, the human population density and land-use characteristics of the Mara Region are broadly typical of rural Tanzania, where 81% of the population live (Bureau of Statistics, 1991). Furthermore, Mara region annual animal-bite incidence figures are comparable to those reported in similar areas of rural Kenya (234 bites/100000) (Kitala *et al.*, 2000).

Even without extrapolating across regions (i.e. when using national bite injury statistics), the predicted incidence of human rabies (0.62 deaths/100000) was 10 times higher than officially reported. The number of official cases would only exceed the predicted number of human deaths if fewer than 12% of suspect rabid dogs were truly rabid, a level well below that recorded here (68%), and from other studies in Kenya (51-58%) (Chong, 1993; Kitala *et al.*, 2000), Swaziland (50%) (Dlamini and Mathunjwa, 1995) and Zimbabwe (36%) (Foggin, 1988).

Our prediction that rabies mortality is highest in children is consistent with the age-distribution of cases reported in other parts of Africa (Fekadu, 1982, Ayalew, 1985) and elsewhere in the world (Tierkel, 1959; Fishbein *et al.*, 1991). A high proportion of childhood deaths increases the number of disability-adjusted life years (DALYs) lost, and therefore the public health burden of a disease (Murray, 1994). Although rabies was not included in the first global burden of disease survey (Murray and Lopez, 1996) (an indication, perhaps, that it is considered a relatively insignificant human disease), recent global DALY estimates for rabies rank the disease 86th in terms of public health burden (Fèvre *et al.*, 1999). Although the figure is undoubtedly a low estimate, as it was based on a global average of officially-reported cases (34000 cases/year), this places rabies above diseases such as onchocerciasis, Dengue fever and Chagas disease, which often attract considerable greater attention (e.g. WHO,1999)

The public health burden of rabies is not limited to mortality or DALYs lost to disease, and a number of additional arguments speak for increasing the resources available for rabies control (Wandeler, 1997). High costs of human PET exert a major economic burden on public health budgets (Bögel and Meslin, 1990; Meslin *et al.*, 1994; Meslin, 1994) and fear of the disease causes considerable psychological trauma within communities. Human rabies is an entirely preventable disease, through appropriate PET or through vaccination of reservoir hosts. However, no successful national rabies control programmes have been implemented in Africa over the past two decades. The reasons for these failures are manifold (Cleaveland, 1998). A lack of awareness of the magnitude of the rabies problem and a lack of data on epidemiological trends serve only to compound these difficulties, hampering the development of disease control initiatives.

This study demonstrates that bite injury data provide a useful and accessible source of epidemiological data that could be used effectively to enhance rabies surveillance in human and animal popula-

tions, detect trends in disease incidence, improve allocation of medical and veterinary resources, and assess the impacts of rabies control measures.

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REFERENCES.

AYALEW, Y. – 1985 - Analysis of 159 human rabies cases in Ethiopia. *In:* Rabies in the tropics, (Kuwert E et al., editors) Berlin, Springer-Verlag, 1985: 481-484.

BABES V. – 1912 - Traité de la rage. Paris, Baillière et Fils, 1912. Cited in Baer GM, Bellini WJ, Fishbein DB. Rhabdoviruses. *In*: Virology. 2nd ed. (Fields BN et al., editors), New York, Raven Press, 1990: 883-930.

BALTAZARD M., GHODSSI M. – 1954 - Prevention of human rabies: treatment of persons bitten by rabid wolves in Iran. *Bulletin of the World Health Organization*, **10**, 797-802.

BALTAZARD M., BAHMANYAR M. – 1955 - Essai pratique du sérum antirabique chez les mordus par loups enragés. *Bulletin of the World Health Organization*, **13**, 747-72.

BÖGEL K., MESLIN F.X. – 1990 - Economics of human and canine rabies elimination: guidelines for programme orientation. *Bulletin of the World Health Organization*, **68**, 281-91.

BOURHY H, KISSI B, TORDO N. – 1993 - Taxonomy and evolutionary studies on Lyssaviruses with special reference to Africa. *Onderstepoort Journal of Veterinary Research*, **60**, 277-82.

BUREAU OF STATISTICS. – 1991 - Tanzania Sensa 1988. Dar es Salaam: President's Office, Planning Commission, Tanzania.

CHONG WK. – 1993 - Rabies in Kenya. *In*: Proceedings of the Southern and Eastern African Rabies Group International Symposium, 29-30 April 1993, Pietermaritzburg, South Africa, 57-67.

CLEAVELAND S. – 1998 - The growing problem of rabies in Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **92**, 131-4.

CLEAVELAND S., KING A., KAARE M. AND LUWONGO S. - 1999 - Rabies surveillance in the Mara Region, Tanzania. *In*: Proceedings of the Southern and Eastern African Rabies Group/World Health Organization Meeting, (Ruebarika *et al.* editors), 29-31 March 1999, Entebbe, Uganda, Lyon, Editions Fondation Merieux, 69-78.

DLAMINI R.X., MATHUNJWA L.D. – 1995 - Rabies in Swaziland. *In*: Proceedings of the 3rd International Conference of the Southern and Eastern African Rabies Group, (Bingham J. *et al.*, editors), 7-9 March, 1995, Harare, Zimbabwe, 58-60.

FAO/IFAD – 1995 - Mara Region Farmers' Initiative Project. Formulation Report. Rome, Food and Agriculture Organization, 4-15.

FEKADU M. – 1982 - Rabies in Ethiopia. *American Journal of Epidemiology*, **115**: 266-273.

FEKADU M. – 1997 - Human rabies surveillance and control in Ethiopia. *In:* Proceedings of the 4th International Conference of the Southern and Eastern African Rabies Group, (Kitala P, Perry P,

Barrat J, King A, editors), 4-6 March, 1997. Nairobi, Kenya, Southern and Eastern African Rabies Group, 77-78.

FÈVRE E.M., COLEMAN P.G., CLEAVELAND S. – 1999 - The disability-adjusted life year (DALY) and rabies. *In:* Proceedings of the Southern and Eastern African Rabies Group/World Health Organization Meeting, (Ruebarika *et al.* editors), 29-31 March 1999, Entebbe, Uganda, Lyon, Editions Fondation Merieux, 134-138.

FISHBEIN D.B. – 1991 - Rabies in Humans. *In*: The Natural History of Rabies (Baer GM. Editor). 2nd ed. Boca Raton, CRC Press, 1991: 519-49.

FISHBEIN D.B., MIRANDA N.J., MERILL P., CAMBA R.A., MELTZER M., CARLOS E.T., BAUTISTA C.F., SOPUNGCO P.V., MANGAHAS L.C., HERNANDEZ L.M., LEONCIO M.M., MERCADO D., GREGORIO S., SALVAE., DOBBINS J.G. AND WINKLER W.G. – 1991 - Rabies control in the Republic of the Philippines: benefits and costs of elimination. *Vaccine*, **9**, 581-587.

FOGGIN C.M. – 1988 - Rabies and rabies-related viruses in Zimbabwe: historical, virological and ecological aspects [PhD Thesis]. Harare,University of Zimbabwe, 261pp.

GODLONTON J. This volume…

KAPLAN M.M., KOPROWSKI H. – 1973 - La rage – techniques de laboratoire. 3rd ed. Geneva, World Health Organization, 65-87.

KITALA P.M., MCDERMOTT J.J., KYULE M.N. AND GATHUMA J.M. – 2000 - Community-based active surveillance for rabies in Machakos District, Kenya, *Preventive Veterinary Medicine*, **44**, 73-85.

LAURENSON M.K. *et al.* This volume.

MESLIN F.X. – 1994 - The economic burden of rabies in developing countries: costs and benefits from dog rabies elimination. *Kenya Veterinarian*, **18**, 523-527.

MESLIN F.X., FISHBEIN D.B., MATTER H.C. – 1994 - Rationale and prospects for rabies elimination in developing countries. *In*: Lyssaviruses (Rupprecht CE, Dietzschold B, Koprowski H, editors), Berlin, Springer Verlag, 1994: 1-26.

MINISTRY OF AGRICULTURE AND CO-OPERATIVES. – 1997 - Report on human rabies and dog bite injuries. Dar es Salaam: Ministry of Agriculture and Co-operatives, Tanzania.

MINISTRY OF HEALTH. – 1997 - Rabies in Tanzania. Dar es Salaam: Ministry of Health, Tanzania.

MURRAY C.J.L. – 1994 - Quantifying the burden of disease: the technical basis for DALYs. *Bulletin of the World Health Organization*, **72**, 429-445.

MURRAY C.J.L., LOPEZ A.D. – 1996 - The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020. Harvard University Press, 1996.

SHAH U., JASWAL G.S. – 1976 - Victims of a rabid wolf in India: effect of severity and location of bites on development of rabies. *Journal of Infectious Diseases*, **134**, 25-29.

SITTHI-AMORN C., JIRATANAVATTANA V., KEOYOO J. AND SONPUNYA N. – 1987 - The diagnostic properties of laboratory tests for rabies. *International Journal of Epidemiology*, **16,** 602-605.

TIERKEL E.S. – 1959 - Rabies. *Advances in Veterinary Science and Comparative Veterinary Medicine*, **5**,183-226.

WANDELER A.I. – 1997 - Human rabies diagnosis and reporting: can we do better? *In*: Proceedings of the 4th International Conference of the Southern and Eastern African Rabies Group, (Kitala P, Perry P, Barrat J, King A, editors), 4-6 March, 1997. Nairobi, Kenya, Southern and Eastern African Rabies Group, 60-63.

WARRELL D.A., WARRELL M.J. – 1988 - Human rabies and its prevention: an overview. *Reviews of Infectious Diseases*, **10**, Supplement 4, S726-731.

WORLD HEALTH ORGANIZATION. – 1994 - World Survey of Rabies No. 28 for the Year 1992. WHO/EMC/ZOO/94.1. Geneva, World Health Organization.

WORLD HEALTH ORGANIZATION. – 1996 - World Survey of Rabies No. 29 for the Year 1993. WHO/EMC/ZOO/96.2. Geneva, World Health Organization.

WORLD HEALTH ORGANIZATION. – 1998 - World Survey of Rabies No. 32 for the Year 1996. WHO/EMC/ZDI/98.4. Geneva, World Health Organization.

WORLD HEALTH ORGANIZATION. – 1999 - Removing Obstacles to Healthy Development: Report on Infectious Diseases. WHO/CDS/99.1. Geneva, World Health Organization.

PERCEPTION AND KNOWLEDGE ABOUT RABIES

K.K.I.M. de Balogh [1], E.H. Frumau [1] and C. Hankanga [2]

1 INTRODUCTION.

Reliable data on rabies are scarce in many areas of the globe. However, this data is needed to understand the epidemiology of the disease and to assess its impact on the human and animal populations (Internet address: http://www.who.int/inf-fs/en/fact099.html). In addition, this information is an essential tool to obtain the necessary commitment and backing from national authorities for the implementation of preventive and control measures.

In Africa, in view of the extent of human diseases such as AIDS and malaria and the presence of animal diseases with large economic impact (e.g. Foot and Mouth Disease, CBPP), governments are using up their often scarce resources for these priority areas, leaving hardly any means for rabies control. Although difficult to measure, the impact of rabies with regard to anxiety caused in the general population due to insufficient availability and high costs of rabies post-exposure treatment and the lack of control measures should not be underestimated.

Nowadays, the constraints to an effective dog rabies control are economic and logistical rather than technical (Perry, 1993). Lack of understanding the seriousness of rabies by the authorities combined with insufficient allocation of resources and inadequate managerial capabilities hamper the successful control of this disease. With regard to Southern Africa, dog-ecology studies have demonstrated that the dog:human ratio is much lower, compared to this ratio in Latin-America and Asia (de Balogh *et al.*, 1993). Further it has been demonstrated, that with relatively scarce resources, effective vaccination campaigns against rabies can be organized (de Balogh, 1995). However, government commitment is crucial for the successful control of rabies in a country. An adequate surveillance and reporting system and the presence of well functioning diagnostic facilities are pre-requisites for the generation of reliable data. Samples of suspected rabies cases from the field need to be correctly collected and stored for their prompt transportation to the diagnostic laboratories. In turn, rapid feed-back of the results of submitted samples need to trigger the implementation of adequate control measures. For this, a functioning infrastructure, dedicated personnel as well as community support is required.

2 THE STUDIES.

Beside government commitment, the involvement of the community is crucial for the successful implementation of rabies control measures. So far there appeared to be a lack of information on rabies exposure, knowledge of the general population about this disease as well as usefulness of different public education methodologies. Therefore, a number of studies were initiated. The presented data are a compilation of the results obtained from studies related to rabies conducted between 1992-2001 at the veterinary faculties in Lusaka (Zambia) and Maputo (Mozambique). Data on rabies samples submitted to the two main rabies diagnostic laboratories in Zambia and on dog-bite cases at the main hospital in Lusaka and Maputo were analysed. Surveys were conducted in Lusaka and Maputo to obtain information on dog-keeping practices and to assess the knowledge about rabies of the persons interviewed.

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2.1 Data on rabies diagnosis in Zambia.

Data on rabies diagnosis in Zambia between 1995-2000 were obtained from the laboratories of the School of Veterinary Medicine, University of Zambia (UNZA) and the Central Veterinary Research Institute(CVRI), Balmoral , Zambia. Both laboratories are located in the Lusaka Province. The data from each sample included the species, clinical history, eventual human contact, result of the test and the province the samples originated from. The data from the CVRI and of the UNZA are presented in graph 1 and 2 respectively.

In the period of study, a total of 426 samples had been sent from the different provinces to the Central Veterinary Research Institute, (CVRI). The laboratory of the School of Veterinary Medicine of the University of Zambia had received 283 samples for rabies diagnosis originating mainly from the capital Lusaka and its surroundings. At CVRI 191 (45%) and 110 (39%) at the UNZA were found positive for rabies. Ninety percent of the samples submitted at both laboratories were from dogs. Other samples originated from bovines, caprines, monkeys, felines, rat, mice, jackals and a zebra. A total of 7 human samples were send to the CVRI in the period studied.

In 1995, 3 human samples from the Copperbelt were received and two of them found positive for rabies. In 1998, one sample originating from a human case from Western Province, was also found positive. In 1999, 3 samples were sent in from the Copperbelt and they were all positive.

Figure 1: Number of samples submitted for rabies diagnosis between 1995-2000 to the Central Veterinary Laboratory (CVRI), Balmoral, Zambia

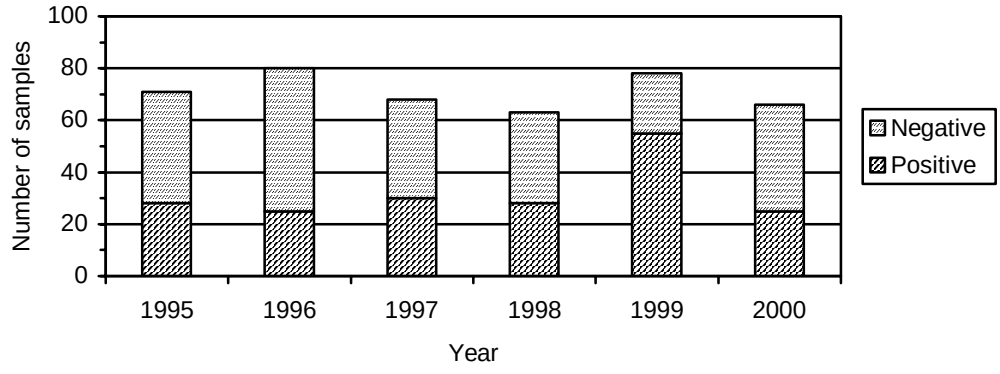
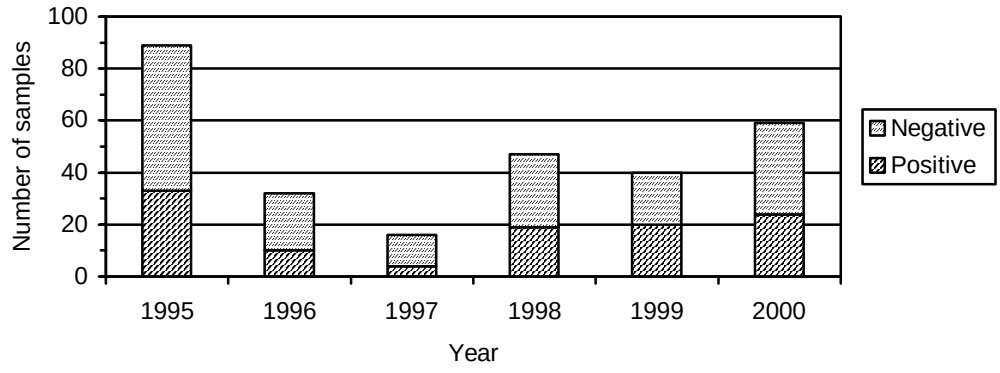


Figure 2: Number of samples submitted for rabies diagnosis between 1995-2000 to the School of Veterinary Medicine, UNZA, Lusaka, Zambia



The samples sent to the CVRI, originated from several provinces of Zambia. Frequently, 3 or 4 samples collected at different dates but originating from one province arrived together at the laboratory, indicating that not all the samples were submitted for diagnosis immediately after collection.

Most of the samples sent to the CVRI originated from the Copperbelt, Lusaka, Central and Southern Province. The Northern, Western, North-Western, Luapula and the Eastern Province are further away from the capital and transportation is not readily available. This might have lowered the number of samples reaching the CVRI from these areas.

The risk of human exposure is associated with canine rabies. Most dogs are kept at human habitations mainly for security reasons (Hayles *et al.*, 1977). From the clinical history accompanying the submitted sample the minimum number of persons in contact with a suspected rabid dog was calculated. In some cases, it was only indicated that there had been human contact. In these cases, the number of persons having come in contact with the suspected dog was counted as one. Therefore, Table 1 only shows the minimum number of human contacts a positive or negative dog had. No information on the follow up of the humans involved was provided.

Table 1: Minimum number of persons in contact with dogs submitted for rabies diagnosis to CVRI and UNZA laboratories in Zambia between 1995-2000.

	CVRI	**UNZA**
Minimum human contacts	227	29
Rabies positive dogs	167	86
	4:1	0.3:1
Minimum human contacts	134	26
Rabies negative dogs	201	134
	0.6:1	0.2:1

Table 1 shows, that dogs found positive for rabies at CVRI had more human contacts compared to the positive dogs that were submitted to the UNZA. This could be explained by the fact that samples are submitted more on a routine basis to UNZA and often originate from animals that had been taken to the University small animal hospital. The samples submitted to the CVRI on the other hand, came from all over the country. Apparently samples from animals where there had been a human contact were more readily sent to the Central Laboratory than if there had been no direct risk for humans.

2.2 Dog-bites reported to main hospitals.

Studies conducted at the main hospitals in Lusaka (population: approx. 1 million), Zambia and Maputo (population: 1.5 million), Mozambique in the 1990's indicated that approximately 1000 dog-bites were reported to these institutions on a yearly basis (de Balogh, 1996). In Lusaka, the data on humans exposed to dog-bites were registered in a poorly kept note book and the absence of specific pre-printed forms reduced the accuracy of the data. In Maputo, the forms did not include a breakdown by sex. For both capitals, the group above 20 years appeared to be most often bitten. In Lusaka for the year 1992, 40% of the patients with bite wounds reporting to the University teaching hospital were adult males followed by 26% of male children. Adult women only accounted for 15%. It was mentioned that most men were bitten at night when dogs are most aggressive. Male children often are bitten when playing or teasing dogs. No data on the age distribution of rabies victims could be traced. Studies, especially conducted in South Africa and Latin America show that children account for the largest percentage of human rabies cases as bites are often inflicted in the head or neck areas (Acha and Arambulo, 1985 ; Godlonton, 1997).

In Maputo and Lusaka most persons reporting to the main hospital lived in the poorer areas of town. It is not clear, if persons bitten in the higher income areas would be significantly lower or they would primarily seek medical assistance from a private clinic. In Lusaka, 80% of the dog-bites reported to the hospital had been caused by unvaccinated dogs or by dogs with an unknown vaccination. Unfortunately, the registration at the hospital did not contain any information on the treatment initiated at the hospital after a dog-bite (de Balogh,1996).

2.3 Procedures after a dog-bite.

In Zambia, when a dog bites a person, the owner of the dog is held responsible for the expenses of the necessary treatments, if there is no proof that the dog involved had been vaccinated against rabies. In 2001, the human post-exposure vaccine was only available at private dispensaries in the capital at a prohibitive cost for most persons.

For 1995, the information obtained in Maputo indicated that out of 981 persons bitten only 43 (5%) had received post-exposure treatment for rabies (PET). It was mentioned, that the Ministry of Health in Mozambique had only received 100 courses of P.E.T. for the whole country for that year. This amount was largely insufficient to give adequate protection to persons in contact with potentially rabid animals. The treatment at the hospital mainly had consisted of wound dressing and in some cases of anti-tetanus injections.

2.4 Questionnaire surveys conducted in Maputo and Lusaka.

In 1996, 300 persons were interviewed at the three main market places in Maputo. Information on their area of residence, type of housing, household size, reasons for keeping dogs, number of dogs kept as well as dog-keeping practices and their general knowledge about rabies was obtained. In Lusaka, a similar questionnaire survey was conducted in 2001 by door-to-door visits. A total of 181 households keeping dogs in 3 urban and 2 peri-urban areas of Lusaka were interviewed.

2.4.1 What happens after a person has been bitten by a dog?

In the Lusaka survey it was noticed that although 75% of the persons interviewed that keep dogs had heard of rabies and knew that rabies is a killer disease, only half of these persons knew that the disease could be transmitted through a dog-bite. When the persons were asked what should be done if somebody gets bitten by a dog, 83% were to go to a hospital and 6% to the police. Less than 3% of the persons interviewed in Zambia indicated that they would wash out the wound after having been bitten by a dog. For Maputo the general knowledge about rabies was rather low as 44% of the persons interviewed during the 1996 survey did not know what rabies was or had erroneous concepts about the disease (34% did not know that rabies is a fatal disease). The Portuguese term for rabies is “raiva” and is also commonly used as a synonym for “anger” and “to be angry”. This could have led to not associating “raiva” with the actual disease rabies. In several cases, rabies was defined as venom transmissible through a dog-bite, comparable to snakebite. This could explain why persons indicated the placing of a tourniquet near the lesion as the way to treat a dog-bite. One person claimed to know a traditional healer able to cure rabies and snakebites. Similar as in Lusaka, 88% of the persons interviewed indicated that they would go to a health centre after a dog-bite. Less than 5% of persons however, would apply some kind of wound-treatment, varying from washing with water and soap to washing with boiled water and salt, or by using iodine or hydrogen peroxide. On the contrary, in a similar study conducted in Cuba in 2001, 55% of the interviewed persons (n=381) indicated the importance of washing a wound after a dog-bite (Veenstra, 2001). On a few occasions in Zambia as well as in Mozambique, the application of burned hair of the involved dog on the inflicted wound was mentioned as a way to prevent the person of getting rabies. So far, it has not been possible to find out the rationale behind this procedure.

It is recognized, that washing the wound under running water with soap is the most effective first aid treatment against rabies available (http://www.who.int/inf-fs/en/fact099.html). In view of the high costs of PET in Africa and its availability only at a few (private) clinics, washing the wound with soap clearly needs to be given much more attention as a way to reduce the risk of developing rabies. It should therefore be an integrated part of public education programmes for rabies.

2.4.2 Public education.

Children, especially boys appear to be the group most at risk of contracting rabies due to their close contact with animals, the site of the bite wounds (near the head) and their dependence on adults to

take them to a health centre. In addition, it is also the group that most often takes the dogs to the vaccination point. Therefore, they are a very important target group for public education campaigns with regard to rabies prevention and control. So far, women have not been considered as a specific target group for rabies information campaigns. However, as they would play an important role especially in taking care of a child after a dog-bite, specific information especially regarding first aid wound treatment and the need for taking the person bitten to a clinic should be targeted to women. Their role in rabies prevention should not be neglected. The message (contents, language) as well as its delivery method, need to be adapted accordingly. More research in this area could therefore provide valuable information on the most effective methods for reaching this target group.

In Maputo, through interviews it was attempted to obtain insight into how persons had obtained their knowledge about rabies. The results indicated that most frequently persons had received information about rabies through informal channels such as from other persons in their family or neighbourhood, at the market or at other informal gatherings. In second place persons mentioned that they had obtained their knowledge about rabies through schools and in third place through the radio. The use of TV for the dissemination of information about rabies appears to be much more limited in Africa when compared to especially the low-income urban areas of Latin America and Asia where TV sets can be found in almost every household. For Maputo, a large portion of the urban population can be reached through TV messages transmitted during the commercial breaks of the very popular "tele-novelas" (mostly Brazilian and Portuguese soap-operas). Although there are only a limited number of TV sets in the poorer areas of the city, it is common that the owners charge a small fee to the neighbours to see the programme. Even many children watch these tele-novelas shown between 20:00 and 21:00 hours and can therefore be reached via this medium. The experiences obtained in South Africa by using popular programmes as “Soul-city” to transmit public education messages could also be further explored.

Posters had a much lesser effect than expected as they were frequently removed. It was mentioned that persons take the posters to decorate their homes. For the poorer urban areas, transmissions of messages with cars through megaphones appear to be very suitable. However, special attention needs to be paid to its timing, the formulation of clear messages also in local languages as well as to the quality of the sound equipment used.

As mentioned before, schools are considered to be very good distribution points for information about rabies and rabies campaigns, reaching especially the young children who most often bring the dogs for vaccination. The designing of comprehensive educational programmes with clear instructions for the teachers could become part of the school curriculum and certainly contribute to the understanding and participation in rabies control.

Churches and other gatherings (political) could also be used to inform persons about rabies and a possible vaccination campaign.

Eventually, drawing competitions for schools to make the best poster or design the logo for the campaign could be organised. Depending on the available budget, other means such as printing and distribution of T-shirts, pens and stickers with the logo of the campaign or of schoolbooks and writing pads with additional information about the disease could also be explored. Videos and specific “rabies (rap) songs” could further enable children to remember key points about rabies (Dandoy and Scanlon, 1999).

Rabies control programmes in Malawi reported positive experiences with songs and theatre as part of the rabies awareness campaign (Personal communication).

3 CONCLUSION.

Rabies cases are generally underreported and only a small number of samples are submitted to diagnostic laboratories. Social and economic impact studies of rabies in Africa could shed light on the burden this disease represents on African societies. Lack of reliable data has direct consequences on the commitment and allocation of resources from governments to rabies control. There is an urgent need to improve the surveillance of diseases like rabies through an efficient reporting system, improvement of the infrastructure for the submission of samples and putting in place reliable diagnostic procedures. Furthermore, clear protocols for dog-bites and the availability of anti-rabies vaccine for animals as well as human pre- and post- exposure treatment are imperative as to drastically reduce the number of

rabies cases. Although the need for good co-operation between medical and veterinary personnel involved in rabies control has been recognised, this has only been realised in few countries.

Efficient rabies vaccination campaigns accompanied by effective public education are the key to the success of any rabies control programme. From the studies conducted in Zambia and Mozambique there is an urgent need to inform the public adequately about the disease in general, its transmission routes and way to reduce the risk of rabies. For public education about rabies the medium and the message have to be fine-tuned depending on the specific target groups. Children can best be reached through schools. Songs and theatre are powerful media to educate them about the dangers of the disease and the need for bringing dogs for vaccination. So far, women appear to have been a neglected target group for rabies education. They specially need to be informed about the first aid treatment after a bite-wound as this could already significantly reduce the risk of rabies. In view of the limited resources available for rabies programmes, public information messages could be combined with other health educational programmes especially those involving women and children. Therefore, by joining forces, sharing resources in combination with creative solutions, much progress could be achieved in the prevention and control of rabies in Africa.

REFERENCES:

http://www.who.int/inf-fs/en/fact099.html

PERRY B.D. – 1993 - Dog ecology in eastern and southern Africa: implications for rabies control. *Onderstepoort Journal of Veterinary Research*, **60**, 429-436.

BALOGH K.K.I.M. DE, WANDELER A.I. AND MESLIN F.-X. – 1993 - A dog ecology study in an urban and a semi-urban area of Zambia. *Onderstepoort Journal of Veterinary Research*, **60**, 437-443.

BALOGH K.K.I.M. DE – 1995 – Two-day rabies vaccination campaign: a sustainable intervention? *In* Proceedings of the Southern and Eastern African rabies group/WHO meeting, Harare, Zimbabwe p. 125-133.

HAYLES L.B., SAWUCHUK A.M., AKAFEKWA G.I., AWAN M.A.Q. – 1977 - Observations on the epizootiology of rabies in Zambia. 1970-1974 *Bull. Anim. Hlth. Prod. Afr.*, **25**, 9-15

BALOGH K.K.I.M. DE, - 1996 - Urban rabies: risks and control measures in Southern Africa. *In* 7th Symposium on Tropical Animal Health and Production, 27 September 1996, Utrecht, the Netherlands, p.41-47.

ACHA P.N. AND ARAMBULO III P.V. – 1985 - Rabies in the Tropics-History and Current Status. *In* Rabies in the Tropics 1985 ed. By Kuwert E., Merieux C, Koprowski H, Bogel K.

GODLONTON J.D. – 1997 - The management of clinical human rabies experiences from Kwazulu-Natal. *In* Proceedings of the Southern and Eastern African rabies group/WHO meeting, Nairobi, Kenya 4-6 March 1997 p.88-90

DANDOY S. AND SCANLON F. – 1999 - Teaching kids about rabies. *Amer. J. Public Health* **89**, 3, 413-414

VEENSTRA B.E. – 2001 - Rabies in Cuba. Internal Report. Faculty of Veterinary Medicine, Utrecht University, the Netherlands. p.31

AN OUTBREAK OF RABIES IN SOUTH DARFUR SUDAN

Ali Yahia Hassan[1]

During April – September 2000 a noticeable increase in the number of cases of human exposure to rabies was reported in South Darfur State. This created the need for the present study to explore rabies there. Out of 417 cases of anti-rabies treatment given in the state, 337 were reported at Nyala public pharmacy and 80 at Adiela province. A total of 10 human deaths from the disease were reported. Poor reporting system, the absence of a link between health and veterinary authorities and weak control measures were evident in the State.

Rabies was reported as one of the most serious zoonotic viral diseases in Sudan in 1904 (Anon –1, 1904-1930). The entrance of the disease to the Sudan was thought to be through West Africa to Darfur and from Eritrea and Abyssinia to the East of Sudan (El Nasri, 1963).

The role of wildlife in rabies epidemiology in Sudan was poorly studied, but Harbi (1976) reported the role of game animals in the spread of rabies in Sudan. Darfur states (North, West, and South) as most of the other states usually report rabies in humans and animals. The first report of rabies in Darfur was in 1924, while the first laboratory confirmed case was in 1926 (Anon 1904 – 1930). The number of reported rabies cases in animals as well as human exposure to the disease in Darfur states was low compared to other states of Sudan, although it is one of the richest states in animal resources (domestic and wild). This is most probably due to the poor reporting system (Anon –3, 1988 – 1998). This report records an outbreak of rabies in South Darfur State in 2000.

South Darfur State is one of the three states of Darfur, with a total area of 127300 km^2. The capital of the state is Nyala City. The state is very rich in domestic animal resources.

There is a lack of information about rabies in the state. For example recording the number of humans receiving anti-rabies vaccine in Nyala public pharmacy began in the last week of April 2000. An active surveillance has been carried out to collect data and information about this outbreak in the state through reviewing the official reports of the state ministry of health and direct contact with exposed people.

From April to September 2000, the number of humans exposed to rabies was continuously increasing. During this period a total of 337 humans received rabies post exposure treatment at Nyala public pharmacy, while a total of 80 people received the vaccine at Adiela province. There was a large discrepancy between the number of human exposures reported by the health authorities and the number of suspect animals reported by the veterinary authorities (Table 1).

Table 1: Reported rabies human exposure and animal suspected cases in South Darfur State (April – September 2000).

Month	*Human exposure to rabies	**Rabies suspected animals
April	2	6
May	36	1
June	60	3
July	68	0
August	97	1
September	74	0
Total	**337**	**11**

* Data collected from Nyala Public Pharmacy.
** Data collected from Veterinary Authorities.

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The analyses of data showed that most of 144 (42.7%) human exposures were reported in Nyala province, 41(12.2%) in Sheiria, 38 (11.3%) in Buram, 25 (7.4%) in Eddelfursan, 14 (4.2%) in Eddien, 9 (2.7%) in Adiela and 3(0.9%) in Rehied Alberdi province, within South Darfur state. Some other cases were recorded in other states (46 in North Darfur (13.6%), 11 in West Darfur (3.3 %) and 6 in West kordufan (1.8%).

Although most of the people interviewed during the survey stated that there were a large number of attacks on domestic animals by stray dogs and wild animals. (foxes and jackals), this was not reported by the veterinary authorities. During this period 9 cases were reported in Nyala (4 dogs, 3 donkeys and 2 horses) and 2 in Rehied Alberdi (1 bovine, 1 donkey) (Figure1).

The main offender animals, which may have been rabid, were dogs 309 (91.7%), followed by donkeys 12 (3.6%), durban (local name of a wild animal between the jackal and fox in size) 6 (1.8%), cats 4 (1.2%), cattle 3 (0.9%), foxes 2 (0.6%), goats 1 (0.3%) (Table 2).

Table 2: Species of offending animals in south Darfur State (April - September 2000).

Animal species	Number	%
Dog	309	91.7
Donkey	12	3.6
Durban	6	1.8
Cat	4	1.2
Cattle	3	0.9
Fox	2	0.6
Goat	1	0.3

From April to September 2000, among of the 337 exposed persons receiving anti-rabies vaccine at Nyala public pharmacy, 191 were males and 146 were females. The highest incidence of exposure in both sexes was seen in 1 – 14 year old people. Ten deaths (7 male and 3 females) due to rabies were reported in the state during the 6 months period.

Between 1988 and 1998, a total of 2247 suspected rabid animals were reported in Sudan, 1908 in Khartoum, 53 in central, 92 in eastern, 52 in Darfur, 117 in Kordufan and 25 in Northern states (Table 3). The number of humans who had received rabies post exposure treatment and those who had died of the disease in the different states is summarized in Table 4. All human and animal rabies cases were diagnosed on clinical grounds only. Their relatives refused post mortems of dead humans and no case was confirmed in the laboratory because usually people do not care to report the cases to the veterinary authorities.

Table 3: Rabies suspected animals in different states of the Sudan (1988-1998)

Year	Khartoum state	Central states	Northern states	Eastern states	Kordofan states	Darfur states	Total
1988	284	14	2	-	12	-	312
1989	249	13	6	22	-	-	290
1990	243	-	-	2	-	13	258
1991	206	-	-	-	-	-	206
1992	159	14	4	5	2	-	184
1993	136	1	-	7	9	-	153
1994	206	-	9	-	4	3	222
1995	145	1	-	21	4	2	173
1996	105	-	-	8	-	15	128
1997	89	-	3	21	-	7	120
1998	94	-	1	6	96	12	209
TOTAL	**1916**	**53**	**25**	**92**	**117**	**52**	**2255**

After the increase of reported human exposures, a campaign to destroy the stray dogs was started in the state and during July and August 2000 a total of 360 stray dogs were destroyed in Nyala province.

Darfur states were always poor in rabies control measures. During the period 1992 to 1998 only 5 animals were destroyed (2 goats, 2 donkeys 1 cow) while no animal was vaccinated during this period. (Anon-2, 1990 to1998).

Rabies is endemic in Sudan and occurs in most parts of the country. The reports revealed that Northern and Darfur states during the last 11 year period (1988 to 1998) reported the lowest figures of animals suspected to have rabies, as well as human exposures to the disease (Tables 3 and 4). After the

noticeable increase in the number of human exposures to rabies during the period April to September 2000, it was necessary to investigate the prevalence of rabies in south Darfur State, through the human exposure reporting system started in the last week of April 2000 and the active survey done in the state, by reviewing the monthly and annual reports of the veterinary and health authorities, direct contact with the exposed people and public representatives of different provinces of Darfur State.

Table 4: Number of human rabies post exposure treatment and deaths from the disease in different states of the Sudan (1988 – 1998)

Year	Khartoum state		Central states		Northern states		Eastern states		Kordofan states		Darfur states	
	*Ex	*De	Ex	De	Ex	De	Ex	De	Ex	De	Ex	De
1988	7390	-	148	2	272	-	442	1	234	2	-	-
1989	3879	2	964	1	74	-	152	1	133	-	-	-
1990	10117	-	60	1	297	1	708	1	214	4	-	-
1991	9939	-	528	2	713	-	6	1	1	1	-	-
1992	1050	2	678	-	91	-	25	-	121	1	223	-
1993	7853	2	232	1	10	1	476	21	144	2	6	-
1994	8122	3	238	15	26	4	215	12	51	3	5	-
1995	1275	3	264	7	12	-	47	1	634	4	16	1
1996	6694	7	142	8	56	-	160	14	40	2	2	3
1997	10685	2	-	1	-	-	2	3	77	4	-	-
1998	6180	-	117	15	41	4	208	8	20	1	-	1
Total	**73184**	**21**	**3371**	**53**	**1592**	**10**	**2441**	**63**	**1669**	**24**	**252**	**5**

* Ex: Exposure
* De: Deaths

From figures presented in Table 1 it is clear that there was no communication between the veterinary and health authorities. The veterinary authorities reported only 11 suspected cases of animal rabies while at the same time, 337 people received rabies post exposure treatment during the period and 80 unrecorded people received the vaccine at Adiela province. The main reason for this discrepancy is that people often do not report animal bites to the veterinary authorities but immediately kill the offending animal. A similar observation was made by Ali (1993).

During the study, most (42.7%) of the 144 reported human exposures to rabies were located in Nyala province, which is the capital of the state where the vaccine is available and where there is more awareness of the disease. The other areas, which reported human exposures, were the large cities in the other provinces in the state. The facts collected through direct contacts with people revealed that a large number of humans exposed to animal bites use local, traditional methods to treat the bites (cauterisation, eating a bird called Abundoloc). Some people believe that eating the meat of this bird, which is a local name of a black bird like turkey in size, can prevent rabies. Some people did not receive post exposure treatment due to financial problems, the interviewed people stated that the number of humans exposed to animal bites is at least 3 times equal to those who had received the vaccine. From this fact it was concluded that the actual number of humans exposed to animal bites in the state is approximately 3 times the reported figure. Dogs were the main-offending animals during the outbreak 309 (91.7%). Hameid (1987) reported the same finding.

The highest number of human exposures of both sexes was between 1 to 14 years of age while males constituted 56.7% of the reported cases. This may be explained because children usually remain outdoors most of the day and play with animals. They do not realise the dangers of playing with animals. During the period of the study 10 human deaths were reported, 7 males and 3 females.

With regard to the incidence of rabies in other states of the Sudan, the figures shown in Table 3 reveal that Khartoum State reported the highest number of suspected rabies-infected animals. On reviewing the figures presented in Table 4 it was found that Khartoun State tended to report the highest figures of human exposures. This is mainly due to increased public awareness about rabies. People came also from different states to receive the vaccine in Khartoum.

Most of the reported human deaths due to rabies were reported in Central and Eastern states, while Darfur, Kordufan and Northern states tended to report the lowest figures of human exposure and deaths from the disease. This phenomenon is in fact due to the weak reporting system in the states. This is clear when comparing the figures collected during the survey of South Darfur state where 98 human exposures were recorded from April to June, while only 2 cases were reported by the official health authorities of the state.

During the outbreak, there were no laboratory confirmed rabies cases. All cases in human and animals were diagnosed on clinical grounds only. This was due to the low number of suspect animals reported to the veterinary authorities and to the lack of facilities for recent diagnostic techniques in the state and other regional laboratories.

The main steps to control rabies are vaccination of animals, particularly of dogs, and the destruction of stray and unvaccinated dogs. Darfur states were poor in applying both measures, from 1992 to1998 neither vaccination nor destruction campaigns were conducted. Only 5 animals were destroyed and this was most probably by request of their owners. This was the direct reason for the increase in rabies incidence rate in the state, which ended with an outbreak during April to September 2000.

From the information collected during this study and from the follow up of the situation, it is clear that rabies is currently a very serious zoonotic disease in the state and the case can be defined as an outbreak. Although there was no laboratory confirmation, the clinical diagnosis of rabies cannot be mistaken, especially when a large number of humans is concerned, because usually the history of animal bite and the obvious clinical signs, especially hydrophobia, helps in clinical diagnosis. However people refuse to apply post-mortem examination to their relatives. Strict control measures including vaccination of susceptible animals, destruction of stray and unvaccinated animals should be applied immediately and considered a routine system. Rabies control measures for wild animals, which are usually seen roaming around the big cities as well as around small villages is highly recommended. Intensive public health extension programmes should be adopted to raise the public awareness of the disease and to aid in its control. The treatment of exposed humans and vaccination of animals should be included in this strategy.

The availability of post exposure rabies vaccine for humans should be secured in the different provinces of the state. The link between veterinary and health authorities should be strengthened and sharing of data about rabies is recommended to help in control measures. Supply of recent diagnostic tools to regional laboratories and training the staff is highly recommended.

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REFERENCES:

ALI.Y.H – 1993 - Rabies problem in Khartoum states. An M.V.sc. theses. Faculty of Veterinary Science, University of Khartoum-Sudan.

ANON.-1 - 1904-1930 - The annual Reports of the animal health services, Ministry of Animal Resources – Sudan.

ANON.-2 - 1990-1998 - The annual reports of the Animal Health services, Ministry of Animal Resources - Sudan.

ANON.-3 - 1988-1998 - The annual reports of the Federal Ministry of Health – Sudan.

ELNASRI – 1963 - A review of animal rabies in the Sudan. *Bulletin of Office International Epizooties*, **60** ,97- 104

HAMEID O.A. – 1987 - Evaluation of the goat adapted rabies vaccine and improvement of diagnosis of rabies in Sudan. An M.V.Sc. thesis. University of Khartoum – Sudan.

HARBI M.S. – 1976 - The incidence of rabies in animals in Sudan. *Bulletin of Animal Health and Production in Africa*, **24**, 43- 46.

TRADITIONAL AND CULTURAL BELIEFS, FACTORS INFLUENCING POST EXPOSURE TREATMENT

J. Godlonton

Adapted from overheads.

1 RESULTS OBTAINED DURING A SURVEY OF KWAZULU NATAL AND SOUTH AFRICAN CLINICS AND HOSPITALS.

Figure 1 : Position of Kwazulu-Natal.

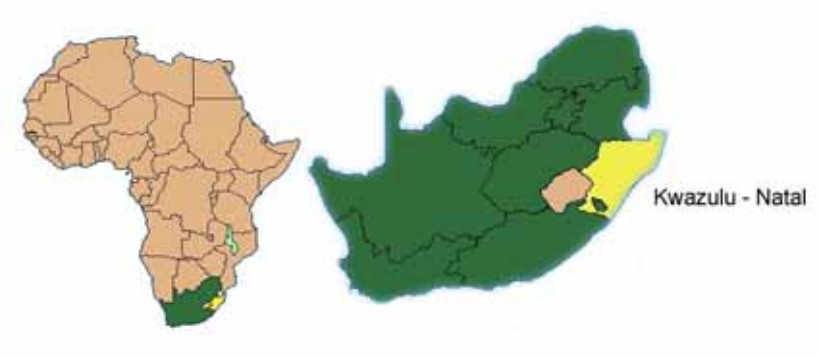
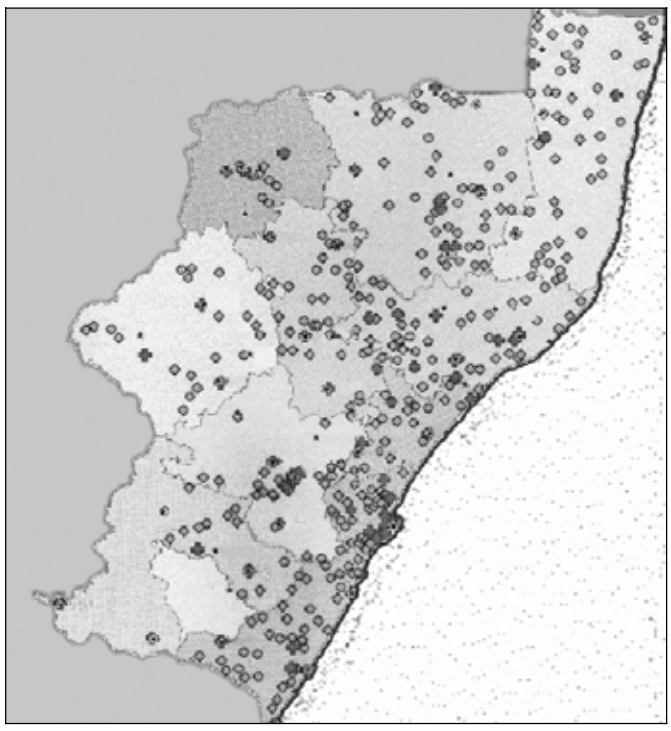


Figure 2: Geographical localisation of the 63 hospitals (crosses) and 354 clinics (losanges) in the Province of Kwazulu-Natal.



2 CLINIC SURVEY.

2.1 General equipment.

21 clinics surveyed. The distance from Edendale Hospital ranged between 2.5 and 124 kilometres with a mean of 47.1 km.

Two of the clinics had ambulances for severe cases only, the 19 remaining had no transport. The taxi/bus costs 4US$ per trip, making 20 US$ for the five visits of a PET.

All clinics had phones.

A single clinic was open throughout the week and others open from 08h00 to 16h00, Monday to Friday.

2.2 Post exposure treatment management.

None of the clinics knew the WHO contact categories.

Neither anti-rabies vaccine nor rabies immunoglobulins were available. In the 21 clinics, neither the correct treatment protocols nor the person to contact regarding the biting animal were known.

3 TREATMENT REPORT FORMS ANALYSIS.

Thirty-one patient forms have been examined.

Twenty-eight of them came within 48 hours of bite contact.

All patients received vaccine on day 0. Five category 1 and 6 category 2 patients received RIG.

All patients came because of dog bite contact; none of the biting animals were followed up. Fifty percents of the patients were 12 years old or younger.

The mean number of visits per patient was 2.15.

The rabies post exposure treatment guidelines were present at the treatment point.

4 INTERN SURVEY.

Twelve interns, qualified at all the leading South Africa faculties, have been interviewed.

All of them believed that they had received adequate rabies training. Five of them did not know that Edendale hospital is in a canine endemic area. One of them knew the WHO contact categories. All of them were uncertain in respect of correct treatment.

5 TRADITIONAL HEALER SURVEY.

Twenty healers have been interviewed comprising 15 nyangas (witchdoctors) and 5 sangomas (female diviners).

When asked what advice, drug or medicine they would give to a dog bite victim, all twenty traditional healers said that they would refer the patient to a hospital. Four of them would have first used a herbal medication.

Eighteen of them knew that rabies is a killing disease that arises from a dog bite. The two others knew nothing about rabies.

The indigenous therapists, in the vicinity of Edendale hospital, seem unlikely to contribute to an increase in human rabies.

6 VETERINARIAN SURVEY.

Fifteen vets were interviewed telephonically.

All of them maintain pre-exposure vaccination status correctly, only one knew his current antibody level.

7 VACCINE AND RIG TELEPHONE SURVEY.

Survey was performed by Dr David Dürrheim, director of Communicable Diseases, Mpumalanga, South Africa. The survey included 146 of 220 facilities (66%) indicated by provincial pharmacists as stocking vaccine and RIG. All nine South African provinces were included in telephone survey.

Three determined attempts were made to phone before recording as unanswered.

In Kwazulu-Natal 25 of the 49 facilities were phoned. Seven (28%) did not answer or corresponded to a wrong number. Two (8%) had no vaccine, 9 (36%) had no RIG and one (4%) had expired RIG.

In South Africa 146 of the 220 facilities were phoned. Forty-six (32%) did not answer or wrong number, 26/146 (18%) had no vaccine 53/146 (36%) had no RIG.

Some problems have been identified in the following topics:

- Post bite “biting animal” management.
- Poor post-exposure categorization.
- Unreliable vaccine and RIG availability.
- Poor rabies PET knowledge.
- Patients do not return for treatment.
- WHO protocol not being complied with.

The following questions raised :

- Change vaccination protocol for South Africa.
- RIG and post-bite interval.
- Ante-mortem rabies diagnosis.
- Raise water temperature for wound treatment.
- Injection of viricidal agent instead of RIG?
- Investigate ALL human rabies deaths.
- Correct ALL deviations from “best practice".

A NEW AFRICAN RABIES TEXTBOOK

P.E. Kloeck[1]

The only official rabies handbook available in South Africa was somewhat outdated in respect of the veterinary aspects while guidelines to the medical management of rabies also required urgent revision.

The Rabies Advisory Group (RAG) undertook the production of a rabies text that would meet almost all the needs of both professions in South Africa.

The RAG is a select committee of veterinarians, microbiologists, epidemiologists, researchers and medical practitioners in South Africa, representing the Departments of Agriculture, Health and the Agricultural Research Council. The committee has existed since 1990 and was established to advise their respective departments on rabies control and management and to formulate policy and legislation for the entire country.

The book is directed at doctors, veterinarians, paramedics and paraveterinarians. It is a comprehensive, high quality production with numerous colour photographs, graphics and illustrations.

The proposed title of the book is “Rabies for the Medical and Veterinary Profession in South Africa”.

The committee attempted to produce a very practical, down to earth production that is easily readable, concise, but packed with useful information and management guidelines.

The contents cover a short introduction of rabies in South Africa incorporating historical aspects, rabies and rabies-related viruses, and pathogenesis in humans and animals.

This is followed by an extensive chapter with numerous illustrations and photographs of rabies in animals. The chapter covers the species involved, transmission and epidemiology and reports on the clinical signs reported in histories submitted with 2743 confirmed rabies cases in domestic animals. Diagnosis, prevention through pre exposure vaccination and procedures to be followed when rabies is suspected, including sample collection and despatch are given special attention.

The death of a human from rabies is viewed as a health system failure. With this in mind the chapter on rabies in humans concentrates on the transmission and prevention through pre-exposure prophylaxis of high-risk occupational groups and children in rabies endemic areas. The text dealing with the management of humans exposed to rabies, the administration of anti-rabies immunoglobulin and rabies vaccines are supported by several Tables of WHO approved regimens.

A flow chart of actions to be taken following the exposure of a human to a suspect rabid animal includes an assessment of the animal, categories of rabies exposure and recommended wound treatment and post exposure immunisation.

The RAG committee is of the opinion that this flow chart should be enlarged and fixed to every clinic and hospital throughout Africa. This chapter closes with the diagnosis and management of clinical rabies in the patient and supportive therapy for parents, family and friends.

The penultimate chapter deals with legislation involving both humans and animals. Vaccinations, internal movements, current import and export requirements, quarantine and certification of animals are briefly discussed.

The concluding chapter deals with rabies control strategies and key factors that influence success.

A list of frequently asked questions with cross-references to the answers in the text and a glossary of term precede a bibliography of 157 scientific references.

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This book is long overdue in terms of its importance and potential usefulness to the medical and veterinary profession in South Africa. Copies will be distributed to all hospitals, medical clinics and their staff, veterinarians, veterinary nurses and animal health technicians.

The committee is of the opinion that the textbook “Rabies for the medical and veterinary profession in South Africa” could be of value and interest to all countries where canine rabies is responsible for human death.

A REVIEW OF RABIES POST-EXPOSURE TREATMENT (PET) DATA IN UGANDA: 1990-1994.

R. Winyi Kaboyo[1], F. Kamunvi[2], A. K. Mbonye[3].

ABSTRACT.

Data from human rabies treatment centres of 22 (56.5%) districts in Uganda was analysed for the period 1990-1994. The findings are presented and discussed. The aim was to characterize the bite victim, identify the biting animals, determine the frequency of bite exposure, assess compliance and outcome of rabies post-exposure treatment (PET) and make recommendations on the management of human rabies. The study subjects were individuals who sought and received treatment for rabies following suspicion of exposure. Interventions included use of rabies vaccine and hyper-immune serum. Results indicate that dog bites were the main reason for giving rabies PET (95.8%) followed by cat bites (1.3%). Individuals under 20 years accounted for 57.2% of all bite victims. Compliance rate to rabies PET was poor, decreasing from 100% to 21.5% by the 5th dose. The difference between male (58.1%) and female (41.5%) receiving PET was statistically significant (P<0.0001).

In preventing human rabies transmission through animal bites, priority should be directed mainly to children and individuals below 20 years combined with regular dog and cat vaccination. Shorter but reliable PET regimens should be explored to improve compliance.

1 INTRODUCTION.

Rabies is a zoonosis, that is, a disease naturally transmitted from vertebrate animals to humans. It is a terrifying and invariably fatal but preventable viral encephalomyelitis. Rabies is a disease of all warm-blooded animals but mainly affecting canines (dogs, foxes, etc.). Other animals, including herbivora and rodents, are infected in nature but do not ordinarily transmit the disease to man (Abdusalam, 1976).

The public health importance of rabies is not based on the number of cases, which is often low, but on the high mortality, which is practically 100% of the untreated patients. Equally important is the emotional impact and the anxiety of bitten persons faced with fear of contracting the disease. Another factor is the economic loss due to the cost and man-hours involved in post exposure treatment. There are also disaster implications if the disease is freshly introduced or is enzootic in an area where there are many stray unvaccinated dogs (Acha and Szyfres, 1989).

In general, the global problem is probably becoming worse despite improved diagnostic techniques and the production of more efficacious vaccines for both humans and animals. In Africa, increases in the number of cases and geographical spread of animal rabies are reported in Kenya (Perry *et al.*, 1995) and Tanzania (Loretu, 1988).

Information on human rabies and mortality in Uganda is scanty, consequently the extent of the problem is not well known. This appraisal therefore attempts to focus on the following epidemiological features: to characterize the bite victims, the animal species involved and patient compliance to the 5-dose post exposure treatment regimen.

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2 MATERIALS AND METHODS.

Routine rabies PET data collected at treatment centres was analysed.

In 1990, a rabies PET report form was designed, pre-tested and adjusted. The forms were availed to rabies treatment centres from where they were completed and returned regularly.

In order to minimize recall bias, information sought concerning the biting animal was limited to the species and whether the animal was killed or had escaped. The treatment centres completed the forms for individuals suspected to have been exposed to rabies and therefore given rabies PET. The information entered on the form included the patient's name, age, sex, address and the name and rank of the reporting officer. Other information included name of district and hospital, date of first treatment, vaccine doses 1 through 5 and prognosis. Treatment centres were asked to send or deliver the completed report forms to the investigators. Data was analysed by computer using EPI-INFO version 6.

Two types of rabies vaccines of cell culture origin were used for post exposure treatment (PET). The Purified Vero Rabies Vaccine (Verorab - Pasteur-Mérieux) and the Human Diploid Cell Vaccine (Institut Merieux) was administered at a dose rate of 0.5 ml and 1.0 ml respectively. Intramuscular (i/m) injections were given on the deltoid in adult and antero-lateral thigh muscles in children on days 0, 3, 7,14 and 30. Hyper immune globulin (HIG) (Imogam Rabies – Institut Mérieux) at a dose rate of 20 I.U./kg body weight was given once. One half of the dose was infiltrated in and around the bite wound and the remainder given i/m at another site from that of vaccine injection.

3 RESULTS.

The review of human PET against rabies in Uganda is based on data from treatment centres in 22 (56.5 %) of the then 39 districts in Uganda (Figure 1). For the year 1990, data was reported for only seven months, January and then July to December. Data was then available for each subsequent month for the rest of the period under review (Table 1).

Table 1: Reported human rabies post-exposure treatment in Uganda, 1990-1994.

Month	1990	1991	1992	1993	1994	Total
January	9 (6.6%)	38 (10.0%)	20 (2.6%)	61 (4.0%)	190 (7.3%)	318 (5.9%)
February	-	111 (29.1%)	100 (29.1%)	40 (2.6%)	117 (4.5%)	368 (6.8%)
March	-	12 (5.3%)	104 (13.6%)	169 (11.1%)	123 (4.7%)	408 (7.7%)
April	-	29 (7.6%)	31 (4.0%)	162 (107%)	147 (5.6%)	369 (6.8%)
May	.	20 (5.2%)	47 (6.1%)	134 (8.8%)	337 (12.9%)	538 (9.9%)
June	-	19 (5.0%)	51 (6.7%)	96 (6.3%)	338 (12.9%)	504 (9.3%)
July	1 (0.7%)	2 (0.7%)	55 (7.2%)	41 (2.7%)	282 (10.8%)	381 (7.0%)
August	3 (2.2%)	23 (6.0%)	60 (7.8%)	83 (5.5%)	203 (7.7%)	372 (6.9%)
September	6 (4.4%)	24 (6.3%)	45 (5.9%)	182 (12.0%)	211 (8.1%)	468 (8.6%)
October	6 (4.4%)	24 (6.3%)	51 (6.7%)	172 (11.3%)	319 (12.2%)	572 (10.6%)
November	68 (49.6%)	17 (4.5%)	111 (14.5%)	193 (12.7%)	215 (8.2%)	604 (11.1%)
December	44 (32.1%)	53 (14.0%)	91 (11.9%)	185 (12.2%)	134 (5.1%)	507 (9.4%)
Total	137 (2.5%)	372 (7.0%)	766 (14.2%)	1518 (28.0%)	2616 (48.3%)	5409 (100%)

A total of 5418 bitten individuals were given rabies PET in the 22 districts (Table 2). Within this same period of surveillance, another 549 animal bite victims were treated for rabies exposure at various clinics and hospitals, including Mulago Hospital, the national referral and Makerere University teaching hospital. However, this data, was not submitted in accordance with the report form provided for the study and was therefore excluded from the analysis.

Mpigi District reported the largest number of bite victims 1760 (32.5%) who received rabies PET. The lowest number 9 (0.2%) was reported and given PET in Kumi District. (Table 2).

There was progressive and statistically significant ($P<0.0001$) increase in the reported number of people receiving rabies PET over the 5-year period (Fig.2, Table 1).

The 5418 bite victims received a total of 14,219 doses of rabies vaccine among whom 310 (5.7%) were given a total of 1456 doses of hyper immune globulin (HIG). On average each bite case received 2.6 doses, approximately half of the recommended 5 doses per case.

Table 2: Number of bite cases given rabies PET by district in Uganda, 1990-1994.

District	No. treated
Apac	183 (3.4%)
Arua	292 (5.4%)
Hoima	21 (0.4%)
Iganga	188 (3.5%)
Jinja	186 (3.4%)
Kabarole	84 (1.6%)
Kampala	652 (12.0%)
Kamuli	29 (0.5%)
Kapchorwa	30 (0.5%)
Kumi	9 (0.2%)
Lira	214 (3.9%)
Masaka	364 (6.7%)
Masindi	48 (0.9%)
Mbale	25 (0.5%)
Mbarara	98 (1.8%)
Moroto	489 (9.0%)
Mpigi	1760 (32.5%)
Mubende	172 (3.2%)
Mukono	223 (4.1%)
Nebbi	17 (0.3%)
Rakai	205 (3.8%)
Tororo	129 (2.4%)
Total	5418 (100%)

Figure 1: Distribution of rabies post-exposure treatment in Uganda (1990-1994).

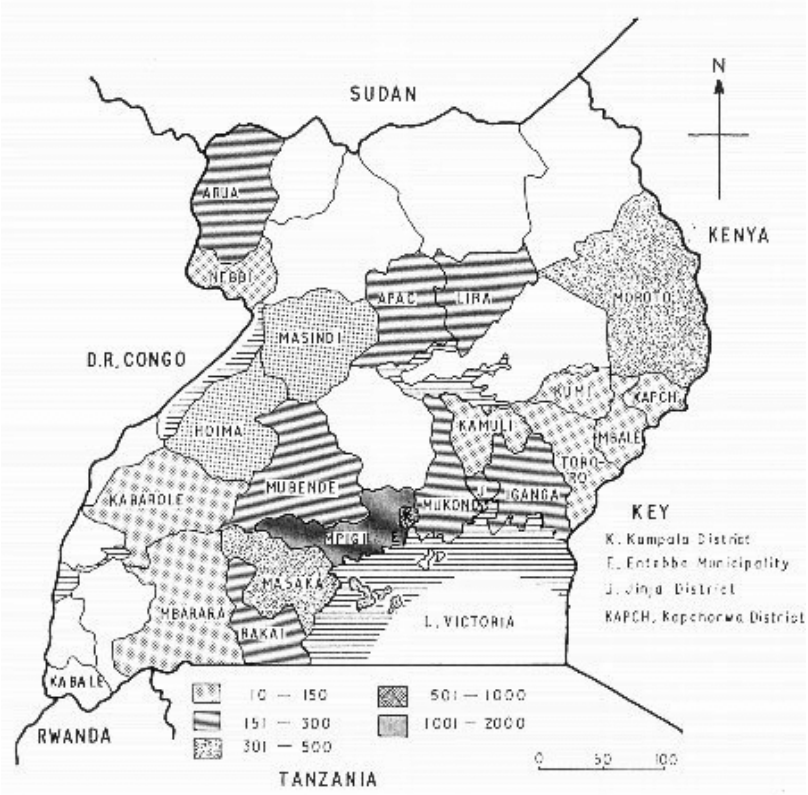
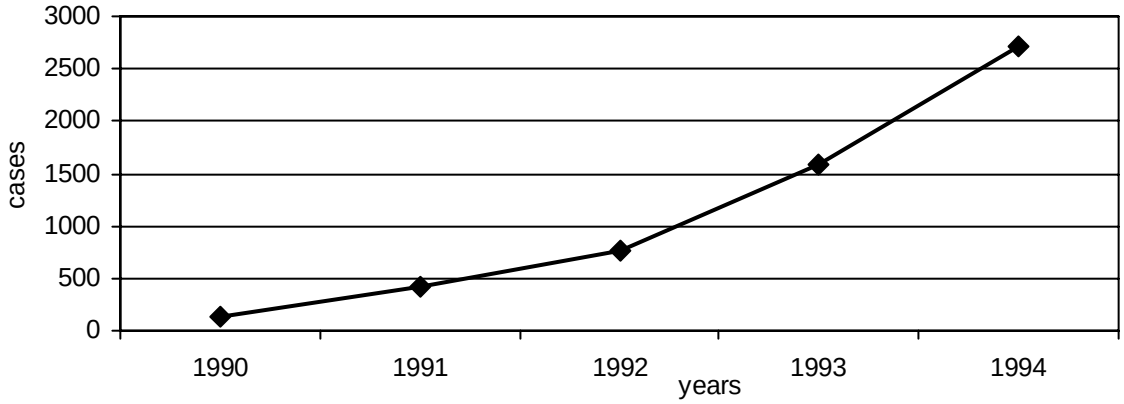


Figure 2: Yearly trend of rabies post-exposure treatment.



The number of bite cases who received the 1st to 5th doses decreased progressively from 5,418 (100%) on day 0 to 3205 (59.2%) on day 3; to 2575 (47.5%) on day 7; then 1854 (34.2%) on day 14 and finally to 1167 (21.5%) on day 28. This indicates that fewer and fewer cases were receiving PET for each successive dose.

The non-compliance rate between successive doses was calculated as follows: $\frac{(a-b)}{a} \times 100$

where: a = number of bite cases receiving the previous dose,
b = number of bite cases receiving the next dose.

Non-compliance between the first and second doses was apparently high (40.8%). Non-compliance rates between the 2nd and 3rd doses (19.6%); and 3rd and 4th doses (28.0%) were much lower. However, the non-compliance rate between the 4th and 5th doses rose up to 37.0%.

Of the 5418 rabies PET recipients, prognosis data was reported for 1300 (24.0%). Of these, 1286 (98.9%) did not develop rabies. But the 14 (1.1%) who died of rabies had reported for PET after they had already developed clinical signs of rabies. The majority, 4118 (76.0%) were not followed up to the end of treatment hence the final prognosis could not be determined.

Domestic animals 5260 (97.1%) comprising mainly dogs 5190 (95.8%) and cats 70 (1.3%) were the main cause of bites to man. Others were cattle, goats, monkeys, foxes, jackals and humans. In the case of 57 (1.05%) of the victims, the biting animal was not identified. Forty nine (0.9%) individuals were reported to have been bitten by an animal that had also bitten someone else. The status of 2819 (52.5%) animals that had bitten people was unknown to the victims, while 1449 (27.0%) animals were reported to have escaped and another 1101 (20.5%) were reported to have been killed soon after the attack. (Table 3).

Table 3: Number of bite cases by source of bite.

Biting animal	No. of bite cases
Dog	5190 (95.8%)
Cat	70 (1.3%)
Cattle	13 (0.24%)
Goat	1 (0.02%)
Monkey	20 (0.37%)
Fox	58 (1.07%)
Jackal	6 (0.11%)
Human	3 (0.06%)
Not identified	57 (1.05%)
Total	5418 (100%)

Gender was reported for 5399 bite victims who received rabies PET, of whom 3148 (58.1%) were males and 2251 (41.5%) females. The sex difference was statistically significant ($p<0.0001$). In 19 (0.4%) of the victims sex was not reported.

Figure 3: Number of bite cases given rabies post-exposure treatment by age and sex.

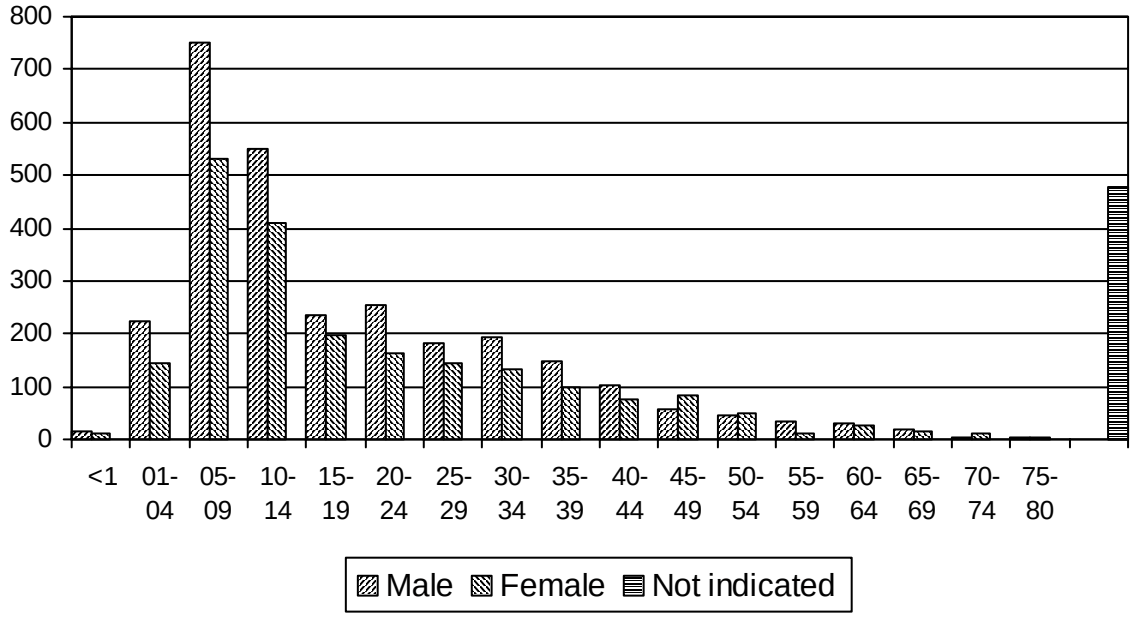


Table 4: Age and sex distribution of bite cases given rabies PET.

Age group (years)	Male	Female	Age and sex not indicated	Total
< 1	17 (0.3%)	7 (0.1%)	-	24 (0.4%)
1 - 4	229 (4.2%)	143 (2.7%)	-	372 (6.9%)
5 - 9	753 (13.9%)	529 (9.8%)	-	1282 (23.7%)
10 - 14	548 (10.1%)	407 (7.5%)	-	955 (17.6%)
15 - 19	271 (5.0%)	196 (3.6%)	-	467 (8.6%)
20 - 24	256 (4.7%)	158 (2.9%)	-	414 (7.6%)
25 - 29	186 (3.4%)	139 (2.6%)	-	325 (6.0%)
30 - 34	197 (3.6%)	132 (2.5%)	-	329 (6.1%)
35 - 39	146 (2.7%)	93 (1.7%)	-	239 (4.4%)
40 - 44	101 (1.8%)	75 (1.4%)	-	176 (3.2%)
45 - 49	53 (1.0%)	74 (1.3%)	-	127 (2.3%)
50 - 54	47 (0.9%)	49 (0.9%)	-	96 (1.8%)
55 - 59	31 (0.6%)	9 (0.2%)	-	40 (0.8%)
60 - 64	25 (0.5%)	20 (0.3%)	-	45 (0.8%)
65 - 69	20 (0.4%)	11 (0.2%)	-	31 (0.6%)
70 - 74	4 (0.07%)	8 (0.13%)	-	12 (0.2%)
75 - 80	6 (0.1%)	6 (0.1%)	-	12 (0.2%)
TOTAL	2890 (53.3%)	2056 (38.0%)	472(8.7%)	5418 (100%)

Age was reported in 4965 cases. The mean age was 19.6 years with a range of 5 months to 79 years, a median of 14 years and a mode of 7 years. Age group 5-19 years accounted for 2704 (49.9%) of all the rabies PET recipients. The 5-9 years age group had the highest number of people 1282 (23.7%) getting PET followed by 10-14 years with 955 (17.6%) individuals treated.

The lowest rates of PET occurred in the oldest age group 70-74 and 75-80 years with 12 (0.2%) victims in each group. This was followed by the under 1 year old group who accounted for 24 (0.4%) of all bite victims getting rabies PET. A gradual but more or less progressive decline in the frequency of rabies PET is observed between 20 to 69 years age group. (Fig.3 and Table 4).

4 DISCUSSION.

The public health importance of rabies in Uganda is overshadowed due to scarcity of reliable data and the persistent endemicity of other major communicable diseases notably malaria, tuberculosis and

AIDS. Likewise, in the training of health staff, rabies does not appear to receive high priority rating as most physicians and medical virologists look at rabies as a problem for the veterinarians (Kyria and Mugerwa, 1975).

In Uganda early cases of rabies were reported mainly in the border districts of Arua (Rollinson, 1956) and Kabale (Kyria and Mugerwa, 1975) (Fig.1). In the 1960s, rabies control measures were remarkably successful and led to a decline in reported cases in dogs from 63 in 1961 to only 3 in 1969 (Aruo, 1974). Since the 1970s, the infrastructure for animal rabies control in Uganda broke down due to civil and political upheavals in the country (Rutebarika and Winyi-Kaboyo, 1995).

In this study the observed increase in animal bite cases with suspected exposure to rabies hence necessitating rabies PET might be:

i. real, due to an increase in the number of rabid animals following the breakdown of the rabies control infrastructure.

ii. apparent, consequent to improved surveillance and public awareness.

The frequency of rabies post exposure treatment (PET) in a given district is influenced by a combination of factors mainly:

a) level of rabies awareness in the district,

b) availability and/or accessibility to the human rabies vaccine and RIG,

c) incidence of animal bites and rabies in the area. Since 1990 most districts in Uganda have appreciated the problem of rabies and have endeavored to improve public education and availability of the vaccine. This has encouraged patients to seek rabies treatment from where it is most likely to be available.

In the case of Mpigi District, 1415 (80.4%) and 345(19.6%) of the patients were given PET at Entebbe Grade 'A' and Grade 'B' hospitals respectively. These were the two hospitals where in the past rabies PET used to be almost exclusively available in the country. Therefore the high number of patients reported to be getting PET in Mpigi District is not a true reflection of the actual incidence of rabies in that district as the addresses of many bite cases indicated that they had come from elsewhere.

In the tropics dogs play an important role in the transmission of human rabies. In Nigeria, based on hospital records from 16 of the 19 states, it was reported that 98.8% of human rabies cases resulted from dog bites (Harry *et al.*, 1985). This compares well with our findings where dogs were responsible for biting 95.8% of all the PET recipients (Table 3). Although cats contributed only 1.3% of all bites, their regular vaccination is important since they are usually in close contact with family members especially children. Secondly, early clinical rabies in cats is often difficult to diagnose until after several exposures or at post-mortem. In a Maryland (USA) study, of 14 cats examined by a veterinarian only 3 (21.4%) were believed to have rabies on initial examination (Fogelman *et al.*,1993).

The three cases of human-to-human bites raise the problem of close contacts of rabid patients. The problem is real and although it is not certain that human transmission of rabies occurs in this way it nevertheless remains a possibility.

In the majority of cases 2819 (52.5%) the fate of the biting animal was reported as "Unknown", others were reported as "Escaped" and their fate was not established. This perhaps could have been a deliberate misinformation by the victims in order not to be denied rabies PET. The animals reported as "killed" were those that had in most instances exhibited aggressive behaviour, attacking and biting people and/or livestock. The significance of these records is that if diagnostic services were efficient and well co-ordinated, 1101 (20.5%) specimens from the animals that were reported killed would have been available for laboratory diagnosis. This compares very poorly with a mere 15 specimens on official record examined over the same period at the Animal Health Research Centre, Entebbe.

More males (58.1%) received rabies PET than females (41.5%), a ratio of approximately 3:2. This is comparable to findings in Ghana where males (60%) were more exposed than females (40%) (Addy, 1985). This is probably due to the male's adventurous and daring behaviour as well as occupational disposition like hunting, animal handling etc. Boys are also more aggressive than girls towards animals and are more likely to provoke an attack, get bitten and consequently exposed to rabies.

Several studies have shown that children account for the largest percentage of human rabies cases (Addy, 1985; Tommori and David-West, 1985). In this review, children aged 0-4 years were less exposed to animal bites (Fig.3, Table 4) and contributed only 7.3% of all PET given. This age group is

often better protected when in and out of the home. The most vulnerable were children aged 5-19 years who accounted for half (49.9%) of all PET. At this age, children go out on their own, are very playful and provocative and yet unable to defend themselves effectively against biting animals. This therefore is the most appropriate age group to target for rabies prevention and awareness campaigns through the School Health Programme. Individuals 20 years and over tend to be more cautious towards aggressive animals and can often defend themselves against attacks. The oldest age groups, 70-74 years (0.2%) and 75-80 years (0.2%) were much less exposed to animal bites and therefore the need for rabies PET probably due to being more or less confined to their home.

A 5-dose post exposure treatment (PET) regimen was applied requiring patients to report on days 0, 3, 7, 14 and 30. Day 0 represents the initial dose of PET. The high non-compliance rate (40.8%) between the 1st and 2nd doses is partly due to a number of victims who initially received the first dose but were discontinued after ascertaining that the biting animal was rabies free. The non-compliance rates between 2^{nd} and 3^{rd} doses (19.6%) and 3^{rd} and 4^{th} doses (28.0%) were much lower. At this stage of treatment, genuine fear of exposure to rabies had been established and therefore patients were willing to wait seven more days and receive up to the 4th dose. Surprisingly the non-compliance rate for the 5^{th} dose went up to 37.0%. In such cases bite victims might have falsely believed that they were safe from rabies and would not wait for another 14 days to receive the 5^{th} and last dose. Approximately one out of five (21.5%) of the original number of patients received all the recommended 5 doses.

It is suggested that post exposure treatment regimens of shorter duration be explored and introduced so as to improve compliance and reduce costs of treatment. The 14 (1.1%) patients who died while undergoing PET had arrived after clinical rabies had set in. This emphasizes the need for correct and prompt medical management of rabies soon after exposure (Aruo, 1974). Rabies vaccine should therefore be available at every district medical office and in hospitals, so that patients can be treated from nearer their homes. In addition 53 more deaths from suspected rabies were reported to have occurred outside the treatment centres in the 1990-1994 period. Thus, as in other parts of Africa the incidence of rabies in Uganda is grossly under-reported (Warrell, 1994). Likewise deaths occur countrywide but not all are reported to the health system. Also where the incubation period has been very long (over 30 days) death may not be readily associated with rabies.

Two main constraints in ascertaining the prognosis of bite victims who received rabies PET were:

i. lack of follow-up of patients since most were being treated on an out-patient basis.

ii. poor compliance to the 5-dose regimen.

Rabies is endemic in Uganda and available data indicate that the dog is potentially the principal vector of human rabies. In this review 95.8% of all human PET were attributed to dog bites. It may also be important to identify the wild animal species involved in the local rabies transmission cycle and have them targeted for elimination or oral vaccination. Aggressive health education programmes on rabies should be targeted to the 5-19 years age group, which has been shown to be the most vulnerable to rabies exposure through animal bites. Above all in the control of human rabies, regular vaccination of dogs and cats should receive high priority.

ACKNOWLEDGEMENTS.

We wish to acknowledge with gratitude all the district health officials and hospital staff for collecting and making available the data for subsequent review.

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REFERENCES.

ABDUSSALAM M. – 1976 - Zoonoses, in: Epidemiology and Community Health in Warm Climate Countries. eds R.Cruickshank, K.L.Standard and H.B.L.Russell. Edinburgh: Churchill Livingstone.

ACHA P.N. AND SZYFRES B. – 1989 - Zoonoses et maladies transmissible communes à l'homme et aux animaux.

ADDY P.A.K. – 1985 - Epidemiology of Rabies in Ghana. In: *Rabies in the Tropics* eds. E. Kuwert, C. Mérieux, H. Koprowski and K. Bogel. Berlin: Springer-Verlag. 1985.

ARUO S.K. – 1974 - Progress and problems of rabies control in Uganda. *Bull.Epizoot. Dis. Afr.*, **22**: 321-325.

FOGELMAN V, FISCHMAN H.R, HORMAN J.T, AND GRIGOR.J.K. – 1993 - Epidemiologic and clinical characteristics of rabies in cats, *J. Am. Vet. Med. Assoc.*, **202**, 1829-1833.

HARRY T.O., ADIEGA A. AND NASIDI A. – 1985 - Rabies in Nigeria. *Lancet* , **11**, 601.

KIRYA G.B. AND MUGERWA J.W. – 1975 - A case of human rabies in Mulago Hospital. Kampala, Uganda. *E. Afr. Med. J.*, **52,** 348-353.

LORETU K. – 1988 - Rabies in Tanzania: An epidemiological review. *Bull. Anim.Hlth. Prod. Afri.*. **36**: 296-299.

PERRY B.D., KYENDO T.M., MBUGUA S.W., PRICE J.E. AND VARMA S. – 1995 - Increasing rabies vaccination coverage in urban dog populations of high human population density surburbs: a case study in Nairobi, Kenya. *Prev. Vet. Med*, **22**; 137-142.

ROLLINSON D.H.L. – 1956 - Problems of rabies control in Africa. *E. Afr. Med. J.*, **33**: 425-433.

RUTEBARIKA C.S. AND WINYI-KABOYO R. – 1995- Multi-sectoral collaboration in rabies surveillance and control in Uganda. In: *Proceedings of the Third Southern and Eastern African Rabies Group (SEARG) Conference.* eds.J.Bingham, A.A. King,and G.Bishop. Lyon:Fondations Marcel Mérieux.

TOMORI O., DAVID - WEST K.B. – 1985 - Epidemiology of Rabies in Nigeria. In: *Rabies in the Tropics* eds. E. Kuwert, C. Mérieux, H. Koprowski and K. Bogel. Berlin: Springer-Verlag.

WARRELL M.J. – 1994 - Rabies in Africa. *Africa Hlth.*, **17**, 10-15.

DISCUSSION

G. Bishop to F. Meslin: Is the "2-1-1" regime feasible for Africa. Personnel at the hospitals are not used to give i.d. vaccines, what happens if it is given s.c

The problem is compliance for 5 doses over a period of 90 days. "2-1-1" should only be used in category II exposures. For category III there is interference with immunoglobulins. The intradermal option which requires only 3 visits over 28 days is being studied. It is easy to learn the i.d. application (also used in TB testing) as shown in Asia.

J. Godlonton: There is a variability of therapist and inconsistency of operator skills. What is done with the rest of the vaccine. The right needle (26G) and a syringe that can measure small amount are needed. Does WHO recognize salivary contact such as indirect (example: children play with ball that has been in the mouth of a rabid puppy, a son uses the toothbrush of a father with rabies)?

A. Wandeler: *Indirect contact is no contact for rabies. Physicians need to reconsider in the examples given.*

F. Meslin: *Small syringes exist and are not too expensive. Ten i.d. doses are available in a reconstituted vial and should be used within 6-8 hours (one working day). This is an important constraint.*

T. Mebatsion: Through concerted action between companies, the costs can be reduced extensively, e.g. by establishing of a local company for Africa for tissue culture vaccine.

F. Meslin: *WHO is not playing a role as "middleman" but has recommended the discontinuation of brain-tissue vaccine and is promoting viable technology transfer.*

J. Godlonton: A golden rule for RSA in a rabies endemic area is that for any category 3 injuries inflicted by a un-catchable or unidentifiable animal, a full treatment should be given.

Discussion on P. Kloeck's presentation: Will this book be restricted to South Africa or distributed more widely through Africa?

There are no royalties. Only the legislation is specific for South Africa. It is otherwise usable for Africa and eventually Asia.

R. Dlamini: Towns keep dogs for security reasons. The dogs are encouraged to bite and vicious dogs are required to protect the home. What is the breed of dog being kept?

S. Cleaveland: *I did not report the breed of dog or the species*.

R. Dlamini: Is it true that children are more exposed to rabies than adults? Are the statistics correct?

S. Cleaveland: *The rabid dogs were classified by their neurological symptoms and by provoked / unprovoked attacks. Of those patients in hospitals presenting with rabies, the number of cases in the 5 – 15 year classes was consistent with findings from other countries.*

R. Winyi Kaboyo: What is the probability of contracting rabies based on the predictions of being bitten on the legs or lower trunk? The incubation period if bitten on the leg might be very long before death.

S. Cleaveland: *There is a differential risk due to nerve innervation. The head, neck and hands are highly innervated There might be a difference in the pathogenicity amongst viruses that are currently in circulation compared to those that circulated some time ago.*

F. Koumba: How did you control the outbreak in Darfur?

Y. Hassan Ali: *The government plays a key role in control.*

F. Koumba: Did only government officials try to control the outbreak?

Y. Hassan Ali: *Control of the outbreak did involve others. Vaccine was not available. The only intervention was the destruction of stray dogs. The control strategy involved help from public representatives.*

R. Winyi Kaboyo: You suggested that the study will involve both public and government areas. I did not hear the government parts. Who in government was interviewed?

K. de Balogh: *The government has a crucial role in this study however, I did not present any data.*

M. Letshwenyo: How do the patients get access to disinfectants for wound treatment?

K. de Balogh:They can buy disinfectants from pharmacies i.e. iodine.

D. Ntebela: Of all the traditional doctors ('witch doctors') can they diagnose rabies in humans?

J. Godlonton: *In our questionnaire, we did not ask whether they could diagnose rabies.*

D. Ntebela: Would the witch doctors send patients to hospital if they suspected rabies? What are the reasons? For other diseases, witch doctors do not send patients to hospital. Why with rabies?

J. Godlonton: *The way that rabies has been publicized has played a major role in sending patients to hospital.*

P. Mijere: Are there herbal remedies for rabies?

J. Godlonton: *No, nothing has been researched.*

K. McColl: I am interested in PET. The use of hyperimmune serum (RIG) to 'mop up' virus is universally used around the world. How do we get cell-mediated immunity acting on the virus in neurons? In some countries, both arms of treatment (PET and vaccine) are recommended. Is the use of both based on success? Do we understand why we are doing this treatment regime?

J. Godlonton: *Demonstrated why in some specific circumstances RIG was un-necessary.*

J. Smith (comment): There has been widespread use of human diploid vaccine in the absence of RIG. This resulted in a large number of treatment failures. Some patients survived with severe neurological damage and died later of septicemia. I advise not to limit the use of RIG.

S.E.A.R.G.

business meeting

S.E.A.R.G. ICONOGRAPHY

J. Barrat[1]

1 THE S.E.A.R.G. DIAGNOSTIC MANUAL.

Technical questionnaires sent to European laboratories performing rabies diagnostic have revealed important variations in the realisation of these techniques sometimes in important steps of the tests.

This booklet should be considered as a summary of what should be done at least in the field of laboratory diagnostic of rabies. Members of the Southern and Eastern African Rabies Group routinely employed in rabies laboratory diagnosis have edited it with the intention to describe the minimum requirements for a reliable rabies diagnosis laboratory, i.e. a robust diagnosis chain.

It is based on literature, on our practical experience and on papers presented at the different meetings of our group.

This manual does not seek to replace any of the recognised textbooks on rabies. The rabies diagnostician is encouraged to be familiar with the OIE "Manual of Standards for Diagnosis Tests and Vaccines", the Technical Report of the WHO Expert Committee on Rabies (Eighth Report) and the WHO Handbook "Laboratory Techniques in Rabies" (Fourth Edition) before embarking on rabies work.

2 PROCEEDINGS.

We are ending the sixth meeting of our group. Fifty-five national reports have been presented with 91 other scientific papers during our meetings in Lusaka (1992), Pietermaritzburg (1993), Harare (1995), Nairobi (1997) and Entebbe (1999).

All this represents an important amount of epidemiological and scientific data. It represents also quite a big weight of paper! In order to have all these documents in a more easy to use volume and presentation, they have been grouped in an electronic form on a CD-ROM.

The following points have been observed to make this CD easy to use on whatever computer (PCstandard):

- There is no need to install any new programme to use data from the CD
- The reading programme is freely distributed
- The papers must be read and printed identically, whatever the equipment of the computer

These conditions have brought us to use "portable document format" files: acrobat reader is a free programme, it is possible to have a version of the programme that can be run from the CD-rom without any installation on the computer.

The CD-rom that has been distributed to the country delegates contains two folders:

- The acrobat folder contains two presentations of acrobat reader 4.0, one that can be run directly from the CD without any installation and one that allows installation from the CD onto the computer.
- The "Proceedings" folder contains five files corresponding to 1992, 1993,1995,1997 and 1999 proceedings. These files have been print optimised.

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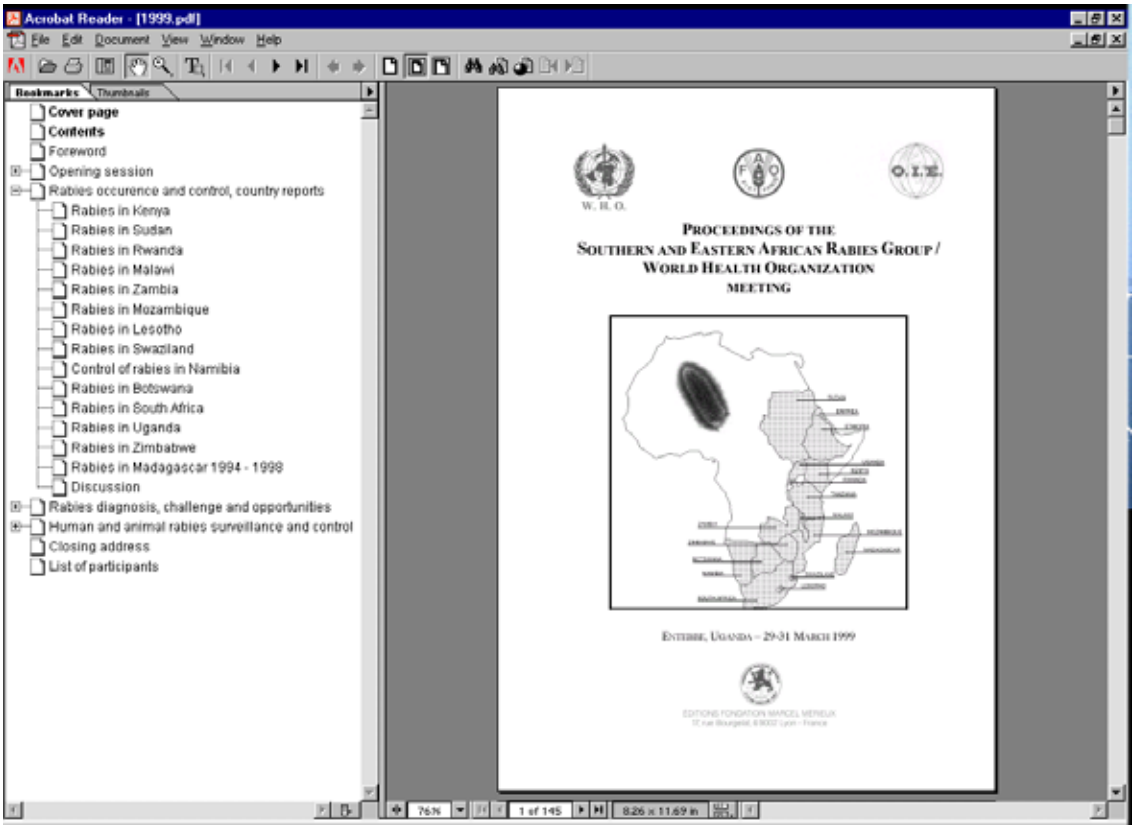
Every file has been indexed on the titles of papers to have a more rapid access. A search function is included in the reader programme.



SEARG QUARTERLY BULLETIN

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The Southern and Eastern African Rabies Bulletin is compiled and edited by

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The survey is sponsored by the World Health Organisation, Geneva, Switzerland

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1. INTRODUCTION

This bulletin is a compilation of the Quarterly Questionnaires sent out to rabies diagnostic officers in the Southern and Eastern African Region.

This issue reports on the rabies cases and diagnostic facilities used in the region for the period January to March 2001. Five out of 13 countries have responded.

The editors would like to thank the people who took the trouble to return the questionnaire and would like to encourage those countries for which no data was received to submit their returns. The data for late returns will be compiled in future bulletins.

2. SUMMARY OF RETURNS.

At the deadline no returns were received from the following countries: Zambia, Tanzania, Lesotho, Swaziland, Uganda, Kenya, Sudan and Mozambique.

3. NUMBER OF RABIES CASES.

3.1 HUMAN RABIES

Table 1: Number of human rabies cases by method of diagnosis.

Country	Laboratory	Clinical	Total
Botswana	NA	NA	NA
Malawi	NA	NA	NA
Namibia	ND	ND	ND
South Africa	1	0	1
Zimbabwe	1	NA	1

NA = Data not available

ND = No data supplied

3.2 ANIMAL RABIES

Table 2: Number of animal rabies cases by method of diagnosis.

Country	Laboratory	Clinical	Total
Botswana	23	9	32
Malawi	24	NA	24
Namibia	46	ND	46
South Africa	139	0	139
Zimbabwe	85	NA	85

Table 3: Number of laboratory-confirmed domestic animal cases by species.

Coun-try	Dog	Cat	Cattle	Horse	Camel	Goat	Sheep	Donkey	Total
Botswana	2		14			4		1	**21**
Malawi	21	1	1			1			**24**
Namibia	20	3	15	1		4	1		**44**
South Africa	73	1	23			3	1		**101**
Zimbabwe	37	4	22			6		1	**70**

Table 4: Number of laboratory-confirmed wild animal cases by species.

Species	Botswana	Namibia	South Africa	Zimbabwe
Jackal	2		2	14
Bat eared Fox			6	
Aadwolf			2	
Cape fox			1	
Suricate			2	
Mongoose			25	
Kudu		2		
Total	**2**	**2**	**38**	**14**

4. DIAGNOSTIC FACILITIES AND TESTS

Table 5: The number of laboratories carrying out rabies diagnosis

	Number of Diagnostic Laboratories	
Country	Human	Animal
Botswana		1
Kenya		2
Malawi		3
Mozambique		4
Namibia	1	1
South Africa	1	2
Sudan	1	2
Uganda	0	2
Zimbabwe	1	1

Table 6: The diagnostic tests used to confirm rabies given according to their relative importance (1= most important).

Country	FAT	MIT	Histology	Virus growth in cell culture	Other
Botswana	1	2	3		
Kenya	1	2			
Malawi	1	2			
Mozambique	1	2			Seller's
Namibia	1		2		
South Africa	1		3	2	Avidin biotin
Sudan	1		2		
Uganda	1	3	2		
Zimbabwe	1	2	3	4	

FAT = Fluorescent antibody test.

MIT = Mouse inoculation test.

5. LATE RETURNS.

During the period October to December 2000, Sudan reported 14 clinically diagnosed animal rabies cases and 17 laboratory confirmed animal rabies cases distributed as follows: 6 dog, 4 cat, 1 cattle,3 goat , 1 sheep, and 2 donkey.

Human vaccinations and vaccines

In Sudan 8758 people received post exposure treatment during year 2000, three types of vaccines were used namely, nervous tissue, tissue culture and embryonated egg vaccine. 2593 doses of vaccine were imported.

QUO VADIS SESSION

Where are we going?

Alex Wandeler chaired the Quo vadis session.

W. Shumba reported that there had been a problem with funds for the Quarterly Report and some countries not responding to the request to submit data for the report. WHO had not given any response since 1999 for the continuation of funds. The countries that had not responded at all were Zambia and Madagascar.

F. Meslin: No money has been sent to Harare for the Quarterly report as the response of countries appeared to be becoming less and there was no clear expression of interest of the countries involved. In order to obtain data from Madagascar, the Pasteur Institute (in Madagascar) should be contacted. WHO will restart funding when there is a positive response from the member states.

O. Hubschle: The results that are communicated in the Quarterly report by the WHO Collaborating Centre on Rabies in Harare also served as a source of information for the WHO rabies survey.

W. Shumba: The WHO nowadays gets the response via the Website.

F. Meslin: The information on rabies is now received via the Website and this information is shared with the rest of the world.

A. Wandeler: The Chairman and Secretary have been “serving” the organization in an admirable way for many years, since the start of SEARG. Both jobs are difficult and demand organizational skills, experience and much time that is not being paid for. It is proposed to elect a new Chairman and Secretary or to re-elect the present.

The members of SEARG are asked to come forward with proposals:

J. Godlonton: First it has to be asked if SEARG is going to continue at all. If this would not be the case, no chairman and secretary would be needed.

G. Bishop: I worked in a serving capacity. Certainly more input from the members is needed, the people for whom the group is intended for. There should be a better response to the Quarterly report. Furthermore, the paternalistic attitude needs to end and it needs to be done by all together.

A. King: During the opening speech it was said that the group belongs to you. If the group is satisfied with the achievements it could continue to meet and further countries could be invited to become part of SEARG. This, however, would require a higher amount of funding and thus of fundraising. The different member countries should also need to contribute for example by funding one of the participants of their own country. The question also is, what happens after the meeting and if the proceedings are distributed within the country?

R. Dlamini: There is a definite benefit of these meetings. Before the countries started reporting in 1995, there was no cooperation between veterinarians and medics. Now quite a number of countries report good cooperation between the two professions.

P. Kloeck: In every meeting there were one or two presentations that have had an influence on the adapted legislation (on rabies in RSA). This is an opportunity to share knowledge and I hope the group will continue to exist. I will take back to RSA the need to contribute financially to the group.

P. Mijere: This is the first time for me to attend this meeting and I have gained a lot. It should not be taken lightly that no data is being collected and learned on specific post mortem technique. There is a need to meet in future.

O. Hubschle: The meetings are very helpful and much information is exchanged. SEARG could eventually enlarge its scope by including other zoonoses in Africa.

S. Masabo: (in French): I am very happy to have been invited to the SEARG meeting. We will certainly continue to work on rabies in Burundi and also participate in these meetings.

M. Letshwenyo: For me it is also the first time to participate personally although the country has been represented before. In Botswana there are still some virological and epidemiological aspects that need to be improved. This is a well-focused and important group. The message for funding will be taken back to Botswana.

J. Godlonton: It is difficult to elect a Chairman and Secretary, they have served us for a long time.

A. Wandeler: Thanks to both the group has continued to exist.

P. Mijere: The Chairman and Secretary do a lot of work amd the country hosting needs to be highly involved to assist.

F. Meslin: The WHO regional Office for Africa is not paying any attention to rabies. It has been brought forward by the mentioned office that rabies is the most important zoonoses in Africa. Therefore it is recommended that the group should stick to one zoonoses and do it well. In the other WHO regions, this type of meeting are also organized and generally the regional office puts the resources together. The WHO regional office in Harare has no staff and no money for this field. This however should not stop these meetings from existing.

A. Wellington: The Industry last presented something during the meeting in Harare (1995) and has not received any Quarterly report. The sponsor do not clearly get anything back from their involvement.

A. Wandeler: This will be corrected immediately.

G. Bishop: Even the Chairman does not receive the Quarterly report.

We have not achieved what had been set out to do in earlier meetings: to stop human rabies. We are presently still at the information gathering stage and the surveillance and liaison has not been improved.

T. Mebatsion: As reallocation of resources is a major issue, is there a possibility for SEARG to become self-sufficient for example by contacting companies that produce vaccine for veterinary use, sell it and then become independent.

A. Wandeler: Please clarify. Would this mean SEARG becoming a private enterprise? We are not a governmental association in any case. We have learned where rabies is and the reports of the countries have become much more open in discussion of the real problems. Therefore it is important for the group to continue. It could be said that every human case of rabies is a reflection of the failure of the system.

F. Meslin: Camilo Vargas from the Americas showed how rabies was decreased to less than 100 human cases nowadays per year for the whole of the Americas. This however did not happen suddenly. During a meeting in the mid 80's in Brazil it was realized that the meetings had to be held at ministerial level with high-ranking officers and the health secretariat in order to have an impact. Maybe the goals of SEARG are too high to reach.

A. Wandeler: One of the major difficulties of SEARG now is that there is too little commitment of the governments at this moment.

G. Bishop: If SEARG would only sponsor one participant, would the government pay for the other participant?

The Group accepted.

R. Winyi Kaboyo: If it would be possible, could the SEARG committee arrange for high-level meetings, for the government to support this organization? Most participants come from middle cadre and have no decision-making powers and mostly operate at technical level and have no influence on the financial side.

With regard to sponsorship: most countries are poor but have not given rabies the necessary support. Some countries only send one delegate, some two only when the persons have been invited (= paid for). It is important to inform the government accordingly.

C. Vargas: I have admiration for the organization. If politicians who also would be scientists would be added, pressure could be put on governments and the WHO regional office.

F. Meslin: The meeting of directors in the Ameicas had certainly had its influence on the programme. A higher profile would facilitate resource allocation.

C. Rutebarika: The proceedings are shared with all the persons involved with rabies in Uganda. It would be useful if the secretary elected and WHO would approach the OIE to include rabies in their programme of the next OIE meeting to be held in Khartoum in October 2001 and request their support.

P. Kloeck: I would propose to re-elect the chairman and secretary and to elect a vice-chairman, who would be "groomed" for this function.

The Chairman (Arthur King) and secretary (George Bishop) are re-elected for these positions and accept. Roland Dlamini is elected vice-chairman

Arthur King thanks Alex Wandeler, Jacques Barrat and George Bishop for their hard work.

The next meetings to be held are proposed as:

Swaziland by Shumba, Namibia by Kloeck and Botswana by Zezah.

George Bishop informs the group that South Africa has not been able to supply conjugate to the region and he recommends the members to write a letter to the Onderstepoort Institute to ask for the support to continue to supply conjugate. Dr. Meslin assured the group that W.H.O. will continue to support for another 3 years the supply of conjugate from Onderstepoort.

Further it was proposed that the SEARG secretariat writes a letter in the name of the members to continue the production of conjugate for the region. Meslin from WHO will also write letter of support. Dr. Liebenberg invited the members to inform her via e-mail about the amount and time-frame when the conjugate would be needed for her to take adequate action.

It was mentioned, the agenda for the regional OIE meeting has already been defined and it is too late to incorporate rabies on its agenda. Nevertheless for the next year meeting this could be included. Each country should push for this at ministerial level for the Chief Veterinary officers to put it forward. Before the session was finalized, Dr. Tekleghiorghis from Eritrea asked WHO to distribute the material for the "straw-sampling-method" for humans. Dr. de Balogh suggested that in future the meeting could contain an active, workshop-like session as to enhance the active involvement of the participants for information exchange.

The meeting was closed by Dr. Chizonda, Controller of Agricultural Services.

At an informal meeting of the SEARG/WHO committee, Swaziland was chosen as the venue for the next meeting to be held in 2003.

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