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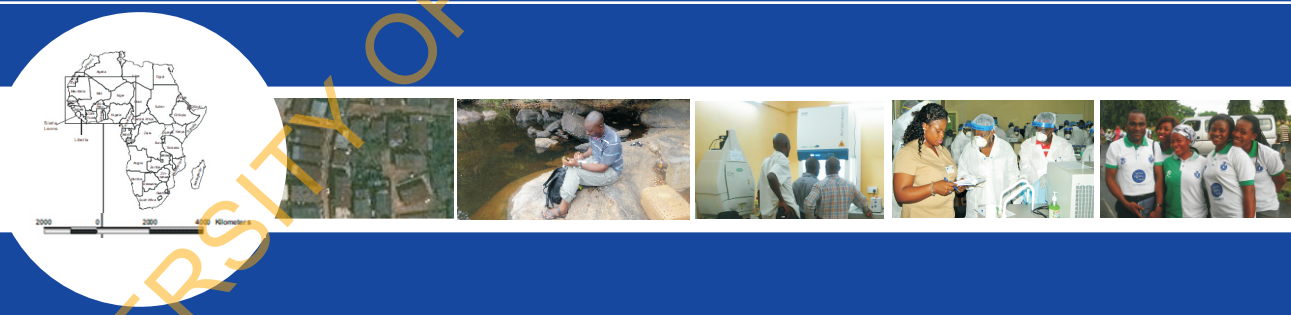
GETTING TO KNOW HUMAN-ANIMAL DISEASE SURVEILLANCE IN WEST AFRICA

A MANUAL OF SPATIAL AND SPATIO-TEMPORAL EPIZOOTIOLOGY



Babasola O. Olugasa
Ayotunde J. Fasunla

Revised Edition

University of Ibadan, Ibadan Nigeria
Centre for Control and Prevention of Zoonoses

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Published by
Centre for Control and Prevention of Zoonoses
Faculty of Veterinary Medicine, University of Ibadan
Ibadan, Nigeria

First edition 2015

Printed in Ibadan, Nigeria

ISBN 978-978-957-961-7

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Dedication

This book is dedicated to all our teachers who inspired us while learning under them, our colleagues who finetuned our thoughts, our students who in many ways challenged and inspired us in our career, and our families for their warm support in writing this book. Above all, to the glory of the Almighty God and Christ Jesus who granted us the grace to complete the writing of the book.

Acknowledgment

The John D. and Catherine T. MacArthur Foundation funded the establishment of the Centre for Control and Prevention of Zoonoses , University of Ibadan, Nigeria, to improve postgraduate training for surveillance of human-animal diseases in West Africa as a priority programme (curriculum) to address major zoonoses challenge in the sub-region.

Administrative oversight for the project was provided by Professor Isaac F. Adewole, Vice-Chancellor, University of Ibadan, Nigeria. Professor Rotimi O. Oderinde (MacArthur Grant Liaison Office - MGLO, University of Ibadan) and his immediate predecessor in office, Professor Godwin O.S. Ekhaguere, did ensure transparent implementation and supervision of the grant. Collaboration between veterinary and medical faculty within the University of Ibadan was led by Professor Victor O. Taiwo, Dean, Faculty of Veterinary Medicine, Professor Bankole O. Oke (Former Dean), Professor Gabriel A.T. Ogundipe (Former Dean), Professor Temitope Alonge (Chief Medical Director, University College Hospital, Ibadan), Professor Ajuwon (Dean, Faculty of Public Health, University of Ibadan) and Professor Oyewale Tomori (President, Nigerian Academy of Science).

Sub-regional collaboration was attained through commitments of Dr. Henrique K. Tokpa (President, Cuttington University, Liberia), Professor Abu Sessey (Vice-Chancellor Njala University, Serria Leone), Professor George K. Aning (Dean, School of Veterinary Medicine, University of Ghana), Professor Albert B. Ogunkoya (Ahmadu Bello University, Zaria, Nigeria), Dr. Ighodalo F. Ijagbone (Director-General, Nigerian Institute of Science Laboratory Technology, Ibadan), Professor Onyebuchi C. Chukwu (Honourable Minister of Health, Federal Republic of Nigeria), Dr. Florence Chenoweth (Honourable Minister of Agriculture, Liberia), Dr. Walter Gweneewale (Honourable Minister of Health and Social Welfare, Liberia), Dr. Muhammed S. Ahmed (Executive Director, National Veterinary Research Institute, Nigeria), and Dr. K. Ibrahim (Chairman, Nigerian Veterinary Medical Association-Oyo State Branch), Dr. Kwesi B. Darkwa (President, Ghana Veterinary Medical Association, 2007-2010), Dr. Osei Agyemang Bonsu (President, Ghana Veterinary Medical Association, 2010-2014).

Materials for curriculum review were provided by experts within and beyond West Africa, notably, Late Professor Gabriel O. Esuruoso (Founding Head, Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Nigeria), Dr. George W. Beran (Distinguished Emeritus Professor, Iowa State University), Professor Harold L. Russel (Department of Public Health, Saint Georges University, Granada, West Indies), Dr. Bolanle Wahab (Department of Urban and Regional Planning, University of Ibadan, Nigeria), Dr. George Nipah (former Deputy Director, Ministry of Food and Agriculture, Ghana), Dr. Richard Suu-Ire (University of Ghana and immediate past President, Commonwealth Veterinary Medical Association), and Dr. Saidu Kanu (Head, Department of Animal Science, Njala University, Sierra Leone).

Adoption of the revised and newly developed curricula was facilitated by Professor Bankole O. Oke (Former Dean of Veterinary Medicine, University of Ibadan, Nigeria and the Director of CCPZ International Programmes), Professor Francis Egbhokhare (Department of Linguistics and African Languages, University of Ibadan and former Director, Distance Learning Centre, University of Ibadan, Nigeria), Dr. Sola Adedoja (Senior Lecturer, Teacher Education, University of Ibadan, Nigeria), Dr. Theodore Brown (Vice-President, Academic Affairs, Cuttington University, Liberia), Professor Samuel A. Agbede (Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Nigeria), Professor Victor O. Adetimirin (Head, Department of Agronomy, University of Ibadan, Nigeria), Dr. Isaac G. Adeyemi (Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Nigeria), Dr. Magbagbeola D. Dairo (Department of Epidemiology and Medical Statistics, University of Ibadan, Nigeria), Dr. Ayotunde J. Fasunla (Department of Otorhinolaryngology, University of Ibadan, Nigeria) and Mrs. Bamke Okunribido (Consultant, Public Healt Monitoring and Evaluation).

Postgraduate field collaboration activities on some CCPZ projects gained additional field experience through teamwork with the United States Centers for Disease Control and Prevention (CDC), High Consequence Pathogen Group, facilitated by the contact persons, Dr. Modupe Oshinubi and Dr. Lora Davies. First participation was in fieldwork to mountain caves in Idanre town, Nigeria for bat trapping. Second was the selection of CCPZ

to host and participate in the Nigeria Bio-security Engagement Training Programme, funded by the United States Department of State.These two activities thusoffered on-site best practices in field research and short course for the detection and diagnosis of high consequence zoonotic pathogens. The training afforded the CCPZ team to test-run some of its equipment for zoonoses surveillance. It also provided model instructional materials for training and fieldwork guidelines. Mrs. A. Sanni-Adeniyi (Deputy Director, Zoonoses, Federal Ministry of Health, Abuja, Nigeria) and Professor Albert B. Ogunkoya (Ahmadu Bello University, Zaria, Nigeria) facilitated CCPZ's hosting of the first international Conference on Rabies in West Africa (RIWA) , 2012.

In-country facilitation of field research in Liberia was by Dr. Charles Mulbah (former Dean of Agriculture and Sustainable Development, Cuttington University), a nd in Nigeria by Dr. Olayinka O. Ishola (Acting Head, Department of Veterinary Public Health and Preventive Medicine, University of Ibadan), Dr. Johnson F. Ojo (Department of Statistics, University of Ibadan, Nigeria) and Dr. Olalekan Taiwo (Department of Geography, University of Ibadan, Nigeria).

Library of instructional resources and template of website were received from Professor James A. Roth (Distinguished Professor of Immunology, Department of Microbiology and Preventive Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa). Administrative guidance was received from Professor Abel Idowu Olayinka (Deputy Vice-Chancellor, Academic, University of Ibadan), especially on development of Memorandum of Understanding with collaborating institutions. Also from Professor Arinola Sanya (Deputy Vice-Chancellor Administration, University of Ibadan), Professor Abel Olorunnisola (Dean, Postgraduate School, University of Ibadan, Nigeria), Professor Ayodele E. Oluleye (Former Dean, Faculty of Technology, University of Ibadan, Nigeria), Professor Bola Udegbe (Director, Office of International Programmes, University of Ibadan, Nigeria) and Dr. Solomon O. Odemuyiwa (Department of Patho-biology, College of Veterinary Medicine, Tuskigee University, Alabama).

Support for day-to-day administration of the Centre was received from all Co-Principal Investigators, Centre for Control and Prevention of Zoonoses, University of Ibadan, namely, Professor Simeon I.B. Cadmus, Dr. Daniel O. Oluwayelu, Dr. Benjamin O. Emikpe and Dr. Adekunle Ayinmode. Immense encouragement for the development of this book was offered at various stages by Dr. Olusegun Fagbohun.

Typesetting of some materials for this book was done by Mr. Olajide Michael. Proof-reading of the manuscript was done by Mr. Olusola Akinbodun and Dr. Eugene Odigie. Editorial review of the original manuscript was done by Professor Albert B. Ogunkoya, Professor Samuel A. Agbede, Dr. Kwesi B. Darkwa and Dr. George Nipah.

This book was therefore made possible by contributions from all the persons mentioned here and many more, for which we are very grateful.

Babasola Oluseyi Olugasa
Ayotunde James Fasunla

Foreword

This book, "Getting to Know Human-Animal Disease Surveillance in West Africa" is the revised edition of instructional manual that supports a revised curriculum for Master of Science (M.Sc.) in Epizootiology and a Certificate of Participation in Human-Animal Disease Surveillance in West Africa by the Centre for Control and Prevention of Zoonoses (CCPZ), University of Ibadan, Nigeria. CCPZ is a centre of excellence established in the Faculty of Veterinary Medicine, University of Ibadan, with funds from the John D. and Catherine T. MacArthur Foundation, United States in January, 2012. It is a novel higher education initiative in Africa.

In almost all the chapters of this book are featured some relevant abstracts from the first international conference on Rabies in West Africa (RIWA) which was jointly sponsored by the CCPZ University of Ibadan and the Federal Ministry of Health, Nigeria which aimed at achieving the mandate for improving postgraduate programmes for human-animal disease surveillance in West Africa. The authors have produced a one-health manual for disease surveillance at the host-pathogene-environment interface. Disease surveillance career persons who are presently unable to embark on full time postgraduate training in Epizootiology may spend 1 to 3 months participating in the activities outlined in this manual at any of the five collaborating institutions running the CCPZ programme, namely the University of Ibadan, (Nigeria), Ahmadu Bello University, Zaria (Nigeria), the University of Ghana (Ghana),

Cuttington University (Liberia) and Njala University (Sierra Leone), to receive the CCPZ Certificate of Participation in Human-Animal Disease Surveillance, endorsed by one of the Vice-Chancellors of the collaborating Universities in West Africa.

The practical exercises on spatial and spatio-temporal epizootiology available in this manual were strategically designed for in-country zoonoses surveillance activities and experiential learning. The authors have made some major contributions to West African sub-regional higher education programmes in epizootiology and one health action which is the commissioned goal of the CCPZ. This may reflect the high quality of research and RIWA service opportunities availed for postgraduate training in the sub-region.

Persons who attend CCPZ short courses for intensive training at the collaborating universities will benefit much more, as they will earn a Certificate of Participation. The Certificate of Participation in human-animal disease surveillance is part of the attainment of the University of Ibadan vision towards the custody of societal salutary values. I therefore recommend this book and the electronic datasets in the compact disc enclosed as very helpful for getting exposed to and acquiring the essential professional skills in human-animal disease surveillance.

Professor **Albert B. Ogunkoya**
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Centre for Control and Prevention of Zoonoses
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List of Contents

Section 1

Introduction to Human-Animal Disease Surveillance

Chapter 1

General Introduction

1.1 What is human-animal disease surveillance?

Surveillance of human-animal disease is an ongoing systematic collection, collation, analysis and interpretation of ***zoonosis*** data and the dissemination of information to those who need to know for action to be taken (adapted from WHO, 1997). The word surveillance, derived from two French words, "*sur*," meaning **over**, and "*veiller*," meaning **watch,** literally means ***watch over***. In disease surveillance, what exactly is watched over? Is it about existing illnesses or new ones, or both? It is about both: enabling mitigation in a community. This book covers these tasks of collecting data in bio-medical, bio-statistical, socio-cultural, geo-spatial and molecular terms; subjecting them to spatial and spatio-temporal analyses. Information from the analyses support tracking of individual diseases at the human-animal-environment interface. Thus, the set of activities in disease surveillance is the essential practice of early detection, control and prevention of diseases among human and animal populations. This is critical for community health promotion in West Africa.

Some well-known human-animal diseases include, avian influenza, Ebola virus disease, Lassa fever and rabies. This group of diseases continue to pose major public health challenge in West Africa. In particular, certain human-animal diseases have caused devastating epizootics in the sub-region, with the recent one being Ebola virus disease (EVD) 2014 outbreak.

Disease surveillance programme supports better understanding and comprehensive knowledge of the determinants of disease occurrence and distribution. In turn, a logical framework for disease control, prevention and elimination is developed. Thus, periodic assessment of the prevalence of priority human-animal diseases is sustained through surveillance and used to re-focus goal of intervention. Disease surveillance programme is a basic public health education, science and service.

Disease surveillance is performed in passive, active or predictive mode. The focus of this workbook therefore, is to elucidate methods of disease surveillance in such a way that may enable the average career personnel to be updated, as to play an effective role in disease surveillance activities. At the same time, closely related to disease surveillance is the monitoring of diseases. Disease monitoring is a process for the assessment of status of a specific disease in a given population without being involved in subsequent intervention in the course of the disease (Salman, 2003).

Thus, building individual and group competence in the surveillance of human-animal diseases is the goal of this book.

Figure 1.1: Human-animal disease surveillance promotion at village square and record keeping by personnel deployed to local disease surveillance unit

Disease surveillance officers, especially those that have been newly employed or assigned to human-animal disease surveillance units would require on-the-job hands-on training that includes methods for ensuring community connection for smooth continuity in zoonosis data collection, collation, analysis and interpretation for response in one-health mode.

1.2 Disease surveillance team composition

The human-animal disease surveillance team is essentially a model of one-health at the community level. The group often comprise individuals that are capable of investigating persons (with suspected zoonotic disease, and differentiating them from persons without cases), place (identifying site names

where cases occurred and can convert them to map points for spatial tracking of cases) and time (when zoonosis case has occurred, collating them into time-series and trend model). Two or more personnel of these multi-disciplinary backgrounds in human and animal health, community administration and law enforcement. Thus, a Medical Officer, Veterinary Officer, Ecologist, Environmentalist, Epidemiologist, Epizootiologist, Geographer, Public Health Officer, Livestock Officer, Laboratory Technologist, Laboratory Technician, Medical Records Officer and Statistician have roles to play on the teamwork. Being a multi-disciplinary team, human-animal disease surveillance requires sustainable leadership and group dynamics skills.

The ability to harness an array of tools available for disease surveillance will determine efficiency of human-animal disease surveillance team. In any case, collection and collation of data for biomedical detection and spatio-temporal analysis are cardinal for interpretation of case distribution pattern on which logical framework for zoonosis control and prevention may be formulated.

In addition to the core professionals in health service, the role of educators in designing zoonosis surveillance education campaign is of increasing importance, linking schools, especially higher education and secondary schools to participate in disease surveillance activities at the community level. As a result, a team for human-animal disease surveillance collaboration may include:

- Human health service providers
- Laboratory service providers
- Animal health service providers
- Community planning officials
- Public awareness (extension) personnel
- Educators

Figure 1.2: Children and dogs play within community spaces. Often the same dog unexpectedly changes its behavior from a friend to a foe when rabid.

Animals and humans enjoy the common spaces in and out of the human homes worldwide. The dog as one of man's best friends is commonly seen in West Africa (Figure 1.2). The unique pathogens at the human-animal interface are the zoonoses. They deserve a priority attention in detection, control and prevention promotion.

1.3 Working locally: community by community

Surveillance of zoonotic pathogens offers unique experiences to physicians and veterinarians working together at the community level. Physicians request victims to identify the location, owner

Rabies in West Africa: How can we address the challenges of under-reporting and exposure care?

Onyebuchi Chukwu
Federal Ministry of Health, Federal Secretariat, Abuja, FCT, Nigeria.

Abstract
Introduction: Girolamo Fracastoro, a Verona born Italian doctor observed the devastating effects of rabies virus in humans. He connected the saliva of infected animals with this disease in human beings. He gave the name rabies which in Latin means 'to rage' to this incurable but preventable disease. Traditional healers had described the existence of the disease in West Africa with local antidotes of tentative efficacy. Although effective rabies vaccine had been available since Louis Pasteur administered the first of its kind to Joseph Meister in July 6, 1885; the challenges of annual human deaths due to rabies remain critical in West Africa. High under-reporting and poor post-exposure care for dog bite victims are two major determinants of this outcome. Methods: Review of the situation of rabies in Nigeria and West Africa and how public health authorities may enable pre-exposure prophylaxis for at-risk population. Review of how post-exposure prophylaxis may be provided to ensure timely care of animal bite victims at every local community. Results: Epidemiological records keeping accounts for locations of humans and animals exposed to rabies annually, and estimates under-reported cases. Simple, measurable, and realistic goals set to achieve population-wide vaccination of domestic dogs and cats in local communities, and within 24 hours prophylaxis for rabies exposed humans will more effectively guide community health care. Conclusion: Smart epidemiologic surveillance and annual public health goals for pre- and post-exposure prophylaxes against rabies are capable of reducing animal bite under-reporting and avoidable annual human deaths due to rabies within West Africa.

Keywords: Dog, human, pre-exposure prophylaxis, post-exposure prophylaxis, public health goal

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Rabies: locate and eliminate

George Beran
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Abstract
Introduction: Rabies in dogs has been essentially eliminated in Western Europe, the United States and Canada. Programs to locate and eliminate the occurrence of rabies deaths in people and dogs are also succeeding in South America and Australia. Tropical Africa and Asia have the highest occurrence of rabies deaths and warrant focus on how to locate and eliminate the disease in people and dogs that inhabit these continents. Programs that will address cardinal questions about laboratory confirmation of exposure to rabies and tracking the source of rabies exposure are needed. Method: Update on what is required to locate and eliminate rabies, the role of veterinarians in prevention of the infection in dogs based on vaccination where dogs have bitten people, or universal, no matter how much it costs. Results: The transmission of rabies to people is considered a "one health" disease dynamics which also needs collaboration to prevent rabies exposure and once exposure has occurred, the exposed population of dogs should be eliminated from the community. Wandering dogs around communities are classed as rabies risks and should be vaccinated. Conclusion: This article explains that locating and eliminating rabies requires that seventy percent of dog population be vaccinated, and how vaccinated dogs should be identified. It describes how community residents should be trained, supplied and protected in vaccinating their dogs. Finally, it shows how the public should be educated before and during community rabies elimination. And when rabies elimination has been undertaken in community, it describes how it should be evaluated.

Keywords: Disease dynamics, dog vaccination, laboratory confirmation, one health, rabies exposure.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

and circumstance (bite) of the offending animal (Beran, 2013). Following victim's examination, the medical doctors who had diagnosed and treated victims in the clinic or hospitals are needed to report cases to community health officials (Beran, 2013).

In a similar way, veterinarians systematically examine agricultural and companion animals for the presence of clinical signs of specific zoonoses in the offending animal. They design treatment regime and control programme for animals. Veterinarians request animal owners to comply with regulations for responsible animal ownership, environmental hygiene and vaccination scheme to prevent dog-transmited rabies in the community. Stray animals around communities are controlled by animal health services and law enforcement authorities. Veterinarians report zoonoses to Animal Health Authorities when they are found in animals. Working together (Figure 1.3), the team ensures disease surveillance and response activities at the human-animal-environment interface are effective and efficient.

Below are phases in human-animal disease surveillance and response activities in one-health approach:

1. Joint surveillance of human-animal disease
2. Control the disease in animals
3. Control the animals
4. Control disease agent in the environment
5. Control the disease among humans.

In keeping track of disease exposure, surveillance team engages

diagnostic laboratory for test to confirm or refute suspected cases in humans, animals and the presence of disease causal agent in the environment, community by community.

Figure 1.3: Disease surveillance team working locally, community by community

1.4 What qualifies a disease for one-health surveillance?

Because animals are essential in the life cycle of zoonoses, collaboration between Animal Health and Human Health is a key qualifier for one-health surveillance. The links between human, animal and environmental health is a platform for field surveillance of zoonoses. Zoonoses surveillance is at the heart of "one-health" initiative. One-health approach is multi-disciplinary, requiring concerted actions of veterinarians, physicians, epidemiologists, public health professionals, agriculturists, economists, educators and sociologists, collaborating to improve and promote human, animal and environmental health. This is an important means for regional

health promotion in West Africa, especially in the events of rabies, Ebola virus disease and Lassa fever epidemics.

Although all zoonotic diseases are readily seen as qualified for one-health surveillance, one-health surveillance team is critically needed to address certain ill-health situations other than zoonoses that could benefit from exchange of expertise for comparative studies and development of solution options. In this situation, the rapid spread of certain human or animal diseases, with high case morbidity and mortality rates and the absence of effective treatment or vaccine, equally qualifies a disease for one-health collaboration.

The deployment of one-health expertise from across multi-disciplinary backgrounds to resolve posed challenges is strongly promoted. Such collaborations often reduce public panic and focus on solutions. The spatio-temporal description and analysis of such events have historic legacy in the cholera epidemic in London during 1854 (Johnson, 2006). The importance of mapping for analytical planning and visualization of geographic distribution of the problem readily becomes a basic tool for controlling epidemics of unknown aetiology and logical solution to an epidemic. This was earlier demonstrated by John Snow, contributing to the emergence of the modern field of epidemiology and epizootiology. Johnson had made the remark that, "when the next great epidemic does come, map will be as crucial as vaccines in our fight against the disease" (Johnson, 2006).

The approach in getting to know human-animal disease surveillance is therefore epizootiological, going through the following steps:

1. Participation in West African hands-on training in human-animal disease surveillance;
2. Utilization of data-sets and guidelines for exploring local disease distribution patterns;
3. Identifying and understanding the use of selected tools for human-animal disease surveillance;
4. Collect suspected specimens and ship them to a diagnostic laboratory for case confirmation;
5. Offering hands-on experience in laboratory detection and diagnosis of human-animal diseases;
6. Remotely sourcing for geographic data associated with human-animal disease cases and using the data for spatial descriptive map of case pattern;
7. Enable time-trend plot and model for predicting case pattern of human-animal disease, community by community;
8. Conduct community-based monitoring and evaluation of disease surveillance project;
9. Conduct mini project on disease surveillance;
10. Actualize a network in a one-health collaboration.

At the end of the practical exercises in chapters 2-10 of this book, you will be able to integrate human and animal health surveillance practices into one-health functions, and in the context of one-West Africa and one-healthy life. The steps above make up the objectives for sub-regional training on human-animal disease surveillance at the Centre for Control and Prevention of Zoonoses, University of Ibadan, Nigeria.

1.5 Further readings

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Emergence of Rabies in West Africa: strategic partnership to improve the surveillance and control of a neglected zoonosis

Harold Russel
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Abstract
Introduction: The failure of rabies control programs in human and animals may be attributed to inappropriate and ineffective control strategies such as dog culling, lack of domestic dog vaccination programmes, lack of relevant public education effort and insufficient funding. In addition there are many challenges, including epidemiological, operational, socio-cultural and legal problems. Rabies in West Africa (RIWA) forum was conceived to improve surveillance and control of this neglected zoonosis. It is essential to describe the process that made RIWA emergence possible and the key facilitators, especially during the critical planning years. Method: A review of the concept and activities that have led to the inauguration of RIWA forum for coordinating regular meetings among governments and stakeholders. Results: RIWA conceptualization commenced at the Rabies in the Americas (RITA) conference held in Quebec, Canada in 2005. RIWA was proposed to be a replica of RITA within West Africa. Its primary focus was to coordinate strategic partnership among governments and stakeholders for one-health actions which would link Anglophone and Francophone West African countries in rabies surveillance and control. RIWA inaugural conference was jointly hosted in Ibadan, Nigeria from 4th to 7th December 2012 by the Nigerian Federal Ministry of Health and the University of Ibadan Centre for Control and Prevention of Zoonoses, Ibadan, Nigeria. Conclusion: This article presents the concept note of Rabies in West Africa forum and how it emerged at its inaugural conference in December 2012. Some key role players in its decision making and resource allocation processes were listed and acknowledged.
Keywords: Concept, planning, rabies surveillance, strategic partnership, West Africa.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Problems of rabies in Nigeria: a review

Albert Ogunkoya[1], Solomon Audu[1], Philip Mshelbwala[3], Yakubu Atuman[2], Ajoke Ehimiyein[1], Modupe Osinubi[3], Ahmed Garba[2], Ebenezer Abidoye[1], Israel Onoja[1]
Department of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria; [2]National Veterinary Research Institute, Vom, Nigeria; [3]Rabies Program, Pox and Rabies Branch, Centers for Disease Control and Prevention, Atlanta, USA

Abstract
IIntroduction: Official reporting of rabies in Nigeria started in 1912. Efforts to prevent the disease progressed to the establishment of National Veterinary Research Institute (NVRI), Nigeria, which produced between 1956 and 2005, some 2,137,615 doses of dog anti-rabies vaccine. Dog population in Nigeria is currently estimated at 8 million. Rabies control through immunization programs has crashed considerably while rabies situation has become confounding. Method: Based on literature review, the prevalence of rabies antigens in brain and saliva of apparently healthy dogs slaughtered for human consumption; or in clinically suspected rabid domestic animals and wildlife submitted to the NVRI for confirmatory diagnosis were evaluated. Molecular characteristics of rabies virus isolates were used to identify direction of spread between Nigeria and her neighboring countries. Results: The NVRI confirmed 4809 cases of animal rabies within the last 77 years (1935-2012). Rabies trend increased from 1983 to 1991 by between 40% and 60% in confirmed cases every decade. Prevalence of rabies antigen in the consumed dogs in North-West, North-East and North-Central regions of Nigeria were 28%, 31% and 24% respectively. Approximately 6%-8% of dogs had rabies antigen in their saliva at selected slaughter points. The presence of rabies antigen in a national game reserve indicated mongoose (11%), jackals (9%), squirrels (8.3%), hyena (17%) and wild cats (16%). Only 10% of national dog population received anti-rabies immunization within the last 20 years (1992 – 2012). Conclusion: Low levels of dog immunization within rabies endemic West Africa is a major risk factor for frequent rabies outbreaks in humans and domestic animals. The presence of the virus in apparently healthy dogs is another level of occupational exposure.

Keywords: Apparently healthy dog, Rabies prevalence, Vaccination, Wildlife
Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Chapter 2

Fundamentals of Zoonosis

2.1 What is zoonosis?

Rudolph Virchow (1821-1902), a German physician and pathologist, coined the term "zoonosis," which literally means, a disease of animals that infects humans. With increasing usage in medical literature and professional practice, zoonosis has come to be defined not just as a disease transmissible from animals to humans, but vice-versa and much more. Today, zoonosis is defined as a disease, infection or infestation that is naturally transmitted between vertebrate animals and humans (WHO, 2006). Some of these diseases have become naturally established (endemic) within local community in West Africa. Some others are just being introduced (emerging). Protracted failure to pay adequate attention to the surveillance and control of some endemic zoonoses, often in developing world has led to their classification as neglected tropical diseases, by the World Health Organization (WHO, 2006).

Several agricultural animals, companion animals and wildlife species are vertebrates (having backbone). It is therefore relatively simple and reasonable to treat the basics about zoonosis under the span of agricultural, companion and wildlife species.

The classification of zoonoses is usually based on their biological taxonomy. However, the purpose of this book makes it imperative and expedient to adopt a slightly modified approach to zoonoses classification.

A classification based on association with agricultural animals, companion animals and wild animals offers a unique convenience for getting to know the technical know-how for disease surveillance. The merit of this approach includes giving audience to wider scope of participants in a community to learn and assimilate the essentials of one-health collaboration.

2.2 Zoonoses of agricultural animals

Surveillance data quality on specific zoonoses among agricultural workers and others in West Africa is still considered quite poor. Some zoonosis cases have been reported in literature by clinicians in medical and veterinary practice, academic faculty and technical staff, and the students. Obviously, many have been left out which contribute to the neglect of some of these zoonoses of agricultural animals. Hence, much needs to be done. Zoonoses of agricultural animals include, anthrax, avian and swine influenza, hookworm, Jigger (*Tunga penetrans),* tuberculosis and brucellosis, among several others in West African region.

Hookworm and Tuberculosis have been such well researched on, with breakthrough therapy, that they now pose little or no public health emergency.

Influenza

Influenza is a familiar disease to most healthcare professionals and the public at large. What may not be well-known is that influenza is a classical zoonotic disease. Historically, Swine influenza was incriminated for the death of some 20 million people worldwide, just after World War I (1918-1919). The swine influenza (also named *Spanish flu*) was reputed and has proved to be five times deadlier than the war in which 6 million people died due to influenza pneumonia in 12 weeks! This is about five times the number of people killed in the war itself since it was estimated that 20,000,000 people were killed in the war itself (Tumpey *et al*., 2005). Again, a pandemic of influenza viruses in 1957 and another in 1968 led to many human deaths. More recently, in 2006-2014 waves of epidemics associated with highly pathogenic avian influenza, H5N1, ravaged poultry in West Africa, with less than ten human deaths recorded. Influenza is caused by a virus, biologically classified as an *orthomyxovirus*. It is categorized into three types - A, B and C, of which types A and B are known to cause severe respiratory disease in animals (including companion and wild animals) and humans.

Influenza viruses are further characterized into subtypes according to the nature of the two main viral structural proteins, ***haemaglutinin*** (H) and ***neuraminidase*** (N). In addition, the year and place of its first isolation have been used to name the virus strain. For example, H5N1 highly pathogenic avian influenza virus was first isolated in Hong Kong in 1997. Human, swine and avian influenza types are also recognized based on the nuclear protein that is considered the major determinant of host species. All influenza viruses are capable of genetic interaction and as a result, new viruses are capable of being produced from time to time when the environment is suitable. This quality makes influenza viruses a high priority candidate for surveillance at the human-animal-environment interface.

2.3 Zoonoses of companion animals

As human population in West Africa is increasing exponentially, with increasing interest in keeping pets for various reasons, the population of companion animals, such as dogs, cats, pet birds, and horses are also increasing. There is room for closer contact between humans and companion animals in West Africa. This relationship has led to repeated cases of zoonotic diseases in recent years among humans and animals. Diseases such as rabies, toxoplasmosis,

hookworm, roundworm and West Nile fever are being diagnosed in the sub-region. The risk of this group of human-animal diseases is high. For example, dogs, carriers of rabies virus, are commonly used for security purpose by men of which most owners pay limited attention to prevent the disease from getting to humans.

Rabies

Rabies is a fatal disease caused by a virus usually transmitted to man through the bite of an infected animal and manifests as nervous signs, including marked depression, convulsion, coma and eventual death (Chukwu, 2013, Ogunkoya *et al.,* 2013). It is one of the oldest known diseases of animals transmissible to humans. Rabies cases occur every year in West Africa (Traore *et al.*, 2013), and with evidence of high under-reporting of cases (Jomah *et al.* , 2013). There are other viruses classified as rabies-related viruses, including Mokola virus and Lagos Bat virus. Mokola virus is known to produce similar disease in animals and humans as the classical rabies virus (Nottidge, 2013).

Vaccines for classical rabies virus are not effective to protect against Mokola virus (Okoh, 2013). Thus, in order to reduce the annual death due to rabies among humans in West Africa, there is a need to place the disease under priority and comprehensive surveillance.

Livestock exposure to rabies in Plateau State, Nigeria: a report of two cases

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Abstract
Introduction: Although rabies could infect any warm blooded animal in nature, the primary hosts are domestic and wild dogs. Some other major susceptible hosts include cats, foxes and bats. Many of the primary hosts also serve as reservoirs and often the source of infection to other animals, including humans and livestock. Incidence of rabies in livestock is relatively low globally, but has been reported in both rabies endemic and hitherto dog rabies free countries. Method: Two ruminants (a goat and a cow) were observed as rabies exposed suspects following reports of bite by rabid animals. Following the death of the animals, their heads were severed and brain tissues harvested for confirmatory diagnosis of rabies. Fluorescent antibody test was performed in accordance with OIE/WHO protocol. Result: The two animals exhibited clinical signs of rabies including hyperactivity, aggression, and drooling of saliva prior to death. The two animals died naturally. Negri bodies were identified on the brain smears showing fluorescence green coloration that was confirmatory of rabies virus. Conclusion: We report two cases of rabies in livestock, including one goat and one cow which were confirmed at the National Veterinary Research Institute, Nigeria. Though these animals are dead-end hosts, rabies was transmitted to them by direct bites and through contact with dog saliva. Control of rabies in domestic dogs through vaccination programme is the more necessary to prevent rabies transmission to other livestock species, including cattle, sheep and goats. .
Keywords: Rabies transmission, Goat, Cow, Fluorescent antibody test.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Epidemiology of human rabies in urban areas of Mali

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Abstract
Introduction: Rabies is a viral disease of humans and animals. Transmission is usually by infected bites. Most of the time once symptoms begins, the mortality is 100% both for humans and animals. Method: Descriptive study and analysis of epidemiologic profile of rabies in two urban areas in Mali was conducted from January 2007 to December 2009 using retrospective data of all bites and rabies cases in humans from all the registers in the Medical Centers, Veterinary Services and Central Veterinary Laboratory of Bamako. Measure of the prevalence of bites, nature of the biting animals and the case categorization of human and animal rabies were reviewed. We evaluated post-exposure treatment of bites. Results: In this period, there were 3211 bite cases comprising 2053 males and 1158 females. Ages of bite exposure varied from 1 month to 87 years old. Less than 20 years old alone accounted for 68%. Use of local treatment was recorded in 97.3% (n = 3123). There were no data in 2.7% (n = 98). No pre-exposure vaccination policy in place. Post-exposure vaccination was available in all the six areas. Vaccine price of 8590 CFA (about US$ 17.18) was the same everywhere. During this period of 3 years, there were 28 case of human rabies confirmed in the study areas, which is an incidence of 0.40 for 100000 hab. Death occurred within 1 to 4 days of admission to the hospitals. Most victims (more than 90%) were exposed to dog bites. Conclusion: This study shows that rabies is a neglected real problem in Mali and there is low level of notification. A good system of epidemiologic surveillance is needed to control the disease.
Keywords: Animal rabies, human rabies, prevalence, post-exposure prophylaxis

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Current knowledge of rabies and rabies-related viruses in Nigeria: any relevance to formulating control and eradication strategies?

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Abstract
Introduction: Rabies is an important zoonosis still endangering the lives of man and warm-blooded animals in Nigeria. Different antigenic groups of rabies variants have been identified in the country on the basis of glycoprotein pattern of reactivity using monoclonal antibodies. It would appear that dog rabies viruses are not homogenous within Nigeria. It is necessary to identify existing questions requiring cogent answers on rabies and rabies-related viruses among domestic animals and wildlife species in Nigeria. Method: conceptual review of rabies viruses isolated from vaccinated dogs by standard methods and thereafter subjected to monoclonal antibody characterization. Cross protection studies with rabies and rabies-related virus variants using inactivated rabies-related virus-specific antibodies was also performed. Results: Some rabies virus isolates did not conform to those of the seed and vaccine strains. This shows that there exists in nature within Nigeria, variants of rabies virus which are not protected by commonly used inactivated human vaccines. Mokola virus, Kotonkan virus and Lagos bat virus were so identified as rabies-related viruses. Conclusion: More studies on rabies virus characterization and the search for rabies-related viruses in dog and cat populations and wildlife in Nigeria are warranted since only a little of the search has been done so far. This will require both political and financial commitments by government and technical assistance by the WHO and other world laboratories working on rabies control and prevention. A more effective rabies control strategy might evolve when all the hanging questions on rabies and rabies-related viruses are thoroughly researched in Nigeria.

Keywords: Rabies, Kotonkan virus, Lagos bat virus, Mokola virus, Wildlife.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Importance of rabies-related viruses in the epidemiology and control of rabies in Nigeria

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Abstract
Introduction: Rabies virus is classified as a member of the family Rhabdoviridae, genus Lyssavirus. Lyssaviruses are all morphologically, genetically and pathologically similar. Twelve rabies-related viruses have been reported worldwide, five of which occurred in Africa. This article seeks to summarize the classification of these rabies-related viruses. Method: Literature search and ethymology review were used to update available information about types of rabies-related viruses of importance to rabies surveillance, control and prevention in Nigeria; categorized into local, regional and global levels of importance. Results: Obodhiang virus was isolated from insects in Sudan while Kotonkan virus was isolated from insects in Nigeria. Mokola virus (MOKV genotype 3) was isolated from shrew in Nigeria. Lagos bat lyssavirus (LBV genotype 2) was first isolated in Nigerian bat. Duvenhage virus (DUVV genotype 4) was isolated from brain of a man suspected bitten by bat in South Africa. Others are European bat lyssaviruses 1 and 2 (EBLV 1 and 2) (genotype 5 and 6) and Australian bat Lyssavirus (ABLV) (genotype 7). Fifteen isolations of LBV were reported in fruit bats and cat, with no association with human disease. MOKV had been reported to cause rabies-like disease in two persons in Nigeria, while DUVV had also caused rabies-like disease in two persons in South Africa. More recently, rabies-like virus (Bas-Congo virus) was isolated following an outbreak of haemorrhagic fever in the Democratic Republic of Congo. Conclusion: Presence of several rabies-related viruses contributed to challenges in rabies diagnosis and control. Capacity for differential surveillance of rabies-related lyssaviruses and their prevalence are important for public health action against them.

Keywords: Rabies, laboratory investigation, standard test, rapid diagnosis.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

2.4 Zoonoses of wild animals

Ebola virus disease (EVD) and Lassa fever are two of the major zoonoses associated with wild animals. At the same time, some zoonoses that have been associated with agricultural and companion animals equally have their reservoir hosts among wildlife species. These include rabies, commonly reserved by bats and hyena.

Lassa fever

Lassa virus causes ***Lassa fever***, which is an acute viral haemorrhagic fever that was first described in 1969 in the town of Lassa, Nigeria (Bond *et al.,* 2012). It is endemic in West Africa with approximately 300,000 cases annually, of which up to 5,000 die. The virus is known to be shed in the urine and other body fluids of the rodent, *Mastomys species.* Geographic distribution of Lassa fever cases within the West African sub-region has been recognized to be in two prominent zones namely, the Lake Chad River Basin zone in the north-eastern part of Nigeria, and the Mano River union zone that comprise Liberia, Sierra Leone and Guinea (Olugasa *et al.,* 2014). Each of the zones have distinct epidemiologic characteristics. Explanation for the bipolar distribution of Lassa fever has been proposed to be associated with human slave trade in West Africa.

Lassa fever remains a public health challenge in West Africa and of high human to human spread. As such

hospital-acquired (nosocomial) cases and community acquired cases are well reported in the medical literature.

2.5 Biosafety issues

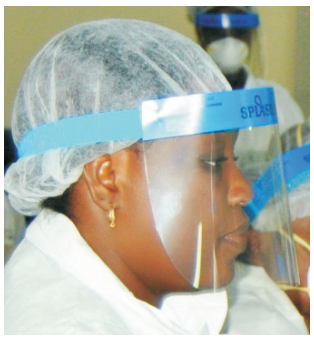
Zoonoses impact negatively on human and animal health, national productivity, food security, food safety and socio-economic well-being of people in West Africa. At present, the available manpower in zoonoses surveillance is grossly inadequate and improperly coordinated for response to public health emergencies. Biosafety implications of attending to some of these pathogens, including influenza, rabies, Lassa fever and Ebola are on the high level ranking. As a result, persons that would be deployed for surveillance and response must be aware of the dangers involved and the biosecurity equipment that must be made available to do the job.

Higher education in human-animal disease surveillance is therefore of paramount importance and play a role in West Africa biosafety and biosecurity training. Working with zoonoses on the field and in the laboratory demands appropriate biosafety kits which must be worn. Wearing the biosafety equipments is thus a practical exercise that all operators of zoonoses surveillance must participate in.

2.6 Practical exercise

Some personal protective equipment (PPE) are shown in Figures 2.1 and 2.2. You are to assemble them for use in class demonstration exercise.

A



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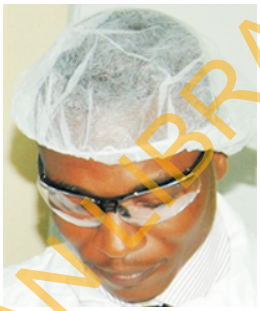
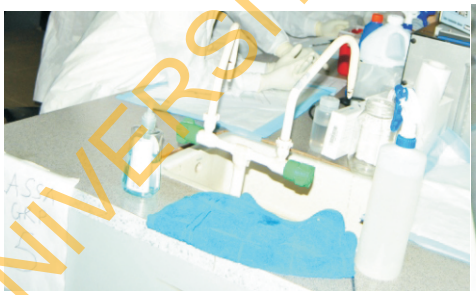


C

D

E



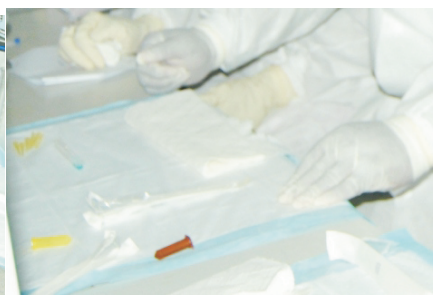


Figure 2.1: Donning of personal protective equipment must include face shield (A), eyes goggle (B), nose and mouth shield (C) and head net cover (D). In addition, work bench must be clean, spacious and have running water and supply of disinfectants (E).

After donning each of these equipment, you need to take some time to discuss the importance of each one of them and what may happen if not used.

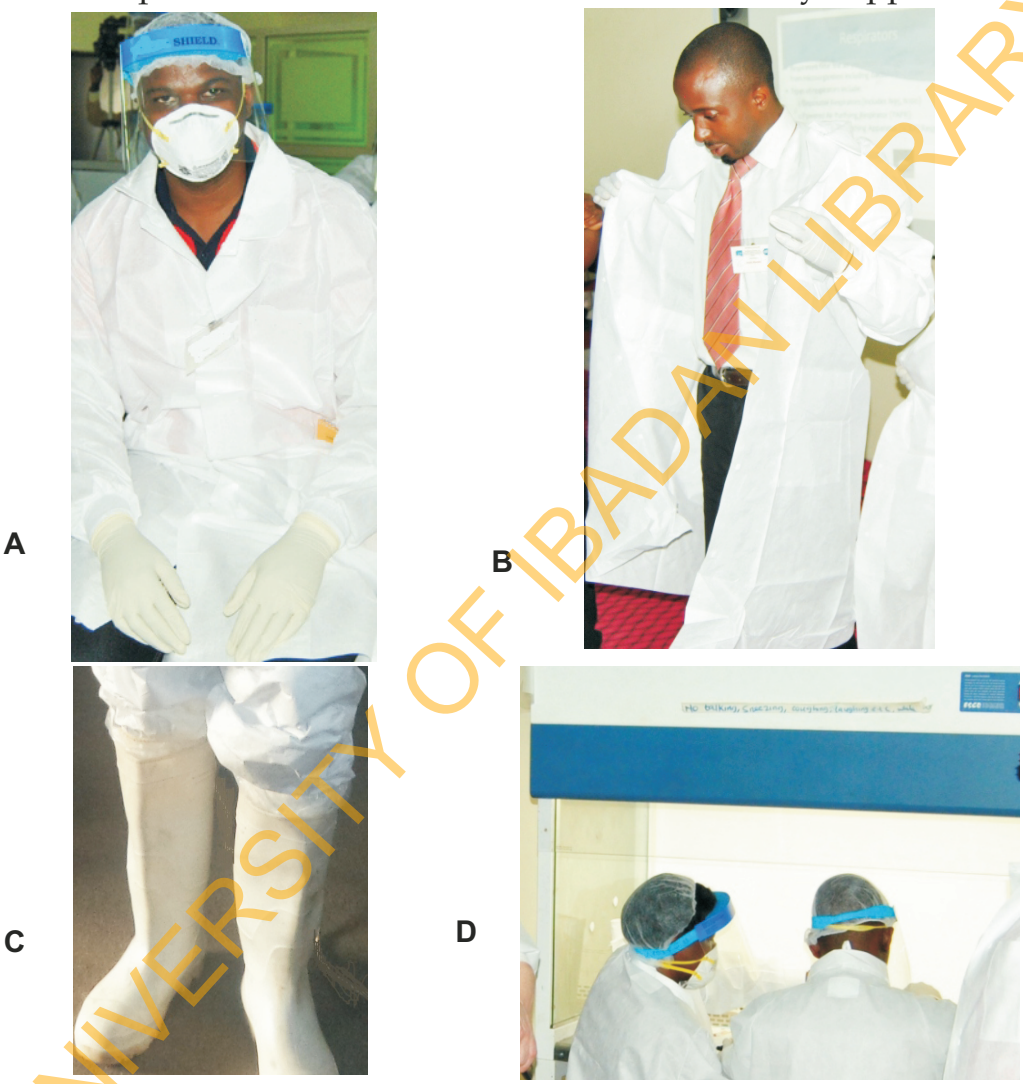


Figure 2.2 : Donning of personal protective equipment must include an overall cover coat (A) and (B),disposable hand gloves (A) and (B) and a pair of rubber (Wellington) boots (C). A biosafety hood (D) that is commensurate to the level of zoonotic pathogen should be used.

2.7 Further readings

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Chapter *3*

Approaches to Zoonosis Diagnosis

3.1 What is diagnosis?

Diagnosis is the process of examining a person or group of persons to detect the comprehensive nature of a disorder plaguing the person or group of persons. Definitive and comprehensive conclusion of diagnosis is crucial for disease surveillance in the sense that a disease must be precisely defined before it is spatially investigated for distribution pattern and risk factors.

In common day-to-day usage, the word ***diagnosis*** connotes detection of the nature of a problem or fault, what the problem is all about, and how it functions to interrupt operations of a system. In certain instances, diagnosis has been made to imply identification of where a fault is located within a system. The concept of diagnosis takes on the same note as it does in day-to-day usage within medical and public health practices, with regards to the detection of nature of ill-health conditions. However, because of the vast multi-systemic contributions to health outcomes, the types and levels of diagnosis in public health and medical practices are diverse. They include, (i) clinical diagnosis, (ii) differential

diagnosis, (iii) aetiological diagnosis, (iv) serological diagnosis, (v) molecular diagnosis (vi) epizootiologic diagnosis and a growing number of other methods.

Human-animal disease surveillance approach to zoonosis diagnosis, requires that the basic level of ***clinical detection*** of disease must be combined with ***ecological detection*** of zoonotic pathogen (causal agent of ill-health) within a common environment and ***molecular detection*** that offers early warning, ahead of clinical manifestation of a disease in at risk population. The approach is presented in this chapter.

3.2 What about clinical diagnosis?

Clinical diagnosis is the process of determining the nature of an ***ill-health condition*** or disease based on physical examination of individual person's or animal's body. Clinical examination enables physicians and veterinarians to detect clinical signs exhibited in the body of individual persons and animals, system by system. Clinical signs may include (i) fever, (ii) vomiting, (iii) diarrhoea, (iv) bleeding, (v) blindness, (iv) coughing, (vii) pain, (viii) swelling. Subsequent examination of group of humans and animals may identify other clinical signs that are presented in the group .

Clinical examination by a physician or veterinarian may conclude on diagnosis about nature of a disease or ill-health condition in an animal or person. Specialized

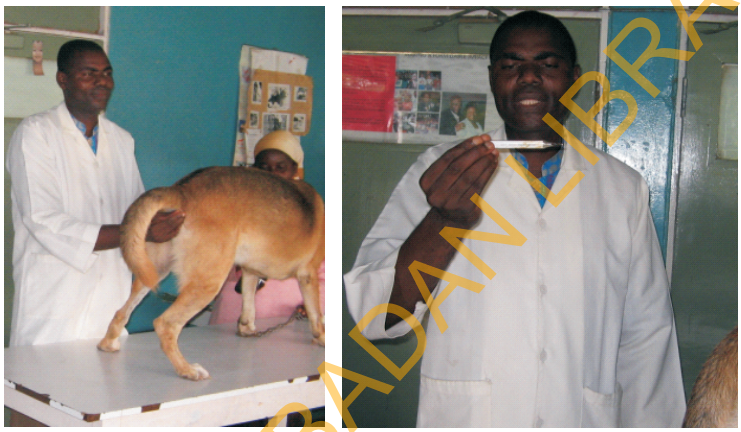

Figure 3.1: A clinical thermometer inserted in the rectum of a dog during physical examination of its body temperature on a Veterinary Clinician's desk

clinical tools enhance the sense of touch, sight, smell and hearing to measure clinical values. Common clinical instruments available for the general practice by a physician and veterinarian, include: (i) the clinical thermometer, (ii) stethoscope, (iii) otoscope, (iv)ophthalmoscope, (v) gloves and (vi) weighing scale.

Clinical-problem solving approaches, especially in drawing conclusion on clinical diagnosis, often require a combination of medical history, taking physical examination of patient, a further investigation of clinical symptoms and signs (in some diagnostic laboratories).

An example is a **clinical case of rabies,** defined as a person presenting with an acute neurological syndrome, dominated by forms of hyperactivity (furious rabies) or paralytic syndromes (dumb rabies) progressing towards coma and death, usually by respiratory failure, within 7 – 10 days after the first symptom (if no intensive care is given). At this stage, WHO mandates aetiologic investigations (WHO, 2005).

Whereas, **probable case** of rabies is a person displaying clinical signs consistent with rabies, though **not confirmed by laboratory** but has appropriate exposure history (WHO, 2005). This definition underscores the role and importance of conducting further laboratory investigation into **clinical signs** and symptoms. Finally, a **suspected case** is a person compatible with the clinical case definition (WHO, 2005).

3.3 Aetiological diagnosis

While a combination of the patient's history and a clinical examination by a general practice physician or veterinarian may be enough to identify **a probable case;** quite often, laboratory investigation procedures are **required to confirm** a clinically suspected diagnosis and to obtain more accurate information about causal (aetiologic) agent involved in a disease. The clinical

Rabies in a five months old puppy: a case report

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Abstract
Introduction: In Nigeria, the dearth of information on reported cases of rabies outbreak has contributed to the claim by WHO that there is no rabies in Nigeria. Contrary to this claim, there are pockets of cases of rabies in some states in Nigeria. Method: With the case history given by the dog owner, rabies was suspected and the dog was quarantined. Food and water were provided. The dog however, died within 2 days of presentation. After death, the brain was harvested and sent to the National Veterinary Research Institute, Vom, Plateau State, Nigeria for definitive diagnosis, using the fluorescent antibody technique (FAT). Result: On the 14th of February 2011, a five month old male mongrel dog was presented to the Veterinary Teaching Hospital (VTH), University of Nigeria Nsukka by the owner with the primary complaint that his dog was bitten by a stray dog some three weeks before, and that the dog was off feed. A change in behavior was observed about 2-3 days after the bite. Dog became anxious, and increasingly sensitive to noise and light. The friendly dog turned aggressive and attacked without or at the slightest provocation. The dog became depressed and withdrawn, hiding in dark and cold places and continually bit and scratched at the site of the bite. By the 5th day, the dog had grown increasingly nervous, irritable and vicious and would bite and attack its feeding plate, chain, cage, sand, wood and shoes. The owner also noticed lack of coordination, difficulty in and refusal to swallow, with drooling and frothy saliva in his mouth. About 10 days after the bite the dog grew progressively weaker until it could not eat, bark, or walk. Presence of green-colored fluorescent particles on brain smear was identified and considered confirmatory of rabies virus. Conclusion: The laboratory report confirmed the animal to be positive for Rabies.
Keywords: Attitude change, fluorescent antibody, canine rabies, quarantine.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Rabies exposure confirmation in Nigeria: importance of laboratory diagnosis

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Abstract
Introduction: The importance of prompt diagnosis of rabies is critical to ensure timely and appropriate management of exposure. There are different diagnostic tests for rabies: The Direct Fluorescent Antibody Test (DFA), Mouse Inoculation Test (MIT), Seller's staining test, the Reverse Transcriptase-Polymerase Chain Reaction test (RT-PCR) and the Direct Rapid Immunohistochemistry Test (DRIT). Method: Using technical feasibility and economic indices based on the assumption that a diagnostic test must be prompt, cheap, sensitive and reliable, we reviewed information in literature. Results: DFA is the gold standard test observed to be 99% sensitive, limited by the cost of a fluorescent microscope, unavailability of immunoglobulin and replaceable spare parts. Mouse inoculation is labour and capital intensive and takes about 21 days for a diagnosis to be made, though it is sensitive. Seller's staining test is cheap but dependent on the presence of Negri bodies in the brain of the biting animal. The Reverse Transcriptase-Polymerase Chain Reaction Test is an expensive, yet sophisticated test that requires expertise. Often difficult to get the reagents to carry it out, though it is sensitive even in archival samples of over 10years. DRIT is a cheap, rapid diagnostic test for rabies that utilizes light microscope and can be carried out on the field. It is as sensitive as DFA and result can be obtained within an hour. Conclusion: The Direct Rapid Immunohistochemistry Test is most adaptable and reliable rabies diagnostic method for developing countries like Nigeria. It enables prompt diagnosis for rabies prevention to ensure reduction in the number of deaths due to rabies.
Key words: Rabies, laboratory investigation, standard test, rapid diagnosis.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

symptoms together with the medical history and physical examination of the patient direct the clinician to request a diagnostic investigation for confirmation or exclusion of suspected specific aetiological agents.

Microbiology and parasitology knowledge and skills are needed to conduct aetiological investigation of bacterial, viral, fungal, helminth, arthropod or protozoan parasite's suspected involvement. Aetiological diagnosis is the process of investigation of the specific pathogen involved in a disease. There are three phases in the process of aetiologic diagnostic investigation (WHO, 2005):

- the pre-analytical phase
- the analytical phase
- the post-analytical phase.

The time and all processes for the preparation of a patient for a diagnostic investigation to the moment when the laboratory investigation is made comprise pre-analytical phase. The analytical phase comprises the time and all processes of a diagnostic investigation. The post-analytical phase comprises the time and all processes for reporting the results of the diagnostic investigation to the person who then undertakes the management of the patient or pursues the surveillance

of the disease, community by community (WHO, 2005).

3.4 Serological diagnosis

Serological diagnosis is the process of detecting antibody specific to a suspected pathogen in human and animal, or vice-versa, using antibody in serum to detect antigen in other tissues of the body. Several specific serological methods have high sensitivity and specificity in pathogen detection. Speed and accuracy are particularly considered in laboratory investigation by virtue of the quantity of specimens that are usually received at laboratory during disease surveillance.

Details of analytical phase of enzyme-linked immuno-sorbent assay (ELISA) is provided in this section as it offers increasing role and importance in the investigation of suspected zoonoses in West Africa. ELISA analytical phase requires specific biological and chemical reagents. The biological reagents include pathogen specific antigen, micro-titre plates, positive and negative control sera, test sera, specimen diluent, wash buffers and enzyme conjugate (Figure 3.2). The chemical reagents for this assay include a chromogen (colour builder) and a stop solution (usually an acid.

Commercial ELISA kits for specific zoonoses investigation provides a desirable level of user friendliness in national laboratory protocol for human-animal disease surveillance. They include protocol for (i) detection of antibody presence in exposure, (ii) tracking disease outbreak, and (iii) detection of specific antigen of suspected pathogen.

A quantitative indirect ELISA (i-ELISA), specific for detection of rabies virus anti-glycoprotein antibody levels (Figure 3.2) is the Platelia™ Rabies II kit (Bio-Rad, Marnes-la-Coquette). The kit includes two microplates pre-coated with rabies glycoprotein extract from inactivated and purified virus membrane. Steps must be taken in accordance with instructions of the manufacturer (Feyssaguet *et al.*, 2007) Serial dilution of positive control sera (4-stage dilution) are placed into pre-determined wells of microplate. (Figures 3.3 and 3.4). Each test serum is allocated a well. The plate is incubated and shaken concurrently (Figure 3.5A) to optimize antigen-antibody reaction for about 30 minutes. Thereafter, the plate is washed thee times.

In the two subsequent steps, an enzyme conjugate, then a chromogen are added to each well, and then incubated. A dark box is needed for colour to develop in about 15 minutes. Microtitre plate remains colourless

until chromogen is added. The word "chromogen" means colour developer. Intensity of colour that develops in a well is a measure of reaction intensity (Figure 3.5).

Figure 3.2: Rabies specific enzyme linked immunosorbent assay (ELISA) kit is a pack of rabies antigen pre-coated plates (A), sample diluent (B), wash solution (C), positive control antibody (D), negative control antibody (E), enzyme conjugate (F), chromogen (G) and stop solution (H).

At the last step, a stop solution is added (Figure 3.7A) to all wells. Results are read using an ELISA reader (IRE 96™, Saint Jean d'Illac) (Figure 3.7B) at a wavelength of 450-620nm.

Optical density (OD) of each test specimen is compared with the OD of positive control serum.

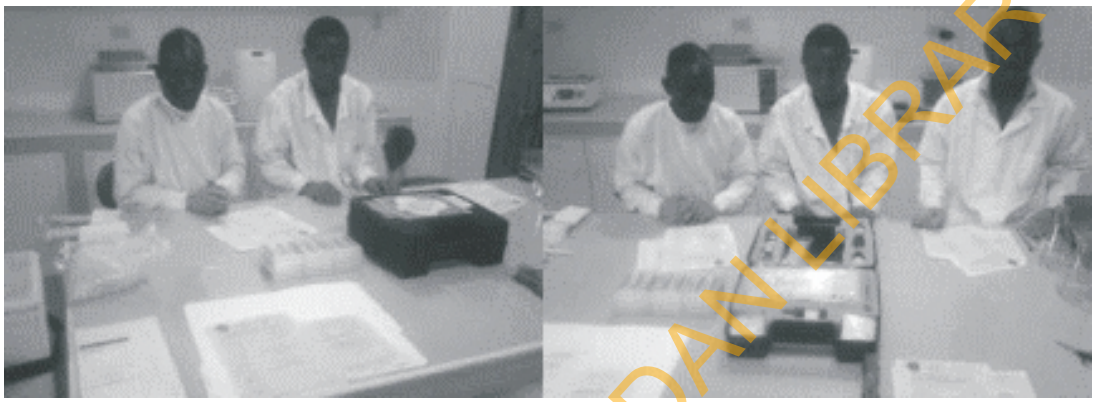

Figure 3.3: Commercial ELISA kit for laboratory investigation of specific zoonosis is used by a group of technicians at a Central Veterinary Laboratory in West Africa.

Figure 3.4: Laboratory technicians study carefully the instructions provided by the manufacturer of ELISA kit to be used in investigation of a clinically suspected zoonosis.

Antibody titre is expressed as equivalent units per ml (eu/ml), derived from a plotted standard OD antibody titre curve. Humans and animals tested are considered to be immune against rabies virus if they produced

antibody titres of 0.5 eu/ml or more (Stantic-Pavlinic *et al.*,2006).

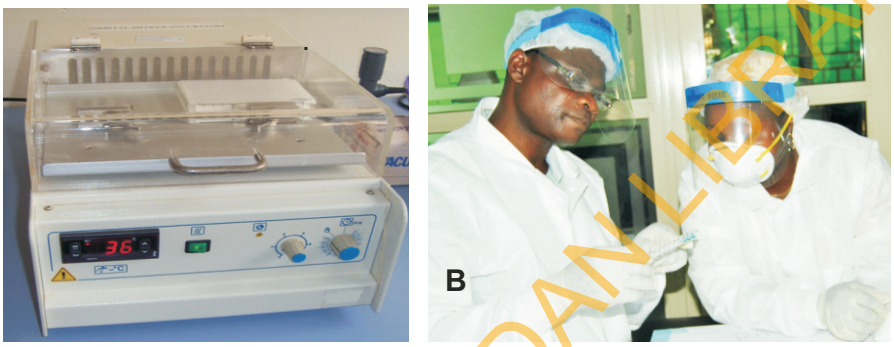

Figure 3.5: Desktop incubator with shaker component (A) provides optimal temperature and contact environment for antigen-antibody reaction within microplate. Laboratory personnel examine a strip of microplate wells for its clarity (B).

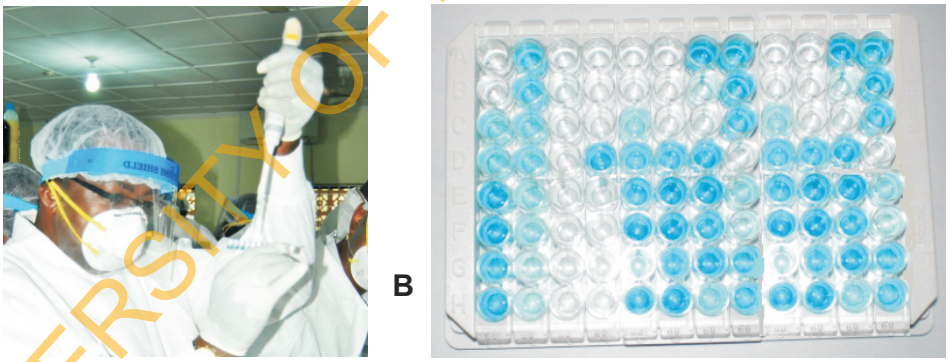

Figure 3.6: Colour develops from a colourless reaction after addition (A) of chromogen to antigen-antibody complex formation (B). The stages include adding specified quantities of reagents to negative and positive controls in designated wells (B) and in turn adding same quantity to the test specimens in each of the other wells. Test reaction is incubated at room temperature in the dark to allow colour development.

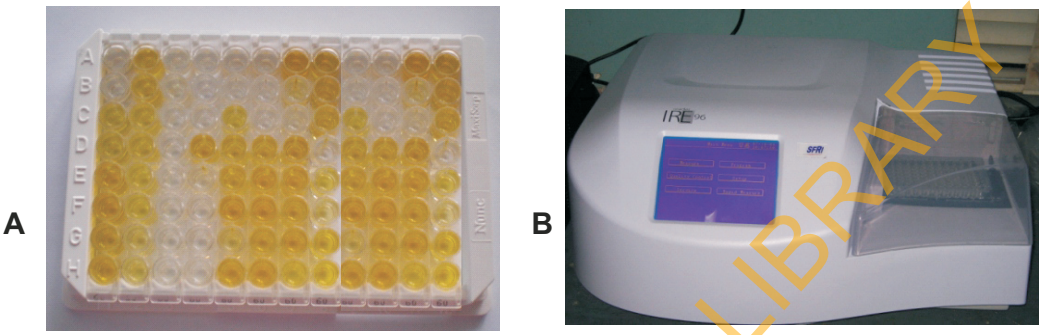

Figure 3.7: Test reaction is halted using a stop solution. The addition of a stop solution changes the reaction from blue to amber colour (A). At this stage, the optical density of each well is measured using ELISA reader (B). The blue screen is window where results of optical density are displayed and are sent to a printer.

optical density values are displayed on ELISA reader screen of some machines (Figure 3.7B). The complete analytical phase of this investigation is achieved by plotting a graph (curve) of OD values versus antibody titre of serial dilution of the positive control sera.

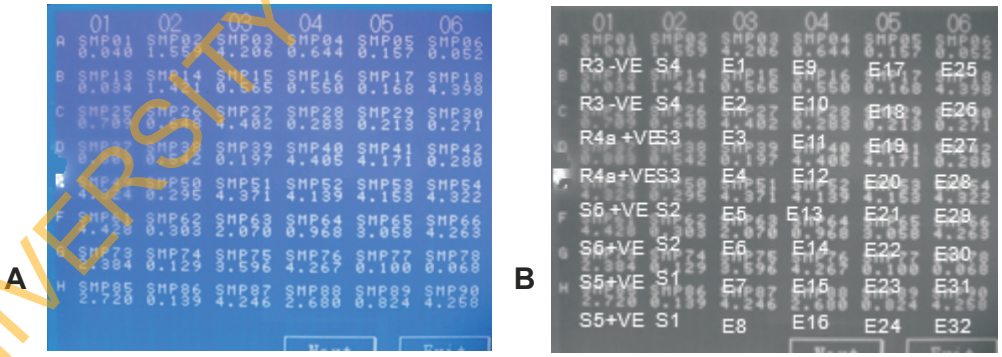

Figure 3.8: Screen view of test results displays optical densities of each specimen in wells of a microplate. Half of a 96-well plate results are shown at a time (A) as 01 to 12 (horizontal) and A to H (vertical). Overlay is specimen identification code (B).

The protocol requires that positive and negative control specimens be loaded in pairs into adjacent wells on microplate. Average OD of each paired sera dilution is used to plot the curve. A straight line is obtained when test protocol is accurately conducted.

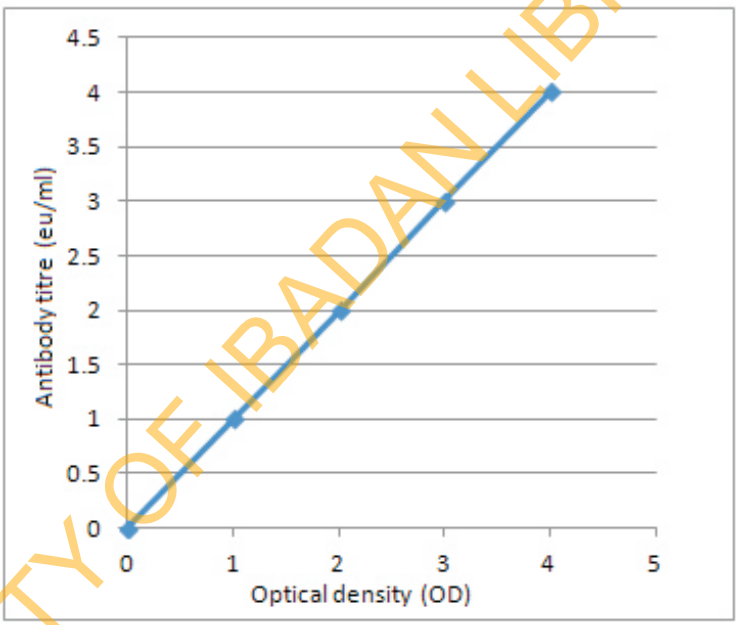

Figure 3.9: A typical line plot of antibody titre and optical density values from positive and negative control sera required for assay quantification.

Antibody titre of each test serum is read across the axes of the curve by locating their OD on graph (Figure 3.9). Analytical and post-analytical phases of the investigation together, are usually completed within 12 hours.

3.5 Molecular diagnosis

Molecular diagnosis is an approach to diagnostic investigation that analyzes genome molecules, namely deoxyribonucleic acid (DNA) or ribonucleic acid (RNA), to identify the pathogen involved in a disease or ill-health condition. All animals, humans and zoonoses causative agents have either DNA or RNA or both in their cells. These molecules are targets for analysis, being able to precisely differentiate suspected causative agent of disease from others that may present similar clinical signs by detection of specific sequences in the molecules.

Each molecular assay requires three basic steps: (i) the extraction and purification of nucleic acid; (ii) the amplification or making copies of the nucleic acid of interest (target) or attaching multiple copies of a dye to a single target copy; (iii) the detection of the amplified target using polymerase chain reaction (PCR) or other methods, such as gene sequencing. The analytical and post-analytical phases of this investigation are together, usually under 8 hours.

3.6 Practical exercise

Rabies is not usually treatable the moment clinical signs set in. It is a stage considered uniformly fatal. Adequate efforts at vaccination of humans and animal

populations at risk is a logical recipe to prevent the disease, community by community. In this exercise, participants will investigate herd immunity against rabies among dogs by investigating antibody levels against rabies in dog population in a community.

3.6.1 Conduct a census of dog population in a local community of your choice. Use resource **re03** on CD as guide.

3.6.2 Inquire from dog owners about main and secondary uses of each dog at home and within the community.

3.6.3 Inquire about vaccination status of each dog, and find out if it has been involved in any bit injury before.

3.6.4 Select a representative sample of dogs for specimens collection in the community, about 25% of population.

Figure 3.10: Presentation of dogs at a local community shed for collection of blood specimens. Observe that each dog was restrained by the owner for phlebotomy by personnel of human-animal disease surveillance team.

3.6.5 Collect some 5ml of blood from the cephalic or the saphenous vein (Figure 3.11) of each dog. Deliver blood into plain bottle (without anticoagulant).

Figure 3.11: Collection of blood from the saphenous vein (A) of dog and specimen delivered into a plain specimen bottle (B) for separation of serum.

3.6.6 Allow blood to clot. Decant sera into sterile specimen bottles. Package and ship sera to laboratory.

3.6.4 Use i-ELISA method to determine antibody levels against rabies in the blood specimens collected.

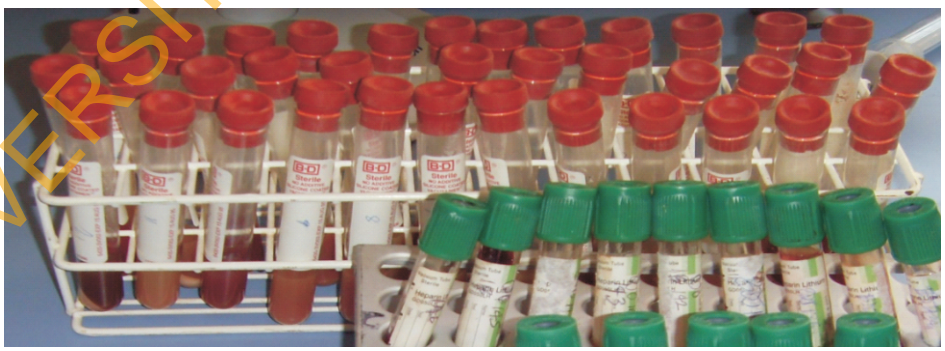

Figure 3.12: Sera gathered are arranged and assigned identification code on each bottle.
Store sera at -20°C immediately after separation from clotted blood until use.

Mental impairment in a wrap of groundnuts? An aphorism about a chemical zoonosis

Lead poisoning and its consequential human deaths around artisanal gold mines in Zamfara State is a public health nightmare in Nigeria [1]. The WHO, 2011 report revealed massive illness, including headaches, seizures and death of hundreds of children in northern Nigeria associated with lead poisoning [2]. Often times at various Nursery and Primary Schools in the capital city of Oyo State, southwestern Nigeria (Figure 1), one or more elderly women are seated by school gates, selling roasted goundnuts in paper wraps to the pupils. Children 3-year old and above while admiring the groundnuts, tell their parents to buy it for them. One parent expressed his fears about the source of the groundnuts because of the possibility of lead contamination, resulting in mental impairment at low doses (<10 µg/dl blood) when eaten by children over long period [3].

Roasted and boiled groundnuts alike are delicacies commonly hawked on West African streets. Groundnuts sold in Nigeria are mostly grown in northern Nigeria. Where is the source of each batch sold at school gates in West Africa? Why would parents sacrifice the mental health of their children on the altar of a ready to eat delicacy? Public health assurance of ready to eat groundnuts is needed to protect children from daily eating low doses of lead with the potentials of permanent mental impairment.

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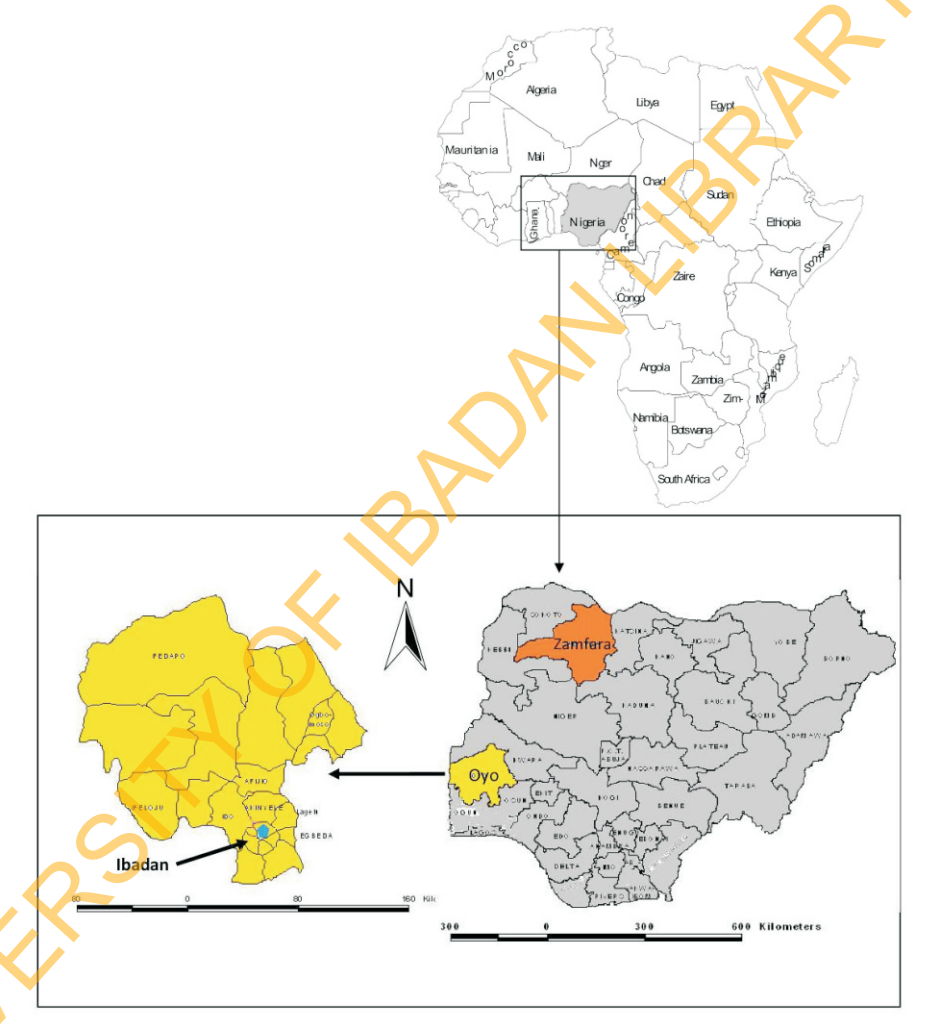

Figure 3.13: Map of Africa with insert showing the locations of Ibadan, Oyo State in southwestern Nigeria and Zamfara State in northwestern Nigeria

3.7 Further readings

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Chapter 4

Spatial Distribution of Zoonosis

4.1 What is spatial distribution?

Spatial distribution of zoonosis is the pattern which a specific zoonosis displays on the earth surface at human-animal-environment interface, and locally, community by community. What is actually special about spatial distribution of a zoonosis is the deep-seated set of questions about why an individual at a particular location or land use area could have contracted the disease. Such questions as: Is there any special risk factor that makes the case to occur where it is located on the earth surface? Did the animal or individual become exposed to the disease within that location where it/he/she resides at the time the disease was detected? Was it contracted elsewhere? Such questions are veritable starting points for a purposeful and careful surveillance of a disease.

When spatial distribution related questions are posed to guide surveillance goal and objectives, answers for a logical framework for the control and prevention of major zoonosis ensues. As a result, the collection of data about spatial

distribution of zoonosis occupies a cardinal position in human-animal disease surveillance.

4.2 Geographic coordinate (map point)

The geographic coordinate which makes it possible to define spatial distribution of zoonosis is the starting point, for linking the environment with the pattern of disease spread. When the geographic coordinates, including latitude and longitude of a place that represents the location of zoonosis case has been identified, then, the spatial distribution can be constructed as map point. For a set of zoonosis cases to be displayed in spatial distribution pattern, some sets of appropriate map points must be generated for each case of the disease that is identified within a community.

Using map points from human cases of dog-bite injury and rabies in Monrovia, the capital city of Liberia, this chapter captures data from the only national dog-bite referral clinic in Liberia, situated in Monrovia (Olarinmoye *et al.*, 2014). Olarinmoye *et al.*, 2014 reviewed available records on data pertaining to dog-bite injury and post-exposure management for rabies among human patients seen over a 5-month period (August-December, 2010) at the clinic.

Table 4.1: Site names and map points of dog-bite victims, Monrovia, Liberia, 2010

Table

dog bite injury - monrovia 2010

FID	Shape *	SERIAL_NO_	DATE_OF_IN	PX__NAME_P	GENDER	ADDRESS	Y_AXIS	X_AXIS
110	Point	111	December 16 2010	Cat Lah	F	Old Road, Sinkor, MONROVIA	6.272724	-10.746427
111	Point	112	December 16 2010	Abe Job (Adult)	M	9th Street, MONROVIA	6.295728	-10.784393
112	Point	113	December 16 2010	Arc Cat (Adult)	M	Lynch Street, MONROVIA	6.302682	-10.800786
113	Point	114	December 16 2010	Rol Jos (Adult)	M	16th Street, MONROVIA	6.29224	-10.777901
114	Point	115	December 17 2010	Tr Be	F	S.K. Boulevard, MONROVIA	6.290561	-10.717241
115	Point	116	December 17 2010	Ein Na	F	Matadi Lakpazee, MONROVIA	6.293689	-10.761008
116	Point	117	December 17 2010	Kwa Qu	M	Lyne Street, MONROVIA	6.302682	-10.800786
117	Point	118	December 17 2010	Prin She	M	Congo Town, MONROVIA	6.26866	-10.73326
118	Point	119	December 17 2010	Jac Kol	M	16th Street, MONROVIA	6.29224	-10.777901
119	Point	120	December 18 2010	Ign Ty	M	121 Street Monrovia	6.292135	-10.772465
120	Point	121	December 20 2010	Net Bl	F	Paynesville ELWA, MONROVIA	6.24	-10.69
121	Point	122	December 21 2010	Ed Kar	M	New Soul, MONROVIA	6.300744	-10.705852
122	Point	123	December 22 2010	Mos Go	M	New Georgia Estate, MONROVIA	6.345138	-10.757446
123	Point	124	December 22 2010	NMc Joh	M	Congo Town, MONROVIA	6.26866	-10.73326
124	Point	125	December 23 2010	G. Ji	F	Great Whale Hotel, 10th Streeet, MON	6.293593	-10.783743
125	Point	126	December 27 2010	Dor Da	F	Congo Town, MONROVIA	6.26866	-10.73326
126	Point	127	December 27 2010	Ruf Sac	M	Congo Town, MONROVIA	6.26866	-10.73326
127	Point	128	December 27 2010	Rich Ho	M	Duport Road, Cowfield , MONROVIA	6.271139	-10.66527
128	Point	129	December 31 2010	Geo Get	M	10th Street, MONROVIA	6.29358	-10.784099
129	Point	130	December 31 2010	Sylv Ma	M	17th Street, MONROVIA	6.290974	-10.777282
130	Point	131	December 31 2010	Mas Kon	M	Paynesville Job Bar, MONROVIA	6.266936	-10.693937
131	Point	132	December 31 2010	Zo Kar	F	New Matadi, MONROVIA	6.298116	-10.768205

132 (0 out of 132 Selected)

dog bite injury - monrovia 2010

4.3 Converting site name to map point

The surveillance group converted site names of dog-bite cases into map points, using hand held Global Positioning System (GPS) (Figure 4.1). The geographic coordinates thus served as map points for plotting a descriptive map and a categorical analysis of identified dog-bite case distribution within Monrovia from August to December, 2010. A spatial distribution map of dog-bite cases (Figure 4.2) was designed.

Where a site name was available for the location of dog-bite incidence, especially at the time the injury was presented for treatment at the reference

Quest for a more effective and efficient rabies surveillance program in West Africa: the University of Ibadan CCPZ curriculum initiative

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Abstract
Introduction: Rabies is a uniformly fatal disease although vaccine preventable, yet neglected in West Africa. Newer surveillance tools for spatial and spatio-temporal investigation of rabies are rudimentary in curricula for human-animal disease surveillance among older Universities in West Africa. This may be attributed to a relatively new access to geographic information system (GIS) applications in higher education in the sub-region. The purpose of this study is to provide updates on rabies surveillance initiatives and stimulate collaboration towards improving postgraduate programs for human-animal disease surveillance in West Africa. Method: Etymologic and historic updates are provided on disease surveillance fundamentals as derived from the two French words "*Sur*" and "*veiller*", meaning "*watch over*" and used to critic rabies surveillance in time and space with existing tools and curricula in five selected Universities in West Africa. A logical framework was used to design a proposed GIS-based *zoonoses surveillance* graduate program at the University of Ibadan Centre for Control and Prevention of Zoonoses (CCPZ) for the sub-region. Results: CCPZ model curriculum has five components for spatial and spatio-temporal epizootiology competencies in action at the human-animal-environment interface. Rabies outbreak investigation and response planning (Module-1); time series analysis and mortality model of dog bite victims (Module-2); local beliefs, attitudes and rabies treatment preferences (Module-3); spatio-temporal mapping and visualization of rabies distribution (Module-4); molecular epizootiology (Module-5). Conclusion: An inclusive systematic epizootiology curriculum is proposed by the University of Ibadan Centre for Control and Prevention of Zoonoses for achieving more effective and efficient rabies surveillance program in West Africa.
Keywords: Higher education, rabies surveillance, spatio-temporal modeling.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Systematic epizootiology: foretaste of a legacy of preventive veterinary medicine at the University of Ibadan, Nigeria

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Abstract
Introduction: Epizootiology was a major course approved by the senate of the University of Ibadan, Nigeria in 1975 for the Department of Veterinary Public Health and Preventive Medicine. It has remarkably achieved its objectives for the past 37 years. The course was made available to allied and other disciplines in the University, including postgraduate programs in Veterinary Pathology, Communication Arts in the Faculty of Arts, Virology in the College of Medicine, and many individuals from different postgraduate courses from other universities, including a Master of Philosophy candidate from the University of California, Davies. Method: syllabus for preventive veterinary medicine was reviewed by a panel of experts, designing logical framework for smart teaching and learning about factors, events, forces and circumstances that may contribute to understanding disease occurrence, distribution, control and prevention in West Africa. Selected objectively verifiable indicators for resetting goals and assumptions of the syllabus included, case incidence; biological characteristics of specific pathogens at human-animal interface; and victims' health seeking preferences. Results: An inclusive platform for teaching, learning and service delivery for preventive veterinary medicine was identified and described as systematic epizootiology modules. The modules comprised clinical epizootiology; indigenous healthcare practice epizootiology; ecological epizootiology; and spatio-temporal epizootiology. Conclusion: Systematic epizootiology is not an end in itself, but a means to many ends as platform for collaboration between education and service providers to improve disease surveillance at the human-animal interface in West Africa. Systematic epizootiology is a novel heritage of preventive veterinary medicine at the University of Ibadan, Nigeria.

Key words: Epizootiology, postgraduate curriculum, higher education, preventive medicine.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

clinic, a handheld GPS was engaged to collect the geographic coordinates of the site. Within Monrovia alone, a total of 132 dog-bite victims (DBVs) were presented to the clinic over the 5-month period and the map point of each one was captured. It was noted on the average, that it took about 10 days before a dog-bite injury was presented for treatment at the clinic.

Figure 4.1: A handheld Global Positioning System (GPS). This device computes map point by measuring the geographic coordinates (latitude and longitude) of a location (site name) where it is engaged.

4.4 Exploring spatial distribution pattern

Three-quarter of all dog-bite cases were classified as probable cases of rabies exposure. In all, about two-thirds of the DBVs received treatment with human diploid cell strain (HDCS) rabies

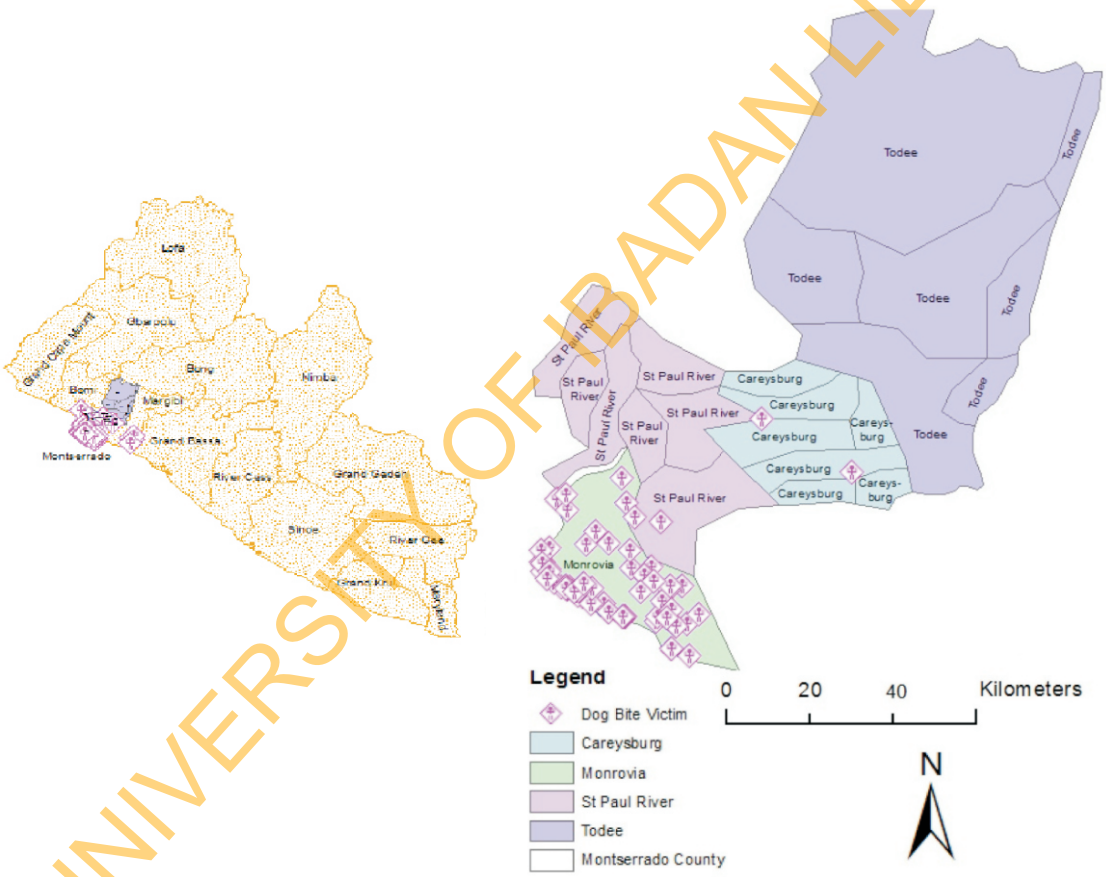

Figure 4.2: Spatial pattern of dog bite injury among humans in Monrovia, August-December, 2010, with inset showing its location within Liberia

vaccine, while a quarter was treated with HDCS rabies vaccine in combination with equine rabies immuno-globulin. Classical rabies signs including hydrophobia, aerophobia, hyper-activity, seizures, coma and fatal outcome were observed in 6 DBVs, presented late for rabies PEP.

A cluster of dog-bite cases among humans in the south-coastal part of the community during the second half of the year 2010 raises more questions, including: Why was

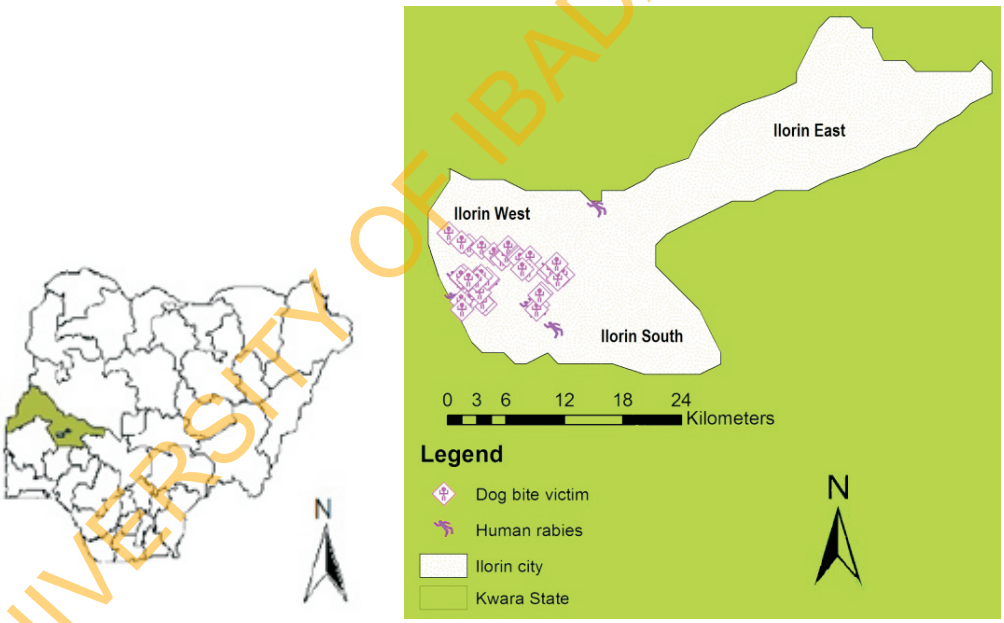

Figure 4.3: Spatial distribution of dog bite injuries among humans in Ilorin city, Nigeria, 2002-2008, with inset showing their locations within Nigeria

the distribution pattern like this? Was it because Rabies National Referral Clinic was located within Monrovia? Was it because of the densely populated communities in Monrovia as reported by national census? Could it be there were more unvaccinated dogs in Monrovia? Was it a case of financial differentials to seek care? Was it that people in Monrovia were more knowledgeable about clinical care for dog-bite victims? How did dog bite and rabies cases in Monrovia compare with other cities? What is not clear from this spatial pattern is whether the rest of the cities were not reporting dog-bite injuries.

In comparison, the spatial pattern of dog-bite injury among humans in Ilorin, capital city of Kwara State, Nigeria, from June 2002 to December 2008 was reported by Olugasa *et al.,* 2009; Olugasa and Aiyedun, 2014 (Figure 4.3). A total of 152 cases of dog bite injury were reported. Seventeen (11.2%) of these individuals were confirmed as clinical cases of rabies with fatal outcome.

4.5 Scenario of urban rabies cycle

There were 11 fatal cases of rabies in children (age 0-15 years), 4 among youths (16-30 years) and 2 adults (31-80 years) reported by Olugasa *et al.,* 2009. Spatial cluster of rabies victims were identified around central abattoir and adjoining beef market in Ilorin city. The map points occupied areas with communal waste foods, abattoir

wastes and wastewater in non-residential areas of the city.

These patterns revealed high incidence of urban human rabies associated with domestic dog-bite injuries in Monrovia, Liberia and Ilorin, Nigeria. There is need for sustainable surveillance and community response for the control and prevention of rabies in urban and rural West Africa. Much more critical need would be expected of rural communities with unreported cases in West Africa.

Rabies surveillance team associated rabies virus infected bites among humans in Monrovia and Ilorin with free-roaming unvaccinated dogs. Rabid dog-bite cases were confirmed especially among children that commuted along various routes by a central abattoir in Ilorin city. In Monrovia, cases of rabid dog bite from personal dogs that lived in the same house as the victim, within Monrovia were confirmed. A high proportion of dog bite cases occurred within the same community. The importance of community hygiene and responsible dog ownership in the control of rabies in West Africa were brought to the fore.

4.6 Practical exercise

A Desk Officer for Disease Mapping (DODM) needs essential skills for developing simple yet accurate maps of zoonoses that are derived from well sourced data such as from national referral clinics for dog bite human victims and Veterinary Teaching Hospital records of rabies suspect and confirmed dogs. By combining datasets from human and animal clinics, some invaluable clues to source of rabies exposure within a community may be identified. In addition, knowledge of direction of spread and level of under-reporting of cases are essential to planning for disease control. The exercise in this chapter offers you an opportunity for hands-on in dog bite case mapping in a local community environment.

You will identify the presence of dog bite victims in a community (see Figure 4.4) and convert their site names to map points.

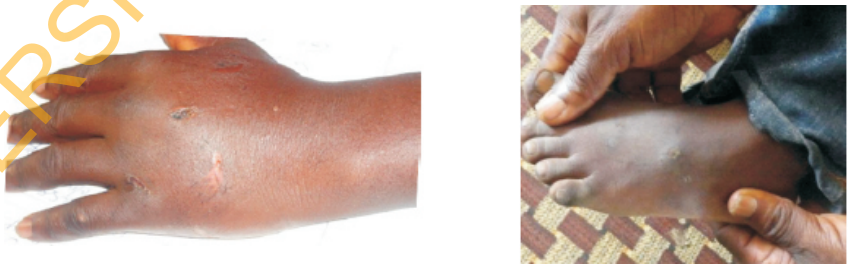

Figure 4.4: Dog-bite injuries on hand and leg of children in urban and rural communities, Liberia (Source: CCPZ fieldwork, 2013).

4.6.1 Retrospective datasets on dog-bite cases presented at some major human hospitals in a Nigerian town (Ogbomosho), 2004-2012 and in a Liberian town (Buchanan), 2008-2012 are provided for this exercise (Tables 4.2 and 4.3).

4.6.2 You will embark on a direct visit to the Nigerian town or Liberian town with lists of site names of dog bite cases provided. Use a handheld GPS to collect geographic co-ordinates of each site name in the dataset provided.

4.6.3 You will use Google Earth Pro® to collect the geographic coordinates of site names of the same datasets in Tables 4.2 and 4.3. Apply the options on Google Earth Pro's toolbar.

4.6.4 You will compare results of GPS readings to Google Earth Pro Latitude and Longitude for each map point. Identify any similarities or differences. Discuss the merits and demerits of using a handheld GPS or Google Earth.

4.6.5 You will create a shapefile of spatial distribution pattern of dog bite site names from the map points you collected.

4.6.6 You will use ArcGIS 10.1 to create a map of spatial distribution pattern of dog bite map points you compiled from conception stage to the end (Figures 4.5 and 4.6).

4.6.7 Finally, you will print the map of the spatial pattern of dog bite victims and discuss your findings with your team.

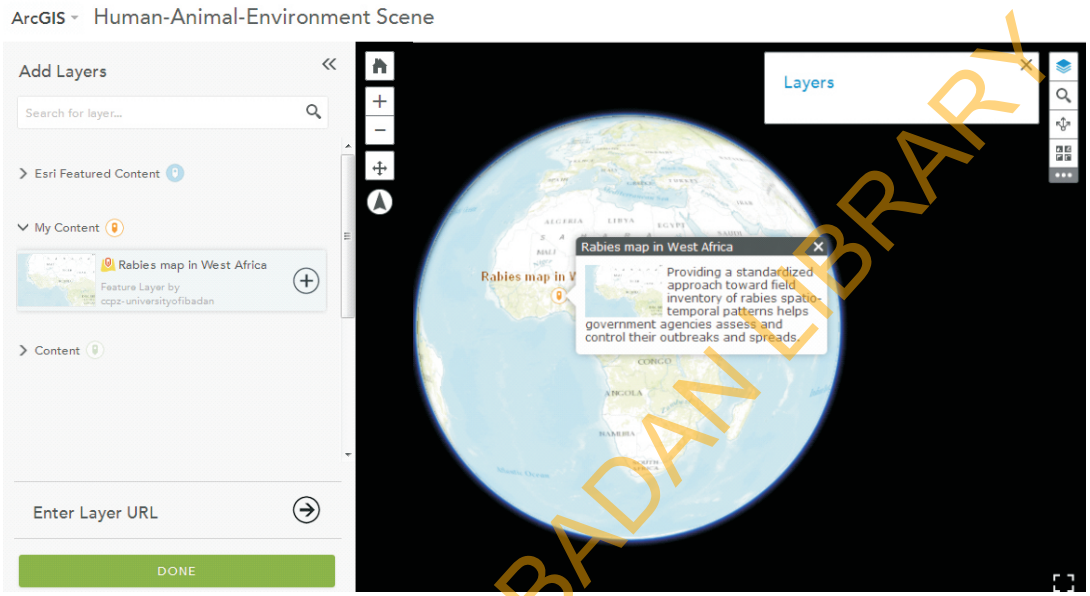

Figure 4.5: Screen view of ArcGIS 10.1 online application on a desktop computer displays scene for rabies map design at human-animal-environment interface.

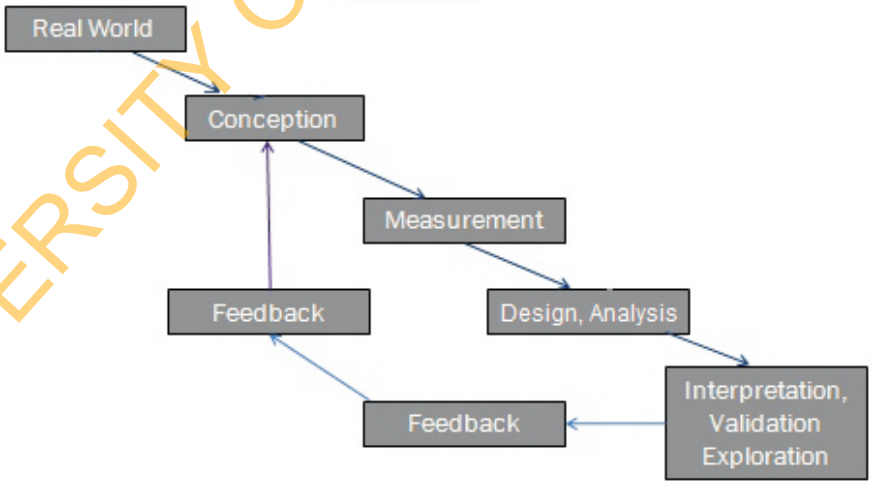

Figure 4.6: Stages in conception and design of spatial distribution of dog-bite cases among humans, conversion of site name to map point and beyond.

4.6.1 Summary of data gathered on dog bite victims in Ogbomosho, 2004-2012 is provided in Table 4.2 below. Site name of selected 20 victims out of 26 are provided in the spreadsheet **GTKHADSTab4.1.**

Table 4.2: Annual cases of dog-bite victims, Ogbomosho town, Nigeria, 2004-2012

Year	Gender		
	Male	Female	Total
2004	1	2	3
2005	0	0	0
2006	2	0	2
2007	3	0	3
2008	3	1	4
2009	1	0	1
2010	1	1	2
2011	3	1	4
2012	1	6	7
Total	15	11	26

4.6.2 You will embark on a direct visit to Ogbomosho town, (if feasible). Go with a handheld GPS device. Locate the site name of each dog bite victim's address and capture the geographic coordinates (geo-reference) of the case. Using the global positioning systems tracking device.

Repeat the steps above for conversion of site names to map points for dog bite victims in Buchanan, Liberia, 2008-2012 (Table 4.3; **GTKHADSTab4.2.xls)**

Dog bite dataset from Buchanan town, Grand Bassa, Liberia, 2008-2012 comprise 332 human victims, 67 of whom were confirmed clinical cases of rabies among humans, **GTKHADSTab4.2.xls** All 67 rabies resulted in human deaths in Buchanan, 2012 (Jomah *et al.*, 2013).

Table 4.3: Age groups of dog-bite victims, Buchanan town, Grand Bassa County, Liberia, 2008-2012

Age Profile of Victims of Dog bite Cases, 2008-2012	
Age	Total *n* (%)
1-17	180 (54.2)
18-34	65 (19.6)
35-51	63 (19.0)
52-68	19 (5.7)
Above 68	5 (1.5)
Total	332 (100.0)

4.6.3 Use online satellite image available on Google Earth Pro® to capture the geographic coordinates of each dog bite site name, converting it to map point for the provided datasets of Ogbomosho and Buchanan.

[If access to online connection is not available for your class, your option is a direct visit with a handheld GPS].

(i) Open Google Earth Pro on your computer desktop;
(ii) Type site name, with town and country into Google Eath search engine. Click on search button. It zooms-in to the town and location of site name of interest;
(iii) Explore satellite image of Buchanan or Ogbomosho;
(iv) Record geographic coordinates of the site name of dog-bite victim, displayed at bottom, right corner of screen (see Figures 4.7, 4.8 and 4.9).

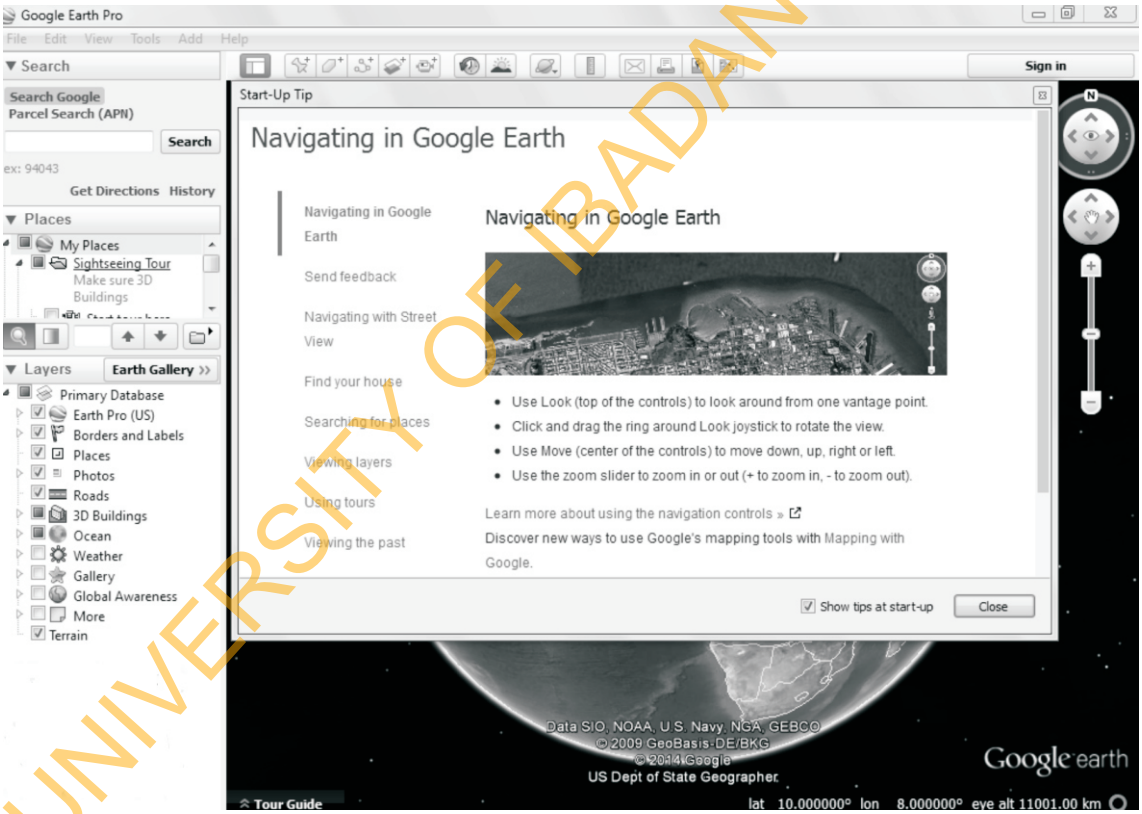

Figure 4.7: Screen view of Google Earth Pro online application on a desktop computer displays scene for rabies

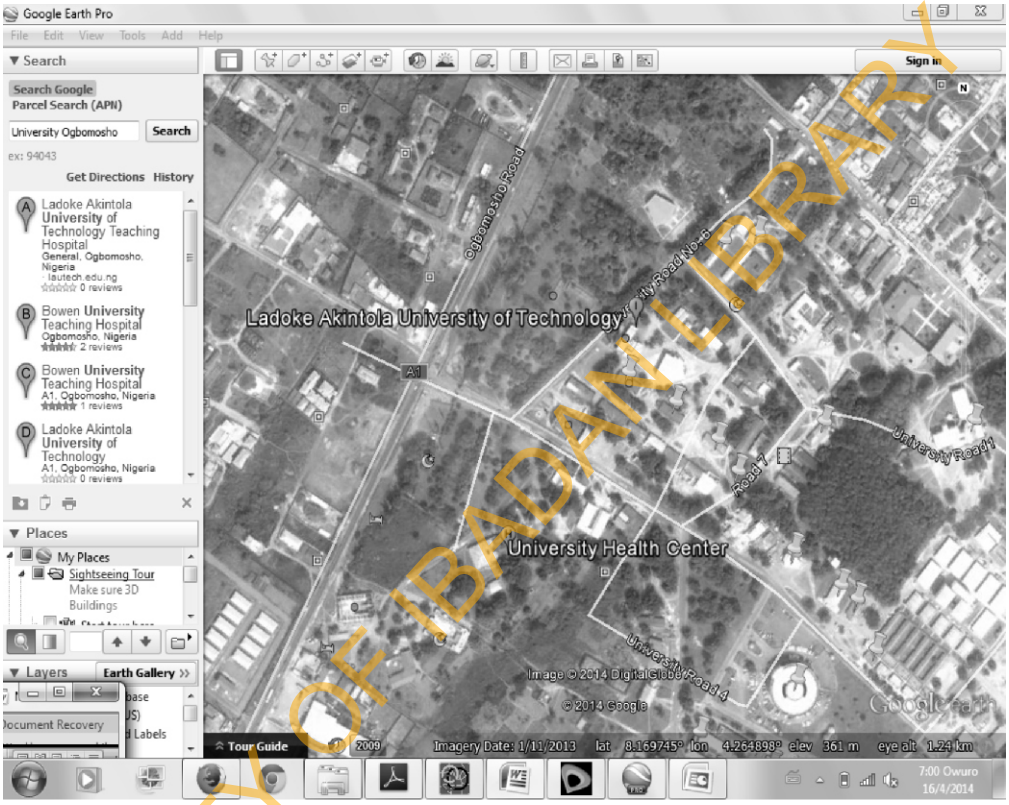

Figure 4.8: Screen view of Google Earth Pro online application on a desktop computer displays some area of Ogbomosho town.

Notice the red box at the bottom right side of the screen view of Google Earth Pro satellite image (Figure 4.9) that there is the latitude and longitude of the location in view. Also note the yellow pins on the background. The latitude and longitude of each point is shown as you position the pins from the toolbar.

Figure 4.9: Screen view of Google Earth Pro online application on a desktop computer displays some area of Buchanan town.

In this way, you have converted the site name to map point, by determining its latitude and longitude. You will then record the geographic coordinates on your data spreadsheet file. Save the file and in the new file name indicate geo-referenced, e.g. **GTKHADSTab4.2geo-ref.xls** as an Excel spreadsheet file.

4.6.4 The global positioning systems provide a similar data in terms of longitude and latitude as Google Earth Pro in converting site name to map point. Have you found any key similarities, differences, merits and demerits of each of these two geographic tools?

Compare the results of GPS readings to Google Earth Pro latitude and longitude for each map point. Identify any similarities or differences. Discuss the merits and demerits of using a handheld GPS or Google Earth.

4.6.5 You will create a shapefile of spatial distribution pattern of dog-bite site names from the map points you collected.

i. Open ArcGIS 10.1 on a desktop computer;

Figure 4.10: Screen view of Start menu for opening ArcGIS (ArcMap) 10.1 desktop.

ii. Select ***open a new project*** option prompt;

iii. Click on ***Add Data*** button on the toolbar (Figure 4.11). Navigate to ***select shapefiles*** of Nigeria, Oyo State and Ogbomosho town provided, or navigate to ***select shapefiles*** of Liberia, Grand Bassa County and Buchanan town in turn;

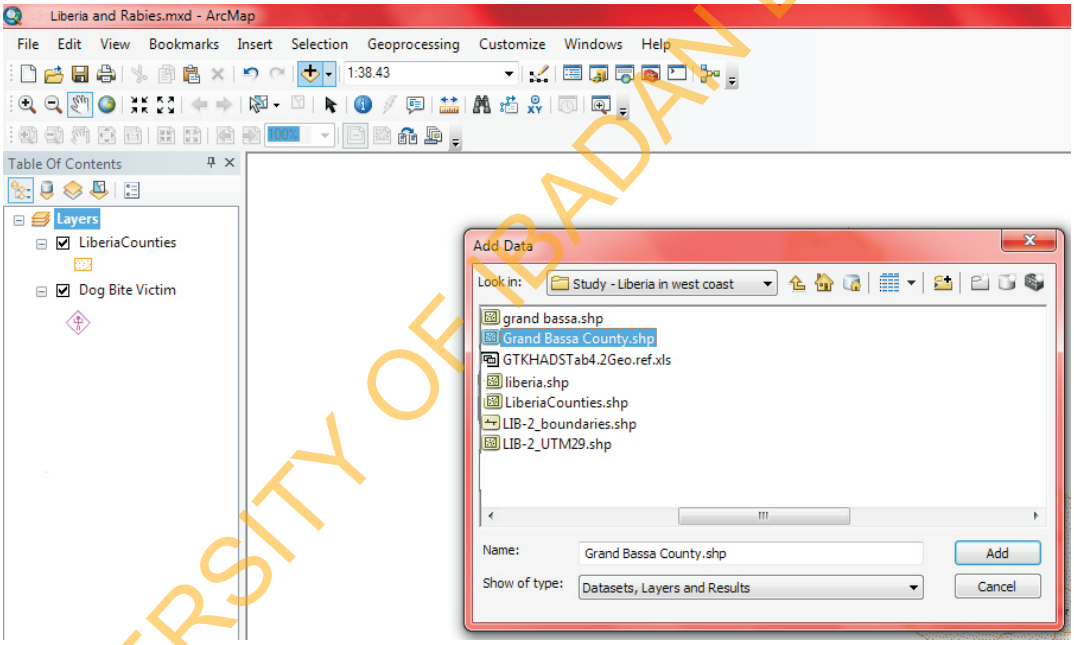

Figure 4.11: Screen view of *Add Data* button and *Add Data* dialogue box in ArcGIS (ArcMap) 10.1 desktop.

iv. Again, click on ***Add Data*** button to add the spreadsheet of site names and attributes of

dog-bite victims with map points earlier saved (**GTKHADSTab4.xgeo-ref.xls)** Figure 4.12;

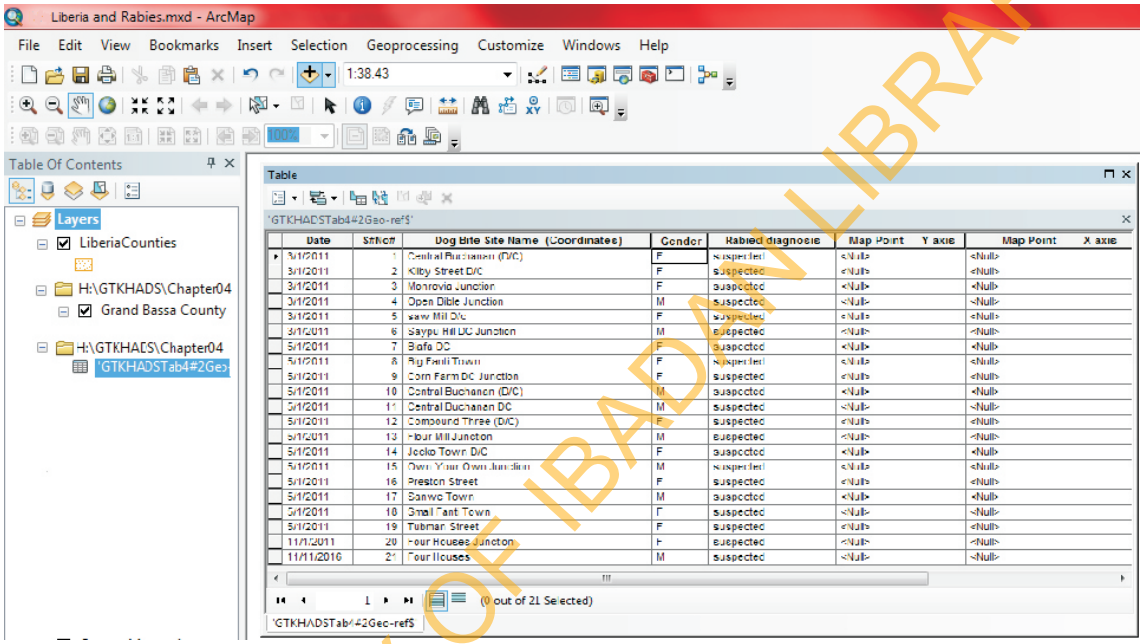

Figure 4.12: Screen view of Table added to ArcGIS (ArcMap) 10.1 project.

v. Note that latitude (Map point Y-axis) and longitude (Map point x-axis) data in Figure 4.12 remain unloaded (null). You will provide the needed geographic coordinates from map points you generated using GPS or Google Pro (objectives 4.7.2 and 4.7.3).

vi. Right click on **GTKHADSTab4.2geo-ref** layer. In the dialogue box that appears,

select display XY Data (Figure 4.13). The command adds a new map layer to the existing view, based on XY events from the table you selected.

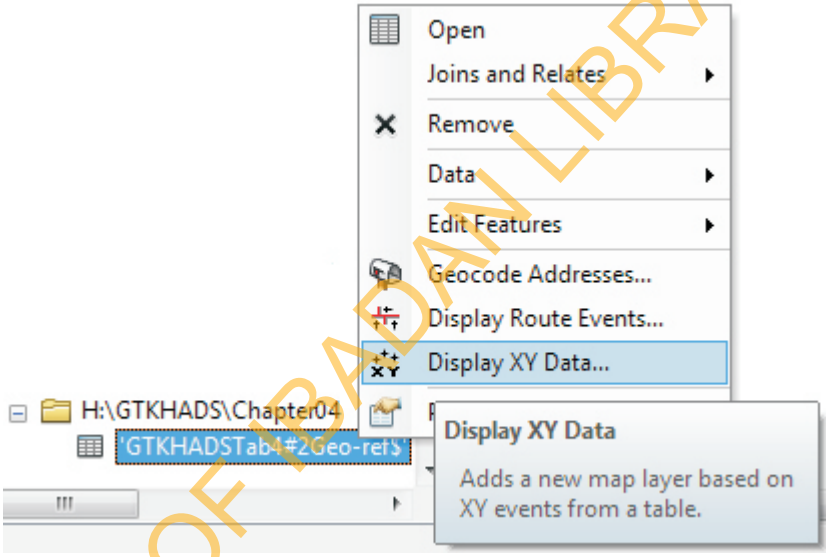

Figure 4.13: Screen view of *drop down* menu to display map points in ArcGIS (ArcMap) 10.1 data view.

vii. When the new map layer appears, right click on it in the content page. In the ***drop down*** menu that appears, click on ***Data***, then ***Export Data*** to ***shapefile***. Accept a ***prompt*** to add the shapefile as ***layer*** to map view;

viii. Change the shapefile's name, **GTKHADST ab4.xgeo-ref.shp** to **Dog Bite Victim;**

ix. Explore the various symbols available in the

theme property dialogue box, and select a symbol you consider adequate to display a dog-bite victim;

x. Save the ***shapefile*** for future exercises.

4.6.6 You have now used ArcGIS 10.1 to create a map of spatial distribution pattern of dog bite victims in a West African town. It is recommended that you share your thoughts on this exercise with your group members and instructor, if any. Consider the steps indicated in Figure 4.5 and critically review the conception of the map and the measurements made in the exercise with your instructor. Are there some things you would have done differently?

4.6.7 Add the legend, north arrow and scale bar to the map layout. Give a title to the map and print it for display.

It will be ideal if you can create an opportunity for other members of the community to respond to your findings by making it into a bill board size, or a poster display for public reading and discussion. You may present at a town hall meeting or at village square meeting, where preferably there are members of your own local community. What is their opinion about your findings? How relevant do they consider your findings to the situation in their own community?

4.7 Further readings

1. Jomah ND, Ososanya TO, Mulbah CK and Olugasa BO (2013). A descriptive and categorical analysis of dog bite cases and rabies-like-illness among humans in Liberia, 2008-2012. Epizootiology and Animal Health in West Africa. 9 (2): 113-125
2. Olarinmoye AO, Dakina GF, Olugasa BO (2014). Case pattern of urban human rabies in Liberia: a descriptive and categorical analysis of age, gender and spatial distribution in Monrovia, August to December, 2010. PowerPoint Slides Presentation at the 20th Congress of the Ghana Veterinary Medical Association, Accra, Ghana, October, 2014
3. Olugasa BO, Aiyedun JO and Akingbogun AA (2009). Identification of geographic risk factors associated with clinical human rabies in a transit city of Nigeria. Epizoo-tiology and Animal Health in West Africa. 5:43-52
4. Olugasa BO and Aiyedun JO (2014). The abattoir environment and rabies epidemics in a transit city of Nigeria, 2002-2008: lessons from a spatial regression study. Epizootiology and Animal Health in West Africa. 10:1-12 (ahead of print)
5. Ormsby T, Napoleon E, Burke R, Groessl C, Feaster L (2001). Getting to know ArcGIS desktop. Environmental Systems Research Institute, Redlands, California. 514pp.

Chapter 5

Control and Prevention of Zoonosis

5.1 What is Disease Control?

In plain terms, disease control is the systematic reduction in the prevalence of a disease. This usually involves a programme for the conscious restraint and regulation of human, animal, specific disease agent and environmental factors, as well as the suppression of events, forces and circumstances that are known to contribute to individual disease prevalence. A variety of methods are used to direct the level of specific disease prevalence. They entail overall governing power to take all the important decisions about systematic way of reducing the prevalence of a disease. Curtailing of risk factors, including physical objects and events is a network of projects contributing to a common goal of prevention. A logical framework must be designed to integrate a range of strategies to limit the occurrence of specific diseases through preventive medicine practice in a community.

Very often the differences between operations that can

and cannot be individually or corporately managed become obvious. Some strategies depend on legislative control of priority diseases. In this wise, the three arms of government, namely, the executive, the legislative and the judiciary, have roles to play and fate to share in the outcome of zoonosis control in West Africa. Governance implication is a reason for control and prevention of zoonosis being a key aspect of Veterinary Public Health specialty. Zoonosis control interfaces with governance and government, providing public health authority.

Main areas of collaboration for **enforcing common-sense solution** options are expressed in the slogan:

i. Control zoonotic pathogen (agent) in animals;
ii. Control the animals (domestic and wildlife hosts);
iii. Control zoonotic pathogen (agent) and related risk factors in the environment;
iv. Control zoonotic pathogen in humans (host);
v. Control human beings by regulating their activities.

The five components of one-health approach to zoonosis control listed above may be referred to as the **pentateuch of one-health programme for** zoonosis control operations. Zoonosis control project is deployed as work system, around each priority disease to deliver logical response, based on epizootiological intelligence

that is gathered from disease surveillance activities.

5.2 What is preventive logical framework?

Preventive logical framework is a planning tool used for systematic definition of disease control programme. Preventive logical framework sets action plan into clear programme goal, objective, outcome and performance indicator for individual diseases. Preventive logical framework shows the relationship between activities and assumptions made to restrict one or more risk factors, events, forces and circumstances associated with the occurrence and distribution pattern of a disease. Zoonosis prevention is to be defined within the larger environmental system of which disease is a part. A preventive system is a set of activities that contribute to the overall goal of reducing prevalence of a disease.

Documented explanation of a plan of control project in a way to convince oneself and others that the project is reasonable, plausible and fool-proof, having accounted for all the real and existing risks (or having made the right assumptions) and having accounted for the resources needed is the concept of logical framework. The goal is the ultimate objective of disease control programme. Usually, more than one project contributes to attaining the goal of a disease control programme. A typical scenario is seen in rabies control programme.

Asymtomatic rabies in Kaduna State Nigeria: prevalence and public health implication

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Abstract
Introduction: The brain and saliva of rabid dogs are known to contain high concentration of rabies virus and the saliva serves as medium for transmission of infection. Isolation of rabies virus from apparently healthy dogs is reported from various parts of the world. There are several active and dynamic dog markets and dog slaughter facilities in daily use for human consumption in Kaduna State, Nigeria. Method: Studies were conducted in six local Government Areas in Kaduna state to determine the proportion of dogs slaughtered for consumption that are carrying rabies antigens in their brains and saliva. One hundred saliva samples and dog heads were collected and tested, the saliva was tested in the slaughter area using immunochro-matograhic test kit for rabies antigen produced by Quicking Biotech Co., ltd, China and heads of same dogs were transported in ice packs to the Rabies Diagnostic laboratory, National Veterinary Research Institute (NVRI), Vom and the brains were extracted and tested for rabies antigens using the direct Fluorescent Antibody Test. Result: Out of 100 samples collected, 6 had rabies antigens in their saliva and the same tested positive for rabies antigens in the brains at NVRI. High level of possible exposure of those involved in dog trade and butchering who work without precautionary measures were estimated. Traditional methods were used for treatment of dog bite wounds and possible rabies exposure. Conclusion: The spread of rabies antigens amongst apparently healthy dogs slaughtered for consumption calls for awareness campaign amongst those involved in dog trade and butchering.
Keywords: Rabies, Dog, Brain, Saliva, immunochromatograhic test.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Adherence to post-exposure prophylaxis treatment for the prevention of human rabies in Vwang district of Plateau State, Nigeria, 2010-2012

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Abstract
Introduction: Animal rabies is common in Plateau State, Nigeria with approximately 18,000 persons per year estimated to have been exposed to potentially rabid dogs. Human rabies, however, is preventable by avoiding exposure or initiating prompt medical intervention after exposure to the virus. Post-exposure prophylaxis (PEP) treatment, which involves prompt wound care, in combination with early administration of rabies immune globulin (RIG) and a course of vaccination immediately after exposure is highly recommended for the prevention of human rabies especially in endemic regions. The objectives of this study were to evaluate the use of rabies PEP by health care provider and patient adherence to treatment in the Vwang district, Nigeria. Method: Medical records of PEP treatments of patients bitten by suspected, probable and confirmed rabid dogs between February 2010 and June 2012 maintained at the hospital in Vwang district, Plateau State, Nigeria were used in the analysis. The patients were treated using purified Vero cell rabies vaccine. Data was compiled and categorically analysed. Results: Some 305 patients were presented for PEP treatment. Full treatment record was available for 182 (59.7%) patients. Treatment involved wound cleaning and vaccination with Vero-cell vaccine. None of the patients received RIG. A 5-dose vaccine regimen was prescribed for 129 (70.9%) patients, 3-dose for 29 (15.9%) patients, 2-dose for 22 (12.1%) patients and 1-dose for 2 (1.1%) patients. Overall, the adherence rate of patients to recommended doses of the vaccine was 33.5% (61/182). Adherence rate to the 5-dose regimen was 27.1% (35/129); 3-dose was 34.5% (10/29); 2-dose was 63.6% (14/22) and 1-dose was 100% (2/2). Conclusion: Rabies post-exposure treatment compliance was low in Vwang compared to WHO recommendations. There is critical need for training on rabies treatment.
Keywords: Adherence, Post-exposure prophylaxis, Human exposure.
Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

A *programme goal* to prevent human rabies in Nigeria, from 2015 to 2020 may drive the following three projects:

Project 1: Nationwide dog pre-exposure prophylaxis.
Project 2: Post-exposure prophylaxis for dog bite victim.
Project 3: Nationwide wildlife anti-rabies prophylaxis.

A project on domestic dog pre-exposure prophylaxis is used to illustrate rabies control logical framework as described in 5.3 below. A goal statement that is "SMART" - being **s**imple, **m**easurable, **a**chievable, **r**ealistic and **t**ime bound. The project plan presents the purpose and describes what the project is expected to achieve, if the project is thoroughly executed within the deadline. Disease control framework establishes relationship between the goal and the action plan within time frame.

5.3 Zoonosis control framework

The importance of ***smart*** goals derived from realistic information about disease risk factors was underscored by the classical work of Dr. John Snow on London, 1854 cholera epidemic. John Snow advanced logical frame-work that later inspired Johnson (2006), to say that "when the next great epidemic does come, maps will be as crucial as vaccines in our fight against the disease." In this sense, authorities have noted that the composition of ***smart*** goal statement for human-animal disease control

is far beyond a simple administration of vaccines and related chemoprophylaxes. Rather, both personal and environmental hygiene measures are crucial in disease control. The framework is here applied to a zoonosis. A typical example of a priority zoonosis for control in West Africa, is rabies. A goal statement for rabies control is quite simple and precise if it is formulated from prevalence dataset, and when spatial pattern of spread, accounting for various risk factors, events, forces and circumstances come into play. A template for rabies control programme is given in Table 5.1. The framework includes activities to measure goal attainment.

Table 5.1: A logical framework for rabies control in Nigeria, 2015-2020

	Rabies Control	Narrative summary A	Performance indicator B	Measurement C	Important Assumption D
A	**Goal**	AA	AB	AC	AD
B	**Purpose (objective)**	BA	BB	BC	BD
C	**Expected results**	CA	CB	CC	CD
D	**Activities**	DA	DB	DC	DD

Where: AA - Prevent human rabies in Nigeria, 2015-2020;
AB - Rural families increase anti-rabies prophylaxis;
AC - Record of dog bite victims at State Public Health Unit;

A reassessment of dog bite alarms and hotspots of rabies in Nigeria

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Abstract
Introduction: Rabies is a fatal and zoonotic infection endemic in Nigeria and Africa in general. The neglect of dogs and other animal reservoirs portends a high risk of exposure to the human population. Cases of incessant dog bites by both apparently healthy dogs and rabid dogs in Nigeria have been reported continuously from several states. Recently, more than ten human deaths due to confirmed rabies cases were reported in Cross River State in 2012. This requires raising public awareness on measures for more effective control of the disease. This presentation seeks to reassess recent response to dog bite alarms in Nigeria. Method: notified outbreaks of dog bite and alarms of rabies in apparently healthy dogs have provided a basis for reassessment of annual dog bite response for more effective pre- and post-exposure prophylaxes for humans and dog populations, respectively. Results: rabies has been reported predominantly in dogs but also in cats, cattle, sheep, goats and horses. Notified cases of humans exposed to rabies through bites of rabid dogs are highest. Concurrent inadequate vaccination coverage of stray and free-roaming dogs in the nooks and crannies of Nigeria are reportedly posing danger to humans. Conclusion: Dog bite poses a great hazard to other animals and human populations because dogs are common domestic animals used as companions, pets, for consumption and guards in many households. There is critical need for dog population census; promote responsible dog ownership; dog vaccination; depopulate stray dogs and sustain collaboration among all stakeholders.
Keywords: Dog pre-exposure vaccination, Dog population census, Rabies control response, Human rabies.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Rabies risk in biting dogs and protocol for post-exposure management of human victims in Zaria, North-western Nigeria

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Abstract

Introduction: Dog bite is a serious public health issue, and prevention strategies have been developed by the WHO for developing countries. The aim of this study was to review cases of suspected rabid dogs, where exposures of humans to rabies were reported for the 2-year period, 2009 – 2010 at a referral veterinary hospital in Zaria metropolis of Kaduna State, North-western Nigeria, with consequent need for anti-rabies treatment of the human victims. Methods: A descriptive retrospective study was conducted on suspected dog bite cases registered in the case files of Veterinary Teaching Hospital, Ahmadu Bello University, Zaria, Kaduna State from January 2009 to December 2010 with notification of an involvement in biting, scratching or saliva contact with humans. Results: a total of 155 exposures were reported, out of which 13 (8.4%) were confirmed positive. Majority (72%, n=155) of the victims did not wash the site of bite with soap and water before reporting. Children were disproportionately affected (72.3%) as victims. Only 29% of the offending dogs were vaccinated against rabies. The high risk of human exposure to rabies demands one health clinical decision on appropriate wound treatment and administration of rabies immunoglobulin (20 IU/kg) or human diploid cell vaccine or purified Vero-cell rabies vaccine, which are highly purified and inactivated with WHO potency standard ($\geqslant$ 2.5 IU) per dose. Conclusion: This paper presents the risk of rabies in biting dogs in Zaria city, Nigeria and relates it to the protocol for post-exposure management of humans in one health mode.

Keywords: Dog bite, Rabies, post-exposure prophylaxis, risk of transmission.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

AD - Rural families do not present dog bite victims for post-exposure prophylaxis.
BA - Reduce human suffering and death due to rabies.
BB - 10 million rural families increase dog pre-exposure prophylaxis (PEP) and human post-exposure prophylaxix by 50%.
BC - Dog vaccination records at State Veterinary Services Department and human prophylaxis at State Hospitals.
BD - Rabies immune globulin (RIG) is not available at rural community clinics and dispensaries for post-exposure treatment of dog-bite victims.
CA - Decrease human and domestic dog rabies cases.
CB - 10 million rural families increase dog pre-exposure vaccination by 50%, while maintaining a quality of 75% of vaccinated dogs attaining antibody titre of 0.5eu/ml against rabies in their blood.
CC - Date of annual pre-exposure vaccination of dogs in rural communities available in records at State Veterinary Services Department.
CD - Rural families do not present dogs for rabies pre-exposure prophylaxis;
DA - Dogs injected with certified anti-rabies vaccine, yearly.
DB - 10 million rural families increase dog pre-exposure vaccination by 50%, between March 2015 and March 2016, repeated over subsequent years till March 2020, while maintaining the quality of 75% of vaccinated dogs attaining antibody titre of 0.5eu/ml against rabies in their blood.

DC - Laboratory records of antibody levels against rabies, community by community available in records of State Veterinary Services Department.

DD - Certain rural communities are not accessible.

Objectively verifiable indicators are needed to tell from empirical basis, when a goal is accomplished. It answers the question about, "How can it be measured?" Through appropriate empirically verifiable indicators, when the goal is accomplished, it can be measured. A mandate of the Ministry of Human Health and of the Animal Health Division of the Ministry of Food and Agriculture is to deliver and work at improving the delivery of zoonosis control programme within their jurisdiction. Assumptions made in a year, provide some basis for methodical considerations in improving the performance of control strategy in the succeeding year.

5.4 A one-health collaboration

One-Health collaboration offers teamwork among health professionals. There may be no end to the convergence of knowledge and skills at this point for ensuring control and prevention of zoonosis at the human-animal-environment interface. By working as a team, local capacity for improving public health is

built. The one-health team thus compiles yearly project delivery with objectively verifiable indicators important in zoonosis control and prevention. It is critical to note that continuous gathering and analysis of progress made in control project is key to success. A logical framework for zoonosis control shows clearly that the activities involved are more than what one person, or one profession alone can deliver.

The role of the physician and veterinarian in rabies control are well recognized. However behind the scene are the roles of the laboratory diagnostician, dog owner and the victim of dog-bite injury in identifying the offending dog. Again, the analysis of the data pool that is generated is the role of the epizootiologist. Epizootiological, descriptive and analytical activities are critical methods for surveillance intelligence in this matter.

The role of a medical doctor includes, examining people who are victims of dog bite. Following the examination, the medical doctors who had diagnosed and treated dog-bite cases in the clinic or hospital requires bite victims to identify the location and owner of the offending dog. The doctor reports to community health officials and medical care of the patients is assured and post-exposure prophylaxis is promptly provided to protect from progression to human rabies (Beran, 2013).

Other persons exposed to a positive rabid animal are provided with vaccination. The positively confirmed human patients are hospitalized and provided possible relief and prefatal care.

The role of a veterinarian includes, examining offending dog involved in injury inflicted on human. The veterinarian is required to differentiate between provoked and unprovoked bite cases. He quarantines and observes behaviour of the offending dog and its case history to ascertain a suspected or probable case of rabies. Veterinarians follow up laboratory tests for confirmation of probable cases of rabies in the dog. It is recommended that vaccination of dogs be performed not only where dogs have bitten people, but also in areas where dogs have been exposed to rabies. The vaccination of dogs is compulsory, no matter how much it costs, even in a resource poor country. This is necessitated by evidence of disaster risk status that portends uncontrolled rabies epidemics in West Africa.

Wandering dogs looking for food around communities, increase are rabies risks. Thus, veterinarians are required to supervise their removal from the community, and to decide when the population of dogs in a community is stable with no report of rabies and, how frequently

vaccination should be administered.

Epizootiologists determine what percentage of the population of dogs should be vaccinated, and realistically, how often and how should vaccinated dogs be identified. The public needs to be educated before and during community rabies prevention programme. How this is to be done is better determined by a one-health team. The epidemiologists and epizootiologists on the team develop a joint document on "rabies surveillance atlas and five-year strategic plan for control in the community to educate all and guide a one-health team.

The Centre for Control and Prevention of Zoonoses (CCPZ), University of Ibadan promotes community-based one-health teams across West Africa. Exploring one-health collaboration along zoonoses surveillance projects, especially one that brings physicians and veterinarians to work together, holding round table discussions on solving zoonosis control challenges, and include interested community members to get more effective outcomes on zoonosis control projects. Essentially, as veterinary medicine and human medicine provide care to animals and humans they deliver on the potentials to provide for a better world through one-health (Beran, 2013). Such one-health values are seen in rabies control and eradication projects in West Africa.

5.5 Enforcement of zoonosis control

The goal of a zoonosis-free world requires a careful enforcement to ensure compliance with prevention of zoonoses. The "one-world" agenda, portends every community in West Africa has a role to play in zoonosis control and prevention. This is more so, because the control and prevention of zoonosis is trans-boundary in nature. In most developing countries of West Africa, it is common knowledge that human-animal diseases, some of which are fully preventable, continue to pose major challenge to the health of communities. The World Health Organization has classified such diseases as neglected zoonoses, while some authorities prefer the expression, "diseases of neglected communities". On this premise, enforcement of zoonosis control is crucial . An example in this regard is rabies control in West Africa.

While zoonosis control falls within the purview of governance at local, national, regional and global levels, the prominent attention is often given to the executive arm of government. Usually, the Ministry of Health and Social Welfare, together with the Ministry of Food and Agriculture play pivotal role. However, in the enforcement of control and prevention, the Ministry of

Justice has major roles to play in zoonosis prevention and eradication. For instance, "Who would be legally responsible for the bite of a dog?" is a question for the justice department of a community.

Legal enforcement starts with the legislative arm of government. While the court is seen as a major institution in regulating dog ownership and rabies control, the question about availability of legislation for responsible dog ownership points to the role of the legislature in formulating essential laws to be enforced by the justice department. Does the local, state or national law provide for dog identification, movement regulation (such as premises confinement) and essential zoonoses vaccination for dosg? How does the law cater for dog-bite victism? Does the legislation identify categories of offending dogs, such as where the dog is owned by the person it bites and when the dog belongs to other persons? How accessible is judicial procedure on dog related matters? What role is there for dog insurance in administrative methods for rabies control and prevention?

The CCPZ facilitated the establishment of a sub-regional organization on Rabies in West Africa (RIWA) to offer community connection platform for one-health empowerment in rabies control in West Africa.

5.6 Practical exercises

In this exercise, participants will assess zoonosis control record keeping facilities for their effectiveness and efficiency in supporting objectively verifiable measurements on project implementation at a local community of choice. Participants will design logical framework for grassroots empowerment in zoonosis control project implementation in a typical local community.

5.6.1 Embark on a direct visit to a community of choice in your neighborhood. Locate a Public Health Centre (PHC) and or a local Veterinary Public Health Coordinating Unit (VPHCU) that serves the community.

5.6.2 Find out about record keeping facility that exists on site. If there is any, find out what it services and the data it keeps. Are data kept about an on-going or a past disease control project within the community?

5.6.3 Identify the project goal. Is it *smart*? Find out about a logical framework developed to guide the implementation of the project.

5.6.4 Perform measurement on number of cases of human-animal diseases that were diagnosed or suspected in the previous year on the project in the community. How does

your findings compare with expected outcome on the project, and as related to that community?

5.6.5 Are there novel initiatives taken by Disease Control Desk Officers to solve project related problems and improve service and outcome?

5.6.7 What can the community do in order to improve on zoonosis control in a way that harnesses their own self-support initiative.

5.6.8 Draw a logical framework for empowering community disease control centre. Set goal statement on grassroots empowerment in zoonosis control project implementation. Offer a purpose narrative for desk officers' training and skills development opportunity. Set objectively for motivating, and holding them responsible and accountable for outcomes of their actions, in their performance to ensure a healthier community.

5.7 Further readings

1. Beran G (2013). Rabies elimination as a One-Health model for the tropics. Epizootiology and Animal Health in West Africa. 9 (1): 7-12
2. Olugasa BO, Odeniyi AO, Adeogun AO and OA Adeola (2010). Antibody levels against rabies among

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3. Olugasa BO, Aiyedun JO and Emikpe BO (2011). Prevalence of antibody against rabies among confined, free-roaming and stray dogs in a transit city of Nigeria. Veterinaria Italiana 47 (4) 453-460.
4. Olugasa BO, Oluwayelu DO, Ayinmode AB, Emikpe BO, Ijagbone IF and SIB Cadmus (2011). Epizootiology in contemporary global health: making a difference in the health of people in West Africa. Nigerian Journal of Epidemiology Vol. 1: 28-33
5. Robinson A (2003). Veterinary Public Health and the Control of Zoonoses in Developing Countries. Published by the United Nations Food and Agriculture Organization (FAO). http://www.fao.org/docrep/006/Y4962t/y4962t02.htm#TopOfPage ftp://ftp.fao.org/docrep/fao/006/Y4962T/Y4962T00. PDF

Section 2

Basic application of specialized tools and methods

Chapter 6

Geographic Referencing and Spatial Analysis of Zoonosis Pattern

6.1 What is geographic referencing?

Geographic data, by definition has some sort of geographic referencing to help identify its location in the world. One possible means of describing the location of an individual zoonosis patient is geographically referenced (or "geo-referenced") with coordinates (such as latitude and longitude). Two others include linear referencing (such as street addresses and mile stones), and indirect positional references (such as distance and direction descriptions from known markers in a community). Geographic referencing standards help define common ways to collect and reference data. This in turn is made possible by the growing technological capabilities for global positioning system. At the end, it provides a more effective way to share and merge information collected by different agencies.

. This chapter uses geographic referencing (or "geo-

referencing") to explore and update national statistics of zoonoses. It is used to promote greater data accuracy, and to facilitate the sharing and aggregation of data. Geo-referencing enables spatial linking of diverse demographic and environmental datasets to records of zoonoses for comprehensive spatial analyses.

The ability to combine data from many sources to identify environmental factors associated with zoonosis risk is a particularly useful epizootiological value of geographic data management in zoonoses surveillance. Georeferencing tools create opportunity to explore habitats that are suitable for emergence, endemicity and neglect of zoonoses. The human-animal-environment interface is then predictable about case pattern, needed for strategic control across board.

6.2 Exploring habitat suitability for zoonosis

Spatial analysis tools are grouped together under the broad heading of Geographic Information Systems (GIS). GIS has major role in tracking, identifying spatial pattern and habitat suitability for transmission of zoonosis. The detailed assessment of what makes an habitat suitable for some zoonoses and not others is an important study in epizootiology. The gathering of data on multiple variables (multivariate) that may contribute

to the occurrence and distribution of zoonosis cases is the basis for exposure science in ecological epizootiology.

Between 1976 and 2012, a total of 22 distinctive Ebola virus disease (EVD) outbreaks were identified in published and unpublished records in Africa. Ebola first appeared in 1976 in simultaneous outbreaks in Nzara, Sudan, and in Yambuku village, near Ebola River in Democratic Republic of the Congo (DRC or Zaire). EVD derived its name from the river in DRC.

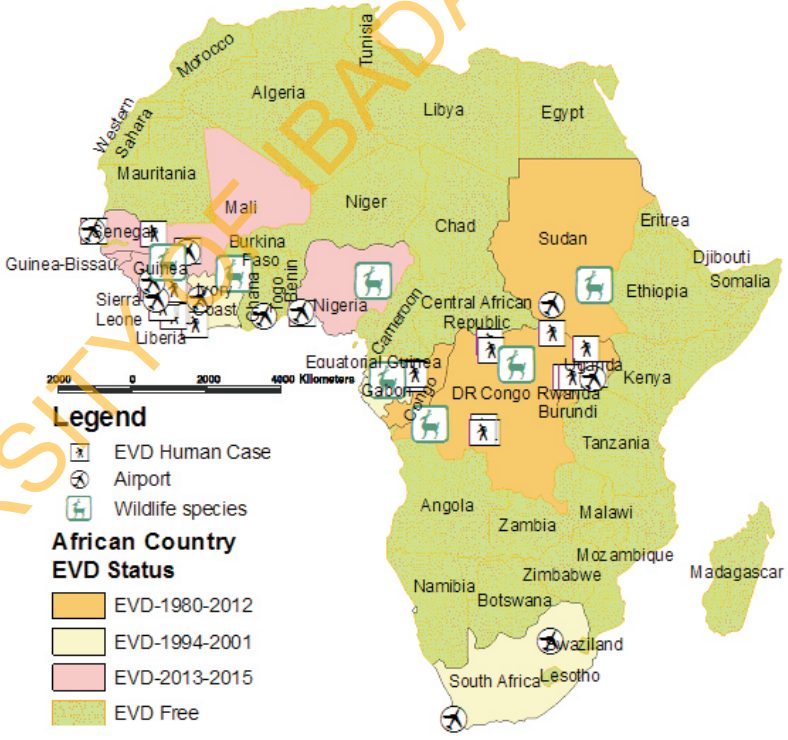


Figure 6.1: Map of Africa showing Ebola virus disease status in each country.

EVD is considered one of the world's most deadly diseases. It has the potential to cause outbreaks of variable magnitude in human populations when it spills over from animal origin to humans. Subsequent human-to-human spread in South Sudan, Sudan, Democratic Republic of the Congo, Cote d'Ivoire, Gabon, Uganda and Congo were recorded. Since the outbreak in December 2013 through 23 September 2014, a total of 6,574 EVD cases were reported from five countries in West Africa (Guinea, Liberia, Nigeria, Senegal and Sierra Leone). The outbreak has been the largest ever in history.

Ecological examination of local environment in DRC and South Sudan revealed that the habitat was rich in primate populations. The spread of EVD was shown that death had been recorded in some wildlife species before human deaths. Index cases were farmers and hunters. EVD spread in the countries were spill-over from wildlife exposed persons to their family members and the rest of the community. An exploration of the geographic risk factors associated with the spatial pattern of the disease is the jungle environment.

Geographic map or the cartogram presents essential tool for surveillance and presenting exploration of habitat suitability for diseases at the human-animal-environment interface in West Africa. Three specialized tools and methods that are harnessed are: (i) SaTscan for spatial and temporal scan

statistics, (ii) GeoDa for ordinary least square regression, and spatial lag regression and (iii) ArcGIS for mapping and construction of geographically weighted matrix of multi-variables applied into spatial regression analysis.

As a community health officer, you have been invited to participate in EVD mapping in West Africa. First to understand EVD outbreaks and case pattern in Central and East Africa compare with outbreaks in West Africa and bring out lessons from two sub-regions of Africa. You will make a map that symbolizes the most endemic countries according to the number of outbreaks that have been recorded in them. The map will show the index cases of the disease in Central, East and West Africa. The map will help public health authorities decide which counties, countries or states to keep under priority surveillance, and how much resources to be committed into each community to do the job.

Exercise 6.1

6.2.1 Start ArcMap by double-clicking the ArcMap icon on your computer desktop. (Alternatively, click the Start button on desktop computer, point to Programmes, point to ArcGIS, and click ArcMap).

6.2.2 In the ArcMap dialogue, click the option to use an existing map. In the scrolling box at the bottom of the dialogue, the phrase "Browse for map..." is highlighted.

Click OK.

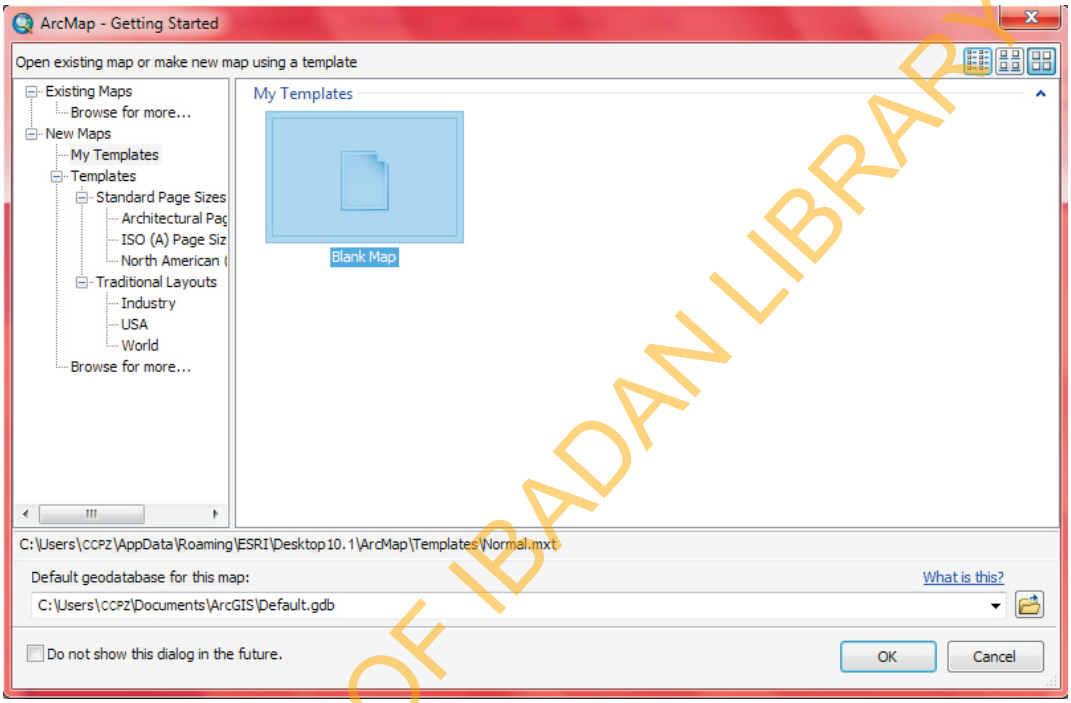


Figure 6.2: Screen view of dialogue box for opening a new map project in ArcGIS (ArcMap) 10.1 desktop.

6.2.3 In the open dialogue, navigate to **C:\GTKHADS\Chapter06**. Click **ex06a.mxd** and click Open.

The map document opens. You see a map of Africa showing EVD cases in countries with outbreaks in Central, East and West Africa. The table of contents lists

the names of the layers in the map. Each layer has a table attached that contains the feature attributes. The EVD_1980-2012 layer has 117 unique geographic transmission clusters as attributes of EVD in Central and East Africa between 1980 and 2012. The EVD_2013-2014 layer in the table of contents has a total of 6,574 EVD cases in West Africa in 2014. Liberia had the highest case count of 3,458 cases, and remained the highest singular outbreak in history; Sierra Leone, 2,021 and Guinea, 1,074. (WHO, 2014). Use the attribute table attached to the map layers to explore the following statistics.

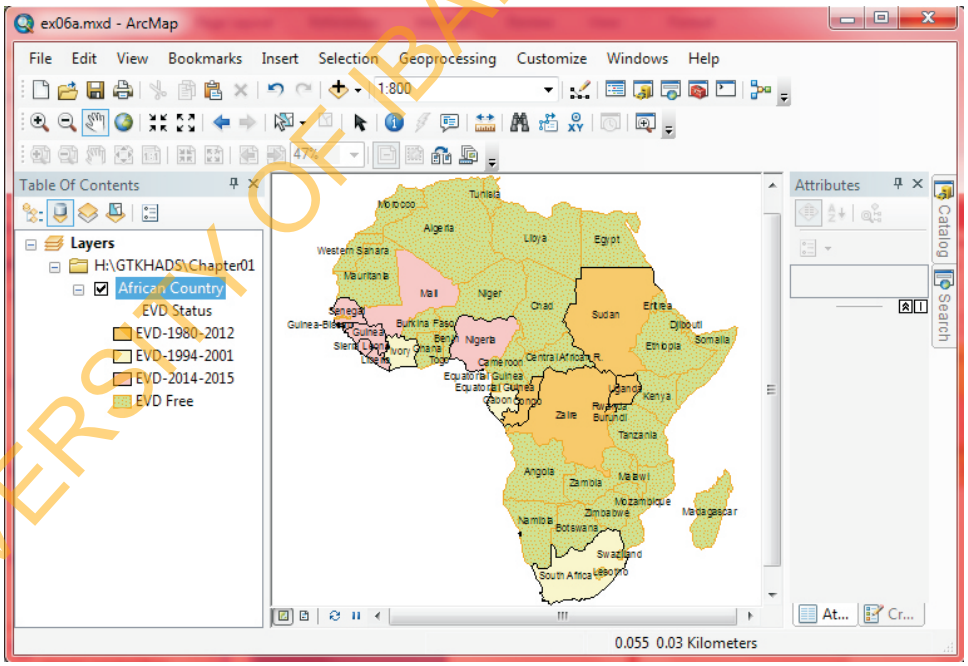


Figure 6.3: Screen view of map layer of Ebola virus disease in Africa on ArcMap 10.1

6.2.4 In the table of contents, a right click on African country EVD Status layer cause a drop down menu to appear. Explore habitat data and update surveillance information by clicking on **Open Attribute Table** menu. When it opens, click on Edit Features. Then update EVD map.

The steps are listed as follows: (i) Open Attribute Table
(ii) Label Features
(iii) Edit Features
(iv) Convert Labels to Annotation
(v) Save as Layer File

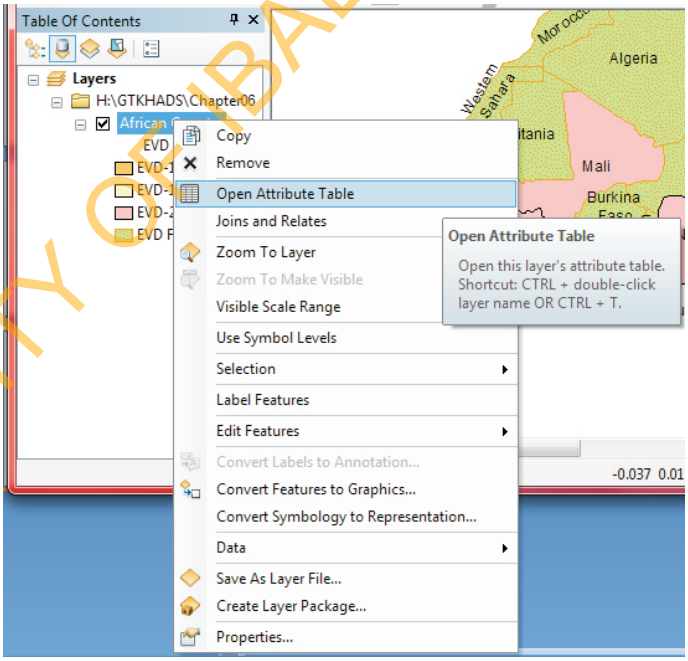


Figure 6.4: Screen view of map layer drop down menu for opening attribute table of Ebola virus disease in Africa on ArcMap 10.1 desktop.

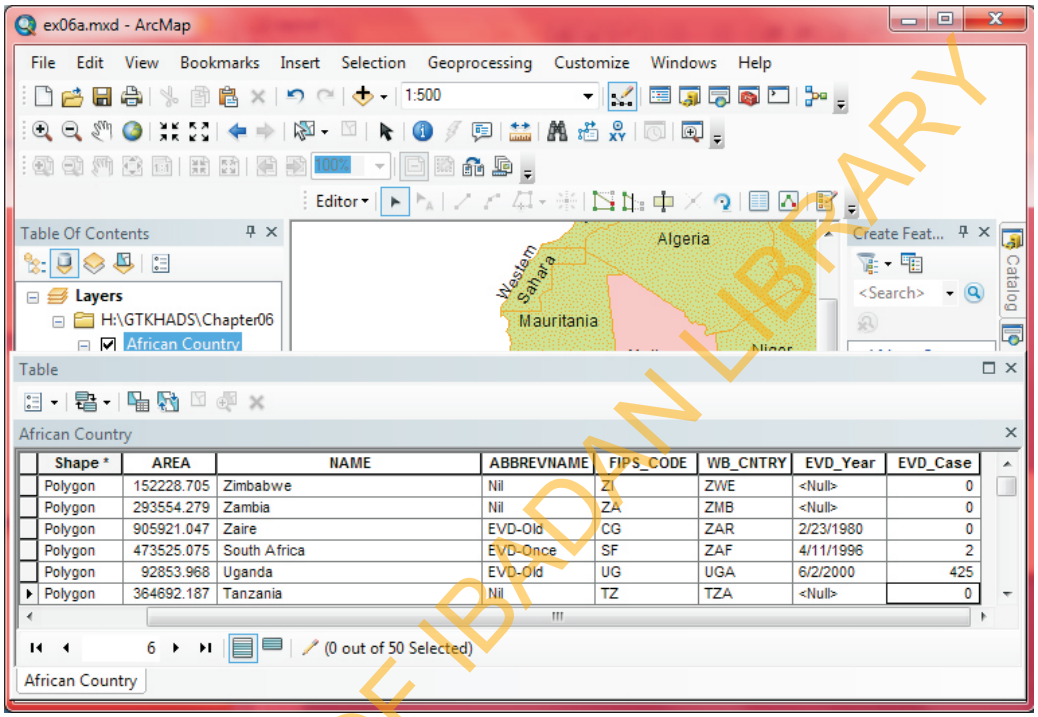


Figure 6.5: Screen view of map layer of Ebola virus disease

(i) A click on **Open Attribute Table** brings the table showing the contents of data attributed to African countries on EVD Status Layer. This data is used to study habitat profile and suitability for EVD status reported in each country.

(ii) A click on Edit Features makes it ready to update records of EVD in African countries, including year and number of cases based on data from WHO, CDC, FAO and National Agencies in each country authorized to keep EVD data.

(iii) Click on Label Features. Label each feature or country appropriately.

(iv) Convert the labels to annotation and then arrange your annotations as best as you can.

(v) Finally, save your complete work as a Layer package.

Table 6.1: Selected records of Ebola virus disease in West Africa, 1994-2014

S.No.	Country	Date of Index	Airport	Village or City
1	Cote d'Ivoire			
2	Guinea			
3	Liberia			
4	Nigeria			
5	Mali			
6	Senegal			
7	Sierra Leone			
	Total			

Fill the gaps in Tables 6.1 and 6.2 to answer the questions below:

(i) Were all towns and villages affected in the outbreak of EVD in each country where new case(s) emerged?

(ii) What was the direction of movement of the outbreak after the index case?

(iii) What modern facilities for transportation or species of wildlife are notable in the various towns or villages where EVD emergence or spread has been recorded?

(iv) State (with evidence) your opinion about means of transmission of the disease in each location of the outbreak? Add more evidence-based geo-referenced data to the map to further explain your conclusion on the means of emergence of the disease.

(v) Did the index case involve an international flight?

Table 6.2: Selected records of Ebola virus disease in Central Africa, 1980-2014

S.No.	Country	Date of Index	Airport	Village or City
1	Uganda			
2	Democratic Republic of Congo			
3	Gabon			
4	Congo			
5	South Sudan			
6	South Africa			
7	Ruwanda			
	Total			

The question about how EVD emerged in West Africa is now unraveled and has become educational case study in basic and applied geo-spatial analysis for lessons in exploration of habitat suitability for zoonoses spread. Continuous surveillance of migrant wildlife to detect carriage of EVD virus to new territories within West Africa is now a necessity. Bats in particular, are known carriers of the virus from endemic areas in Central and Eastern Africa to other parts of Africa.

The risk of infected humans and animals carrying the virus across national boundaries along modern transportation routes and systems by air, sea and road is a critical factor for surveillance in West Africa.

Dataset about indigenous habitats and farming practices in individual communities are now being joined with the attribute table of EVD surveillance data in West Africa to improve the study value at the Centre for Control and Prevention of Zoonoses (CCPZ), University of Ibadan. Based on the same purpose, data about the detection of EVD virus or its antibody in domestic and wild animals, humans and soil in a geo-referenced database (or "geo-database") is a growing aspect of the CCPZ geo-spatial information infrastructure (EVD surveillance). Gallery of electronic datasets preservation serves educational, scientific and service delivery functions in West Africa.

6.3 Habitat scenario for an emerging zoonosis

A disease is considered ***emerging*** (or "new") at a given geographic location at a certain point in time when it had never been known to exist in that community prior to the time a first case was identified. However, when it had occurred before and was once eliminated but re-appears, it is considered ***re-emerging***. From the initial emergence site, a disease may spread to other places where it may continue to adapt itself to the habitat and persist as an ***endemic*** (enzootic) disease. A disease may continues to occur in a community to the extent that public attitude has come to accept it as an unavoidable malady in the

local environment, with little or no control programme accorded, then it may be described as ***neglected*** disease.

In this section, the geographic nature of emerging, re-emerging, endemic and neglected disease at the human-animal environment interface is illustrated. Scenarios with Highly Pathogenic Avian Influenza (H5N1), Lassa fever and rabies are provided to illustrate these trends.

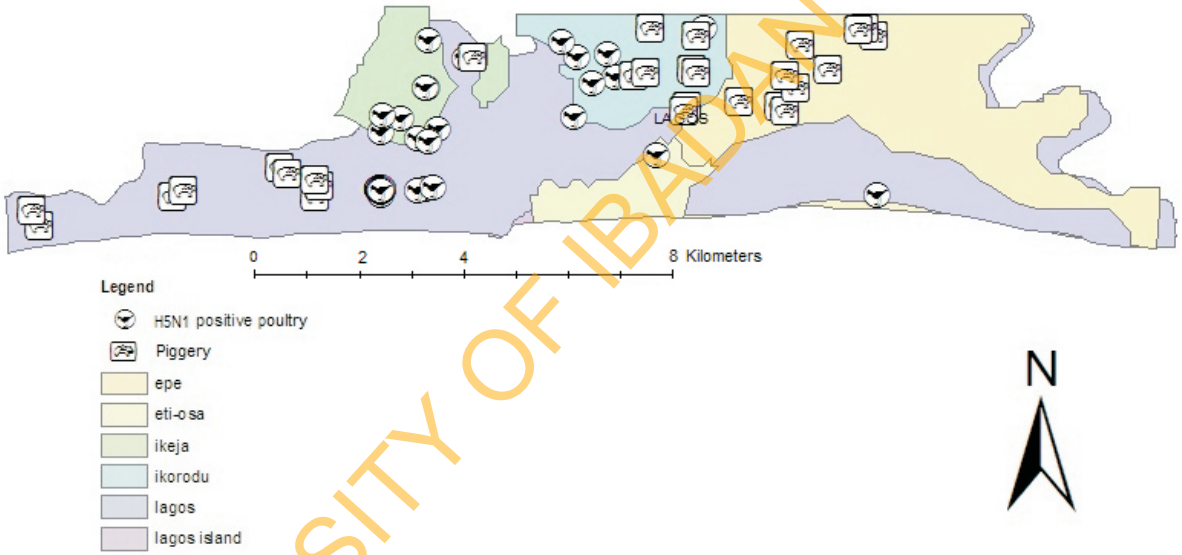


Figure 6.6: Screen view of map layer of Influenza H5N1 virus infected poultry and neighbouring pig farms in Lagos State, Nigeria, 2006-2007

The first human case of highly pathogenic avian influenza (H5N1 virus) in Nigeria was confirmed in the laboratory in January 2007 in Lagos State, south-western

Nigeria (Nweke *et al.*, 2007), 12 months after the first outbreak of the virus in poultry population in the country. This situation raises public health concern about the disease and its presence in Nigeria. However, more concern is in the possibility of the virus co-infecting pigs in the same local environment (Figure 6.6). Influenza H3N2 virus circulates among pigs in south-west Nigeria (Adeola *et al.*, 2015). Such event, has been known in history to be a pre-condition for re-assortment and emergence of novel influenza viruses that may be highly pathogenic and infectious among swine and human populations.

Exercise 6.2

Is habitat scenario in Lagos state suitable for the emergence of novel influenza viruses? This is a question that surveillance team must investigate. Required for this spatial exploration is a geo-referenced dataset of poultry infected with HPAI H5N1 in Lagos state, and a geo-referenced dataset of pig farms in the state.

6.3.1 Start ArcMap by double-clicking the ArcMap icon on your computer desktop. (Alternatively, click the Start button on desktop computer, point to Programmes, point to ArcGIS, and click ArcMap).

6.3.2 In the ArcMap dialogue box, click the option to use an

existing map.

6.3.4 In the opened dialogue, navigate to **C:\GTKHADS\Chapter06**. Click **ex06b.mxd** and click Open.

The map document opens. You see a map of Lagos State, Nigeria showing poultry infected with Influenza H5N1 Influenza virus in years 2006 and 2007. The flocks were depopulated and premises disinfected. A layer of pig farms in Lagos state is also displayed on the map in the table of contents lists.

6.3.4 Determine the shortest distance and farthest distance between poultry infected with influenza H5N1 and each neighbouring pig farm, using ArcMap 10.1 (Figure 6.7).

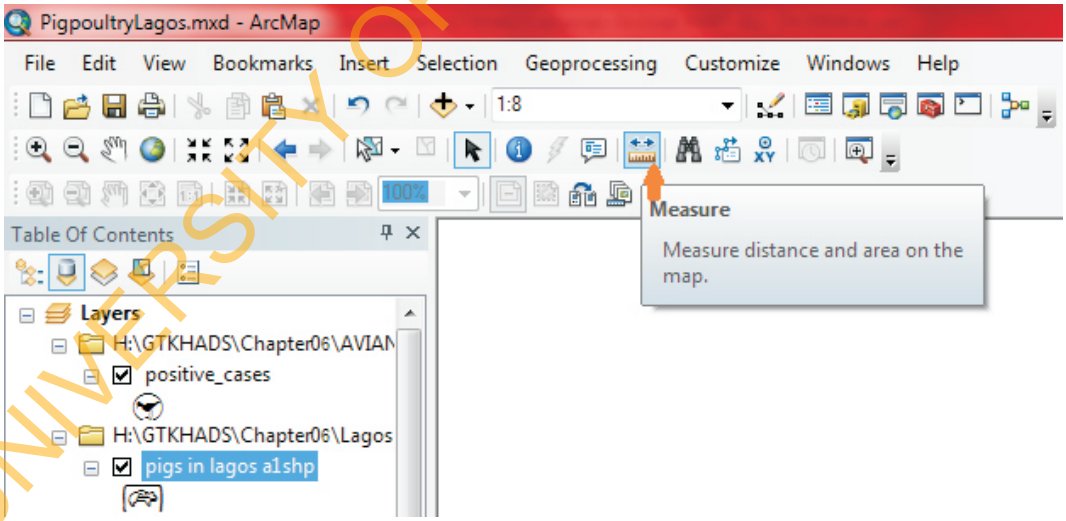


Figure 6.7: Screen view of toolbars and menu on ArcMap 10.1, showing the measure button on the menu bar

ArcMap 10.1 toolbars and menu with a button for measuring spatial distance in a local environment is shown in Figure 6.7.

6.3.5 Identify the Local Government Area with highest number of H5N1 HPAI-infected poultry. How many pig farms are within graded distance (0.5km, 1.0km) of HPAI H5N1 in Lagos environment? Fill-in the gaps in Table 6.3.

Table 6.3: Proximity of Influenza virus infected poultry to piggery in Lagos, Nigeria, 2006-2007

S.No.	Pig Farm	Influenza Type	Nearest Poultry (m)	Farthest Poultry (m)
1	PF1			
2	PF2			
3	PF3			
4	PF4			
5	PF5			
6	PF6			
7	PF7			
8	PF8			
9	PF9			
10	PF10			
	Total			
	Average			

6.3.6 Open attribute table of map. Check pig farms infected with Swine or Human H3N2 or H1N1 Influenza A virus.

Computation of nearest pig farm cluster is easily performed using Kulldorff's 2-dimensional spatial scan statistic software (Kulldorff, 1997) (Figure 6.8). The method is based on the use of circular window, which represents a circular geographical area. The null hypothesis assumes that the relative risk of H5N1-infection is the same within the window when compared with outside it.

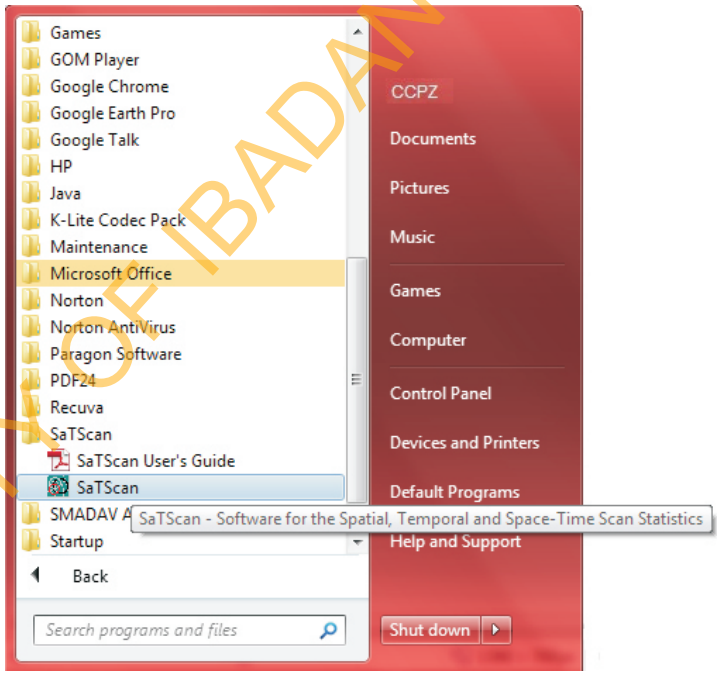


Figure 6.8: Screen view of *Start menu* to open SaTScan statistical software on desktop computer

6.3.7 Use SaTScan software to detect high-risk local spatial clusters of H5N1-avian influenza virus infected poultry.

H5N1-avian influenza cluster may be assessed based on Bernoulli or Poisson distribution model at each local community. A Bernoulli distribution assumes case and control pattern, while a Poisson distribution assumes case and population pattern of analysis. The option depends on data available. The assessment may be carried out as follows:

(i) Create Case File: The file may be created by categorizing all poultry infected with avian influenza as cases (Figure 6.9).

(ii) Create Control File: The file may be created by categorizing all pig farms now assumed to be avian influenza-free as control (Figure 6.9).

(iii) Geographic Coordinate File: The geographic coordinates for each location ID of poultry and pig farms observatory sample in Lagos state, 2006 and 2007 were created from an Excel format. If two location IDs have exactly the same coordinates, the data for the two are treated as a single location.

(iv) Follow an import wizard in the input file window to generate each file. Generate a case file by following the steps on the wizard till the new file, **Avian Influenza cases in Lagos, 2006-2007.cas** is imported (Figure 6.9).

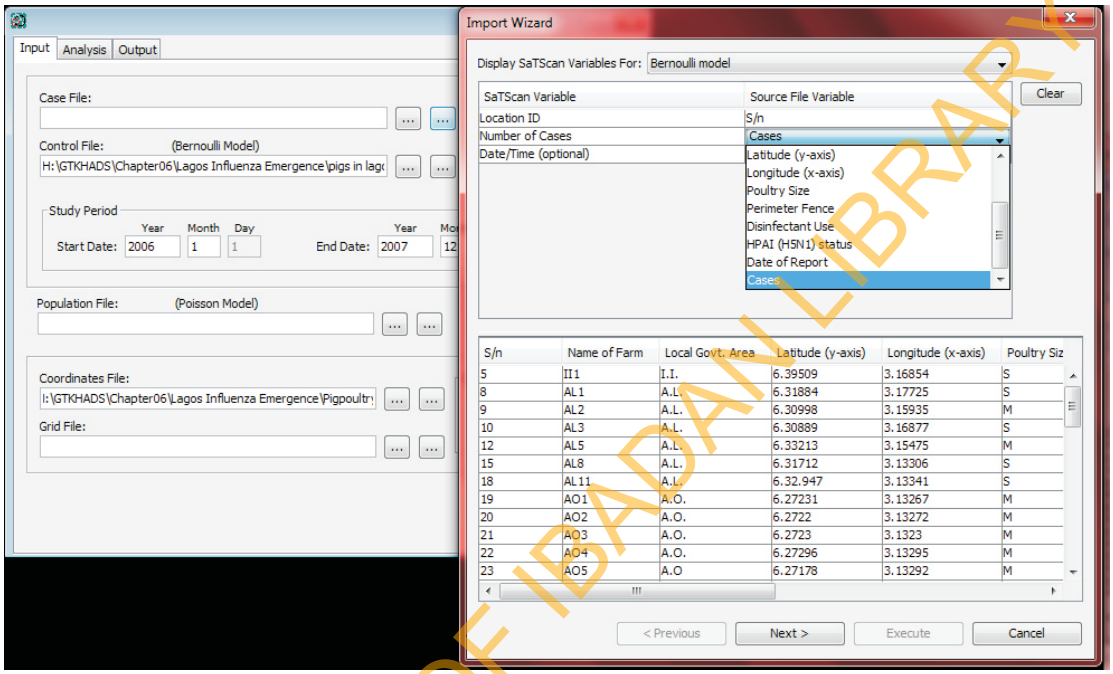


Figure 6.9: Screen view of wizard for creating input files (case, control, population, coordinates and grid) on SaTScan package.

(v) Specify spatial analysis for poultry and piggery datasets in SaTScan by selecting smart statistical method. In this instance, a retrospective analysis in purely spatial scan, Bernoulli probability mode for high rates risk is selected (Figure 6.10).

This method, purely spatial analysis, helps identify areas of high risk and unexpected clustering from potential farm sources of avian influenza H5N1

mixing with pigs in a local environment, thus, allowing additional risks to be identified and factored into surveillance screening plan by epizootiologists as they develop a targeted screening programme for emerging influenza strains at "mixing pot" locations.

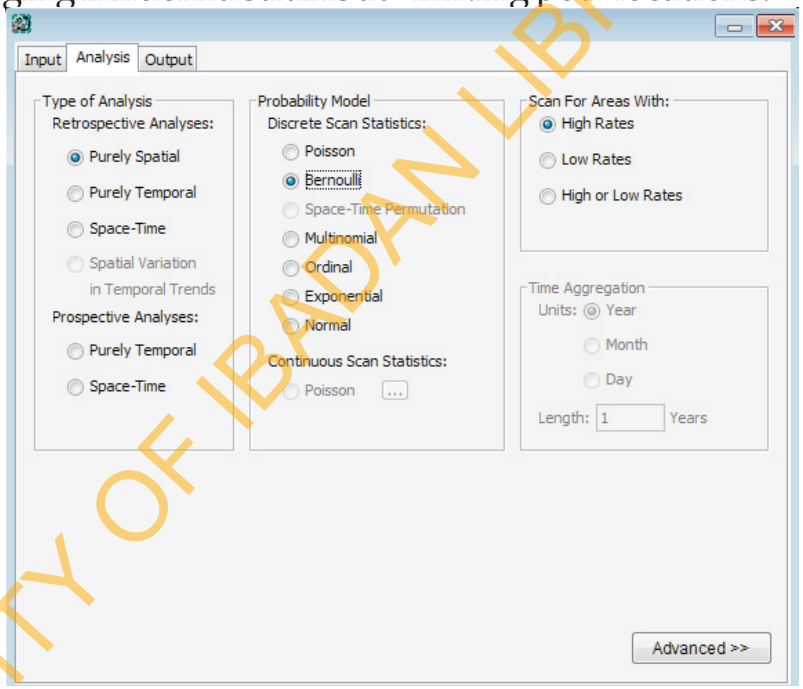


Figure 6.10: Screen view of statistical analysis options on SaTScan package.

6.3.8 Specify maximum size of spatial scan window that should be used for statistic analysis on SaTscan. Click on "Advances>>" (Figure 6.10) to select window size. It is advisable to limit size to 50% of the total population. The statistical significance of each cluster is also based on comparing the log likelihood ratio (LLR) against a

null distribution assessed through Monte Carlo simulation. The window with the maximum LLR is deemed the cluster least likely to be due to chance. (Kulldorff and Nagarwalla, 1995; Kulldorff, 1997).

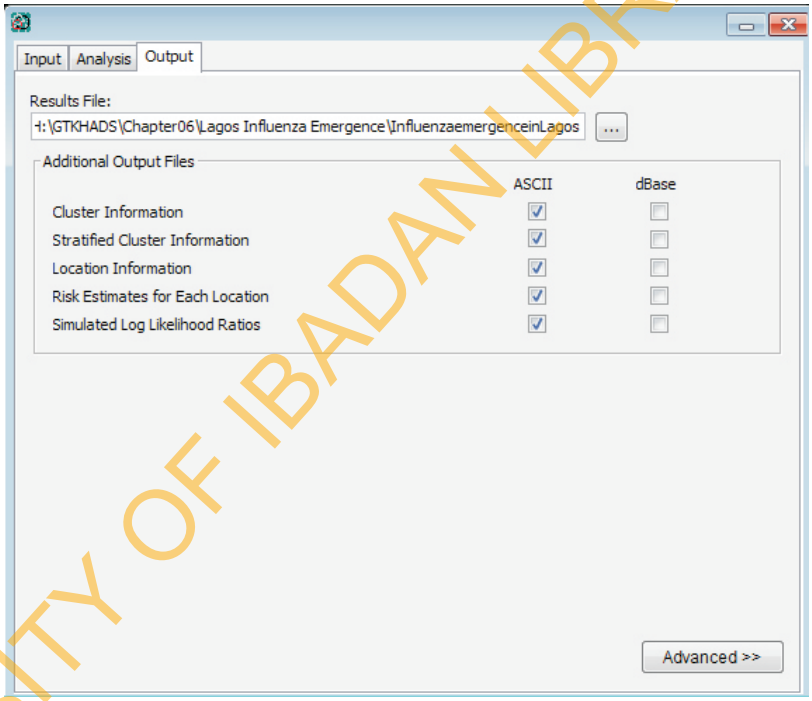


Figure 6.11: Screen view for specifying a directory for saving output file of spatial analysis on SaTScan package.

6.3.9 This exploration of habitat suitability for emergence of novel influenza virus and its possible outbreak is a pointer to a need for geo-referencing of human-animal facilities to merge environmental variables for analysis. Spatial analysis of high risk clusters of human-animal

influenza distribution offers a real support for surveillance and detection of risk factors in potential emergence of a new strain of the disease. This trend may get ignored if epizootiologists are not at work.

6.3.10 Identified cluster of pig and poultry farms on the map generated is a valuable step in risk assessment to investigate molecular changes (see Chapter 7) in disease pathogen potentially associated with changes in local mixing of influenza viruses in pig mixing pot.

These tools and methods support the exploration of spatial relationships and trends that may otherwise go unnoticed. Find the primary cluster of high rates in Lagos state and save the results of analysis (Figure 6.11). A primary and two secondary clusters are identified in the area (Table 6.4). How important are these results?

Table 6.4: Primary and secondary clusters of Influenza virus infected poultry within pig farm neighborhood in Lagos, Nigeria, 2006-2007

Type	County	Observed cases	Expected cases	Control	Relative risk (RR)	p-Value	Log likelihc ratio (LLF
Most likely (Principal)	Amuwo-Odofin	29	23.42	9	1.33	0.002	7.12
Secondary 1	Isolo	17	13.73	4	1.28	0.222	3.92
Secondary 2	Ikorodu	11	8.88	1	1.27	0.799	2.47

6.4 Habitat scenario for an endemic zoonosis

In 1969, Lassa fever was identified for the first time in medical literature as a new disease from a developing country in West Africa. The first case ever described was in a missionary nurse infected at a Nigerian town, called Lassa in Borno State. Since then, annual cases of Lassa fever are reported in Nigeria and few other West African countries. The presence of the multi-mammate rat, *Mastomys natalensis* has been associated with the endemicity of the disease. In addition, person-to-person transmissions of the disease further influences its case pattern among human population. It is known that Lassa virus multiplies in *Mastomys* rats with no clinical signs of illness. The rat which is known to shed Lassa virus in its urine and faeces, contaminates living environment, including human foods (Figure 6.12). A scenario of this transmission cycle is explored in two datasets on human cases of Lassa fever diagnosed at National Referral Hospitals in Nigeria and Liberia.

Exercise 6.3

In this exercise, Lassa fever outbreak locations and spatial pattern in the sub-region will be used to bring out lessons on the habitat suitable for ***endemicity*** of the disease. Geo-referenced files (or shapefiles) of cases and control retrospectively collated by a team at the CCPZ in collaboration

with the Ministry of Health and Social Welfare, Liberia. Clinical cases are categorized into confirmed, probable and suspected. The site name of each case is identified and converted into map point. Analyse spatial clustering of the cases and investigate activities and associated risk factors at each local communities of endemicity.

6.4.1 Use Satellite images, available in Google Earth Pro (Remote Sensed data), to study the dataset provided in 2008-2012 Liberia Lassa fever Geospatial Observation Data (Table 6.5) profile available in **ex06c.mxd.**

Figure 6.12: A community scenario of rice cultivation habitat (A), post-harvest street drying of rice by a woman (B), and *Mastomys* rat infestation of a neighbourhood in West Africa.

Table 6.5: Community environmental variables: description and data sources

Community characteristic	Operational description	Data source (year)
Number of houses (Count)	Number of purpose-built flats that serve as "on-farm" residential accommodation for workers and the industrial or plantation offices that have some non-residential use.	Google Earth Pro imagery, 2013; National Reference data
Forest edge (Proximity)	Shortest distance between houses on camp and the edge of the rubber plantation, measured in kilometers.	Google Earth Pro imagery, 2013
Rice cultivation (Proximity)	Shortest distance between houses on camp and the edge of the nearest rice farm on plantation, measured in kilometers.	Key informants; Focused group discussion; Google Earth imagery, 2013
Main road (Proximity)	Shortest distance between houses on camp and the main road that runs through the rubber plantation, measured in kilometers.	Google Earth Pro imagery, 2013
Human hospital (Proximity)	Shortest distance between houses on camp and the LAC Hospital, measured in kilometers.	Google Earth Pro imagery, 2013
Refuse dump (Proximity)	Shortest distance between houses on camp and edge of waste dump, that usually include agricultural wastes, household leftover food, rice husks, corn shafts, etc	Key informants; Questionnaire; and Google Earth Pro imagery, 2013
Camp land area (Area)	A product of the length (kilometers) and width (kilometers) of a camp's land area, expressed in square kilometers.	Google Earth Pro imagery, 2013
Human population (Density)	Number of people living per unit of land area on camp, between 2008 and 2012, computed using 2008 population census figures and the camp land area.	National Reference data and Google Earth Pro imagery, 2013
Post-harvest rice storage (Density)	Estimated total production of rice (paddy) per camp, or the quantity of paddy that was stored on camp, post-harvest, divided by the total number of houses on camp.	Focused group discussion; key informants.
Mastomys species (Infestation)	Presence of the commensal multimamate rat, *Mastomys species*, identified based on their morphometry (body dimension, colour, and number of mammary glands).	Direct observation, 2013; Questionnaire.
Rodent detterent (Density)	Aluminium sleeves that was fitted on all the platform legs of rice storage to keep *Mastomys* species from infesting the store, divided by number of houses on camp.	Focused group discussion; key informants, 2013.

6.4.2 In the open dialogue box (Figure 6.2, page 84), navigate to **C:\GTKHADS\Chapter06\ex06c.mxd.** Click Open.

The map document opens. A map of Liberia, showing Lassa fever cases nationwide, during years 2008 to 2012 appears (Figure 6.13)

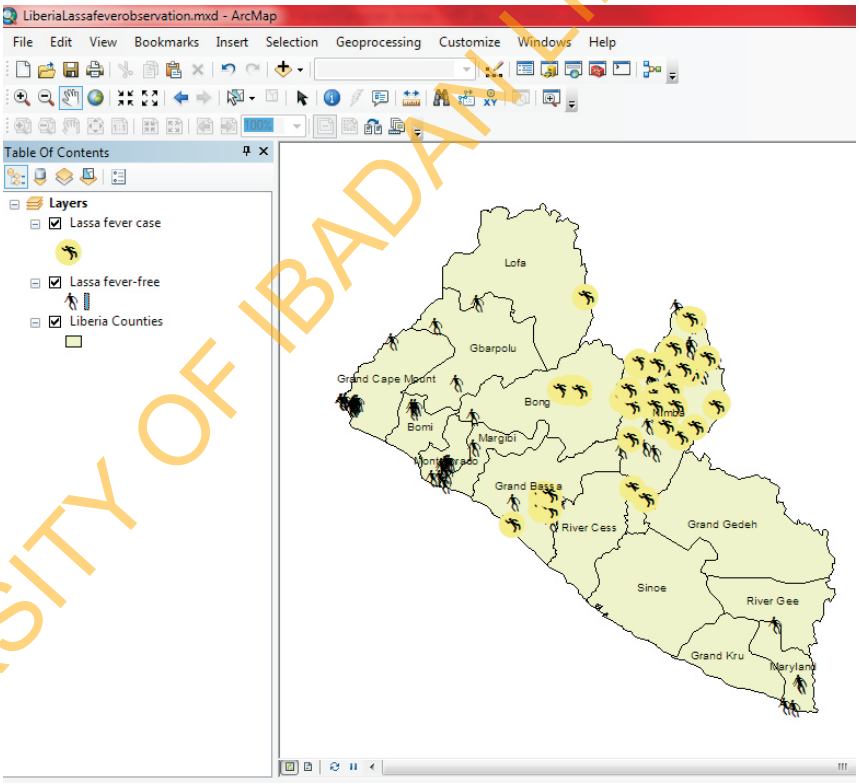


Figure 6.13: Screen view of Lassa fever cases and suspected cases, Liberia, 2008-2012

6.4.3 Open attribute table of Lassa fever case and control.

With the aid of the geographic coordinates, identify case location on Google Earth Pro. Are the activities found consistent with what is presented in the attribute table?

6.4.3 Use SaTScan software to detect high risk spatial clusters of Lassa fever in retrospectively mode:

(i) Create Case File: The file may be created by categorizing all l Lassa fever patients as case file.

(ii) Create Control File: The file may be created by categorizing all Suspected cases as control file.

(iii) Geographic Coordinate File: The geographic coordinates for each location ID of Lassa fever case and control in Liberia, 2008-2012 are used to create coordinate file from the original Excel format.

6.4.4 This ecological study is concerned with associations between the observed incidence of Lassa fever and potential risk factors, as measured on community basis, defined by geographical area, rather than individuals.

6.4.5 Disease cluster studies focus on identifying geographical areas with a significantly elevated risk of disease, or on assessing the evidence of elevated risk around putative sources of hazard. Uses include the target of follow-up studies to ascertain reasons for the

observed clustering in disease occurrence, or the investigation of control measures where the aetiology of observed clustering has been established.

Group 1 model examines the effect of environmental variables related to residential camp design by spatial scale in a local community environment. The model is computed with the geographic features of road, forest and hospital proximity to camp edge and human population density on camp. The spatial weight matrix is defined over 46 camps selected in the spatial cluster environment through a combination of purposive and stratified randomization.

The regression model is defined by:

$$y = \rho Wy + X\beta + \varepsilon$$

Where

y is an N by 1 Lassa fever case
ρ is the scalar spatial coefficient
Wy is an N by 1 weighted matrix of Lassa fever case
x is an N by k matrix of explanatory variables (X_1 is forest edge proximity to camp, X_2 is camp proximity to main road, X_3 is hospital proximity to camp edge, and X_4 is human population density on camp)
β is a k by 1 vector of parameters
ε is an N by 1 vector of random error terms

Group 2 model examines the effect of environmental variables related to vector-host-virus (LASV) dynamics by scale in the local environment. Compute the model with variables (identified based on Keenlyside *et al.*, 1983; Vander Waals *et al.*, 1986; McCormik *et al.*, 1987), namely distance to rice farmland, post-harvest storage density of rice, rodent deterrent density and refuse distance within camp. Spatial weight matrix is defined over 46 camps selected in the spatial cluster environment through a combination of purposive and stratified randomization.

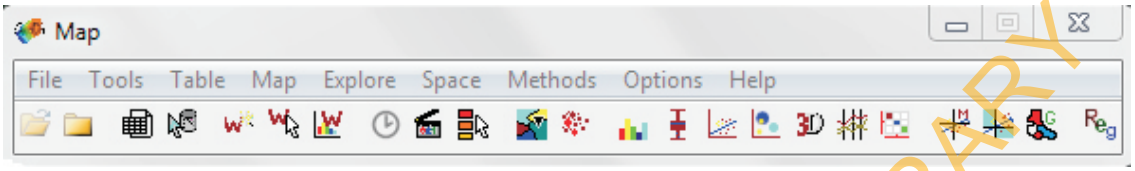
The regression model is defined by:

$$y = \rho Wy + X\beta + \varepsilon$$

Where

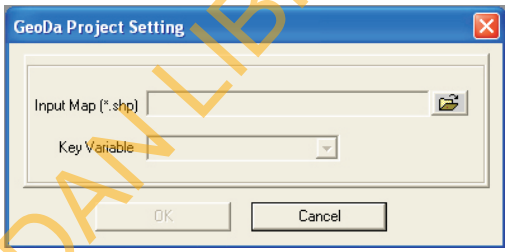
y is an N by 1 Lassa fever case
p is the scalar spatial coefficient
Wy is an N by 1 weighted matrix of Lassa fever case
x is an N by k matrix of explanatory variables (X_1 is rice farm proximity to camp, X_2 is density of post-harvest storage of rice on camp, X_3 is house proximity to refuse dump on camp and X_4 is density of rodent deterrents used on rice storage on camp)
β is a k by 1 vector of parameters
ε is an N by 1 vector of random error terms

A



6.4.6 Use GeoDa application software to run groups 1 and 2 models in turn. The analysis is carried out as follows :

B

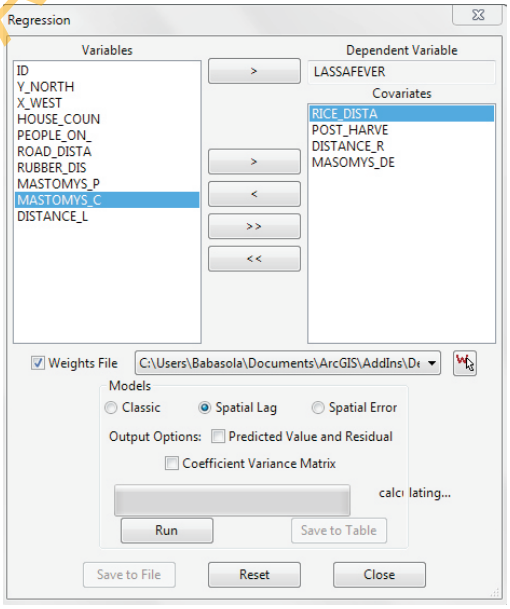


(i) Import ***shapefile*** into GeoDa by clicking on Open file (Figure 6.14A).

(ii) Click on Methods, select regression (OLS). The dialogue box (Figure 6.14 c) appears.

(iii) Select Classic (or Spatial Lag). Load the dependent and independent variables (Group 1 or 2).

C



(iv) Run the model.

Figure 6.14: Menu bar (A), dialogue box for opening shapefile (B), and for specifying dependent and independent variables in GeoDa

Compare OLS and spatial models using the Akaike Information Criterion (AIC), which examined overall model fitness and model complexity. The lower AIC value is a better result. Estimate spatial lag model by maximum likelihood (Anselin, 1988). The k-Nearest Neighbour (KNN) of 8 symmetric ***spatial weighted matrix*** (Figure 6.15) is used for ***Moran's I-test*** and Lagrange Multiplier (***LM) test*** against spatial regression specifications to evaluate OLS regression residuals for evidence of spatial auto-correlation. Spatial lag regression model incorporates spatial effects by including spatially-lagged dependent variables as predictors. Example of the results is shown in Table 6.6.

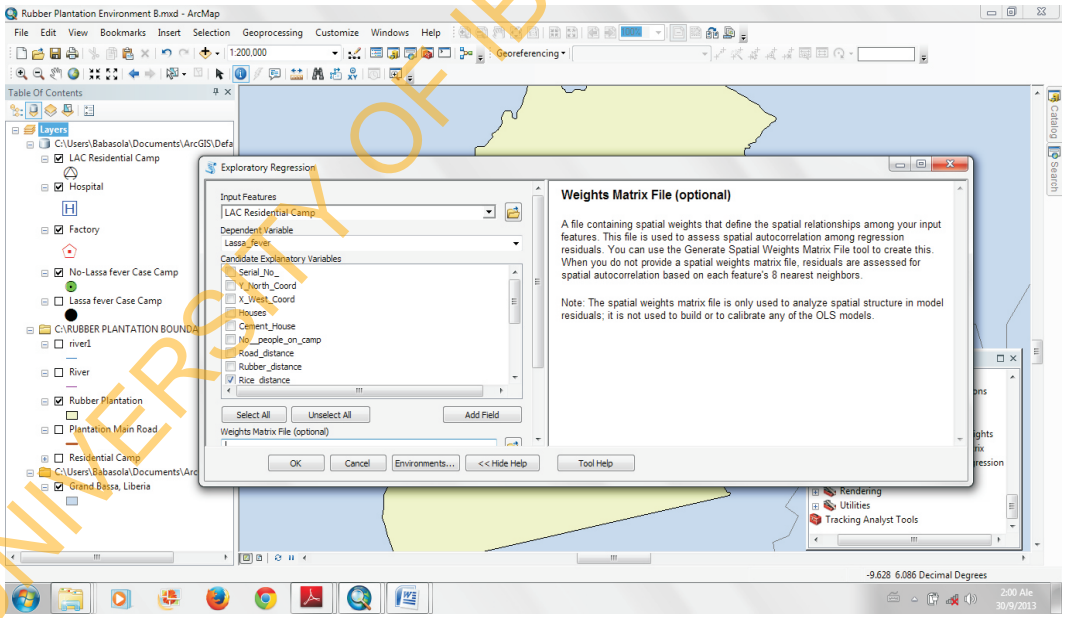


Figure 6.15: Dialogue box for generating geographically weighted-matrix on ArcMap 10.1

6.4.6 By now, you have combined at least four GIS software for geo-referencing and analysis of zoonosis data. They have enabled you to better understand the spatial distribution and risk factors associated with habitats for zoonosis. Where are the clusters of high risk located? Are they associated with farming communities? What are the crops at high risk of enabling spatial scale of Lassa fever transmission? How does knowledge of risk factors and spatial distribution of Lassa fever help you to establish necessary controls or take preventive action?

Table 6.6: Summary of ordinary least square (OLS) estimation parameters generated by GeoDa software package

Data set :	Camps		
Dependent Variable :	LASSAFEVER	Number of Observations :	46
Mean dependent var :	0.23913	Number of Variables :	5
S.D. dependent var :	0.426553	Degrees of Freedom :	41
R-squared :	0.850151	F-statistic :	58.1524
Adjusted R-squared :	0.835532	Prob(F-statistic) :	2.32465e-016
Sum squared residual:	1.25417	Log likelihood :	17.5787
Sigma-square :	0.0305894	Akaike info criterion :	-25.1575
S.E. of regression:	0.174898	Schwarz criterion :	-16.0142
Sigma-square ML:	0.0272645		
S.E of regression ML:	0.16512		

Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	0.02675262	0.07243751	0.36932	0.7137892
RICE_DISTA	-0.02852057	0.03388114	-0.8417832	0.4047926
POST_HARVE	0.03186008	0.01450835	2.195982	0.0338069
DISTANCE_R	-0.0067173	0.01053868	-0.6373949	0.5274106
MASTOMYS_D	0.1841702	0.02934774	6.275446	0.0000002

6.5 Habitat scenario for a neglected zoonosis

Many endemic zoonoses in West Africa fall into the WHO category of neglected zoonotic diseases (NZDs). The reason being that, at local, national and international levels, they are neglected. These diseases are stigmatised. They are thus covered up in secrecy as much as possible. The extent of their burden is usually not known. As a result, little or no public health resources are committed to controlling them. People living in poverty are affect mostly, with special aid needs.

A classical example of this scenario is seen in rabies in West Africa. Since most habitat scenarios in endemic zoonoses apply to neglected zoonoses, the practical exercise below therefore explores a case scenario of an urban and rural environment earlier started in Chapter 4 . Estimation of annual death due to rabies is provided.

6.6 Practical exercise

In this exercise, a dataset on human rabies and antibody levels against rabies among dogs in Ilorin city, 2012 is provided. You will convert site name of a case to map point. After conversion to map point, use the geo-referenced data to investigate spatial clustering of the disease. Performe further studies on the primary

cluster of cases to assess risk factors in the local area.

6.6.1 Retrospective datasets on rabies cases presented at a University Teaching Hospital in a Nigerian city is provided. See **Exercise 6d**.

6.6.2 Use Google Earth Pro® to convert site name to geographic coordinates in the dataset. Apply the menus on Google Earth Pro's toolbar.

6.6.3 Now create case, control and coordinate files of the dataset on dog-bite patients on SaTScan.

6.6.4 Perform purely spatial scan statistic on the dataset. Identify local areas of high risk of dog-bite and rabies among humans in the city.

6.6.5 Generate data to perform ordinary least square regression (OLS) on the dataset. Design two groups of OLS model. One group should examine community-design variables and selected variables based on vector-host interaction in terms of dogs, their antibody titre and garbage feed available in the local environment.

6.6.6 Use GeoDa application software to run groups 1 and 2 models in turn. Follow the steps in (Figure 6.14).

6.6.7 What are your findings? How does the OLS of Group 1

Spatio-temporal pattern of dog bite victims and rabies transmission in Ilorin, North-central Nigeria

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Abstract
Introduction: Rabies is endemic in Ilorin, Nigeria with outbreaks occurring every year. Increasing interest to implement more effective control and preventive measures necessitates more knowledge of the dynamics of the disease in the city. Geographic locations of dog bite victims were used to create spatial model of rabies exposure at the dog-human interface in Ilorin, a transit city of Nigeria, and to characterize associated environmental risk factors. Method: records of dog bite victims (DBV) among humans presented at the University of Ilorin Teaching Hospital from June 2002-December 2008 were reviewed and categorized into suspected, probable and confirmed rabies cases. Victim's residential addresses were converted to map points using Google Earth Pro environment. Spatio-temporal cluster pattern of DBVs and hotspots of rabies were determined using Kulldorff's space-time permutation model in the city. Chi-square test of significant difference in age groups and gender categories of DBV's was conducted at $p<0.05$. Result: A total of 152 DBVs were retrieved and verified. Some 17 (11.2%) victims were confirmed as clinical rabies with fatal outcome. There were 11(64.6%), 4(23.6%) and 2(11.8%) fatal cases in children (age 0-15year old), youth (16-30 years old) and adult (>31 year old), respectively. Spatial cluster ($p<0.001$) of DBVs and rabies exposure hotspot was identified at high income residential area. The major risk factors of rabies in Ilorin included unvaccinated dogs, free-roaming and stray within the city. Conclusion: we identified a spatio-temporal cluster of dog bite victims and hotspot of rabies exposure within a high income residential area of Ilorin city, Nigeria.
Key words: Rabies, Hospital records, Space-time cluster, Geographic pattern.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Detection of rabies virus antigen in apparently healthy dogs and bats slaughtered for human consumption in Enugu State, Nigeria

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Abstract

Introduction: The surveillance of rabies is important to ensure up to date information and mitigation of human exposure. There are different locations and trading places where dogs are sold, slaughtered and processed for human consumption in Enugu State, south-eastern Nigeria which are not often under surveillance by Anima Health and Public Health Authorities in the state. Method: A total of 104 heads of dogs and 50 heads of bats (two species namely; *Tadarida nigeriae* and *Eidolon helvum*, 20 and 30 respectively), were collected from Enugu West and Enugu East senatorial zones of Enugu State were dogs and bats are slaughtered as delicacy for human consumption. These were subjected to Fluorescent Antibody Test (FAT) for examination of rabies virus antigen. Positive samples were isolated in mice. The genotypes of positive specimens were determined. Results: Out of 104 dog brain samples collected, 7 (6.7%) of them using FAT and 6 (5.8%) of them using Mice Inoculation Test were found to be positive for rabies antigen. The findings of this work revealed that 6 (100%) of the M.I.T positive samples were genotype1 rabies virus (RABV 1). Out of the 50 bat heads obtained, none (0%) was positive for rabies antigen. Conclusion: This study provided further evidence that rabies virus exists in apparently healthy dogs. It also corroborates with perceived risks associated with dog selling business and possible rabies outbreak among dog sellers and consumers. This therefore calls for review of dog bite cases and institution of proper preventive vaccination for human and dog population.

Keywords: *Eidelon helvum*, Rabies, Slaughtered dog, *Tadarinda nigeriae.*

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

model compare with OLS of Group 2 model? Is there need for spatial lag regression on the dataset? Which of the groups of variables are better associated with spatial clustering?

6.7 Further readings

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Section 7

Molecular Diagnostic Methods in Zoonosis Surveillance

7.1 What is molecular diagnostic method?

Molecular diagnostic method is the use of nucleic acid molecules in the characterization and detection of the specific disease organism that is present in an individual or group of individuals. Precisely, the molecules that are predominantly engaged in this process are the deoxyribonucleic acid (DNA) and the ribonucleic acid (RNA). The two molecules bear endless information about individual agents of zoonoses.

Molecular diagnostic methods are especially valuable to surveillance of zoonoses because of their versatility which are brought to this field of activities, right from the stage of specimens collection to analysis. Molecular specimens collection method offers higher level of safety in handling zoonosis biohazards. FTA cards are particularly employed. All the way from pre-analysis, through analysis to post-analysis phases of molecular investigation; the methods offer speed and accuracy.

7.2 Exploring molecular safety features

Fast technology for the analysis of nucleic acid (or FTA cards) which comprise a cellulose-based matrix (filter paper) and applied certain chemicals, including chelating agent, weak base, detergent and uric acid, to enhance the preservation of nucleic acids by breaking cell membranes, denaturing proteins on contact, physically entrap nucleic acids, immobilize and stabilize them for storage at room temperature. In addition, the chemicals inactivate many dangerous pathogens that may be in biological specimens.

It is established that FTA protects nucleic acids from nucleases, oxidation, ultraviolet ray damage, microbial and fungal attack. Samples collected on FTA cards and enclosed in more than one layer of envelopes can be shipped through the post. This quality makes FTA card an extremely useful tool for field collection of blood, brain, saliva, and other biological specimens. CCPZ active surveillance across West Africa harnesses this in-built molecular safety feature (Figure 7.1).

Exploring this feature on the field, in transportation and laboratory storage reduces the risk of staff exposure to potential infectious pathogens remarkably. In spite of these safety features, wearing of gloves when handling FTA cards is compulsory to avoid contamination of the cards. When unused, the cards are kept cool and dry.

7.3 Molecular specimen collection method

Fast technology for analysis of nucleic acid works by rupturing of cells, releasing nucleic acids therein unto the card matrix. The nucleic acid is then entrapped within the card cellulose fibres. It is important to get nucleic acid-containing specimen into the card in the presence of moisture to activate cell-breaking and nucleic acid protective chemicals.

Why FTA is ideal for collection of nucleic acids, include its merit in a long storage life at room temperature. When nucleic acids are immobilised in the fibres of FTA cards they are stabilized for long term storage. Manufacturers of FTA cards have indicated stability of nucleic acids for over 2 years. Some other investigators have suggested that FTA cards may keep specimens for up to 12 years for RNA and 60 for DNA.

Figure 7.1: FTA card with specimens of dog brain collected in some West African countries and shipped to CCPZ laboratory, Ibadan, Nigeria.

7.4 Nucleic acid extraction method

The procedure for extraction of nucleic acids from FTA cards is as specified by the manufacturer. Below is a summary of the steps involved. Extraction kit (Figure 7.2) may also be used.

1. Cut out portion of FTA card where specimen is fixed. Place disc in capped micro-centrifuge tube.
2. Add 200µL of FTA purification reagent supplied in FTA extraction kit to the disc in centrifuge tube.
3. Incubate for 5 minutes at room temperature (manually agitate the tube will allow thorough mixing for reagent to effectively wash the disc).

Figure 7.2: Total ribonucleic acid (RNA) extraction kit (Aurum, Bio-Rad) is a pack of reagents that comprise RNA binding columns (A), capless wash tubes, 2ml (B), Capped microcentrifuge tubes, 1.5ml (C), capped microcentrifuge tubes, 2.0ml (D), DNase 1 (lyophilised) (E), lysis solution (F), low stringency wash solution (G), high stringency wash solution (H), Elution solution (I), and RNase-free DNase dilution solution (J).

NB: Aurum Total RNA extraction kit is not specific for FTA cards, it works well with the FTA card procedure here captured.

Lyssavirus surveillance in fruit bats in Ghana

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Abstract
Introduction: Bat populations among wildlife species in particular constitute a large and often under-investigated reservoir of infectious agents. The emergence and re-emergence of human and domestic animal pathogens are driven by a complex set of factors, most of them linked to the sharp and exponential rise in global human activity. Although rabies is endemic in Africa, there is a huge knowledge gab in the epidemiology of lyssaviruses due to lack of active surveillance and poor laboratory capacities. This study was designed to investigate presence of rabies and rabies-related virus antigens and antibodies, especially of Lagos bat virus (LBV) in Ghanaian fruit bats (*Eidolon helvum*) populations. Methods: Blood, brain tissues, urine and feces specimens were collected fruit bats (*Eidolon helvum*) populations in Greater Accra, Ghana. Samples were screened for LBV-neutralizing antibodies using a modified flourescent antibody virus neutralisation (FAVN) test. Virus antigens from brains of freshly killed (euthanized) bats (n=59) were tested using Fluorescent Antibody Test (FAT). Total RNA was extracted from brain specimens were tested for LBV using hemi-nested-RT-PCR. Results: Seroprevalence of 37% was found in *Eidolon helvum* for LBV exposure. All bats were negative for LBV antigens in brain tissue, urine and feces samples tested by RNA and FAT. Conclusion: Antibodies to Lagos bat virus were present in Ghanaian fruit bats population in Greater Accra region, indicating exposure of the species to this rabies-related virus in the natural environment.
Keywords: Lagos bat virus, Ghana fruit bats, RNA extraction, molecular characterization, epidemiology

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Control of rabies and rabies-related viruses in Nigeria: perspectives from the National Veterinary Research Institute

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Abstract
Introduction: Rabies is a neglected and under-reported zoonosis, caused by lyssaviruses. It remains a serious public health hazard in many developing countries, where dog bite is the main mode of transmission of the disease to humans. Rabies is preventable through vaccination of dog populations. There is need to determine number, distribution and ecology of dogs; promote responsible dog ownership; dog vaccination; depopulate stray dogs and sustain collaboration among all stakeholders. We review some recent activities of the National Veterinary Research Institute towards rabies control over one decade, 2002-2012. Method: At the National Veterinary Research Institute (NVRI) rabies diagnosis is carried out at no cost to clients. The diagnosis of rabies is based on Fluorescent Antibody Test (FAT), the WHO/OIE approved gold standard test for the detection of viral antigen and confirmation of rabies. Capacity and upgraded facilities for the Fluorescent Antibody Virus Neutralization Test (FAVNT); Rabies Tissue Culture Isolation Test (RTCIT); Monoclonal Antibody Typing (Mab Typing) and Reverse Transcriptase Polymerase Chain Reaction (RT-PCR). The NVRI produces egg-based rabies vaccines for the prevention of rabies in animals, especially dogs and cats. Results: rabies and rabies-related viruses with human exposures were notified and laboratory confirmed in 17 out of 36 States of Nigeria, including the Federal Capital Territory. Proportion of confirmed to suspected cases ranged from 50% to 72.3%. Conclusion: The National Veterinary Research Institute uses molecular detection to differentiate rabies from rabies-related viruses by policy and produces rabies vaccine for local use in pre-exposure prophylaxis of animals against rabies in Nigeria. .
Keywords: Rabies virus, Diagnosis, Control, Animal, Human, Nigeria

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

,

4. Remove and discard used FTA purification reagent from the centrifuge tube using a pipette.
5. When specimen is blood impression on FTA, steps 2-4 are repeated twice, making a total of 3 washes with FTA purification reagent. When the specimen is bacterial samples, repeat steps 3-5 once, making a total of 2 washes with reagent.
6. Add some 200µL of TE-1 Buffer (10mM Tris-HCl, 0.1mM EDTA, pH 8.0) to the PCR tube.
7. Incubate for 5 minutes at room temperature.
8. Remove and discard all used TE-1 Buffer with a pipette from the micro-centrifuge tube.
9. Repeat steps 6-8 once for a total of 2 washes with TE-1 buffer.
10. Remove all wash solution from the tube, so that it remains only nucleic acid band (RNA/DNA). Store in the refrigerator at -20°C or -80°C till use.

When a nucleic acid has been successfully extracted and purified, the next step is the amplification or making of copies of the target nucleic acid (DNA or RNA), or the attachment of multiple copies of a dye to a single Target copy of the nucleic acid.

7.5 The polymerase chain reaction

Each priority zoonoses has its optimal protocols. The RNA of rabies virus is used as a case study of PCR step, because of its ready availability at disease surveillance

national laboratories in West Africa and at CCPZ.

1. **Preparation of Complementary DNA:** RNA is usually unstable, so it must be converted to a stable form, the cDNA to store at -80°C, until PCR is conducted. Add some 10 pmol of forward primer Lys001 to some 5 µl of the total RNA and incubated at 94°C for 1 min only. Afterwards, allow the mixture to cool on ice block for 5 min. Conduct a reverse transcription for 90 min at 42°C on some 20µl of mixture specimen, by adding 4.5 µl 5X reverse transcriptase buffer, some 2.2µl of deoxy-nucleoside triphosphate mixture (10 mM), some 0.4µl of avian myeloblastosis virus (AMV) reverse transcriptase (20 U/µl), and some 0.4 µl RNase inhibitor (40 U/µl) only.

2. **Primary PCR:** The first step is amplification of 5 µl of the reverse transcription cDNA product. This is performed on a sample volume of 50 µl (Figure 7.3). Add 1X PCR buffer, that is, 1.5 mM magnesium chloride, to 200 µM deoxynucleoside triphosphates, and 7.5 pmol of Lys001, 7.5 pmol of primer 550B, and some 0.5U of AmpliTaq GOLD. Place the tube in thermal cycler (the PCR machine, Figure 7.4) and programme for the follo-. wing temperature in the second step (the denaturation). Perform the cycle 5 times at 95°C for 90s, 45°C for 90s, 50°C for 20s, and 72°C for 90s. Again run the cycle some 40 times at 95°C for 30s, 45°C for 60s, 50°C for 20s, and 72°C for 60s. At the last cycle being a single run at 95°C for 30s, 45°C for 90s, and 50°C for 20s,

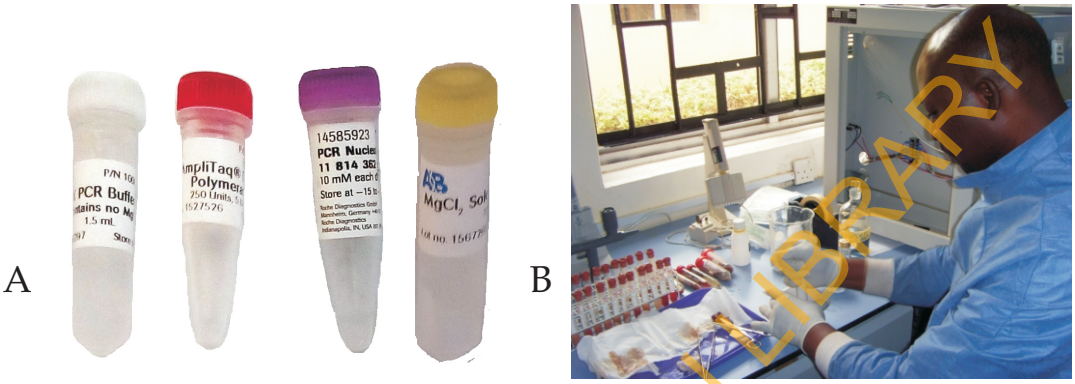

Figure 7.3: PCR reagents, including buffer, taq amplifier, magnesium chloride solution (A). Grinding tissues for nucleic acid extraction.

The extension step allows template to be coupled with primer at 72°C for 10 min. At this stage, the DNA polymerase synthesises a new DNA strand complementary to the DNA template. The genus Lyssavirus has rapidly expanded due to increase in molecular surveillance.

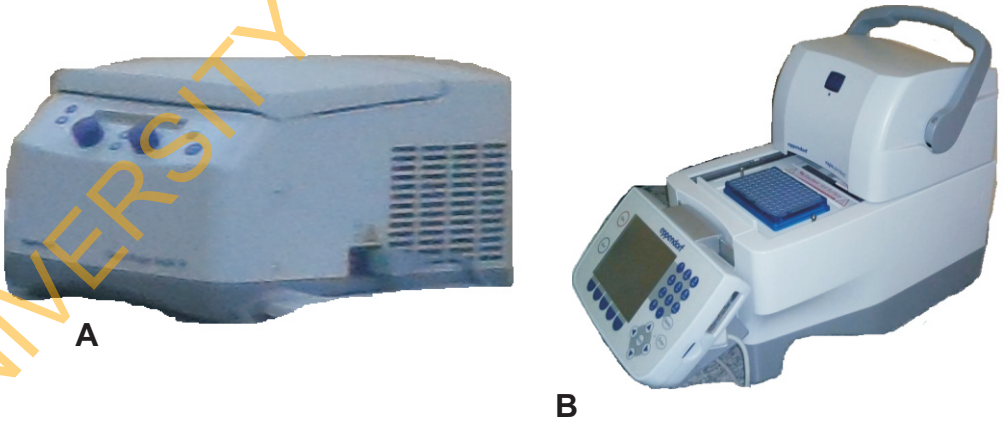

Figure 7.4: A cold centrifuge (A), and a thermal cycler (PCR machine) (B) are two major equipment in molecular detection of zoonoses agents.

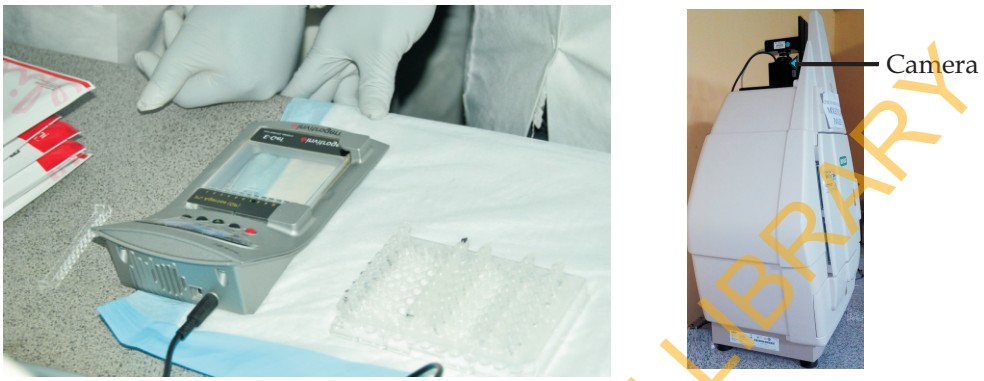

Figure 7.5: Electronic-gel electrophoresis (A), and digital gel imaging system (B).

Continual evaluation and modification of molecular detection method has been used to revise the PCR procedure to ensure effective detection of all the known rabies and rabies-related viruses.

3. **Secondary PCR:** For example, rabies genome may be detected using a heminested (HnPCR) procedure. It is advisable to follow the manufacturer's manual. In essence, 1µl of amplified PCR product is added to some 99µl RT buffer (10µl of 5X RT buffer, 2.2 µl dNTP mixture 10 mM, 10pmol forward primer 541lys [5´-CACMGSNAAYTAYAARACNAA-3´, position 541-561 according to the PV genome] and 12.5 pmol reverse primer 550B] and 0.25 µl AmpliTaq polymerase. Mix thoroughly by brief centrifugation in PCR tube. Place the tube in thermal cycler and programme for the . following temperatures: 94°C for 1 min, cycle reactions 40times at 94°C for 30s, 45°C for 30s, 72°C for 60s,

and at 72°C for 7 min. The gene is thereby multiplied.

4. **Gel electrophoresis:** After the PCR run, PCR product (amplicon) must be checked to confirm if there is any PCR product and if the product is of the desired size. This is done by running the product through an agarose gel stained with ethidium bromide and visualize using a trans-illuminator, gel imagery (Figure 7.5) .

7.6 Practical exercise

7.6.1 You are provided with brain specimens from clinical cases of suspected rabies in a girl. Investigate agent of the disease.

7.6.2 Extract the genome (DNA or RNA) from the specimens provided on FTA card.

7.6.3 Extract the RNA following the protocol here provided.

7.6.4 Conduct polymerase chain reaction to confirm (yes or no), your clinical diagnosis.

7.6.5 Conduct gel electrophoresis using 1% agarose gel on Invitrogen e-gel machine or any other available to you

7.6.6 Document the electrophoresis gel image using a trans-illuminator.

7.6.7 Present and discuss your findings with your supervisor.

7.7 Further readings

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5. Liang X, Chigerwe M, Hietala SK, Crossley BM (2014). Evaluation of Fast Technology Analysis (FTA) cards as an improved method for specimen collection and shipment targeting viruses associated with Bovine Respiratory Disease Complex. Journal of Virological Methods, 202:69-72..

Chapter 8

Harnessing Indigenous Knowledge for Zoonosis Surveillance

8.1 What is indigenous knowledge?

Indigenous knowledge is defined as knowledge-base that belongs to or originates from a place, acquired through experiences. Traditional societies in West Africa have their indigenous knowledge about human-animal diseases that enables them to comprehend ancestral-communal efforts that were established to generate socio-economic, physical and mental well-being. Local health values, in terms of attitudes and practices are arguably a reflection of their indigenous knowledge. It also reflected in their local preferences in health seeking behavior, usually developed in response to the local environment and conditions.

Indigenous beliefs, attitudes and practices form parallel institution to global health education, science and service, especially in surveillance of diseases and public health. This co-existence of diverse health beliefs in West Africa do not have the same knowledge-base and practices which demand understanding for comprehen-

sive unification towards community health. Harnessing these institutions justifies indigenization of human-animal disease surveillance in West Africa sub-region.

8.2 Indigenization of zoonosis surveillance

West Africa indigenous knowledge and practices about zoonoses are diverse and practically limited in documentation. Hence, there is a need to bridge the gap through higher education for the society to benefit from harnessed indigenous knowledge, community-by-community in West Africa. Systematic and methodical engagement of key informants (information sources) is a social method for documenting local knowledge and practices. Disease surveillance, education and research explore indigenous knowledge through a process that identifies relevant issues, such as community features, diseases, their symptoms, signs, treatments and outcomes. Local information on these features are documented and evaluated for knowledge about disease exposure, endemicity, points of geo-spatial and time integration and coordination for successful surveillance. Steps enumerated above constitute CCPZ protocol for indigenization of zoonoses surveillance.

8.3 Engaging key informants on local beliefs

Basic social science tools and methods are used to engage well-informed members of a local community

Indigenous knowledge and practices associated with rabies in Oyo State, Nigeria: imperative for one-health training at the University of Ibadan

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Abstract
Introduction: Indigenous knowledge (IK) drives and sustains indigenous communities toward achieving self-reliance in the areas of food production, healing, poverty alleviation, socio-cultural development, soil conservation and infrastructural development. Traditional African societies possess indigenous knowledge systems which enable the indigenous people to comprehend ancestral-communal efforts that have been established to generate socio-economic, physical and mental well-being (*àlàáfíà*), biological, technological, and spiritual development. This paper argues that Africa's health systems and higher education must be rooted in her indigenous knowledge for sustainability. Method: A combination of literature review, rapid key informant and in-depth interviews conducted in purposively selected communities in Oyo state was used to capture the knowledge and practices of indigenous people about rabies. The paper integrates the findings into current efforts of the University of Ibadan toward documentation and promotion of IK which gave approval to the Centre for Sustainable Development to run Postgraduate Diploma and Master's Degree programs in IK and Development, beginning from the 2012/2013 academic session. Results: Local farmers and hunters who kept and used dogs claimed that rabid dogs and their human victims were curable and regularly cured with local herbs (*apààsà, imí-èsù*, goat weed) and materials (àdí-èyan). Orthodox veterinary practitioners stated that there was no cure for rabid dogs but human victims were often treated preventatively following exposure to rabies virus in human hospitals. Conclusion: The importance of integrating indigenous knowledge and practices into one health curriculum is advocated for improving rabies surveillance in West Africa.
Key words: Rabies, higher education, global health education, collaboration.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Rabies control and prevention challenges in Nigeria: a commentary

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Introduction: Rabies is a neglected zoonotic disease in many developing countries, including Nigeria. Mostly, public concern and fears focuses on dogs as the source of rabies infection to humans and other domestic animals. Other sources of rabies infection with public health hazards include wild animals and bats. Mass anti-rabies vaccination and control of stray dog population are effective strategies at community level. This poster reviews some hindrances to rabies control and prevention in Nigeria. Method: We identified and reviewed major comments raised by multiple stakeholders as contributory to the absence of strategy and consequence failure of coordinated response for rabies control. The term control was considered to imply reduction in case occurrence, or rate of increase to a tolerable limit. Control of rabies is a major challenge faced by veterinarians and public health managers. Results: Factors identified to affect control and eradication of rabies were political neglect, dog migration, dog owners' attitude and irresponsibility towards vaccination, absence of cold chain, unavailability of vaccine and WHO recommended RIG, uncertain vaccine efficacy, existence of multiple hosts, existence of reservoir hosts, existence of healthy carriers, long incubation period, existence of rabies-related viruses, inconsistent vaccination programme and wrong vaccination regime, vaccine failure, use of low potency vaccines. Conclusion: shortage of quality rabies vaccines for both dog and human use in Nigeria, coupled with limited public health promotion of dogs and cats vaccination remain critical components of the neglect of rabies control and prevention in Nigeria. There is need for more political attention to rabies control.

Keywords: Rabies, Control, Strategy, Eradication, Nigeria.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

on local beliefs about immediate cause of individual zoonoses. Methods of ***rapid key informants interview*** (RKII) and ***in-depth key informants interview*** (IKII), coupled with other tools usually prove adequate to elicit needed information on local people's knowledge and practices about a disease, such as Ebola virus disease, rabies and Lassa fever.

Figure 8.1: Key informants interview in a local community. The interviewer holds writing materials (A) and a global positioning tool (B).

8.4 Engaging key informants on local attitudes

Similarly, social science tools and methods could be used to engage informed members of a local community on local attitudes about types of zoonoses, such as Ebola virus disease, rabies and Lassa fever. Some of the methods are RKII and IKII. Attitudes inquired include, common preferences in care-seeking behaviour associated with each disease.

8.5 Engaging key informants on local practices

The social science methods of RKII and IKII are applied in engaging purposively selected informed community members on local practices. Local practices inquired

Knowledge, attitude and practice about rabies exposure in Ile-Ife and environs in south-western Nigeria

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Abstract
Introduction: Rabies is a highly fatal disease with a case fatality rate of about 100%. Transmission of the disease occurs mainly following adequate contact of virus -laden saliva with broken skin but other rare means of transmission include via aerosol, neural and infected tissues. This study was carried out to assess the knowledge, attitude and practice about rabies in rural community around Ile-Ife. Method: The participants for this study were adults drawn by random selection from the 2 villages near Ile-Ife town. With the aid of questionnaires, information was obtained from a total of 50 adults. 75% of the respondents were male while 25% were female. Results: The ages of the respondents ranged between 45-65 years. They all know about rabies, however they are familiar only with signs of furious form of rabies hence the disease was called 'mad dog disease'. All the respondents knew that rabies is transmitted through dog bite. 50% keeps dogs for hunting and security purposes while the remaining 50% do not keep dogs. 60% of the respondents knew someone who was bitten by dog, out of which 15% said the person were taken to the hospital, 85% said the victims received traditional treatment. The antidote for the treatment of rabies by the respondents are salt, intestine of cobra, fresh okro, blood of the dog, 'aporo epa', herbal concoction, raw walnut used on the wound immediately after bite. All respondents claimed the local treatments were effective. Herbs were sourced from the wild. Conclusion: There is need for rural people to be properly educated about rabies so that they can avoid dogs, recognise potential exposures, report cases to hospital and pass on the knowledge to others.
Keywords: Rabies antidote, dog bite, traditional treatment, rabies exposure.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Knowledge, attitude and practice about animal bite and rabies exposure in Enugu, South-eastern Nigeria

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Abstract
Introduction: The threat of animal bites is a huge socio-medical problem and the issues surrounding it constitute a major public health concern. This study was carried out to find out the knowledge, attitude and practices (KAP) associated with animal bites and rabies exposure management in Enugu, Eastern Nigeria. Method: Questionnaire survey of knowledge, attitude and practices towards dog bite carried out among city residents, observing a stratified non-random sampling method that targets dog bite victims and dog owners. A total of 139 individuals received a semi-structured questionnaire administered. Out of these, 130 people responded. Key Informant Interview was carried out among consenting adults. Descriptive summary and categorical analysis of the gender, age and care-seeking preferences of the respondents were calculated. Test of significant difference in care-seeking preferences of dog bite victims and dog owners was conducted using Chi-Square test at $p<0.05$. Results: Some 86.92% of respondents indicated that they have heard about animal bites in their neighbourhood. Respondents acknowledged that the disease is a serious one but details known were infinitesimal. Treatment of wounds and receiving vaccination (28.8%) was the commonest treatment procedure; immediate intervention (55.77%) in treating victims was observed. Security (47.5%) was the commonest purpose for keeping dogs. 81.82% of the respondents had never received the rabies vaccination and only 32% felt it was an important vaccination to receive irrespective of being at risk or not. Conclusion: The knowledge and practices of stakeholders show some unique cultural and social practices which contributes to the outcome of dog bite victims exposed to rabies virus in Enugu.
Keywords: Animal bites, Knowledge, Attitudes, Practices, Rabies.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

include, geographic or environmental resources utilization in the treatment of each disease. In particular, IKII is used to guide the identification and geo-referencing of locally suspected risk factors of zoonosis.

8.6 Practical exercise

Influenza is a common human-animal disease in West Africa. In this exercise, you will investigate indigenous knowledge, beliefs, attitudes and practices about influenza. You will gather information about the local name of the disease, what causes it, its symptoms and signs, when it occurs, who are at risk and what may be used to treat it. At the end of the exercise, prepare a comprehensive report for your instructor to grade.

8.7 Further readings

1. Wahab B (2013). The importance of indigenous knowledge and practices associated with rabies in Oyo State, Nigeria: implication for global health training at the University of Ibadan. Epizootiology and Animal Health in West Africa 9 (2013):23-37
2. Oluwole OE, Emikpe BO, Olugasa BO (2012). Attitude of poultry farmers towards vaccination against Newcastle disease and avian influenza in Ibadan, Nigeria. Sokoto Journal of Veterinary Sciences 10 (1): 5-12

Chapter 9

Time-Series Analysis in Zoonosis Surveillance

9.1 What is time-series analysis?

Time-series analysis is a method of investigating how case frequency changes over time among humans or animals in order to draw meaningful information from data series, and to minimize error in conclusion drawn. The role of chance (probability process) in time-based data of zoonosis cases is evaluated in this method. Time-series data have a natural temporality order, making time series a special kind of probability process indexed by time (t). This is usually illustrated by the use of arithmetic graph of a series of zoonosis cases observed against time. The series is described in terms of outliers, troughs, or presence of turning points that may be pronounced on a time-plot. Usually, time plot is used to determine the components of time-series, including; (i) trend, (ii) seasonal movement, (iii) cyclical movement, (iv) irregular variation and (v) forecasting characteristics. Retrospective dataset on zoonosis cases among humans and animals are essential in the presentation of time-series for modeling zoonosis burden of a community, and forecasting zoonosis trend.

9.2 Exploring zoonosis case and time-plot

Time-series methods are essential in epizootiology practice. They are notably used to categorize diseases into emerging, endemic, epidemic and sporadic. The tools and methods used, starting from the collection, through organization, presentation and sorting, to analysis and modeling of case-series are explored in zoonosis surveillance. A simple time-plot of case frequency versus time as an independent variable is called a time-plot of zoonosis cases. Time-plot is used to establish the following terms and definitions:

i. Endemic: a disease that continues in a stable frequency of cases over a relatively long period of time. In other words, there is no noticeable increase or decrease in the prevalence of cases.
ii. Epidemic: an outbreak of disease, leading to an increase in the number of cases above the usual per time in a specified location.
iii. Sporadic: an outbreak of a disease that occurs suddenly and terminates promptly on a self-limiting basis.

Time-series analysis also promotes awareness and capacity building towards the ambitious goal of "arriving at the site of an outbreak before the pathogen."

Seasonal categorization of time-series data is a second

major exploration in zoonosis surveillance. Recent application of this method has produced clear description and categorical analysis of seasonal

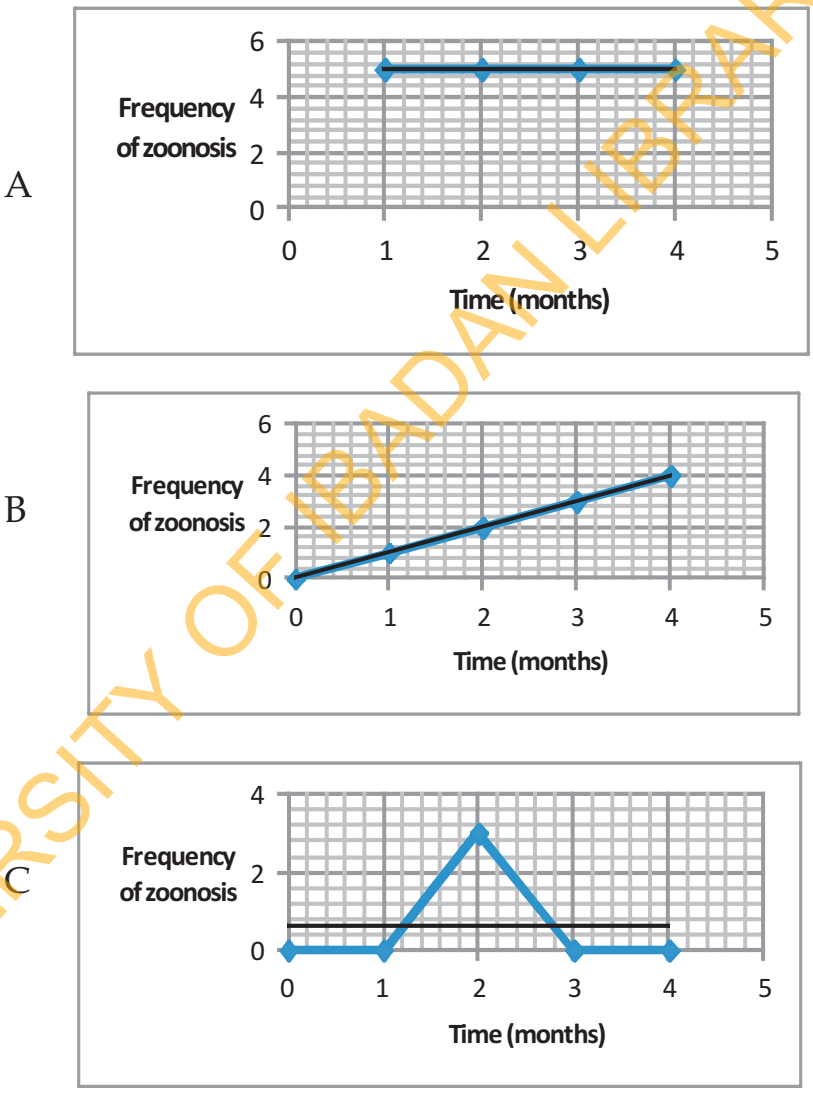

Figure 9.1: Graphic sketch (or time-plot) for an endemic (A), epidemic (B) and a sporadic (C) zoonosis.

Descriptive and categorical analysis of age, gender and seasonal pattern of dog bite victims presented for rabies exposure treatment in three cities of Liberia, 2008-2012

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Abstract
Introduction: Dog bite victims in three selected cities of Liberia, namely Buchanan; Gbarnga; and Voinjama were investigated in post-conflict period to determine age and seasonal distribution patters in the cities, 2008-2012. Methods: Dog bite records were retrieved from human hospital records in the cities, namely Liberian Government Hospital, Buchanan; Phebe Hospital and Nursing School, Suakoko; and Tellewoyan Memorial Hospital, Voinjama. Cases were reviewed, categorized into site of bite, victim's age, gender and seasonal occurrence [dry (October–March); wet (April–September)]. Chi-square test of significant difference was determined at $p<0.05$. Results: Four hundred and eighty-eight dog bite victims (DBVs) were validated at hospital level and were enlisted into the study. Site of bite ranged from the lower limb (n=178, 36.48%), head or face (101, 20.7%), multiple sites (97, 19.87%) and upper limb (72, 14.75%), to trunk and bottom (40, 8.20%). The highest number of DBV (150, 30.7%) involved children below 10 years of age, followed by the age group 11-20 years old (108, 22.13%), and 21-30 years old (51, 10.45%). The lowest number of DBV (31, 6.35%) was among individuals above 51 years old. Significant difference was established between male and female dog bite victims ($p < 0.05$) only among children 1-10 years old [male (91, 60.7%); female (59, 39.3%)]. More DBVs (53.28%, n=260) occurred in dry season than wet season (46.72%, n=228). Conclusion: More than half of dog bite victims presented for rabies exposure treatment were below twenty years of age, mostly male. Season of the year did not influence dog bite distribution in the three Liberian cities.
Keywords: Dog bite, hospital record, rabies exposure, retrospective data.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Development of a weekly model of dog-bite victims and rabies trend among humans in Monrovia, Liberia, 2010 – 2011

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Abstract

Rabies is considered a neglected disease in West Africa, of which very few published reports exist in post-conflict Liberia. The objective of this study was to develop trend model for predicting weekly cases of dog-bite victims (DBVs) and human rabies in Monrovia, Liberia. Secondary data were gathered at the only rabies referral clinic in Liberia, situated in the capital city, Monrovia and used to conduct retrospective study of 12 months (August 2010 – July, 2011) trend of post-exposure management of animal bite victims among human patients presented at the clinic. Data retrieved were classified into suspected, probable and confirmed cases based on WHO guidelines. A quadratic curve was used to estimate weekly trend of DBVs due to its superior performance (lowest Akaike Information criterion). A total of 388 animal bite victims were presented to the clinic over the 12-month period. Majority were DBVs (383/387, 98.71%). Of the dog-bite cases, 36.29% (139/383) were classified as probable cases of rabies exposure. Overall, about half of the DBVs (54.83% or 210/383) received treatment with human diploid cell strain (HDCS) rabies vaccine, while 22.98% (88/383) were treated with HDCS rabies vaccine in combination with EQUIRAB™ (equine rabies immunoglobulin). Classical rabies signs, including hydrophobia, delirium and fatal outcome were observed in 14 DBVs. A model equation of

Keywords: Case pattern, Dog-bite, Human rabies, Time-trend model.

Source: Ogunkoya AB, Suu-Ire R, Olugasa BO (ed.) (2014). Book of abstracts of the 2nd International Conference on Rabies in West Africa. Held 28-31 October, 2014 at the Institute of Local Government Studies, Madina, Accra, Ghana.

frequency of some priority zoonoses, including rabies and Lassa fever. Seasonal index is computed using the frequency of confirmed cases during the months of a year, categorized into rainy and dry seasons. Average percentage method, which involves the expression of specific zoonosis cases as a percentage of the total over retrospective number of years. Percentages for corresponding months (rainy and dry seasons) of different years are summarized. A categorical analysis, using chi-square method on expected versus observed frequencies, which assumes that there is no difference in number of cases between the two seasons of the year. A cyclical movement method sorts dataset into 52 weeks of a year for frequency analysis.

9.3 Exploring zoonosis time-trend model

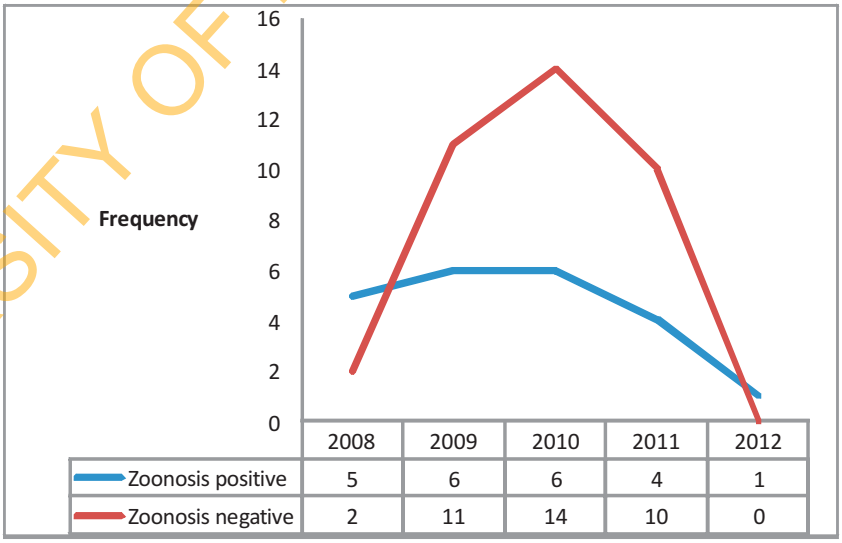
Time-trend model of zoonosis utilizes mathematical analysis of historic time-series data to determine future case pattern of disease. Mathematical models with the best goodness-of-fit for historic time-series data is trained to predict outbreaks during some future dates. Exploration of time-trend model assumes first, normal, then quadratic or geometric association between case of zoonosis and time. Where a quadratic relationship exists but is not accounted for, would lead to biased parameter estimates and incorrect inference. Thus, the selection of model is always to be based on a test of the goodness-of-fit. Time-trend model depicts relationship.

9.4 Estimating zoonosis trend parameters

Time-trend model examines the effects of trend-fit on time-plot of zoonosis cases. Parameter are estimated from best fit model equation. Then, parameters predictors are run on least square method to predict specific zoonosis trend-cases for a prospective 5 years period.

For example $T_t = b_0 + b_1 t + b_2 t^2$

Where,
T_t (trend value) is an N by 1 case
t is the time index/year
t^2 is the square of the i^{th} time/year
b_0 is the intercept
b_1 is the slope attached to time trend index/year
b_2 is the slope attached to the square of the i^{th} time/year.



	2008	2009	2010	2011	2012
Zoonosis positive	5	6	6	4	1
Zoonosis negative	2	11	14	10	0

Figure 9.2: Graphic sketch of time-trend curve of a zoonosis of unknown aetiology.

9.5 Predicting zoonosis case pattern

You will use the least squares method to appropriate model equations for predicting zoonosis case pattern. Statistical packages, including SaTScan, performs time-trend model estimation and computation by selecting prospective analysis mode (see Figure 9.3).

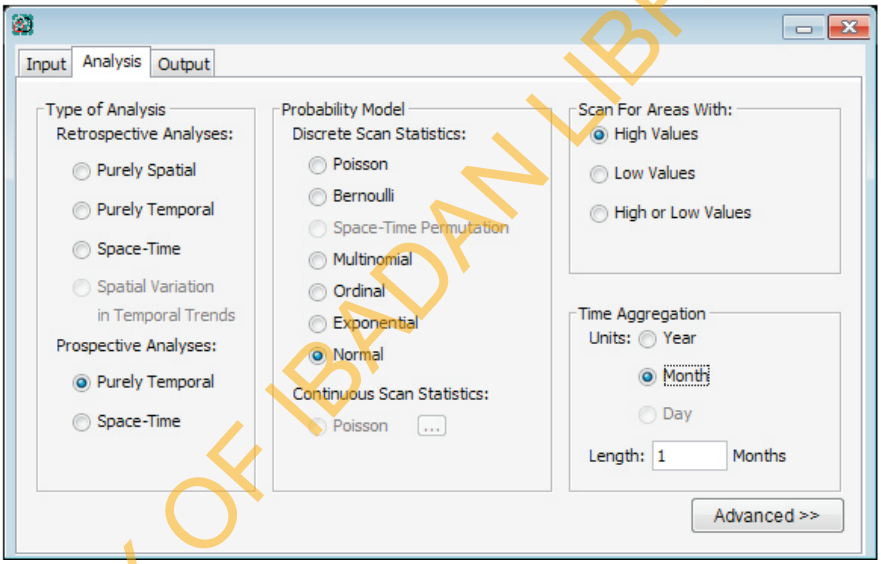


Figure 9.3: Screen view of SaTScan packagewith prospective time-trend options.

9.6 Practical exercise

In this exercise, a dataset on Lassa fever among people in a certain West African country in the year, 2008-2012 is provided. You will enter the data into SaTScan package and conduct forecast analysis. You will explain the results on a purely temporal scan statistics.

9.6.1

Retrospective datasets on Lassa fever surveillance at a National Zoonoses Centre of a West African country is provided in **ex9lf**.

9.6.2 Import the data from the spreadsheet provided, **ex9lf** into SaTScan package and safe as a case file.

9.6.3 Use dataset ex9ct to create control files of non-Lassa fever patients on SaTScan.

9.6.4 Perform purely spatial scan statistic on the dataset. Identify local areas of high risk of dog-bite and rabies among humans in the city.

9.6.5 Generate data to perform ordinary least square regression (OLS) on the dataset. Select Bernoulli as the probability model for prospective, purely temporal analysis (Figure 9.3).

9.6.6 Reset the analysis mode. Now, select retrospective analysis in purely temporal mode and probability model in Bernoulli. Follow the steps in (Figure 6.12).

9.6.7 What are your findings? How does the forecast (prospective) compare with the retrospective analysis? Is there need for control intervention against Lassa fever in the years ahead?

9.7 Further readings

1. Dogba JB, Cadmus SIB, Olugasa BO (2014). Mapping of *Mycobacterium tuberculosis* cases in post-conflict

Liberia, 2008-2012: A descriptive and categorical analysis of age, gender and seasonal pattern. African Journal of Medicine and Medical Sciences, 43 (Supplement1);117-124.

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5. Olugasa BO and Dogba JB (2015). Mapping of Lassa fever cases in post-conflict Liberia, 2008-2012: A descriptive and categorical analysis of age, gender and seasonal pattern. Annals of African Medicine, 14 (2): 120-122.

Chapter 10:

Monitoring and Evaluation of Zoonosis Prevalence

10.1 What is zoonosis prevalence?

Prevalence is a simple arithmetic measure of the proportion (ratio) of confirmed cases of a disease existing at a specific point in time, rather than new cases occurring over a period of time. The prevalence count is the number of individual humans (or animals) in a population (or group) that have an attribute or disease at a particular time. Zoonosis prevalence is the number of individual in a population that have a confirmed case of a human-animal disease at a particular time.

The prevalence ratio (P) (also referred to simply as prevalence) is calculated as $P = \frac{\text{case}}{\text{par}}$

where, case = number of cases of zoonosis in a population at a point in time
par = number of humans (or animals) in the *population at risk* at the same point in time.

For example, if you bleed 60 goats from a small ruminants' farm and test for brucellosis (Malta fever) and 5 test results are positive, *P* is:

$$\frac{5}{60} = 0.083 = 8.3\%$$

This indicator offers information about the burden of a zoonosis in a population, either within a local community or in a national population. However, the accuracy of zoonosis prevalence depends upon the accuracy of diagnosis. Prevalence is a scalar quantity in that it has magnitude but no direction attached to it, unlike geo-referenced data-profile of a zoonosis in an environment. Prevalence may be computed from investigation conducted by individual scientist or from a group of scientists, an organization, such as government agency dedicated to monitoring of disease (including zoonoses) prevalence.

The wide diversity of population subsets upon which prevalence may be based on farming units, such as poultry, piggery, cattle ranch, or community units, human household, street, district, town, city, state, there is the need to harmonize prevalence profile in the interest of public health. This chapter presents institutions at local, national and regional levels, saddled with the responsibility of monitoring the prevalence of zoonoses, albeit with notable challenges in West Africa.

10.2 Monitoring prevalence by local authority

Local authorities have units for public health and animal health. These units monitor the prevalence of zoonoses in the local community, including the abattoir, animal control post, dispensary, health and veterinary centres, human and veterinary clinics or hospitals. Local government animal statistics may include prevalence of human, animal and zoonotic diseases in local communities. Monitoring the prevalence within a local community is by compilation of annual records of these units. Among humans in a community, zoonosis prevalence is monitored by epidemiology and community health unit in a local government authority.

Gross pathology-based inspection of slaughtered animals at local abattoirs are used for computation of prevalence in animals in a community. Unfortunately, some sporadic reports on zoonosis prevalence by individuals or agencies have not proved to be very useful due to data limitations and the lack of completeness, or a standard methodology.

10.3 Monitoring prevalence by national authority

The Nigerian Institute of Medical Research (NIMR, established in 1977) and National Veterinary Research Institute (NVRI, established in 1924), were set up

Animal Health Club impacts rabies awareness promotion in Sierra Leone

Roland Suluku[1], Ibrahim Abu-Bakarr[2], Jonathan Johnny[2], Felixtina Johsyn-Ellis[3]
[1]Department of Animal Science, Njala University, Sierra Leone, [2]Department of Wildlife Management, Ecotourism and Bio-diversity Conservation, Njala University [3]Department of Biological Sciences, Njala University, Sierra Leone.

Abstract
Introduction: Rabies is a serious threat to animal and human health in Sierra Leone. It is however not prioritized in surveillance by the Ministries of Health and Agriculture. With inadequate medical and veterinary personnel, shortage of rabies diagnostic facilities, vaccines as well as lack of information on dog bite treatment, rabies exposure cases among humans in rural communities are often treated using local traditional medicines. The purpose of this study was to establish a correlation between selected one-health actions including awareness promotion about dog vaccination with dog bite victims outcomes in Sierra Leone. Method: Njala University Animal Health Club (NUAHC) teachers, students and pupils visited community households on selected weekends to monitor, provide advice, and conduct One Health actions on pre-designed bye-laws for control and prevention of rabies at human-animal interface. Data collection was based on mixed sequential explanatory design to explore impact of NUAHC awareness promotion about rabies control and prevention in dog population and post-exposure care-seeking preferences of humans bitten by dogs. Results: weekly rabies awareness education was held in 163 schools in six districts of Sierra Leone. Approximately 7,000 dogs were vaccinated between 2010 and 2012 in rural community households. Conclusion: The awareness brought about by teachers, students and pupils in participating communities and households provided access to veterinary public health services and inter-disciplinary collaboration. Although this may have yielded reduction in incidence of rabies among animals and their owners, human mortality due to rabies has not been empirically estimated following the Animal Health Club awareness campaign.

Key words: Rabies, human-animal interface, one health action.
Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Collaboration of Nigerian Federal Ministry of Health with higher education institutions in West Africa: strategy for achieving a more effective and efficient rabies surveillance programme

Olufunmilayo Sanni-Adeniyi[1&], Albert Ogunkoya[2], Babasola Olugasa[3]
[1]Federal Ministry of Health, Abuja, Nigeria; [2]Department of Veterinary Medicine, Ahmadu Bello University, Zaria, Kaduna State, Nigeria; Centre for Control and Prevention of Zoonoses, University of Ibadan, Ibadan, Nigeria.

Abstract
Introduction: Federal Ministry of Health, Nigeria has the mandate to ensure access and equitable dispatch of high quality health services and public health. It builds and conducts baseline surveillance of health and disease indices. There is need for partnership among higher education institutions in West Africa for effective and efficient rabies surveillance program. Methods: The MacArthur Foundation Higher Education Initiative in Africa supports the University of Ibadan and Ahmadu Bello University, Zaria (Nigeria) to improve postgraduate programs for human-animal disease surveillance over a 3-year period, 2012–2014. The collaboration of these higher educational institutions with the Federal Ministry of Health, Agriculture and departments in other universities, research institutes and private sectors in Ghana, Liberia, Sierra Leone, Mali, Niger, Chad and beyond is needed to broaden the scope of health services, public health surveillance and disease control in West Africa. The 2012 outbreak of rabies in southern Nigeria was a reference case for the institutions and the National Veterinary Research Institute, Vom. Results: Njala University (Sierra Leone), Cuttington University (Liberia); University of Ghana (Ghana) and the University of Ibadan (Nigeria), form the core of Anglophone West Africa network to strengthen expansion of research and training in surveillance of endemic, emerging and neglected zoonoses, based on a revised curriculum, joint teaching and supervision of research. Conclusion: Federal Ministry of Health, Nigeria in collaboration with Ahmadu Bello University and the Universities of Ibadan advanced its contributions to the promotion of rabies surveillance program and public health in West Africa.

Keywords: Collaboration, curriculum, one health, one West Africa
Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

respectively, to investigate human and animal diseases, conduct a wide range of research on diseases of public health and animal health importance in Nigeria and to develop structures for the dissemination of research findings as well as to provide facilities for health research and training in conjunction with the federal and state Ministries of Health and in collaboration with universities, allied institutions and organized private sector nationally and globally. The two major institutes conduct disease surveys and control programmes with grassroots independently. They engage village heads and other native authorities in monitoring activities, generating data on human and animal diseases, community by community. With network across the country, these agencies collect specimens for laboratory confirmation nationwide.

All member states of the United Nations (UN) are mandated to provide information through UN reporting platforms to UN Food and Agriculture Organization, the World Health Organization, and the World Organization for Animal Health (OIE) on their findings in monitoring the prevalence of reportable zoonoses within their territories. Such reports encourage UN prioritisation and allocation of resources to zoonoses control within national health systems. Such prioritisation is assisted not only by information on prevalence, but also by similar data on time-trend in

zoonoses-specific prevalence. The Nigerian Centre for Disease Control (NCDC, established in2001), builds national capacity for public health response.

10.4 Role of the National Zoonoses Centre

A considerable scientific effort to measure annual burden of zoonoses that is not immediately accessible from the more commonly available disease prevalence monitoring agencies of national and local authorities for national statistics is the role of the National Zoonoses Centre (NZC). The NZC promotes platforms for common standards between several animal health and human health authorities to provide comparable data profile on zoonises prevalence between subsets of national population. The NZC champions 'one-health' initiative, thereby facilitating research projects on prevalence monitoring, prioritization, creating logical framework for their control, prevention and ultimate eradication strategic plan, notably for brucellosis, influenza, rabies and tuberculosis.

The dual academic and professional roles of the NZC (established in Nigeria in 1982) were reinforced by the then Minister of Agriculture, Dr. Bukka Shuaib who engaged and supported the University of Ibadan, Faculty of Veterinary Medicine to host the Nucleus Laboratory of the NZC. The NZC was coordinated by the founding Head of the Department of Veterinary Public Health and Preventive Medicine, Professor

Gabriel Esuruoso. The objective was to design a National Zoonoses Data Management and Information System for gaining understanding of the prevalence of major zoonoses among people and animals in all ecological zones of Nigeria. Such zoonosis statistics on population subsets, including prevalence among abattoir workers, specific animal species handlers, in contrast to the rest of the population, such as secondary school teachers, primary school pupils, hunters, or high court judges should be particularly informative from a NZC. Thus, planning for national zoonosis control services

10.5 Role of higher education institution

Commitments of higher education to human-animal disease monitoring in West Africa have long been shown by the University of Ibadan. In 1982, the University provided a Nucleus Laboratory building for a NZC in Nigeria. Although subsequently plagued by political constraints and unable to deliver its mandate, in 2012, the University of Ibadan established CCPZ, in collaboration with some other oldest Universities in the sub-region. CCPZ advances the goal of a NZC. Focusing on educational objectives. CCPZ's goal to improve upon postgraduate programmes for surveillance of human-animal diseases, including setting up of learning centres and providing a platform for member states to share knowledge and tools across borders, conducting

Cumulative value of an improved one-health training program at the University of Ibadan, Nigeria

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Abstract
Introduction: One-health education has a goal towards multi-disciplinary and multi-sectoral collaboration for local, regional and global improvement of human, animal and environmental health. The approach incorporates and improves human-animal disease surveillance programs, connecting learning and practice at local, national and sub-regional levels. The cumulative vision and mission statements of one-health training at the University of Ibadan is yet to be defined. This paper aims to rekindle agenda for this task. Method: A review of curricula and instructional materials in human health and animal disease surveillance at the University of Ibadan was carried out to identify common and cumulative goals for rabies exposure education and management at the human-animal interface in West Africa, evaluate annual human deaths due to rabies and develop framework for eradication of rabies in one- health action. Results: Cumulative value of collaborative one-health action in human-animal disease surveillance is in the long and short term disease exposure trend, quality and quantity of disease exposure, impact and/or magnitude of independent action of private and public sectors on health education, science and service in West Africa. Rabies surveillance offers distinctive one-health curriculum adaptable to major endemic, emerging and neglected zoonoses in West Africa. Conclusion: A model one-health curriculum for disease surveillance in action at the University of Ibadan is proposed for rabies control in view of its cumulative value for sub-regional adoption and perspectives for dissemination in West Africa through the networking of Ibadan Centre for Control and Prevention of Zoonoses.
Keywords: Curriculum initiative, higher education, human-animal interface, rabies surveillance program

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

Human and dog rabies control: regional and global perspectives

Francois Meslin
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Abstract

Introduction: Rabies is widely distributed across the globe, with only a few countries (mainly islands and peninsulas) being free of the disease. There are marked variations from region to region and also from country to country regarding the impact of dog mediated rabies and the intensity of control activities. The Pan-American Health Organization's dog rabies control programme initiated in 1983 has eliminated human and dog rabies from most urban areas. There are only a few well-coordinated human and dog rabies control projects underway in Africa. It is therefore imperative to set up well co-ordinated human and dog rabies control programmes in Africa.
Method: A non-quantitative description of a one-health, one world model is here put into a perspective for West Africa. The World Health Organization has been combating the "cycle of rabies neglect" for many years through advocacy and promoting the use of new tools and activities for the control of rabies.
Results: While an average of two indigenous human rabies deaths is reported annually in the USA and most follow contact with insectivorous bats, dog-to-human rabies is predominant in most of the developing world where the greater burden of human rabies also falls. Likewise, the number of bat-to-human transmitted rabies cases has been increasing in Latin America in the past 10 years.
Conclusion: It may be summarized that the major reason why rabies tragedy is still going on today is that rabies is a disease which often affects people whose deaths are not heard about and not accounted for.

Keywords: Control, bat-to-human, dog-to-human, neglected disease, rabies.

Source: Ogunkoya AB, Sanni-Adeniyi OA, Olugasa BO (ed.) (2012). Book of abstracts of the 1st International Conference on Rabies in West Africa. Held 4-7 December, 2012 at the International Conference Centre, University of Ibadan, Ibadan, Nigeria.

zoonosis prevalence monitoring and prioritization.

Rigorous scientific research and publications emanating from the CCPZ have blazed the trail in achieving the objectives of the NZC. In sustaining manpower development in zoonosis monitoring, surveillance, control, prevention and eradication, CCPZ lends higher education commitments to develop local, national and sub-regional continuing education programme. In partnership with the Society for Epizootiology in West Africa (SEIWA), publishing of the journal of Epizootiology and Animal Health in West Africa is sustained as a peer-reviewed journal to meet sub-regional need.

10.6 Practical exercise

In this exercise, participants will compute prevalence of zoonoses from records of local authorities. You will evaluate the efficiency of record keeping format in support of monitoring and evaluation of prevalence at a local authority of choice. Participants will design logical framework for grassroots empowerment in zoonosis prevalence monitoring at the local community.

10.6.1 Embark on a direct visit to a community of choice in your neighborhood. Locate an epidemiology unit and or a local abattoir that serves the community.

10.6.2 Find out about record keeping facility that exists in the centre. What purpose does it serve? What data does it keep? Where does it report its findings to?

10.6.3 Count the number of cases of human-animal diseases that were diagnosed or suspected in the previous 2 years Calculate the prevalence of each human-animal disease.

10.6.4 How does your findings compare with the reported prevalence of each zoonosis among major population subsets in the community and in West Africa?

10.6.5 Compute prevalence of individual zoonosis along subsets of the community population at risk.

10.6.6 What can the community do in order to improve on zoonosis control in a way that harnesses their own self-support initiative?

10.6.7 Design a logical framework for empowering local abattoir and their authority in disease monitoring. Set goal statement for a project to effectuate the goal. Offer a purpose narrative for training of officers and building their skills through CCPZ opportunity. Set objectively verifiable indicators for motivating, and holding them responsible and accountable for outcomes of their actions, in ensuring a healthier community.

10.7 Further readings

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Section 3

Practical consolidation exercises

Chapter 11

Consolidated Practical Exercises

Consolidated practical exercise on human-animal disease surveillance provides case scenarios for investigation. Each of the scenarios combines the use of at least three out of five specialized tools and methods presented in this manual. Each exercise commences with a clinical presentation that serves as index. The goal of postgraduate education and a certificate of participation programme at CCPZ guarantees practised ability in one-health approach to the surveillance of zoonosis in each member country, facilitating geographic data management and analytical planning for zoonosis education and public health engagement in West Africa. Faculty and staff with core competence in one-health approach to zoonosis studies are drawn from Colleges of Human and Veterinary Medicine and allied fields to jointly mentor the participants (trainees) on in-country hands-on practical exercises.

Supportive specimens for wet laboratory investigations are provided by CCPZ for each consolidated exercise

here provided. Participants are divided into one-health groups to conduct the following exercises.

Exercise 11.1

A twenty-seven year old postgraduate student in animal science presented with cough, change in voice, progressive difficulty with breathing. He had worked at a cattle ranch where he agreed to meet with people that has chronic cough. He was there to collect data for his doctoral (Ph.D.) programme.

11.1.1 Who should be your target in investigating this problem to achieve 'one health' goal in surveillance and control and of the infectious disease?

11.1.2 You are provided with additional clinical examination reports and sputum specimens from the student and some other members of at-risk groups where he has spent considerable time during the exposure period. What is your clinical diagnosis about this disease?

11.1.3 Extract the genome (DNA or RNA) from the specimens provided and conduct appropriate molecular analysis to confirm (yes or no) your clinical diagnosis.

11.1.4 You are provided with the site names of the residence or work place of the student and each of the in-contact persons that their clinical specimens were provided. Convert the site names to map points and analyze the

spatial distribution of the disease.

11.1.5 Dataset on first date of presentation of illness to health facility for each of the cases in a community is provided. Plot a case-time curve of the disease and develop a time-trend model for prediction of cases of the disease.

11.1.6 Submit a comprehensive report on your findings.

Exercise 11.2

A paediatrician developed fever, headache, body aches and generalised malaise. Three days ago, he was involved in the management of a 12-year old boy from a remote village who died of a febrile illness, and whose younger brother had also died 10 days prior to his presentation due to fever and uncontrollable bleeding from body orifices.

11.2.1 Who should be the target in achieving 'one health' strategy for the control of the infective disease?

11.2.2 What should be the nature of data collection and information dissemination?

11.2.3 You are provided with additional clinical examination reports and serum specimens from the pediatrician, the

dead boy and some members of his family. What is your clinical diagnosis about this disease?

11.2.4 Detect antibody level against the suspected disease from the sera provided to confirm (yes or no) your clinical diagnosis.

11.2.5 You are provided with additional surveillance data about this case, with their site names. Convert the site names to map points and evaluate habitat suitability model for the spatial distribution of the disease.

11.2.6 Identify other locations in which this disease may be present within West Africa.

11.2.7 Plot a time-series curve of the cases you identified, and submit a comprehensive report on your findings.

Exercise 11.3

A girl (11-year old) was reported bitten by her family's dog. The bite occurred when she was feeding the dog. The wound was treated with antibiotics at a hospital as accidental. Some 5 months after, she developed nervous signs, characterized by behavioural changes, agitation, difficulty in swallowing, breathing, coma and death.

11.3.1 What specimens would be the target in confirming the diagnosis and instituting control of the disease?

11.3.2 What should be the direction of data collection and information dissemination?

11.3.3 You are provided with additional clinical examination reports and panel of specimens from the girl and dog. What is your clinical diagnosis of the disease?

11.3.4 Extract the genome (DNA or RNA) from the specimens provided and conduct appropriate molecular analysis to confirm (yes or no) your clinical diagnosis.

11.3.5 You are provided with the location of the community where the dog-bite occurred. What ethical considerations would you take to conduct interview about dog bite incidents in the community?

11.3.6 Conduct key informants interview to update the magnitude of dog-bite injury in the community. Determine the site of bite on victims' body, pre- and post-exposure treatment of victims, and the outcome.

11.3.7 Plot a time-series curve of dog-bite cases you identified and empirically estimate annual number of human deaths associated with rabies in the community.

11.3.8 Submit a comprehensive report on your findings.

In summary

The three consolidated practical exercises here provided enable a participant to explore the major tools and methods in disease surveillance, harnessing first; the investigation of persons (in terms of biomedical detection of case or non-case individuals, by way of diagnosis of a zoonosis); second being the investigation of the place (in terms of site name and its conversion to map point, cluster analysis and exploration of habitat suitability for zoonosis endemicity, emergence or epidemics); and the investigation of time factor (temporality, both in retrospective and prospective terms). These are the essential three competencies of disease surveillance for which a participant is required to develop competence.

Chapter 12

Mini Project

The goal of the mini project initiative is to actualize the training of personnel in a milieu of active surveillance and research activities that will enable hands-on learning of human-animal disease surveillance within the geographic context of West African countries. The high cost of prevention of such diseases as Ebola virus disease within the time-frame of epidemic indicated high importance attached to control policy against highly pathogenic zoonotic disease in West Africa.

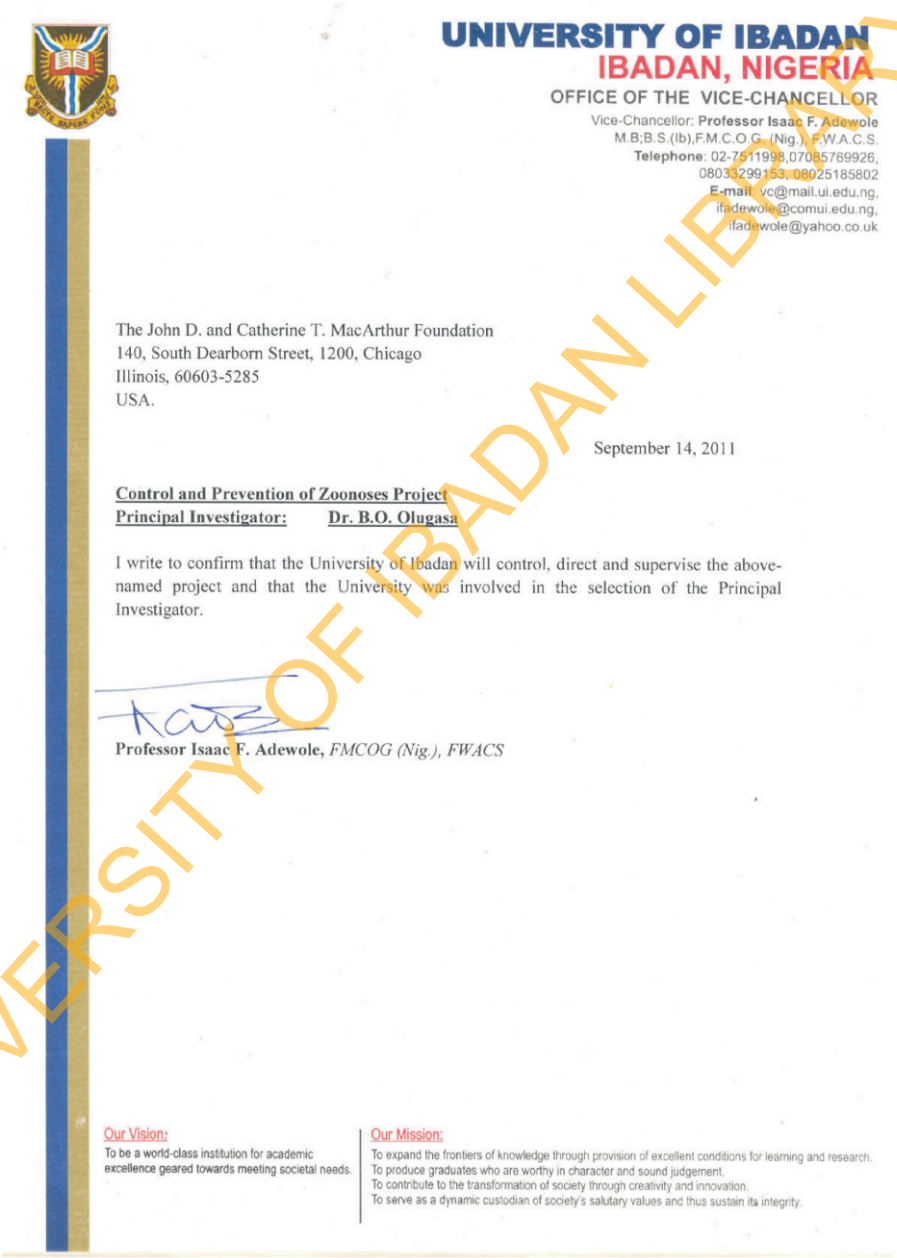
Conditions for ethical approval are pre-evaluated, pursued and satisfied, based on the initiative of CCPZ before a mini project is approved for implementation. Individual or group of participants are assigned to a panel of supervisors. Together with the supervisor, you will study the set of protocols already designed and approved for CCPZ by national board or tertiary education Ethical Board (see Appendix I-VIII). A mini project is conducted in collaboration with the Ministries of Health, Agriculture and the community. Indicate how local community livestock workers and community health officers in your choice community of study will facilitate the mini project.

The mini project networks with specific Societies for Epizootiology in West Africa (SEIWA), Rabies in West Africa (RIWA), Lassa fever in West Africa (LIWA) and others as they are instituted by the CCPZ network for effective and efficient sustenance of surveillance structure for human-animal diseases in West Africa. The mini project thus keeps contacts with private and government agencies, harmonize stakeholders and tools for the prevention and control of rabies, Tuberculosis, Lassa fever and Ebola in West Africa.

CCPZ short course in human-animal disease surveillance offers a semester of field and laboratory-based investigations of persons, place and time in the west coast of Africa. The accompanying mini project is internationally coordinated, offering opportunity for one-health and meeting specific goal and objectives of improving postgraduate programmes for human-animal disease surveillance in West Africa. As such, the mini projects from participation in CCPZ sub-regional courses must corroborate the vision of the University of Ibadan, being a world-class institution that strives to meet societal needs (See Appendices I - VIII).

CCPZ mini project must be of publishable quality in international journals. The journal of Epizootiology and Animal Health in West Africa is devoted to peer-review and publishing of quality articles in West Africa.

Appendix I



UNIVERSITY OF IBADAN
IBADAN, NIGERIA
OFFICE OF THE VICE-CHANCELLOR

Vice-Chancellor: **Professor Isaac F. Adewole**
M.B;B.S.(Ib),F.M.C.O.G. (Nig.), F.W.A.C.S.
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The John D. and Catherine T. MacArthur Foundation
140, South Dearborn Street, 1200, Chicago
Illinois, 60603-5285
USA.

September 14, 2011

Control and Prevention of Zoonoses Project
Principal Investigator: Dr. B.O. Olugasa

I write to confirm that the University of Ibadan will control, direct and supervise the above-named project and that the University was involved in the selection of the Principal Investigator.

Professor Isaac F. Adewole, *FMCOG (Nig.), FWACS*

Our Vision:
To be a world-class institution for academic excellence geared towards meeting societal needs.

Our Mission:
To expand the frontiers of knowledge through provision of excellent conditions for learning and research.
To produce graduates who are worthy in character and sound judgement.
To contribute to the transformation of society through creativity and innovation.
To serve as a dynamic custodian of society's salutary values and thus sustain its integrity.

Appendix II

The John D and Catherine T. MacArthur Foundation

September 30, 2011

Professor Isaac Folorunso Adewole
Vice-Chancellor
University of Ibadan - Nigeria
Office of the Vice-Chancellor
Ibadan Oyo State 200001
NIGERIA

Dear Vice-Chancellor Adewole:

It is my pleasure to inform you that the MacArthur Foundation has awarded a grant in the amount of $890,000 to the University of Ibadan to improve your organization's graduate training for surveillance of human-animal diseases in West Africa. The terms and conditions of this grant are described in the enclosed agreement. We ask that an authorized representative of your organization execute the agreement and return it to my attention. If you or your staff have any questions on the contents of the agreement, please contact Phillis Hollice, Program Administrator.

We wish you every success in your important work which we are pleased to support.

Sincerely,

Joshua J. Mintz
Vice President and General Counsel

Enclosure
Grant No. 11-97944-000-INP

140 South Dearborn Street, Suite 1200, Chicago, Illinois 60603-5285
Telephone (312) 726-8000 Facsimile: (312) 920-6258 www.macfound.org

Appendix III

UNIVERSITY OF IBADAN
IBADAN, NIGERIA
OFFICE OF THE DEPUTY VICE-CHANCELLOR (ACADEMIC)

A. Idowu OLAYINKA,
B.Sc. (Ibadan), M.Sc. (London), Ph.D.(Birmingham), DIC, FGS
Professor of Geophysics

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28 February, 2012

The President,
Cuttington University,
Suakoko, Bong County,
P.O. Box 10-0277,
1000 Monrovia 10,
Liberia,
West Africa.

Re: Memorandum of Understanding between University of Ibadan and the Cuttington University, Suakoko, Liberia

I write to forward two copies of the above-named agreement duly signed by our Vice-Chancellor and Registrar.

We appreciate your interest, and look forward to a full implementation of the terms Therein as we work together.

Thank you.

Sincerely,

O.O. Afolabi
Assistant Registrar
Office of the Deputy Vice-Chancellor (Academic)

Our Vision

To be a world-class institution for academic excellence geared towards meeting societal needs

Our Mission

To expand the frontiers of knowledge through provision of excellent conditions for learning and research.
To produce graduates who are worthy in character and sound judgement.
To contribute to the transformation of society through creativity and innovation.

CUTTINGTON UNIVERSITY

SUAKOKO, BONG COUNTY, P. O. Box 10-0277,
1000 MONROVIA 10, LIBERIA
WEST AFRICA

MEMORANDUM OF UNDERSTANDING
between
UNIVERSITY OF IBADAN, NIGERIA
and
CUTTINGTON UNIVERSITY, SUAKOKO, LIBERIA

This Memorandum of Understanding is made this ……27th… day of …**February**…… …… …..**2012**….. and written in the spirit of promoting international friendship and understanding by stimulating and supporting international activities and projects with emphasis on **Internationalisation of Higher Education**.

University of Ibadan, Nigeria a body corporate established by the laws of Nigeria (hereinafter called **HOME UNIVERSITY** and **CUTTINGTON UNIVERSITY** (hereinafter called the **COLLABORATING UNIVERSITY** do hereby agree to establish mutual co-operative relations and collaboration between both Institutions under the following provisions.

1. **Areas of Co-operation**

Subject to the availability of funds and approval of the President of the **COLLABORATING UNIVERSITY** and the Vice-Chancellor of the **HOME UNIVERSITY** or their nominees and in the interest of expanding and providing high quality education relevant to globalised work environments, the two Universities will develop programme of activities which are mutually beneficial in the following areas:

(a) Exchange of undergraduate and postgraduate students
(b) Exchange of Staff and Training
(c) Exchange of academic material and information
(d) Development of internationalized curricula
(e) Mounting of Joint internships and practical field courses
(f) Credit Transfer
(g) Development of Joint Degree Programmes
(h) Development and mounting of Joint Research programmes

2. **Implementation**

All programmes or activities implemented under the terms of this Memorandum of Understanding shall be mutually agreed upon in writing, including the necessary budget for the programme of activity as the need may arise.
The parties will designate one officer each who will develop and co-ordinate specific programmes or activities between them in line with the terms of this agreement.

3. **Covenants of HOME UNIVERSITY**

Provision of free transport fro and to the airport of arrival and departure to staff and students of COLLABORATING UNIVERSITY
Provision of free accommodation to staff and students
Provision of free tuition to staff and students

4. **Remuneration and Allowance**

Remuneration of staff and allowance of students shall be the responsibility of both parties in this Agreement.

5. **Disciplinary Matters**

All disciplinary matters shall be treated by the respective institution after a report would have been made by either party on any student or staff who has committed a misconduct while on this exchange programme.

6. **Duration and Renewal of Agreement**

This Memorandum of Understanding shall remain in force for a period of five (5) years from the date of the last signature and may be extended by mutual consent of the two parties for specific periods not more than five (5) years at each instance.

7. **Amendments of Memorandum of Understanding**

4.1 This Memorandum of Understanding may be amended by the exchange of letters between the two institutions or by signing of agreements specific to the areas of co-operation and collaboration between them.
4.2 Such amendments, once approved by both institutions will form part of this Memorandum of Understanding.

8. **Termination of Agreement**

This agreement may be terminated by either party giving a ninety (90) days notice to the other party in writing, provided however that such termination shall not affect the completion of any programme or activity underway at the time that the notice of termination is given.

9. **Dispute Resolution**

All disputes shall be resolved by conciliation, mediation and arbitration by the relevant laws of the HOME UNIVERSITY. Litigation will only arise where all these steps fail.

10. **Patency of Research Breakthroughs**

All research breakthroughs and publications shall be patented and protected by the relevant copyright laws of the countries in each institution. Profits shall be shared on 50-50 basis as coming from the research and publications.
This Agreement supercedes all earlier reached agreements understanding concessions and negotiations.

IN WITNESS WHEREOF the parties through their duly authorized representatives have hereunto set their hands the day and year first above written.

SIGNED AND DELIVERED
By the duly authorized representatives
Of the within-named HOME UNIVERSITY

VICE-CHANCELLOR

REGISTRAR

SIGNED AND DELIVERED
By the duly authorized representatives
Of the within-named COLLABORATING UNIVERSITY

PRESIDENT

REGISTRAR

Appendix IV

CUTTINGTON UNIVERSITY

SUAKOKO, BONG COUNTY
P. O. BOX 10-0277
WEST AFRICA

Email: cuttingtonuniversity@yahoo.com
Website: www.cuttington.org

OFFICE OF THE PRESIDENT

Dr. Walter Gweneewale
Honorable Minister
Ministry of Health and Social Welfare (MOH&SW)
Monrovia, Liberia

22 April 2013

Dear Dr. Walter

RE: CUTTINGTON UNIVERSITY AND UNIVERSITY OF IBADAN, NIGERIA JOINT MENTORING, EDUCATION AND RESEARCH PROGRAMMES ON "ONE WORLD, ONE HEALTH" INITIATIVE

Cuttington University is pleased to invite the Ministry of Health and Social Welfare (MOH&SW) to partner with her and the University of Ibadan, Nigeria in implementing the John D and Catherine T. MacArthur Foundation sponsored activities to improve graduate programmes for surveillance of human-animal diseases in West Africa. This support emphasizes collaboration between the Universities, the Ministry of Health and the Ministry of Agriculture in promoting national and sub-regional development.

Young career officers in the University, Ministry of Health and Social Welfare, Ministry of Agriculture and Cuttington University shall be supported on career development programmes to improve their skills in human-animal disease surveillance and risk management in Liberia. Cuttington University will jointly work with both Ministry of Agriculture and Ministry of Health and Social Welfare in recommending staff for higher education and short term trainings.

Cuttington University and the University of Ibadan, through their Colleges of Nursing, Agriculture, Medicine and Veterinary Medicine shall jointly design and supervise graduate student research projects at the M.Sc., MPhil-PhD and PhD degree levels on this program.

I thereby wish to seek your nomination of one Senior Administrator/Career staff to represent your Ministry on this program. In particular Director of National Public Health Laboratory and the Surveillance Officer shall be appropriate for their expertise.

I thank you most warmly.

Henrique F. Tokpa, Ph.D.
President, Cuttington University

Appendix V

CUTTINGTON UNIVERSITY

SUAKOKO, BONG COUNTY
P. O. BOX 10-0277
WEST AFRICA

Email: cuttingtonuniversity@yahoo.com
Website: www.cuttington.org

OFFICE OF THE PRESIDENT

Dr. Mrs. Florence Chenoweth
Honorable Minister
Ministry of Agriculture (MOA)
Gardenersville, Monrovia, Liberia

22 April 2013

Dear Dr. Chenoweth

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I thank you most warmly.

Henrique F. Tokpa, Ph.D.
President, Cuttington University

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Getting to Know Human-Animal Disease Surveillance in West Africa

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ISBN: 978-978-957-961-7
978-978-957-961-7 0