

PILOTING A WEB BASED RABIES SURVEILLANCE SYSTEM IN LUSAKA AND
KASAMA DISTRICTS

BY
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*A Dissertation Submitted to the University of Zambia in Partial Fulfillment of the requirements
For the degree of Master of Science in Tropical Infectious Diseases and Zoonosis*

The University Of Zambia

Lusaka

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I, Grace Tembo, student number 2019103788, do hereby declare to the senate of the University of Zambia that this dissertation is my original work and has not been submitted for a degree award in any other University

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Date

CERTIFICATE OF APPROVAL

This dissertation by Grace Tembo has been approved as fulfilling the requirements for the award of the degree Master of Science in Tropical Infectious Diseases and Zoonoses by the University of Zambia

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ABSTRACT

Rabies is one of the most feared Zoonoses, nearly always resulting in fatal acute encephalitis. In humans, the incubation period of rabies is highly variable, ranging from days to years, with an average of 2–3 months. At the moment, rabies is underreported in humans at a rate of 1:60, and this rate may even be much higher for animal rabies incidence. There is huge potential for mobile technologies to improve health care and public health service delivery especially in resource-poor settings. Utilization of mobile phones and ICT technologies to improve disease surveillance in public and animal health has been reported in other countries, including China, Madagascar, Uganda, and Kenya.

The cross-sectional study was applied with a sample size of thirty-six (36) veterinary clinics and districts health offices. The study was carried out in three stages; (i) evaluation of the surveillance tool before piloted; (ii) Piloting the tool; and (iii) assessing tool's effectiveness in rabies surveillance after being piloted. The study used semi-structured questionnaires to assess the effectiveness of the tool in rabies surveillance. Quantitative data was coded, manually processed, entered and analyzed using computer software SPSS version 16.

Most respondents 50% (18/36) indicated that the tool was easy to use and 55.6%, (20/36) indicated that the tool was very important in rabies surveillance. Of the 32 respondents, 21 (65.6%) of them Agreed that the tool facilitated timely reporting and 53.1% (17/32) agreed that the surveillance tool facilitated completeness of reporting, most respondents 50% (18/36) agreed that reporting using this surveillance tool can be a cheaper way of notifying an outbreak. The Tool was also assessed for data quality improvement and most of the participants, 47% (17/32) agreed that the tool can help improve data quality.

The study looked at piloting the rabies surveillance system and the design of the system promotes the integration of Public Health and Animal Health Surveillance. The study deduced that the tool was easy to operate, facilitated timely and completeness of reporting, was cost effective and improved data quality. As a result, it has great potential for use as a highly effective tool in rabies surveillance. Implementation of low cost mobile technology in rabies surveillance which can be used offline and without a smart phone in order for surveillance to be cost effective.

DEDICATION

This study is dedicated to my family members and most importantly my husband and my mother who supported me throughout my postgraduate studies.

ACKNOWLEDGEMENTS

In the first place, I thank God Almighty for his grace and according me an opportunity to do my study successfully.

My sincere gratitude goes to my principal supervisor Dr. Walter Muleya, Department of Biomedical Sciences, School of Veterinary Medicine, University of Zambia, and my Co-Supervisors Prof Boniface Namangala, Director, Institute for Distance Education, The University of Zambia and Eng. Katumbi Nyundu.

Special thanks goes to the ACEIDHA project for awarding me the scholarship to pursue this Master's degree.

Additionally, many thanks goes to Ministry of Health and Ministry of Fisheries and Livestock for availing data to me on rabies control as well as to veterinary clinics which participated in this study. I also appreciate the many helpful suggestions received from my course mates, my husband for supporting me through out and my colleague at work Mr Arnold Mwisa for the support.

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4 LIST OF ABBREVIATIONS

ACEIDHA Africa Centre of Excellence for Infectious Diseases of Humans and Animals

CDC Centre for disease control

CSS Cascading Style Sheets

DHO District Health Office

EDC Electronic Data Capture

EHT Environmental Health Technician

HIS Health Information System

HTML Hypertext Makeup Language

HTTP Hypertext Transfer Protocol

ICT Information and Communications Technology

MOH Ministry of Health

MFL Ministry of Fisheries and Livestock

MySQL My Structured Query Language

PHP Hypertext Preprocessor

TDR Tropical Diseases Research

UNICEF United Nations International Children and Education Fund

UNZA University of Zambia

WHO World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

Rabies is one of the most feared zoonoses, nearly always resulting in fatal acute encephalitis (Hemachudha et al., 2002). It is a viral disease, belonging to the Lyssavirus genus of the Rhabdoviridae family (WHO 2013, Hemachudha et al., 2013) whose pathology is characterized by an acute inflammation of the brain in both humans and other warm-blooded animal leading into neurodegeneration (Fekadu, 1988). The most common animal reported to be rabies positive is the domestic dog.

In humans, the incubation period of rabies is highly variable, ranging from days to years, with an average of 2–3 months, being influenced by location, extent and depth of the wound, distance between the location of the wound and the central nervous system, concentration of inoculated virus particles and virus strain. The incubation period in children tends to be shorter than adults (Despond et al., 2002).

With an estimated 60,000 fatalities per year, mostly in developing nations, this disease continues to be a global public health concern. Rabies is still a tropical disease that receives little attention from governments and has few effective control measures in many nations. At the moment, rabies is underreported in humans at a rate of 1:60, and this rate may even be much higher for animal rabies incidence. (Léchenne et al., 2016).

Early detection of disease outbreaks using appropriate surveillance methods is a basic principle for effective reduction and control of epidemics (Pavlin et al., 2003). The enzootic status of rabies

is brought about by uncoordinated and poor reporting system, untimely detection of rabid animals which serve as vehicles for transmission of rabies virus to humans through bites and poor mapping of endemic areas (Kipanyula, 2016)

There is huge potential for mobile technologies to improve health care and public health service delivery especially in resource-poor settings (WHO, 2011, Free et al., 2013, Tomlinson et al., 2013). Mobile technologies are ideally suited for surveillance, a fundamental component of health systems critical for measuring the progress of disease control and prevention measures, for appropriate targeting of resources and for elimination of infectious diseases (Henderson, 1976). Successful surveillance depends on timely and comprehensive gathering of information to assess disease status, determine appropriate control strategies, and monitor their impact (Mghamba et al., 2004).

Mobile phone use is widespread, inexpensive, and growing rapidly worldwide, especially in Africa (De Vriendt et al., 2002, Mtema et al., 2016). Mobile phone-based health applications have also increased and can be used to deliver scalable interventions, customize care, and personalize treatment at a low cost (Free et al. 2013; Mtema et al., 2016). They can also be used to encourage interaction among front-line staff, program managers, patients, and communities. In order to increase rabies surveillance, the goal of this study was to pilot a web based rabies surveillance system.

1.2 Statement of the Problem

Surveillance is poorly resourced, particularly in developing countries lacking good infrastructure and especially for zoonosis which require combined veterinary and medical capacity and collaboration (Townsend et al., 2013). Furthermore, lack of proper diagnostic facilities often limits rabies surveillance, weak field capacity for investigating cases and poorly functioning reporting

networks is perhaps a more enduring problem (Halliday et al., 2012). In Zambia the logistics of reporting dog rabies appears to be inefficient due to the ambiguity procedure that needs to be followed before the victim could undergo treatment (SEARG/WHO, 2001).

Rabies appears to be endemic in all provinces of Zambia and comparing the period 1984-2004, there has been increase in reported human rabies cases. Additionally, the increasing trend is from 0.20 per 10000 in 2004 to 4.24 per 10000 in 2013 (Babaniyi O. et al., 2016).

According to personal communication, reporting of rabies cases and complaints of dog bites is currently being done using a surveillance form which is in hard copy. In addition, most health facilities do not have computers hence data is shared and stored as hard copy. In the case of facilities that have computers, data is shared both on hard copy and through an email and stored as such. Additionally, health facilities in Kasama reports using a surveillance form which is hard copy and captures data and shares it on Whatsapp (personal communication). This type of reporting system is expensive and can cause delays as it requires an officer to travel from a facility to the district health office. Furthermore, data can easily be misplaced and a computer can crash hence reporting and sharing with stakeholders may be incomplete resulting in negligible timely feedback.

Weak surveillance may therefore result in delayed control interventions and complacency (WHO, 2005) and can jeopardize chances of disease elimination (Henderson, 1976). Furthermore, most surveillance in Zambia is paper-based, poorly incentivized, and results in delays, limited reporting, inaccurate data, and costly processing. Unless an effective reporting and surveillance program is developed, there is no prospect for a successful eradication program (Henderson, 1970).

1.3 Rationale of the study

Surveillance of both human and animal rabies is essential to detect high-risk areas and outbreaks quickly and to monitor the use of vaccine as this has potential to yield a net economic benefit, since the reductions in adverse health effects and health care costs outweigh the costs of undertaking the interventions (WHO 2011).

There is a gap in rabies surveillance where mobile technology is concerned in Zambia and this study addressed those gaps. Despite the estimated low number of vaccinated dogs in the country and increase in number of notified dog bite cases (Mulipukwa C.P et al., 2017), there are no studies that have been conducted on piloting a web based rabies surveillance system. Consequently, this study aims at piloting a Web Based Surveillance System to Intensify Rabies Surveillance in Lusaka and Kasama Districts. Furthermore, implementation of the surveillance system can improve and coordinate reporting system, timely detection of rabid animals, identifying areas most at risk and prompt response to treatment and prevention strategies.

1.4 Study Objectives

General Objective

To pilot a web based rabies surveillance system in Lusaka and Kasama districts

Specific objectives

- a) To evaluate the Web based Rabies surveillance system before it is deployed.
- b) To assess the effectiveness of the Web based Rabies Surveillance system

1.5 Significance of the study

This study is important because disease surveillance is the Focus of disease prevention and health promotion. Ill-health does not only lead to poor quality of life of people but can also lead to hindered personal and national development as people spend time and resources on procuring treatment. Preventing sickness among people and securing disease free population is critical. For the Zambian government, management over a healthy nation makes running the affairs of the state cheaper because the scarce resources are made available for other socio-economic activities.

Furthermore, the study will also add to the already existing body of knowledge in the area of rabies surveillance as well as surveillance of other zoonotic diseases. Additionally, the web based mobile App is prime as it will facilitate near real time reporting of animal bites and human and animal vaccine use, improve data quality, timeliness, and completeness while reducing costs. This may have direct influence on the health system as policy makers may use this knowledge to intensify surveillance in Zambia. The findings will also be useful to other stakeholders such as the general public as it will provide the information they need to fight against human and animal rabies.

1.6 Scope of the study

This study describes the incorporation of a web based surveillance system into rabies control activities in Zambia to not only gather field data relevant in intensifying rabies surveillance, but also to identify specific geographic areas that are endemic to rabies and coordinate education and vaccination activities in these areas. The study will also demonstrate the feasibility of the system to pave way for effective and efficient country wide sharing of rabies surveillance information. This will favor even those in remote areas as reporting of rabid cases will be quick and cost effective. If this approach is rolled out more extensively across Zambia, this surveillance strategy has the potential to significantly reduce the incidence of rabies in both dog and human populations.

CHAPTER TWO

LITERATURE REVIEW

2.1 General overview of Rabies

Rabies has existed for more than 4,300 years making it one of the most typical zoonoses known through the ages. The virus is a member of Lyssavirus genus of the Rhabdoviridae family (De Mattos et al., 2001, MacLachlan et al., 2011). In Southern Africa, 4 genotypes of the lyssavirus, which cause rabies, are endemic. The most common is Genotype 1 (Rabies virus, RABV). Others are Genotype 2 (Lagos bat virus, LBV), Genotype 3 (Mokola virus, MOKV) and Genotype 4 (Duvenhage virus, DUVV). European bat lyssavirus-1 (genotype 5), and European bat lyssavirus-2 (genotype 6) have been isolated in Western Europe, including countries that are considered free of classical (genotype 1) rabies (Barret, 2004).

2.2 Epidemiology

Dogs are the main reservoirs for rabies and usually infect by an unprovoked bite. Wild mammals such as foxes, raccoons, skunks and wolves are also reservoirs in certain countries and lyssavirus infection of bats has been detected everywhere it has been sought. Canine rabies virus causes 99% of the human deaths (WHO 2013). All mammals are susceptible to rabies and are potential carriers including cats, other domestic animals but rarely monkeys while Bites by rodents carry a very low risk (Gautret P et al., 2014). Previous data have shown that, approximately 59,000 human deaths are caused by rabies per year globally. Of those, 24,000 occur in Africa where rabies has the highest per capita death rate (Hampson et al., 2015). In Zambia, approximately 15,000 dog bite cases and 50 human deaths caused by rabies are reported annually, hence per capita death rate (per 100,000 persons) is estimated to be 0.19 (Hampson et al., 2015).

2.3 Rabies Management

Partly documented cases of human rabies survival, reported over the last 40 years, have provided optimism that rabies encephalomyelitis is probably treatable. Nevertheless, there has been no precise remedy that has proved effective. Rabies of canine origin remains 100% fatal in unvaccinated people. Patients ought to be admitted to health facility in order that their agonizing signs and symptoms can be palliated with adequate doses of analgesic and sedative drugs (Jackson A.C. et al., 2003). Those contaminated by patient saliva should be given prophylaxis. Hospital staff are vaccinated for reassurance. Intensive care may be appropriate in previously vaccinated patients, or those infected by an American bat virus, especially those presenting early with detectable rabies antibody (Warrel M.J and Warrel A.D 2015).

2.4 Rabies Control

The vaccination of dogs against rabies is now regarded as the most effective rabies control strategy, combined with strict dog population control via restricted breeding, restricted movements and culling of unwanted dogs especially stray dogs (Lembo et al., 2010). In Zambia, rabies control is enshrined in the Animal Health Act and Public Health Act which stipulates that animal owners vaccinate their animals against all scheduled or notifiable diseases (Animal Health Act 2010. Act. No.27, Public Health Act Cap 295). Rabies mass vaccination campaigns targeting at least 70% of the population over consecutive years have the ability to interrupt rabies transmission chains amongst dogs while those lower than 30% offer little protection (Lembo et al., 2010).

2.5 Disease Surveillance Systems

Successful surveillance depends on timely and comprehensive gathering of information to assess disease status, determine appropriate control strategies, and monitor their impact.

Community-based disease surveillance strategies have the potential to benefit from improved data quality and access, given the current increased trend in the penetration of smartphones and ownership, as well as universal Internet access by rural communities. The use of paper-based system to record and submit health events data in resource-poor countries contributes enormously to delayed response. Traditional passive surveillance systems typically rely on data submitted to the relevant public health authority by various healthcare providers (Milinovich et al., 2014). This process is often expensive and inefficient as substantial delays between an event and notifications are common, resulting in an incomplete account of disease emergence. Such limitations of traditional surveillance systems are a shared concern worldwide.

It is also common practice in African cultures that the health care pathway does not start off at official health facilities but rather at home or traditional healers. Thus, most health events within communities are not captured in the official health surveillance system. The quest for an early warning system calls for community members to be directly involved in the surveillance and detection of health events (i.e., participatory epidemiology). Innovative solutions are therefore needed to bridge the gap of capturing health events at community level that should inform the relevant authorities to provide appropriate responses in a timely manner.

Disease related information is retrieved from a wide range of available real-time electronic data sources, which play critical roles in the identification of early events and situational preparedness by offering current, highly local information about outbreaks, even from remote areas that have been unapproachable by traditional global public health efforts (Keller et al., 2009). These systems help to monitor and predict diseases.

A disease surveillance approach that is grounded in One Health principles as well as in participatory is likely to enhance early detection of human and animal diseases at the community

level. This approach empowers communities to take ownership and control over local decisions and to have a stake in maintaining the surveillance structures and practices (The Record, 2014). Previous studies have suggested that new systems exhibit remarkable potential for expansion and for enhancing the capacity of traditional surveillance systems for emerging infectious diseases (Ginsberg et al., 2009).

Implementation of Integrated diseases surveillance and response strategy in Zambia has recorded some success. However, several gaps hinder effective implementation. It is important that the gaps are addressed for Zambia to have a strong surveillance system that could inform policy in a comprehensive and timely manner (Mandyata C.B et al., 2017).

2.6 Web based application as surveillance tool

The Internet has revolutionized efficient health-related communication and epidemic intelligence (Chunara, Freifeld, and Brownstein 2012) and thus, many online surveillance systems that use real-time data have been developed to prevent the occurrence of infectious diseases (Lombardo et al., 2003). The increased frequency of Internet use for acquiring health information has contributed to the rise of web-based early detection systems for infectious diseases (Polgreen et al., 2008). Smartphones have also been used as successful surveillance tools due to their ability to browse and as such, are to be utilized in disease reporting and data collection. Both smartphones and the internet have enabled “health communication” through cloud-based systems thus promoting collaborations and sharing of files. In the coming years, smartphones will surpass other means of mass education such as radio and television (Swathi et al., 2020). This is because mobile phones are cheap and with a massive growth globally (De Vriendt et al., 2002).

The widening use of mobile phones in sub-Saharan Africa, where the penetration rate has reached 67% (The Guardian. 2015), offers the opportunity to develop innovative participatory surveillance strategies that rely on the design and deployment of digital and mobile technology solutions.

Electronic Health (eHealth) is the use of information and communication technologies (ICT) for health as defined by the World Health Organization (WHO, 2012). The adoption of ICT in health is increasingly being implemented in sub-Saharan Africa with an aim to strengthen different components of the health sector. One example of eHealth which is envisaged to become very popular is Mobile Health (mHealth) through various phone devices. Implementing mHealth will complete the patient safety cycle, and also promotes accurate electronic patient record keeping. For these reasons, the national governments, health system managers, manufacturing, packaging and software industries should understand the importance of mHealth in improving patient's safety (Moss et al., 2019).

Utilization of mobile phones and ICT technologies to improve disease surveillance in public and animal health has been reported in other countries, including China (Yang et al., 2009), Madagascar, Uganda, and Kenya (Zurovac et al., 2012). A few of these studies or systems have combined the use of mobile technologies with participatory approaches.

In India, the first mobile App was developed for guiding health-care professionals regarding animal bite wound management. The RabiApp facilitates appropriate decision-making by health-care professionals while encountering animal bite wound cases (Swathi et al., 2020). Furthermore, a mobile App to track stray dogs by global positioning system (GPS) and monitor mass canine vaccination program to prevent canine rabies was developed by the United Kingdom-based charity group known as "mission rabies," which has been implemented in various parts in India (The

University of Edinburgh, 2018). The mission rabies App permits fast data collection during rabies vaccination campaigns in Africa, Asia, and South America. A researcher from Tanzania, a middle-income country, developed an App for health workers to record information on dog bite cases and treatment in 2016. This multi-sectoral mobile phone system assists in reporting of animal bites and human as well as animal vaccine use (Mtema et al., 2016). These studies have highlighted the importance of various mobile Apps for evidence-based information for health-care providers.

2.7 Strengths and challenges of emerging web-based surveillance systems

Internet-based systems are intuitive, adaptable, inexpensive to maintain, user-friendly and operate in real time in surveillance (Milinovich et al. 2014). Web apps do not require any actions from a user to upgrade. Since upgrades are applied directly to a server, users always get the latest version of an application whenever they launch it. Since web apps are cross-platform, they can be launched on different platforms. Basically, they can be run on any device that has internet access and a web browser. The level of accessibility is another vital difference between desktop and web applications. A computer at hand is not entirely needed in order to use a web app. Users can access web apps from any PC (or another device) with an internet connection. So the location and the type of device used does not matter at all. This is ideal for a developing country like Zambia.

Advanced computational capabilities involving internet searches enable automated and rapid collection of large volumes of data, referred to as “big data”, and provide the public with “real-time” detection and improved early notification of localized outbreaks (Reis et al. 2007). In addition, a system based on web queries can easily be applied to various infectious diseases, as the underlying mechanisms are very similar (Pattie et al. 2009).

Developing countries that are particularly prone to the spread of infectious diseases should seek ways to emulate the strengths of existing web-based surveillance systems and broaden the group of users directly accessing and utilizing such systems (Samoff et al. 2012). However, the new internet-based surveillance systems are not without limitations, thereby provoking skepticism. First, due to the unstructured nature of the data sources, interpreting the information may require highly complex techniques to effectively implement the system initially (Wilson et al. 2009).

Second, Internet use and health-seeking behavior vary among individuals, and between different sectors of the community and environment. Thus, the limited environments in which these tools are useful must be considered along with the demographics of the population (Zhou et al. 2013). Large discrepancies occur between availability of the internet and active seeking of healthcare information that account for unequal use and access (Chan et al. 2011, Hale et al. 2010). Third, data sharing permits more and better-quality data to be used to monitor public health and potential outbreaks (Bernstein et al. 2012). However, use of data with precise information connected to individuals could be a privacy concern. Careful and appropriate decisions need to be made to avoid any further privacy intrusion on personal information. Last, forecasting health and disease-related phenomena is very likely to provoke accuracy issues because health fluctuates in every individual, and how people perceive their health status is very subjective. Although monitoring trends in disease outbreaks and health outcomes is possible, forecasting them is subject to false predictions. Thus, data sources must be evaluated extensively, particularly to identify gaps in coverage and false decisions (Willard and Nguyen 2013).

In Zambia, less than 5% of dogs are vaccinated against rabies and about 1% are registered, however, in 2018, over 16,000 dog bites and 23 human rabies deaths were recorded, a figure likely to be an underestimate due to the omission of community-based data (Nakazwe et al., 2019). This

can be attributed to weak surveillance system and a lack of sharing of information among stakeholders.

The web based surveillance system which incorporates professionals and the community in rabies surveillance is not there in Zambia hence the study was aimed at piloting a web based rabies surveillance system which can facilitate and coordinate reporting of dog bite cases, rabies cases and vaccinated. As a result, this will help stakeholders to track vaccination of animals, identify areas at risk and come up with preventive measures timely. Additionally, use of a web based system in rabies surveillance is cost effective, enables easy access to information and improves data quality.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The research sites for this study were Lusaka and Kasama districts in Zambia. Lusaka is an urban town located in the Lusaka Province of Zambia and it is Zambia's largest and capital city. Being one of the southern African cities that is growing the fastest, Lusaka has a cosmopolitan character that attracts a variety of people. The city serves as both the capital of Zambia and the hub of commerce and industry. It is situated at the intersection of the nation's four main highways that lead north, south, east, and west. Meanwhile, Kasama, the provincial capital of Zambia's Northern Province, is a rural town. Public employees provide services to the nearby farming and rural communities make up the majority of the town's population.

Both Lusaka and Kasama were purposively selected using three criteria. These criteria were convenience, representation of the local community and heterogeneity of the two towns. The research sites were selected as it was going to be easy and convenient for the researcher to access data and to visit the selected research sites. As for heterogeneity, Lusaka and Kasama differ distinctly in character, Lusaka being a city and Kasama, a rural town. As the largest metropolitan area in the country, Lusaka represents the major cities in the country, while Kasama represents the rural towns in the country with regards to rabies surveillance. Therefore, the selection of these two towns gave the study an opportunity to investigate views from both urban and rural participants.

3.2 Study Design

The cross-sectional study was used because it is faster and inexpensive. The study was carried out in three stages; (i) evaluation of the surveillance tool before piloted; (ii) Piloting the tool; and (iii) assessing tool's effectiveness in rabies surveillance.

3.3 Study population

The current estimate of the population of Lusaka is 2,627,716 (Central Statistical Office Zambia 2019) while that of Kasama is 306,462 (Central Statistical Office Zambia 2019). According to the District Veterinary officer in Kasama and Veterinary association of Zambia (VAZ), Kasama has two (2) veterinary clinics while Lusaka has thirty-six (36) veterinary clinics respectively. Thus the target population comprised a total of thirty-eight (38) veterinary clinics and 2 district Health offices in Lusaka and Kasama districts.

3.4 Variables

The variables that were used to assess the surveillance system were tool usability, timeliness of reporting, and completeness of reporting, Cost effectiveness and Quality of data

3.5 Sampling frame and sample size

The sampling frame consisted of veterinary clinics and district health offices in Lusaka and Kasama districts.

There has been no studies to indicate the sample proportion hence a proportion of 50% was used in this study.

$$Z^2 P(1-P)/d^2 = n$$

n= sample size

Z= Statistic corresponding to the level of confidence

p= sample proportion

d= margin of error

$$n = 1.96^2 \times 0.5(1-0.5)/0.05^2$$

$$n = 3.8416 \times 0.5 \times 0.5 / 0.0025$$

$$n = 0.9604 / 0.0025$$

$$n = 384$$

The primary sample size was 384.

Since the population is finite, to determine the sample size of this study, a secondary formula was introduced:

$$\text{The formula: } N / (1 + N (e)^2) = n$$

When n = Sample size

N = Population size

E = degree of tolerable error

1 = Constant

Therefore, applying the formula and allowing 5% error margin,

$$\text{We have: } n = 40 / (1 + 40 (0.05)^2)$$

$$n = 40 / (1 + 40(0.0025))$$

$$n = 40 / (1 + 0.1)$$

$$n = 40 / 1.1$$

$$n = 36.364$$

Hence the secondary sample size was thirty-six (36), consisting of (32) veterinary clinics in Lusaka which were randomly selected, two (2) veterinary clinics in Kasama which happens to be the only vet clinics in the district and the two (2) District Health offices.

Of the thirty-four (34) veterinary clinics that were selected, only ten (10) veterinary officers gave consent to participate in the study. However, to attain the thirty-six (36) sample size, twenty-six (26) Environmental Health Officers were recruited from the two District Health Offices. Furthermore, the participants were trained to operate the surveillance tool.

3.6 Sampling strategy

Simple random sampling method was used as this procedure gives each of the N sampling units of the population an equal and known nonzero probability of being selected. To ensure this requirement was achieved, the lottery method where each member of the population was assigned a number was used. These numbers were written on pieces of papers and put in a box and it was well shaken and the first piece of paper drawn. This procedure was repeated until a sample of the desired size was drawn.

3.7 Software Development

The surveillance tool was designed as a client-server software that enables data entry on the client-side via the web browser. Data is stored in the cloud based server and files format are in Structured Query Language (SQL). The system was developed using agile development and involves the utilization of several programming and structural languages such as Hypertext Preprocessor (PHP), JavaScript, Cascading Style Sheets (CSS), Hypertext Markup Language 5 (HTML5) and MySQL. Using the agile development methodology, an analysis of the requirements was conducted in the initial stage. This was followed by software design and development. Upon completion of the development process, the system was then subjected to tests for defects. Thereafter, the system was then deployed. The agile development methodology was repeated if

errors occurred during the operations of the system after deployment to enhance the quality of the system.

Evaluation of the surveillance Tool before being deployed

In the evaluation stage, the tool was assessed for its functionality and usability before it was deployed. This was done by collecting data that has been reported in the last two months on vaccination of animals against rabies, rabies cases and dog bites from selected veterinary clinics and district health offices in Lusaka and Kasama districts. Data was collected using data collection forms and then entered in the tool. The tool was then observed during reporting and when viewing reported data

Assessing the Effectiveness of the Surveillance Tool after being deployed

The tool was assessed for its effectiveness with regards to rabies surveillance. Initially, 34 veterinary officers from different veterinary clinics and two EHT's from two district health offices were selected and trained on how to operate the surveillance tool. As the tool was deployed, some veterinary officers withdrew from the study due to various reasons which included lack of internet bundles and some leaving the private institutions and joined the Ministry of Fisheries and Livestock. Because the population was so limited, an alternative of twenty six (26) Environmental Health officers from the two District Health Offices and ten (10) veterinary officers were trained again on how to operate the surveillance tool. The tool was deployed and allowed to operate for three months before it was assessed. During assessment, a questionnaire was administered to all the participants. The tool was assessed on usability, timeliness of reporting, completeness of reporting, its cost effectiveness and the quality of data. The questionnaire rated the importance of each item on a 4 or 5-point scale as well as Likert. Others required the participants to agree or disagree.

3.8 Data collection instruments and procedures

The study used semi-structured questionnaires to assess the effectiveness of the tool in rabies surveillance. The closed questions in the questionnaire assisted in producing quantitative data. Thirty six (36) questionnaires were distributed in the selected veterinary clinics and district health offices. The questionnaires were administered to all the personnel who were trained in use of the surveillance tool. Trained research assistants were engaged in data collection.

3.9 Data analysis instruments and procedures

Quantitative data was coded, manually processed, entered and analyzed using computer software SPSS version 16. The results collected were presented in terms of descriptive statistics in form of frequencies, percentages and graphs.

3.9.1 Ethical considerations

Clearance to undertake this study was obtained from University of Zambia Biomedical Research Ethics Committee (UNZABREC) and the National Health Research Authority. The research participants were fully informed about the procedures involved in the research and were asked to give their consent to participate. The study confidentiality was ensured through the use of codes instead of names. The mobile App does not store any personal information, photographs, or biometrics.

Functionality of the surveillance tool

A user-friendly tool was developed in order to aid in surveillance of rabies as it facilitates timely reporting, its cost effective, improves data quality and it facilitates completes of reporting especially in remote areas with poor road networks.

First time users are required to register with their gadgets using the website www.ivetgen.com/register with a username gracetembol@gmail.com. Once registration is complete then a password is used to login to the surveillance system on the home screen (figure 4.1.1 a). Successful login directs the user to the second screen which is the dashboard (figure 4.1.1 b) where various functions can be navigated.

The third screen functions as a registration system or reporting system and provides three different options for the user to choose from with regards to the item being reported (figure 4.1.2 c). These options include; reporting on rabid dogs, reporting on vaccinated dogs or reporting on dog bite cases. Clicking on any of the options directs the user to the fourth screen where the actual reporting is done (Figure 4.1.2 d). When reporting, information about the animal being reported is entered into the surveillance system. The information required include sex, species, breed, GPS Coordinates, province, town, sample ID etc. after this information is entered, the user clicks on the submit button and when successfully submitted, the system automatically updates the statistics on what has been reported. This system employs data-entry application and uses an http protocol to send data to a server running a MySQL database for storage and management. Forms for phone-based data entry on the fourth screen were largely adopted formats of existing paper registers used in vet clinics for reporting vaccination, rabies cases and dog bites.

In order to view what has been reported, the user navigates back to the dashboard and selects an option either to view reports or the graph. Clicking on view reports brings the fifth screen (figure 4.1.3 e) which has three types of reports and depending on which report is desired, clicking on any of the reports brings the sixth screen which shows a table on what has been reported (figure 4.1.3 f). Clicking view graph brings a pie chart showing figures of different parameters that have been reported (figure 4.1.4 g). A pie chart graph was used so as to easily determine which parameters are frequently reported.

The system is able to share information on time of reporting and helps complete the process of reporting. It also helps identify areas where vaccination has/is being conducted. Furthermore, it can be used to identify areas where cases of dog bites are high, hence helping identify areas that are at risk of rabies outbreak. The surveillance tool can be used to identify areas that have reported rabies cases hence frontline workers can respond on time.

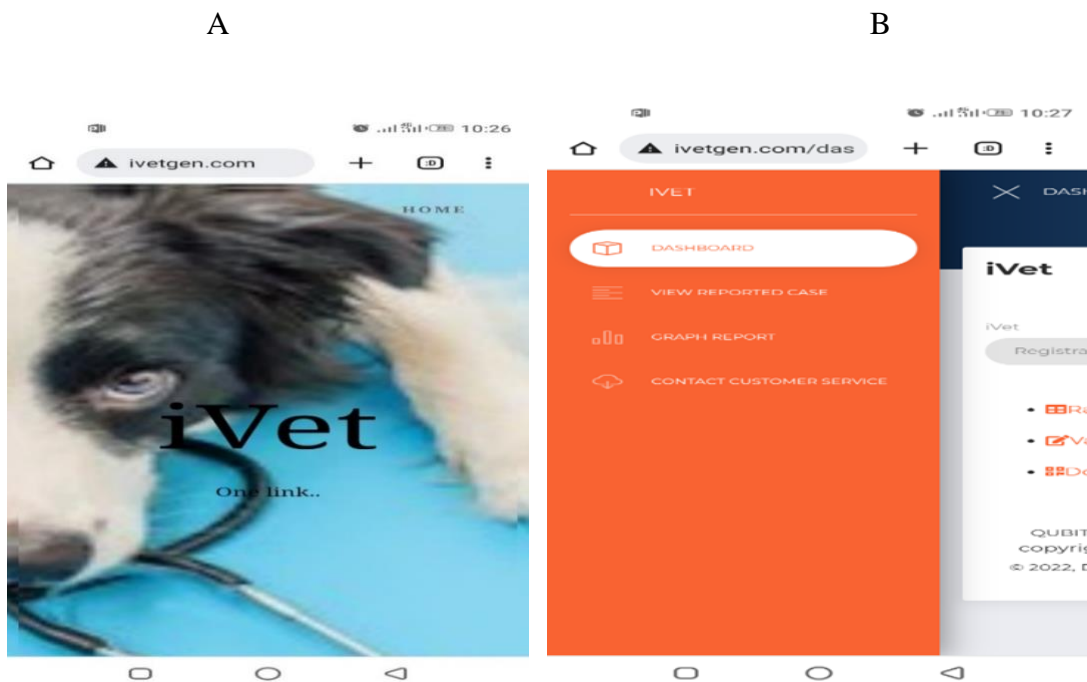


Figure 4.1. 1 The first screen (a) and the second screen (b) of the Surveillance Tool

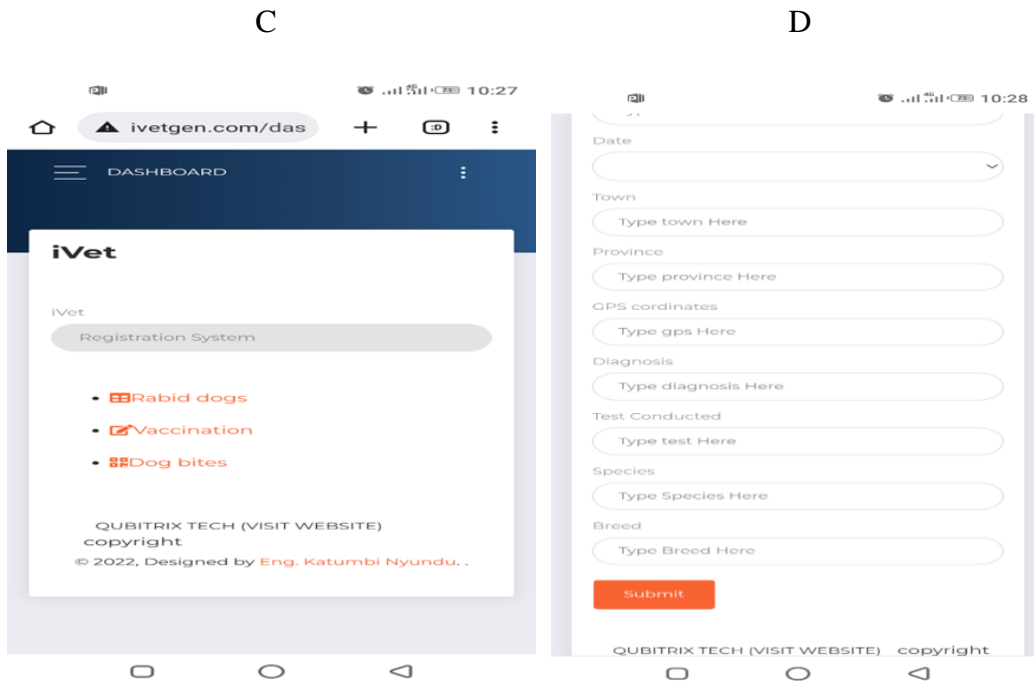


Figure 4.1. 2 The third screen (c) and the fourth screen (d) of the Surveillance Tool

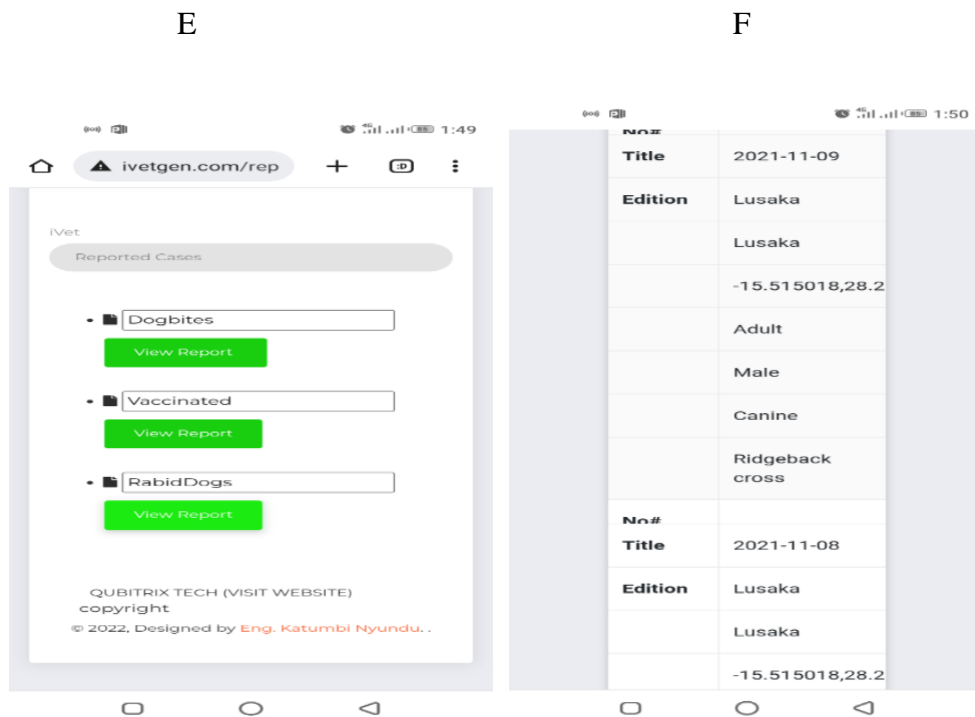


Figure 4.1. 3 The fifth screen (e) and the sixth screen (f) of the Surveillance Tool

G

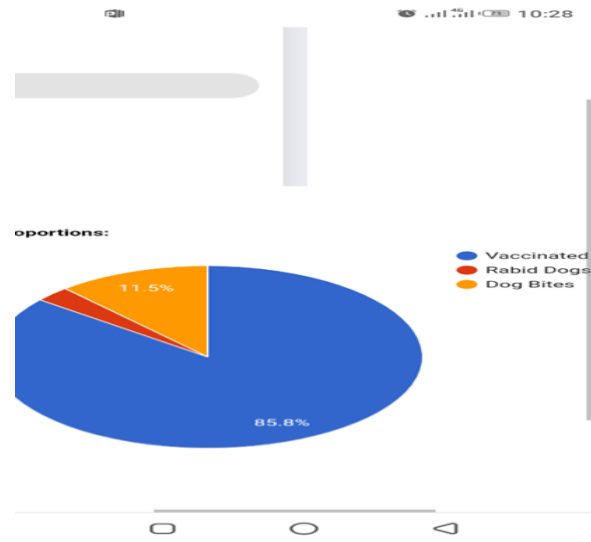


Figure 4.1. 4 The seventh screen (g) of the Surveillance Tool

CHAPTER FOUR

RESULTS

4.1 Assessment of the Surveillance System

The Surveillance System was hosted online and deployed in various Health facilities and vet clinics in Kasama and Lusaka districts. After three months, a questionnaire was administered to the users to assess the effectiveness of the Surveillance System with regards to rabies surveillance. The results are presented in frequency tables, pie charts and bar charts according to responses from the questionnaires. The frequency tables show the frequencies and percentages while bar charts and pie charts show the percentages.

4.2 Generated results from the deployed Surveillance System

In three months of deployment of the surveillance system, a total of 139 reports were submitted, of which 112 were for vaccinated dogs, 26 for dog bites cases and 1 for rabid dog.

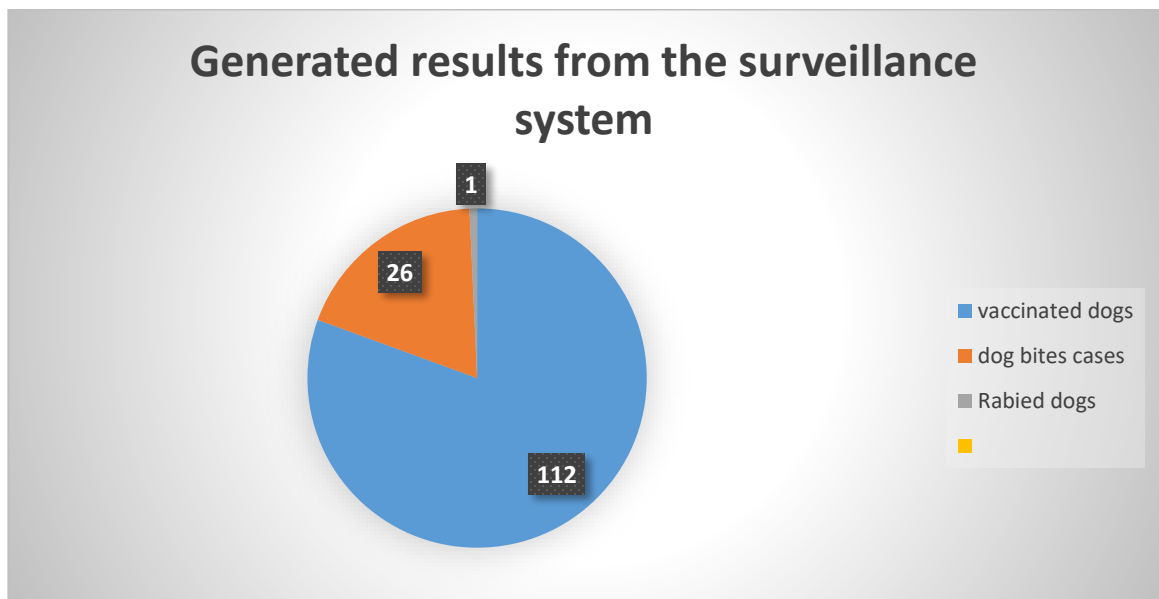


Figure 4.1.5 Generated results from the surveillance system

4.3 Respondents Demographic Characteristics

Of the thirty-six participants who responded, 55.6% (20/36) were male and 44.4% (16/36) were female. Majority of the respondents which is 44.4% (16/36) were between the age of 26 and 35years, 22.2% (8/36) were between the ages of 18 to 25 years and 36 to 45 years while the least of the respondents which is 11.4% (4/36) were above the age of 46. All the respondents had acquired tertiary education and 63.9% (23/36) resided in rural area while 36.1% (13/36) resided in an urban area (Table 4.1).

Table 4. 1 Social Demographic characteristics of the respondents

General Characteristics	Category	Frequency	%
Sex	Male	20	55.5
	Female	16	44.4
	Total	36	100
Age	18-25	8	22.2
	26-35	16	44.4
	36-45	8	22.2
	46+	4	11.2
	Total	36	100
Level of Education	Tertiary	36	100
	Secondary	0	0
	Primary	0	0
	Total	36	100

Residence	Urban	13	36.1
	Rural	23	63.9
	Total	36	100

4.4 The relationship between surveillance tool usability and demographic characteristics

An assessment was conducted using Chi-square test to ascertain if there was a correlation between effectiveness in operating the surveillance tool and the demographic characteristics. The results indicated that there was no correlation between gender and effectiveness in operating the surveillance tool with a P value of 0.245. Additionally, there was no relationship between participant’s place of residence and effectiveness in operating the surveillance tool with a P value of 0.573. There was no relationship between age group and effectiveness in operating the surveillance tool with a P value of 0.170.

Table 4.2 relationship between surveillance tool usability and demographic characteristics

	Category	Surveillance Tool Usability			P value
		Very easy	Easy	Somewhat easy	
Gender	Male	10	10	0	0.245
	Female	6	8	2	
Residential Area	Urban	7	5	1	0.170
	Rural	9	13	1	
Age Group	18-25	3	5	0	
	26-35	8	8	0	
	36-45	5	2	1	
	46+	0	3	1	

4.5 Surveillance System Usability in Rabies surveillance

During an assessment on the usability of the Surveillance Tool, 50% (18/36) of the respondents indicated that the tool was easy to use, 43.8% (16/36) indicated that the tool was very easy to use while 6.2% (2/36) indicated that the tool was somewhat easy to use (Figure 4.1.6 h). In addition, the tool was assessed for its importance in rabies surveillance and 55.6%, (20/36) indicated that the tool was very important in rabies surveillance, 38.8 (14/36) respondents indicated that the tool was important and 5.6% (2/36) respondents indicated that the tool was somewhat important in rabies surveillance (Figure 4.1.7 i). Furthermore, 50% (18/36) of the respondents agreed that they learnt to operate the tool immediately they were trained, 33.3 (12/36) respondents strongly agreed while 16.7% (6/36) respondents disagreed to learning how to operate the tool immediately they were trained (Figure 4.1.7 j).

H

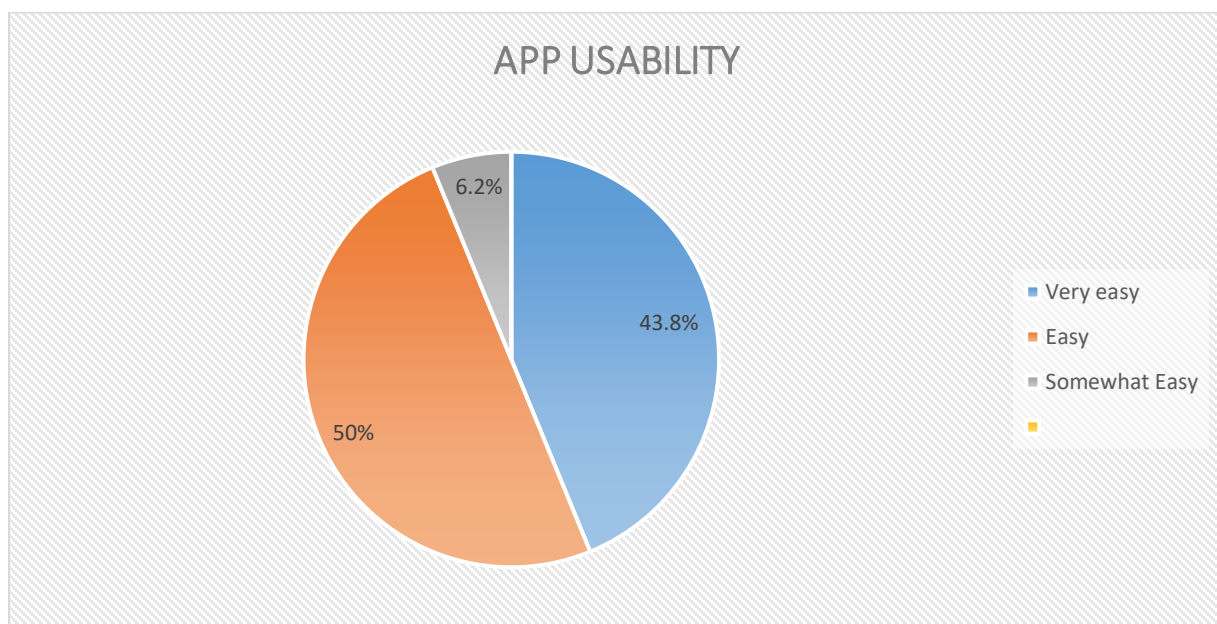


Figure 4.1.6 Respondent's response distribution on how easy they find using the Surveillance System (h).

I

J

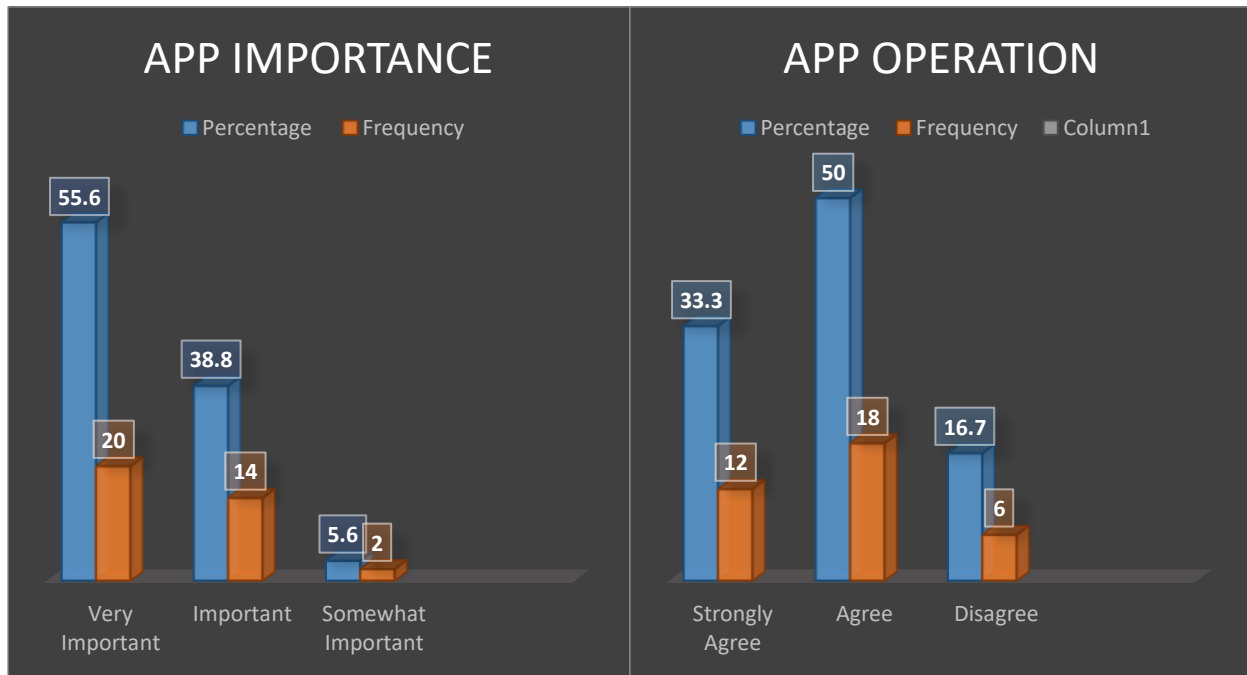


Figure 4.1.7 Responses on how important the Tool is in rabies surveillance (i) Respondent's responses on whether they learnt to operate the Tool immediately they were trained (j).

4.6 Distribution of Respondents Responses on whether the Surveillance System

Facilitated Timeliness of Reporting

The Tool was assessed for timeliness of reporting and of the 32 respondents, 21 (65.6%) of them Agreed that the Tool facilitated timely reporting, 9 (28.10%) strongly agreed while 2(6.2%) disagreed that the Tool facilitated timely reporting (figure 4.1.8 k). With regards to timely reporting helping to monitor disease outbreaks and identifying areas at risk of the outbreak, 84.4% (27/32) of the respondents strongly agreed, 12.50% (4/32) agreed while 3.1% (1/32) were undecided (figure 4.1.8 l).

K

L

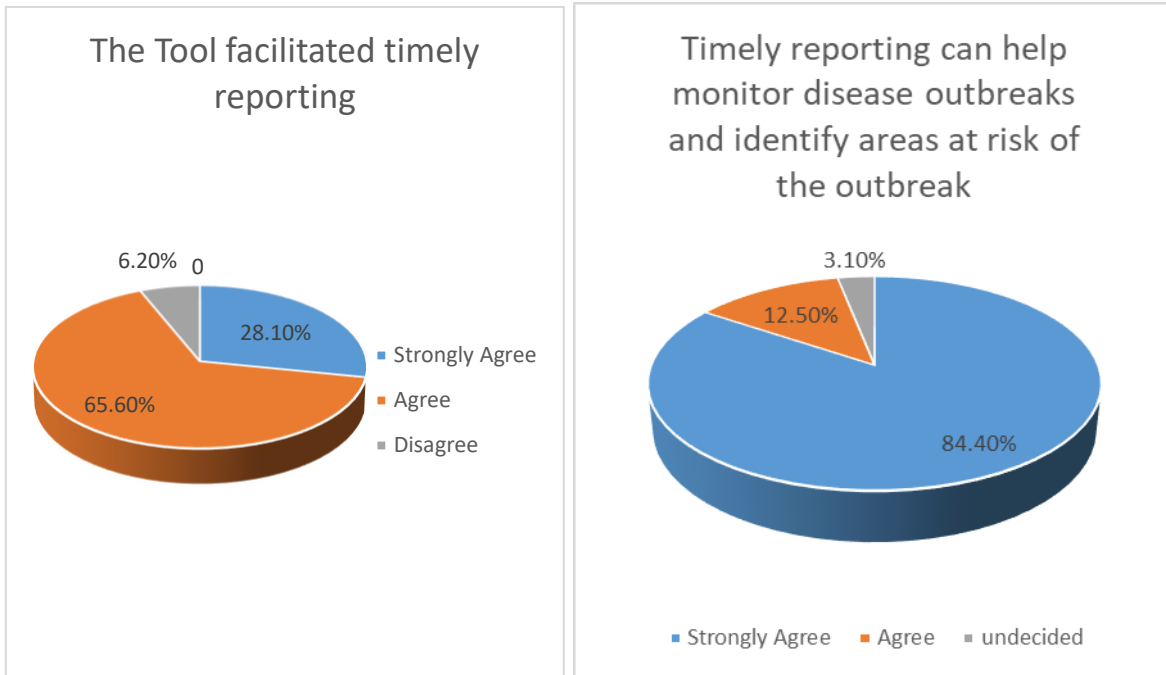


Figure 4.1.8 Responses on whether The App facilitated reporting timely (k). Responses on whether timely reporting can help monitor rabies outbreaks and identify areas at risk of the outbreak (l)

4.7 Distribution of Respondent’s responses on whether the Surveillance System facilitated completeness of reporting

During an assessment of the Tool on completeness of reporting, 31.2% (10/32) of the respondents strongly agreed, 12.5% (4/32) didn’t know while 3.1% (1/32) of the respondents disagreed that the Tool facilitated completeness of reporting (Figure 4.1.9 m). Furthermore, majority 65.6% (21/32) of the respondents strongly agreed 28.1 (9/32) of the respondents agreed and 6.2% (2/32) of the respondents didn’t know that health facilities in remote areas with poor road networks have difficulties in submitting their reports on dog bite cases, vaccinated dogs and rabies cases completely and timely hence contributing to incompleteness of reporting (Figure 4.1.9 n).

Additionally, 61% (22/36) of the respondents strongly agreed, 33.3% (12/32) of the respondents agreed and 5.6% (2/32) of the respondents didn't know that incompleteness of reporting can lead to negligible timely feedback from decision makers (figure 4.2.0 o).

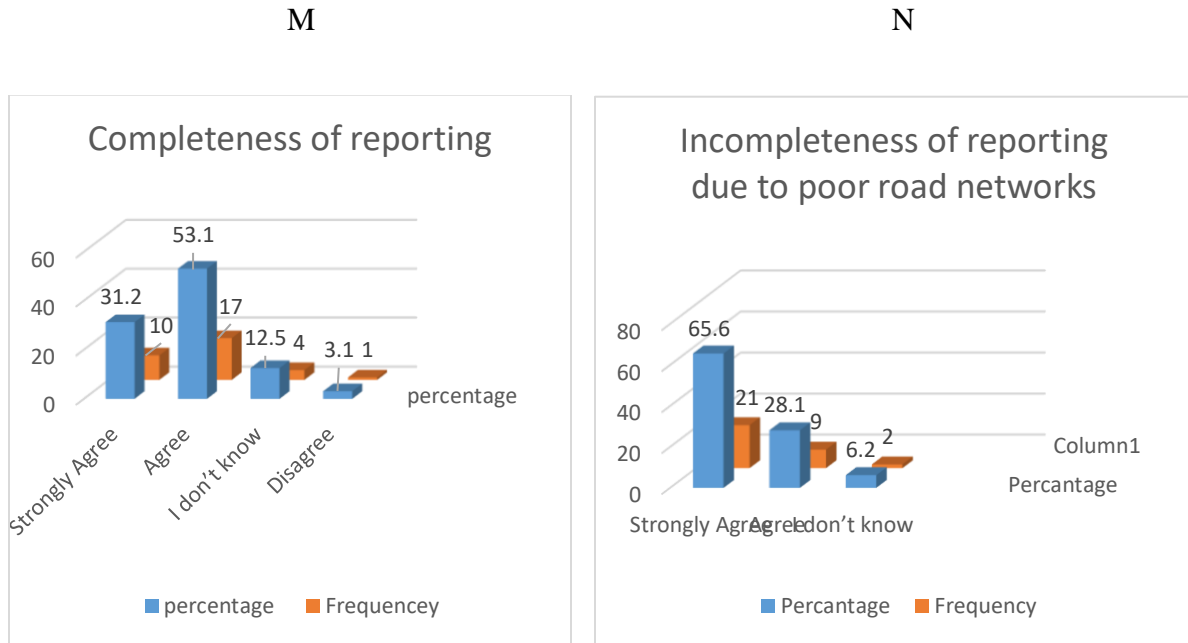


Figure 4.1.9 Responses on whether the Tool facilitated completeness of reporting (m). Responses on whether health facilities in remote areas with poor road network have difficulties in submitting their reports hence contributing to incompleteness of reporting (n).

O

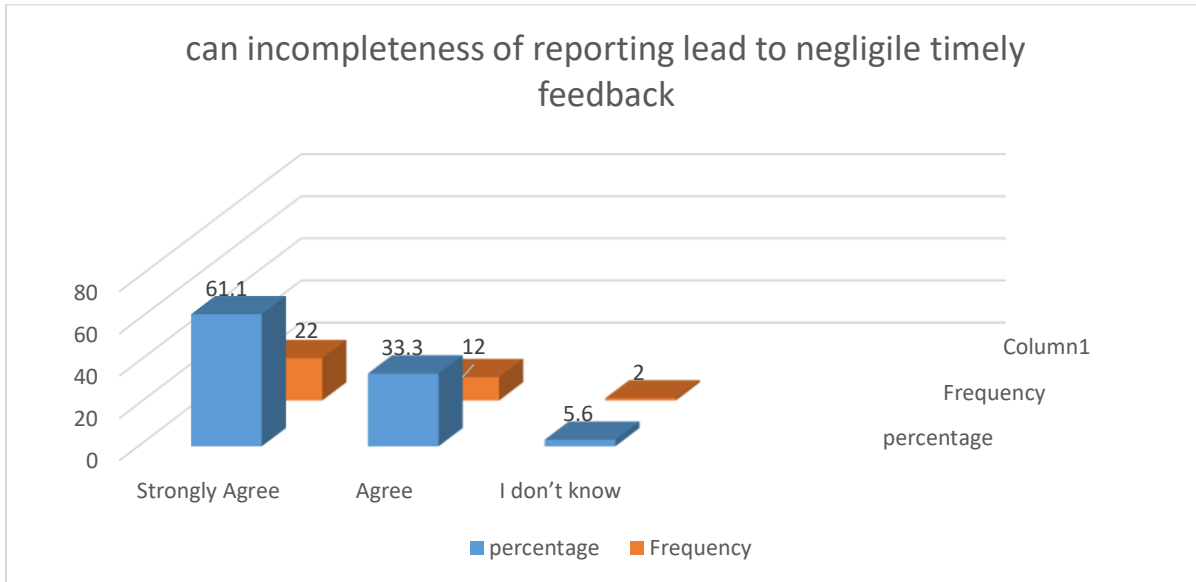


Figure 4.2.0 Responses on whether Incompleteness of reporting can lead to negligible timely feedback from decision makers (o).

4.8 Respondent's responses on whether using the Surveillance System can be cost effective

With regards to assessing the Tools cost effectiveness in rabies surveillance, 50% (18/36) of the respondents agreed, 30.5% (11/36) of the responded strongly agreed, 13.9% (5/36) of the respondents were undecided and 5.5% (2/36) of the responded disagreed that reporting using this App can be a cheaper way of notifying an outbreak to the line Ministries (Figure 4.2.1 p).

In addition, majority 55% (20/36) of the respondents agreed, 36.1% (13/36) of the respondents strongly agreed while 8.35% (3/36) of the respondents were undecided if Reporting using this Tool can cut on the expenses which can be incurred if an officer was to travel from their station of duty in order to report rabies cases, dog bite cases or vaccination of dogs (Figure 4.2.1 q).

P

Q

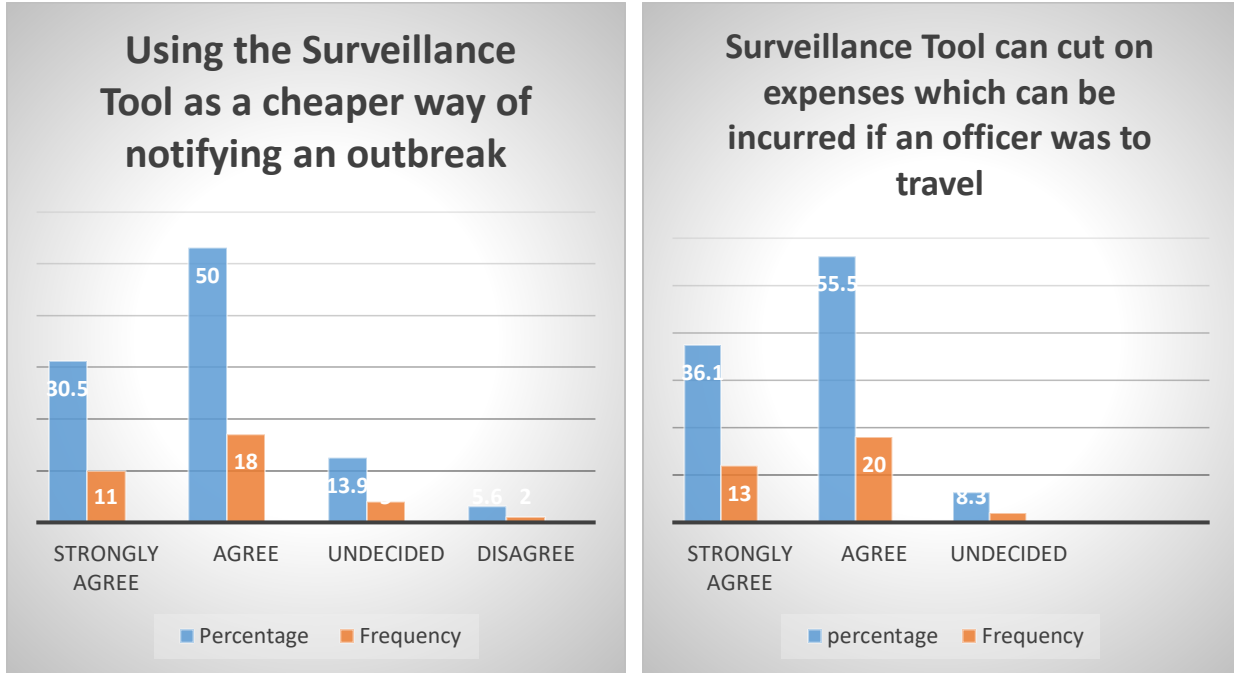


Figure 4.2. 1 Responses on whether Reporting using this Tool can be a cheaper way of notifying an outbreak to the line Ministries (p). Responses on whether reporting using this Tool can cut on the expenses which can be incurred if an officer was to travel from their station of duty in order to report (q).

4.9 Distribution of Respondent’s responses on whether using the Surveillance System improves data quality

The Tool was also assessed for data quality improvement and most of the participants, 47% (17/32) of the respondents agreed, 38.9% (14/36) of the respondents strongly agreed, 8.3% (3/36) of the respondents were undecided while 5.6% (2/36) of the respondents disagreed that data reported using the Tool cannot go missing or misplaced compared to paper based data hence improving data quality (Table 4.2).

Furthermore, 55.6% (20/36) of the respondents agreed, 19.4% (7/36) of the respondents were undecided, 13.9% (5/36) of the respondents strongly agreed and 11.1% (4/36) of the respondents disagreed that the Tool enables one to access data anytime, anywhere and easily hence improving accessibility to information (Table 4.3).

Table 4. 3 Responses on whether data reported using the Surveillance System cannot go missing or misplaced compared to paper based data hence improving data quality.

Valid	Frequency	Percent
Strongly Agree	14	38.9
Agree	17	47.2
Undecided	3	8.3
Disagree	2	5.6
Total	36	100.0

Table 4. 4 Responses on whether the Surveillance Tool enables one to access data anytime, anywhere and easily

		Frequency	Percent
Valid	Strongly Agree	5	13.9
	Agree	20	55.6
	undecided	7	19.4
	Disagree	4	11.1
	Total	36	100.0

CHAPTER FIVE

DISCUSSION

The study involved piloting a web based rabies surveillance system in Lusaka and Kasama districts. The web based rabies surveillance system was designed to facilitate rabies surveillance at community level through an integrated approach by including inputs from Environmental Health practitioners, Veterinarians and Laboratory Scientists who report dog bite incidents, animal rabies vaccinations and animal rabies cases. It required the use of internet and a smart phone or computer and performed two major functions which included reporting as well as analyzing and translating the reported data into a graph and a table.

During piloting of the tool, a total of 36 participants were recruited and they were trained on how to operate it. They were more (55%, 20/36) males that participated than females and most (44%, 16/36) of them were in the age range of 26-35. Additionally, all respondents attained tertiary education while most (63%, 23/36) of them were from rural areas (Table 4.1). The surveillance tool was deployed and hosted online for six months. The first two months of online hosting was used for evaluating the tool and the last three months of online hosting was used by the participants to operate the surveillance tool in reporting and monitoring.

With the deployment of the rabies surveillance system, stakeholders from different ministries were able to share information on real time. Additionally, reporting was complete, cost effective and the tool was easy to use as most participants were able to operate it almost immediately after being trained. In various settings over the past ten years, mobile phone-based surveillance systems have undergone pilot testing. Malaria surveillance initiatives in New Guinea (European Centre for Disease Prevention and Control 2012), rabies surveillance initiatives in Tanzania (Mttema Z. et al.

2002) and influenza in Kenya, Tanzania, and Uganda (Njuguna H. et al. 2012) have resulted in significant improvements in report timeliness, with the median reporting delay for influenza in Kenya falling from 21 to 7 days.

An assessment was conducted to ascertain the correlation between effectiveness in the operation of the surveillance tool and demographic characteristics. However, all variables were not significant hence there was no correlation between age, gender, residential area and surveillance tool usability. In order to operate the surveillance tool, there's also need of some basic knowledge of writing and reading hence the aspect of education was necessary among the participants.

The tool was later assessed for its effectiveness in rabies surveillance and it was observed that most participants found it easy to operate the tool (50%, 18/36). Additionally, most of them found it to be very important in surveillance of rabies (55%, 20/36) while 50%, (18/36) of them agreed that they learnt to operate the tool immediately they were taught. The findings are consistent with Coetzer A. et al., (2019) as the GARC App is effective in rabies surveillance and brings most of GARC's surveillance tools to a user's smartphone enabling them to capture data anytime, anywhere and easily. Additionally, Chinese Center for Disease Control and Prevention CCDC Weekly / Vol. 3 / No. 36, indicated that the reporting process using Mobile Electronic Surveillance System was found to be clear and simple as well as reporting immediately.

Majority of respondents (65%) agreed that the surveillance tool facilitated timely reporting. According to Rosewell A, et al, (2017), the use of mobile technologies in capturing and reporting provides timely and high quality data required for elimination of communicable diseases. Furthermore, 84% (27/32) of respondents strongly agreed that timely reporting can help monitor disease outbreaks and identify areas at risk of an outbreak. Respondents also indicated that within weeks, they were able to submit their reports timely regardless of poor road networks and the

remoteness of the health facility. It can be deduced that the App facilitated reporting of vaccinated dogs, dog bite cases and rabies cases timely. These results were consistent with El-Khatib et al. (2018) where, within weeks, the completeness and timeliness of weekly surveillance report considerably improved, and the improvement maintained. Additionally,

A fair number of respondents (53 %, 17/32) agreed while (31 %, 10/32) respondents strongly agreed that the surveillance tool facilitated completeness of reporting. Additionally, (65%, 21/32) respondents strongly agreed that health facilities that are in remote areas with poor road network have difficulties submitting their reports timely and completely and 61%, (22/36) respondents strongly agreed that Incompleteness of reporting can lead to negligible timely feedback from decision makers. The combination of participatory community-based approaches with mobile technology has the potential to support not only early detections of disease events happening at the community level (Freifeld et al., 2010) but also near real-time responses. According to El-Khatib et al. (2018) comparison with paper-based surveillance in both the pilot district the year prior and in a nearby comparison district during the same time period, median completeness of reporting from the health facilities more than doubled to 81%. Furthermore, general syndromic surveillance projects in Papua New Guinea (Rosewell A, 2013) have produced moderate improvements in the completeness of reporting from 40% prior to 70% during the pilot.

With regards to cost effectiveness in rabies surveillance, (50%, 18/32) of the respondents agreed that it can be a cheaper way of notifying an outbreak to the line Ministries within a short space of time and with few resources. Additionally, (55%, 20/36) of the respondents agreed that using this tool can cut on the expenses which can be incurred if an officer was to travel from their station of duty in order to report rabies cases, dog bite cases or vaccination of dogs. Mobile health technologies have been recognized as a cheaper approach to provide high quality healthcare

services to patients in Low and Middle-income countries (LMICs) with its fragile health systems (WHO 2016).

During the assessment of the surveillance tool with regards to improving data quality, it was noted that 47%, (17/36) of the respondents agreed while 38%, (14/36) of respondents strongly agreed that using the surveillance tool in rabies surveillance can improve data quality because data cannot go missing or misplaced as compared to paper based data. Additionally, 55%, (20/36) respondents also agreed that the tool enables one to access data anytime, anywhere and easily hence improving data quality. The tool was hosted on a cloud server, providing access at any location in time and since it is web based, the App is less hardware dependent. A study in Malawi indicated improvement in data quality in the rural health facilities which was achieved through the introduction of Electronic Data Capture (EDC) using OpenDataKit. Health workers in the facilities showed satisfaction with the use of EDC (Tizifa T, et al., 2021).

Several challenges were encountered in this study that require consideration. The study required the use of smart phones for the participants. Unfortunately, the budget was limited hence couldn't provide the gadgets for the smooth running of the project and some participants who didn't own a smartphone were automatically excluded from the study based on that. Additionally, internet bundles were required for participants to use when reporting, unfortunately, they were not provided. Most participants encountered challenges with internet connectivity especially in some parts of Kasama district in rural areas. Further, some features of the App were not developed due to inadequate resources. These features included a map, notification, partitioning of weekly, monthly and yearly reports, to mention but a few. These features would have enhanced the operation of the tool in rabies surveillance. The tool could not be hosted online up to the completion of this study due to inadequate resources.

In a constrained resource setting like Zambia, use of Low-cost yet robust feature phones that could run java based applications in rabies surveillance would bring about positive impact. The positive impact was noted in the water and sanitation sector in Zambia after changing the District Health Information System (DHIS) which demanded use of smart phone and internet bundles when reporting to Low-Tech phones with robust features that could run DHIS2 java based application (Akros, 2021).

CHAPTER SIX

CONCLUSION

The study looked at piloting the rabies surveillance system in Lusaka and Kasama districts. The design of the surveillance system in this study promotes the integration of Public Health and Animal Health Surveillance system. This effort may help in the implementation of one health approach to rabies prevention. The tool was developed and assessed for its effectiveness in rabies surveillance using a questionnaire. This study deduced that the tool was easy to operate, facilitated timely and completeness of reporting, was cost effective and improved data quality. As a result, it has great potential for use as a highly effective tool in rabies surveillance.

6.1 Recommendations

Collaborating across sectors to implement one health approach and ensure the early detection of rabies outbreaks using suitable surveillance techniques. Additionally, Ministry of Fisheries and Livestock to actively combat rabies by ensuring continuous vaccination and prompt reporting of vaccinated dogs. The Ministry of Health to ensure that reporting and surveillance systems are put in place along with early detective systems in cases involving dog bites. Furthermore, Ministry of Local Government and Rural Development should ensure compiling statistics on dogs in an area and reporting of vaccinated dogs. Additionally, the Government of the Republic of Zambia to introduce low cost mobile technology in rabies surveillance which can be used offline and without a smart phone in order for surveillance to be cost effective. Future research to focus on improving the surveillance tool so that it can be used offline and on non-smart phones as this solution would address most of the challenges that were encountered during the study.

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CHAPTER SEVEN

APPENDICES

Consent Form

SCHOOL OF VETERINARY MEDICINE

DIRECTORATE OF RESEARCH AND POSTGRADUATE STUDIES

Vets and Health Personnel's Information Sheet and Consent Form

Title of Study: Development of a Web Based Mobile Application to intensify rabies surveillance system in Lusaka and Kasama districts, Zambia.

Principal Investigator: Grace Tembo

Co-Principal Investigators: Dr Walter Muleya, Prof Boniface Namangala and Eng. Katumbi Nyundu,

This study is being conducted on Development of a Web Based Mobile Application to intensify rabies surveillance system in Lusaka and Kasama districts in Zambia. Lusaka is an urban town located in the Lusaka Province, on the other hand, Kasama is a rural town based in the Northern Province. Both Lusaka and Kasama were purposively selected using three criteria. These criteria

were convenience purpose, representation of the local community and heterogeneity of the two towns.

The study sites will focus on vet clinics and district health offices (DHO).

Vet clinics will be selected randomly and the vets of the randomly selected clinic will be asked for consent for data to be collected from their clinic.

Brief description of the Study

Approximately 59,000 people die from rabies each year in the world, with Asia and sub-Saharan Africa accounting for more than 95% of these deaths (Hampson et al. 2015). On average, Zambia reports about 20 human rabies deaths annually, a figure likely to be an underestimate due to the omission of community-based deaths (Nakazwe, Gianetti 2019). No studies have been done on developing a mobile App in intensifying rabies surveillance despite the estimated low number of vaccinated dogs in the country and increase in number of notified dog bite cases. As a result, this study aims at Developing and implementing a Web Based Mobile App to Intensify Rabies Surveillance System in Zambia.

Therefore, if you do consent to take part in this study, you will be expected to give permission to collect some data on previous vaccination of animals, reported rabies cases and dog bites. This process has been planned to last us 1hour. Furthermore, you will also be expected to use this App for reporting of vaccination of animals, rabies cases and dog bites for a period of 3 months which is a trial phase.

May you wish not to take part in this study, you will not be victimized/penalized in any way and you are also at liberty to leave the study at any time when you feel it is necessary to do so.

According to the study design and our understanding, there are no risks associated if you agree to take part in this study. As participants in this study, you will not be paid any money or any material in form of payment. The benefits of the study shall be on community level and the country at large as the mobile App will facilitate near real time reporting of animal bites, rabies cases and animal vaccine use while reducing costs. This may have direct influence on the health system as policy makers may use this knowledge to intensify surveillance systems in Zambia.

Notice should be made that information collected in this study is highly confidential and strictly for academic purposes and not in connection to individuals that provide the information. You may also wish to know that permission will be sought from the University of Zambia Biomedical Research Ethics Committee (UNZABREC).

If you have questions, complaints, or problems as a result of participating in this study, you may call Grace Tembo (+260971079092 or email: gracetembo1@gmail.com) or contact the University of Zambia, School of Veterinary Medicine, Department of Biomedical Sciences.

By undersigning this consent form, you agree and declare that;

You have been informed about this study's purpose, procedures, possible benefits and risks.

You have been given the chance to ask questions before you sign.

You have voluntarily agreed to participate in this study.

i. Permission Letter



NATIONAL HEALTH RESEARCH AUTHORITY
Paediatric Centre of Excellence, University Teaching Hospital, P.O. Box 30075, LUSAKA
Chalala Office Lot No. 18961/M, Off Kasama Road, P.O. Box 30075, LUSAKA
Tell: +260211 250309 | Email: znhrasec@nhra.org.zm | www.nhra.org.zm

Ref No: NHRA00004/24/09/2021

Date: 24th September, 2021

The Principal Investigator,
Ms Grace Tembo,
University of Zambia,
Lusaka, Zambia.

Dear Ms Tembo

Re: Request for Authority to Conduct Research

The National Health Research Authority is in receipt of your request for authority to conduct research titled “**Development of A Web Based Mobile Application to Intensify Rabies Surveillance System in Lusaka and Kasama Districts, Zambia**”.

I wish to inform you that following submission of your request to the Authority, our review of the same and in view of the ethical clearance, this study has been **approved** on condition that:

1. The relevant Provincial and District Medical Officers where the study is being conducted are fully appraised;
2. Progress updates are provided to NHRA quarterly from the date of commencement of the study;
3. The final study report is cleared by the NHRA before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by the NHRA, the final study report is shared with all relevant Provincial and District Directors of Health where the study was being conducted, University leadership, and all key respondents.

Yours sincerely,

Prof. Godfrey Bemba
Director/CEO
National Health Research Authority

ii. Ethical Clearance



**UNIVERSITY OF ZAMBIA
BIOMEDICAL RESEARCH ETHICS COMMITTEE**

Telephone: 260-1-256067
Telegrams: UNZA, LUSAKA
Telex: UNZALU ZA 44370
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Federal Assurance No. FWA00000338

Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia
E-mail: unzarec@unza.zm
IRB00001131 of IORG0000774

30th August 2021

Your REF. No. 1825-2021.

Ms. Grace Tembo,
University of Zambia,
School of Public Health,
P.O Box 50110,
Lusaka.

Dear Ms. Tembo,

**RE: DEVELOPMENT OF A WEB BASED MOBILE APPLICATION TO INTENSIFY
RABIES SURVEILLANCE SYSTEM IN LUSAKA AND KASAMA DISTRICTS,
ZAMBIA (REF. NO. 1825-2021)**

The above-mentioned research proposal was presented to the Biomedical Research Ethics Committee on 25th August 2021. The proposal is **approved**. The approval is based on the following documents that were submitted for review:

- a) Study proposal
- b) Questionnaires
- c) Participant Consent Form

APPROVAL NUMBER : REF. 1825-2021

This number should be used on all correspondence, consent forms and documents as appropriate.

- **APPROVAL DATE** : 30th August 2021
- **TYPE OF APPROVAL** : Ordinary
- **EXPIRATION DATE OF APPROVAL** : 29th August 2022
After this date, this project may only continue upon renewal. For purposes of renewal, a progress report on a standard form obtainable from the UNZABREC Offices should be submitted one month before the expiration date for continuing review.
- **SERIOUS ADVERSE EVENT REPORTING:** All SAEs and any other serious challenges/problems having to do with participant welfare, participant safety and study integrity must be reported to UNZABREC within 3 working days using standard forms obtainable from UNZABREC.
- **MODIFICATIONS:** Prior UNZABREC approval using standard forms obtainable from the UNZABREC Offices is required before implementing any changes in the Protocol (including changes in the consent documents).

- **TERMINATION OF STUDY:** On termination of a study, a report has to be submitted to the UNZABREC using standard forms obtainable from the UNZABREC Offices.
- **NHRA:** You are advised to obtain final study clearance and approval to conduct research in Zambia from the National Health Research Authority (NHRA) before commencing the research project.
- **QUESTIONS:** Please contact the UNZABREC on Telephone No. 00260977925304 or by e-mail on unzarec@unza.zm.
- **OTHER:** Please be reminded to send in copies of your research findings/results for our records. You are also required to submit electronic copies of your publications in peer-reviewed journals that may emanate from this study. Use the online portal: unza.rhinno.net for further submissions.

Yours sincerely,

Sody Mweetwa Munsaka, BSc., MSc., PhD
CHAIRPERSON
Tel: +260977925304
E-mail: s.munsaka@unza.zm

iii. Questionnaire

Questionnaire ID Number (for official use only):

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Instructions

Many questions in this survey make use of rating scales. Kindly tick the number that best describes your opinion.

In making your ratings, please remember the following points:

- * Be sure to answer all items – do not omit any.
- * Never circle more than one number on a single scale, unless requested to do so.

Where box spaces are provided, please write your responses in there.

Please read each question carefully.

General Information

Respondents Demography

1. Age:

18-25	1.
26-35	2.
36-45	3.

46+	4.

2. Gender:

Male	1	2	Female
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3. Level of education:

Primary school	1
Secondary	2
College	3
University	4

4. Urban/Rural

Urban	1.	2.	Rural
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App Usability

1. How easy do you find using the App in reporting?

Very easy	1	2	3	4	Not easy at all
-----------	---	---	---	---	-----------------

2. How important is this App in disease surveillance?

Very important	1	2	3	4	Not important at all
----------------	---	---	---	---	----------------------

3. I learnt to operate the App immediately I received a training.

yes	1	2	no
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Timeliness of Reporting.

4. The App facilitated reporting of vaccinated animals timely.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

5. The App facilitated reporting of dog bite cases timely.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

6. The App facilitated reporting of rabies cases timely.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

7. Do you think timely reporting can help monitor disease outbreaks?

yes	1	2	no
-----	---	---	----

8. Do you think timely reporting can help identify areas at risk of diseases?

yes	1	2	no
-----	---	---	----

Completeness of Reporting

9. The App facilitated completeness of reporting of vaccinated animals.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

10. The App facilitated completeness of reporting of rabies cases.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

11. The App facilitated completeness of reporting of dog bite cases.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

12. Which of the following do you think contributes to incompleteness of reporting?

a) Lack of innovative reporting system.

Agree	1	2	3	4	5	Don't agree
-------	---	---	---	---	---	-------------

b) Lack of resources and incentives.

Agree	1	2	3	4	5	Don't agree
-------	---	---	---	---	---	-------------

c) Some health facilities are in remote areas with poor road network making it difficult for frontline workers to submit their reports.

Agree	1	2	3	4	5	Don't agree
-------	---	---	---	---	---	-------------

13. Can incompleteness of reporting lead to negligible timely feedback from decision makers?

yes	1	2	no
-----	---	---	----

Cost Effectiveness

14. Reporting using this App can be a cheaper way of notifying an outbreak to different stakeholders and the community across the nation.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

15. Reporting using this App can cut on the expenses that can be incurred if an officer was to travel from their station of duty in order to report.

Strongly agree	1	2	3	4	5	strongly disagree
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Quality of Data

16. Reported data cannot go missing or misplaced as compared to paper-based data hence improving data quality.

Strongly agree	1	2	3	4	5	strongly disagree
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17. The app enables one to access information anytime, anywhere and easily

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

18. The availability of the App can capture data from the community which is usually missed.

Strongly agree	1	2	3	4	5	strongly disagree
----------------	---	---	---	---	---	-------------------

Thank you for completing this questionnaire

iv. Data collection Form

Number	Sample ID	Date	Origin (N	Region (C	Age	Sex	Species	Breed	# Of Dog Vaccinati	# Of Vac	GPS Cor
1											
2											
3											
4											
5											
6											
7											