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Status of canine vaccination and the prevalence of rabies in humans and dogs in Plateau State, Nigeria 1998-2007

by

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Submitted in partial fulfilment of the requirements for the degree of Magister Scientiae (Veterinary Science) in the Department of Paraclinical Sciences, Faculty of Veterinary Science, University of Pretoria, South Africa

Date submitted: January 2009

ACKNOWLEDGEMENTS

The completion of this dissertation would not have been possible without the support of the following people and I wish to thank:

Professor CME McCrindle, my supervisor for her enthusiasm and valuable guidance from the inception to the completion of this dissertation

Ms S Lebogo, secretary of VPH, for her patience and secretarial assistance

Drs. Melvyn Quan and M Suleiman for assistance with computer work.

The Director, staff and management of the Directorate of Veterinary Services in the Ministry of Agriculture and Natural resources, Jos Plateau State.

The Executive Director, staff and management of National Veterinary Research Institute Vom, for their valuable support. Dr. LU Muhammad, Mal Salisu Musa and the other staff members of the Veterinary Extension department (VERLS) of the NVRI , Plateau State Specialist Hospital Jos staff and management, Jos University Teaching Hospital staff and management, ECWA Evangel Hospital Jos staff and management and ECWA veterinary clinic Jos staff and management. I say thank you all, and God bless.

I wish to thank my Daddy; Col. JEJ Idachaba (rtd), Mummy; Mrs HA Idachaba and siblings for their support and unrelenting prayers to God Almighty for success in my academic endeavour. I needed the prayers! I love you all, thank you and God bless.

DEDICATION

I dedicate this work to God Almighty, for the strength and ability to do this work even in the midst of so much challenges and discouragement. Glory be to God Almighty (Amen).

DECLARATION

I, **Stella Ejura Idachaba,** hereby declare that the work on this thesis is original and that neither the whole work or part of it has been, is being, or shall be submitted for another degree at this or any other university, institution for tertiary education or professional examining body.

_____

Stella Ejura Idachaba (DVM)

12 January 2009

_____

Date

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ABBREVIATIONS

DVS	=	Director of Veterinary Services Plateau State
LGA's	=	Local Government Areas
GVC	=	Government Veterinary Clinic
PVC	=	Private Veterinary Clinic
NVRI	=	National Veterinary Research Institute Vom
RDL	=	Rabies Diagnostic Laboratory
PEP	=	Pre-Exposure Prophylaxis
ARV	=	Antirabies Vaccine
HRIG	=	Human Rabies Immunoglobulin
ERIG	=	Equine derived Rabies Immunoglobulin
IFAT	=	Immunoflourescent Antibody Test
JUTH	=	Jos University Teaching Hospital
ECWA	=	Evangelical Church of West Africa
OLA	=	Our Lady of Apostle Hospital
PSSH	=	Plateau State Specialist Hospital
PSVH	=	Plateau State Veterinary Hospital
FCAH&		Federal College of Animal Health and
PT	=	Production Technology
GIS	=	Geographical Information System
WHO	=	World Health Organisation
PET	=	Post Exposure Treatment
LEP	=	Low Egg Passage
HEP	=	High Egg Passage

SUMMARY

Title:

Status of canine vaccination and the prevalence of rabies in humans and dogs in Plateau State, Nigeria 1998-2007

Researcher Name : **Stella Ejura Idachaba**

Promoter : Professor C M E McCrindle

Department : Paraclinical Science

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Abstract

The aim of the study was to assess the risk rabies constitutes to the public in Plateau State. Despite the existence of regulations on antirabies vaccination, dog movement and population control (WHO, 1997; WHO, 2004), rabies remains a public health problem in Nigeria. Most reported cases of rabies deaths in humans and canines are associated with unvaccinated dogs, and the infection could be prevented through appropriate vaccination as recommended by the law of the state.

This research established the canine rabies vaccination coverage of Plateau State. The status of human rabies, canine rabies and mitigation strategies for control of rabies were also determined. A total of 760 cases were recorded; n=5

(0.66%) cases of human rabies, n=751 (98.8%) in dogs and n=4 (0.5%) in cats in the study period (1998-2007).

Research indicated a low prevalence of human rabies in Plateau State which may be attributed to under-reporting, although showing 100% cases of recorded human rabies were due to dog exposure, a high status of canine rabies in the state with a prevalence rate of >59% with a sharp increase in the rate of occurrence of canine rabies in the years 2000, 2001, 2002, 2003 and 2004. The high level of occurrence persisted in 2005, 2006 and 2007 indicating its endemicity in the state. All the purposively selected ten local government areas visited indicated occurrence and passive canine rabies control surveillance in the state, with a canine rabies vaccine coverage of 10.57%.

Informal interviews with medical doctors in the state and members of the public showed that citizens at risk of contracting rabies do not go for the pre-exposure prophylactic treatments. It appears that many of the citizens of Plateau State still see rabies as ‘insignificant’ and do not take serious measures to prevent or control the occurrence of the disease in the state. During the study n=72 purposively selected citizens of the state were interviewed. Of these, n=9 persons indicated they were ignorant of the disease, n=25, said that they would not vaccinate their dogs because it changed the taste of dog meat and affected the canine teeth of hunting and protection dogs. Only n-23 always vaccinated their dogs for preventive purposes, because they had heard about the disease and wanted their dogs and themselves to be safe, this group appeared to be pet dog owners. Also, n=15 persons could not remember vaccinating their dogs.

An aggressive enlightenment campaign should be carried out to create awareness of the endemicity of rabies in the state and of the importance of post-exposure prophylaxis in people bitten by dogs, as this does not seem to be happening. There appears to be a lack of record keeping and this deficiency must be made a priority in order to do effective surveillance and control of canine rabies in Plateau State.

It was also recommended that there is a need for active and effective collaboration between veterinarians, medical doctors and environmental specialists to help control and prevent the occurrence of rabies in Plateau State.

Veterinary extension and communication strategies were used to develop risk communication and risk mitigation and were demonstrated by the preparation of posters and pamphlets appropriate for use in Plateau State Nigeria.

CHAPTER 1

INTRODUCTION

1.1 Background

The endemicity of rabies in Nigeria has been well documented (Bougler & Hardy, 1960; Owolodun, 1969; Banerjee & Elegbe, 1970; MacAdam, 1976; Opaleye *et al*., 2006). Although available records on rabies in Nigeria are far from complete, reports of human deaths from rabies in the country are a matter of great concern (Bryceson *et al*., 1975; Fagbami *et al*., 1981; Opaleye *et al*., 2006). Fagbami and his co-workers reported 99% of rabies victims in Nigeria contracted the disease from dogs. The Nigerian public is largely aware that rabies results from dog-bites (Harry *et al*., 1984). A substantial body of epidemiological theory has been developed over the past 20 years, in relation to the design of vaccination programmes, mainly in the context of infectious diseases of humans (Anderson & May, 1991). An epidemiological theory has however been applied much less to veterinary vaccination programmes and relatively few empirical data sets are available to test the predictions of epidemiological theory (Cleaveland *et al*., 2003).

Rabies is a fatal disease distributed all over the world, which can be eliminated by vaccination of reservoir animal populations (Wolfgang, 1999; Cleaveland *et al*., 2003). It is an acute viral disease that attacks the central nervous systems of its victim and is passed from animal to animal or human to human through bites or scratches. Direct human to human transmission has also been described (Fekadu

et al., 1982; Seifert, 1996; Wolfgang, 1999; Bishop *et al*., 2002; Swanepoel, 2005; CDC, 2007; WHO, 2008). The rabies virus is mainly contained in the saliva of animals (Seifert, 1996; Bishop *et al*., 2002; Swanepoel, 2005; CDC, 2007; WHO, 2008) but tears, urine, serum and other body fluids may be infectious as well (Wolfgang, 1999). There is little or no chance of survival after the onset of clinical symptoms, thus the concept of treatment is to remove and neutralize the infectious virus before it enters the nervous system (Wolfgang, 1999; Bishop *et al*, 2002; Swanepoel, 2005; CDC, 2007; WHO, 2008). However, during 2004, an unvaccinated Wisconsin patient received a new medical treatment and became the first documented survivor of rabies who had not received pre-exposure vaccination or post-exposure prophylaxis (PEP), suggesting the possibility of successful future interventions (Pro Med, 2006).

1.2 Motivation

A few surveillance studies of the epidemiological status of rabies and canine and human vaccination have been carried out in Plateau State Nigeria, but records are scanty and not properly collated and stored. This study should provide current data on the occurrence of rabies in humans and dogs in Plateau state, Nigeria. Maps of Nigeria and Plateau state are shown in Plates 1.1 and 1.2.

The data obtained will be used to calculate the incidence of rabies in the state, and thus add to the knowledge of the epidemiology of rabies. It should also create better awareness of the status of rabies and further stimulates the interest of the population at risk in the prevention and control of rabies.

Plate 1.1 Map of Nigeria showing Plateau State

Plate 1.2 Map of Plateau State, Nigeria. Study area showing different local government areas (LGA's)

1.3 Research Problem

Reliable data on rabies is scarce in many areas of the globe, making it difficult to assess its full impact on human and animal health. Prevention of human rabies must be a community effort involving both the veterinary and public health officials (WHO, 2004; 2008).

In Nigeria, canine rabies is thought to be on the increase in Plateau State. Due to the fact that rabies constitutes a severe public health threat, it is proposed that a further study of the epidemiological status of rabies in the state be carried out. An attempt will be made to enlighten the public about the risk of this disease in Plateau State and possibly other parts of Nigeria. This poses the following research questions:

- What hazard does rabies pose to the public (hazard characterization)? [relative frequency in dogs]
- What is the risk of transmission (risk assessment and exposure assessment)? [relative frequency in humans]
- What mitigation of the risk of rabies is in place?
- What possible future strategies can be suggested for risk mitigation?
- What possibilities are there for risk communication?

From these research questions, the hypothesis was developed.

1.4 Hypothesis

That the risk of rabies transmission to humans by dogs is high in Plateau State, Nigeria, because the majority (>50%) of the cases of rabies are as a result of rabid dog bites and vaccination coverage in dogs throughout the State is less than 70%.

1.5 Objectives

The following objectives have been identified:

- To determine the number of dog rabies cases reported to major veterinary hospitals in Plateau State over a ten year period (1998 – 2007), using retrospective records from the veterinary clinic and diagnostic division, NVRI Vom, Evangelical Church of West Africa (ECWA) veterinary clinic in Bukuru, as well as the Plateau State Veterinary Hospital at Jos.
- To determine the incidence of human exposure to dog bites using retrospective records from the medical facilities at Plateau State Specialist Hospital and the Jos University Teaching Hospital, over the same ten year period.
- To compare rabies control in Nigeria with WHO and OIE guidelines.
- To propose risk mitigation and risk communication strategies on the basis of results received from the above retrospective records in various facilities visited for data collection within the state.

1.6 Work Plan

The work plan is summarised below:

- Human medical health care facilities will be visited to obtain retrospective data from records of human rabies within the study period. Prior to the record search, three medical officers from each of the different facilities will be interviewed on their experiences of the management of human rabies cases seen and dog-bite wounds. Information on standard procedures used for human pre and post-exposure prophylaxis will be recorded.
- Veterinary practices in the different Local Government Areas (LGA's) and major veterinary facilities where rabies cases are handled, will be visited to investigate records of rabies cases encountered and managed within the study period. Data will be obtained retrospectively from these records of anti-rabies vaccine coverage in the state over the ten year period.
- An interview will be conducted with the chief veterinarian in the state to get details on legislation concerning rabies and the on-going control measures used in Plateau State**.**
- After returning to the Section of Veterinary Public Health (VPH) in the Department of Paraclinical Studies at the Veterinary faculty of the University of Pretoria, the data will be analysed using Microsoft Excel ®.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

"*The horrendous manner in which rabies manifests itself in its victims continues to attract the attention of scientists, health and veterinary workers*"

(Bishop *et al*, 2002).

Rabies is a transmissible viral disease that affects both animals and humans. It is a fatal disease of humans and all other mammals, caused by a virus which has been associated with animal bites for more than 3,000 years and it is the oldest infectious disease known to medical science (Rupprecht *et al*., 1987; Wilkinson, 1988; Bishop *et al*., 2002; Swanepoel, 2005). Rabies is a preventable viral disease of mammals most often transmitted through the bite of rabies infected animals (Bryceson *et al*., 1975; WHO, 2004; Swanepoel, 2005; Luyang, 2006; Morales *et al*., 2006; Paweska *et al*., 2006; CDC, 2007). It is a viral infection that causes acute, progressive encephalitis and is considered to be universally fatal (Pro Med, 2006; Coetzee & Nel, 2007). Rabies however, remains a vaccine- preventable disease but is still a significant public health problem in many countries in Asia and Africa (WHO, 2008). Domestic dogs (*Canis familiaris*) have long been recognised as the main transmitters of the disease to people (Foggin, 1982; King & Turner, 1993; Oboegbulem, 1994; WHO, 2004; Haiying & Boayan, 2006; Sengoz, *et al*., 2006; WHO, 2008). Rabies virus is one of the most widespread animal viruses and continues to scourge virtually the entire globe as the agent of severe and lethal

encephalopathy of all terrestrial mammals, including man (WHO, 2004; Swanepoel, 2005; Coetzee & Nel, 2007). Over 99% of human cases of rabies are as a result of exposure to rabid dogs and nearly all cases terminate in death of the affected individual (Swanepoel, 2005; Goudsmil *et al*.; 2006; Lodmell *et al*., 2006; Blanton *et al*., 2007; WHO, 2008).

Recently, there have been several developments in the knowledge of rabies and its control measures. Molecular biology has revealed that several different strains of the virus exist and some strains appear to show clear host preferences. This opens the possibility of more specific diagnosis and epidemiological studies (Bishop *et al*., 2002). Luyang (2006), suggested that as rabies is a public health problem internationally, there should be strengthening of health education on prevention and control, in order to enhance people's consciousness of self protection and motivate for regular immunization of dogs and cats. This is in accordance with the OIE's suggestion in the Terrestrial Animal Health Code (Thrusfield, 2005; O.I.E, 2008). The spread of canine rabies depends on the tradition of human-dog interactions as well as on the structure and density of the existing dog population, with feral and stray dogs playing crucial roles (Beck, 1975; Tierkel, 1975; Umoh & Belino, 1979).

2.2 Aetiology

Rabies is caused by a virus of the family Rhabdoviridae and the genus Lyssavirus. This type of specie is now called Lyssavirus 1 (Swanepoel, 1994; Seifert, 1996; Swanepoel, 2005). The virus is bullet-shaped, measuring 180x75nm and consists

of a nucleocapsid measuring size 160x50nm which is surrounded by a bilayer lipid envelope derived from host cell membranes (M), through which flattened spikes, or peplomeres project. It contains an RNA genome (Charlton 1994; Seifert, 1996; Coetzee & Nel, 2007).

2.3 Epidemiology

Rabies is an ancient disease and its history traces back more than 3,000 years (Bishop *et al*, 2002), yet it remains an important global disease (Lackay *et al*., 2008) with over 50,000 annual fatalities (Swanepoel, 2005; Goudsmil *et al*., 2006; Lodmell *et al*., 2006; Blanton *et al*., 2007; WHO, 2008). Most of the human cases occur in Asia and Africa, where dog rabies remains endemic or epizootic, and thus the main source for human exposure (Fu, 1997). An enzootic viral disease widespread throughout the world, it is a vaccine preventable disease (Sugiyama & Ito, 2007).

2.3.1 Distribution and transmission

Rabies is widely distributed throughout the world and it is present in all continents (Rupprecht *et al*., 1987; Wolfgang, 1999; CDC, 2008; WHO, 2008). Canine rabies has existed in Algeria, Morocco, Tunisia and Egypt for centuries; these countries reporting more than 100 cases a year in dogs (Cleaveland *et al.*, 2002).

The natural transmission of rabies from animal to animal or to man is via bites as the virus is present in the saliva of the affected animal (Wilkinson, 1988; Bishop *et*

al., 2002; Swanepoel, 2005). As the virus is excreted in saliva, infection can also occasionally occur via scratches infected with saliva although the infection rate is 50 times lower (McKay & Wallis, 2005). There is no substantiated case of transmission by human saliva, although transmission from human to human has been described through organ transplants (WHO, 2004). Two types of rabies epidemiology are described. The first is the so-called “street form”, “urban rabies” or “canid rabies” where the domestic dog is the main vector and there is a very high risk to humans. Secondly, the so–called “sylvatic form” where the disease circulates in the wildlife population and man is only an accidental or occasional host (Bishop *et al*., 2002; Swanepoel, 2005). In Nigeria, the urban form is probably the most significant (Opaleye *et al*., 2006).

2.3.2 Potential sources of human infection

The potential sources of human infection are listed as:

- Any infected animal that has started to excrete the virus in the pre-clinical phase, several days before clinical signs are seen, in countries where rabies is endemic in wildlife, pets and livestock (Bishop *et al*., 2002; Coetzee & Nel, 2007; OIE, 2008).
- The only infective and zoonotic source of rabies in the United Kingdom (UK) is in that part of the bat population, which is infected with the EBLV2 (and possibly EBLV1) strain of the virus (McKay & Wallis, 2005; CDC, 2007).
- Workers in quarantine kennels or dealing with animals imported illegally and or the owners of those animals may be exposed to infection brought in from abroad in countries such as UK, Australia and New Zealand, where rabies is not endemic (WHO, 2004).

- In countries with established infections, infected wildlife or companion animals would be the most likely sources (WHO, 2006).

2.4 Symptoms

2.4.1 Rabies in dogs

The domestic dog (*Canis familiaris)* has been described as the natural reservoir or vector host of the virus, depending on the author (Foggin, 1982; King & Turner, 1993; Oboegbulem, 1994; WHO, 2004; Haiying & Boayan, 2006; Sengoz, *et al*., 2006; Lackay *et al*., 2008; WHO, 2008).

Plate 2.1 A rabid dog showing aggression (**Source: WHO**, **2008)**

Dogs represent more than 75% of rabid animals in most African countries (Okoh, 2000; Bishop *et al*., 2002; Swanepoel, 2005).

A photograph of a dog in the aggressive phase of rabies is shown in Plate 2.1

The classical course of rabies in dogs has the following three stages:

- The prodromal stage. The dog is shy, quite or unusually friendly.
- The excitation stage (raging fury). This stage is characterised by restlessness, excitement, aggressiveness, a mania for biting and snapping at any object. At this stage, the saliva is highly infective.
- The paralysis stage or silent fury. This stage appears shortly before death (Charlton, 1994; Seifert, 1996; Bishop *et al*., 2002; Swanepoel, 2005).

2. 4. 2 Symptoms of human disease

The incubation period of the disease may range between 9 days to 2 years in humans, but is generally 2-8 weeks (Bishop *et al*., 2002; McKay & Wallis, 2005). Early symptoms may include numbness or tingling around the bite site, fever, loss of appetite, tiredness, weakness, headaches, or other aches and pains (Bishop *et al*., 2002; Lackay *et al*., 2008). Later, stimulation of any of the senses (by touch, noise or light etc) may provoke violent and painful muscle spasms (See Plate 2.2).

Hydrophobia and maniac behaviour may alternate with periods of full comprehension. The disease progresses to paralysis and coma, and death follows from respiratory arrest (WHO, 2001; Bishop *et al*., 2002; Swanepoel, 2005; Lackay *et al*., 2008).

Plate 2.2 A patient (male) showing muscle spasm. (Source: Wikipedia, free encyclopedia, 2008)

The severity, location and multiplicity of bites inflicted on the victim influence the outcome. Bites on the head and neck result in the shortest incubation (resulting in a quick manifestation of clinical signs and symptoms in humans; Headache, malaise, restlessness and hydrophobia seen almost immediately) periods and the highest mortality rate (Seifert, 1996; Bishop *et al*., 2002; Swanepoel, 2005).

Rabies should be suspected in any case where a dog or human (patient) presents with neurological signs after having been bitten by a rabid dog or other mammal, particularly in an endemic area (Bishop *et al*., 2002; McKay & Wallis, 2005; Swanepoel, 2005). Plate 2.3 shows a child with a bite on the face caused by a rabid dog.

Plate 2.3 A child with a bite on the face caused by a rabid dog. (Source WHO, 2008.)

2.5 Diagnosis

No *intravitam* test for rabies exists, therefore determination of whether to kill an animal and examine its brain for evidence of rabies depends on the situation of attack. Stray and unwanted domestic dogs and cats involved in unprovoked biting incidents are killed and tested (Smith, 1996). If the animal is not overtly “rabid”, it

can be observed for 10 days (Seifert, 1996; Bishop *et al*., 2002; Swanepoel, 2005).

Euthanasia of the animal is always considered after an attack or bite by animals, especially dogs showing rabies symptoms, in order to make a diagnosis and treat the human concerned (Oboegbulem, 1994; Seifert, 1996; Bishop *et al*., 2002; McKay & Wallis, 2005; Swanepoel, 2005).

No tests are currently available to diagnose rabies infection in humans before the onset of clinical disease (Smith, 1996; WHO, 1997; Jackson, 2007). Hence diagnosis in human patients is based on clinical history, symptoms and signs, supported by epizootiological information (Fu, 1997; McKay & Wallis, 2005; Jackson, 2007). Diagnosis is usually made at autopsy, if rabies is suspected and the patient dies (Swanepoel, 2005).

2.5.1 Laboratory diagnosis

The brain tissue is examined and rabies antigen detected within a few hours by direct immunoflourescence. The direct immunoflourescent-antibody (dIFA) test is the preferred test for rabies diagnosis (Smith, 1996; Bishop *et al*., 2002; McKay & Wallis, 2005; Swanepoel, 2005). The dIFA test is rapid, sensitive, specific, easy to perform, and relatively inexpensive (Dean *et al*, 1996; Smith, 1996; WHO, 1999).

The immuno-peroxidase test can also be used on both fresh and formalin-fixed brain tissues to diagnose rabies (Hamir & Moser, 1994; Baba, 1999; Whitfield *et al.*, 2001; Ajayi *et al*., 2006).

2.5.2 Differential diagnosis

Rabies is considered in the differential diagnosis of many suspected mammalian encephalitides. Some conditions that may be clinically confused with rabies in canine and feline species include tetanus, canine distemper and infectious canine hepatitis, toxoplasmosis, cerebral babesiosis and tetanus should be differentiated in bovine and ovine species, meningitis /encephalitis, botulism and heartwater in cattle and sheep (Seifert, 1996; Bishop *et al*., 2002).

2.5.3 Differential diagnosis of rabies in humans

Conditions like hysterical pseudo-hydrophobia, tetanus, encephalitides, including other viral infections, *delirium tremens*, various chemical intoxications, typhoid fever and poliomyelitis can be clinically confused with rabies in humans (Warrell, 1996; Bishop *et al*., 2002; Swanepoel, 2005).

2.6 Control

Control of rabies is by prevention of infection, which can be maintained by active immunization of animals and strict quarantine regulations (Okoh, 2000; McKay &

Wallis, 2005; Swanepoel, 2005; Opaleye *et al*., 2006; Sugiyama & Ito, 2007; OIE, 2008).

A range of highly effective, safe and thermostable, inactivated veterinary vaccines is currently available (Barth *et al*., 1985; Van Steenis *et al*., 1985; Swanepoel, 1994). In some countries (e.g. Nigeria) live rabies vaccines are still used in dogs (Okoh, 2000; Opaleye *et al*., 2006). In most other countries, inactivated vaccine is used (Swanepoel, 2005).

2.7 Human immunization and post-exposure treatment

The high demand for post-exposure prophylaxis (PEP) in Africa and Asia exerts a substantial economic burden, as a result of the high cost of human vaccine (Cleaveland *et al*., 2003). Antiserum is used to provide immediate protection until vaccine–induced immunity becomes effective (Swanepoel, 1994; Swanepoel, 2005). Inactivated and purified vaccines prepared from virus grown in human diploid cell cultures were developed during the 1960s and became increasingly available for use in humans during the 1970s and 1980s, however they are expensive to produce, partly because of rigorous quality control (Kuwert & Scheiermann 1985; Bishop *et al*., 2002).

From the WHO website it can be noted that:

"WHO strongly advocates the use of modern (purified products prepared on cell-culture) vaccines for the PET that comply with WHO criteria for potency, innocuity

and have been assessed satisfactorily in humans in well-designed field trials'' (WHO, 2006).

2.7.1 General considerations in rabies post-exposure treatment

General considerations in PET include the following:

- A rabies case is an emergency and as a general rule should not be delayed or deferred.
- There is no contradiction if modern purified rabies biologicals are used.
- PET must be applied using vaccine regimens and routes of administration that have been proven to be safe and effective (WHO, 2006).

Immediate washing or flushing with disinfection of the wound and rapid administration of purified immunoglobulin and modern vaccine according to the modalities described in the guidelines, assure prevention of infection in almost all circumstances (WHO, 1997). Human cases require specialised hospitalisation procedures. Management failures are usually due to deviations from the WHO management recommendations and lack of essential biologicals (Jackson, 2007; Wilde, 2007).

2.8 Literature review of the status of rabies in Nigeria

The epidemiology of rabies in Nigeria is like that of many developing countries where the canine, rather than the sylvatic, form predominates and all the classic

and well-known aspects of the dog-human cycle are reported (Boulger & Poterfield, 1958; Shope *et al*., 1970; Ezeokoli & Umoh, 1987). Rabies in Nigeria, as in many parts of the world, endangers both human and animal health (Radostis *et al*., 1995). The disease has vernacular names; "*ara nkita*" in Igbo, "*ciwon haukan kare*" in Hausa, "*ginnaji*" in Fulfulde, "*digbolugi*" in Yoruba, "*idat ebua*" in Efik/Ibibio authorities (Oboegbulem, 1994). Outbreaks are frequently reported to veterinary authorities. The epidemiology of the disease is further complicated in Nigeria, by stray dogs that roam the cities, as most dog owners let their dogs roam the streets. Rabies is likely to be enzootic in urban areas, as in all states of Nigeria as dogs are the main reservoir host (Acha & Szyfres, 1987).

Since the ancient times it had been recognised that the causative agent of rabies is associated with saliva of mad dogs (Boulger & Poterfield, 1958; Oboegbulem, 1994). Despite efforts to control rabies, the disease continues to be a major scourge of dogs and cats in Plateau state and in Nigeria in general (Umoh & Belino, 1979; Ezebuiro *et al*., 1980; Fabgami *et al*., 1981; Okoh, 1986).

In Nigeria, all published reports have established dogs as the predominant vector of rabies. The 1942 annual report of the Veterinary Division of Northern Nigeria recorded canine rabies outbreaks from Kano, Zaria, Borno and Ilorin and in 1946 outbreaks were reported from Plateau, Markurdi and Enugu. A more extensive record compiled from the annual reports of the Rabies Diagnostic Laboratory at the National Veterinary Research Institute (NVRI) Vom, indicates that during the period 1928 to 1990, 3,555 out of 3,770 animal rabies cases confirmed in Nigeria

occurred in dogs (Oboegbulem, 1994). In 1993, the WHO reported that in Ghana, a neighbouring country to Nigeria, dogs accounted for 474 (or 96%) of 494 incidents of animal rabies confirmed between 1981 and 1999 (Alonge & Abu, 1998; Domingo, 2000; Kiyali *et al*., 2003).

Specific control measures are crucial for recognising and minimizing the incidence of rabies. The routinely applied strategy is the annual vaccination of dogs and cats against rabies. In Nigeria vaccination against rabies commenced in 1935 (Okoh, 1982). Later, the production laboratory was faced with problems during manufacture, storage and transportation and the vaccine became associated with neuroparalytic accidents and vaccine failure (Okeke, 1983 unpublished work). Consequently the dog vaccine was withdrawn from the field within five years of its issue (Thorne, 1954). In 1956, the NVRI Vom made available the Flury low egg passage (LEP) vaccine, which has since then been made available for vaccination of dogs and cats in Nigeria (Oboegbulem, 1994).

Among the measures recommended for rabies control, vaccination constitutes the main solution that can be applied against canine rabies (Lombard *et al*., 1988) as well as to interrupt the rabies transmission cycle; WHO recommends 70% minimum vaccination coverage of the population at risk in all areas (Adeyemi & Zessin, 2000). Thousands of dogs are vaccinated annually with the Flury LEP vaccine strain, produced at Vom, Nigeria (Nawathe *et al.,* 1981), but the prevalence of the disease in dogs and cats has not declined (Durojaiye, 1984; Okoh, 1986). Various workers have reported rabies in vaccinated dogs in Nigeria (Okoh, 1982; Bobade *et al*., 1983; Okoh *et al*., 1985; Oboegbulem *et al*., 1987).

Okoh in 2000 also isolated rabies virus from three previously vaccinated dogs that died of rabies.

The occurrence of street rabies virus in vaccinated dogs dying from the disease suggests a failure of the LEP vaccine to protect against invading street variants, although it was not possible to determine the antibody titre in dying vaccinated dogs (Okoh, 2000). Occasional failure occurs even when the vaccine is assumed to be potent (Hattwick *et al*., 1972; CDC, 1976). It was also suggested that lack of cold-chain maintenance in vaccines used in dogs may have made them less effective or ineffective (Adeyemi & Zessin, 2000; Adesina & Harry, 2005).

Inadequate vaccination coverage may also contribute. Low vaccination coverage results in a build up in the susceptible dog population and favours large scale epizootic or focal outbreaks, with an increase in the risk of rabies for humans (Adeyemi & Zessin, 2000). Reported cases of dog bites and rabies in humans in Nigeria are low; this could be attributed to under-reporting, or lack of knowledge of the danger of rabies to humans and cultural beliefs in the area (Fagbami *et al*., 1981; Oginni *et al*., 2002). Prevention and control of rabies in humans is by vaccination, treatment and health education. According to Coker *et al.,* (2000) as a first measure to improve control, the link between the veterinary and medical officers in Nigeria, which was very weak, needs to be strengthened.

CHAPTER 3

MATERIALS AND METHODS

3.1 Model system and justification of model

The model system employed was collection, collation, classification and analysis of retrospective data on rabies in humans and dogs in Plateau state, Nigeria, from 1998 to 2007. This was an incidence study, as described by Thrusfield (2005). The data was used do risk analysis and propose suitable risk mitigation and communication strategies to decrease the incidence of human and dog rabies. Data were collected taking into consideration environmental determinants that influence the disease occurrence, canine gender, age and vaccination records and general history of affected animal/human to estimate seasonal and annual incidence rates.

3.1.1 Study area

The study area included the human and dog populations of Plateau State. Census data from the Nigerian National Census of 2006 showed that the state has an estimated human population of 3.1 million people. In Plateau State dogs are kept both for hunting and as a source of meat and dogs are sold commercially, however there is little data available on the dog population and dog: human ratio. Retrospective data was collected from the Plateau State Veterinary Hospital, the National Veterinary Research Institute Vom and the Evangelical Church of West

Africa (ECWA) veterinary clinics Bukuru-Jos, as these are the main sources of data on rabies in Plateau State Nigeria. Records on dog bites and rabies in humans were also sourced from the ECWA Hospital (Evangelical Church of West Africa), Plateau State Specialist Hospital and the Jos University Teaching Hospital, as these are also the main sources of data on human cases (dog bite/rabies) in Plateau State Nigeria. These records have not previously been studied or collated for clues to the control of rabies in Plateau State.

The study area, Plateau State, is one of the thirty-six states that make up the Federal Republic of Nigeria, including the Federal Capital Territory of Abuja. It derived its name from the Jos plateau, which is the ubiquitous and predominant geographical landscape in the middle belt of Nigeria. Plateau State is located in the Middle Belt Zone, lies within latitude 80^{o} 22" North and 100^{o} 24" North and longitude 80^{o} 32" East and 100^{o} 38" East and has a total land area of 26,899 square kilometres. It is bordered in the North West by Kaduna State, in the North East by Bauchi State, in the South West and West by Nasarawa State and in the South East by Taraba State (see map in Chapter 1 Plates 1.1 and 1.2). The State has a daily average temperature of between 18^{0}C and 22^{0}C.

Plateau State is inhabited by several ethnic groups, who speak mainly Hausa and English. The Nigerian National Census of 2006 revealed that about 3.1 million people live in Plateau State. It is cosmopolitan because a fraction of every tribe in Nigeria can be found in the State (National Population Commission, 2008). The State has seventeen local government areas. These include Barakin-Ladi, Bassa, Bokkos, Jos North, Jos South, Jos East, Kanam, Kanke, Lantang North, Lantang

South, Mangu, Mikang, Pankishin, Quan-Pan, Riyom, Shendam and Wase. The population is mainly engaged in farming, hunting and mining as their means of livelihood. On the average, 30% of the population are civil servants (National Population Commission, 2008).

3.1.2 Study design

A checklist was developed to collect, collate and classify data on rabies vaccination, number of submitted and positive cases (animal) from Plateau State Veterinary Hospital, National Veterinary Research Institutes, veterinary clinic and diagnostic division and the ECWA veterinary clinic Bukuru. Retrospective data of human cases of dog bites / rabies were also collected from the ECWA Hospital, Plateau State Specialist Hospital and the Jos University Teaching Hospital for analysis. These facilities diagnose and control rabies in the Plateau State and neighbouring areas.

3.2 Observational and analytical procedures and statistical tools

Simple descriptive statistical methods were used in the study and description of recorded rabies cases and the possible causal factors. The incidence of rabies in the state was measured by looking at the frequency per annum / local government area over 10 years and recording this in the form of tables and graphs. The incidence of rabies over the 10 year period in different LGA's in the study area was calculated.

Risk analysis, involving hazard characterization, risk assessment, risk mitigation or management and risk communication was also considered (Thrusfield, 2005).

3.2.1 Data analysis

Data obtained were analysed using the Centres for Disease Control and Prevention statistical package (Epi-Info 6.04 package, Centres for Disease Control and Prevention, Atlanta Georgia) and Microsoft Excel ® (Microsoft Corporation, USA).

3.2.2 Statistical analysis

Quantitative data was entered into Microsoft Excel ® (Microsoft Corporation, USA). Data were presented as frequency tables and graphs. Data was analysed for significant correlation as described by Thrusfield (2005).

3.2.3 Decision tree analysis

Decision tree analysis as described by Thrusfield (2005) was used to calculate probabilities to estimate the risk of zoonotic transfer of rabies from dogs to humans in Plateau State.

3.3 Interviews

Structured interviews (the questionnaire is listed in Appendix B 3) were used to

conduct an expert opinion survey of the medical officials (n=10) at the three (human health) facilities to record opinions and experiences of the disease and how it was managed. Details of pre and post exposure vaccinations in humans were also recorded. An expert opinion survey of private practicing veterinarians was also conducted on their experiences with the disease (the questionnaire is listed in Appendix B 1).

An informal interview was conducted with the Director Veterinary Services in the state to get details on actual legislation in place concerning rabies and the on-going control measures in Plateau State.

CHAPTER 4

RESULTS

4.1 Overview

The problem of prevention and control of rabies in Nigeria is a topical issue as it is an important zoonosis. Over the last decade (1998-2007), 760 cases among humans, dogs and cats were registered in Plateau State.

The results of this study include data on canine rabies vaccination and rabies occurrence in dogs, obtained from the Plateau State Veterinary Hospital (PSVH); the Federal College of Animal Health and Production Technology clinic (FCAH & PT) Vom; National Veterinary Research Institute Rabies Diagnostic Laboratory (NVRI-RDL), Vom; private veterinary clinics in Jos and government veterinary and livestock centres in Plateau State. Data on the occurrence of human rabies was obtained from Jos University Teaching Hospital (JUTH); the ECWA Evangel Hospital; Plateau State Specialist Hospital (PSSH) and Our Lady of Apostle (OLA) Hospital, Jos. The human incidence was worked out according to the population of Plateau State obtained from the National Population Commission Nigeria (NPC) (National Population Commission, 2008). As it was obvious from the data collected that there was considerable under-reporting, incidence was also estimated from expert opinion surveys and reported incidence in neighbouring states, as per OIE standards (OIE, 2008). Using this data, risk analysis was done on human and

canine rabies in Plateau State and risk mitigation and communication strategies were designed.

4.2 Relative frequency of canine rabies vaccination

Appendix A, Table 1 shows the number of doses of canine rabies vaccines used annually by selected major veterinary clinics in Jos city and major government veterinary clinics in LGA's in Plateau State.

Ten (n=10) out of 17, randomly selected local government areas were visited to examine their records. It was noticed that canine vaccination is poorly carried out in the LGA's (see Fig 4.1). Figure 4.2 shows the level of canine rabies vaccination in the main private veterinary clinics in Jos city with Unity Veterinary doing the largest number of vaccinations in the year 2000. Maas Veterinary Clinic recorded the next highest number in 2007. Almond Veterinary Clinic had the lowest vaccination rate. The clinics generally did fluctuating numbers of canine rabies vaccination annually during the study period.

However, we were told that dog owners that take care of their dogs would rather visit government establishments because of the subsidies they offered.

Fig 4.1 Canine rabies vaccination records of Government Veterinary Clinics in Jos Central and ten LGA's in Plateau State

KEY: PSVH= Plateau State Veterinary Hospital Jos; BDVC= Bassa Divisional Veterinary clinic; BLDVC= Barakin Ladi Divisional Veterinary Clinic; RYDVC= Riyom Divisional Veterinary Clinic; MNDVC= Mangu Divisional Veterinary Clinic; PNDVC=Pankshin Divisional Veterinary Clinic; SHNDVC= Shendam Divisional Veterinary Clinic; JEDVC =Jos-East Divisional Veterinary Clinic; KNDV= Kanke Divisional Veterinary Clinic; JSDV=Jos South Divisional Veterinary Clinic.

Figure 4.1 shows the level of canine rabies vaccination in the different veterinary clinics in the LGA's in Plateau State over the study period. Fewer canine rabies vaccinations were done at GVC's, in comparison to the private clinics shown (Fig 4.2). A notable exception is the PSVH Jos, which is in the central urban area, where there was a high number of vaccinations throughout the study period, with a marked increase in 2007.

Fig. 4.2 Canine rabies vaccination record of private veterinary clinics within Jos city (Plateau State Nigeria)

KEY: FCAH= Federal College of Animal Health and Production Technology; MVC= Maas Veterinary Clinic; YYC= Yaks and Yaks Veterinary Clinic; UVC= Unity Veterinary Clinic; AHVC= Ahmid Veterinary Clinic; AVC = Almond Veterinary Clinic; EVC= ECWA Veterinary Clinic Bukuru.

Appendix A, Table 2 indicates the total number of dogs seen at each of the clinics annually over the same period. Rabies vaccine is done annually in Nigeria, as rabies is endemic (OIE, 2008).

Fig 4.3, below shows the number of dogs seen as patients over the ten year period in the state clinics in Jos, it shows that a relatively high number of dogs visited the GVC in Jos city. These dogs were brought in for different purposes while Fig 4.4 shows the number of dogs seen in private clinics over the same period. The different clinics have different figures of dogs that visited the clinics in the study period; not all the dogs that were seen by the Veterinarians in the clinics

came in for rabies vaccination as others were there for conditions like distemper, worming, neutering, and surgery etcetera.

Fig 4.3 Dogs seen by Government Veterinary Clinics in Jos Central and the different LGA's over the ten year period

KEY: PSVH= Plateau State Veterinary Hospital Jos; BDV= Bassa Divisional Veterinary Clinic; BLDVC= Barakin Ladi Divisional Veterinary Clinic; RYDVC= Riyom Divisional Veterinary Clinic; MNDVC= Mangu Divisional Veterinary Clinic; PNDVC=Pankshin Divisional Veterinary Clinic; SHNDVC= Shendam Divisional Veterinary Clinic; JEDVC =Jos-East Divisional Veterinary Clinic; KNDVC= Kanke Divisional Veterinary Clinic; JSDVC=Jos South Divisional Veterinary Clinic; BKDVC=Bokkos Divisional Veterinary Clinic.

4.2.1 Dogs seen by private veterinary clinics in Jos

The private veterinary clinics appear to have seen more dogs than the state clinics, over the study period but EVC shows an even larger number of dogs. The clinic is located in a peri-urban area located close to the city centre as the major veterinary clinic around that side that has been noted previously.

Fig 4.4 Dogs seen by private veterinary clinics in Jos

KEY: FCAH= Federal College of Animal Health and Production Technology; MVC= Maas Veterinary Clinic; YYC= Yaks and Yaks Veterinary Clinic; UVC= Unity Veterinary Clinic; AHVC= Ahmid Veterinary Clinic; AVC = Almond Veterinary Clinic; EVC= ECWA Veterinary Clinic Bukuru.

4.2.2 Canine rabies mass vaccination campaign, Plateau State 2007

A mass canine rabies vaccination campaign was conducted in August to September 2007, sponsored by the government. This resulted from speculations from the public and records received from the RDL- NVRI that canine rabies was on the increase in the state. Result shows a sharp rise in number of positive cases encountered from the year 1998 through to 2006. The campaign was carried out in the entire LGA's in the state as shown below in Fig 4.5.

Fig 4.5 Canine rabies mass vaccination campaign 2007, number of doses used (indicates the number of dogs vaccinated)

KEY :BLG = Bassa Local Government Area; BLLG = Barakin Ladi Local Government Area; BKLG = Bokkos Local Government Area; JELG = Jos East Local Government Area; JNLG = Jos North Local Government Area; JSLG = Jos South Local Government Area; KMLG = Kanam Local Government Area; KNKLG = Kanke Local Government Area; LNLG = Langtang North Local Government Area; LSLG = Langtang South Local Government Area; MNLG = Mangu Local Government Area; MKLG = Mikang Local Government Area; PNKLG = Pankshin Local Government Area; QPLG = Quan-Pan Local Government Area; RYL= Riyom Local Government Area; WLG = Wase Local Government Area; JCLG = Jos central Local Government Area; SHNLG = Shendam Local Government Area.

Figure 4.5, above, shows the proportion of dogs vaccinated in each LGA during the mass vaccination campaign in 2007. This is probably not a good estimation of the total number of dogs in each area.

The data for each area are also shown in Table 4.1 below. During the mass vaccination campaign, a total of 11,165 dogs and 34 cats were vaccinated in the entire state, with the highest number being vaccinated in the Jos city centre.

Table 4.1 Canine rabies mass vaccination record for Plateau State from August- September 2007

Vaccination Station	Number of dogs and cats vaccinated	
	Dogs	Cats
Bassa	991	
Barakin-Ladi	494	
Bokkos	544	
Jos East	203	
Jos North	778	10
Jos South	808	
Kanam	198	
Kanke	782	
Langtang North	586	1
Langtang South	593	
Mangu	543	
Mikang	200	
Pankshin	793	
Quan- Pan	573	
Riyom	205	
Shendam	695	
Wase	200	
Veterinary Hospital, Jos	1,979	23
Total	11,165	34

Very few cats were vaccinated, perhaps because cat owners were not aware of the need for vaccination or because they were unable to transport them to the vaccination sites.

4.2.3 Calculated relative frequency of canine rabies vaccination

Using the 2007 data, the relative frequency of vaccination was estimated for each area using the estimated dog population. The calculated relative frequency of canine rabies vaccination in the state was 10.57%. Relative frequency was calculated by dividing the numbers of dogs vaccinated during the mass canine rabies vaccination campaign by the estimated dog population.

Number of vaccinated dogs n=11,165

Estimated dog population 105,595

Thus n=11,165/105,595=0.10573*100=10.57% which is quite low compared to the theoretically recommended figure of 70% to achieve rabies immunity in a dog population (OIE, 2008).

4.2.4 Estimated dog population in Plateau state and dog: human ratio

From expert opinion interviews with veterinary professionals (n=3) working in Plateau State, an average dog population for Plateau State of 105,595 was estimated:

Expert A+B+C/3= Estimated dog population. This was calculated according to the recommendations of Thrushfield (2005). Expert opinions were sought from 3 different veterinary practitioners in Jos Plateau State to reach the estimation (Table 4.2).

Table 4.2 Expert opinion on dog population

Expert	Job description	Estimate dog population
Dr. A	Veterinarian in general veterinary practice	120,550
Dr. B	Veterinarian in general veterinary practice	100,435
Dr. C	Veterinarian in general veterinary practice	95,800
Total		316,785
Average		316,785/3=105,595

The estimated dog population is n=105595 (see Table 4.2) and the human population in Plateau State is n=3178712 (NPC, 2008). The dog: human ratio could thus be estimated to be 1:31.

4.3 Incidence of canine rabies

Incidence is the number of new cases that occur in a known population over a period of time (Thrusfield, 2005). The number of positive cases in Plateau State is shown in Figure 4.6. From this, the incidence was estimated.

Fig. 4.6 Annual distribution of positive canine rabies cases in Plateau state

KEY: NVRI-RDL= National Veterinary Research Institute Vom Rabies Diagnostic Laboratory;
PSVH= Plateau State Veterinary Hospital; FCAH&PT=Federal College of Animal Health and Production Technology Clinic.

It can be seen that the highest number of new cases of canine rabies occurred in the years 2002 and 2004 followed by the year 2001 and 2003. The lowest numbers of new cases diagnosed occurred in the years 1998 and 2007. Figure 4.6 also shows a very low number of new cases submitted to PSVH for diagnosis in the years 2000 and 2003.

4.3.1 Estimated annual incidence of canine rabies (cases /population at risk)

Three different incidence levels were calculated:

4.3.1.1 The estimated incidence of canine rabies using the cases recorded in the NVRI Rabies Diagnostic Laboratory

This was (n=751) and the estimated dog population in Plateau State was105, 595. (see Table 4.2). The incidence thus came to 0.071% (see below for calculation). This is probably the most accurate incidence.

Incidence = (New Cases/ Population at risk) * C

(Thrusfield, 2005)

The population at risk is the same as the dog population, which is 105,595 (estimated by working out the average of n=3 experts (Table 4.2). The number of canine rabies cases from 1998-2007 is 751. Thus, the average number of cases per annum calculated from the cases listed by NVRI/RDL = 751/10 = 75.1.

Thus annual incidence is (75.1/ 105,595) X 100

=0.071 %, or slightly less than one in every thousand dogs (Incidence A).

4.3.1.2 Estimated annual incidence from PSVH:

The total number of cases diagnosed from PSVH (see Appendix A Table 3) was 101 over 10 years.

The average number of new cases per annum is therefore 101/10=10.1

The annual incidence is thus (10.1/105,595) X 100

=0.0095 or just less than 1 dog in ten thousand per annum (Incidence B).

4.3.1.3 Estimated annual incidence from FCAH & PT:

Using the data from the FCAH & PT, the total number of cases diagnosed (see Appendix A Table 3) was 322 over 10 years. Thus the average number of cases per annum was 322/10=32.2

The annual incidence is (32.2/105,595) X 100

approximately 3.2 dogs in 10,000 per annum (Incidence C).

The three incidences (A, B and C) calculated above give a range of the incidence of canine rabies in Plateau State (1998 to 2007) of between 0.0095% and 0.071%.

4.3.1.4 Distribution of rabies cases in LGA's:

Table 4.3 shows the distribution of the positive rabies cases in LGA's in the study area.

Several of the LGA's show very low numbers, suggesting under-reporting or that these results may be due to the distance that must be travelled to reach the

laboratory for diagnosis. For instance, NVRI-RDL, Vom is over 30 kilometres (Km) from the city centre and 100km to 1000km, away from the other LGA's.

Table 4.3 Number of positive canine rabies cases diagnosed from different LGA's in study area.

Location	Dogs	Cats
Barakin Ladi	17	
Bokkos	9	
Jos –East	5	
Jos- North	39	
Jos – South	4	
Kanan	6	
Kanke	4	
Langtang –North	17	
Langtang –South	25	
Mangu	8	
Mikang	10	
Pankshin	34	
Quan – Pan	2	
Riyom	16	
Shendam	10	
Wase	13	
Jos –Central	423	4

4.3.2 Seasonal trend

Canine rabies occurred throughout the year as shown in Table 4.4. However the largest number of positive cases was recorded in the month of September in the study period followed by October and November of the study period, which is the dog breeding season and the beginning of dry months of the dry period in Nigeria.

This agrees with Ezeokoli & Umoh, 1987, who reported that canine rabies occurrence corresponds with the dog breeding season in Nigeria.

Table 4.4 Monthly distributions of positive canine rabies cases as recorded by NVRI-RDL

Year	Month												
	J	F	M	A	M	J	J	A	S	O	N	D	Total
1998	3	5	2	4	3	5	4	3	2	6	5	2	44
1999	4	4	5	2	6	2	5	4	5	6	5	4	52
2000	4	6	5	6	4	5	4	7	6	5	7	6	65
2001	7	8	5	8	5	10	7	5	16	8	7	9	95
2002	6	8	9	12	10	8	6	5	6	10	14	6	100
2003	8	8	5	6	9	6	7	6	9	8	10	10	92
2004	6	7	8	8	9	6	10	8	12	14	8	4	100
2005	6	5	6	4	5	8	4	6	8	7	7	14	80
2006	5	7	6	9	7	7	6	7	9	6	5	8	79
2007	2	4	6	2	4	3	6	2	4	6	3	2	44
Total	51	62	57	61	62	60	59	53	77	76	71	62	751

Positive cases of rabies in cats cases were recorded in December and March of years 1998 and 2001, n=2 in each of these years. There were too few cases for any conclusion to be drawn.

4.3.3 Geographical coordinates

The study area in Plateau State included the ten LGA's which were randomly selected. The geographical coordinates of each LGA visited in Plateau State while carrying out this research is shown in Table 4.5. More cases were recorded in Jos Central probably because more dogs are seen in the clinics in the city, agreeing with Ezeokoli *et al*., (1987) that more rabies outbreaks are encountered in the urban than rural area.

Data from the RDL-NVRI listed numbers of confirmed cases of canine rabies originating from the rural and peri-urban areas in Plateau State, Nigeria.

Table 4.5 Geographical coordinates (Locations)

Location	Geographical coordinate	
Bassa	10º, 06'. 34. 80"N	8º, 53', 40.78"E
Barikin- Ladi	9º, 33'. 27.03"N	9º, 02', 28. 69"E
Riyom	9º, 33', 31. 54"N	8º , 48', 21.67" E
Mangu	9º 20', 44.54"N	9º,15', 47. 04"E
Pankshin	9º, 13',41. 89" N	9º, 29', 16.19"E
Shendam	8º , 40', 12.99" N	9º, 34' , 51. 74" E
Jos –South	9º, 38' , 30.68'' N	8º, 49', 35.31'' E
Jos–East	9º, 52', 18.01'' N	9º, 12', 26.32'' E
Kanke	9º , 22' ,12.62'' N	9º ,43' ,00.73''E
Bokkos	9º , 12' , 38.29' N	9º ,00', 21. 96'' E

Location plotting on the Map in Fig 4.7 shows that positive cases originated from locations not too far from each other, such as Riyom, Jos-South and Barakin Ladi LGA's, Bassa and Jos East LGA's, Bokkos and Mangu LGA's and Kanke and Pankshin LGA's. However, Shendam LGA, which seems farther from the centre of the state, also showed the occurrence of positive cases.

Fig 4.7 GIS map showing location of positive samples

4.3.4 Cultural beliefs about rabies in Plateau state

The objective of this investigation was to collect and collate data from official sources on rabies cases and rabies vaccination in Plateau state. Informal interviews with citizens (N=72), during the course of the study, showed that there was also a lack of knowledge of rabies and rabies vaccination in the general public. It also emerged during these informal interviews that several cultural beliefs were influencing the control of rabies. Of these 72 respondents, 63 had previously heard about rabies, the other nine did not know what the word meant. Twenty three of those who know about rabies had vaccinated their dogs, 25 had not and the other 15 could not remember. Of interest is that the 15 who did not vaccinate their dogs said that they felt the vaccine could alter the flavour of the dog meat and 10 would not vaccinate as they felt it would affect the canine teeth of the dog and prevent it from hunting. More than half (n=50) said that they thought that the number of “mad dogs” had increased over the last 10 years. Any dog on the street that shows “mad” or aggressive behaviour is immediately killed by passers-by, usually using sticks or clubs. When asked what they would do if bitten by a mad dog, they described traditional treatments:

- You could pull hairs from the dog that bit you and rub it on the bite site to prevent rabies.
- You could kill the dog and remove and boil the brain and spinal cord and feed this to the victim.
- A herbal concoction is available from traditional healers for oral consumption to prevent rabies.

Those who used more western methods described the use of neat (undiluted) antiseptic (Dettol ® or Tincture of Iodine) rubbed into the bite wound. They also described how chemists who have Patent Medicine shops will inject tetanus toxoid into dog bite victims. Out of the 72 respondents, 35 of them believed that rabies could be treated with native remedies at home, without visiting a medical doctor.

4.4 Incidence of human rabies

The incidence of canine rabies in humans in Jos Plateau State within the study period was determined using the number of cases diagnosed and the current census data (NPC, 2008):

Incidence = (cases/ Population at risk) * C, where C is a constant.

(Thrusfield, 2005)

The number of cases over the 10 year period = 5 i.e. = 0.5 persons/year

Population at risk =3,178,712 (NPC, 2008)

Incidence= 0.5/3,178,712 X C =0.000000157

Very few (n=5) human cases of rabies were diagnosed over the 10 year study period: four of these cases were diagnosed at JUTH, two in 2000, one in 2002 and one in 2005. Only one case was recorded at OLA hospital. This patient was a child of 14 years old, who showed typical symptoms but was discharged because the hospital lacked the facilities needed to treat a case of human rabies. All affected

patients were below 20 years of age. The diagnoses were all based on clinical signs as necropsies were not performed, due to cultural and religious practices.

4.4.1 Data on dog bite cases from medical facilities.

Table 4.6 shows data on dog bite cases diagnosed over the ten year period under study. The data originated from medical facilities including ECWA, JUTH, PSSH and OLA in Jos.

Table 4.6 Annual distribution of dog bite cases from hospitals investigated in Plateau State.

Source	Year	Diagnosis	M	F	Total
ECWA	1998	Dog bite	10	5	15
	1999	Dog bite	13	0	13
	2000	Dog bite	6	2	8
	2001	Dog bite	13	0	13
	2002	Dog bite	6	0	6
	2003	Dog bite	4	1	5
	2003	Dog bite	5	2	7
	2005	Dog bite	10	0	10
	2006	Dog bite	10	0	10
	2007	Dog bite	5	8	13
JUTH	Record Not available.	-	-	-	-
PLSH JOS	2004	Dog bite	3	6	9
OLA hosp. Jos	2001	Dog bite	0	2	2
	2003	Dog bite	0	2	2
	2004	Dog bite	2	0	2
	2005	Dog bite	2	0	2
	2006	Dog bite	2	0	2
	2007	Dog bite	3	1	4
					123

The hospitals mentioned above confirmed that they administered antirabies vaccine to dog bite victims that reported to the hospital. Rabies hyperimmune serum was not readily available.

Table 4.7 Doses of post-exposure treatment used for dog bite patients

No of Doses of ARV received	No. of patients	Percentage
1-2	103	83.73
3	2	1.62
5	18	14.63
Total	123	100%

Although 123 dog bite victims received antirabies vaccines (ARV), 105 did not complete the treatment, 103 of them received between one to two doses, 2 patients only 3 doses, while only 18 patients received the complete five doses.

The age distribution of dog bite patients is shown in Table 4.8 below.

Table 4.8 Age distribution of dog bite victims

Age range	Gender	
	M	F
0-9	46	18
20-29	29	7
30-39	14	4
40+	4	1

It can be seen that of the 123 patients, 64 (52.0%) were children while 59 (47.97% were adults).

More cases of dog bite were recorded among male patients; (n=93 or 75.6%). Of these, 21 (17.0%) were males older than 23years, 72 (58.5%) were males aged 0-20 years, 8 (6.5%) were males between 17-20 years of age. Only 30 (24.3%) were

females. It was found that 103 (83.7%), belonged to the low socio-economic (i.e. persons whose estimated annual income is less than $ 5,000.00) or illiterate groups, while 95 were from LGA's close to Jos city and 20 (16.26%) belonged to the upper socio-economic or elitist group (i.e. persons whose estimated annual income is above $20,000.00). Over 100 patients received ARV over the study period in the four human facilities visited in Plateau State. In the records seen, all patients treated with ARV suffered from dog bites.

The antirabies vaccine used by ECWA Evangel, PSSH and OLA hospitals was the Verorab® or Raipur® rabies vaccine; imported from India. Only 10 vials of human rabies immunoglobulin (HRIG) was used in the treatment course as it was not readily available. It is also very expensive; the price is N5,000.00 per vial ($41.00).

A breakdown of victims of dog bite by gender and age showed that more dog bite wounds were found in young males between 0-19 years old. The site of dog bite wounds were predominantly the extremities, 62 of the 72 cases (86.1%) being a lower limb while 8 of the 72 (11.1%) were on the upper limbs and only 2 of the 72 (2.7%) on the neck of the patient.

4.4.2 Informal interviews with members of the public in Plateau State

During the study, 72 persons were randomly selected, (taking seven per LGA in Plateau State) and 63 of these revealed that they were aware that a disease called rabies existed, but were not sure of the prognosis of the disease and thought traditional medicines or home remedies could be used to treat or prevent it when it

occurred. Out of those interviewed, nine knew nothing about rabies and its transmission.

4.4.3 Expert opinion

Table 4.9 shows the results obtained from an expert opinion survey of medical personnel (n=11).

Table 4.9 Expert Opinion Survey of medical personnel.

Medical personnel	Hospital	Practice Specialization	No. of rabies cases seen	Diagnosis method
Dr. A	Evangel hospital Jos	General practitioner	0	-
Dr. B.	Evangel hospital Jos	General practitioner	0	-
Dr. C	Evangel hospital Jos	General practitioner	0	-
Dr. D	Plateau State specialist hospital	General practitioner	0	-
Dr. E	Plateau State specialist hospital	General practitioner	0	-
Dr. F	Plateau State specialist hospital	General practitioner	0	-
Dr. G	JUTH	General practitioner	3	Symptomatic
Mr. H	JUTH	Pharmacist	0	-
Mr. I	OLA hospital Jos	Pharmacist	0	-
Mr. J	OLA hospital Jos	Nursing officer	1	Symptomatic
Mr. K	OLA hospital Jos	Nursing officer	1	Symptomatic

The questionnaire used for the expert opinion survey is attached as Appendix B 3. The doctors interviewed were in practice in the study area. Two pharmacists were also interviewed as they issue medications for dog bite cases. A total of eleven (n=11) medical personnel were interviewed. Three medical personnel who had experienced rabies cases in their work place agreed that rabies is a serious

disease with a high fatality rate in Nigeria, although this was not borne out by data obtained from hospitals and laboratory facilities (see earlier). The common responses obtained from questionnaires administered to veterinarians and medical personnel are also attached as Appendix B 2 and 4.

4.4.4 Symptoms and signs of rabies

As mentioned previously, five patients were affected with rabies over the study period and four did not obtain the correct first wound care protocol as recommended by WHO. The full course of treatment was not offered before clinical manifestation set in. In one patient, a child, who had received the full course of treatment, presented severe clinical signs (malaise, fever, headache, restlessness, hydrophobia and aerophobia) and died after 4 days of hospitalization. The record files of the five rabies victims showed that they were bitten by stray dogs between 45-90 days before they were presented at the hospitals.

CHAPTER 5

DISCUSSION

Data was recorded from human and veterinary facilities and diagnostic laboratories as described earlier. Cases that occur in rural and peri-urban areas may have gone unreported, thus the positive cases in this study were probably an underestimate of the actual number of cases in dogs, cats and humans. Over the period 1998-2007 in Plateau State, a total of 760 rabies cases were diagnosed, five (0.66%) in humans and 755 (99.3%) in dogs and cats.

In Nigeria currently, the RDL-NVRI Vom is the only approved and recognised rabies diagnostic centre to which various samples are sent from all over Plateau State and the country as a whole (Ogunkoya, 2008).

Appendix A Table 1 and Figures 4.1 and 4.2 showed that rabies vaccination fluctuated throughout much of Plateau State over the study period. However, a marked increase in vaccination coverage was seen in 2007 in all the LGA's in Plateau State, due to a canine rabies mass vaccination campaign that was carried out free of any charge to dog owners (Fig 4.5).

Appendix A Table 2 shows 98,786 over the 10 year period as the estimated number of dogs in Jos City, probably because it is urban, located in the centre and the administrative location of the state, with probably the highest dog population. Figures 4.1 and 4.2 compare the vaccination coverage by privately owned

veterinary clinics as well as the government owned veterinary clinics, showing different levels of canine rabies vaccination in Plateau State. The vaccination campaign gave a coverage of 10.57%. Effective vaccination campaigns need to reach a sufficient percentage of the population to eliminate disease and prevent future outbreaks (which for rabies is advised to be 70%) at a cost that is economically and logistically sustainable (Kaare *et al*, 2008). A survey was carried out in Nigeria by Vose *et al*. (1997) and it was found out that

40% of owned dogs were unvaccinated. This agrees with the result obtained from the interview with the public in Plateau State, where 34.7% of the respondents did not vaccinate their dogs.

5.1 Canine rabies diagnosis

The immunoflourescent antibody test (IFAT) is the gold standard test recommended for rabies diagnosis. This test is the laboratory method most widely used to diagnose rabies in humans and animals (Dean *et al.*, 1996; WHO, 1999). A high percentage of the dog samples taken from the different parts of Plateau State, to the NVRI Rabies Diagnosis Laboratory for rabies analysis were positive for canine rabies during the study period; 100% in 2002, 2004 and 94% in 2005 as shown in Appendix A, Table 3 and Fig 4.6. This finding is similar to the rates of positive dogs found in a region of Tanzania within an active surveillance system (Cleaveland *et al*, 2002).

5.1.1 Mass canine rabies vaccination campaign

The DVS and his team appealed to the government to sponsor a mass canine rabies campaign as there were speculations and reports from the RDL-NVRI on the increase of canine rabies in the state (Fig 4.5). From reports from the NVRI-RDL, the number of positive cases had risen sharply and control measures would be necessary in the state. This was not, however verified by data obtained in this study.

The mass canine rabies vaccination campaign was a control measure carried out to control the occurrence of rabies and sensitize the public about the disease and how to prevent its transmission.

Although veterinarians made an attempt to vaccinate all dogs, there were insufficient vaccines available for the dogs brought to the vaccination points. Veterinarians doing the vaccines also mentioned that not all dog owners were aware of the campaign and suggested that more publicity be done in future. However, as this applied equally in all areas, the numbers probably give a good indication of the proportion of dog owners in each area.

5.2 Incidence of human rabies

The low number of positive human cases (n=5) probably reflects only a small proportion of actual cases. This could be due to poor record keeping in many of

the hospitals, failure of patients to report to hospitals because of their traditional beliefs and treatment, or the long distances to health care facilities.

In Plateau State, the hospitals that had records of suspected cases of rabies confirmed that clinical manifestation were severe and the patients were usually presented when the clinical manifestation had set in. From the history they received, most patients were attacked and bitten by stray dogs. Under-reporting may have occurred due to transportation difficulties or the choice by victims to use traditional remedies due to poverty and cultural beliefs. None of the victims of rabies in this study applied correct first wound care, although chemical or physical elimination of rabies virus at the site of infection is recommended as the most-effective mechanism of protection (WHO, 1997).

It has been suggested that the true extent of human exposure to rabies in Nigeria is difficult to establish due to lack of reporting (Ogunkoya & Fekadu, 1986). It is no different in Plateau State. It appears as if the situation in some other developing countries is also similar to what obtains in Nigeria and Plateau State (Domingo, 2000; Cleaveland *et al*., 2002; Marc- Alain *et al.,* 2002; Kayali *et al., 2003;* Ali *et al.,* 2006).

Although rabies is often considered a relatively insignificant cause of human mortality in developing countries, data from Tanzania indicate that the disease is under-reported (Cleaveland, *et al*., 2003), while in Sudan resurgence in rabies post-exposure was observed and a high number of human deaths due to the fact that rabies is continuously occurring (Ali *et al.*, 2006). In N'Djamena, the capital of

Chad, the annual incidence of canine rabies is 1.4 per 1000 unvaccinated dogs (Kayali *et al*, 2003). Togo experienced 13 major outbreaks between 1954 and 1974. In 1997, in Lome, capital of Togo, 816 dogs had bitten people with 2 deaths recorded (Domingo, 2000). Kitala *et al*, (2000) reported 8.6 rabid dogs per 1000 dogs with an active surveillance system in Machakos District of Kenya 1992-1993. The surveillance method in Plateau State Nigeria was however, passive as only cases admitted to human or veterinary clinics were counted.

5.3 Dog bite and rabies from human facilities

The 123 cases of dog bite cases that were reported over different years within the study period are shown in Table 4.5. Certain facilities did not record rabies cases, probably because they lacked the facilities to manage the cases. In places where the cases were managed, post-exposure treatment included the administration of anti-rabies vaccine (5 shots at days 0, 3,7,14 and 28 of report of dog bite exposure to the hospital), tetanus toxoid and ampilcloxallin antibiotics. Human rabies immunoglobulin serum was not readily available and this may be why it was not used. It was also very expensive. The apathy of the public to rabies because the mortality rate is very low (often labelled as ‘insignificant’) may be the reason for not taking the prophylactic measures seriously. The medical experts interviewed, said that members of the public in high risk occupations were advised to do have pre-exposure vaccination done to prevent this risk. Rabies in Plateau State can be regarded as a disease of the poor, as the majority of cases occurred in rural and peri-urban areas, in low income indigenous populations.

5.4 Informal interviews

Members of the public (n=72) interviewed, claimed that they were too busy with other personal chores to take dogs for vaccination. It was interesting that 25 respondents said dogs were kept for food purposes and vaccination could affect the taste of meat. Many households also depend on dogs for hunting and security.

Interviews however, revealed that human antirabies vaccines were not readily available in the hospitals visited. As a result, human patients have to buy these vaccines from elsewhere at exorbitant prices i.e. N2, 500 ($21.00) per vial and those that cannot afford this either become apathetic towards antirabies treatment or resort to native treatment.

5.4.1 Traditional treatment

Herbal concoctions were made for victims for oral consumption or the hairs of the offending dog was removed and rubbed on the bite site or the brain or spinal cord of offending dog removed, boiled and given to the victim to eat.

Of the veterinarians interviewed, 15 advocated the need for focused public education about rabies including prevention through annual canine vaccination. They agreed to further advise the state government to encourage public health awareness campaigns through a collaborative effort by veterinarians and medical practitioners to create awareness and enlighten the public about the risk of rabies in their communities.

5.5 Risk Analysis

When analysing the risk of canine rabies in Plateau State, the issue of inappropriate canine rabies vaccination coverage comes into play as the entire dog population may not be protected with the most recent 10.57% vaccination coverage, thus putting the human population at risk, bearing in mind that canine rabies is endemic in the state. However this risk may be reduced if pre-exposure prophylaxis (PEP) is taken more seriously in high risk occupations like veterinarians, dog breeders and hunters, who use dogs for hunting. Dog owners should also vaccinate their dogs as part of P.E.P.

If Plateau State had a protected dog population, the risk of contracting the disease from dog bites would be markedly reduced. Elsewhere, vaccination of dogs has not only led to a decline in dog rabies, but also to a rapid reduction in demand for human post-exposure treatment (Cleaveland *et al.*, 2003).

5.5.1 Hazard identification and characterisation

The hazard identified in this rabies survey in Plateau State is the presence of stray dogs and the lack of interest of dog owners towards proper care of their pets and hunting dogs. According to Fagbemi *et al*., (1981), 99% of rabies victims in Nigeria contracted the disease from dogs. Due to the incidence of canine rabies, the fact that dogs are left to stray in most of the areas in Plateau State as well as the lack of enthusiasm of these dog owners in regard to the proper care and vaccination of their dogs and cats, the risk of rabies transmission is high. All of the

cases suspected to be human rabies in Plateau State have resulted after exposure to dog bites.

Fig 5.1 shows a decision tree with the probabilities of rabies transmission in Plateau State.

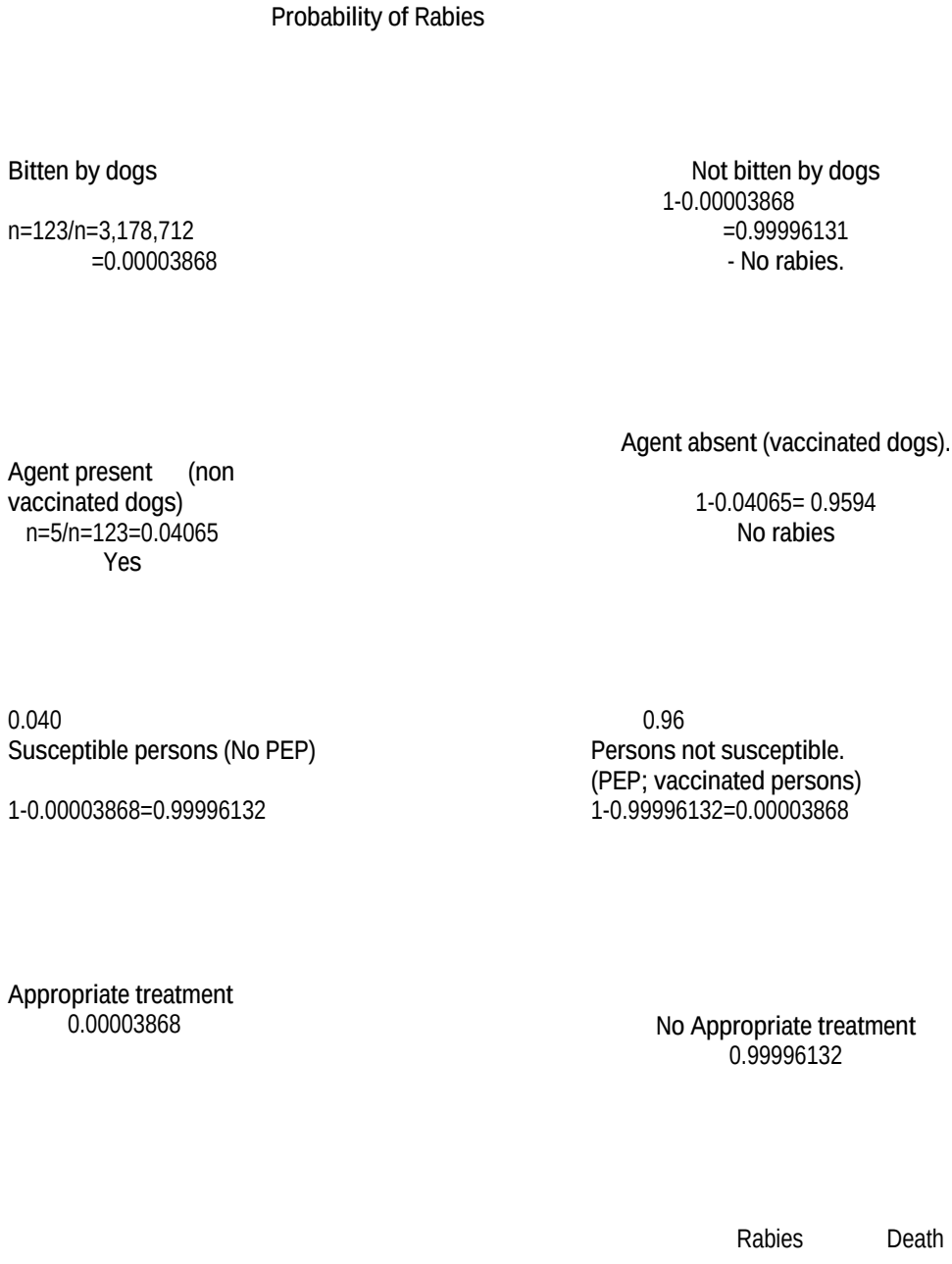

Fig 5.1 Decision tree on Probability of Rabies

Based on the decision tree in Fig 5.1, there is a high probability (p=0.99) of dying of rabies if bitten by a dog in Plateau State, especially with the existence of feral dogs in the street as they go around looking for their own food, with most of the citizens of the state not doing PEP and the low probability of receiving an appropriate treatment post-exposure. The decision tree shows that in a population with vaccinated dogs, the probability (0.95%) of 'No rabies' is very high. Because many dogs are left to stray, the issue of vaccinating them is not very practical as their owners may find it difficult to restrain them for vaccination.

Also, the probability of persons not contracting rabies after being bitten is high if PEP is done. When the appropriate steps of post-exposure treatment (PET) are followed in time, death is prevented.

5.6 Mitigation strategies

The laws of the federation of Nigeria in Chapter 55 of 1958 deal exclusively with dogs. It requires that every dog be licensed and a certificate is issued upon payment of a fee; any dog without a licence must be quarantined; any dog in quarantine proved or suspected by a veterinary officer or medical officer to be suffering from rabies may be destroyed by the authority. There is no mention of antirabies vaccination of dogs. This law needs to be reviewed to specifically include the need for annual canine rabies vaccination due to the endemicity of the disease in Nigeria (Fagbami *et al.,* 1981).

In Plateau State however, the above law is followed, with the incentive of the veterinary division of the Ministry of Agriculture enlightening the public about the risk of rabies to society and advice on prevention by annual rabies vaccination of their dogs and cats.

Meetings with the DVS in Plateau State suggested that collaboration between veterinarians and human medical doctors took place with “aggressive sensitization”, as the public seem to view the disease as ‘insignificant’. The most important factor was to sensitize the public about the risk they faced due to the numerous feral ‘pariah’ dogs that went around the streets.

During this sensitization process, members of the public should be told the importance of washing the bite site when there is a dog or cat exposure with soap and water for at least 5 minutes and reporting to a medical centre for proper treatment to avoid the issue of “If only I had known what to do”.

Meetings should be held with school teachers and they should be taught the risk of rabies and how it could be avoided, so that they could in turn teach their pupils and students about rabies.

Currently a three years mass canine rabies vaccination campaign is running in Plateau state which commenced in August 2007.

5.7 Communication strategy

Four different types of posters (25 copies each) and one pamphlet (100 copies) were designed and printed and distributed to members of the public while carrying out surveys (See Appendix D1-5). One of the posters was written in Hausa language, the commonly spoken language in the area. The posters and pamphlets were distributed amongst the dog owners, veterinarians, the general public and medical clinics and hospital personnel.

Developing an adequate communication strategy is of great value to the control of rabies and the safety of the public in a community and country as a whole. To communicate effectively, the **S**end, **M**essage, **C**hannel, **R**eceiver, **E**ffects (**SMCRE)** strategy must be used (McCrindle, 2008).

A number of communication tools which could be used to channel this information include the use of radio, television, posters and pamphlets/handbills, workshops and conferences.

In Plateau state there are different target audiences with different characteristics and different risk activities that must be addressed

- Families with children who own or play with dogs (pet owner's children)
- Children who are in the streets with feral dogs but do not usually interact with dogs
- Adults walking in the streets
- Adults who own dogs for hunting

- Adults who breed or catch dogs for meat
- Families who have dogs for security purposes

Of the above target audiences the ones most likely to responds to vaccination to decrease a risk of rabies will be those who own dogs as pets, breed dogs or hunt with dogs as they are in close contact and their dogs can easily be infected by a feral dog or cat. Also, they are able to restrain their dogs for vaccination, unlike the pariah dogs in the streets that are not handled.

The general public who do not own dogs, also need to be warned about rabies and probably the best place to do this economically would be to educate the owners of the chemist shops and to educate teachers of young children.

This strategy was fully employed during the course of this project. Only a small number of posters and pamphlets were made because of lack of funds, as a larger number of posters and pamphlets could have gone round a larger population in the state educating more persons. However, the preferred communication tool would have been the radio, as there would have been a wider coverage of information and even the illiterates who cannot read would hear the message and be informed of the risk canine rabies constitutes to their community and how to prevent it.

In this case only the educated persons will be able to read the information on the posters and pamphlets and inform others who cannot read. Lack of funds was the main factor against public enlightenment through the use of the radio.

Enlightened members of the public, were interested in knowing more about canine rabies and its transmission as it sounded new to them and they exhibited a willingness to vaccinate their dogs immediately, to avoid tragedy.

On evaluation of the strategy employed, the aim of the risk communication was achieved, as dog owners who could afford the canine rabies vaccines were immediately willing to vaccinate their dogs.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6 Conclusions

In conclusion, research has shown that the number of reported cases of rabies represents only a fraction of the total cases that occur each year in Plateau State. The predominantly passive nature of rabies surveillance and lack of formal census of animal populations dictates that accurate incidences and data for rabies cannot be determined for humans, dogs and cats in Plateau State. Results show that record keeping of rabies occurrence and dog bite cases in Plateau State is inadequate, especially in the human hospitals, as victims are not readily taken to the hospitals and the native belief of being able to heal the disease at home by using local fetish knowledge. Examples of local traditional treatments are:

- When a victim is bitten by a dog, the dog is immediately killed and the brain and spinal cord is taken out and cooked for the victim to eat to prevent further consequence.
- The hairs of the biting dog is removed and rubbed on the bite site to avoid further consequence.

Control of rabies is hampered by cultural, social and economic realities i.e. refusal to vaccinate dogs because of selfish reasons of meat taste and blunting of the dogs canine teeth for hunting and security. Post-exposure prophylaxis is not done, as the current price of a full dose intramuscular vaccine is beyond what an

average family in Plateau State can afford. Immunoglobulins are currently not readily available worldwide. In the countries where rabies is endemic, there is the perception that insufficient public and professional education concerning rabies and rabies treatment has been carried out (Wolfgang, 1999).

This research has also shown that dogs were the main causes of rabies infection in humans through dog bites in Plateau State. Canine rabies vaccination coverage is relatively low in the state. Failure to control dog rabies across much of the developing world has been attributed to various factors, including inappropriate vaccination strategy design, lack of will, competing national health priorities and inadequate resources (Kaare *et al*, 2008).

Prevalence is the number of occurrence of disease infection, antibody presence in a population usually relating to a particular point in time (Thrusfield, 2005). In this research the prevalence of human rabies in Plateau State is very low as records revealed only n=5 cases which occurred between year 2004 and 2005 in a population of over 3 million people. For canine rabies the relative frequency was found to be high in brains (751) submitted for diagnosis and new cases of canine rabies were encountered annually over the study period (see Tables 4.3 and 4.4 and Appendix A Table 3).

6.1 Recommendations

- The prevention and control of rabies should be encouraged through the education of the population in general, with a focus on the indigenous populations in the

LGA's in Plateau State and children in particular with advice on animal care, animal wellbeing, and on measures to adopt following aggression by an animal.

- Education projects should focus on an aggressive educational awareness and involvement of the vulnerable population of Plateau State and inform them of the value of dog vaccinations, proper garbage disposal and appropriate rabies treatment.

- The people in rural areas should be educated to let them know that rabies can be prevented in humans and can be eliminated in dogs. Picture posters would be the most efficient way to educate people on rabies located in the rural areas in Plateau State.

- The local population should be empowered to engage fully and effectively in rabies prevention and control; to vaccinate dogs against rabies and lower the density of susceptible dogs; voluntary undergraduate students could be provided with an opportunity to be involved in rabies control programs so that the people's attitudes and level of awareness on matters concerning rabies should be understood by the veterinary profession in future.

- Annual canine rabies vaccination should be carried out to decrease the endemicity of the disease in the state. There should be radio campaigns to promote vaccination of dogs. Government assistance in subsidizing the cost of canine rabies vaccines would go a long way and poor dog owners would always be able to afford to vaccinate their dogs annually.

- The government should increase the resources available to help the veterinary department continue to conduct canine rabies vaccination throughout the state by providing cold chain facilities and training more community animal health workers to help in the vaccination process. This could also be taken to dog owners' houses to tackle the issue of difficulty in transportation.

- Human antirabies vaccines (ARV's) should be made more available and affordable if government subsidized rabies vaccination by non-governmental organizations.

- The government should help to make Human (HRIG) or equine (ERIG) derived rabies immunoglobulins (HRIG, ERIG) available. These are essential biologicals to be administered together with the rabies vaccines for post-exposure treatment (WHO, 1997).

- The government should help create health care centers closer to the population at risk, with adequate facilities to diagnose and treat rabies in humans.

CHAPTER 7

REFERENCES

1. **Acha, P.N. & Szyfres, B. 1987.** Zoonoses and communicable diseases common to man and animals. 2nd ed. Pan American Health Organisation.

2. **Adesina, A. & Harry, T. 2005.** Cold chain facility status and the potency of animal rabies vaccine used in Nigeria. Nigerian Journal of Health and Biomedical Sciences 67, 4: (2)112-116.

3. **Adeyemi, I. & Zessin, K. 2000.** Retrospective dog rabies vaccination evaluation at the university of Ibadan, Nigeria (1988-1992). Veterinarski Arhiv, 70: (5) 223-230.

4. **Ajayi, B.B., Rabo, J. S. & Baba, S. S. 2006.** Rabies in apparently healthy dogs: histological and immunological studies. The Nigerian Postgraduate Medical Journal, 13: (2) 128-134.

5. **Ali, Y, H., Inistar, K. S., Wegdan, H. A. & Ali, E. B. 2006.** Epidemiology of Rabies in Sudan. Journal of Animal and Veterinary Advances, 5: (3) 266-279.

6. **Alonge, D.O & Abu, S.A. 1998.** Rabies in Ghana, West Africa. International Zoonoses, 11: (1) 53-58.

7. **Anderson, R. M & May R.M. 1991.** Infectious diseases of humans. Oxford Scientific Press. Oxford: United Kingdom.

8. **Baba, S. S. 1999.** Detection of rabies virus RNA and antigen in tissues from naturally infected Nigerian dogs: in situ hybridization and immunohistochemical studies. Revue d' elevage et de medecine veterinaire des pays tropicaux, 52: (2) 85-91.

9. **Banerjee, A. K. & Elegbe, S.O. 1970.**The incidence and diagnosis of rabies in Nigeria. Bulletin de Epizootes Disease de Africa, 18: 53.

10. **Barth, R., Gruschkau, H. & Jaeger, O. 1985.** Chick-embryo-cell inactivated rabies vaccine for veterinary use. Laboratory and field experience. In: Kuwert, E., Merieux, C., Koprowski, H. & Bogel, K., eds. Rabies in the Tropics. Springer –Verlag. Berlin: Germany, EU.

11. Beck, A. M .1975. The ecology of feral and free roving dogs in Baltimore. Ch 26. In: Fox, M. W., ed. The wild canids. Van Nostrand Reinhold Co. New York, USA. pp 380-390.

12. Bishop, G. C., Durrheim, D. N., Kloeck, P. E., Godlonton, J. D. , Bingham, J., Speare, R. & The Rabies Advisory Group. 2002. Rabies: Guide for the Medical, Veterinary and Allied Professions. Government Printer, Pretoria, South Africa**.** ISBN: 1-86871-119-6.

13. Blanton, J.D., Hanlon, C.A. & Rupprecht, C.E. 2007. Rabies surveillance in the United States during 2006. Journal of the American Veterinary Medical Association, 231: 540 - 560.

14. Bobade, P. A., Aghomo, H.O., Akinyemi, J.O. & Apkavie, S.O. 1983. Proceedings of the first International Conference on viral and bacterial vaccines, (Institute Pasteur Production, Paris), 47-49.

15. Boulger, L. R. & Hardy, J. 1960. Rabies in Nigeria. West African Medical Journal, 9:223-234.

16. Boulger, L. R. & Porterfield, J.S. 1958. Isolation of virus from Nigerian Fruit bats. Transactions of the Royal Society of Tropical Medicine and Hygiene, 52:421-424.

17. Bryceson, A. D. M., Greenwood, B. M., Warrell, D. A., Davidson, M. N & Wilcox, G. E. 1975. Demonstration during life of rabies antigen in humans. Journal of Infectious Diseases, 131:71.

18. CDC (**Centre for Disease Control and Prevention**)**. 1976.** Rabies surveillance report, Annual Summary, October, 1977, (Centre for Disease Control Atlanta, GA).

19. CDC (Centre for Disease Control and Prevention). 2007. Human rabies: Indiana and California, 2006. Morbidity and Mortality Weekly Report. 2007, 56: 361 - 365. Accessed online at URL http://www.cdc.gov/rabies/about.html in March 2008.

20. CDC (Centre for Disease Control and Prevention). 2008. Morbidity and Mortality Weekly Report. 2008. Accessed online at URL http://www.cdc.gov/nciddod/EiD/vol12no12/06-0764.htm in April 2008.

21. Charlton, K. M. 1994. The pathogenesis of rabies and other lyssaviral infections: recent studies. In Rupprecht, C.E.,Dietzschoid, B. & Koprowski, H. eds. Lyssaviruses. Springer- Verlag. Berlin, Germany. pp 95-119.

22. Cleaveland, S., Fevre, E.M., Kaare, M. & Coleman, P.G. 2002. Estimating Human rabies mortality in the United Republic of Tanzania from dog bite injuries. Bulletin WHO, 80: (4) 304-310.

23. Cleaveland, S., Kaare, M., Tiringa, P., Mlengeya, T. & Barrat, J. 2003. A dog rabies vaccination campaign in rural Africa: impact on the incidence of dog rabies and human dog-bite injuries. Vaccine, 21:1965-1973.

24. Coetzee, P. & Nel, H. 2007. Emerging epidemic dog rabies in Coastal South Africa: A molecular epidemiological analysis. Emerging Infectious Diseases, 13:527-31.

25. Coker, A.O., Ishokpehi, R. D., Thomas, B. N., Fagbenro-Beyioku, A. F., & Omilabu, S. A. 2000. Zoonotic infections in Nigeria: overview from a medical perspective. Acta Tropica, 76 :(1) 59-63.

26. Dean, D.B., Abelseth, M.K. & Atanasiu, P. 1996. The fluorescent antibody test. In: Meslin, F. X., Kaplan, M.N., Koprowski, H. eds. Laboratory Techniques in Rabies, Fourth ed. World Health Organisation, Geneva, pp88-95.

27. Domingo, A.M. 2000. Current status of some zoonoses in Togo. Acta Tropica, 76:65-69.

28. Durojaiye, O.A. 1984. Rabies in Nigeria. International Journal of Zoonoses, 11: 65-68.

29. Ezebuiro, E. O., Fagbami, A.H. & Anosa, V. O. 1980. A survey of rabies in man and animals in Nigeria. A study commissioned by Federal Livestock Department, Federal Ministry of Agriculture. Lagos, Nigeria .pp142.

30. Ezeokoli, C.D. & Umoh, J. U. 1987. Epidemiology of rabies in northern Nigeria. Transactions of the Royal Society of Tropical Medicine and Hygiene, 81:268-272.

31. Fagbami, A.H., Anosa, V.O & Ezebuiro, E.O. 1981. Hospital records of human rabies and anti-rabies prophylaxis in Nigeria 1969-78.Transactions of the Royal Society of Tropical Medicine and Hygiene, 75:872.

32. Fekadu, M., Shaddock, J. H. & Baer, G. M. 1982. Excretion of rabies virus in the saliva of dogs. Journal of Infectious Diseases, 145: 715-719.

33. Foggin, C. M. 1982. Atypical rabies virus in cats and dogs in Zimbabwe.Veterinary Record, 110: 338.

34. Fu, Z.F. 1997. Rabies and rabies research: past, present and future. Vaccine, 15: 20-24.

35. Goudsmil, J., Marissen, W. E., Weldon, W. C., Niezgoda, M., Hanlon, C. A., Rice, A. B., De Kruif , J., Dietzschold, B., Baker, A. B. H. & Rupprecht, C.E. 2006. Comparison of antirabies human monoclonal antibody combination with human polyclonal antirabies immune globulin. Journal of Infectious Diseases, 193: (6)796-801.

36. Haiying, L. & Baoyan, W. 2006. Analysis of prevalent features of rabies in Zhongshan City in 1980-2004. China Tropical Medicine, 6: 1173-1174.

37. Hamir, A.N. & Moser, G. 1994. Immunoperoxidase test for rabies: Utility as a diagnostic test. Journal of Veterinary Diagnostic Investigation, 6: 148-152.

38. Harry, T.O., Adeiga, C.E., Anyiwo, C.E. & Nasidi, A. 1984. Anti-rabies Treatment of dog-bite victims in Lagos, Nigeria: trial of suckling mouse brain and fetal bovine kidney cell rabies vaccines. Vaccine, 2: 257-260.

39. Hattwick, M.A.W., Weiss, T.T., Stechschultle, C.J., Baer, F.M. & Gregg, M.B. 1972. Recovery from rabies, a case report. Annals of Internal Medicine, 76:931-942.

40. Jackson, A.C. 2007. Humam Disease .In Jackson, A.C. & Wunner, A. H. Rabies. 2nd ed. Elsevier Academic Press. pp 309-340. London. United Kingdom.

41. Jambalang, A.R., Ibu, J., Gisilanbe, M., Bertu, W. & Jwander, L. 2006. Diagnosis of rabies: A case study of the disease in an adult male Nigerian local dog. Vom Journal of Veterinary Science, 1: 34-43.

42. Kaare, M., Lembo, T., Hampson, K., Ernest, E., Estes, A., Mentzel. & Cleaveland, S. 2008. Rabies control in rural Africa: Evaluating strategies for effective domestic dog vaccination. Vaccine, 9:54.

43. Kaplan, M. M. & Koprowski, H. 1980. Rabies. Scientific American, 2: 103-114.

44. Kayali, U., Mindekem, R., Yemadji, N., Oussiguere, A., Naissenger, S. & Ndoutamia, A. G. 2003. Incidence of canine rabies in N'Djamena, Chad. Preventive Veterinary Medicine, 61: 227-233.

45. 45. King, A. A. & Turner, G. S. 1993. Rabies: a review. Journal of Comparative Pathology, 108:1-39.

46. Kitala, P.M., McDermott, J.J., Kyule, M.N. & Gathuma, J. M. 2000. Community–based active surveillance for rabies in Machakos District, Kenya. Preventive Veterinary Medicine, 44: 73-85.

47. Kuwert, E. & Scheiermann, N .1985. Rabies: Post exposure prophylaxis in man. Annales de l'Institut Pasteur Microbiologie, 136E, 425-445.

48. Lackay, S.N., Yi Kuang, M.S. & Fu, Z.F. 2008. Rabies in Small Animals. Veterinary Clinics Small Animal Practice, 38: 851-861.

49. Lodmell, D. L. , Ewalt, L. C., Parnell, J., Rupprecht, C. E. & Hanlon, C. A. 2006. One time intradermal vaccination in ear pinnae one year prior to infection protects dogs against rabies virus.Vaccine, 24: 412-416.

50. Lombard, M. C., Chapius, B., Chomel, T. D. & DE Beublain, T. D. 1988. Three years of serological and epidemiological results after a rabies dog vaccination campaign in Lima, Peru. Proceedings of the International Conference on epidemiology, control and prevention of rabies and brucellosis in eastern and Southern African Countries. Nov. 23-25. Gaborone.pp 71-79.

51. Luyang, Z.T. 2006. Analysis of prevalence of rabies in Linyi city and control measures. China Tropical Medicine, 6:999-1000.

52. MacAdam, I. 1976. Rabies vaccination: Man and dog. Veterinary Record, 99:173.

53. McCrindle, CME. 2008. Community-based Animal Health: Veterinary Communication and Extension course, CAH 812, University of Pretoria, South Africa.

54. Marc-Alain, W., Gustavo, J. M., Sandra, C. & James, M. 2002. Epidemiology of urban canine rabies in Santa Cruz, Bolivia, 1972-1997. Emerging Infectious Diseases, 8: 301-302.

55. McKay, N. & Wallis, L. 2005. Rabies: a review of UK management. Emerging Medicine Journal, 22: 316 - 321.

56. Morales, M, M. E., Rico-Rosillo, G., Gomez-Olivares, J. L. & Aguilar-Setien, A. 2006. Immunologic importance of the N protein in rabies virus infection. Mexico Veterinaria, 37: 351-367.

57. National Population Commission. 2008. Nigerian national census. 2006. Accessed online URL http://www. plateaustategov.org in May 2008.

58. Nawathe, D.R. 1980. Rabies control in Nigeria. Bulletin of International Epizootics, 92: 129-139.

59. Nawathe, D.R., Banerjee, I., Okeke, E.N & Tiyagnet, J. 1981. Production and use of avianised rabies vaccines in Nigeria. International Journal of Zoonoses, 8: 1-4.

60. NVRI (National Veterinary Research Institute). 2007. Veterinary clinic records. NVRI Printing Press. Vom, Plateau State, Nigeria.

61. Oboegbulem, S. I. 1994. Rabies in Man and Animals. 2nd ed. Fidelity Publishers. pp 1-45. Nigeria.

62. Oboegbulem, S.I., Okolo, M.I. O. & Erojikwe, E. O. 1987. Rabies in vaccinated dogs: observations in Eastern Nigeria. *Revue Scientifique et Technique de l'Office International des Epizooties,* 6: 69-76.

63. Oginni, F. O., Akinwande, J. A., Fagade, G.F., Arole, G. F. & Odunsanya, S. A. 2002. Facial dog bites in south-western Nigerian children: an analysis of eight cases. Tropical Doctor, 32: (4) 239-240.

64. Ogunkoya, A. B. 2008. Review of rabies and Problems of rabies in Nigeria. Proceeding of the National Conference / workshop on rabies. IDR-ABU, Zaria, Nigeria.pp 62-81.

65. Ogunkoya, A. B. & Fedaku, M. 1986. Emergence of antirabies vaccine of unknown origin for human treatment in Nigeria. Vaccine, 4: 77.

66. OIE 2008. website of the World Animal Health Organisation. Accessed online URL: http://www.oie.int in April 2008.

67. Okeke, E. N. 1983. Production of Rabies Vaccine at N.V.R.I, Vom. Unpublished handout.

68. Okoh, A.E.J. 1982. Canine rabies in Nigeria, 1970-1980: reported cases in vaccinated dogs. International Journal of Zoonoses, 9: 118-125.

69. Okoh, A.E. J. 1986. Dog ecology with reference to surveillance for rabies and characterization of rabies virus isolates in Plateau State, Nigeria, (Ph.D thesis, Ahmadu Bello University, Zaria, Nigeria).

70. Okoh, A.E.J. 2000. Antigenic Characterization of Rabies Virus Isolates from Vaccinated Dogs in Plateau State, Nigeria. Veterinary Research Communications, 24:203-211.

71. Okoh, A.E.J., Umoh, J.U. & Ezeokoli, C.D.1985. High egg passage flury strain vaccine induced rabies in a cat. Nigerian Veterinary Journal, 14: 34-36.

72. Opaleye, O.O., Adesiji, Y.O., Olowe, O. & Fagbami, A.H. 2006. Rabies and antirabies immunization in South Western Nigeria: Knowledge, attitude and practice. Tropical Doctor, 36:116-117.

73. Owolodun, B.Y. 1969. Rabies: Present situation in Nigeria. West African Medical Journal, 18: 143-144.

74. Paweska, .J T., Blumberg, L.H., Liebenberg, C., Hewlett, R. H. W., Grobbelaar. A.G., Leman, P. A., Croft, J.E., Nel, H. L., Nutt, L. & Swanepoel, R. 2006. Fatal human infection with rabies-related Duvenhage virus, South Africa. CDC; Emerging Infectious Diseases, 12:12.

75. Pro Med. 2006. Rabies, human in USA (Indiana, Califonia). Accessed at URL http://www.cdc.gov/mmwr/preview/mmwrhtml in March 2008.

76. Radostis, O. M., Blood, D.C. & Gay, C. C. 1995. Veterinary Medicine, 8th ed. ELBS.

77. Rupprecht, C.E., Glickman, L.T., Spenser, P.A. & Wiktor, T.J. 1987. Epidemiology of rabies virus variants. American Journal of Epidemiology, 126: 298-309.

78. Seifert, S. H. 1996. Tropical Animal Health. 2nd ed. Kluwer Academic Publishers. pp 260-270. Dordrecht, The Netherlands.

79. Sengoz, G., Yasar, K. K., Karabela, S. N., Yilirim, F., Vardarman, F.T. & Nanzlican, O. 2006. Evaluation of cases admitted to a centre in Istanbul Turkey in 2003 for rabies vaccination and three rabies cases followed up in the last 15 years. Japanese Journal of Infectious Disease, 59:254-257.

80. Shope, R.E., Murphy, A. F., Harrison, A. K., Causer, O. R., Kemp, G. E., Simpson, D.I.H. & Moore, D. L. 1970. Two African viruses serologically and morphologically related to rabies virus. Journal of Virology, 6: 690-692.

81. Smith, E. C. 1928. Canine Rabies in Nigeria. West African Medical Journal, 2: 265-267.

82. Smith, J. S. 1996. New Aspect of Rabies with Emphasis on Epidemiology, Diagnosis and Prevention of the Disease in the United States. Clinical Microbiology Reviews, 9: (2)166-176.

83. Sugiyama, M. & Ito, N. 2007. Control of rabies: Epidemiology of rabies in Asia and development of new-generation vaccines for rabies. Comparative Immunology and Microbiology, 30 :(5-6) 273- 286.

84. Swanepoel, R. 1994. Rabies, In: Infectious Diseases of Livestock with Special Reference to Southern Africa, Coetzer J.A.W., Thomson, G. R & Tustin, R.C.eds. Oxford University Press, Southern Africa. Volume1: pp 493-552. Cape Town, RSA.

85. Swanepoel, R. 2005. Rabies. In: Infectious Diseases of Livestock with Special Reference to Southern Africa, Coetzer J.A.W. & Tustin, R.C. eds. Oxford University Press, Southern Africa,. Volume 1: pp1123–1182. Cape Town, RSA.

86. Thorne, A.L.C. 1954. The Problem of rabies in Nigeria. Bulletin de Epizootes Disease de Africa, 2: 265-267.

87. Thrusfield, M. 2005. Veterinary Epidemiology, 3rd ed. Blackwell Sciences Ltd. Oxford, U. K..

88. Tierkel, E. 1975. Canine rabies. In: Bauer, G.M. ed. The Natural History of Rabies. Volume 11. pp 123-137. Academic Press. New York. USA.

89. Umoh, J. U. & Belino, E. D. 1979. Rabies in Nigeria: A historical review. International Journal of Zoonosis, 6: 41-48.

90. Van Steenis, G., Van Wezel , A. L ., Hannik , Ch. A., Van Der Marel , P., Osterhaus, A.D.M.E., De Groot , I.G.M., Koning , C., Lelyveld , J. L. M . & Ruitenberg, E.J. 1985. Immunogenicity of dog kidney cell rabies vaccine (DKCV). In: Kuwert, E.,Merieux , C., Koprowski, H . & Bogel, K., eds. Rabies in the Tropics .Berlin: Springer – Verlag.Germany.

91. Vose A. Aylan O. & Turan B. (1997). Oral vaccination (Ov) of dogs against rabies: Studies in Turkey to combine this technique with the traditional method of parenteral vaccination if indicated to reach a better overall coverage. Rabies Bulletin Europe, 21: (1)11-14.

92. WHO. 1997. WHO Recommendation on rabies post-exposure treatment and the correct technique of intradermal immunization against rabies. Accessed

at URL http://www.who.int/eme-documents/rabies/docs/whoemczoo966.pdf. Accessed in July 2008.

93. WHO. 1999. The World survey for rabies No. 35 for the year 1999. Document WHO/CDS/CSSR/EPH/2002.10. Geneva, Switzerland.

94. WHO. 2004. WHO Expert Consultation on Rabies. Technical Report Series, 931. Geneva, Switzerland.

95. WHO. 2006. Current WHO GUIDE for Rabies Pre and Post-exposure Treatment in Humans. Geneva, WHO, 2002. Accessed at URL http://www.who.int/ in July 2008

96. WHO. 2008. WHO Expert Consultation. Rabies - a neglected zoonotic disease. Geneva, Switzerland. Accessed at URL https://www.who.int/mediacentre/factsheet/fs099/en/ in April 2008.

97. Warrell, M. J .1996. Rabies. In: Cook, G.C. ed. Manson's Tropical Diseases. 20th edition. WB Saunders. pp 700-720. London, UK.

98. Wikinson, L. 1988. Introduction. In: Campbell J. B and Charlton K M. eds. Rabies. Kluwer Academic Publishers .pp 1-23. Boston, USA.

99. Whitfield, S.G., Fedaku, M. Shaddock, J.H., Niezgoda, M., Warner. C.K. & Messenger, S.L. 2001. A comparative study of the fluorescent anti- body test for rabies diagnosis in fresh and formalin-fixed brain tissue specimens. Journal of Virological Methods, 95: (1-2) 145-151.

100. Wilde, H. 2007. Failures of post-exposure rabies prophylaxis. Vaccine, 25: 7605-7609.

101. Wolfgang, H. 1999. Rabies- risk of exposure and current trends in prevention of human cases. Vaccine, 17: 1742-1747.

APPENDIX A Table 1 Canine rabies vaccination records in Plateau State (APPENDIX A) over the 10 year period

Clinic location	Year										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Plateau State Veterinary Hospital, Jos PLSVH	315	350	404	267	302	547	663	713	785	920	5266
Fed.Coll. of Animal Health and Prod. Tech. Vom FCAH&T	104	85	154	264	241	139	183	190	137	138	1635
Maas Veterinary Clinic Jos	534	567	541	455	726	909	1006	909	1006	1056	7709
Yaks and Yaks Veterinary Clinic Jos	691	127	158	220	75	686	109	61	77	263	2467
Unity Veterinary Clinic and consultancy Rantya Jos	77	38	1080	721	890	882	793	799	874	949	7103
Ahmid Veterinary Clinic Jos	196	291	362	151	224	197	135	254	174	231	2215
Almond Veterinary Clinic Jos	240	201	285	295	262	289	291	359	138	121	2481
ECWA Veterinary Clinic Bukuru, Jos	NA	NA	NA	NA	NA	563	506	592	699	760	3120
Bassa Divisional Veterinary and Livestock office Clinic	54	51	50	49	50	34	44	60	59	515	966
Barakin-Ladi Divisional Vet. and Livestock office Clinic	70	93	65	72	103	121	71	89	84	95	863
Riyom Divisional Veterinary and Livestock office Clinic	81	80	79	49	51	52	63	76	123	288	942
Mangu Divisional Veterinary and Livestock office Clinic	35	65	52	64	9	65	20	21	27	645	1003
Pankshin Divisional Veterinary and Livestock office Clinic	42	53	61	26	62	45	21	21	68	759	1158
Shendam Divisional Veterinary and Livestock office Clinic	2	4	0	6	4	2	3	1	0	0	22
Jos-East Divisional Veterinary and Livestock office Clinic	0	0	6	0	4	2	1	3	0	0	316
Kanke Divisional Veterinary and Livestock office Clinic	0	6	12	6	4	6	0	0	0	0	34
Jos-South Divisional Veterinary and Livestock office Clinic	2	6	8	3	4	6	8	3	2	45	87
Bokkos Divisional Veterinary and Livestock office Clinic	5	20	15	16	17	22	6	27	16	45	189
Total	2448	2037	3332	2664	3028	4567	3923	4178	4269	6830	37276

NA= Not available.

APPENDIX A Table 2 Number of dogs that came to each clinic per year over the 10 year period

Clinic location	Year										
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Plateau State Veterinary Hospital, Jos PLSVH	3345	3706	6236	6868	4486	3087	4847	4193	4150	4159	45077
Fed.Coll. of Animal Health and Prod. Tech. Vom FCAH&T	657	577	886	1076	783	591	1007	944	871	878	8270
Maas Veterinary Clinic Jos	675	722	949	617	1009	1079	906	1087	1103	1266	9413
Yaks and Yaks Veterinary Clinic Jos	773	682	803	796	722	686	735	581	820	969	7567
Unity Veterinary Clinic and consultancy Rantya Jos	1233	1124	1414	1209	1212	1083	1214	1208	1290	1228	12215
Ahmid Veterinary Clinic Jos	797	990	837	768	739	794	825	682	727	757	7916
Almond Veterinary Clinic Jos	782	785	796	853	788	714	875	854	869	1012	8328
ECWA Veterinary Clinic Bukuru, Jos	NA	NA	NA	NA	NA	1527	1497	1555	1507	1520	7606
Bassa Divisional Veterinary and Livestock office Clinic	132	213	95	106	87	58	84	218	284	589	1866
Barakin-Ladi Divisional Veterinary and Livestock office Clinic	129	169	126	146	174	190	225	306	202	215	1882
Riyom Divisional Veterinary and Livestock office Clinic	157	145	161	153	146	113	143	149	207	348	1722
Mangu Divisional Veterinary and Livestock office Clinic	179	132	131	108	245	312	161	119	146	930	2463
Pankshin Divisional Veterinary and Livestock office Clinic	85	132	278	135	153	117	141	124	164	901	2230
Shendam Divisional Veterinary and Livestock office Clinic	10	6	17	22	14	23	25	40	60	44	261
Jos-East Divisional Veterinary and Livestock office Clinic	25	18	8	28	4	4	29	11	16	12	155
Kanke Divisional Veterinary and Livestock office Clinic	0	10	14	8	4	10	23	6	4	18	97
Jos-South Divisional Veterinary and Livestock office Clinic	2	8	8	4	10	6	8	6	4	48	104
Bokkos Divisional Veterinary and Livestock office Clinic	14	20	19	22	25	34	16	30	17	48	245
Total	8997	9439	12778	12919	10601	10428	12761	12113	12441	14942	117419

NA- (Not Available) Records for those periods were not available.
Colour figures obtained from veterinary clinics in Jos city as number of dogs that visited over the 10 year period.

Appendix A Table 3 Data on canine rabies from PSVH, FCAH&P and NVRI diagnostic laboratory over the 10 year period

PSVH				FCAH & P			NVRI RDL		
Year	No. confirmed rabid	No. suspected rabid	%	No. confirmed rabid	No. suspected rabid	%	No. confirmed rabid	No. suspected rabid	%
1998	8	143	5.6	8	88	9.0	44	63	69.8
1999	6	6	100	17	97	17.5	52	79	65.8
2000	3	3	100	27	171	15.8	65	76	85.5
2001	14	49	28.6	62	122	50.8	95	170	55.9
2002	10	46	21.7	44	190	23.2	100	184	54.3
2003	2	44	4.5	46	196	235	92	109	84.4
2004	14	61	23	37	267	13.9	100	103	97.1
2005	21	67	31.3	20	199	10.1	80	177	45.2
2006	15	98	15.3	30	248	12.1	79	187	42.2
2007	8	56	14.3	31	167	18.6	44	122	36.1
Total	101	573	17.6	322	1745	18.4	751	1270	59.1

APPENDIX B 1

STRUCTURED QUESTIONNAIRE

EXPERT OPINION SURVEY - FOR DIRECTOR VETERINARY SERVICES AND OTHER PRIVATE VETERINARIANS

Name……

Address……

Questions

1) Have you had encounters with dogs suspected/confirmed to be rabid?

2) How was it managed?

3) Are dogs in the State vaccinated against rabies and do you recommend antirabies vaccination? How frequent?

4) What was the outcome?

5) What is your opinion on the prevalence of rabies in dogs in Plateau State/year? 0%-25%, 0%- 50% ,0%-100%

6) What is the prevalence of rabies/10,000 patients (dog bite) per year in the state?

7) Are dog bite/suspected rabid cases often reported to the Veterinarian/hospital?

8) Do you recommend Pre-exposure prophylaxis?

9) How have patients responded to your recommendation?

10) What is the state's mitigation policy against rabies and what legislation in place about rabies and dog bite in Plateau State?

APPENDIX B 2

COMMON RESPONSES FROM VETERINARIANS AND THE DIRECTOR OF VETERINARY SERVICES IN PLATEAU STATE

1) Yes.
2) Suspected cases are quarantined and observed for 14 days. If canine or animal dies by day 14, the head is severed and taken to the laboratory at NVRI for confirmation.
3) Yes, Dogs are vaccinated annually especially in the urban areas; annual vaccination is recommended.
4) Rabies is controlled.
5) 0-50%/year.
6) 2-5/10,000 patients (dog bite)/year.
7) Usually on dog bite, victims come to the veterinary clinic but are referred to human hospitals for post-exposure treatment.
8) Yes especially to people in high risk professions like Dog breeders, hunters, veterinarians, dog handlers.
9) Very well and promise to go and get vaccinated.
10) The state has none specifically, except for the national laws; that is the Northern Nigerian Laws and the Federal law of 1958, which is still in place.

APPENDIX B 3

STRUCTURED QUESTIONNAIRE

EXPERT OPINION SURVEY - HUMAN FACILITIES MEDICAL OFFICERS

Name……

Address……

Questions

1) About how many patients does this hospital see per year?

2) Approximately how many people with rabies do you see or treat every year at this hospital?
3) How many cases of dog-bites/ suspected rabies are reported to the hospital per year?
4) How many of the suspected cases are found to be positive?

5) How were the patients exposed to rabies: What proportion from stray dogs, from pet dogs, from dogs slaughtered for food?

6) Which Department/s of the hospital is involved in the diagnosis and treatment of patients exposed to rabies or suffering symptoms of rabies?

7) How is a patient with rabies/ suspected rabies handled? Do you go by the WHO, OIE and CDC guidelines?

8) Do you administer post exposure prophylactic treatment in the hospital?

9) How have patients responded to your recommendation?

10) What was the outcome of treatment (survivors/ deaths) of patients exposed to rabies?

11) Is there any data on the incidence of rabies in humans in Plateau State?

12) Do you recommend vaccination of patients likely to be occupationally exposed (e.g. vets, those who breed/ slaughter dogs) against rabies at this hospital?

13) Do you think it would be a good idea for all or most dogs in Plateau state to be vaccinated against rabies? Give reasons for your answer.

APPENDIX B 4

COMMON RESPONSES FROM MEDICAL PERSONNEL

1) > 50,000- 100,000/year.
2) None in the recent past.
3) About 1-10 /year.
4) Not sure.
5) Usually from dog bite after 65 days to 3 months.
6) Patients are first taken to the OPD (Out Patient Department) where they continue with their treatment course until they are discharged. Clinical cases are handled by the Medicine Department.
7) Yes, dog bite wound is washed properly with soap and water with antiseptic, and then treated with iodine solution.
8) Yes, antirabies vaccine is administered immediately on day 0, then subsequently on day 3, 7, 21 and 28. On day 0 the patient is also treated with tetanus toxoid and ampliclox antibiotics given for 5 days.
9) Patients have shown willingness to get the pre-exposure vaccination and a number requested for it immediately.
10) In most cases, the dog bite patients recover and get well after the treatment course.
11) None published.
12) Yes.

13) Yes. Dogs will be protected, preventing transmission of the virus. This will consequently protect the human and animal population in the state thus reducing the risk of rabies

Appendix C1- A risk communication poster 1

Appendix C2- poster 2

Appendix C3-Poster 3 written in 'Hausa' language –the commonly spoken language in Plateau State

Appendix C4- poster 4
A very simple form of communication

Appendix C5 – A communication pamphlet on rabies

Appendix D – Photographs from Veterinary clinics

Dog owner with dog at PSVH Jos

A dog owner with dog at the ECWA veterinary clinic Jos

Clinic staff washing a dog at the PSVH Jos

A dog being vaccinated with antirabies vaccine at PSVH-Jos