UNIVERSITY OF NAIROBI

PRECLINICAL CARE, CLINICAL MANAGEMENT, AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

BY

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A DISSERTATION SUBMITTED TO THE UNIVERSITY OF NAIROBI IN FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (PhD) IN TROPICAL AND INFECTIOUS DISEASES

DECLARATION

I, Stevens Kisaka, hereby declare that this dissertation is my original work and that to the best of my knowledge, it has not been presented to any institution (s) either partially or in total for any academic award (s), publication (s), or other use (s). Where other people's work or my own work has been used, it has properly been acknowledged and referenced in accordance with the University of Nairobi requirements. All previously published papers from this work were reproduced with permission from the publishers. I, therefore, present it to the University of Nairobi for consideration.

Signature: _____ Date: **November 14th, 2022**

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DEDICATION

To my late father, Mathias B. Tulabiddaawo (1944 – 2010) and my late sister, Lydia Namubiru (1982 – 1983). You always believed in my ability to succeed. It is this belief in me that has made this journey possible. You went too soon!!

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ABSTRACT

Uganda is endemic for rabies disease primarily transmitted to humans through dog bites. Although Uganda has established guidelines on appropriate wound care following dog bites, anecdotal reports of patients applying local regimens to treat dog bite wounds (DBWs) exist, posing the risk of clinical rabies and/or wound infections. The patterns of preclinical practices, their underlying causes, and their linkages to clinical management and outcomes are not well known. The main objective of the study was to assess the preclinical care practices, the clinical management for DBWs and their association with wound infection and other outcomes in the high rabies burden districts of Wakiso and Kampala in Uganda. The study was conducted in Mulago National and Entebbe General Referral Hospitals among patients presenting with dog bite injuries between March and October 2019. To assess the compliance with preclinical practices as recommended in the Uganda Clinical Guidelines (UCG), an explanatory sequential mixed methods study was conducted. A structured questionnaire was administered to patients with DBWs and thirteen in-depth interviews were conducted. To ascertain the determinants of compliance, prevalence ratios (PRs) were computed by the use of a generalized linear model (GLM) with Poisson family and a log link with robust standard errors. The qualitative data were analyzed following a deductive thematic approach. A total of 379 patients were recruited in the study. Nearly half (190/376, 50.5%) had a dog bite in Wakiso district, 201/376 (53.5%) were males, and 203/376 (54.0%) were aged 15 years and above. Seventy patients (18.6%) complied with the preclinical guidelines including washing the wounds with water and soap, and seeking medical care within 24 hours. Factors associated with a reduced likelihood of compliance include being aged 15 years or older; not being certain whether the same dog bit other people; and knowing the owner of the biter. Having a secondary or higher education, being employed, and believing the biting dog was sick was associated with increased likelihood of compliance. Secondly, to assess compliance to clinical guidelines on clinical management of dog bite injuries by healthcare workers, an exploratory qualitative study that used observation of healthcare worker-patient encounters; reviews of medical records; and in-depth interviews with healthcare workers was undertaken. A deductive thematic approach was used to analyse the data. The study found that verification and recording of history was not being done, DBWs were incorrectly classified, and ancillary laboratory tests such as culture and sensitivity were not being done. Antibiotics were being administered based on availability and affordability rather than UCG recommendations. Additionally, there was indiscriminate prescribing of the anti-rabies vaccine. Adherence to UCG was hampered by frequent anti-rabies vaccine stock outs, a lack of coordination/cooperation among post-exposure treatment (PET) centers, and a lack of knowledge and skills on DBWs and rabies management. Thirdly, to assess the antimicrobial resistance burden associated with DBWs, 199 patients with infected wounds had a swab sample from the wound collected and cultured under aerobic and anaerobic conditions. Antibiotic susceptibility testing was conducted using the disc diffusion method following the modified Kirby-Bauer method. Eighty four percent (168/199) of the swabs were culture-positive, yielding a total of 768

isolates, of which 406 (52.9%) were gram-positive bacteria. Among the gram-positive isolates, *S. intermedius, S. canis,* and *Corynebactrium spp,* were resistant to three classes of antimicrobial agents, while *S. aureus, S. pyogenes, E. feacalis, Lactobacillus spp* and *Lactococcus spp* were resistant to 4 or more classes of antimicrobial drugs. Among the gram-negative isolates, *P. vulgaris, C. werkmanii, E. asburiae,* and *Bacteriodes spp* were resistant to antimicrobial agents in three classes, while *P. mirabilis, K. pneumonae, K. oxytoca, M. wisconsensis, C. canimorsus, E. coli* and *B. zoohelcum* were resistant to 4 or more classes of antimicrobial drugs. Fourthly, the predictors of wound infection were determined via a GLM with the Poisson family and a log link with robust standard errors. Time to detection of wound healing was assessed by using Kaplan-Meier survival curves and used log rank test to test differences in curves. Bivariate logistic regression was used to explore relationships between the selected variables and delayed wound healing. The rate of wound infection among the participants was 52.9% at PET initiation. By day 7, the infection rate had dropped by 40% and 56 new infections had been realized. Having complied with UCG preclinical recommendations and having received conventional treatment before reporting for PEP significantly reduced the chances of infections by approximately 40% and 23%, respectively. Conversely, Category III wounds were associated with a 20% more chances infection at initial presentation than category II. Taken together, the study showed that: 1) compliance with preclinical guidelines was low; 2) clinical management of DBWs did not fully follow the UCG; 3) bacteria from DBWs were highly resistant to metronidazole, and there is a high rate of multi-drug resistance (MDR) to antibiotics commonly used to treat DBWs; and 4) deviations from preclinical guidelines by patients and PEP protocols by clinicians resulted in poor outcomes. This highlights the need for targeted health education programs; regulation of the activities of herbalists with regard to DBWs; interventions that reduce human-dog interactions in public spaces; adoption of an integrated bite case management system; continuing medical education programs for healthcare workers; revisiting metronidazole as one of the antibiotics of choice in UCG for the management of DBWs; enlisting DBWs for surveillance during routine antimicrobial resistance programs and the need for risk assessments before prescribing antibiotics for DBWs in rabies-endemic settings, and creation of awareness on post-exposure prophylaxis and making it available and accessible to the wider communities to minimize risk of human cases of rabies.

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ACRONYMS AND ABBREVIATIONS

AIC:	Akaike Information Criterion
AMR:	Antimicrobial Resistance
ARV:	Anti-rabies vaccine
AST:	Antibiotic susceptibility testing
CDC:	Centers for Disease Control and Prevention
CI:	Confidence interval
CME:	Continuing Medical Education
CoNS:	Coagulase-negative Staphylococci
DALYs:	Disability-adjusted life years
DBI:	Dog bite injury
DBW:	Dog bite wound
DMT:	District Medical (Health) Team
EMHSLU:	Essential Medicines and Health Supplies List for Uganda
EUCAST:	European Committee on Antimicrobial Susceptibility Testing
GLM:	Generalized Linear Model
HSB:	Health Seeking Behavior
IBCM:	Integrated Bite Case Management
IDI:	In-depth interview
KCCA:	Kampala City Council Authority
LMIC:	Low- and Middle-income countries
MDR:	Multiple drug resistance
MoH:	Ministry of Health, Government of Uganda

NHS: The National Health Service of the United Kingdom

NMS: National Medical Stores

NSAID: Non-steroidal anti-inflammatory drugs

OIE: *Office International des Epizootie*s (Changed to WOAH: World Organisation for Animal Health)

OR: Odds ratio

PCA: Principal Component Analysis

PEP: Post-exposure Prophylaxis

PET: Post-exposure Treatment (Therapy)

PR: Prevalence ratio

RV: Rabies vaccine

SES: Socio-economic status

UBOS: Uganda Bureau of Statistics

UCG: Uganda Clinical Guidelines

WHO: World Health Organization

OPERATIONAL DEFINITIONS

In this study, the following constructs and terms were used in various sections. Below, the meanings and definitions of such terms are presented, as applied to the study, including the sources, especially if the term is standard:

- Adherence: The degree to which a patient or health-care provider correctly follows medical advice and / or clinical guidelines. Another term used synonymously with adherence is "compliance" (WHO, 2003).
- Antibiotic: The type of antimicrobial drug used in the treatment and prevention of bacterial infections by either killing or inhibiting the growth of bacteria (NHS, 2014).
- Antibiotic resistance: The ability of bacteria to resist the effects of an antibiotic that once could have successfully treated those bacteria. Because of this, standard treatments become ineffective and the infection usually persists (WHO, 2016).
- Bioburden: The occurrence and number of microorganisms, particularly bacteria, within an injury / wound (dog bite, in this study) that has been presented for clinical management at the health facility.
- Category I bite: According to the WHO, this is when there is contact with the dog or the dog licks the intact skin of the victim. It is considered that there is no rabies exposure and, therefore, only washing of exposed skin surfaces is recommended with no post-exposure prophylaxis (WHO, 2018b).
- Category II bite: According to the WHO, this is when there is nibbling of uncovered skin, minor scratches or abrasions by the dog but without bleeding, hence resulting in minor

exposure. It is recommended that the wound be washed and the victim immediately given an anti-rabies vaccine (WHO, 2018b).

- Category III bite: According to the WHO, this constitutes a single or multiple transdermal dog bites or scratches, contamination of the mucous membrane or broken skin with saliva from dog licks. Since there is severe exposure, washing of the wound, administration of the anti-rabies vaccine, as well as rabies immunoglobulins are recommended (WHO, 2018b).
- Clinical management: Management of a dog bite at the health facility or according to the recommended guidelines and this includes treatment centered on local wounds as well as consideration of antimicrobials, tetanus prophylaxis, and rabies prophylaxis (WHO, 2014; O'Brien & Nolan, 2019).
- Dog bite: This is an injury inflicted upon a person by a dog using its teeth.
- Healthcare worker (health worker or procvider): A person whose profession is to deliver care and services to the sick and ailing either directly as doctors and nurses or indirectly as aides, helpers, laboratory technicians, or even medical waste handlers (Bobby & Merlyn, 2016).
- Incidence: This characterizes the number of new cases (i.e. people in a population who experience a dog bite injury) in a specific period of time. It reflects the rate at which new dog bite injuries are being added to a specific population (CDC, 2012).
- Infection: Invasion of an organism's body tissues by disease-causing agents (bacteria, in this study), their multiplication, and the reaction of host tissues to the infectious agents and the toxins they produce.

- Post-exposure prophylaxis: This is any preventive medical treatment started after exposure to a disease-causing organism, in order to prevent the infection from occurring. It is also called post-exposure prevention. In this study, PEP is within the context of rabies and tetanus. It involves immediately washing/flushing the wound with water and soap for 15 minutes; applying an antiseptic; anti-rabies vaccine administration; and administration of imunogloblins and a tetanus vaccine, if indicated (Wiktor et al., 1984; WHO, 2012; O'Brien & Nolan, 2019).
- Practice: The customary, habitual, or expected procedure or way of doing of something and in this study, it refers to the way the dog bite injury is managed (Oxford Dictionary, 2018).
- Preclinical care: The care that is applied to the dog bite injury either by the dog bite victim or their caretakers before the victim is presented to a healthcare facility for clinical management, for example, the treatment given at home prior to visiting the hospital / healthcare facility for conventional medical treatment (Jain & Jain, 2014).
- Traditional healing: The sum total of all knowledge and practices, whether explicable or not, used in diagnosing, preventing or eliminating a physical, mental or social disequilibrium and which rely exclusively on past experience and observation handed down from generation to generation, verbally or in writing; and health practices, approaches, knowledge, and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercise, applied singular or in combination, to treat, diagnose and prevent illnesses or maintain well-being (Bellchambers, Harris, Cullinan, Gaya, & Pepper, 1999).

LIST OF PUBLICATIONS

1) **Kisaka S**, Makumbi FE, Majalija S, Bangirana A, Thumbi SM. Epidemiology and preclinical management of dog bites among humans in Wakiso and Kampala districts, Uganda: Implications for prevention of dog bites and rabies. *PLoS One* (2020) Sep 21; 15 (9):e0239090. doi: 10.1371/journal.pone.0239090. PMID: 32956373; PMCID: PMC7505423.

2) **Kisaka S**, Makumbi F, Majalija S, Bahizi G, Thumbi SM. Delays in initiating rabies post-exposure prophylaxis among dog bite victims in Wakiso and Kampala districts, Uganda. *AAS Open Res* (2021), 4:49 (https://doi.org/10.12688/aasopenres.13311.2).

3) **Kisaka S**, Makumbi FE, Majalija S, Kagaha A, Thumbi SM. "As long as the patient tells you it was a dog that bit him, why do you need to know more?" A qualitative study of how healthcare workers apply clinical guidelines to treat dog bite injuries in selected hospitals in Uganda. *PLoS One* (2021) Jul 14; 16 (7):e0254650. doi: 10.1371/journal.pone.0254650. PMID: 34260651; PMCID: PMC8279313.

4) **Kisaka S**, Makumbi FE, Majalija S, Muwanga M, Thumbi SM. The potential for the double risk of rabies and antimicrobial resistance in a high rabies endemic setting: detection of antibiotic resistance in bacterial isolates from infected dog bite wounds in Uganda. *Antimicrob Resist Infect Control* 11, 142 (2022). https://doi.org/10.1186/s13756-022-01181-0.

CHAPTER ONE: GENERAL INTRODUCTION

1.0 Introduction

The interaction between humans and dogs, which has evolved over time, is built on mutual benefits. Historically, the dog was the first animal to be domesticated and had a deep influence on the course of early human history and civilization (Wiktor et al., 1984; Etheart et al., 2017). The origins of the domestication of dogs have been traced to South East Asia, approximately 33,000 years ago, though this is still contentious (Wiktor et al., 1984; Savolainen, Zhang, Luo, Lundeberg, & Leitner, 2002). Domestication and socialization were undertaken primarily because of the characteristics and skills that dogs possess, especially the ability to smell, hunt, and retrieve prey. People found these to be very useful to human survival. Over time, the benefits of this relationship have been expanded to include security, companionship, therapy, social-class symbolism, research, and food, among others (Magiorakos et al., 2012; Raza, Chander, & Ranabhat, 2013; Suswardany et al., 2017).

Although much of the relationship between dogs and humans is mutual, it is not without problems. One major problem is that dogs can bite not only their prey but also their masters or other people. Dog bite injuries (DBIs) among people constitute a huge health burden to societies in both developed and developing countries. In the United States, there are approximately 4.5 million dog bite injuries annually, with an estimated 30,000 of such cases requiring reconstructive procedures, while 3% to 18% develop infections (WHO, 2018a; Tuckel & Milczarski, 2020). Similarly, in England, the 7,227 hospital admissions for dog bites between March 2014 and February 2015 indicated an increase of 76% compared to the past decade (HSCIC, 2015). However, the situation is worse in the low and middle income countries (LMICs), with India reporting 17.4 million dog bites and between 18,000 and 20,000 cases of

human rabies annually (Gogtay et al., 2014). In Thailand, the number of dog bites is around 400,000, compared to Vietnam and Bangladesh, which register approximately 350,000 and 300,000 bites per year, respectively (Gongal & Wright, 2011; Lee et al., 2018). Kenya registered 146,362 animal-bite injury cases and 858 confirmed human rabies cases between 2002 and 2012. The latter were caused by owned free-roaming dogs (Zoonotic Disease Unit, 2014).

However, the burden of dog bite injuries takes on a different dimension in terms of incidence and bite circumstances in low- and middle-income countries (LMICs) as compared to the developed world (WHO, 2013a). Unlike in developed countries, where domestic dogs are responsible for most of the bite injuries, stray dogs (particularly in Asia) and free roaming dogs with traceable ownership (particularly in Africa) cause the majority of bite injuries in LMICs. Nonetheless, in many cases, the origin and owner of these dogs are unknown in LMICs. Dogs in LMIC's usually do not receive the sufficient veterinary and management. They are left to roam freely, and this increases the risk of bites to people by approximately 50% as a result of increased chances of interaction between the dogs and people (Millán J. et al., 2013; Pfortmueller, Efeoglou, Furrer, & Exadaktylos, 2013).

The occurrence of dog bites has been attributed to the interplay between human, dog, and environmental risk factors. These risk factors vary from setting to setting. Human disturbances, threats, and territorial invasions (Marina Morgan & Palmer, 2007; Rezac, Rezac K, & Slama P, 2015) have been singled out as major risk factors, especially for young males in Belgium, the USA, Asia, and Africa (Gershman, Sacks, & Wright, 1994; Keuster, Lamoureux, & Kahn, 2006; Sambo M et al., 2013; Samanta et al., 2016). In Canada, risk factors include sick dogs on treatment, food aggression, initially sharing a bed with the owner, small breeds, exhibiting fear of children, and strangers (Guy et al., 2001). In Uganda, the bites are mainly from dogs whose

ownership is unknown, a common reference to stray or wild dogs (Wangoda, Nakibuuka, Nyangoma, Kizito, & Angida, 2019). Other factors like the dog's breed, sex, socialization, training, health, reproductive status, and quality of ownership have been associated with bites (Gershman et al., 1994; AVMA, 2001; Marina Morgan & Palmer, 2007; Shuler, DeBess, Lapidus, & Hedberg, 2008). Furthermore, some authors have emphasized the role of spatial and environmental factors in promoting dog bites (Beyene, Mourits, Revie, & Hogeveen, 2018). They contend that summer weather, a shining moon, and the presence of children and other dogs contribute to the frequency of bites (Tipping & Segall, 1995; Hsiao et al., 2012).

Dog bites have a wide spectrum of temporary and/or lasting consequences. They not only result in direct injury but may also expose the victims to rabies, disability, disfigurement, fear and anxiety with associated morbidity and death (Patronek GJ., Sacks JJ., Delise KM., Cleary DV., & Marder AR., 2013; WHO, 2013b; Huang et al., 2017). In terms of global mortality, rabies is responsible for more than 59,000 human deaths annually, of which 99% occur in Africa and Asia, where rabies is endemic (Aidaros, 2015; Hampson et al., 2015). Notably, children under the age of 15 account for more than half of these deaths (WHO, 2013b; Ezra Olatunde Ogundare et al., 2017). In Africa, where close to half of the global bites occur, studies have estimated the rabies burden in humans to be between 21,000 and 25,000 deaths, in addition to disability-adjusted life years (DALYs) amounting to approximately 609,000 (WHO, 2013b; Adesina, Olufadewa, OgaH, & Nwachukwu, 2020). This just adds to the cost of management, which constitutes an enormous economic burden on households and health systems. Globally, there is a 6-billion-dollar annual monetary loss and more than 1.9 million DALYs attributed to dog bites. In Vietnam alone, the total economic impact of canine rabies was over $719 million USD from 2005 to 2014, with 92% of the impact being costs related to post-exposure prophylaxis (PEP)

(Chibwana, Mathanga, Chinkhumba, & Campbell, 2009). In East Africa, dog vaccinations to prevent rabies result in a cost of approximately $400 per life saved (Mwangome, Prentice, Plugge, & Nweneka, 2010). These highlight the seriousness and the broad range of the consequences of dog bites across societies.

Due to the significance of the consequences of dog bite wounds (DBWs) described above, the World Health Organization (WHO) developed guidelines on their management and post-exposure treatment (WHO, 2012). It is from these general guidelines that Uganda's Ministry of Health formulated the Uganda Clinical Guidelines (UCG), which indicate how to care for dog bite victims before presenting for medical care (preclinical) and during clinical treatment (MoH, 2016b). The recommended preclinical practices include immediate cleaning of the wound thoroughly with plenty of clean water and soap to remove any dirt or foreign bodies (Diallo, Diallo, Dicko, Richard, & Espié, 2019). The bite patients should seek medical attention at the healthcare facility immediately.

At the healthcare facility, the guidelines recommend that the wound be rinsed and allowed to dry before applying antiseptics like chlorhexidine solution 0.05%, hydrogen peroxide solution 6%, or povidone iodine solution 10% (M. R. Smith, Walker, & Brenchley, 2003; Aziz et al., 2015). Supportive therapy is recommended to treat shock if any or if swelling is significant, in which case analgesics are administered and the patient is immobilized. Lastly, tetanus prophylaxis, prophylactic antibiotics, immunoglobulins, and anti-rabies vaccine are given depending on the vaccination status, culture and sensitivity results, as well as wound characteristics and their WHO classification (Herbert, Basha, & Thangaraj, 2012; Sabhaney & Goldman, 2012). In summary, the management guidelines are framed to alleviate pain; prevent progression to

clinical rabies; avert the development of tetanus; and avoid bacterial infection of the wounds as well as promote wound healing.

However, these preclinical guidelines by the WHO are not always followed by dog bite victims across different societies. For instance, in the US, of the estimated 4.5 million annual dog bite victims, only about 885,000 report to healthcare facilities for medical care (Gilchrist, Sacks, White, & Kresnow, 2008). Likewise, it is estimated that only one third of those bitten by dogs in the United Kingdom (UK) actually proceed to receive further medical treatment (Westgarth, Brooke, & Christley, 2018). Similarly, in areas like Bhutan, up to 39% of dog bite victims do not seek post-exposure prophylaxis (Shaikh & Hatcher, 2004; Tepsumethanon, Wilde, & Meslin, 2005). Even among those who seek medical care, there are those who delay, and this may compromise outcomes since the course of tetanus, rabies, or even wound infection may have started earlier (Tepsumethanon et al., 2005; Barbosa Costa et al., 2018). Such delays have been reported in Uganda, coupled with to victims not washing their wounds with soap and water. In addition, preclinical treatment of DBWs with herbal or traditional concoctions prior to presenting at health facilities has been reported before (Kato, 2015). This illustrates the variability in preclinical practices and divergence from the standards across societies.

Just like in the preclinical phase, there is variability in the clinical management of dog bite wounds at healthcare facilities. Many times, health workers do not sponge away visible dirt, or perform copious irrigation and debridement of devitalized tissue. In addition, infection risk assessment through a careful evaluation of bite circumstances and patient needs are not done before the administration of prophylactic antibiotics as recommended (MoH, 2016b, WHO, 2010). Furthermore, antibiotic sensitivity tests are not routinely conducted for dog bite injuries, yet they are recommended in the UCG. Missing the benefits of sensitivity tests poses significant

risks to patients in terms of finances, side effects, and the development of antimicrobial resistance (M. R. Smith et al., 2003). Coupled with this, not completing treatment, especially the anti-tabies vaccine, is a common observation among patients in Iran, India, and Benin (Aghahowa & Ogbevoen, 2010; Kassiri, Kassiri, Mosavi, Jashireh, & Lotfi, 2014; Poorolajal, Babaee, Yoosefi, & Farnoosh, 2015; S. Sharma, Agarwal, Khan, & Ingle, 2016). In Uganda, 41% of patients who present with bites from suspected rabid dogs, do not complete the course of post-exposure treatment, resulting in 1.26 rabies deaths per 100,000 people (Fèvre et al., 2005).

Preclinical and clinical practices that deviate from the standards may lead to undesirable outcomes. These undesirable outcomes may include bacterial infections such as from *Staphylococci, Streptococci, Pasteurella*, and *Capnocytophaga canimorsus*, among others, which have been found in up to 30% of dog bite patients in the United Kingdom (Murray, 2017), and may lead to delayed healing. In addition, undesirable outcomes may include death associated with rabies infection, though some other unexplained causes may also play a role (Aghahowa & Ogbevoen, 2010; Sharafi et al., 2016). However, there is a scarcity of data on adherence to existing preclinical and clinical guidelines as well as the quantification of the effects of poor or lack of adherence on dog bite outcomes. This study evaluated the level and determinants of adherence to preclinical and clinical guidelines by bite victims and health workers, respectively. In addition, it assessed the antimicrobial susceptibility of bacterial isolates from the bite wounds. Lastly, the study determined the effect of preclinical practices, clinical management, and bioburden of the dog bite injury on wound infection and other treatment outcomes such as wound healing, time to detection of healing, and rabies.

1.1 Problem statement

In Uganda, dog bite injuries among humans pose a significant public health burden, including being a source of fatal infections, physical disfigurement, and psychological effects. Data from the Ministry of Health show an increase in bites recorded in healthcare facilities, with 20,764 bites recorded in 2015 and 28,725 bites in 2020, indicating a 38.3% increase (MoH, 2016a). In addition, between 2001 and 2015, Uganda registered 486 deaths as a result of suspected human rabies (Masiira et al., 2018). However, some authors have estimated the per capita annual death rate from rabies to be at 0.39/100,000 resulting into approximately 156 human deaths per year (Hampson et al., 2015). The victims of these bites are exposed to an increased risk of rabies; tetanus; physical disfigurement; and mental health effects like fear and anxiety, among others. These risks have often resulted in stigma, morbidity, and death.

The Ministry of Health (Uganda) developed and introduced the Uganda Clinical Guidelines (UCG) for managing dog bites, although there is limited knowledge on how they are adhered to. At the preclinical level, a low prevalence of wound washing with soap and water has been previously reported in the country. Previous studies have reported that 41% of patients presenting with bites from suspected rabid dogs do not complete the course of post-exposure treatment (Fèvre et al., 2005). In addition, anecdotal reports show that some victims resort to local regimens like herbs and soil to treat dog bite wounds (Kato, 2015). Such deviations from standards may result in an increased risk of developing clinical rabies and death; bacterial infections, as well as other complications such as tetanus, among others. Although some studies have attempted to describe the patterns of preclinical practices, the underlying causes of these practices have rarely been evaluated, thereby failing to offer pertinent recommendations.

Furthermore, compliance with UCG during the clinical management of DBWs has not yet been established. Healthcare workers also do not assess the bio-burden of DBWs in routine practice before administering antibiotics, something that contravenes the UCG. Such practices not only raise the cost of treatment but also have the potential to propagate antimicrobial resistance. Additionally, reports of stock-outs of essential medicines and vaccines for treating dog bites are common. This prompts the health workers and the dog bite patients to improvise the treatment in deviation from the recommended standards. Combined with poor preclinical practices, clinical management that deviates from guidelines may further complicate the treatment outcomes. This study, therefore, investigated the level and determinants of compliance with or adherence to preclinical and clinical guidelines; the antimicrobial susceptibility of bacterial isolates from bite wounds, and the effect of all these on wound infection and other treatment outcomes.

1.2 Study objectives

1.2.1 General objective

To assess the preclinical care practices, clinical management and antimicrobial resistance burden associated with dog bite injuries among humans and their influence on wound infection and other treatment outcomes in high rabies burden districts of Wakiso and Kampala (Uganda) in order to inform treatment guidelines, public health policy and improving patient care.

1.2.2 Specific objectives

i) To determine the preclinical practices for humans following dog bites and adherence to recommended guidelines.

ii) To asess the level of compliance / adherence to the recommended clinical guidelines on treating DBWs at selected post-exposure treatment centers.

iii) To determine the antimicrobial resistance burden associated with DBWs among dog bite patients presenting to the selected post-exposure treatment centers.

iv) To determine the risk factors for infection and other outcomes of dog bite injuries.

1.3 Specific research questions

a) What are the preclinical practices undertaken for dog bite patients in Wakiso and Kampala districts?

b) How do healthcare workers in selected hospitals in Wakiso and Kampala districts, treat dog bite injuries in comparison to recommended clinical guidelines?

c) What are the antimicrobial susceptibility profiles of bacteria associated with dog bite wounds among patients presenting to the selected health facilities in Wakiso and Kampala districts?

d) What are the risk factors for infection and other outcomes of dog bite injuries among patients within an 18 months' duration in Wakiso and Kampala districts?

1.4 Significance of the study

The results of this study have the potential to be used to promote awareness about dog bites and improve the management of DBWs for those who present to healthcare facilities for PEP. The findings on the epidemiology of the bites may also be used to explain and understand why dog bites and the poor outcomes of dog bites persist in Ugandan communities. The data on management practices and associated factors may help to identify population and health workers' needs and, as such, ease uptake of proposed interventions to prevent and control dog bites and

poor outcomes such as rabies and DBW infection. In addition, it may empower local communities to advocate for and seek timely treatment. The data gathered on the bioburden and antimicrobial resistance will guide the refinement of dog bite treatment policies and guidelines.

CHAPTER TWO: LITERATURE REVIEW

Key words: *dog bite, antimicrobial resistance, post-exposure prophylaxis, preclinical, clinical, practices, outcomes.*

2.1 Introduction

Dog bites among humans are injuries caused by dogs primarily through the use of their teeth (Shantavasinkul et al., 2010; National Canine Research Council, 2013). Such injuries expose the victims to the risk of rabies, tetanus, psychological challenges (like anxiety) and physical disfigurement. In turn, there is stigma, morbidity, hospitalization, and deaths among the victims (Peters, Sottiaux, Appelboom, & Kahn, 2004; MacBean, Taylor, & Ashby, 2007; Golinko, Arslanian, & Williams, 2017; Ngugi, Maza, Omolo, & Obonyo, 2018). Further, there are also consequences for biting dogs, ranging from relinquishment and seizure to euthanasia (Wilde et al., 1996; Kopel, Oren, Sidi, & David, 2012; WHO, 2018b). These injuries are on the increase in Uganda (Kato, 2015; MoH, 2016a). Despite this, coupled with an exponential increase in injuries as a result of dog bites among people in Uganda, the preclinical and clinical practices undertaken for dog bite victims remain generally undescribed. Furthermore, the influence of such practices on outcomes has not been well studied. The literature presented in this chapter focuses on preclinical practices, clinical management, and outcomes of DBWs within a Ugandan context.

This chapter reviews previous published work on the focus of this research. To obtain literature, the research question was broken down into key thematic areas, including pre-treatment management; preclinical care; clinical management; antimicrobial therapy and resistance; as well as treatment outcomes. For each theme, keywords, phrases, synonyms, and alternative spellings were identified. They were later used to search for the literature in *Cochrane*, *Embase* and

Pubmed databases. Only papers published in English were selected according to publication date, country of origin, study design, and study population. The chosen papers were systematically reviewed in terms of objectives, methods, and findings. In summary, collecting literature to review existing critical opinions and theories, as well as research findings and then selecting research methods for this study, was based on a systematic approach.

This chapter starts with a summarized description of gaps in the literature pertaining to preclinical care, clinical management, and outcomes of DBWs. Afterwards, evidence from various literature sources, together with methodological shortfalls of specific studies, is assessed. The various explanations for the occurrence and burden of dog bites are discussed. Later, literature on types and patterns of preclinical practices for dog bite victims, including what influences such health seeking behavior, is presented. The section then reviews literature on the clinical management of dog bites based on clinical and microbiological assessment; antimicrobial therapy and the resistance of bacterial isolates; treatment and level of adherence to treatment by healthcare providers. Lastly, literature on treatment outcomes and their determinants is reviewed.

2.2 Research gaps and what remains to be known

Generally, research on preclinical and clinical practices of dog bite victims and health workers as well as the bio-burden and treatment outcomes of dog bites had gaps. The full scope of complexity of deviation from recommended practices and its consequences / implications on treatment outcomes had not adequately addressed. This paucity of information may be limiting the design of interventions directed towards the prevention, control, and management of dog bite injuries.

Most of the studies reviewed on divergent preclinical and clinical practices are mainly quantitative and rarely explore the reasons why victims in different societies deviate from standard guidelines (Agarvval N & Reddaiah VP, 2003; Jain & Jain, 2014; Messam, Kass, Chomel, & Hart, 2018; Park et al., 2019; Penjor, Tenzin, & Jamtsho, 2019). Although the practices vary by setting (Aghahowa & Ogbevoen, 2010; Jain & Jain, 2014; Tschopp, Bekele, & Aseffa, 2016; Dhiman, Thakur, & Mazta, 2017), little is known about what dog victims preclinically do in Uganda. Even the clinical practices in health facilities are not fully known or described. In addition, previous studies made little or no effort to assess the consequences of these practices on outcomes. In conclusion, this study addresses this gap by exploring the reasons for and dangers of violating standard preclinical and clinical guidelines for dog bite management.

Secondly, microbiological examination of dog bite injuries occupies a critical step in the treatment. It guides the choice of therapeutic or prophylactic antibiotics to be used in wound management. However, it is not routinely done in Uganda. Much as the usefulness of bacterial assessment is still questionable (E. J. C. Goldstein, 1989; M. Morgan, 2005; Quinn, McDermott, Rossi, Stein, & Kramer, 2010), it forms the basis of sensitivity tests that are recommended in national clinical guidelines (MoH, 2016b). Consequently, bacterial strains commonly present in cases of DBIs are not known. Worse still, their sensitivity to recommended antibiotics cannot be predicted, yet antimicrobial resistance in strains isolated from dog bite injuries (DBIs) has been reported elsewhere (Malik, Peng, & Barton, 2005; Meyers, Schoeman, Goddard, & Picard, 2008; Damborg et al., 2016). This formed the basis for this study, which not only examined the bacteriology of these wounds but also evaluated the sensitivity of isolates to recommended antibiotics.

Thirdly, the rate and drivers of compliance with set guidelines for managing dog bites vary not only across but also within socio-cultural settings. In multiple studies, the rates of compliance differ even within the same country (A. Sharma, Bhuyar, Bhawalkar, & Pawar, 2007; Aghahowa & Ogbevoen, 2010). Moreover, studies done so far on the subject have each yielded a unique timing of non-compliance ranging from pre-clinical to post-exposure prophylactic anti-rabies vaccine (Romero-Sengson, 2013; Anandara & Balu, 2017). Additionally, these studies were purely quantitative and do not provide a deeper understanding as to why healthcare providers do not comply. To add to this, factors associated with it also follow a similar trend of variation, just like rates (Romero-Sengson, 2013). This means that available information from elsewhere cannot be extrapolated to Uganda. Therefore, this research had to investigate it within the local context in order to derive only that data relevant to the setting.

Lastly, there are few studies that followed up patients to examine the outcome. The majority of these studies relied on clinical records, which they prospectively evaluated to draw conclusions on management outcomes (Wilde, 2007; Tarantola et al., 2015; Ogundare et al., 2017; Tarantola, Tejiokem, & Briggs, 2019). This means they missed patient perspectives as to why they had certain outcomes and what they made of them. Additionally, some studies do not have a clear definition of outcomes like rabies and infection, which limits their conclusions (Griego, Rosen, Orengo, & Wolf, 1995; WHO, 2018b). Furthermore, no study had previously evaluated the association between preclinical practices, initial bio-burden, and outcomes. Hence, there was a necessity to undertake a more comprehensive study to evaluate these for the main purpose of guiding both clinical and public health actions.

2.3 Why do dogs bite?

The adaptation of dogs to domestic life has evolved over several centuries. As such, their association with humans has also improved. Subsequently, their use across societies has expanded from just hunting and security to social and healthcare needs. However, in some dogs, aggressive behavior, reminiscent of wild instincts, still remains and has led them to attack and bite humans (Bowler, Duerden, & Armstrong, 2001; Salomão et al., 2017; Omoke & Chukwueloka Onyemaechi, 2018). In line with this, authors have argued that dogs do not attack their targets for no reason. They bite because they are reacting to a stimulus, for example, the need to defend themselves or their territory. When they feel scared or startled, they tend to respond by biting, especially if they have something valuable to them that they seek to protect, e.g., their puppies. In addition, they may bite due to the need to be left alone, especially when they are sick. Lastly, even in happy situations, dogs may bite. Exciting a dog during play, for example, might cause it to nip or even bite the people it is interacting with at that time (Jemberu, Molla, Almaw, & Alemu, 2013). In summary, the human-dog relationship, much as it is mutually beneficial, presents complexities and challenges, especially those that come from bites.

2.4 Burden of dog bite injuries

There is a high likelihood that much of the data available across societies on the burden of dog bites are potentially inaccurate. The reason for this is that most of the studies on the burden of dog bites are based in healthcare facilities like PET centers (Weiss, Friedman, & Coben, 1998; Abubakar & Bakari, 2012; Salomão et al., 2017). In the United States, the overall incidence of dog bites is reported as 1.3 per 1,000 people, but this statistic was drawn from only for those that sought treatment (Weiss et al., 1998). Similarly, a population-based study estimated that in the

USA, the bite rate in communities was six times greater than that which sought medical attention (Sacks, Kresnow, & Houston, 1996). This shows that compared to community surveys, healthcare facility-based surveys are not able to yield good estimates of the burden.

Despite the weaknesses described above, facility-based data has been used as a proxy to quantify the burden of dog bites and rabies in Uganda. Using healthcare facility-based passive surveillance, it was estimated that 6,601 dog bites to humans occur each year in Uganda (Fèvre et al., 2005). Secondly, in their study on animal bites in Uganda, Masiira and others estimated that up to 196,000 animal bites were inflicted by dogs during a period of 15 years (Masiira et al., 2018). When translated into annual terms, the latter estimate approximately doubles the previous one. Just like other studies in Chad reported (Kayali, 2003; Lechenne, 2016), the two studies in Uganda agree that dog bites constitute over 90% of the animal bites reported in healthcare facilities.

2.5 Preclinical practices for dog bite injuries

2.5.1 Types and patterns of preclinical practices

Health authorities recommend a number of preclinical guidelines to be undertaken for those who have been bitten by dogs in Uganda. These guidelines are based on national laws and World Health Organization (WHO) guidelines (Government of Uganda, 1935a; WHO, 2012). Firstly, the Public Health Act 1935 outlines the immediate measures to be taken in case of a dog bite. More importantly, the Act states that the biting dog should be identified and, if it is not exhibiting any clinical signs of rabies, then it should be carefully watched for the next ten days. However, if it has clinical signs of rabies, then it should be euthanized and beheaded for the brain to be analyzed at necropsy for lesions caused by the rabies virus (Government of Uganda,

1935a). Secondly, Uganda Clinical Guidelines (UCG) emphasize that the bite wound be irrigated and washed immediately with plenty of clean soap and water to remove any dirt or foreign bodies (MoH, 2016b). Washing not only reduces the viral load, if the dog is rabid, but also reduces the bacterial burden due to the bite and dirt. Lastly, the victim should be taken to a healthcare facility for clinical attention as soon as possible. In summary, preclinical guidelines focus on both the health of the biting dog and the patient.

However, it has been reported regularly in literature that dog bite victims do not adhere to the preclinical guidelines. Studies suggest that guidelines are not fully implemented for dog bite victims in various socio-cultural settings across the world. In the USA, out of the 4.5 million people bitten by dogs annually, around 900,000 seek conventional medical care (Gilchrist et al., 2008). Conversely, even among those that seek care, delays in reporting to the health facility are a common finding with a variance in the average time of delay across different settings (Keuster et al., 2006; Hampson et al., 2008; Aghahowa & Ogbevoen, 2010; Liu et al., 2017). In India, levels of washing the wound with water and soap as low as 58.5% have been reported (Ichhpujani et al., 2008). Worse still, in this region, some victims reportedly attempt treatment of their wounds with unrecommended materials such as turmeric powder, lime, chillies, salt, lime, snuff powder, acidic liquids, and ash. These are usually provided by magicians and traditional healers in the said localities (Sudarshan et al., 2006; Gogtay et al., 2014; Tschopp et al., 2016). A similar situation has been observed in Uganda, where traditional herbal concoctions are reportedly used (Kato, 2015). In conclusion, there is evidence of a wide array of preclinical practices that needed to be systematically and specifically documented across societies.

2.5.2 Factors influencing the health seeking behavior of dog bite victims

In sub-Saharan Africa and Asia, patterns of resort for numerous diseases have been studied in the broad context of health-seeking behavior. Such patterns are influenced by various factors, including geographical, social, economic, cultural, and organizational factors like the accessibility of healthcare facilities (Tipping & Segall, 1995; Shaikh & Hatcher, 2004). A good example is that in Malawi, patterns of resort for children under five years of age were determined by traditional beliefs, unavailability of drugs, inaccessible formal healthcare systems, and trust in traditional medicines (Chibwana et al., 2009). Other factors include gender and education level in Gambia; cultural beliefs and religion in Nigeria; and the fate of animals thought to have transmitted the disease in Thailand (Feyisetan, Asa, & Ebigbola, 1997; Tepsumethanon et al., 2005; Mwangome et al., 2010). With regard to DBIs, the severity of bites, body parts involved, dog ownership, and rabies vaccination status of the biting dog also influence the victims' resort to medical care (Knobel et al., 2005; Sambo, Cleaveland, Ferguson, & Sikana, 2014; Barbosa Costa et al., 2018). In Ethiopia, the predictors for seeking healthcare include being bitten by unknown dogs, the severity of the bite, the body part bitten, economic status, and distance to the healthcare center (Beyene et al., 2018). In short, for each sociocultural setting, seeking medical care is informed by specific factors.

As observed above, most studies on preclinical practices are riddled with shortcomings. Many of them use quantitative methods only and do not explore the reasons why victims in different societies deviate from guidelines (Gilchrist et al., 2008; Ichhpujani et al., 2008; Gogtay et al., 2014). While Ichhpujani and colleagues followed up patients, they only assessed rabies as an outcome which they associated with delays and failure to seek timely and appropriate treatment (Ichhpujani et al., 2008). Similarly, Gogtay and others only assessed completion of the regimen

of the PEP vaccine and attributed non-completion to patients lacking funds (Gogtay et al., 2014). Notably, however, in the majority of studies, there is evidence to conclude that there has been no demonstrable effort to understand why victims undertake such practices and also have these practices linked to outcomes. In short, the current study was premised on such shortcomings because it comprehensively clarifies the practices and links them to outcomes.

2.6 Clinical management of dog bite wounds

2.6.1 Clinical assessment of dog bite injuries

There is a laid down process of evaluating and characterization of dog bite wounds to guide treatment. As a first step in assessment, Murray emphasizes good history taking to enable the practitioner to assess all the elements involved, e.g. dog breed, size of dog, circumstances, time, place, and infection risk (Murray, 2017). Furthermore, WHO classifies the bites into: Category I, where the victim's skin remains intact; Category II, which presents with minor scratches but with no bleeding as a result of contact, or licks on broken skin; and Category III, where there are one or more wounds, scratches, licks on the skin that is broken, or other contact that breaks the skin) (WHO, 2013a). However, a number of studies rely on a grading system developed by Lackmann which classifies the bit injuries into: stage I (superficial injury not involving muscle), stage II (deep injury involving muscle), stage III (deep injury involving muscle, with loss of tissue), stage IVA (stage III characteristics and injury to vessels or nerves) and stage IVB (with stage IVA features and bone involvement) (Lackmann, Draf, Isselstein, & Tollner, 1992). Nonetheless, it is advised that the location of the bite also be assessed because it is associated with the risk of infection (N. Thomas & Brook, 2011; Esposito, Picciolli, Semino, & Principi, 2013). As seen in

various approaches, it can be concluded that clinical characterization of DBIs is based on site or location, number, and severity of the bite.

Studies that have characterized the location of bite wounds have yielded mixed results. Many authors contend that legs and hands are the most affected body parts among patients (Ioannidou, Galanis, Tsoumakas, & Pavlopoulou, 2012; Dehghani R., Sharif A., Madani M., Kashani H. H., & Sharif M. R., 2016; Sharafi et al., 2016). However, Murray affirms that there is a connotation between the age of the victim and the location of the bite. This author states that among children, facial wounds are the most common due to their short height, but agrees with others that hand injuries are the most frequent for adults (Murray, 2017). Contrary to this, findings from a community survey that showed that leg injuries are the most common in rural India dispute the notion of hand injuries being the most common (Agarwal & Reddajah, 2004). This view is supported by a review of animal bite reports in the USA (Lyu et al., 2016). On the other hand, when it comes to associations with outcomes, various authors agree that hand injuries are the most prone to infection (Mannion & Graham, 2016). Conclusively, this illustrates the conflicting information on locations of the body that are frequently affected by dog bites.

2.6.2 Microbiological assessment of dog bite injuries

Whether clinically infected or not, dog bite injuries usually present with complex bacteriology. Understanding this microbiology is important because bacteriology not only complements clinical examination to facilitate treatment but may influence outcomes like infection (Mouro, Vilela, & Niza, 2010). However, the bioburden of dog bites varies in terms of species and quantity (Talan, Citron, Abrahamian, Moran, & Goldstein, 1999). On quantity, various authors estimate that on average, a dog bite wound contains 2–5 different species of bacteria depending

on whether the wound is an abscess, purulent or non-purulent. Additionally, the source of bacteria is also complex. They are usually derived from either the oral flora of the dog, the skin of the victim, the environment, or all three. Nonetheless, contrary to what is expected, the yield of bacteriologic isolates is not related to the interval between the bite and specimen collection or between specimen collection and culture (Talan et al., 1999; Rothe, Tsokos, & Handrick, 2015). This demonstrates the complexity of dog bite bacteriology.

Despite this complexity, dog bite injuries usually present with mixed anaerobic and aerobic bacteria. Among the aerobes isolated are *Staphylococcus* ssp, *Pasteurella* spps *(P. multocida, P. canis, P. dagmatis), Capnocytophaga canimorsus, Bacillus, Actinomyces*, and *Corynebacterium* spps, as well as many others. However, in all studies, *Pasteurella spp* is the most common, comprising up to 50% of isolates from dog bites (Abrahamian & Goldstein, 2011; N. Thomas & Brook, 2011; Ward, 2013). In addition, an emerging syndrome of meticillin-resistant *S. aureus* (MRSA) infections shared between pets and people has been described (Oehler, Velez, Mizrachi, Lamarche, & Gompf, 2009). Still, anaerobes are isolated more frequently from abscesses than other types of infections (Talan et al., 1999). These include, but are not limited to, Bacteroides, Clostridia, Fusobacteria, Porphyromonas, Prevotella, Propionibacteria, and Peptostreptococcus (Meyers et al., 2008; Ward, 2013). In summary, both clinically as well as non-clinically infected DBWs can yield a combination of aerobic and anaerobic bacteria.

2.6.3 Clinical treatment of dog bite injuries

Clinical therapy for dog bites is both local and systemic. Local treatment involves sponging away visible dirt, copious irrigation, and debridement of devitalized tissue (MoH, 2016b). In addition, for puncture wounds and those that are more than 8 hours old, primary wound closure

should not be done (Sabhaney & Goldman, 2012). On the other hand, systemic therapy involves the use of antibiotics, tetanus toxoid, and rabies vaccine after a careful assessment of patient needs (MoH, 2016b, WHO, 2010). The intention of using antibiotics is to prevent the progression of bacterial infection as well as stop bacterial growth. Secondly, the tetanus toxoid and the rabies vaccine are intended to halt the progress of tetanus and rabies disease, respectively. This is a synopsis of the local and systemic treament as well as its intended benefits.

Although specific antibiotics are recommended for dog bite wound treatment, their use is surrounded by scientific controversy. The benefits of antibiotic prophylaxis following a dog bite are still under question and debate. This is because there is limited evidence to support their routine use. While some authors believe that antibiotics are beneficial (Cummings, 1994), others believe that they are ineffective for prophylactic purposes (Medeiros & Saconato, 2001; Marina Morgan & Palmer, 2007). However, this conflict is based on studies that relied on poor methodological approaches. In general, the studies are old; tested antibiotics that are no longer in use; and their designs are characterized by small numbers of participants (Cummings, 1994; Medeiros & Saconato, 2001). In conclusion, the evidence on the use of antibiotics is not only contradictory but also based on methodologically questionable studies, which this study addresses.

Regardless of this, antibiotics for dog bite patients are still recommended in Uganda, albeit with some challenges. Antibiotics like metronidazole, methicillin, amoxicillin/clavulanic acid, doxycycline, and cotrimoxazole are recommended in UCG but with a caveat that they are used after sensitivity tests (MoH, 2016b). However, sensitivity tests are not routinely performed for patients in clinical practice in the entire country. Missing the benefits of sensitivity tests poses

significant risks to patients in terms of finances, side effects, and the development of antimicrobial resistance (M. R. Smith et al., 2003). Already, the latter has been widely reported in dog bite wounds (Meyers et al., 2008; Gustavsson, Johansson, Monstein, Nilsson, & Bredberg, 2016). In conclusion, given the widespread use of antibiotics and the literature's disagreement on their usefulness, there is a need to evaluate their effectiveness on common potential infections such as *Pasturella multocida*, *Staphylococcus aureus*, *Pseudomonas aeruoginosa*, β-hemolytic streptococci, and *Clostridium tetani*, among others.

2.6.4 Context of clinical management of dog bites in Uganda

2.6.4.1 Legal context of clinical management of dog bite wounds

The laws of Uganda ascribe particular emphasis to dogs, dog bites, and rabies. Broadly, the National Objectives and Directive Principles of State Policy XIV (b) of the Constitution of Uganda obligate the State to fulfill the fundamental rights of all Ugandans to enjoy rights and opportunities, as well as access to health services (Government of Uganda, 1995). It is from this that the subsequent laws and regulations relating to the clinical management of rabies are drawn. Section 10: 1(e) of the Immunization Act 2017 allows the administration of vaccines whenever so required, pursuant to applicable international practices. In addition, there are specific international practices elaborated in the World Health Organization's recommendations for Rabies vaccines and immunoglobulins (WHO, 2012).

Furthermore, the Rabies Act 1935 places duties on owners and persons in charge of diseased or suspected dogs. This Act obligates every owner or person in charge of a suspected diseased dog to cause it to be destroyed or to be securely tied or otherwise confined (Government of Uganda, 1935b). This avails the opportunity to observe the dog while the patient is undergoing clinical

management. In line with this Act, the Kampala City Council Authority (KCCA) additionally passed the Livestock and Companion Animals Ordinance 7. Section 12 of this Ordinance makes it the responsibility of the owner of livestock suspected to have rabies to immediately notify the veterinary officer of the Council or the local council authority of the area or the police of his or her infected livestock (Kampala Capital City Authority, 2006). Further, the Ministry of Health developed the Uganda Clinical Guidelines (UCG) that particularly give the procedures that healthcare workers must undertake for dog bite patients, including patient assessment and treatment regimens within the framework of the Rabies PET Guidelines (MoH, 2016b).

2.6.4.2 Context of vaccines and drugs for clinical management of dog bite wounds

Annually, Uganda allocates approximately UGX 7 billion ($1.9 million) to rabies management and this investment largely goes to the procurement of pre-exposure as well as post-exposure prophylaxis (PEP) vaccines for humans. In addition, the funds also cater for rabies vaccination for cats and dogs (Omodo et al., 2020). The Government of Uganda mandated the National Medical Stores (NMS) to procure, store, and distribute essential medicines, vaccines, and medical supplies to all public health facilities in the country. NMS receives funds from the Government of Uganda to undertake this service under the National Medicines Policy 2015. This policy seeks to ensure that essential medicines are of good quality; safe; efficacious; appropriately used; affordable; and available at all times (MoH, 2015). In addition, NMS is guided by the 2016 Ministry of Health's Essential Medicines and Health Supplies List for Uganda (EMHSLU), which is borne out of WHO's Model Essential Medicines List (Birabwa et al., 2014). For dog bite injuries, anti-rabies vaccines, antibiotics, tetanus vaccines, and analgesics are the essential inputs. The procurement of such inputs is based on a compilation of needs estimated at the district or referral hospital levels.

Much as essential medicines should be freely available at public healthcare facilities, this is not always the case in practice. In the two health centers where the study was conducted, there were both private and public sections. It is not uncommon to find the rabies PEP inputs out of stock in the public section but available in the private one. The private sections of these health facilities are stocked using internally generated funds and sell the inputs at subsidized prices, e.g. UGX 50,000 ($ 14) per dose of anti-rabies vaccine. However, the occasional absence of rabies PEP inputs in public sections has also caused the private sector to stock the inputs (Birabwa et al., 2014). Therefore, some of the rabies PEP inputs can be found in private pharmacies, drug shops, private clinics, and private hospitals. In this setting, the inputs are at slightly higher prices, e.g. between UGX 150,000 and UGX 200,000 per dose of anti-rabies vaccine. The private players usually obtain their supplies from individual importers; local manufactures; and Joint Medical Stores (a Private-Not-For Profit Non-Governmental Organization established as a joint venture between the Uganda Catholic Medical Bureau and Uganda Protestant Medical Bureau).

2.6.4.3 Medical personnel-patient context of clinical management of dog bites

When dog bite patients report to the health facility, they are assessed by medical or clinical officers in the emergency medicine department. It is the medical or clinical officer that takes the history of the dog bite, undertakes the clinical assessment, and prescribes the desired treatment. Interactions at this stage may be between the health worker and the patient (in the case of adults) or the caretaker (in the case of minors presenting with caretakers). Upon receiving the prescription, the patient takes it to the treatment room and presents it to the nurse. The nurse reads and interprets the prescription before administering the desired treatment. The treatment usually includes first aid, analgesics, antimicrobials, tetanus prophylaxis (vaccine), and rabies prophylaxis (anti-rabies vaccine). The medicines, which are not parenteral, are obtained from the

health facility's pharmacy by the patient by presenting their prescription. For the additional visits to the hospital, the patients go straight to the nursing station for follow-up treatment.

2.6.5 Antimicrobial resistance of bacterial isolates from dog bite injuries

The bacterial isolates from DBWs exhibit different levels of susceptibility to commonly used antimicrobial drugs. Previously, dogs have been identified as reservoirs and transmitters of antibiotic resistant bacteria (Guardabassi et al., 2004). Gustavsson and colleagues elaborate on the susceptibility of various isolates to ampicillin and meropenem, but show resistance to oxacillin, clindamycin, and gentamicin. This means that using oxacillin or clindamycin in combination with an aminoglycoside is not effective in most animal bite wounds (Gustavsson et al., 2016). However, in dogs bitten by other dogs, a study in South Africa reported that amoxycillin plus clavulanic acid, first and third generation cephalosporins, ampicillin or amoxicillin/clavulanic acid, and potentiated sulphonamides gave the best in-vitro sensitivity results (Meyers et al., 2008). In summary, different isolates present different susceptibilities to various antibiotics.

2.6.6 Adherence to clinical treatment for dog bite injuries

The UCG, issued by Uganda's Ministry of Health, provide specific procedures on wound cleaning as well as the length and specifics of post-exposure treatment. For unvaccinated patients, it is recommended that the rabies vaccine (RV) be administered on the following days: 0, 3, 7, 14, and 28. Previous alternatives included administering the RV on days: 0, 3, 7, 28, and 90. However, in severe cases such as Category III DBWs, rabies immunoglobulin is also recommended for administration, in addition. This is different for patients who report a verifiable history of rabies vaccination. In such patients that have had full pre-or post-exposure rabies

vaccination within the last 3 years, booster doses of rabies vaccine are given on day 0 and day 21. However, if completely vaccinated > 3 years earlier or if incompletely vaccinated, a complete post-exposure vaccination courses of RV and passive immunization with rabies immunoglobulin (RIG) if necessary, are recommended. In addition, patients must be followed up for at least 6-18 months to confirm the outcome of treatment. Similarly, the antibiotics used in managing dog bites have specific guidelines depending on the type chosen (MoH, 2016b). This summarizes the specific guidelines of post-exposure treatment for dog bites.

However, compliance with treatment regimens is often not achieved across many settings. There are conflicting findings on the levels of compliance with rabies treatment in different settings. In Iran, 81% to 84% of patients do not complete PEP regimens, and the majority of those who require immunoglobulins do not receive them (Kassiri et al., 2014; Poorolajal et al., 2015). Although in India, Sharma and colleagues reported better compliance in slum areas than in rural locations (S. Sharma et al., 2016); the reverse is reported by another study that puts the non-compliance at 17.4%, especially for doses on days 14 and 28 (Anandara & Balu, 2017). Additionally, in Sri Lanka and Benin, only 1.7% and 4.2%, respectively, got less than the recommended doses of anti-rabies vaccine (Aghahowa & Ogbevoen, 2010; Kularatne, Ralapanawa, Weerakoon, Bokalamulla, & Abagaspitiya, 2016). Likewise, in Uganda, a passive study found that 41% of patients did not complete their course of post-exposure therapy (PET). These are clear examples of how compliance varies not only across socio-cultural settings but also within them.

There are many factors for non-compliance with PET for dog bites. Anandra and Balu assert that half of the patients in India lack time to complete the vaccination schedule. They further state that a quarter of the non-compliers base their decision on the biting animals being healthy after

the stipulated time (Anandara & Balu, 2017). Additionally, in the Philippines, non-compliance is attributed to fear of acquiring rabies, high vaccine costs and non-affordability, and just like in India, knowledge of the health status of biting animals (Romero-Sengson, 2013). Other factors include lack of PEP, a low socioeconomic status, and a long distance to medical facilities (Wilde, Tipkong, & Khawplod, 1999; Hampson et al., 2008; Bharti O. et al., 2012; Sambo M et al., 2013; Alabi et al., 2014). All this shows that, much as some factors are shared between settings, many others are unique to specific communities. Also important to note is the lack of in-depth inquiry into these factors in all the studies reviewed. In conclusion, factors contributing to non-compliance with clinical treatment are numerous but poorly described.

2.7 Outcomes of dog bite injuries

2.7.1 Outcomes of dog bite injuries following treatment

Bacterial infection, as a treatment outcome in dog bite wounds, shows great variability in both rates and cause. Murray reviewed published literature and found that the infection rate of 30% among patients is due to *Staphylococci, Streptococci, Pasteurella,* and *Capnocytophaga canimorsus* (Murray, 2017). In another review, Esposito and colleagues concluded that bacterial infection was the most common outcome. However, in the USA, infection rates were determined to be as low as 5.2%, which falls within the range of 5 – 20% found in another study by Rothe and colleagues (Rothe et al., 2015; Tabaka, Quinn, Kohn, & Polevoi, 2015). Nonetheless, in a 4-year retrospective chart review of patients less than 20 years of age in the USA, Golinko and others found that only 4% of patients returned with soft tissue infections. Additionally, several reviews have suggested a wound infection rate of between 3% and 45%, which accommodates all the findings of subsequent studies (Cummings, 1994; Damborg et al., 2016; Golinko et al.,

2017). Notable is that all these studies did not examine the relationship between infection and the bioburden of the wounds at initial presentation. Finally, these studies had inconsistencies in their definition of infection and inclusion criteria of study participants, though all point to the variability in infection rates.

Another outcome, death, is poorly described. In Benin and Iran, death was attributed to rabies. However, this was insinuative since the studies were retrospective with clinical records as data sources (Aghahowa & Ogbevoen, 2010; Sharafi et al., 2016). In India, deaths due to rabies are a prominent outcome (Agarwal & Reddajah, 2004; Ichhpujani et al., 2008; Samanta et al., 2016). However, in Bangladesh, the specific causes of death of 3% of the victims were unexplained in a cross sectional community study (Ghosh et al., 2016). Similarly, though the rabies vaccine was accessed by only 25% of patients, a study in the same country, did not assess completion of treatment and neither did it explain specific causes of deaths (Rumana et al., 2013). Though these studies had no clear, validated outcome measure to determine rabies, they reveal how death is a common outcome.

2.7.2 Determinants of outcomes of dog bite injuries following treatment

There are a variety of predictors for bacterial infection, though some are contradictory. Infection is associated with the type of wound and its clinical management in the USA. Some authors contend that puncture wounds, their location, and management by closure are predictors of infection (Tabaka et al., 2015). Additionally, Damborg and colleagues argue that the quantity and type of bacteria, foreign material, and patient immune status are infection predictors (Damborg et al., 2016). However, some studies have found no increase in the wound infection rate when low-risk dog bites are closed after adequate washout and debridement (Mannion &

Graham, 2016). Nevertheless, other factors associated with infection include delay in seeking treatment, tissue loss, full-thickness wounds, extensive crush injuries or devitalized tissue, and associated patient factors (such as comorbidities and age) (Griego et al., 1995; Marina Morgan & Palmer, 2007; Bothra, Bhat, Saxena, Chaudhary, & Narang, 2011). It is noteworthy that all these studies on DBI infection did not investigate the association between initial microbial culture results and the development of infection.

However, death due to rabies is attributed to several risk factors. Importantly, deaths have been observed among patients who do not receive rabies immunoglobulin treatment (Gadekar, Domple, Inamdar, Aswar, & Doibale, 2014; Ghosh et al., 2016). Nevertheless, there are population dynamics when it comes to the impact of the availability of PEP. A study in Tanzania found that when PEP was not delivered, the risk of rabies was higher in pastoralist than agro-pastoralist areas (Hampson et al., 2008). In India, this is compounded by a failure to seek timely and appropriate treatment (Ichhpujani et al., 2008). This view is further reinforced by a systematic review which concludes that deaths due to rabies are associated with incomplete treatment, financial constraints, and scarcity of vaccines (Abuabara, 2006). However, failure to complete treatment does not necessarily mean the development of rabies and death as observed in Iran (Kassiri et al., 2014). Other factors associated with death include resorting to traditional medicine and delays in receiving PEP (Ogundare et al., 2017). Conclusively, there is a wide array of risk factors for developing rabies and subsequent death.

2.8 Key methodological issues

From the literature discussed above, it can be seen that most of the studies on dog bite management practices relied on quantitative approaches without avenues to explore the explanations behind these practices (Joseph Jessy, N Sangeetha, Khan Amir Maroof, & Rajoura

O. P., 2013; Ghosh et al., 2016; Tschopp et al., 2016). In addition, many of the studies that have investigated dog bite circumstances and outcomes have been based on retrospective review of clinical records or review of existing literature (Benson, Edwards, Schiff, Williams, & Visotsky, 2006; Ogundare et al., 2017; Kisaka, Makumbi, Majalija, Bangirana, & Thumbi, 2020). Still, some of the studies relied on gray literature like newspaper reports whereas others used telephone interviews (Peters et al., 2004; Dimaano, Scholand, Alera, & Belandres, 2011; Romero-Sengson, 2013). Furthermore, most of the studies have focused on risk factors, bite patterns, and use of antibiotics as well as treatment outcomes (M. Morgan, 2005; Rezac et al., 2015; Tabaka et al., 2015; Murray, 2017). Although these areas are imperative, there are many other significant aspects that have not been intensively researched, yet they are critical in the understanding and management of dog bites. Among these are the associations and linkages between preclinical, clinical management, wound bioburden, antibiotic use, and treatment outcomes. These are the gaps that this research sought to address.

2.9 Conceptual framework

This study integrated Axel Kroeger's Health Seeking Behavior (HSB) model and multifactorial causation theory to explain treatment practices (Kroeger, 1983; Broadbent, 2009). HSB are actions undertaken by someone with the goal of finding appropriate remedies for themselves or for the person they take care of when they have a health problem or illness (Olenja, 2003). It is these practices that are categorized as either compliant or non-compliant with the guidelines. However, Kroeger explains that the choice of a particular practice depends on the interactions between predisposing factors (e.g., age, sex, ethnic group, education, degree of cultural adaption, health beliefs on dog bites, occupation, place of origin); enabling factors (cost, accessibility,

quality of services, and social acceptability); and perceived need (severity of bite, expected benefits of treatment, and bite characteristics).

Additionally, this study was built on the premise that practices are also driven by factors surrounding dog bites. These are explained by the multifactorial causation theory that organizes them into host, agent, and environmental factors (epidemiological triad) as earlier described (Morabia, 2007; Broadbent, 2009). **Figure 2.1** shows the relationships between the host, agent and environmental factors.

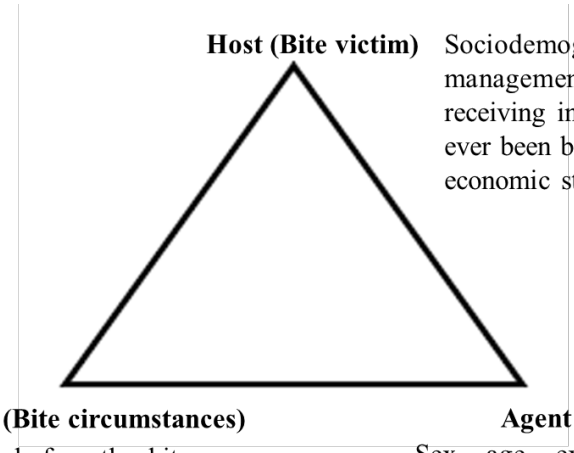

Figure 2.1: The multifactorial model based on the epidemiological triad to explain factors behind the practices

Host/human factors are those that characterize dog bite victims and put them at the risk of being bitten by dogs, e.g., age, sex, comorbidities, bite knowledge, history of having experienced at least one dog bite, size, physical status, socioeconomic status, and behavior preceding the bite. Agent/dog factors include sex, size, breed, age, ownership, vaccination status, history of biting, training, domestication status, duration of ownership, and health status. The environment includes circumstances in which the person was bitten.

A combination of Kroeger's HSB model and the multifactorial causation theory forms inter-relationships between predisposing, human and health system factors. These interrelationships are typically a major determinant of which preclinical practice is undertaken for the dog bite victim. The preclinical practice undertaken may or may not be consistent with established guidelines. Therefore, the combination of models guided how the different sub-studies were interconnected with each other. **Figure 2.2** is a schematic demonstration of the interplay of the models, various variables, and study outcomes.

For sub-study I (first objective), the epidemiology of DBWs and the determinants of compliance with recommended pre-clinical guidelines were investigated. The outcomes of the preclinical practices might play a role in guiding the choice of treatment that is given by the health worker when the patient reports to the health facility. Sub-study II (second objective) sought to understand if such treatment for DBWs by healthcare workers follows the UCG. It is also important to note that the bio-burden of the DBW is heavily dependent on the preclinical practices (as explained by the factors in the HSB model and multifactorial causation theory), the biting dog, and the victim. This underscores the basis of sub-study III (third objective). Lastly, despite the fact that the patient had gone through the preclinical and initial clinical phases of the continuum of treatment, the factors in Kroeger's model again play a critical role in determining what they do while on treatment as well as the outcomes of the treatment. It is these outcomes that sub-study IV (fourth objective) investigated.

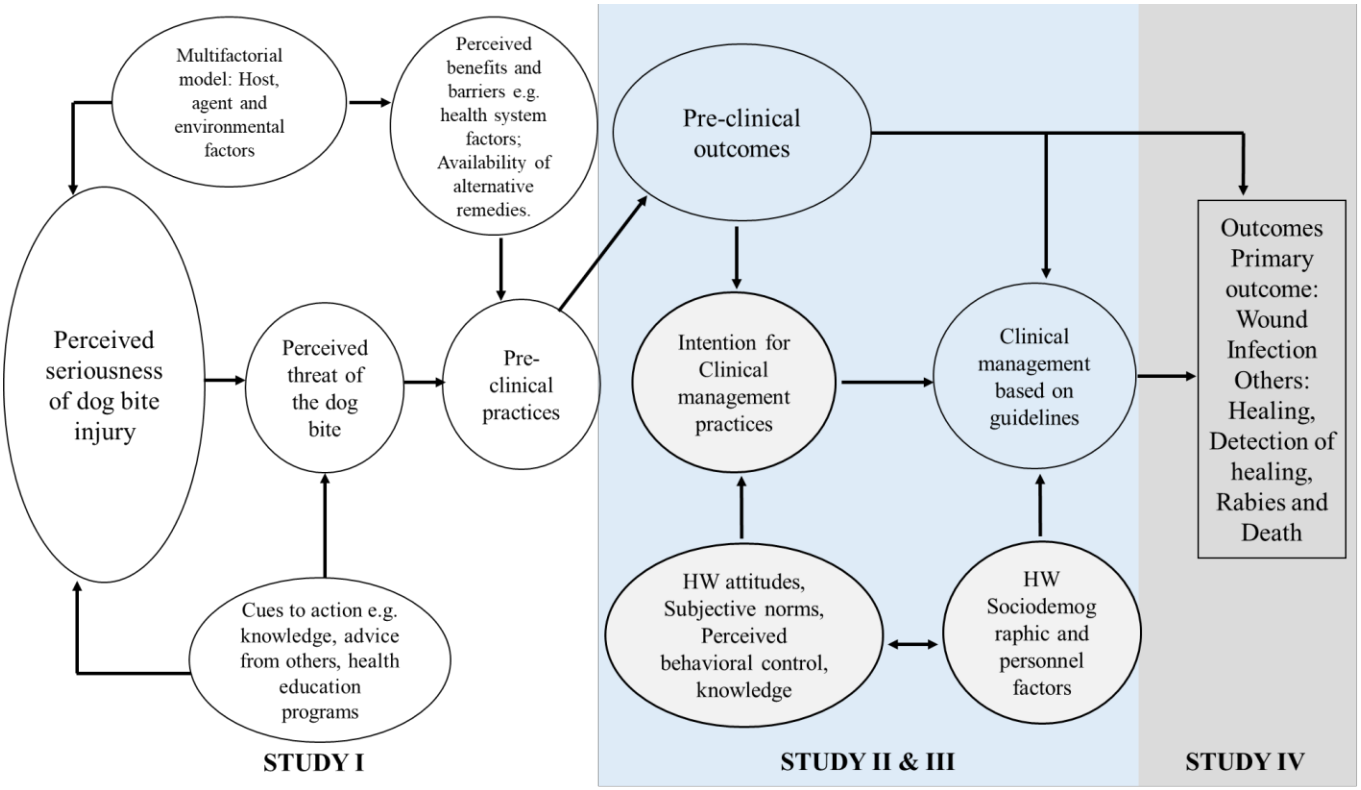

Figure 2.2: Conceptual framework based on the multifactorial causation theory and Kroeger's and Anderson's health seeking behavior models

CHAPTER THREE: MATERIALS AND METHODS

3.1 Ethical considerations

3.1.1 Ethics review and ethical conduct

The study protocol, including consent forms, was approved by the University of Nairobi - Kenyatta National Hospital Ethics Review Committee (Kenya) *REF: P687/09/2018*; Mulago National Referral Hospital Research and Ethics Committee (Uganda) *REF: MREC 1518*; and the Uganda National Council of Science and Technology (Uganda) *REF: SS4911*. Administrative permission was also sought and obtained from the two study sites, namely: Mulago National Referral Hospital and Entebbe General Hospital. The ethical principles of scientific research were strictly adhered to, as well as national laws and regulations that applied to this study.

3.1.2 Participant information and consent

The Principal Investigator (PI) ensured that participants were given full and adequate oral and written information about the nature, purpose, possible risks, and benefits of the study. Participants were notified that they were free to discontinue or leave the study at any time. They were given an adequate opportunity to ask questions and were allowed time to consider the information provided. The subject's signed informed consent was obtained before conducting this study. The PI kept the original signed informed consent form, and a copy was given to the participant.

3.1.3 Participant data protection

The study data were stored in a computer database while maintaining confidentiality. Unique enrolment numbers were used to identify participants in this database. It was only the PI that had

access to the participant identification list which was stored separately and included their unique codes, full names, and latest known addresses.

3.2 Methods for Sub-study I: Preclinical practices undertaken for dog bite victims

3.2.1 Study area

The study was in Uganda, a country with a 10% rabies vaccination coverage for dogs and an average of 14,865 dog bites and 36 human rabies deaths annually (Hampson et al., 2015; Akusekera, Namayanja, & Okello, 2021). This study covered Kampala City and Wakiso District **(Figure 3.2)** which have populations of 1,507,080 and 2,007,700 people respectively (UBOS, 2014). It was conducted in two PET centers at Mulago National and Entebbe General Referral Hospitals. These are the health facilities that are involved in treating most dog bite wounds in Kampala City and Wakiso district.

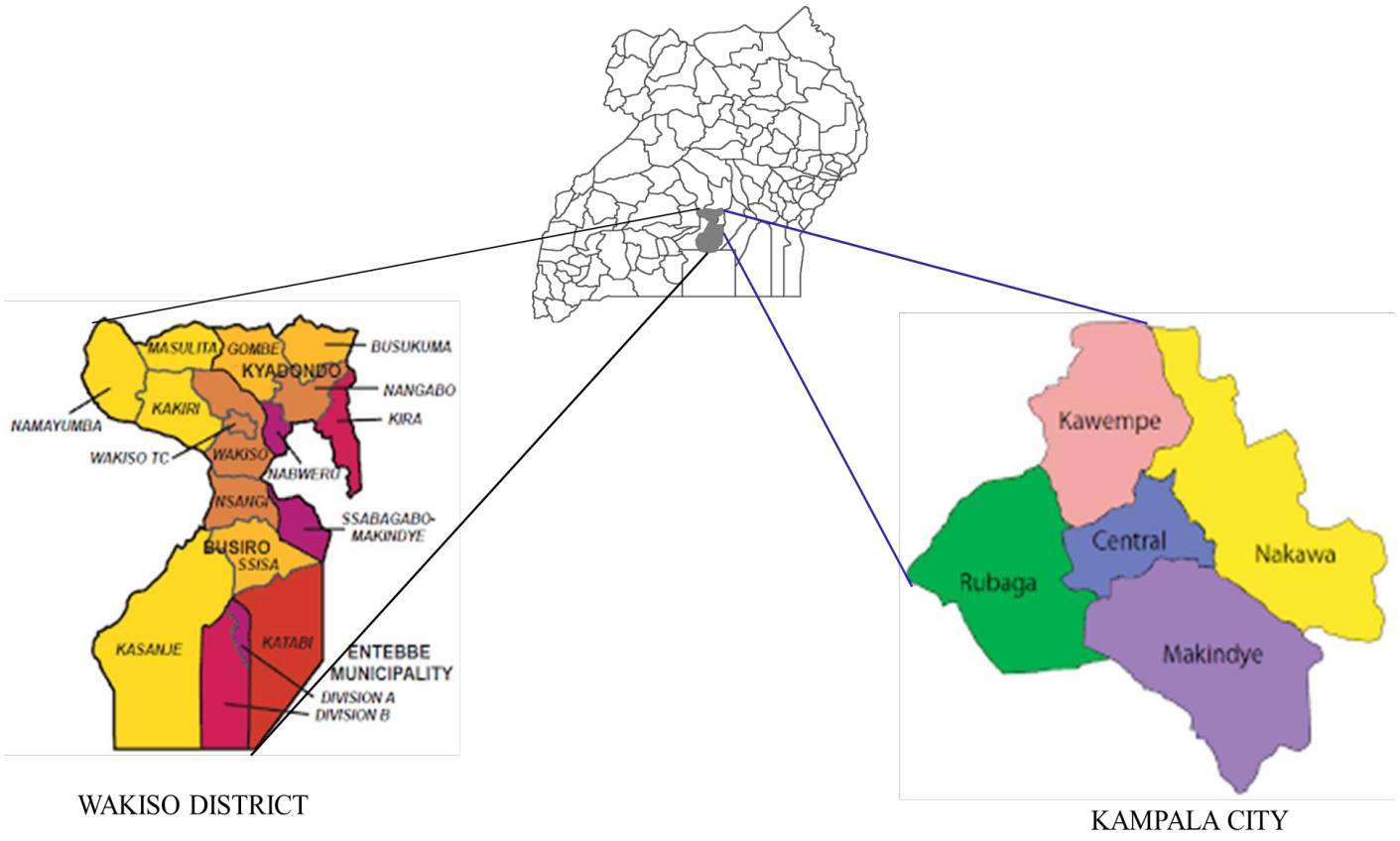

Figure 3.3: Map of Uganda showing the study districts (Adapted from UBOS)

Combined, these hospitals serve approximately 4 million people. An average of 2 dogs are kept in each of the 12% of households in the city and district of study (MAAIF & UBOS, 2010). The two areas have the highest number of people suspected of contracting rabies in the country (Kukundakwe & Bagala, 2011). Increasing numbers of stray dogs and dog bites are also commonly reported in Kampala (Radoli, 2013; Ainebyoona, 2016; Masiira et al., 2018). Lastly, the 2 hospitals serving the study area, treat an average of 4 to 10 dog bite patients daily (Kukundakwe & Bagala, 2011; Kato, 2015).

3.2.2 Study population

This study was carried out amongst patients presenting to the two select health facilities with dog bite injuries during the study between March and October 2019. Other categories of subjects included in the study were sub-county veterinary officers of the study area and herbalists that had been seen by the patients before or after presenting to the hospital.

All patients seeking PEP from the selected healthcare facilities during the study period and providing consent to the study were included. Others were veterinary officers from the sub-counties with the highest number of cases and herbalists involved in treating dog bite injuries. However, the study excluded patients assessed as not requiring PEP and standard treatment, e.g., those with Category I dog bites; as well as patients, veterinary officers, and herbalists, who, for any reason, were unable to give responses in the questionnaire, e.g., due to aggravated injuries, distress, or the caretaker being away (for patients) or being absent and unreachable (for veterinary officers and traditional healers).

3.2.3 Study design

This was an explanatory sequential mixed methods study which used both quantitative and qualitative approaches. Firstly, quantitative data were collected, analysed, and themes formed before going ahead to collect qualitative data.

3.2.4 Sample size estimation

For the quantitative component, the aim was to estimate the proportion of patients who comply with preclinical guidelines. The sample size was calculated based on an earlier study in Ethiopia in which it was found that 31% of dog bite victims had washed the dog bite wounds as first aid (Digafe, Kifelew, & Mechesso, 2015). Given that this study was conducted in a similar setting (Eastern Africa) as Uganda, it was used to calculate the sample size using the formula below, as earlier recommended for cross sectional studies (Charan & Biswas, 2013);

$$n = \frac{z_{\alpha/2}{}^2 pq}{d^2}$$

Assuming a 5% margin of error and a 95% level of confidence, for an unknown population, the sample size was calculated as 376 after adjusting for an expected non-response rate of 12.5%.

Conversely, for the qualitative component, patients with outstanding compliant and non-compliant practices were recruited together with veterinary officers for the sub-counties from which most dog bites originated, as well as all herbalists. The herbalists were identified by patients who had gone to them before presenting at the healthcare facility. In total, thirteen (13) in-depth interviews were conducted with seven (07) patients, three (03) caretakers, two (02) local veterinarians and one herbalist.

3.2.5 Recruitment procedure

3.2.5.1 For quantitative data

The study healthcare facilities were purposively selected based on being the largest providers of PEP for dog bites. The sampling unit was a patient with a DBW and all new patients that visited the health facilities with DBWs were consecutively enrolled at the time of initial reporting. A structured questionnaire, developed based on the conceptual framework, was used to record patient socio-demographics, bite circumstances, bite characteristics, and type of wound care given before presentation.

3.2.5.2 For qualitative data

- There were two categories of patients, namely those: a) who complied with UCG; and b) who did not comply with UCG. For each of the categories, in-depth interviews were conducted consecutively with patients until saturation was realized.
- For patients who (were) reported to have been treated by a herbalist before presenting to the hospital (PET center), the herbalist was contacted for a key informant interview. Only one herbalist attended to the patients from the two districts, hence one interview was conducted.
- Two veterinary officers for the sub-counties were contacted for Key Informant Interviews because they were the only ones available by virtue of their official positions.

3.2.6 Study variables

3.2.6.1 Outcome variable

The outcome variable for this sub-study was compliance with preclinical guidelines regarding dog bite injuries as spelt out in the Uganda Clinical Guidelines (UCG). A “compliant”

respondent was defined as one who had washed the wound with soap and water and had presented to the hospital within 24 hours following the bite event.

3.2.6.2 Independent variables

Data were collected on independent variables that are potentially associated with adherent practices, including: 1) patient sociodemographic characteristics; 2) human factors; 3) biting dog factors; 4) dog bite circumstances (before, during, and after the bite); and 5) socio-economic factors.

3.2.7 Data collection process

3.2.7.1 Data tools

Structured questionnaires and in-depth interview guides *(Appendices IV - XIII)* were used for data collection conducted by the PI and trained research assistants. The questionnaire was interviewer-administered, with mostly close-ended questions. It covered participant identification as well as the practices undertaken before presenting to the healthcare facility. Responses were sought on patient sociodemographic characteristics, human factors, biting dog factors, dog bite circumstances (before, during, and after the bite), and socio-economic factors.

Furthermore, in-depth interview guides were used to conduct in-depth interviews through face-to-face sessions with the selected patients. Key informant interview guides were used to collect data from the veterinary officers and herbalists. It is during this time that information on motivations and barriers to adherence to UCG by dog bite victims was captured. All the data collection tools were in English and Luganda since the study population was known to generally speak one of the two languages. Each participant was offered the opportunity to choose the language that they were most comfortable with.

3.2.7.2 Data collection procedure

The first step was to obtain administrative permission from the healthcare facilities. Secondly, for potential respondents, the process of informed consent was undertaken. Data were collected from those who consented, while those who did not consent were removed from the study. Those who had either strictly complied with the UCG or deviated from them significantly were taken to be illuminating cases and thus selected for in-depth interviews. The process that was followed to collect data from respondents is summarised in **Figure 3.3**.

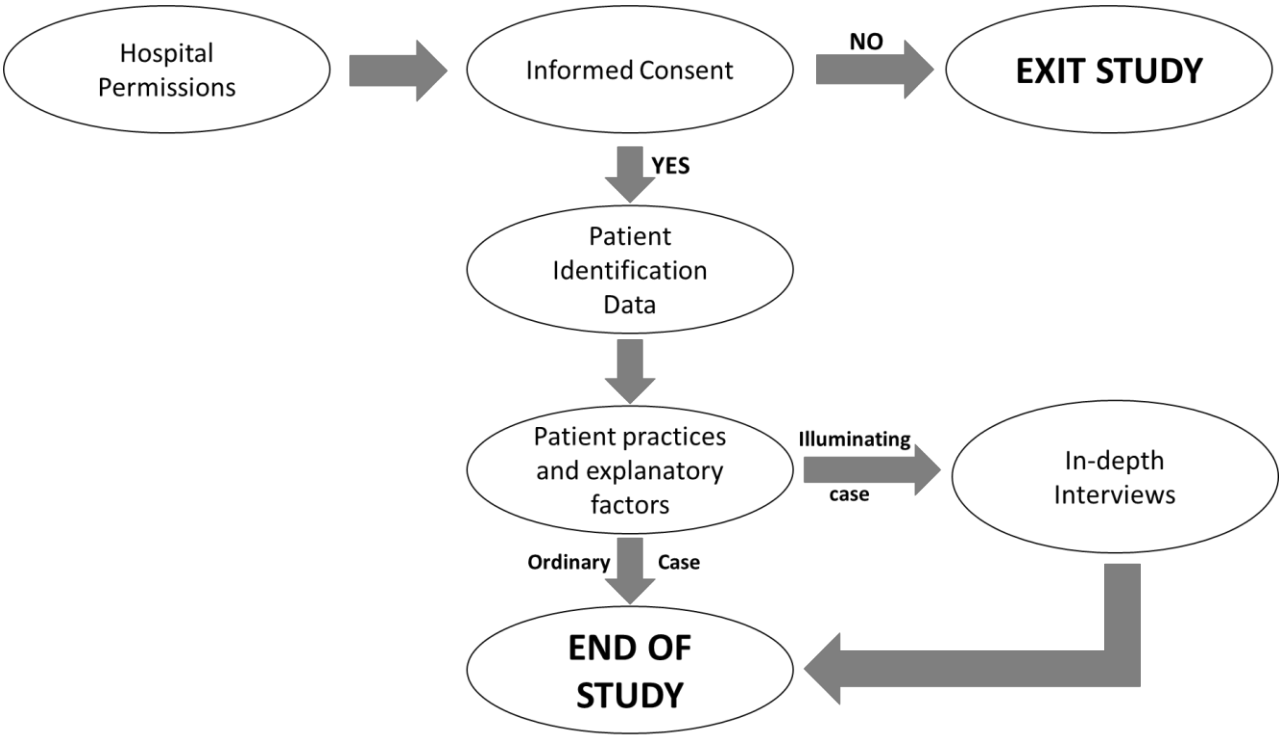

Figure 4.3: Flow chart showing the quantitative and qualitative process of data collection

In-depth interviews were conducted in a private environment that encouraged free-expression. The interviewer first introduced himself or herself. Time was allowed for the participant to introduce himself/herself if the interviewer determined that they needed to do so with the purpose of building a positive relationship with the participant. The study's purpose and objectives were thoroughly explained to the participant before consent was obtained. The

interview commenced and proceeded according to the in-depth interview guide. Efforts were made not to hurry the participants while maintaining time-limits.

The interviews were digitally audio-recorded using an audio recorder device (SONY ICD PX333 Digital Voice Recorder®) in addition to notes that were taken on major points. To secure the confidentiality and anonymity of the participants, the recordings as well as the data collected during the interview were assigned codes that only the interviewer could identify. Any personal information relating to respondents was not made available during and after the interview process. The audio recording did not mention the names or any personal information of the respondents at any given point. Key points brought up during the interview, in accordance with the theoretical framework of the study, were noted down and made visible only to the interviewer to avoid any form of bias on the part of the interviewee. Noting key points was a precaution and a preventive measure to ensure that any crucial information was not overlooked.

When it was realized that no new or relevant information was materializing from additional interviews, it was determined that data saturation had been reached. This approach has been recommended by various authors on qualitative methods (Glaser & Strauss, 1967). For example, saturation for this study occurred when the last participant unequivocally mentioned the same aspects the previous respondents had mentioned. This was determined by identifying the use of keywords during the interviews or even after they had ended, while transcribing. However, as advised by Flick (2009), transcribed interviews were compared and assessed for saturation and exhaustiveness of concepts to ensure that the data collected covered all the constructs in the conceptual framework (Flick, 2009). Upon ending the interview, the interviewer orally thanked the respondent in the most appropriate language and way possible.

3.2.8 Quality assurance and quality control

3.2.8.1 Recruitment and training of research assistants

The research assistants were recruited through an equal-opportunity mechanism. Internal adverts within Makerere University were made and these targeted individuals with experience in collecting both qualitative and quantitative data. The eight (8) selected assistants were trained on the objectives, procedures, and ethics of the study.

3.2.8.2 Pre-testing

The study tools were pre-tested on 10 animal bite patients in Mukono Health Center IV (Uganda) in order to authenticate their validity and reliability. The goal of this process was to ensure that the items of the tools are easily and consistently understandable among participants. For items that proved to be difficult to understand, the Principal Investigator (PI) readjusted and reformulated them accordingly.

3.2.8.3 Data accuracy and editing

Prior to ending the interview process, data collectors checked the questionnaires to ensure that all the relevant sections for a particular participant had been completed. Joint daily meetings with the data collectors were convened by the Principal Investigator (PI) to collectively review the accuracy and completeness of the responses prior to judging whether they should be entered or not, or to seek further clarification from the participant. At this stage, data editing was also done to eliminate errors.

3.2.9 Data management and analysis

3.2.9.1 Data Management

For each participant, the completed interview questionnaire was blind-double entered into Epi Info™ version 7.2.0.1 statistical software (CDC, June, 2016). The copies were compared to

check for any errors or inconsistencies in the values / responses of the variables. Univariable, bivariable, and multivariable analysis was conducted using Stata 16 software (StataCorp, June 2019). **Outcome variable**

"Practices" were recorded and categorized as "compliant" or "not compliant" based on whether what the patient did (or what was done for the patient by the caretaker) was in conformity with the UCG or not. Items used to measure this included: anything that was done to the DBW (yes/no); what was exactly done to the DBW (washed it with water and soap/washed it with water only/did not wash it all/other, and specify); anything applied after bite (yes/no); what was applied (describe); date and estimated time of bite, and the date and time the patient presented to the hospital (PET center). Those who immediately washed the wound with soap and water, (or even applied an antiseptic in addition) and reported to the PET center within 24 hours were assessed as having complied with the UCG.

Explanatory variables

The human factors and how they were handled and managed are shown in **Table 4.1**.

Table 3. 1: Management of variables (human factors) related to the dog bite patients

Variable	Type	Measurement
Age	Continuous	Lived years from date of birth
Sex	Categorical	Male (0), Female (1)
Religion	Categorical	Christian (0), non-Christian (1)
Highest level of formal education attained	Categorical	No formal education obtained (0), primary education (1), secondary education and above (2)
Marital status	Categorical	In union (0), not in union (1)
Household size	Categorical	Four and less (0), between five and eight (1), nine and above (1)
Patient staying with spouse	Categorical	No (0), yes (1)
Presence of teenagers in home	Categorical	No (0), yes (1)
Patient in employment	Categorical	No (0), yes (1)

(income generating activity)		
Sex of patient's caretaker	Categorical	Male (0), Female (1)
Highest level of formal education attained by caretaker	Categorical	No formal education obtained (0), primary education (1), secondary education and above (2)
Dog ownership	Categorical	No (0), yes (1)
Breed of dogs owned	Categorical	Local (0), exotic (1)
Use of dog owned	Categorical	Pet (0), security (1), hunting (2), other (4)
Duration of owning dog	Discreet	Estimated number of complete years that the dog (s) has (have) been in a home
Residence of the dog	Categorical	Stays in own house / kennel (0), stays in compound (1), shares the house with people (2), roams around the village (3)
Patient has ever been bitten by dog before current episode	Categorical	No (0), yes (1)
Patient believed that a dog could bite them prior to bite episode	Categorical	No (0), yes (1)
Patient immunized against rabies prior to bite episode	Categorical	No (0), yes (1)
Socioeconomic status	Categorical	Lower tertile (0), Middle tertile (1), Upper tertile (2)
Ever got dog bite information in last 6 months	Categorical	No (0), yes (1)

The factors that are related to the biting dog are shown in **Table 4.2**.

Table 3.2: Management of factors related to the biting dog

Variable	**Type**	**Measurement**
Sex of the biting dog	Categorical	Male (0), female (1), do not know (2)
Age (months/do not know)	Discreet	In complete months, if known
Dog appeared to be sick		No (0), yes (1), do not know (2)
Showed fear of people	Categorical	No (0), yes (1), do not know (2)
Use of dog	Categorical	Security (0), pet (1), do not know (2)
Vaccination status	Categorical	No (0), yes (1), do not know (2)
Spay / castration status	Categorical	No (0), yes (1), do not know (2)

Dog was on leash	Categorical	No (0), yes (1), do not know (2)
Dog had ever bitten someone	Categorical	No (0), yes (1), do not know (2)
Dog went on to bite other person(s)	Categorical	No (0), yes (1), do not know (2)

Before the bite event, the patients were asked about the different dimensions of circumstances leading to the event. The variables on this item were handled as shown in **Table 4.3**.

Table 3.3: Management of variables on the circumstances of the dog bite before the event

Variable	Type	Measurement
Day of bite	Descriptive	Day, month, and year
Time of bite, if known	Descriptive	Estimated time that the bite event occured
Time of day of that bite occurred	Categorical	Morning (0), evening (1), night (2)
If it was raining	Categorical	No (0), yes (1)
If there was a moon (night bites)	Categorical	No (0), yes (1)
Bitten by own dog	Categorical	No (0), yes (1)
Duration of stay with dog if bitten by own dog	Categorical	No (0), yes (1)
Dog borne in victim's home	Categorical	No (0), yes (1)
Owner of biting dog is known	Categorical	No (0), yes (1)
Patient bitten on property of dog owner	Categorical	No (0), yes (1)
Owner was around during bite	Categorical	No (0), yes (1)
Perceived size of dog	Categorical	Small (0), medium (1), large/very large (2)
Dog was known to the patient	Categorical	No (0), yes (1)
Patient was in company of another person during the bite event	Categorical	No (0), yes (1)
Activity of victim just before bite	Categorical	Walking (0), seated (1), chasing it away (2), feeding it (3), other (4)
Dog activity before bite	Descriptive	Describe what the dog was doing.
Demeanor of dog	Descriptive	Interpretion of the mood of biting dog

The patients were asked about the different dimensions of circumstances during the dog bite event. The variables on this item were handled as shown in **Table 4.4**.

Table 3.4: Management of variables on the circumstances of the dog bite during the event

Variable	Type	Measurement
Who approached the other	Categorical	Victim (0), dog (1)
Dog movement	Categorical	Stationary (0), moving (1)
Purpose of interaction	Descriptive	Description of why victim came into contact with dog
Patient tried to fend off the dog	Categorical	No (0), yes (1)
Location of bite on body	Categorical	Head (0), neck (1), leg (2), hand (3), abdomen (4) other (5)
Number of bites	Categorical	One (0), two (1), there or more (2)
Perceived depth of wounds	Categorical	Scratch (0), shallow (1), Deep (2)
Reason victim thinks dog bit them	Descriptive	Description of the perceived reason of the bite

The patients were asked about the different dimensions of circumstances after the dog bite event.

The variables on this item were handled as shown in **Table 4.5**.

Table 3.5: Management of variables on the circumstances of the dog bite after the event

Variable	Type	Measurement
Perceived seriousness of bite	Descriptve	Description of how patient perceives the bite
Action against dog after bite	Categorical	Chased away (0), killed (1), nothing (2), ran away (3), other (4)
Action on carcass if dog was killed	Descriptive	Decapitated (0), buried (1), left to rot (2), don't know (3), other (4)
Aware that head was taken to laboratory for examination (if dog was killed)	Categorical	No (0), yes (1)
Immediate action by owner	Categorical	Describe what owner did upon knowing that the dog bit the victim.
Actions by the owner to help victim were satisfactory	Categorical	No (0), yes (1)
Effect of the bite on the rest of the patient's day	Categorical	Description of how the bite affected the patient and their activities for the day.

Qualitative data

In-depth interviews explored participants' views on why they think the dog bit them; things that could have prevented dogs from biting them; and threats about dog bites. Other aspects explored included how wounds affected their lives; reasons for what was done to the bite wound; and knowledge about wound infection. Also discussed were: who decided that hospital was best choice and why; dangers of not presenting early; reasons for delay to report to health facility; rabies knowledge; and what respodents planned to do to prevent the event from happening again.

Additionally, area veterinarians gave their perception of the reasons why people are bitten by dogs. Further, they were asked to discuss what they are doing about the problem, especially in ensuring that victims adhere to the preclinical guidelines. Lastly, herbalists that were approached by the dog bite patients were asked how and why they treat dog bite victims.

3.2.9.2 Data analysis

The data were analyzed at four levels, as shown in the flow diagram **(Figure 3.4)**, namely univariable analysis, bivariable analysis, multivariable analysis, and deductive thematic analysis.

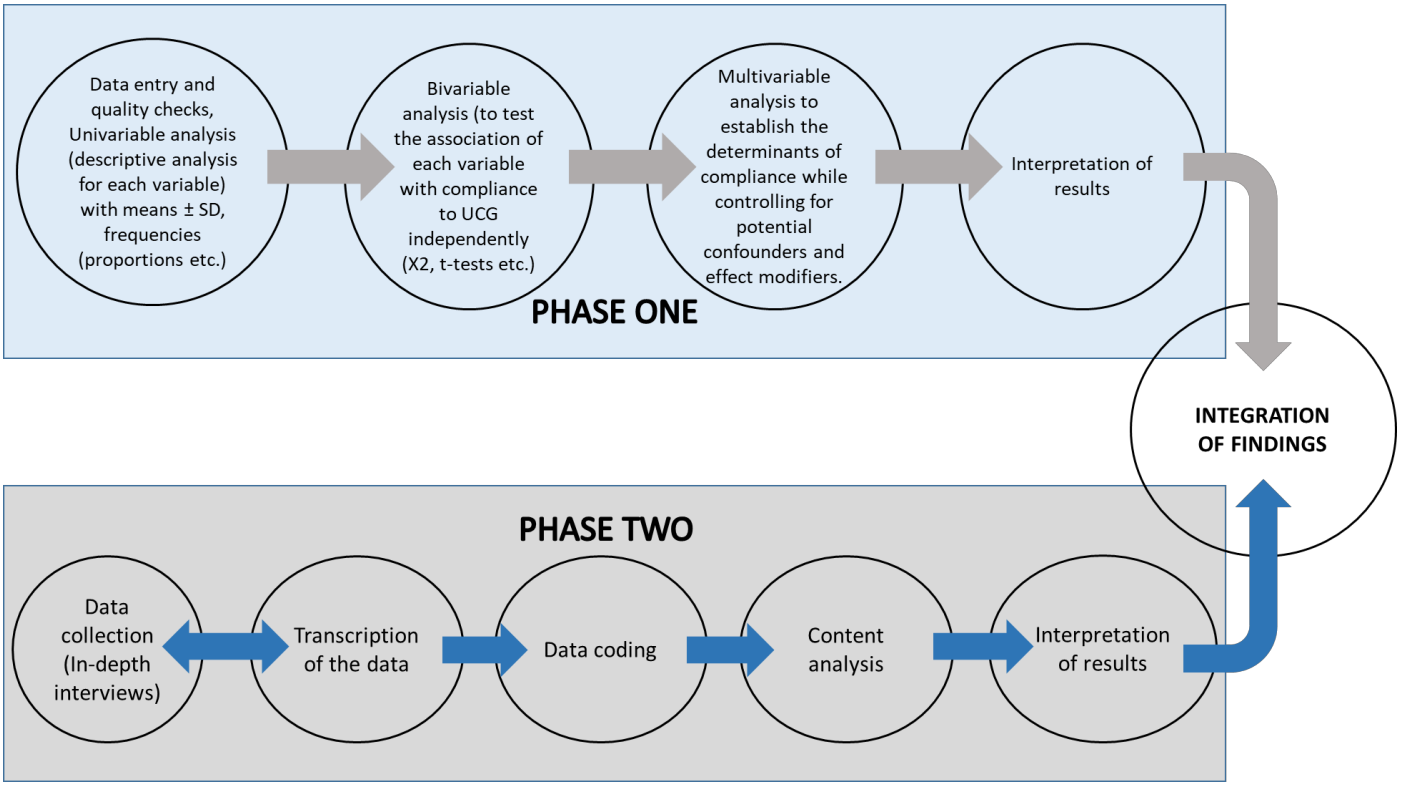

Figure 3.5: Schematic representation of the order of processes involved in data analysis

3.2.9.2.1 Descriptive analysis

At Univariable analysis, descriptive statistics were computed. For continuous variables like age, distance from hospital and others, mean (±standard deviation) or median (range) was computed. In addition, frequencies were summarized as proportions (e.g. percentages) for categorical variables, e.g., dog ownership, sex, etc. Data from univariable analysis were displayed in tables and graphs.

3.2.9.2.2 Analysis of the outcome

Preclinical practices were categorized as "compliant" or "non-compliant" depending on whether what the respondent did was in line with the UCG or not, respectively. Proportions (together with corresponding percentages) were used to express the magnitude of compliance, i.e., the

percentage of compliers with all the respondents as the denominator. Furthermore, non-compliers were disaggregated according to specific practices undertaken and expressed as percentages, graphs, and tables.

3.2.9.2.3 Analysis of factors associated with preclinical adherence / compliance

Prevalence ratios (PRs) were used as a measure of association between the outcome and explanatory variables. These were computed using a generalized linear model (GLM) with modified Poisson regression and a log link with robust standard errors. This approach was used because the outcome was binary and common (greater than 10%). If logistic regression had been used, the odds ratios would have overestimated the effect as explained by the earlier authors (Zocchetti, Consonni, & Bertazzi, 1997). Further, using log-binomial models, which similarly would provide PR, would have presented a non-convergence challenge. In addition, the use of prevalence ratios in cross-sectional studies is usually encouraged and they are easier to interpret since they are a direct comparison of two prevalences (Thompson, Myers, & Kriebel, 1998).

The independent variables, which had a p-value ≤ 0.20 at bivariable analysis and those whose association with the outcome is biologically plausible, were included in the multivariable model. The logical model building technique was used to develop the models, and the best fitting model was identified using the *estat ic* function that yielded the smallest Akaike's information criterion (AIC). The model with the smaller AIC was taken to fit the data better than the one with the larger AIC as dictated by the AIC formulator (Akaike, 1974). Variables with a p-value ≤ 0.05 at a 95% confidence interval (95% CIs) were considered to be statistically associated with the outcome. The unadjusted (PRs) and adjusted prevalence ratios (adj.PR), together with their respective 95% CI and p-values, were used to present the results.

3.2.9.2.4 Analysis of qualitative data

Recorded interviews were transcribed into written text. Each transcript was then given to the respective data collectors. They read through and verified whether the transcripts were a true record of what transpired during data collection while comparing the transcript with the written notes. If there was a need to obtain more clarity or a deeper understanding of the issues raised during the interview, the data collectors went back to the particular respondent to seek the required information.

NVivo 11.4.1® software (QSR International, 2017) was used to organize these data for analysis. Two readers reviewed the transcripts and identified the information that is related to the pre-set themes like bite circumstances and reasons for the use of herbal substances. Under each theme, the information was deductively coded into sub-themes and then patterns were identified to form the explanatory points of what was being observed. Key statements corresponding to the themes were presented together with specific quantitative findings so as to augment the latter.

3.3 Methods for sub-study II: Adherence by health workers to recommended clinical guidelines.

3.3.1 Study site: Entebbe General Hospital in Wakiso district and Mulago National Regional Referral Hospital in Kampala district.

3.3.2 Study population

This sub-study was carried out amongst health workers attending to dog bite patients that presented for PEP.

- Inclusion criteria: All healthcare workers who had been treating dog bites for no less than 6 months and who gave consent to participate in the study were included.

- Exclusion criteria: Healthcare workers who, for any reason, could not undertake interviews, e.g., those absent from duty.

3.3.3 Study design

This was an exploratory qualitative study.

3.3.4 Sample size estimation

All the health workers involved in the diagnosis and treatment of dog bites were interviewed.

3.3.5 Recruitment procedure

A checklist, developed based on UCG, was used to record the treatment process and the type of therapy given to the patient by that particular healthcare worker. In addition, medical records of patients were examined to establish compliance with UCG. The health workers treating dog bite patients were enrolled consecutively for in-depth interviews. Such health workers were those who met the inclusion criteria: 1) assigned to treat dog bite wounds, and 2) having treated dog bite wounds for at least six months. Health workers who meet the criteria were approached by the researcher for an in-depth interview. An in-depth interview guide was used to collect data on practices reflecting adherence, barriers, and motivations.

3.3.6 Study phenomenon

The phenomenon for this sub-study was the adherence, by healthcare workers, to the guidelines for treatment of dog bite injuries as spelt out in the UCG. The issues explored in relation to the phenomenon included the motivations and barriers to adherence to the guidelines.

3.3.7 Data collection process

3.3.7.1 Data tools

Data were collected using data observation checklists and in-depth interview (IDI) guides *(Appendices IX and X).* The IDI guides had information on motivations and barriers to adherence to UCG while treating dog bite patients. All data collection tools were in English since the study population is elite and known to use that language.

3.3.7.2 Data collection procedure

Administrative permission and informed consent were obtained as in sub-study I above. For data abstraction, patient files were assessed for the items elaborated in the UCG. Where a procedure or step was not recorded, it was assumed that it was not performed and therefore not adherent. In-depth interviews were conducted as per the procedure in sub-study I.

3.3.8 Quality Assurance and Quality Control

3.3.8.1 Recruitment and training of research assistants

As in sub-study I.

3.3.8.2 Pre-testing

The study tools were pre-tested on 3 health workers treating animal bite patients in Mukono Health Center IV.

3.3.8.3 Data accuracy and editing

As in the qualitative component of sub-study I.

3.3.9 Data management and analysis

3.3.9.1 Data Management

Adherence was recorded and categorized as "adherent" or "non-adherent" based on whether what the health worker did was in conformity with the UCG or not. Items that were used to measure this included: history taking, clinical examination, specific treatment prescribed, counseling, and follow-up of patients.

3.3.9.2 Descriptive analysis

Descriptive statistics were computed to describe the respondents. For continuous variable like age, distance from hospital and others, mean (±standard deviation) was computed, for example. In addition, frequencies will be summarized as proportions (e.g., percentages) for categorical variables, e.g., dog ownership, sex, etc. Data from univariable analysis was shown in tabulated form or graphically.

3.3.9.3 Analysis of qualitative data

As in the qualitative component of sub-study I.

3.4 Methods for sub-study III: Burden of antimicrobial resistance associated with dog bite wounds

3.4.1 Study site: As in sub-study I.

3.4.2 Study population

This sub-study was carried out among dog bite patients presenting for post-exposure prophylaxis (PEP). These were the same patients recruited in sub-study I.

3.4.3 Study design

This was a cross sectional study with a quantitative approach.

3.4.4 Sample size estimation

A total of 376 participants as in sub-study I.

3.4.5 Recruitment procedure

All dog bite patients meeting the inclusion criteria in sub-study I were included. Patient characteristics recorded in sub-study I were used to describe the participants, e.g., sociodemographic characteristics and preclinical practices. The wound was cleaned with normal saline. Where there were multiple DBWs, the first bite was considered for sampling. However, where the patient could not identify the first bite, or where the bites were of varying intensity, one that was most serious (i.e. Category III) was selected for sampling. A sterile moistened cotton swab was used to obtain a sample of pus or wound secretion, purulent exudates, or wound discharge from each study participant. Care was taken not to contaminate the swab with commensal bacteria from the skin surrounding the wound. The swab was then immersed in a container of Brain Heart Infusion (BHI) transport medium. For abscesses and puncture wounds, the specimens for bacteriologic examination were obtained by needle aspiration and mini-swabs, respectively. The samples collected each day were transported to the microbiology laboratory at the Makerere University College of Veterinary Medicine, Animal Resources and Biosecurity (MakCOVAB).

3.4.6 Laboratory procedures

3.4.6.1 Bacterial culture, identification and antimicrobial susceptibility testing

In the laboratory, the swab samples were inoculated onto MacConkey agar, mannitol salt agar, pseudomonas agar media, blood agar plate (BAP) and chocolate agar plate (CAP). Those inoculated on the previous three media were incubated at 37ºC for 18 – 24 hours. The samples on BAP and CAP were incubated in a humid, 5% carbon dioxide environment for 18 - 22 hours at 35ºC – 37ºC. The plates were incubated under aerobic conditions and assessed for bacterial growth after the standard incubation timelines. For those that showed growth, they were further sub-cultured on their respective media to obtain pure cultures. Colonies of the organism to be subcultured were selected with a sterile disposable loop, and subcultured on the appropriate medium by touching the loop on to the surface of the agar and plate out. However, if any plate did not show growth after this time, it was incubated for a further 24 hours. Upon obtaining pure colonies, they were subjected to Gram stain, colony morphology, and biochemical tests (Oxoid, Ltd.). Species identification of the isolates was performed from pure colonies using classical biochemical tests according to the standard guidelines (Public Health England, 2014).

Molecular identification was performed for strains that were resistant to three or more antibiotics. In short, following the manufacturer's protocol with minor modifications, DNA was extracted from the bacterial suspensions using the QIAamp® DNA mini kit (QIAGEN). DNA was eluted in 50 μl of TE buffer. DNA quantification and quality control were done using the NanoDrop 2000c (Thermo Scientific™) following the manufacture’s protocol. The specific primer sets that were used in PCR for each candidate gene were obtained from literature. PCR amplifications were performed using 10 μl of the eluted DNA in a 50-μl mixture containing 250 μM each deoxynucleoside triphosphate (Life Technologies), 1.5 U of Taq DNA polymerase

(Life Technologies), 20 mM Tris-HCl (pH 8.4), 50 mM KCl, and 2 mM MgCl2. The PCR tests were run in a programmable thermal cycler (BioRad.) Amplification conditions consisted of 10 min at 95°C, followed by 40 cycles of 1 min at 95°C, 30 seconds at 55°C, and 30 seconds at 72°C, with a final step of 5 minutes at 72°C. The success of the amplifification was determined by ethidium bromide staining following the resolution of products by 1.5% agarose gel electrophoresis. Each experiment included sterile water as a negative control and a positive control.

Antibiotic susceptibility testing was conducted using the Kirby-Bauer disk diffusion susceptibility test protocol as earlier recommended (Hudzicki, 2009). Antimicrobials that were recommended in the UCG to manage DBWs were given priority at testing i.e. metronidazole, methicillin, amoxicillin/clavulanic, doxycyline and cotrimoxazole (trimethoprim-sulfamethoxazole (MoH, 2016b). In addition, common antibiotics used in routine clinical practice were also tested, including: streptomycin (10 μg), vancomycin (30 μg), oxacillin (5 μg), gentamicin (10 μg), ciprofloxacin (5 μg), ceftriaxone (30 μg), chloramphenicol (30 μg), ampicillin (10 μg), and imipenem (10 μg).

In summary, the isolates were plated on Brain Heart Infusion (BHI) agar and incubated for 24 hours. Colonies were picked and emulsified in 0.85% Sodium chloride to create a suspension matching the 0.5 McFarland standard, an approximate concentration of 1.5 × 108 CFU/ml. Two hundred microliters (µl) of the suspension were inoculated on the plates, spread using a sterile loop, and allowed to dry for 2–5 min. The antibiotic discs were thereafter applied to the plates using a disc dispenser, pressed down, and incubated at 25-30°C for 18–24 hours. The zones of clearance were measured using a plate ruler. A strain that was not susceptible to at least one

antimicrobial in three or more antimicrobial classes was declared as having Multidrug Resistance (MDR) as earlier defined (Magiorakos et al., 2012).

3.4.7 Study variables

3.4.7.1 Outcome variable

The outcome variable for this sub-study was antimicrobial susceptibility measured on 3 sub-scales, i.e., Susceptible, Intermediate, or Resistant.

3.4.7.2 Independent variables

Participants' sociodemographics and preclinical practices (as in sub-study I) were used as independent variables to describe antimicrobial susceptibility. In addition, bacterial characteristics such as gram stain, were also considered.

3.4.8 Data collection process

3.4.8.1 Data tools

Data were collected using data forms designed to capture information on bacterial strain characteristics and antimicrobial susceptibility *(Appendix XI)*.

3.4.8.2 Data collection procedure

For each of the samples obtained from a particular participant, the results of the antimicrobial susceptibility test were recorded as Susceptible, Intermediate, or Resistant.

3.4.9 Quality assurance and control

While performing laboratory procedures, the quality of antimicrobial susceptibility experiments were assured and controlled as follows:

a) Use of control strains, including both susceptible and resistant strains, which served to monitor test performance. *Staphylococcus aureus* ATCC 25923 and *Escherichia coli* ATCC 25922 strains were used as controls while performing susceptibility tests for gram positive and gram negative bacteria, respectively. These were obtained from the National Collection of Type Cultures (UK), through the Microbiology Laboratory at Makerere University College of Health Sciences.

b) The equipment that was used, like microscopes and incubators, among others, was calibrated according to manufacturer guidelines. In addition, the particular test conditions, media, antimicrobial tests, interpretation, and reporting guidelines followed the protocol laid out by the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

After obtaining the data, the mistakes and errors that appeared were corrected by comparison and cross-checking the laboratory records, clinical case recording forms, and data collection tools used in sub-study I. In addition, data were double entered and compared for consistency.

3.4.10 Data management and analysis

3.4.10.1 Data Management

Outcome variable: "Antimicrobial Susceptibility" was recorded and categorized as "Susceptible, Intermediate, or Resistant" based on the break-point readings.

3.4.10.2 Descriptive analysis

Stata (version 16) was used to analyze the data. At univariable analysis, descriptive statistics were computed where for continuous variables like age, the mean (±standard deviation) was

computed. In addition, frequencies were summarized as proportions (e.g. percentages) for categorical variables, e.g., strain, gram positivity or negativity, delays in seeking PEP, adherence to preclinical practices, etc.

3.4.10.3 Analysis of antimicrobial susceptibility

Proportions (percentages) were used to describe the antimicrobial susceptibility for each of the bacterial isolates. Separate tables were generated for both gram negative and gram-positive bacteria.

3.5 Methods for sub-study IV: Predictors for infection and other outcomes of dog bite injuries

3.5.1 Study site

As in sub-study I.

3.5.2 Study population

As in sub-study I.

3.5.3 Study design

This was a prospective study with a quantitative approach.

3.5.4 Sample size estimation

As in sub-study I.

3.5.5 Recruitment procedure

All dog bite patients meeting the inclusion criteria in sub-study I were included. Patient characteristics recorded in sub-study I were used to describe the participants in addition to forming the baseline data for the participants. Each participant was followed for 18 months

through the use of routine clinical data, phone calls, or home visits. The follow-up period was determined by rabies incubation period of rabies virus. Wound assessment for infection was done on days 3, 7, 14, 21, and 28 when the patients were expected to return for follow-up rabies vaccine (RV) doses. Thereafter, the participants were contacted on a monthly basis for an assessment of the rabies outcome. If the participants did not turn up for the scheduled doses, efforts were made to trace them by either phone calls or home visits.

3.5.6 Study variables

3.5.6.1 Outcome variables

Infection and other treatment outcomes such as rabies and wound healing.

3.5.6.2 Independent variables

Independent variables were those variables whose information was recorded in sub-studies I and III. In addition, using interviews, the participants were assessed for adherence to treatment and any treatment that was undertaken in addition to the one offered at the hospital, i.e., simultaneous resort *(Appendix XII)*. Furthermore, in cases of clinical infection, bacteriological analysis of the wound was undertaken as in sub-study III.

3.5.7 Data collection process

3.5.7.1 Data tools

Trained medical officers collected data on infection using a modified ASEPSIS (additional treatment, serous discharge, erythema, purulent exudate, separation of deep tissues, isolation of bacteria, and stay duration as an inpatient) tool. The PI and research assistants used a structured

follow-up interview tool *(Appendix XII)* to capture additional treatment administered by the participants themselves.

3.5.8 Data management and analysis

3.5.8.1 Data Management

For each dog bite victim, completed data tools were double-entered into Epi Info™ version 7.2.0.1 statistical software (CDC, June, 2016). The two data sets were compared for any errors or inconsistencies in the values. Data analysis was done using Stata 16 software (StataCorp, June 2019).

3.5.8.1.1 Outcome variable

Infection was the primary outcome, which was assessed and scored as per the guidelines of the ASEPSIS tool. The scores for each patient on each visit were interpreted as satisfactory healing (0-10), disturbance of healing (11-20), minor wound infection (21-30), moderate wound infection (31-40) and severe wound infection (>40), with 70 being the maximum score as per guidelines (A. P. Wilson, Treasure, Sturridge, & Gruneberg, 1986). Secondary outcomes like rabies and healing were described in terms of patient characteristics, practices, and the time of occurrence after the dog bite event and the initiation of treatment.

3.5.8.1.2 Independent variables

As in sub-studies I, II, and III. In addition, adherence to prescribed treatment was assessed using medical records for subsequent scheduled visits. Any deviation from the treatment or schedules was taken as non-adherence.

3.5.8.2 Analysis of factors associated with infection

Infection was categorized at a binary level (yes/no) and a generalized linear model (GLM) was used to assess the determinants of infection. Procedures to carry out the GLM analysis with modified poisson and a log link with robust standard errors are described in sub-study I.

3.5.8.3 Analysis of time to detection of DBW healing and factors associated with delayed wound healing

The time to detection of wound healing was assessed by using Kaplan-Meier survival curves (with correpsonding Log Rank tests) for key variables including, initial infection status, compliance status, wound category, and having received prior treatment. The hypothesis that guided this analysis was that the hazard ratios between the comparative groups were equal to one, i.e., $h_0(t) = h_1(t)$. The test of equality of survival distributions between the different levels of comparative groups was the Log Rank test. It was assumed that censoring is independent or unrelated to the likelihood of developing the outcome (detection of healing). Another assumption related to censorship that was made was that at any time, patients who were censored had the same survival prospects as those who continued to be followed. In addition, it was assumed that the survival probabilities were the same for subjects recruited early and late in the study and that the event (detection of healing) happened at the time specified.

Additionally, the outcome, wound healing, was categorized into timely (within 28 days) and delayed (29 days or more). Since the outcome (delayed wound healing) was uncommon with fewer numbers, bivariate logictic regression was conducted to explore relationships between the selected variables and this outcome. Odds ratios (OR) were computed and their statistical significance was interpreted at a 95% confidence interval and $p \leq 0.05$.

3.7 Dissemination of findings

The dissertation was submitted to the Faculty of Health Sciences, University of Nairobi, as a partial requirement for the award of the Doctorate in Tropical and Infectious Diseases. Secondly, dissemination sessions were held with the District Health Teams (DMTs) of Kampala and Wakiso districts as well as participating hospitals to discuss the findings and recommendations. In addition, four (04) manuscripts were published in peer-reviewed scientific journals. Lastly, some of the findings were disseminated at scientific conferences.

3.8 Summary of research methods used

The methods above have been summarized as shown in **Table 3.6**.

Table 3.6: Summary of methods, variables and data analysis approaches for each of the sub-studies (objectives)

Study design, population and sample size	Data collection	Variables	Analysis
Sub-study I: Explanatory sequential mixed methods study among dog bite patients presenting for initial post-exposure prophylaxis (n = 376); qualitative data (2 veterinarians, 3 patient caretakers, 7 patients, and 1 herbalist).	Interviews using structured questionnaires	Host factors, dog factors, bite circumstances, and preclinical management	Descriptions of patterns of preclinical management measures; prevalence of compliance to preclinical guidelines and generalized linear models (GLM) with Poisson family and a log link with robust standard errors for factors associated with compliance.
	In-depth interview (IDI) guides	Perceptions on preclinical management practices	Deductive thematic analysis.

Sub-study II: Exploratory qualitative study among all the health workers involved in the diagnosis and treatment of dog bites	Observation checklists and in-depth interviews (IDI) using IDI guides.	Treatment given for dog bite injuries and perceptions on clinical management practices	Deductive thematic analysis.
Sub-study III: Cross sectional study with a quantitative approach among patients recruited for sub-study I (n=199).	Culture and sensitivity laboratory approaches.	Bacterial strains, antimicrobial susceptibility patterns, wound and patient characteristics	Prevalence of different bacterial strains; and antimicrobial susceptibility patterns
Sub-study IV: Prospective study with a quantitative approach among study participants recruited in sub-study I (n = 376).	Observations suing the ASEPSIS tool and interviews using structured questionnaires.	Preclinical management practices, wound characteristics and bio-burden as well as clinical management.	Generalized linear model (GLM) analysis with Poisson family and a log link with robust standard errors for factors associated with wound infection; and logistic regression to explore factors associated with healing.

CHAPTER FOUR: RESULTS

4.1 Results for sub-study I: Preclinical practices

The total number of dog-bite patients enrolled in the study was 376. Of these, 201 (54%) were males, and the median (IQR) age was 18 (IQR: 7; 29.8) years. One hundred and ninety (50.5%) of the study participants were from Wakiso district. However, the highest number of patients (69, 18.4%) came from Kawempe Division (sub-county), followed by Makindye Division (46, 12.3%), both in Kampala City. The distribution of patients by subcounty of origin or dog bite area shown in **Figure 4.6** below.

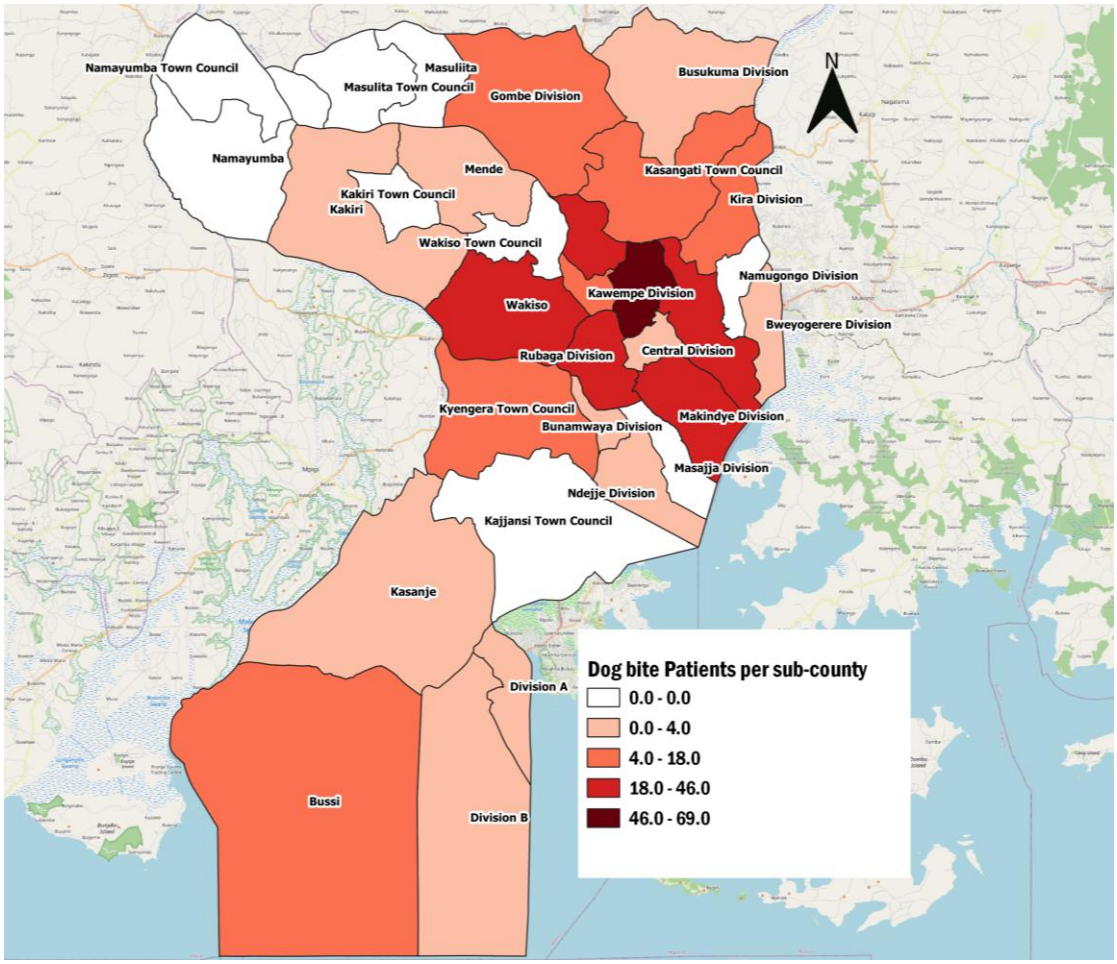

Figure 4.6: Distribution of study participants by subcounty of origin / bite event

Furthermore, 11% of the bite-patients reported owning at least one dog, while only 5.1% had ever been vaccinated (pre-exposure) against rabies. Nearly three-quarters (72%) had ever received some information about dogs and dog bites from sources including friends (46%), family (14%), school (10%), and books (4%). Some victims (8%) reported having suffered dog-bites previously. A summary of the socio-demographic characteristics of the dog-bite patients, dog-ownership, and sources of information on dog-bites for the study participants is provided in **Table 4.7**.

Table 4.7: Characteristics of the 376 dog bite study participants, stratified by district of the bite event.

Characteristics / variables	Frequency	Wakiso N=190 (50.5%)	Kampala N=186 (49.5%)	p-value
Sex				
Male	201 (53.5)	97 (51.1)	104 (55.9)	
Female	175 (46.5)	93 (48.9)	82 (44.1)	0.345
Age				
≤15 years	173 (46.0)	85 (44.7)	88 (47.3)	
>15 years	203 (54.0)	105 (55.3)	98 (52.7)	0.616
Hospital				
Entebbe (Wakiso)	110 (29.3)	72 (37.9)	38 (20.4)	
Mulago (Kampala)	266 (70.7)	118 (62.1)	148 (79.6)	≤0.001
Religion				
Christian	301 (80.1)	159 (83.7)	142 (76.3)	
Non-Christian	75 (19.9)	31 (16.3)	44 (23.7)	0.145
Marital status				
Not in union	285 (75.8)	137 (72.1)	148 (79.6)	
In union	91 (24.2)	53 (27.9)	38 (20.4)	0.091
Highest education level				
No formal education	52 (13.8)	26 (13.8)	26 (13.9)	
Primary	160 (42.7)	76 (40.2)	84 (45.2)	
Secondary and above	163 (43.5)	87 (46.0)	76 (40.9)	0.572
Household size				
≤4	176 (46.7)	81 (45.3)	95 (52.2)	
5-8	161 (44.6)	84 (46.9)	77 (42.3)	
≤9	24 (6.7)	14 (7.8)	10 (5.5)	0.357
Teenagers at home				
No	188 (50.0)	97 (51.1)	91 (48.9)	
Yes	188 (50.0)	93 (48.9)	95 (51.1)	0.680
Employment status				
No	181 (48.1)	89 (46.8)	92 (49.5)	
Yes	195 (51.9)	101 (53.2)	94 (50.5)	0.611

Current dog ownership				
No	334 (88.8)	165 (86.8)	25 (13.2)	
Yes	42 (11.2)	169 (90.9)	17 (9.1)	0.216
Immunised against rabies				
No	357 (94.9)	183 (96.3)	174 (93.6)	
Yes	19 (5.1)	7 (3.7)	12 (6.4)	0.221
Get dog information				
No	105 (27.9)	50 (26.3)	55 (29.6)	
Yes	271 (72.1)	140 (73.7)	131 (70.4)	0.482
Socio-economic status				
Lower	197 (52.5)	95 (50.2)	102 (54.8)	
Middle	62 (16.5)	33 (17.5)	29 (15.6)	
Upper	116 (31.0)	61 (32.3)	55 (29.6)	0.673
Believed a dog could bite them before the bite event				
No	313 (83.2)	150 (78.9)	163 (87.6)	
Yes	63 (16.8)	40 (21.1)	23 (12.4)	0.024

*Significance at p≤0.05 and 95% confidence interval (95% CI).

4.1.2 Characteristics of dog bite injuries

Nearly two-thirds of the dog bite wounds (239/376, 63.7%) were single bites. Three-quarters (293/376, 77.9%) of the wounds were category II and the rest were category III. Forty-six percent of the dog bite patients had wounds on their legs, 14% on the head, 3% on the face, and 3% on several bite sites. The dog-bite distribution by body part and age of bite-patients are summarized in **Table 4.8**.

Table 4.8: Age-specific dog bite distribution by body part among the 376 participants

Age (yrs)	Leg	Thigh	Arm	Abdomen	Back	Head	Face	Other	Combination	Total
≤15 years	62	31	17	3	16	25	7	3	9	173
Percentage	35.8	17.9	9.8	1.7	9.3	14.5	4.1	1.7	5.2	100.0
>15 years	109	38	7	0	10	29	4	3	3	203
Percentage	53.7	18.7	3.5	0.0	4.9	14.3	1.9	1.5	1.5	100.0
Total	171	69	24	3	26	54	11	6	12	376
Percentage	45.5	18.4	6.4	0.8	6.9	14.4	2.9	1.6	3.2	100.0

4.1.3 Characteristics of the biting dogs

Seventeen percent of the dog-bite patients had been bitten by their own dogs, while 46% of the victims knew the owner of the dog that bit them. Nearly a third (30%) of the bite patients could identify the offending dog. Of the 113 biting dogs that were known to the dog bite victim, 21% had been vaccinated against rabies, 26% had not been vaccinated, and 53% were of unknown vaccination status. The victims described the dog as being male in 35% of the cases, 19% female, and the rest were of unknown sex. Details on the characteristics of the biting dogs are presented in **Table 4.9.**

Table 4.9: Characteristics of biting dogs as reported by the study participants for the two districts

Characteristics	Frequency N=376	Wakiso	Kampala	p-value
Sex				
Male	133 (35.4)	73 (38.4)	60 (32.3)	
Female	73 (19.4)	33 (17.4)	40 (21.5)	
Don't know	170 (45.2)	84 (44.2)	86 (46.2)	0.382
Rabies vaccination status				
No	50 (13.3)	30 (15.8)	20 (10.8)	
Yes	41 (10.9)	24 (12.6)	17 (9.1)	
Don't know	285 (75.8)	136 (71.6)	149 (80.1)	0.154
Dog looked sick				
No	250 (66.5)	133 (70.0)	117 (62.9)	
Yes	73 (19.4)	38 (20.0)	35 (18.8)	
Don't know	53 (14.1)	19 (10.0)	34 (18.3)	0.069
Exhibited fear of people				
No	253 (67.3)	129 (67.9)	124 (66.7)	
Yes	102 (27.1)	54 (28.4)	48 (25.8)	
Don't know	21 (5.6)	7 (3.7)	14 (7.5)	0.254
Breed of dog				
Local	222 (59.0)	103 (54.2)	119 (64.0)	
Crossbreed and exotic	48 (12.8)	27 (14.2)	21 (11.3)	
Don't know	106 (28.2)	60 (31.6)	46 (24.7)	0.156
Bitten someone before				
No	73 (19.4)	38 (20.0)	35 (18.8)	
Yes	77 (20.5)	49 (25.8)	28 (15.1)	
Don't know	226 (60.1)	103 (54.2)	123 (66.1)	0.023*
Bitten someone after				
No	104 (27.7)	59 (31.1)	45 (24.2)	
Yes	76 (20.2)	41 (21.6)	35 (18.8)	

Don't know	196 (52.1)	90 (47.4)	106 (57.0)	0.163
Dog size				
Small	69 (18.4)	32 (16.8)	37 (19.9)	
Medium	167 (44.4)	86 (45.3)	81 (43.6)	
Large	140 (37.2)	72 (37.9)	68 (36.6)	0.747
Mood interpreted				
No	193 (51.3)	99 (52.1)	94 (50.5)	
Yes	183 (48.7)	91 (47.9)	92 (49.5)	0.761
Dog owner known				
No	201 (53.5)	93 (48.9)	108 (58.1)	
Yes	175 (46.5)	97 (51.1)	78 (41.9)	0.076

*Significance at $p \leq 0.05$ and 95% confidence interval (95% CI).

4.1.4 Circumstances of dog bites

Most of the dog bites (166/376, 44.2%) occurred in the afternoon to evening time (12 noon – 6pm) and the least (58/376, 15.4%) happened at night (7pm – 5am). The majority of the bites (339, 90%) were unprovoked. Additionally, 137 (37%) of the bites occurred when the people bitten were walking on the road. Nearly all the biting dogs (324, 86%) were unrestrained without a leash. The summary of the circumstances surrounding the bites, as reported by the bite patients, is shown in **Table 4.10**.

Table 4.10: Circumstances of dog bite events among the 376 dog bite patients seeking PET in the 2 selected hospitals in Uganda.

Circumstances /contextual factor	Frequency (n)	Percentage (%)
What time of day did the dog bite event happen?		
Morning	152	40.4
Afternoon	166	44.2
Evening / night	58	15.4
Was it raining when the dog bite event happened?		
No	347	92.3
Yes	29	7.7
If the dog bite happened at night, was there a visible moon?		
No	27	46.5
Yes	31	53.5
Was the owner around when the bite happened?		
No	255	67.8
Yes	121	32.2
Did victim previously know the biting dog?		
No	262	69.9
Yes	113	30.1
Where did the event happen (place of event)?		

Own home*	124	33.0
Premises of person known to victim	86	22.9
Premises of person not known to victim	4	1.1
On the road	137	36.4
Other (e.g. market, classroom)	25	6.6
Was the victim in company of other people when dog bite occurred?		
No	211	56.1
Yes	165	43.9
What was the victim doing just before the dog bite?		
Walking	209	55.6
Seated	46	12.2
Chasing dog away	8	2.1
Feeding dog	8	2.1
Other	105	27.9
Was it the victim that approached the biting dog?		
No	37	9.8
Yes	339	90.2
Was the biting dog on the leash?		
No	324	86.2
Yes	52	13.8
Did the victim attempt to fend off the biting dog?		
No	218	58.0
Yes	158	42.0
Did the victim think or feel that the dog intended to bite them?		
No	124	33.0
Yes	252	67.0
Does the victim blame anyone for the bite?		
No	286	76.1
Yes	90	23.9
What immediate action was taken against biting dog?		
Chased it away	91	24.1
Killed it	19	5.1
Nothing	177	47.1
Ran away by itself	83	22.1
Other	6	1.6

*Includes victims bitten by dogs on their own property.

4.1.5 Circumstances of dog bites

Routine activities bringing dogs and humans into close proximity

Additional insights into dog bite circumstances are grouped as shown in **Table 4.11**. A common view was that victims were bitten while undertaking routine / everyday activities. Respondents spoke about holding something that drew the interest of the dog. Additionally, they talked about activities that brought dogs into close proximity with people, as some explained:

"On my way back from the abattoir to buy meat, I didn't know that there was a dog nearby, I only realized when it was holding onto my leg…… the dog continued biting me until a man came and hit it. By this time, it had even bitten my buttocks." (Adult patient, female).

"We were playing with other children, running in circles in the compound. Our dog joined us and we ran with it. When I stopped, it jumped and bit me without warning." (Patient, male child).

Disturbing dogs and threatening owner

However, some respondents explained that the biting dogs had been deliberately disturbed, either by themselves or by others. In addition, some thought that dogs also bit them when they acted in a way that threatened the dogs' masters. Notably, such dogs had been on the loose in presence of strangers. One of the participants explained it as follows;

"That Saturday morning, I went to visit my friend. We talked right there in the compound, standing. However, when we laughed loudly, I remember the dog barked. When we gave each other a 'high-five' and hugged, all I remember is the owner shouting at the dog to let go of my shirt. In the struggle, it bit me two times on the back and leg." (Male adult patient).

Unusual behavior and protective tendencies

Some dog owners who had been bitten explained the unusual behavior of the dogs, e.g., biting every living thing in the homestead, whether it posed a danger to it or not. They interpreted this as potentially rabid behavior. In addition, others were bitten by dogs protecting each other in a pack or with young ones (puppies), as one explains;

".... since our dog produced [had delivered]*, it did not want to interact with us. It no longer sits in front of the kitchen door as it used to do. I was with this boy in the kitchen, and when I left to go to the house, he said he went behind the kitchen to see the dog and*

its babies [puppies]. *He said that is when it jumped and bit him on the shoulder. When I checked on the dog, it also wanted to bite me." (Caretaker / mother to a child patient).*

Deviant handling practices

A number of respondents bitten by their own dogs explained circumstances that pointed to deviations from routine practices in handling the dogs. They tended to inflict pain on the dogs during handling. In retaliation, the dogs bit them as one of them elaborated;

"Normally, I call them to follow me to their kennel, and they do. But this time one of them refused, and after taking in the others, I went back and dragged it by the front leg. When it resisted, I lifted it and tried to push it into the house. This is when it bit my hand……" (Adult male patient).

Seasons

For some, there were conditions like rain that caused interaction with the dogs in open shelters. However, some described circumstances of having been bitten by dogs left unattended, even without sharing shelter with them. On the other hand, some practitioners described bites as a seasonal issue, linking them to late-night activities especially during festive days, as one explains;

"I get most of the people during big [festive] *days like Christmas and Easter. This is when my house [serves as the care facility] is always full. Do you know why? People drink, yet most of the dogs without owners also move at night. So they meet themselves, and in most cases, people harass these dogs first because they are scared of them. This is when they get bitten and come here for treatment." (Herbalist attending to dog bite victims).*

4.1.6 Immediate actions taken by bite victims

Reporting to local leaders and area veterinarians

When we inquired into what victims did immediately after the bite, the key actions included seeking medical care and legal action, as summarized in **Table 4.6**. Reporting to local authorities was quite common, especially when victims wanted local leaders to put the owners of the biting dog to the task of owning up to the responsibility of treating them. However, local veterinarians explained that some victims immediately call them because they know that it is their responsibility to ensure that dogs do not bite them. In other circumstances, the victims call veterinarians to seek treatment advice, as one explains;

> *"They can call to be advised. Others rush to the nearest health center, and that is where they refer them to Entebbe hospital..... Many of them ask if my office has anti-rabies vaccines, thinking such vaccines are kept with the area vet. They even get annoyed when I tell them I don't have the vaccine." (Local Veterinarian).*

Presenting to healthcare facility

Notably, there are some who immediately go to a healthcare facility. In comparison, some victims spent time reflecting on the bite event and were terrified of the bite's consequences, particularly death.Those that experienced this state related to the previous events that they had heard or witnessed in their lives, as one narrates below;

> *"I cried, I just sat there and cried. I thought I was going to die. In our place* [of origin]*, a dog bit a man, and after 3 months, he started barking like a dog, yes. All my thoughts ran to that man who died, thinking that I was going to be like him. Besides, I was also in too much pain. You see this finger, I still feel paralysis and sharp pain in it." (Adult female patient).*

Table 4.11: Circumstances of the dog bites, immediate actions taken by victims and reasons for different applications and health seeking behavior.

Category	Theme
(a) Circumstances of the dog bite event.	1) Routine / everyday activities; 2) provocation of the dog; 3) releasing domestic dogs in the presence of strangers; 4) dogs protecting their young ones; 5) potentially rabid dogs; 6) deviant dog management practices; 7) open shelters shared by people and dogs; 8) unattended to dogs; and 9) mating season for dogs and 10) late night movements.
(b) Immediate actions taken for and by dog bite victims.	1) Reporting to authorities; 2) contacting professionals for guidance; 3) expression of regret; and 4) seeking medical care.
(c) Reasons for application of different materials / substances.	1) To kill and remove rabies-causing organisms (virus); 2) substances are known to treat regular wounds; 3) to stop circulation of germs in the body; 4) knowledge and practices of first responders; 5) historical experiences of caretakers.
(d) Reasons for seeking care from herbalist.	1) Trust in herbalists; 2) Pedigree of healers 3) Thinking that medical care was not affordable.
(e) Reasons for simultaneous resort.	1) Information sharing with fellow patients; 2) conflicting advice.
(f) Why victims sought care directly from healthcare facility.	1) Knowledge and experiences on consequences of a dog bite without treatment; 2) Mistrust and trust in community advice.

4.1.7 Compliance to preclinical guidelines

Only 70 participants (19%) complied with the guidelines and reported that they washed the wounds with water and soap and presented to a healthcare facility within 24 hours. Of these, 45% (32/70) applied an antiseptic in addition to washing. However, 19/376 (5%) washed with water only and 183/376 (48.7%) neither washed the wound nor applied anything. Antiseptic (46), herbs (25) black stone (10) unknown creams or other materials such as beans, dog urine, dust,

tobacco, coins, brake fluid, acid, powder made from dog hair, and salt were the most commonly used materials on the wounds of the 193 victims receiving preclinical care.

Notably, only 8 out of 29 study participants who had previous dog bite episodes complied with preclinical guidelines. Additionally, presentation within 24 hours was mentioned by three-quarters (74.7%) of the victims. The median (IQR) time to presentation at a health facility was 18 (IQR: 7; 49) hours. **Table 4.12** shows the factors that were associated with increased compliance, including education ($p<0.001$), employment status ($p = 0.01$) and accessing information about dogs ($p = 0.005$).

Table 4.12: Distribution of selected characteristics of 376 respondents by compliance

Characteristics	Frequency, n (%)	Complied, n (%)	p-value
District			
Wakiso	190 (50.5)	38 (20.0)	
Kampala	186 (49.5)	32 (17.2)	0.486
Sex			
Male	201 (53.5)	34 (19.9)	
Female	175 (46.5)	36 (20.6)	0.364
Age			
≤15 years	173 (46.0)	36 (20.8)	
>15 years	203 (54.0)	34 (16.8)	0.313
Religion			
Christian	301 (80.1)	54 (17.9)	
Non-Christian	75 (19.9)	16 (21.3)	0.499
Marital status			
Not in union	285 (75.8)	56 (19.7)	
In union	91 (24.2)	14 (15.4)	0.363
Highest education level			
No formal education	52 (13.8)	7 (13.5)	
Primary	160 (42.7)	15 (9.4)	
Secondary and above	163 (43.5)	48 (29.5)	<0.001*
Household size			
≤4	176 (46.7)	30 (17.1)	
5-8	161 (44.6)	35 (21.7)	
≤9	24 (6.7)	4 (16.7)	0.541
Employed			
No	181 (48.1)	24 (13.3)	
Yes	195 (51.9)	46 (23.6)	0.010*
Current dog ownership			
No	334 (88.8)	66 (19.8)	
Yes	42 (11.2)	4 (9.5)	0.140

Patient vaccinated against rabies			
No	357 (94.9)	64 (17.9)	
Yes	19 (5.1)	6 (31.6)	0.136
Get dog information			
No	105 (27.9)	10 (9.5)	
Yes	271 (72.1)	60 (22.1)	0.005*
Socio-economic status			
Lower	197 (52.5)	27 (13.7)	
Middle	62 (16.5)	21 (33.9)	
Upper	116 (31.0)	22 (18.9)	0.002*
Dog looked sick			
No	250 (66.5)	25 (10.0)	
Yes	73 (19.4)	35 (48.0)	
Don't know	53 (14.1)	10 (18.9)	<0.001*
Exhibited fear of people			
No	253 (67.3)	24 (9.5)	
Yes	102 (27.1)	36 (35.3)	
Don't know	21 (5.6)	10 (47.6)	<0.001 *
Vaccination status			
No	50 (13.3)	7 (14)	
Yes	41 (10.9)	5 (12.2)	
Don't know	285 (75.8)	58 (20.4)	0.303
Bitten someone after			
No	104 (27.7)	19 (18.3)	
Yes	76 (20.2)	39 (51.3)	
Don't know	196 (52.1)	12 (6.1)	<0.001*
Dog owner known			
No	201 (53.5)	51 (25.4)	
Yes	175 (46.5)	19 (10.9)	<0.001*

*Significance at p≤0.05 and 95% confidence interval (95% CI).

4.1.8 Explanations for application of non-recommended substances

To kill micro-organisms

On deeper inquiry, some respondents thought that by applying substances of unusual pH or temperature, they would kill the rabies virus. This came out as one of the reasons why some applied hot water, salt and battery acid, as one explains;

> *"When the dog came and bit me, many of my colleagues in the garage where I work told me to first put battery acid to kill the germs* [virus] *that cause dog madness before they could go very far inside the meat* [flesh]. *So, they removed the battery from the car and drained its acid into the wound here* [shows hand]*." (Male, adult patient).*

Routine management of wounds

Some respondents had witnessed routine wound management with certain substances or by certain procedures. It was the reason they managed the dog bite in a similar way without the specifics of a dog bite, as one explains:

> *"At times, you find people with bandages. When you ask them why, they tell you they do not want the blood to move to the brain carrying dog poison. They think rabies is like snake poison that travels in the bloodstream." (Area veterinarian).*

Knowledgeable caretakers and trust in herbalist

Additionally, some victims did not apply herbs out of choice but relied on the knowledge, skills, and practices of first responders who they thought were more knowledgeable in managing dog bites. This was more pronounced when the caretaker also doubled as the decision-maker on which line of treatment to take. Similarly, a number of respondents applied herbs because they trusted the herbalist. This trust extended to the treatment, which they took without questioning, as one recounted:

> *"My mother sent me to the traditional doctor* [herbalist]. *There is some powdered medicine he tells you to put under the tongue, then he cuts you on the leg here like this* [shows around the ankle], *then he puts a black stone…... He told me to go home and not to bathe using cold water, drink cold drinks ……. I did not ask, I just followed instructions, it was my mother who had sent me to him". (Female adult patient).*

Pedigree of herbalist

The pedigree of a particular herbalist also played a key role in informing the decisions of victims. Some dog bite victims based their decisions on success stories they had heard, as one herbalist explains:

"They come because I have a history of healing them since the 70s. Even when they go to Mulago [hospital]*, some pass here. People believe in me. My treatment is cheap because, over time, I have found out that dogs bite the poor. They should thank God, not me, for He has kept me longer." (Herbalist for dog bite victims).*

Perceived high cost of conventional treatment

However, some patients sought herbalist assistance because they thought they could not afford conventional treatment. They only went to the hospital when they learnt that treatment was free, as one elaborates;

> *"I sent my girl* [daughter] *to the herbalist, and I did not go because I did not have money for both of us. I first felt pity for this young one* [smiles]. *I stayed and put tobacco on the wound. But when the dog died, I was worried. I went to Mulago* [hospital] *after a week, where I learnt that the treatment was free. I went back home and brought my daughter too. She didn't go back to the herbalist again." (Adult female patient and mother to a patient).*

Conflicting information on efficacy of both herbs and modern treatment

When we investigated why some of the patients used conventional and non-conventional medicine at the same time, they pointed to information from fellow patients they found in the hospital. Another reason they gave for the simultaneous resort was the conflicting information proving and disproving the efficacy of herbs. Therefore, they chose to use two lines as one elaborates:

> *"I went to the herbalist because our family members knew very well that he worked well on dog bites……one of my daughters healed well, so I was sure that his medicine* [herbs] *would heal those bitten by dogs. But when our LC* [local leader] *told me that in Mulago treatment was more effective and free, I also decided to come this side* [hospital]*." (Adult female patient).*

4.1.9 Explanations for seeking medical care from hospital

Mistrust in herbalists

Some patients talked about the mistrust they had in herbalists, even when some of them patients first went to them. They indicated dissatisfaction with the herbalist's procedures. According to one account, some of them purposefully refused the processes and went to the hospital without using any herbs.

> *"Now to go to Mulago* [hospital]. *It has professional doctors, but the one they had directed me to is a herbalist. He even wanted to cut my leg and put a black stone in it. He did not wear gloves, so I refused. That is why I stopped him from adding more things to my wound. I went away." (Adult male patient).*

Knowledge and experiences on dangers of dog bites

Knowing someone who had suffered negative consequences from dog bites attributed to inadequate medical care also came out as one of the reasons why some people immediately went to hospital. Such experiences were common among the victims, as one of them recounts;

> *"People talk. There was also a time when we were in Kikandwa* [place of birth] *and a child passed on. A dog bit him, and he was taken to a* [herbalist] *and received treatment. After a period of some months that I can't recall, a child started barking and passed on. This was last year. So I could not risk going to that man* [herbalist]*." (Female adult patient).*

Community advice

However, other respondents attributed their action of seeking medical care paradoxically to both mistrust and trust in community advice. Those who mistrusted community advice questioned the efficacy of different applications that were suggested to them. However, those who trusted community advice heeded it and went to the hospital.

4.1.10 Factors associated with compliance to standard preclinical management guidelines for victims seeking post-exposure prophylaxis

In the adjusted analysis, factors significantly associated with a higher likelihood of compliance to preclinical guidelines were having a secondary education or higher compared to no formal education, adjPR = 1.76 (95% CI: 1.24, 3.79; p= 0.024), being employed (or having a source of income) compared to those with no employment, adjPR = 1.48 (95% CI: 1.09, 2.31; p = 0.047), perceiving the dog as being sickly compared to those that did not have this perception, adjPR = 1.47 (95% CI: 1.02, 2.72; p = 0.042) and knowing that the dog went on to bite another person compared to those that did not know, adjPR = 1.69 (95% CI: 1.01, 2.86; p = 0.048). Compliance was significantly lower among the older (15+ years) relative to the younger (<15 years) victims, adjPR = 0.70 (95% CI: 0.47, 0.92; p = 0.045), those who were not certain whether the dog went to bite another person or not compared to those who were certain, adjPR = 0.35 (95% CI: 0.17, 0.70; p = 0.003) and knowing the owner of the biting dog relative to those that did not know, adjPR = 0.65 (95% CI: 0.36, 0.93; p = 0.034). The factors that were significantly associated with compliance to clinical guidelines are presented in **Figure 4.7**.

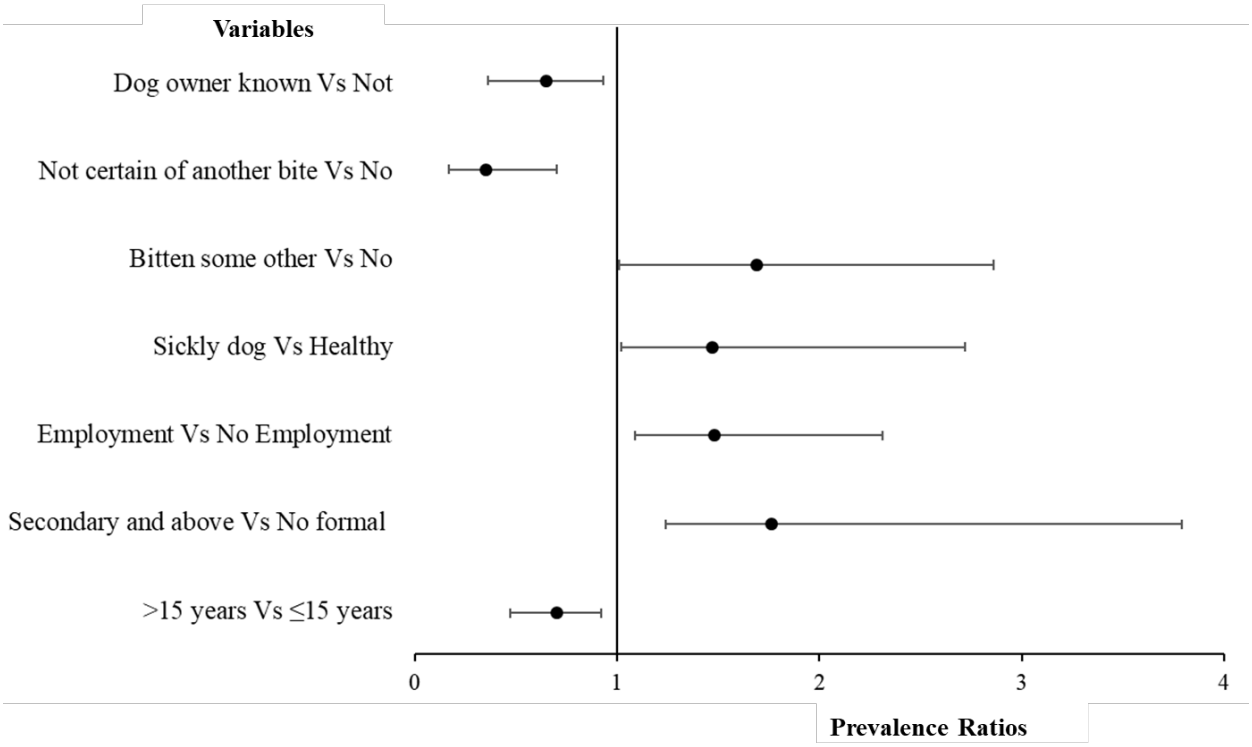

Figure 4.7: Forest plot showing factors that are significantly associated with compliance to standard preclinical management guidelines for 376 victims seeking PEP in the 2 selected hospitals in Uganda.

Important to note is that the sex and rabies immunization status of the victim did not have any bearing on the compliance as shown in **Table 4.13**. Notably, the interaction effects between sex and age as well as sex and marital status on compliance were not significant.

Table 4.13: Multivariable analysis of factors associated with compliance to standard preclinical management guidelines for 376 victims seeking post-exposure prophylaxis in the 2 selected hospitals in Uganda.

Characteristics	Unadjusted PR (95% CI)	p-value	Adjusted PR (95% CI)	p-value
District				
Wakiso	1.0			
Kampala	0.86 (0.56 - 1.32)	0.488		
Sex				
Male	1.0		1.0	
Female	1.22 (0.79 – 1.86)	0.365	1.04 (0.73 – 1.49)	0.798
Age				
≤15 years	1.0		1.0	
>15 years	0.81 (0.53 - 1.23)	0.315	0.70 (0.47 - 0.92)	0.045*
Religion				

Christian	1.0			
Non-Christian	1.19 (0.72- 1.96)	0.495		
Marital status				
Not in union	1.0			
In union	0.74 (0.39 - 1.41)	0.364		
Highest education level				
No formal education	1.0		1.0	
Primary	0.70 (0.30 - 1.62)	0.400	0.89 (0.81 – 2.05)	0.783
Secondary and above	2.19 (1.05 – 4.54)	0.036	1.76 (1.24 – 3.79)	0.024*
Employment status				
No	1.0			
Yes	1.78 (1.13 – 2.79)	0.012	1.48 (1.09 – 2.31)	0.047*
Current dog ownership				
No	1.0			
Yes	0.48 (0.18 - 1.25)	0.135		
Immunised against rabies				
No	1.0		1.0	
Yes	1.76 (0.88 – 3.54)	0.112	1.48 (0.81 - 2.74)	0.203
Get dog information				
No	1.0		1.0	
Yes	2.32 (1.23 – 4.37)	0.009	1.40 (0.74 - 2.66)	0.295
Socio-economic status				
Lower	1.0			
Middle	2.47 (1.51 – 4.05)	<0.001	1.29 (0.82 - 2.05)	0.269
Upper	1.38 (0.83 - 2.31)	0.216	1.01 (0.63 – 1.62)	0.292
Perceived health status of dog				
Healthy	1.0		1.0	
Sickly	4.79 (3.08 - 7.46)	<0.001	1.47 (1.02 – 2.72)	0.042*
Don't know	1.89 (0.96 - 3.69)	0.064	1.29 (0.63 – 2.45)	0.430
Exhibited fear of people				
No	1.0		1.0	
Yes	3.72 (2.34 - 5.91)	<0.001	1.53 (0.88 – 2.67)	0.132
Don't know	5.01 (2.79 – 9.05)	<0.001	1.52 (0.79 – 2.91)	0.931
Rabies vaccination status of dog				
No	1.0		1.0	
Yes	0.87 (0.30 - 2.54)	0.801	0.72 (0.28 - 1.83)	0.491
Don't know	1.45 (0.70 - 3.00)	0.312	0.96 (0.38 – 2.45)	0.931
Bitten someone after				
No	1.0		1.0	
Yes	2.81 (1.77 – 4.46)	<0.001	1.69 (1.01 – 2.86)	0.048*
Don't know / not certain	0.34 (0.17 - 0.66)	0.002	0.35 (0.17 - 0.70)	0.003*
Dog owner known				
No	1.0		1.0	
Yes	0.43 (0.26 - 0.69)	0.001	0.65 (0.36 - 0.93)	0.034*

*Significance at p-value ≤0.05 and 95% confidence interval (95% CI).

4.2 Results for sub-study II: To describe the adherence by health workers to recommended clinical guidelines for treating dog bite injuries in selected hospitals

4.2.1 Characteristics of study participants

The demographic characteristics of respondents were collected at baseline. All health workers were either involved in the diagnosis of the patients or the administration of treatment. The participants had been involved in the management of dog bites for periods ranging from 3 to 29 years, with a median duration of 7 years. Of the 14 health workers (8 from Entebbe General Referral Hospital and 6 from Mulago Nationa Referral Hospital), 5 were medical officers with Bachelor's degrees and 2 were clinical officers with diplomas in clinical medicine. The rest were nurses who held various certificates in nursing.

4.2.2 Themes

The broad theme of this sub-study was the clinical management of dog bite injuries. This encompassed the following organizing themes: history taking; examination of the dog bite injuries; treatment of dog bite injuries; follow up of dog bite patients; and challenges in the clinical management of dog bites within UCG, as shown in **Figure 4.8**.

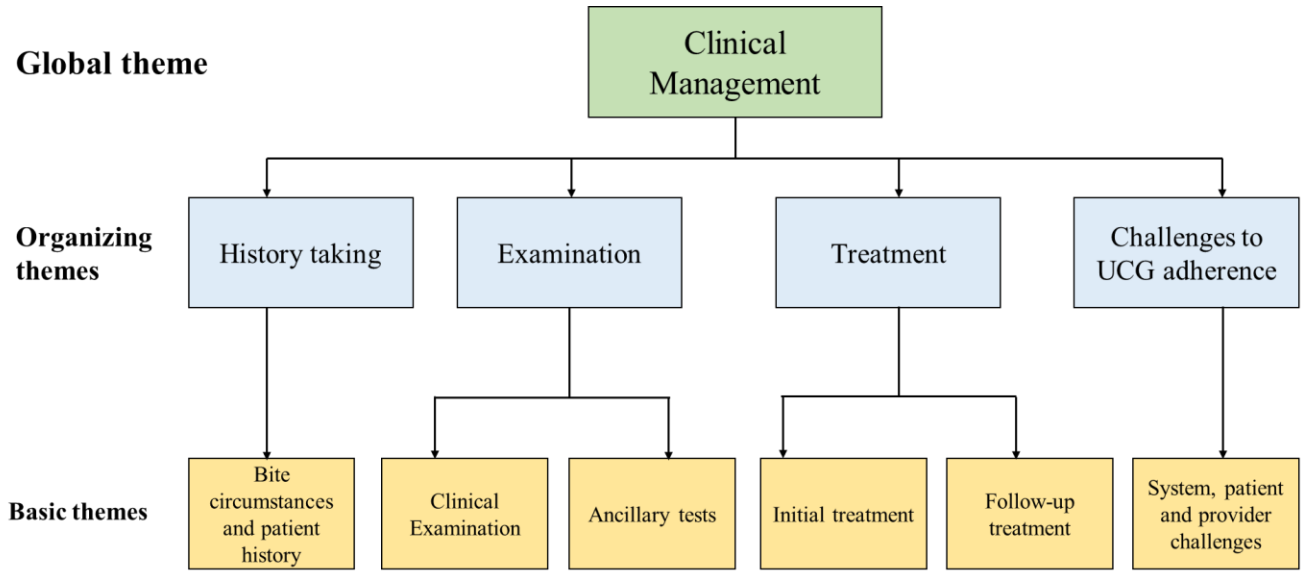

Figure 4.8: Thematic analysis for clinical management of dog bite injuries

The findings are therefore presented following these themes. In addition, a summary of key themes and concepts identified in the data is presented in **Table 4.14**.

Table 4.14: Themes and concepts out of the qualitative data

Themes	Concepts
History taking	• History is taken in order to estimate the likely outcomes of the bite as well as guide the choice of treatment. • Circumstances of the event investigated include patient actions before the bite and whether the bite was provoked or not; time of event; patient factors and well as of characteristics. • Much of the history is taken, but it is neither verified nor written down in the patient's file.
Examination of the dog bite injuries;	• Some of the patient's vital signs are taken before noting the site of injury. • There were attempts to classify the wound depending on the severity with the aim of determining the line of treatment, though the clinicians could not accurately describe the classification. • Ancillary tests like radiology; complete blood counts; and culture and sensitivity tests are not done. • Wounds are examined for present infection signs. • In cases of symptomatic rabies, the practitioners undertake differential diagnosis.
Treatment of dog bite injuries	• Wounds are cleaned with either povidone iodine mixed with water; or soap and water. • Antibiotics are given for both the treatment of infection and prophylactic purposes. • Antibiotic prescription is not based on UCG, but rather on availability, affordability, and wound healing progress. • Tetanus vaccination is seldom undertaken, but this depends on the hygiene levels of the wound or anticipated contamination but not the history of vaccination of the patient. • Rabies immunoglobulin (RIG) is not given due to its unavailability and cost to the patient, even in the circumstances where it should have been given. • Pain is managed by prescribing either paracetamol, ibuprofen, or diclofenac. • Anti-rabies vaccines (ARV) are given depending on the vaccination status of the patient as well as the class / severity of wound. • ARV course is a 5-dose regimen on days 0, 3, 7, 14, and 28 but it is modified according to whether

	the biting dog is healthy or vaccinated against rabies. • Sometimes the ARV is given to patients when it is unnecessary e.g. in category I bites. • Health education regarding the prevention of dog bites is not given to patients.
Follow up of dog bite patients;	• Patients do not go back to the clinician but to the vaccination station where three elements are done: additional post exposure rabies vaccine doses; assessment of wounds; and reporting on the health status of the biting dog. • Non-compliance includes termination of treatment, violating the vaccination schedule, and adding traditional treatments to the wounds.
Challenges in the clinical management of dog bites according to UCG	• Respondents mentioned the absence of the immunoglobulins; frequent stock outs of the vaccine; lack of collaboration and linkages among health facilities; distance to be covered by patients; high costs of treatment; deviations from wound homecare instructions; and insufficient knowledge and skills on how to manage rabies and dog bite injuries.

4.2.3 History taking

4.2.3.1 Essence of taking history

In almost all the cases observed, the medical officer asked the patient about the history of the bite. All respondents knew the essence of taking the history of a dog bite. They reasoned that knowing the history of the bite event has links with the severity of the event, its likely outcomes as well as the treatment line to the undertaken:

> *"So, I started seeing animal bite patients every day of my daily practice. When patients come, because you will get one who will say, I was bitten by a dog. Okay! Because when a person is bitten by a dog, you now get the history, when the dog bit the person, from where, then you ask, is it a domestic dog? Is it a stray one? Do you know the owner of the dog? All those questions we ask because those questions help us in guiding on what type of drug to give and for how long." (R3, Medical Officer).*

> *"Is it domestic or stray? If she says, I know, it is for my neighbor's dog, then you ask them: did you talk to the neighbor? Is the dog vaccinated or not? You find out because other people tell them. This tells you whether the dog is likely to be rabid or not. Then you will know the seriousness of the bite." (R2, Medical Officer).*

4.2.3.2 Circumstances of the bite event

In all cases observed, the practitioners assessed the circumstances of the dog bite, particularly what the patient was doing before being bitten and whether they knew the biter or not. Other circumstances investigated included whether the event was provoked or unprovoked and whether the dog went on to bite other people or not. The respondents explained that circumstances are essential in determining the behavior of the dog and its rabid status, as one explains:

"When they come, of course they are the ones to tell you "musawo [health worker] I was bitten by a dog". Then you ask them: Do you know the owner of the dog? Is it domestic or stray? Was it you who approached it, or did it come by itself to bite you? All this will inform me whether the dog is probably rabid or not." (R2, Medical Officer).

"The behavior of the dog is crucial in determining whether it was rabid. The other day, one patient told me the dog had bitten four of them within the same locality. Such dogs are most likely rabid. So that guides you on what to do for such a patient." (R6, Clinical Officer).

4.2.3.3 Vaccination status of patient

It was noted that it was in 46/376 observations where the vaccination history of the patient was asked. For why the history of previous rabies vaccination was not regularly taken, the health workers explained that they assumed that all people were not vaccinated against rabies. In addition, some providers found it of no essence since even the patients who are usually vaccinated, e.g., veterinarians, insist on getting the full course of treatment, including all the doses of the vaccine recommended for non-vaccinated people:

"Rabies vaccination is not routine, so almost all people are not vaccinated. Many times we get the vets [veterinarians] *bitten, but they demand to get all doses. This includes those from wild life. So that is something I rarely ask." (R4, Medical Officer).*

4.2.3.4 Prior (previous) dog bite injuries

In all the observations, none of the patients was asked whether they had had a dog bite episode before the current one. However, upon being interviewed, only one practitioner agreed to having ever investigated this in practice. Others either found no need or it was something they did not think was relevant in practice.

I: "Have you ever taken history and gotten circumstances where someone comes with a dog bite but has a history of a prior dog bite?"

P: "I rarely ask about that, but I have received a few such cases. Sometimes there are those who come, the dog bit the person, came here and completed the treatment. After 3 or 4 months, a dog bites them again and they come back. But according to the treatment, if it is within one year, they are protected." (R5, Medical Officer).

"No. I have never asked that question before. And even if they are there, I don't think there is value in asking them because we are dealing with the current bite. So I take history on the current bite." (R2, Medical Officer).

3.3.5 Dog characteristics

While taking history, the health providers sought information on the factors surrounding the biting dog. Commonly sought out were whether the dog was domestic or stray and its vaccination status. These two elements were common across all observations. When asked why they take a keen interest in these two factors, the respondents said that these elements guide them in deciding the treatment regimen and advising the patient as regards observing the dog.

"Because we first ask about the dog: do you know the dog? Was it vaccinated? Many will tell you they know the dog but we are not sure if it was vaccinated. So, if the person is not sure of this, we vaccinate them straight away. Some come with veterinary cards [vaccination cards]. *We look at the cards and if the dog was vaccinated within a period of 1 year, we don't need to vaccinate them." (R1, Medical Officer).*

"Others who are really good and will say, "I went to the neighbor, he accepted it is vaccinated and this is the card". They come along with the original copy from the owner. Then when you look at that one, you definitely know the dog is vaccinated, but you still have to counsel her and tell her to continue observing the dog for ten days." (R3, Medical Officer).

4.2.3.6 Time of bite

It was observed that in all cases, the health provider asked about the time the event happened. However, this was to varying depths. In 141 out of 376 observations, there was an effort to ask the patients about the estimated time of the bite with the health worker leading the patient. In the remaining cases, there were broad responses as regards the time, e.g., 'yesterday', 'the day before yesterday'. The respondents reasoned that they have to investigate the time in order to evaluate the probability of success in preventing rabies if the dog was indeed rabid.

> *"Finding out the delays is really important because of one aspect. For any clinical management, when you get an early diagnosis and you get early treatment or intervention, the outcomes are better……. For rabies per se, the incubation period is so varied that you find cases and you really wonder if it is true or not. So, the time as to when they have reported and you have intervened by giving them the anti-rabies vaccine to develop their antibodies so that their bodies are immune is much more crucial for them. So, that is why history is more important." (R7, Clinical Officer).*

> *"At times, there are those that come even after two weeks, after a month, and those cases you know are already coming with full blown rabies. So we take the history of the time of the bite to know which stage of progression to rabies the patient might be at." (R3, Medical Officer).*

4.2.3.7 Verification of history

In all the observations made, the health workers did not make any efforts to verify what the patients were telling them. Even when some patients carried the vaccination cards of the biting dogs, the providers did not ask for them upon receiving the answer that the dog was vaccinated. The prior vaccination of the patient was also not verified in all cases, for the 46 who answered such a question in the affirmative. Whereas some providers pegged their inability to huge

caseloads (emergency medicine departments handle other cases besides dog bites), others took the position that patients know that providing accurate information is in their best interest and therefore there was no need to verify:

> *"Well, huh you can't be sure of what they are telling you (laughs). But you have to listen to the other party because you were not there. And you have to believe that the patient will be telling you the truth regarding his or her health. They are the ones who require the treatment." (R4, Medical Officer).*

4.2.3.8 Handling of history taken from dog bite patients

Much as a number of aspects of history are taken from the patient, there is little that is written down. A larger part of history is left as verbal in favor of what each provider thinks is important:

> *"I don't write some things. I only write the necessary ones like the time when the dog bit the person, what sort of dog, is it a home dog, is it a stray dog which they have never seen, was it in someone's compound tied or not tied." (R8, Clinical Officer).*

However, this has resulted in some challenges faced by the healthcare workers that administer the treatment. They reported that because patients come with only a prescription and not a written history to get the treatment, they give them blanket advice. They cannot tailor the post-treatment counseling to a specific patient. Secondly, it introduces challenges where the treatment administerer cannot explain to the patient why they are receiving a particular line of treatment:

> *"They bring the prescription to me. I give the treatment as requested. But I cannot specifically tell the patient what to do except for the general things like wound care and compliance to treatment. Some are to get one dose of the vaccine only. I can't explain to the patient why, but if there are not many patients, then I can ask the patient again if this was a domestic dog and I talk about observation." (R9, Nurse).*

4.2.4 Examination of dog bite wounds

During the examination of patients, it was observed that vital signs like body temperature, pulse rate, respiration rate, and blood pressure were not taken. In addition, no pain assessment was done. However, in all observed cases, practitioners examined and assessed the bite wound.

4.2.4.1 Aspects of clinical examination of the site of bite

For all patients, there was a description of the location of the injury, e.g., face, hands, legs, and others, although no effort was made to take pictures or draw sketches for the patient's file. The emphasis of examining the location was explained by all respondents:

> *"The site must be examined because there are some injuries that are nearer the central nervous system. Those ones will not take long because if the dog has rabies, it [virus] will move faster to the brain and they [patients] will get signs and symptoms of rabies. Therefore, the bite site is considered an emergency if it is near the central nervous system."(R5, Medical Officer).*

> *"A child is short, so any bite wound on a child is on the fingers, head, or neck. Even if it is their treasured dog and it was vaccinated, I give the vaccine. Chances are that the bite is close to the central nervous system. If there is a virus, it will move from the site into the nervous system. So for me, I treat such children with particular attention." (R7, Clinical Officer).*

4.2.4.2 Classification of the bite wound

For all observations made, there was an effort to classify the bite wounds in either a standard way as per UCG or through a description. However, there was no measurement of the length and depth of the wounds, only a subjective description. All respondents said that the severity of the wound is important in choosing the treatment line. In what is conventionally classified as

category I wounds, there were two incidences where the examining officers called their colleagues to determine if, indeed, there was no damage to the skin. Asked why, they explained that triangulation of examiners increases the accuracy in determining that the patient needs no medical treatment.

> *"Some people come with very intact skins, and they claim I have been bitten. Maybe the dog did not manage to inflict a bite. I always get a colleague to help me by looking at the wound. If both of us cannot see something like an injury, then this is a category 1 bite. I just go ahead and counsel that patient." (R7, Clinical Officer).*

However, all respondents could not accurately fit their descriptions of bite wounds into the right standard categories, i.e., Category I (where the dog licks on intact skin with no exposure); Category II (where there is nibbling of uncovered skin, minor scratches or abrasions without bleeding, thus exposure); and Category III (with single or multiple transdermal bites or scratches and broken skin with saliva from dog licks, thus severe exposure):

> *"Majority of the wounds are category I. By category I, I mean it is just a mere disturbance of the epidermis, they don't go deep into the flesh. Those that involve flesh and bone are rare. In most cases, these constitute an emergency, severe bleeding, shock, and a lot of anxiety, so those ones are managed on the ward." (R3, Medical Officer).*

> *".....then the patient exposes the body part that they claim was bitten and you examine it. You examine for anything as small as any abrasion on the skin and any abrasion, be it minor or what you can see, whether category one, that is to say, there is minor nibbling of the skin with some superficial scratches to severe categorization of the wound, you can term it an animal bite* **(**emphasis**)** *there and then." (R5, Medical Officer).*

On the significance of classification of the severity of the wounds, all respondents agreed that it helps to guide the choice of treatment. In addition, four of the respondents added that

determining the severity of the wound guides the counseling of patients on what they should expect as regards wound healing, as one explains below:

> *I: "You are on the look out for the severity of the wound. What is the significance of that?"*
>
> *R: "Of course, you know how big the wound is. The bite can damage some of the internal structures around where the wound is. For example, if it is the calf muscles or joints, expect healing to be delayed. So you tell the patient that the wound is likely to stay for a longer time, unlike in other bites. I also advise them to get some walking aid devices." (R2, Medical Officer).*

4.2.4.3 Ancillary examination and testing

Of the 7 clinicians, 6 mentioned that they go further to assess the wounds for infection by examining them for foreign materials, foul odor, erythema, exudates, edema, and heat. They reasoned that this informs them on which antibiotic to use in either treating or prevention of infection.

> *"I check the site and what the wound looks like, how the patients are, and the area they come from because if the patient is coming from the village, there is always dust. Sometimes you suspect the wound may develop some infections or be already infected when it is hot, smells bad or has fluids oozing out. This will tell you which antibiotic you should use." (R5, Medical officer).*
>
> *"Sometimes you may suspect infection has set in. When we suspect there is an infection, there are signs of infections for example fever and wound some characteristics. So, when it comes to antibiotics, we give an antibiotic depending on the seriousness of the infection." (R7, Clinical Officer).*

Four of the seven clinicians had ever experienced handling cases of rabies. They explained that, in such circumstances, they go further to document the signs they are observing:

"……so, you can start it but if they come in an advanced stage, they are afraid of taking water, they are shouting at everyone, they are violent, they are very nervous, they are behaving with mental inequalities, they can't tolerate light, they can't hold their saliva, at that stage you admit and do conservative management." (R6, Clinical Officer).

However, when rabies is suspected, two of the seven clinicians said they were keen on undertaking a differential diagnosis so that they could rule out other causes of mental disturbance:

"You assess for any other cause. Could it be cerebral malaria? It may be any other form of encephalitis, anxiety. So before I declare suspected rabies, then you must say it with some level of authority so that you don't alarm the patient. Besides, you need to counsel the patient based on facts." (R2, Medical Officer).

"Some other diseases may present the same picture, like rabies. So what we can do in such cases is to look for comorbidities. Those ones can include HIV; you will think now that maybe toxoplasmosis. However, we don't also subject the patient to things like HIV tests, because, don't forget, these people don't have money. Most of them don't have money." (R7, Clinical Officer).

On radiographic investigations, all respondents had never felt the need to undertake them. Although they had ever received patients with bites that involved joints, they did not use radiographic tools to investigate the extent of the damage.

"No, we don't go beyond the examination that I have told you earlier. I try as much as possible to save the patient from incurring additional costs. I also know that the free vaccine is usually out of stock, so I do fewer tests to leave the patient with some money to obtain the vaccine. Remember, the vaccine is the most important thing." (R1, Medical Officer).

In all observations made, there was no recommendation for a wound culture or complete blood count even when infection was suspected. The clinicians explained that because of the amount

funds and time constraints involved in such tests, they usually forego them, even when they find some of them necessary:

> *"The vaccine in the causality [emergence medicine department] is free but gets finished up within a few days. So, you don't need to go into intensive investigations because patients can't pay for them. But as a medic, you must know that history and visual inspection yield a lot of information about the dog bite. So you rely on that." (R2, Medical Officer).*

> *"Culture may be necessary, but the time isnt much. And patients come from far away, so you cannot tell them to come back after a week to pick up their results. It is better to give them an antibiotic that covers their infections broadly." (R5, Medical Officer).*

4.2.5 Treatment interventions

In both study sites, the clinical management of dog bites comprises local wound sanitation, pain relief, antimicrobials, tetanus prophylaxis, and rabies prophylaxis. The clinicians who are diagnosing the patients are the ones that prescribe the line of treatment.

4.2.5.1 Wound management

In observations, wound sanitation was prescribed in 132 cases as per UCG. These wounds were cleaned with either povidone iodine mixed with water; or soap and water. The clinicians explained that they recommend this in order to reduce the bacterial burden of the wound. They also advise the patients to continue doing the same at home after initial treatment, using locally prepared saline water.

> *"After the* [*diagnosis*]*, sometimes, the nurses are instructed to do social toilet. The wash the wounds with running water and soap. If there are bacteria, the number is reduced.*

Therefore, it is a way of disinfecting the wound that compliments the antibiotics to be given." (R7, Clinical Officer).

"Here we use an antiseptic, povidone, to clean the wound. But we advise patients at home just to use normal saline. Normal saline can be made locally at home by boiling water, cooling it and adding a bit of salt and it is very effective if the person cleans and we don't advise wound covering." (R9, Nursing Officer).

However, it is only in a few cases that clinicians found the wounds worth debriding. Only one clinician had ever recommended debridement because the wound was too big in size; had the potential for infection; and was bleeding profusely. In this same case, the wound was closed mainly to control bleeding:

"In my practice, it was once, actually last year. We admitted one patient. They did debridement on him in the theatre but people doubted whether it was a dog because the wound was really big. But he kept insisting that it was a dog. We had to clean, debride, and actually close the wound because it was so big and it had bleeders. We actually closed it. That is the only one I have seen for debridement." (R4, Medical Officer).

4.2.5.1.1 Use of antibiotics

In nearly three-quarters of the observations, antibiotics were prescribed. Notably, in all cases that received antibiotics, there were no wound culture and sensitivity tests as per UCG. This was attributed to time constraints as well as the high costs that would be incurred by the patient if this was to be done. However, the main reasons for the prescription of antibiotics were either to treat existing infections or to deter wounds from progressing to infection:

"….then there are infections like somebody who comes when they have placed other local medicine around it [wound]*, definitely know that you have a potential infection and you have to prevent the infection that is likely to occur and then tell them to keep the wound clean afterwards." (R1, Medical Officer).*

"So, when it comes to antibiotics, first of all, we give an antibiotic when we suspect there is an infection. We base on signs of infection like fevers and wound exudates. In most cases, when skin barriers are broken, you at least have an infection." (R6, Clinical Officer).

"I give antibiotics as a precaution to prevent further or likely infections in the wound because of our environment is usually dirty. Besides, keeping the wound clean might be difficult for the patients. So, once antibiotics reduce the infection, it will probably help with wound healing." (R2, Medical Officer).

"I check the site of the bite and what the wound looks like. But I also consider where the patient comes from and what they do. If it is a village, there is always dust. And you may find that this individual tells you that they go to the garden often. If somebody has been working in the garden or goes there, you suspect the wound may develop some infections. You have to administer some antibiotics at least to prevent the development of wound infections." (R7, Clinical Officer).

One of the clinicians explained that the severity of the wound would also be a basis for the decision to prescribe antibiotics:

"…….like, if there is a small scratch, surely you may not need an antibiotic. You may just need to care for the wound, and if it is a domestic dog that is vaccinated, get your one shot of the anti-rabies [vaccine] *and observe and monitor the dog." (R2, Medical Officer).*

4.2.5.1.2 Choice of antibiotics

For all observations, the antibiotics prescribed for dog bite patients in the two study sites included: amoxicillin/clavulanic acid, Ampiclox (ampicillin & cloxacillin), metronidazole, ceftriaxone, dicloxacillin, ceftriaxone, and Flucamox (amoxycillin & flucloxacillin). On what guided the choice of antibiotic, the clinicians cited "simplicity" of antibiotic, availability, affordability, and progress of wound healing. However, even if treatment has been started,

changes to the antibiotic can be made depending on the progress of wound healing and the level of infection.

> *"Amoxicillin/clavulanic acid is a simple one that I first prescribe. But there are times when the wound needs a stronger one, for example, when it is septic or turns septic. There I change to metronidazole for just 5 days. Patient will then continue cleaning the wound and eventually the wound will heal." (R6, Clinical Officer).*

> *"If up to the seventh day, which is almost a week, the wound is still not healed, and these are rare cases, and then you can change the antibiotic. If you have not given metro [metronidazole]. You change to the stronger antibiotic." (R7, Clinical Officer).*

> *"I choose the antibiotic depending on availability and someone's pocket, but normally we try to give cloxacillin, ampiclox, dicloxacillin, or flucamox in that range and sometimes cefixime. Basically, what is available is what you give though you may find that what is available is expensive for that [particular] patient. There, you write for them a cheaper one, which they can get outside the health facility." (R5, Medical Officer).*

4.2.5.2 Tetanus vaccination

In the UCG, it is recommended that patients receive a tetanus toxoid if the last tetanus vaccination was more than five years prior to the bite or for patients with an unknown tetanus vaccination. Those with fewer than three lifetime vaccinations may receive tetanus immunoglobulin or tetanus toxoid. However, in all observations, the tetanus vaccination status was not investigated. However, the vaccine was prescribed in six cases and specifically by one clinician. The clinician explained that the decision to prescribe the tetanus vaccine depends on the low levels of hygiene of the wound, especially in those who attempt preclinical treatment:

> *"In most cases, these dog bite wounds are not that bad. In a month, you can get 1 or 2 with severe sepsis locally, and there is severe contamination, and you ask what have you been putting here? When someone tells you cow dung or a sisal bag, you anticipate that*

this dirty wound might have picked a tetanus germ. But in most cases, people who come and tell you that when I got this, I went to a local clinic or I washed here and it is a clean wound. Chances are not there that you will give tetanus." (R7, Clinical Officer).

All other clinicians who were not prescribing tetanus vaccine explained that their decisions were informed by the costs involved and rarity of the disease. However, they all agreed that the vaccine is always available but not the immunoglobulins:

"The charges will be high when you add the tetanus vaccine. Patients won't be able to afford……. But I think most of the time, the tetanus vaccine is available. By the way, no mother goes without the tetanus vaccine during antenatal care. So, it is available, but I don't give it to dog bite patients for the reasons I gave. What is urgent and most important is the anti-rabies vaccine because tetanus is rare." (R2, Medical Officer).

"No, I have never found a need for tetanus immunoglobulins. They are not here; in fact, I have never seen them being ordered [stocked] for us. So, I think when the wound necessitates tetanus vaccines, then they should be given. But I have never found this necessity." (R5, Medical Officer).

4.2.5.3 Rabies immunoglobulin (RIG)

The UCG recommend RIG be administered in cases where the biting dog's vaccination records are not available and can't be restrained for observation (e.g., stray or wandering dogs) or is showing signs of rabies disease. In addition, RIG is recommended for category III wounds or immunocompromised patients with category II wounds. However, for all observations, no RIG was prescribed. When asked why it was not prescribed at all, the clinicians said the health facilities do not stock it, including their private wings. They had resigned from ever prescribing it, even for patients that could afford to purchase it:

I: "Have you, in your practice, ever given immunoglobulins?"

P: "No, because it is never available and it is also expensive for people to buy. If I can recall, I think immunoglobulin should be given when somebody has been bitten by a dog and we suspect it has rabies."

I: "It is expensive, yes, but what if a patient can afford it?"

P: "Honestly, even if people can afford it, I normally don't bother writing for them. It has never crossed my mind that an individual comes and has to get it." (R2, Medical Officer).

"In xxxx [name of facility]*, we don't have human immunoglobulins for rabies. So, we don't have that and for years we have only managed with the rabies vaccine. The immunoglobulin part of it is expensive. We had people from India who wanted to give us* [supply] *the equine immunoglobulin, but it was so costly and, remember, most people who come are poor people. Don't forget that dog bites are a problem of the poor. So, we rely on active immunization. That is what we do." (R6, Clinical Officer).*

However, some patients were said to demand the RIG by themselves, though it still could not be prescribed:

"Then some can come with preconceived information that we have the immunoglobulin and we should give [administer] *it to them. These patients usually get information from the Internet. They come and say that RIG cures rabies. But still, we counsel them out of it and give them a conviction that the vaccine will still do fine." (R7, Clinical Officer).*

One respondent described how, a couple of years ago, the hospital got a few immunoglobulin doses for their private wing. However, the patients were not comfortable with the process of administering due to the pain during infiltration:

"There was a time we tried to bring it here, but the patients did not receive it well. That was in the private wing. So, they were trying to add the immunoglobulin by injecting it around the wound. The patients would feel a lot of pain and ask to be given only the vaccine. They would say, "Even if I don't get this one, I know I will be better." So now we are only concentrating on the anti-rabies vaccine." (R1, Medical Officer).

4.2.5.4 Management of pain

Analgesics were prescribed in 359/376 patients observed. They received either paracetamol, ibuprofen or diclofenac. The clinicians explained that prescription of analgesics depends on whether the patient experiences pain or not:

> *"Not all patients get the painkillers. Some may come with a wound but they may not feel any pain, so not everybody needs a pain reliever." (R3, Medical Officer).*

4.2.5.5 Anti-rabies vaccine (ARV)

Both study sites use the Abhayrab® vaccine, which is a purified, vero cell rabies vaccine. It is a purified inactivated rabies vaccine prepared on Vero Cells using the L. Pasteur 2061/Vero Rabies Strain. The health facilities are using the updated Thai Red Cross (TRC) regimen:

> *"So, what we do, we just give them the anti-rabies vaccine according to the clinical guidelines. So we usually give around 0.5 or 0.1 in divided doses. First dose is given in half on each set. Then the second dose, we give until they finish because usually here in xxxxx* [name of facility]*, we use the other regiment were somebody receives around 5 doses on day 0, which is the time when the person comes. Then there is day 3, day 7, day 28, and then we used to give day 90, and those are five. So, that is how we have been treating them here." (R1, Medical Officer).*

However, there are variations in the regimen depending on the type of the biting dog. Clinicians noted that the full set of five (5) doses is given only in conditions where the dog cannot be observed for 10 days. For domestic dogs, including those with proof of rabies vaccination, the patients receive one dose on day 0, and then observe the dog:

> *"The other criteria is that when we give the first dose, we tell those people to observe the dog for 10 days. In the majority of cases, they don't come back to give us a report, meaning that the dog is fine and the patient is fine." (R6, Clinical Officer).*

"For domestic dogs that are vaccinated, I normally give one dose of the PEP anti-rabies vaccine on day 0. On top of being sure that the patient is guarded against rabies, the dose is also for psychological management pending observation. Therefore, this is done regardless of whether the dog is vaccinated or not. We give it for a domestic dog bite." (R7, Clinical Officer).

If the patients do not present evidence of vaccination of biting dog, the practice is to give them all the doses required. However, if the dog is observed for more than 10 days and is determined to be fine, then the treatment ceases:

"…. those ones who claim that the dog is immunized but do not produce evidence to that effect, we encourage them to finish the 5 doses. But if the dog is still alive, don't come back. Even those who say, the neighbor told me the dog is immunized without producing evidence, we say no, you have to come and finish the dose because you don't have evidence, unless the dog is fine after 10 days." (R11, Nursing Officer).

Nonetheless, clinicians are aware that the vaccine is sometimes administered inadvertently, such as in Category I bites. They attributed this to the high levels of anxiety that patients present with. In addition, they have reason to believe that the patients at times do not give them the right information in the hope that the practitioners will decide not to give the vaccine, yet they want it:

"Then as regards bites by domestic dogs, some people who are good at fearing, the hypochondriacs, even to say, 'no matter whether the dog is vaccinated or not, vaccinate me if it has no harm'. We can vaccinate such people. We can vaccinate them because they are willing and able to purchase the vaccine. You know our limitation to some vaccination is finance." (R2, Medical Officer).

4.2.5.6 Management of rabies

In a few cases, patients present with full-blown signs of rabies disease. One of the patients during the study presented with clinical rabies. The patient was referred to the national referral facility,

where she was admitted. During the admission of such patients, respondents said they stick to supportive treatment but the outcome is always negative:

> *"When one has clinical rabies, we can't say 'Mr. we are sorry you are going to die'. We admit them to lengthen their lives pending death, which is the only outcome in such cases. That's why we admit them." (R7, Clinical Officer).*

However, there are some patients who know that the outcome will be bad and refuse to be admitted. In such cases, two of the clinicians said they allow them to go home. Nonetheless, one of the clinicians said that before releasing them, the patient at least receives some symptomatic treatment, for example, sedation, in order to restrain them on the journey home:

> *"Obviously, you can't admit someone who doesn't want to. What I do is to counsel them. I sedate the patient, usually with some diazepam to calm them down. I encourage them to manage the patient at their nearest health facility. So, that is what we do for those people who come when it is at a later stage." (R2, Medical Officer).*

The treatment and management of patients with clinical rabies also extends to their caretakers. The clinicians explained that since the caretakers are potentially exposed to the saliva of the patient, they give them protective wear as well as the vaccine. This is done in both cases of hospital admission and home management of human rabies:

> *"Those people who are nearest to them* [patients]*, we give them the anti-rabies vaccine. We tell them that because they are exposed to contacts, vaccination is important. We teach them how to handle the patient and their secretions. We actually give them a lot of gloves to take home with them. You see, some of them want to abandon the patient when they hear it is rabies. So you have to work on the negative attitude using several reassurances." (R7, Medical Officer).*

4.2.5.7 Health education to dog bite patients

In both research sites, health education was given after the administration of the anti-rabies vaccine (ARV). However, this focused entirely on wound management, including washing the wound; taking all the medication as prescribed for wound healing and pain management; dates of return; and what to expect while at home and during the return visit. This was done for all the 376 patients who were observed for this study. Notably, in both sites, there was no attempt to give the patients or their care-takers information on dog bite prevention. When asked why the health providers do not do this, they advanced reasons related to the high number of patients vis-à-vis the time required to attend to one patient, as well as a lack of health education materials:

> *"The way the outpatient department runs, you just can't attend to one patient forever. Remember, we don't only receive dog bite patients. No. So I focus on the treatment of the bite and leave the rest to the nurses. They are the ones who spend more time with the patient giving the vaccine. There is a lot of information that follows the vaccine, so prevention issues are better explained at that point." (R4, Medical Officer).*

> *"We have many patients to attend to. So I personally give the patients instructions on how to take their medicine. I have never given a talk on prevention of future bites to these patients or those who bring them. Maybe if there are flayers, we can give them but in their absence, there is simply no time." (R9, Nursing Officer).*

4.2.5.8 Follow-up treatment and assessment

(a) Follow-up procedures / processes

In both health facilities, patients with Category II and III bites were asked to return to the hospital. For these particular visits, the patients go straight to the treatment points without seeing the clinicians. The reasons given for this include a large number of new patients at the

emergency departments. However, if there are complications, the patient can be taken back to the clinician by the nurses:

> *"We normally don't get a chance to see them again because we already wrote the doses fully. They normally just come back to the vaccine area and it is only those ones with complicated wounds, or where the wound may not be healing, or if there is a problem with the bite site. They are the ones that they bring back to us. But it is rare." (R7, Clinical Officer).*

At both study sites, the three key elements that are of essence in follow-up visits are handled by the nurses. The three things include: additional post exposure rabies vaccine doses; assessment of wounds; and reporting on the health status of the biting dog, if it was put under observation:

> *"When they come we ask them: 'how is the wound? How do you feel? Is the dog still there and well?' So, I ask all those questions. They will say 'the dog is still there and it has not bitten anybody else' or 'the dog has died'. If the dog is still alive and well and has not bitten more people, you just advise them that the anti-rabies doses that you got are enough for now. Since the dog is still alive, it means it has no problem. So, we can stop the treatment here but continue with your medication because the wound needs to heal." (R14, Nursing Officer).*

(b) Follow-up of anti-rabies vaccine

For patients who are to receive additional doses of the vaccine, they have to report on days 3, 7, 14, and 28. The nursing officers in charge of administering the treatment discuss these days together with the corresponding dates to the patients. However, not all of the patients comply with the treatment calendar. For the observations made, all returned for the second and third doses whereas 371/376 (98.7%) and 242/376 (64.4%) returned to the healthcare facility for the 4^{th} and 5^{th} doses, respectively. The nurses explained that some patients don't complete the doses because of treatment termination based on the nurses' advice. This is in situations where the dog

under observation is healthy after 10 days, as one explains above. Nonetheless, there are cases where the patients take it upon themselves to decide not to return for treatment because the dog is healthy, as one nurse explains:

> *"Sometimes the patients feel they are okay and don't come back. This is usually when the dogs are okay and their wounds have healed. Those ones will not come back, not even to report about the dogs and the finishing of antibiotics." (R14, Nursing Officer).*

> *"You see, we tell them about the signs of rabies in dogs. If they don't see these signs in two weeks, they abandon the treatment. You don't see them after the third dose. For some, after the second dose, they never come back." (R12, Nursing Officer).*

Another category of non-compliance is patients who do not abandon the treatment but do not return on time. These mostly come after the agreed dates of return. Three nursing officers mainly attribute this to distance and lack of funds to pay transport fares, as one explains below:

> *"After day 0, they are usually active and they come back on day 3, day 7. But there are those who don't come on the exact days* [dates]. *When they turn up, they will tell you they live far away and did not have the money to come back." (R9, Nursing Officer).*

Wound assessment on follow-up

At the two study sites, the nurses examine the wound for progress in healing as well as infection. If there is infection, the nurse will refer the patient back to the clinician who prescribed the treatment for further advice. However, during the assessment process, they investigate what the patient has been doing for home wound care. If the home management is divergent from what was discussed on the prior visit, then more health education is done for that particular patient.

> *"We usually check the wound when they complain that the wound has refused to heal. Usually we ask them, 'how have you been caring for the wound?' We usually tell them to use salty water. So, they will tell you other things, and then you insist to them on using*

what you told them. But if the wound is badly infected, we take them to the doctors to see the wound, and the doctors will advise accordingly." (R11, Nursing Officer).

"There are those who come when they have applied black-stone, the bean, those drugs, but we usually discourage them and say "don't do it again". But they do it often, and if infection has set in, we change and put them on stronger antibiotics." (R6, Clinical Officer).

4.2.6 Challenges related to clinical management of dog bites

This theme was organized under three challenges, i.e., health system, patient, and health provider challenges.

4.2.6.1 Health system-related challenges

As regards the health system, nearly all respondents concurred that the absence of immunoglobulins was a major setback for them in managing human rabies cases. They reasoned that the presence of immunoglobulins in the UCG recommendations is testimony to their usefulness and, therefore, they must be stocked.

"The Ministry [of health] *implores us to use immunoglobulins. But we have never received them. They only bring the anti-rabies vaccines. If it is in the national guidelines, then it is supposed to be supplied. Practice should not be different from the guidelines." (R2, Medical Officer).*

Another crosscutting health system challenge from the health providers' perspective was the vaccine stock-out. While other medications are always in stock, the vaccine quantities, especially for the public wings of the health facilities, are inadequate. All respondents concurred that this was one of the causes of patients missing their follow-up doses, especially those who could not

afford to buy their own vaccine. To validate this, 51 of the 68 observations made accessed the vaccine from the private wings due to stock-outs of the vaccine in the public wing.

> *"The problem is, others don't complete because, at times, the vaccine is not available. So, if you tell them today there are no vaccines, some of them will be like, 'we don't have the money musawo* [health worker]*, I will come back when it is available.' Some keep checking for the free vaccine, others don't come back." (R11, Nursing Officer).*

> *"All the other medicines that are needed are available. It is only the vaccine that is a problem. Sometimes it is available, but sometimes it is not; we advise them to get it from Mulago* [national referral hospital] *if they cannot afford the private wing charges." (R10, Nursing Officer).*

Four respondents decried the lack of collaboration and linkages among health facilities. They explained that, as the key treatment centers for dog bites, they ought to know what was happening as regards each other's operations. For example, they said that before referring the patients to the facility, due to stock outs of vaccines, they could not establish the availability of the vaccine in the facility they were referring the patients to. Secondly, for patients that come from far away, respondents explained that it would improve compliance with treatment if follow-up treatment is handled by the facilities where the patient comes from. However, there are no established ways of determining their capacity to handle dog bites.

> *"If a person is from Mbarara or Kabale* [places are over 250 km from this health facility]*, there is no way I can crosscheck to find out whether the service is available so that I advise this patient to complete the treatment there. So I have to tell the patient to come back here. But transport fares only, are thrice the cost of treatment." (R9, Nursing Officer).*

> *"Because we don't have the contacts of our colleagues in Mulago* [national referral hospital]*, we can't ask them before referring our patients there. So sometimes we send them there and they return to say there is no vaccine, either. The patient spends too much*

money looking for the vaccine. This is a serious problem for us too. Patients lose confidence in us." (R12, Nursing Officer).

Nearly all respondents identified distance as a key constraint to the clinical management of dog bites. They said that distance not only translates into high treatment costs but some places are inaccessible because the scheduled means of transport might not coincide with the scheduled days of the patient's visit:

"Then some of them stay far away, like in the islands. Commuting from the islands and coming here is impossible on some days. And remember, most dogs on islands are stray, not vaccinated, so they carry a high risk of rabies. But the challenge increases when they don't have the money to travel. If they come but have missed the schedule, you adjust the schedule dates accordingly and you encourage them to come." (R1, Medical Officer).

4.2.6.2 Patient-related challenges

The patient-related challenges that the respondents discussed included non-adherence to the treatment schedule and recommended homecare management. All respondents said that they had ever experienced patients who had missed the scheduled doses. The reasons that the patients gave the healthcare providers included having travelled to faraway areas for personal business; forgetting the schedule; lack of money for both transport and medical costs:

"Instead of coming on the right date, they said we were still looking for money, especially in the private wing, because each time you come here you are supposed to pay for the dose. Others don't look at the medical forms, so they forget and come after 2 or 3 or more days. But generally, most of the challenges they face are monetary." (R10, Nursing Officer).

For home care, some patients apply other substances to the wounds. Nearly all respondents had experience of patients reporting having applied herbs and other substances to their wounds. They

attribute this to patients seeking advice from other individuals who influence their choices. The respondents said they try as much as possible to counsel the patients out of such practices:

> *"Some patients apply traditional substances to the wounds even after receiving the initial doses of the vaccine. They report for scheduled addtinal doses of the vaccine with beans tied to the wound. You ask them why, and they say some relative advised them to do so. They mostly apply herbs and black-stones. Few come with them here, but many just tell you they were removed before coming here." (R14, Nursing Officer).*

4.2.6.3 Health provider-related challenges

The health provider challenge that came out of the discussion was the inadequate knowledge and skills for handling dog bites, especially among those administering the treatment. They explained that much as they are skilled in immunization, dog bites are challenging because they are handled in the routine immunization section. They explained that when they are new, they cannot give the required health education to the patients because they don't have experience with rabies vaccination.

> *"Knowledge is a big challenge, especially when the rotation lands you here for the first time. That is a challenge. That is a challenge. That is a challenge. Unlike other immunizations, the rabies one is different. It needs you to know more about dog bites and dogs. It is not like the patient comes, you vaccinate them and they go. Personally, when I know there is a new person at the immunization wing, I go there regularly to teach them how to handle animal bite patients." (R13, Nursing Officer).*

> *"I know our nurses are disturbed a lot when it comes to learning about dog bites. This is even true for those who have been in service for long. We don't give them CME* [continuing medical education]. *Actually, for the period of 15 years I have stayed here, there has been no CME on rabies vaccination or dog bite management. And they are the ones who treat the patients all through the five doses. This is a huge mistake on our part.*

We just prescribe and don't follow up, but I know they have challenges." (R6. Medical Officer).

4.3 Results for sub-study III: Burden of antimicrobial resistance associated with dog bites

The total number of participants with DBWs that were enrolled in this study was 376. Of these, 201 (54%) were males, and the median (IQR) age was 18 (22.75) years. More participants (54.0%) were aged 15 years and above, while 11% of the bite-patients reported owning at least one dog, and only 5.1% had ever been vaccinated against rabies. Nearly three-quarters (72%) had ever received some information about dogs and dog bite prevention and management. In addition, 199 (52.9%) of the patients presented with DBWs, which were classified as "infected". A summary of the socio-demographic characteristics of study participants, disaggregated according to infection status, is provided in **Table 4.15**.

Table 4.15: Characteristics of the 376 dog bite study participants stratified by infection status of the dog bite wound.

Characteristics	Frequency	Non-infected N = 177 (47.1%)	Infected N=199 (52.9%)	p-value
Sex				
Male	201 (53.5)	94 (53.1)	107 (53.8)	
Female	175 (46.5)	83 (46.9)	92 (46.2)	0.898
Age				
≤15 years	173 (46.0)	82 (46.3)	88 (47.3)	
>15 years	203 (54.0)	95 (53.7)	98 (52.7)	0.907
Hospital				
Entebbe (Wakiso)	110 (29.3)	49 (27.7)	61 (30.7)	
Mulago (Kampala)	266 (70.7)	128 (72.3)	138 (69.3)	0.528
Religion				
Christian	301 (80.1)	143 (80.8)	158 (79.4)	
Non-Christian	75 (19.9)	34 (19.2)	41 (20.6)	0.736
Marital status				
Not in union	285 (75.8)	118 (66.7)	141 (70.9)	
In union	91 (24.2)	12 (6.8)	14 (7.1)	0.603
Highest education level				
No formal education	53 (14.7)	31 (17.1)	25 (12.6)	
Primary	180 (48.0)	84 (47.7)	96 (48.2)	
Secondary and above	143 (37.3)	62 (35.2)	78 (39.2)	0.432

Household size				
≤4	176 (46.7)	80 (47.6)	96 (49.7)	
5-8	161 (44.6)	81 (48.2)	80 (41.5)	
≤9	24 (6.7)	7 (4.2)	17 (8.8)	0.141
Employment status				
No	181 (48.1)	88 (49.7)	93 (47.7)	
Yes	195 (51.9)	89 (50.3)	106 (53.3)	0.563
Current dog ownership				
No	334 (88.8)	157 (88.7)	177 (88.9)	
Yes	42 (11.2)	20 (11.3)	22 (11.1)	0.216
Immunized against rabies				
No	357 (94.9)	167 (94.3)	190 (95.5)	
Yes	19 (5.1)	10 (5.7)	9 (4.5)	0.618
Get dog information				
No	114 (30.3)	57 (32.2)	57 (28.6)	
Yes	262 (69.7)	120 (67.8)	142 (71.4)	0.453
Socio-economic status				
Lower	197 (52.5)	92 (52.3)	105 (52.8)	
Middle	62 (16.5)	30 (17.1)	32 (16.0)	
Upper	116 (31.0)	54 (30.7)	62 (31.2)	0.969

4.3.1 Compliance with preclinical guidelines by participants with infected DBWs

Of the 376 study participants, 149 (39.6%) delayed to report to the PET center. However, the differences in the delays between the study participants with infected wounds and those with non-infected wounds were not statistically significant ($p = 0.277$). In addition, only 19.1% ($n = 38$) of the 199 participants with infected wounds had complied with the pre-clinical guidelines, which included reported washing of the wounds with water and soap and presenting to a healthcare facility within 24 hours. Notably, compliance to UCG did not differ between patients with infected wounds and those with non-infected wounds ($p = 0.800$) while the infection rates between those who applied an anticeptic and those who did not, differed significantly ($p = 0.003$). Further, about a quarter of patients who adhered to pre-clinical guidelines (23.7%, 9/38) had applied an antiseptic.

Practices undertaken for patients who did not fully adhere to the pre-clinical guidelines included applying a wide range of materials to the wounds such as herbs, black stone, creams that patients

did not know, beans, urine from the biting dog, dust, tobacco, coins, brake fluid, acid, powder made out of dog hair, and salt. Outstandingly, there were two deaths as a result of suspected clinical rabies and both had delayed to present to the healthcare facilities. **Table 4.16** shows a comparison of key pre-hospital wound management practices for patients with non-infected and infected wounds.

Table 4.16: Key pre-hospital wound management practices for patients with non-infected and infected wounds

		Dog bite wound		
Practices	**Frequency**	**Non-infected N = 177 (47.1%)**	**Infected N=199 (52.9%)**	**p-value**
Delayed for more than 24 hours				
No	227 (60.4)	112 (63.3)	115 (57.8)	
Yes	149 (39.6)	65 (36.7)	84 (42.2)	0.277
Washed with water and soap				
No	204 (55.4)	91 (52.3)	113 (58.3)	
Yes	172 (44.6)	86 (47.7)	86 (41.8)	0.296
Antibiotics administered**				
No	250 (66.5)	122 (68.9)	128 (64.3)	
Yes	126 (33.5)	55 (31.1)	71 (35.7)	0.345
Antiseptic applied				
No	330 (87.8)	146 (82.5)	184 (92.5)	
Yes	46 (12.2)	31 (17.5)	15 (7.5)	0.003*
Complied with UCG***				
No	306 (81.4)	145 (81.9)	161 (80.9)	
Yes	70 (18.6)	32 (18.1)	38 (19.1)	0.800

*Significance at $p \leq 0.05$

**Antimicrobials administered prior to the patient presenting at the PET center

***The patient had washed the dog bite wound with water and soap in addition to seeking medical care within 24 hours.

4.3.2 Bacterial isolates from DBWs

Of the 376 participants, 199 had infected DBWs, of whom 151 (75.9%) were category II while the rest were category III wounds. Commonest in the category II injuries were the purulent wounds, which were 89 (58.9%) while in category III, the distribution of abscesses and purulent wounds was approximately similar. Of the 199 DBWs, 168 (84.4%) wounds were culture

positive, with 28/151 (18.5%) and 3/48 (6.3%) of the category II and category III respectively, not showing any bacterial growth. A total yield of 768 isolates was registered, with gram-positive bacteria making up 406 (52.9%) of the yield. Four hundred and ninety-six (64.6%) isolates were recovered from category II wounds, while the rest were from category III wounds. Of the 168 swab cultures that showed growth, a total of 123 (73.2%) yielded single cultures, while the rest had a mixture of aerobic and anaerobic bacteria.

Among the 406 gram-positive bacteria, there were 339 (83.5%) aerobes, of which *Staphylococcus aureus* (103, 30.4%), *Corynebactrium spp* (33, 9.7%), Coagulase-negative staphylococci / CoNS (68, 20.1%), *S. epidermidis* (42, 12.4%), *S. intermedius* (30, 8.8%), and *S. pyogenes* (29, 8.6) were the commonest isolates. Of the 67 anaerobic isolates, *Lactobacillus spp* (31, 46.3%) and *Gemella morbillorium* (21, 31.3%) were the commonest, as shown in **Table 4.17**.

Table 4.17: Gram positive bacterial isolates from category II (123 patients) and category III (45 patients) dog bite wounds of patients on initial presentation at 2 PET centers in Uganda

Bacteria	Category II, n (%)	Category III, n (%)	Total, n (%)
Aerobic bacteria			
Staphylococcus			
S. aureus	72 (21.2)	31 (9.1)	103 (30.4)
S. intermedius	20 (5.9)	10 (2.9)	30 (8.8)
CONS	49 (14.1)	19 (5.6)	68 (20.1)
Streptococuss			
S. canis	13 (3.8)	5 (1.5)	18 (5.3)
S. pyogenes	22 (6.5)	7 (2.1)	29 (8.6)
Other Streptococci	9 (2.7)	3 (0.9)	12 (3.5)
Bacillus spp	5 (1.5)	6 (1.8)	11 (3.2)
Enterococcus			
E. feacalis	12 (3.5)	7(2.1)	19 (5.6)
E. faecium	2 (0.6)	0 (0.0)	2 (0.6)
Other Enterococci	4 (1.2)	2 (0.6)	6 (1.8)
Micrococcus spp	6 (1.8)	2 (0.6)	8 (2.4)
Corynebactrium spp	23 (6.8)	10 (2.9)	33 (9.7)
Total: aerobic isolates	**237 (69.9)**	**102 (30.1)**	**339 (100)**

Anaerobic bacteria			
Gemella morbillorium	8 (11.9)	13 (19.4)	21 (31.3)
Lactobacillus spp	12 (17.9)	19 (28.4)	31 (46.3)
Lactococcus spp	5 (7.5)	10 (14.9)	15 (22.4)
Total: anaerobic isolates	**25 (37.3)**	**42 (62.7)**	**67 (100)**

Furthermore, among the 362 Gram negative isolates, 217 (59.9%) were aerobes, and the commonest isolates were *P. maltocida* (64, 29.5%), *Capnocytophaga canimorsus* (36, 16.6%) and *P. canis* (26, 12.0%). However, among the 145 anaerobes, *Fusobacterium spp* (48, 33.1%), *Bacteriodes spp* (34, 23.5%) and *Prevotella spp* (35, 24.1%) were the most frequently isolated bacteria, as shown in **Table 4.18**.

Table 4.18: Gram negative bacterial isolates from category II (123 patients) and category III (45 patients) dog bite wounds of patients on initial presentation at 2 PET centers in Uganda:

Bacteria	Category II, n (%)	Category III, n (%)	Total, n (%)
Aerobic bacteria			
Pasteurella			
P. maltocida	38 (17.5)	26 (12.0)	64 (29.5)
P. canis	11 (5.1)	15 (6.9)	26 (12.0)
Other pasteurella	24 (11.1)	7 (3.2)	31 (14.3)
Proteus			
P. vulgaris	2 (0.9)	0 (0.0)	2 (0.9)
P. mirabilis	6 (2.8)	1 (0.5)	7 (3.2)
Pseudomonas			
P. aeuroginosa	3 (1.4)	0 (0.0)	3 (1.4)
P. stutzeri	2 (0.9)	1 (0.5)	3 (1.4)
P. alcaligenes	2 (0.9)	0 (0.0)	2 (0.9)
Other pseudomonas	7 (3.2)	4 (1.8)	11 (5.1)
Klebsiella			
K. pneumonae	8 (3.7)	3 (1.4)	11 (5.1)
K. oxytoca	4 (1.8)	2 (0.9)	6 (2.8)
Acinetobacter spp	1 (0.5)	2 (0.9)	3 (1.4)
Moellerella wisconsensis	4 (1.8(	1 (0.5)	5 (2.3)
Capnocytophaga canimorsus	14 (6.5)	22 (10.1)	36 (16.6)
Stenotrophomonas maltophilia	2 (0.9)	2 (0.9)	4 (1.8)
Bergeyella zoohelcum	2 (0.9)	1 (0.5)	3 (1.4)
Total: aerobic isolates	**130 (59.9)**	**87 (40.1)**	**217 (100)**
Anaerobic bacteria			
Citrobacter			
C. werkmanii	0 (0.0)	1(0.7)	1 (0.7)
C. freundii	2 (1.4)	0 (0.0)	2 (1.4)
E. coli	5 (3.4)	1 (0.7)	6 (4.1)
Enterobacter			

E. asburiae	1 (0.7)	0 (0.0)	1 (0.7)
Other enterobacter spp	8 (5.5)	5 (3.4)	13 (9.0)
Serratia			
S. rubidae	2 (1.4)	0 (0.0)	2 (1.4)
S. entomophila	0 (0.0)	3 (2.1)	3 (2.1)
Fusobacterium spp	25 (17.2)	23 (15.9)	48 (33.1)
Bacteriodes spp	20 (13.8)	14 (9.7)	34)23.4)
Prevotella spp	23 (15.9)	12 (8.3)	35 (24.1)
Total: anaerobic isolates	**86 (59.3)**	**59 (40.7)**	**145 (100)**

4.3.3 Antimicrobial susceptibility patterns of bacterial isolates

Table 4.19 presents the antimicrobial susceptibility patterns of the Gram-positive bacterial isolates. Among the gram-positive isolates, the most frequent, *S. aureus*, exhibited high resistance to metronidazole (103, 100%) and oxacillin (94, 91.3%), while the resistance to amoxicillin/clavulanic acid, doxycycline, and trimethoprim / sulfamethoxazole was considerably lower at 19 (18.5%), 14 (13.6%), and 9 (8.7%), respectively. Notably, *S. aureus* was found to be totally sensitive to ceftriaxone, gentamicin, ciprofloxacin, imipenem, streptomycin, doxycycline, methicillin, and chloramphenicol. Among the Streptococci, *S. pyogenes* was the predominant and it was majorly resistant to metronidazole (21, 72.4%) and ceftriaxone (12, 41.4%). Its resistance to imipenem (3, 10.3%) and oxacillin (8, 27.6%) was low, whereas it was sensitive to all other antibiotics. In addition, the most frequent Enterococcus was *E. feacalis* and it exhibited high resistance to methicillin (12, 63.2%), ceftriaxone (11, 58.9%) and metronidazole (19, 100%) while resistance to gentamycin (5, 26.3%), imipenem (4, 21.1%), oxacillin (9, 47.4%), streptomycin (3, 15.8%), and chloramphenicol (7, 36.8%). All *E. feacalis* isolates were susceptible to trimethoprim/sulfamethoxazole, vancomycin, amoxicillin/clavulanic acid, doxycycline, and ciprofloxacin. Notably, all gram positive isolates exhibited total sensitivity to vancomycin and ciprofloxacin.

Table 4.19: Antimicrobial susceptibility patterns of Gram-positive bacterial isolates from wound swab cultures among dog bite patients reporting to two DBW care centers in Uganda in the period March 2019 – October 2019.

	Number of isolates that are resistant to antimicrobial agent, n (%)												
Bacterial isolates	**CRO**	**ME**	**CN**	**AML**	**SXT**	**VA**	**CIP**	**IPM**	**S**	**DOX**	**OX**	**C**	**MET**
Staphylococcus													
S. aureus (n=103)	0 (0.0)	103 (100)	0 (0.0)	19 (18.5)	9 (8.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	14 (13.6)	94 (91.3)	0 (0.0)	0 (0.0)
S. intermedius (n=30)	0 (0.0)	30 (100)	0 (0.0)	12 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (93.3)	15 (50.0)	0 (0.0)
CONS (n=68)	7 (10.3)	66 (97.1)	0 (0.0)	21 (30.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (11.8)	61 (89.7)	0 (0.0)	0 (0.0)
Streptococuss													
S. canis (n=18)	6 (33.3)	18 (100)	2 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (44.4)	18 (100)	4 (22.2)	0 (0.0)	0 (0.0)
S. pyogenes (n=29)	12 (41.4)	21 (72.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (10.3)	0 (0.0)	0 (0.0)	8 (27.6)	0 (0.0)	0 (0.0)
Other Streptococci (n=12)	3 (25.0)	8 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)	0 (0.0)	0 (0.0)
Bacillus spp (n=11)	4 (36.4)	11 (100)	3 (27.3)	1 ((9.1)	4 (36.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (27.3)	2 (18.1)	0 (0.0)
Enterococcus													
E. feacalis (n=19)	11 (58.9)	19 (100)	5 (26.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (21.1)	3 (15.8)	0 (0.0)	9 (47.4)	7 (36.8)	12 (63.2)
E. faecium (n=2)	1 (50.0)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)
Other Enterococci (n=6)	0 (0.0)	6 (100)	1 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	2 (33.3)	0 (0.0)	0 (0.0)
Micrococcus spp (n=8)	0 (0.0)	8 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Corynebactrium spp (n=33)	0 (0.0)	33 (100)	9 (27.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (36.4)	0 (0.0)	0 (0.0)
Gemella morbillorium (n=21)	0 (0.0)	21 (100)	1 (4.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (9.5)	0 (0.0)	18 (85.7)	0 (0.0)	0 (0.0)
Lactobacillus spp (n=31)	8 (25.8)	26 (83.9)	5 (16.1)	4 (12.9)	0 (0.0)	0 (0.0)	0 (0.0)	8 (25.8)	7 (22.6)	6 (19.4)	26 (100)	8 (25.8)	0 (0.0)
Lactococcus spp (n=15)	8 (53.3)	8 (53.3)	3 (20.0)	0 (0.0)	3 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (26.7)	10 (66.7)	4 (26.7)	2 (13.3)
Total isolates N = 406	*60 (14.8)*	*380 (93.6)*	*29 (7.1)*	*57 (14.0)*	*16 (3.9)*	*0 (0.0)*	*0 (0.0)*	*15 (3.7)*	*21 (5.2)*	*51 (12.6)*	*278 (68.5)*	*36 (8.9)*	*14 (3.5)*

CRO: Ceftriaxone; ME: Metronidazole; CN: Gentamycin; AML: Amoxicillin/clavulanic acid; SXT: Trimethoprim / sulfamethoxazole; VA: Vancomycin; CIP: Ciprofloxacin; IPM: Imipenem; S: Streptomycin; DOX: Doxycycline; OX: Oxacillin; C: Chloramphenicol; MET: Methicillin

In **Table 4.20**, the antimicrobial susceptibility patterns of the Gram-negative bacterial isolates from DBWs are shown. The predominant gram-negative isolates were *P. maltocida* (n=64), *P. canis* (n=26) and *C. canimorsus* (n=36). *P. maltocida* was highly resistant to metronidazole (64, 100%) but had low resistance to gentamycin (6, 9.4%), amoxicillin/clavulanic acid (12, 18.8%), ampicillin (8, 12.5%) and oxacillin (6, 9.4%). It was susceptible to all other antimicrobial drugs. However, much as *P. canis* was highly resistant to metronidazole (26, 100%), the resistance to amoxicillin/clavulanic acid (7, 26.9%) and ampicillin (10, 38.5%) was substantially lower. Nevertheless, the *P. canis* isolates were sensitive to the rest of the antimicrobials, including ceftriaxone, gentamicin, trimethoprim/sulfamethoxazole, ciprofloxacin, imipenem, doxycycline, and oxacillin. *C. canimorsus* isolates were resistant to metronidazole (36, 100%), oxacillin (34, 94.4%), ampicillin (31, 86.1%), amoxicillin/clavulanic acid (16, 44.4%), trimethoprim/sulfamethoxazole (15, 41.7%), ceftriaxone (11, 30.6%), chloramphenicol (10, 27.8%), and streptomycin (5, 13.9%). Prevotella spp isolates were also 100% resistant to metronidazole, but their resistance to amoxicillin/clavulanic acid and doxycycline was noticeably low, i.e., (6, 17.1%) and (12, 34.3%), respectively. Notably, all *E. coli* isolates were resistant to metronidazole, amoxicillin/clavulanic acid, doxycycline, trimethoprim/sulfamethoxazole, oxacillin and ampicillin. Notably, all isolates were resistant to metronidazole but susceptible to ciprofloxacin, while one isolate (*P. alcaligenes)* was resistant to imipenem.

Table 4.20: Antimicrobial susceptibility patterns of Gram-negative bacterial isolates from wound swab cultures among dog bite patients reporting to two DBW care centers in Uganda in the period March 2019 – October 2019.

	Number of isolates that are resistant to antimicrobial agent, n (%)											
Bacteria	**CRO**	**MET**	**CN**	**AML**	**SXT**	**CIP**	**IPM**	**S**	**DOX**	**OX**	**C**	**AMP**
Pasteurella												
P. maltocida (n=64)	0 (0.0)	64 (100.0)	0 (0.0)	12 (18.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (9.4)	0 (0.0)	8 (12.5)
P. canis (n=26)	0 (0.0)	26 (100.0)	0 (0.0)	7 (26.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (38.5)
Other pasteurella (n=31)	0 (0.0)	31 (100.0)	3 (9.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Proteus												
P. vulgaris (n=2)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
P. mirabilis (n=7)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (42.9)	4 (57.1)	2 (28.6)	0 (0.0)	3 (42.9)
Pseudomonas												
P. aeuroginosa (n=3)	0 (0.0)	3 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)
P. stutzeri (n=3)	0 (0.0)	3 (100.0)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)	0 (0.0)
P. alcaligenes (n=2)	1 (50.0)	2 (100.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	1(50.0)	2 (100.0)	2 (100.0)	2 (100.0)	0 (0.0)	2 (100.0)
Other pseudomonas* (n=11)	0 (0.0)	11 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (27.3)	0 (0.0)	11 (100.0)	2 (18.1)	3 (27.3)
Klebsiella												
K. pneumonae (n=11)*	2 (18.1)	11 (100.0)	0 (0.0)	11 (100.0)	5 (45.5)	0 (0.0)	0 (0.0)	0 (0.0)	7 (63.6)	11 (100.0)	3 (27.3)	11 (100.0)
K. oxytoca (n=6)	0 (0.0)	6 (100.0)	4 (66.7)	6 (100.0)	4 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	6 (100.0)
Acinetobacter spp (n=3)	0 (0.0)	3 (100.0)	0 (0.0)	0 (0.0)	3(100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)	0 (0.0)	3 (100.0)
Moellerella wisconsensis (n=5)	3 (60.0)	5 (100.0)	0 (0.0)	5 (100.0)	3 (60.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (60.0)	5 (100.0)	2 (40.0)	5 (100.0)
C. canimorsus (n=36)	11 (30.6)	36 (100.0)	0 (0.0)	16 (44.4)	15 (41.7)	0 (0.0)	0 (0.0)	5 (13.9)	0 (0.0)	34 (94.4)	10 (27.8)	31 (86.1)
S. maltophilia (n=4)	0 (0.0)	4 (100.0)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
B. zoohelcum (n=3)	0 (0.0)	3 (100.0)	0 (0.0)	3 (100.0)	3 (100.0)	0 (0.0)	0 (0.0)	3 (100.0)	3 (100.0)	0 (0.0)	0 (0.0)	3 (100.0)
Citrobacter												
C. werkmanii (n=1)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)
C. freundii (n=2)	2 (100.0)	2 (100.0)	0 (0.0)	1 (50.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	2 (100.0)	2 (100.0)
E. coli (n=6)	0 (0.0)	6 (100.0)	0 (0.0)	4 (66.7)	6 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (66.7)	6 (100.0)	0 (0.0)	4 (66.7)
Enterobacter												
E. asburiae (n=1)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	1 (100.0)	0 (0.0)

Other enterobacter spp (n=13)	7 (53.9)	13 (100.0)	0 (0.0)	6 (46.2)	13 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (53.9)	13 (100.0)	0 (0.0)	13 (100.0)
Serratia												
S. rubidae (n=2)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
S. entomophila (n=3)	0 (0.0)	3 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)
Fusobacterium spp (n=48)	0 (0.0)	48 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)
Bacteriodes spp (n=34)	0 (0.0)	34 (100.0)	4 (11.8)	1 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (82.4)	2 (5.9)	0 (0.0)	0 (0.0)
Prevotella spp (n=35)	0 (0.0)	35 (100.0)	0 (0.0)	6 (17.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (34.3)	0 (0.0)	0 (0.0)	0 (0.0)
Total isolates N = 362	*26 (7.2)*	*362 (100)*	*13 (5.3)*	*54 (14.9)*	*53 (14.6)*	*0 (0.0)*	*1 (0.3)*	*16 (4.4)*	*83 (22.9)*	*106 (29.3)*	*20 (5.5)*	*111 (30.7)*

CRO: Ceftriaxone; ME: Metronidazole; CN: Gentamycin; AML: Amoxicillin/clavulanic acid; SXT: Trimethoprim / sulfamethoxazoleI; VA: Vancomycin; CIP: Ciprofloxacin; IPM: Imipenem; S: Streptomycin; DOX: Doxycycline; OX: Oxacillin; C: Chloramphenicol; AMP: Ampicillin

Generally, there were some differences in the resistance of bacterial isolates obtained from Category II and Category II DBWs. For gram-positive isolates from Category III wounds, there was more resistance to many drugs compared to Category II wounds. As shown in **Table 4.21**, resistance to streptomycin (p = 0.001), doxycycline (p = 0.038), and oxacillin (p<0.001) was significantly associated with the isolate being from category III DBWs among gram positive isolates. Furthermore, for gram negative isolates, there was no significant association between the resistance from isolates of Categories II and III DBWs.

Table 4.21: Comparison of antimicrobial resistant patterns of Gram-positive and Gram-negative isolates among patients with category II and category III DBW reporting to 2 PET centers in Uganda between March and October 2019.

Antimicrobial	Pattern	GRAM POSITIVE ISOLATES			GRAM NEGATIVE ISOLATES		
		Category II wounds (n = 279), %	Category III wounds (n = 127), %	X^2 (p-value)	Category II wounds n = 217	Category III wounds n = 145	X^2 (p-value)
Ceftriaxone	R	38 (13.6)	22 (17.3)	1.23 (0.54)	15 (6.9)	11 (7.6)	1.85 (0.40)
	I	7 (2.5)	2 (1.6)		3 (1.4)	5 (3.5)	
	S	234 (83.9)	103 (81.1)		199 (91.7)	128 (88.9)	
Metronidazole*	R	264 (94.6)	116 (91.3)	1.57 (0.21)	217 (100.0)	145 (100.0)	-
	I	15 (5.4)	11 (8.7)		0 (0.0)	0 (0.0)	
	S	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	
Gentamicin	R	21 (7.6)	8 (6.3)	1.97 (0.37)	9 (4.2)	4 (2.8)	4.24 (0.11)
	I	11 (3.9)	9 (7.1)		3 (1.4)	7 (4.8)	
	S	247 (88.5)	110 (86.6)		205 (94.5)	134 (92.4)	
Amoxicillin/clavulanic acid	R	34 (12.2)	23 (18.1)	2.54 (0.11)	31 (14.3)	23 (15.9)	0.16 (0.69)
	S	245 (87.8)	104 (81.9)		185 (85.7)	122 (84.1)	
Trimethoprim / sulfamethoxazole	R	11 (3.9)	5 (3.9)	0.14 (0.93)	37 (17.0)	16 (11.0)	4.74 (0.09)
	I	7 (2.5)	4 (3.2)		9 (4.2)	12 (8.3)	
	S	261 (93.6)	118 (92.9)		171 (78.8)	117 (80.7)	
Vancomycin*	R	0 (0.0)	0 (0.0)	-	ND	ND	-
	S	279 (100.0)	127 (100.0)		ND	ND	
Ciprofloxacin	R	0 (0.0)	0 (0.0)	-	0 (0.0)	0 (0.0)	-
	S	279 (100.0)	127 (100.0)		217 (100.0)	145 (100.0)	
Imipenem*	R	9 (3.3)	6 (4.7)	0.55 (0.46)	1 (0.5)	0 (0.0)	
	S	270 (96.7)	121 (95.3)		216 (99.5)	145 (100.0)	
Streptomycin	R	7 (2.5)	14 (11.0)	13.51 (0.001)**	6 (2.8)	10 (6.9)	3.84 (0.15)
	I	4 (1.4)	3 (2.4)		5 (2.3)	2 (1.4)	
	S	268 (96.1)	110 (86.6)		206 (94.9)	133 (91.7)	
Doxycycline	R	23 (8.3)	14 (11.0)	6.56 (0.038)**	55 (25.3)	28 (19.3)	329 (0.19)
	I	4 (1.4)	7 (5.5)		9 (4.2)	3 (2.1)	
	S	252 (90.3)	106 (83.5)		153 (70.5)	114 (78.6)	
Oxacillin*	R	169 (60.6)	109 (85.8)	25.78 (≤0.0001)**	62 (28.6)	44 (30.3)	0.13 (0.72)
	S	110 (39.4)	18 (14.2)		155 (71.4)	101 (69.7)	
Chloramphenicol	R	22 (7.9)	14 (11.1)	3.14 (0.21)	12 (5.5)	8 (5.5)	3.57 (0.17)
	I	31 (11.1)	20 (15.7)		5 (2.3)	9 (6.2)	
	S	226 (81.0)	93 (73.2)		200 (92.2)	128 (88.3)	

Methicillin*	R	9 (3.2)	5 (3.9)	0.27 (0.61)	ND	ND	-
	S	270 (96.8)	122 (96.1)		ND	ND	
Ampicillin	R	ND	ND	-	68 (31.3)	43 (29.7)	1.19 (0.55)
	I	ND	ND		7 (3.2)	8 (5.5)	
	S	ND	ND		142 (65.4	94 (64.8)	

S: sensitive; R: resistant; I: intermediate; ND: not done; *Antimicrobial agent did not have an intermediate zone; **differences are statistically significant at $p \leq 0.05$

4.3.4 Multidrug resistance of bacterial isolates

Out of the 768 isolates, 226 (29.4%) were resistant to at least one antimicrobial in three or more antimicrobial classes, so they were taken to be multidrug resistant (MDR). Among the 406 Gram-positive isolates, 121/406 (29.8%) were found to be multidrug resistant. Specifically, these included*, S. intermedius, S. canis,* and *Corynebactrium spp,* which were resistant to three classes of antimicrobial agents. In contrast, *S. aureus, S. pyogenes, E. feacalis, Lactobacillus spp* and *Lactococcus spp* were resistant to 4 or more classes of antimicrobial drugs as shown in **Table 4.22**.

Table 4.22: Multidrug resistant patterns in gram-positive bacterial pathogens isolated from wound swab cultures among patients with DBW attending PET centers in Uganda

Gram positive	Antimicrobial classes and related number of resistant isolates (%)				
Bacteria	Number	R_1	R_2	R_3	$\geq R_4$
Staphylococcus					
*S. aureus**	103 (25.4)	56 (13.8)	11 (2.7)	24 (5.8)	12 (2.9)
*S. intermedius**	30 (7.4)	2 (6.7)	15 (3.7)	13 (3.2)	0 (0.0)
CONS	68 (16.7)	53 (13.1)	15 (3.6)	0 (0.0)	0 (0.0)
Streptococuss					
*S. canis**	18 (4.4)	0 (0.0)	2 (0.5)	10 (2.5)	6 (1.5)
*S. pyogenes**	29 (7.1)	2 (0.5)	14 (3.5)	12 (2.9)	1 (0.3)
Other Streptococci	12 (2.9)	11 (2.7)	1 (0.3)	0 (0.0)	0 (0.0)
*Bacillus spp**	11 (2.7)	2 (0.5)	3 (0.7)	4 (1.0)	2 (0.5)
Enterococcus					
*E. feacalis**	19 (4.7)	4 (1.0)	9 (2.2)	2 (0.5)	4 (1.0)
E. faecium	2 (0.5)	0 (0.0)	1 (0.3)	1 (0.3)	0 (0.0)
Other Enterococci	6 (1.5)	5 (1.2)	1 (0.3)	0 (0.0)	0 (0.0)
Micrococcus spp	8 (1.9)	8 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)
Corynebactrium spp	33 (8.1)	18 (4.4)	9 (2.2)	6 (1.5)	0 (0.0)
Gemella morbillorium	21 (5.1)	18 (4.4)	3 (0.7)	0 (0.0)	0 (0.0)
Lactobacillus spp*	31 (7.6)	9 (2.2)	8 (1.9)	4 (1.0)	10 (2.5)
Lactococcus spp*	23 (5.6)	7 (1.8)	6 (1.5)	6 (1.5)	4 (1.0)
Total	*406 (100)*	*195 (48.0)*	*98 (24.1)*	*82 (20.2)*	*39 (9.6)*

*MDR bacteria; R1 - ≥R4 Resistance to classes of antimicrobial agents 1, 2, 3, 4 and above.

Of the 362 Gram negative isolates, 105 (29.0%) exhibited MDR. Of these, *P. vulgaris, C. werkmanii, E. asburiae,* and *Bacteriodes spp* were resistant to antimicrobial agents in three classes. Additionally, *P. mirabilis, K. pneumonae, K. oxytoca, M. wisconsensis, C. canimorsus, E. coli* and *B. zoohelcum,* were resistant to 4 or more classes of antimicrobial drugs as shown in **Table 4.23**.

Table 4.23: Multidrug resistant patterns in gram-negative bacterial pathogens isolated from wound swab cultures among patients with DBW attending PET centers in Uganda

Gram negative	Antimicrobial classes and related number of resistant isolates (%)				
Bacteria	**Number**	**R_1**	**R_2**	**R_3**	**≥R_4**
Pasteurella					
P. maltocida	64 (17.7)	47 (13.0)	17 (4.7)	0 (0.0)	0 (0.0)
P. canis	26 (7.2)	19 (5.2)	7 (1.9)	0 (0.0)	0 (0.0)
Other pasteurella	31 (8.6)	3 (0.8)	28 (7.7)	0 (0.0)	0 (0.0)
Proteus					
*P. vulgaris**	2 (0.6)	0 (0.0)	0 (0.0)	2 (0.6)	0 (0.0)
*P. mirabilis**	7 (1.9)	2 (0.6)	1 (0.3)	2 (0.6)	2 (0.6)
Pseudomonas					
P. aeuroginosa	3 (0.8)	0 (0.0)	3 (0.8)	0 (0.0)	0 (0.0)
P. stutzeri	3 (0.8)	3 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)
P. alcaligenes	2 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.6)
Other pseudomonas*	11 (3.0)	4 (1.1)	3 (0.8)	2 (0.6)	2 (0.6)
Klebsiella					
*K. pneumonae**	11 (3.0)	0 (0.0)	3 (0.8)	4 (1.1)	4 (1.1)
*K. oxytoca**	6 (1.7)	0 (0.0)	2 (0.6)	0 (0.0)	4 (1.1)
Acinetobacter spp*	3 (0.8)	0 (0.0)	0 (0.0)	3 (0.8)	0 (0.0)
*M. wisconsensis**	5 (1.4)	0 (0.0)	1 (0.3)	1 (0.3)	3 (0.8)
*C. canimorsus**	36 (9.9)	3 (0.8)	8 (2.2)	11 (3.0)	14 (3.9)
S. maltophilia	4 (1.1)	3 (0.8)	1 (0.3)	0 (0.0)	0 (0.0)
B. zoohelcum	3 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.8)
Citrobacter					
*C. werkmanii**	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)
*C. freundii**	2 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.6)
*E. coli**	6 (1.7)	0 (0.0)	2 (0.6)	0 (0.0)	4 (1.1)
Enterobacter					
*E. asburiae**	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)
Other enterobacter spp	13 (3.6)	0 (0.0)	0 (0.0)	6 (1.7)	7 (1.9)
Serratia					
S. rubidae	2 (0.6)	0 (0.0)	2 (0.6)	0 (0.0)	0 (0.0)
S. entomophila	3 (0.8)	0 (0.0)	3 (0.8)	0 (0.0)	0 (0.0)
Fusobacterium spp	48 (13.3)	40 (11.0)	8 (2.2)	0 (0.0)	0 (0.0)
Bacteriodes spp*	34 (9.4)	5 (1.4)	4 (1.1)	25 (6.9)	0 (0.0)
Prevotella spp	35 (9.7)	23 (6.4)	12 (3.3)	0 (0.0)	0 (0.0)
Total	*362 (100)*	*152 (42.0)*	*105 (29.0)*	*58 (16.0)*	*47 (12.9)*

*MDR bacteria; R1 - ≥R4 Resistance to classes of antimicrobial agents 1, 2, 3, 4 and above.

4.4 Results for sub-study IV: Outcomes of the management of dog bite injuries

All the 376 patients recruited for this study were followed up for 18 months. Just over half of the study participants, 201 (54%), were male. The median (IQR) age for all study participants was 18 (22.75)

years. Approximately 50.5% of the participants were from Wakiso District. Only 5.1% had ever been vaccinated against rabies, and approximately three-quarters (72%) had ever received some information about dogs and dog bites. Infection at initial presentation was significantly different between those who had complied and those who had not ($p<0.001$), Category II vs Category III DBWs ($p = 0.03$), and those with vs without prior treatment ($p = 0.008$). The details of the socio-demographic characteristics of dog-bite patients and other bite related variables are shown in **Table 4.24** below.

Table 4.24: Characteristics of 376 study participants with their corresponding wound management outcomes

		Wound infection at initial reporting			Wound healing		
Characteristics	**Frequency N (%)**	**Infection absent n = 177 (47.1%)**	**Infection present n=199 (52.9%)**	**p-value**	**Delayed healing absent**	**Delayed healing present**	**p-value**
Sex							
Male	201 (53.5)	94 (53.1)	107 (53.8)		192 (54.7)	8 (34.8)	0.064
Female	175 (46.5)	83 (46.9)	92 (46.2)	0.898	159 (45.3)	15 (65.2)	
Age							
≤15 years	173 (46.0)	82 (46.3)	88 (47.3)		164 (46.7)	7 (30.4)	0.129
>15 years	203 (54.0)	95 (53.7)	98 (52.7)	0.907	187 (53.3)	16 (69.6)	
Hospital							
Entebbe (Wakiso)	110 (29.3)	49 (27.7)	61 (30.7)		101 (28.8)	9 (39.1)	
Mulago (Kampala)	266 (70.7)	128 (72.3)	138 (69.3)	0.528	250 (71.2)	14 (60.9)	0.291
Religion							
Christian	301 (80.1)	143 (80.8)	158 (79.4)		280 (79.8)	19 (82.6)	
Non-Christian	75 (19.9)	34 (19.2)	41 (20.6)	0.736	71 (20.2)	4 (17.4)	0.742
Marital status							
Not in union	285 (75.8)	118 (66.7)	141 (70.9)		264 (75.2)	19 (82.6)	
In union	91 (24.2)	12 (6.8)	14 (7.1)	0.603	87 (24.8)	4 (17.4)	0.423
Highest education level							
No formal education	55 (14.7)	30 (17.1)	25 (12.6)		53 (15.1)	2 (8.7)	
Primary	180 (48.0)	84 (47.7)	96 (48.2)		168 (48.0)	10 (43.5)	
Secondary and above	143 (37.3)	62 (35.2)	78 (39.2)	0.432	129 (36.9)	11 (47.3)	0.498
Household size							
≤4	176 (46.7)	80 (47.6)	96 (49.7)		165 (49.1)	11 (47.8)	
5-8	161 (44.6)	81 (48.2)	80 (41.5)		149 (44.4)	10 (43.5)	
≤9	24 (6.7)	7 (4.2)	17 (8.8)	0.141	22 (6.5)	2 (8.7)	0.923
Employment status							
No	181 (48.1)	88 (49.7)	93 (47.7)		167 (47.6)	12 (52.2)	0.669
Yes	195 (51.9)	89 (50.3)	106 (53.3)	0.563	184 (52.4)	11 (47.8)	
Immunized against rabies							
No	357 (94.9)	167 (94.3)	190 (95.5)		333 (94.9)	22 (95.6)	0.869
Yes	19 (5.1)	10 (5.7)	9 (4.5)	0.618	18 (5.1)	1 (4.4)	
Get dog information							

No	114 (30.3)	57 (32.2)	57 (28.6)		105 (29.9)	8 (34.8)	0.622
Yes	262 (69.7)	120 (67.8)	142 (71.4)	0.453	246 (70.1)	15 (65.2)	
Socio-economic status							
Lower	197 (52.5)	92 (52.3)	105 (52.8)		181 (51.7)	15 (65.2)	
Middle	62 (16.5)	30 (17.1)	32 (16.0)		59 (16.9)	3 (13.0)	
Upper	116 (31.0)	54 (30.7)	62 (31.2)	0.969	110 (31.4)	5 (21.8)	0.450
Comply							
No	306 (81.4)	113 (63.8)	193 (97.0)		284 (80.9)	20 (87.0)	
Yes	70 (18.6)	64 (36.2)	6 (3.0)	≤0.001*	67 (19.1)	3 (13.0)	0.472
Delay beyond 24 hrs							
No	227 (60.4)	107 (60.5)	120 (60.3)		213 (60.7)	14 (60.7)	
Yes	149 (39.6)	70 (39.5)	79 (39.7)	0.976	138 (39.3)	9 (39.1)	0.986
Wound severity							
Category II	293 (77.9)	144 (81.4)	149 (77.9)		284 (80.9)	7 (30.4)	
Category III	83 (22.1)	33 (18.6)	50 (25.1)	0.03*	67 (19.1)	16 (69.6)	≤0.001*
Prior treatment							
No	263 (69.9)	112 (63.3)	151 (75.9)		246 (70.1)	17 (69.5)	
Yes	113 (30.1)	65 (36.7)	48 (24.1)	0.008*	105 (29.9)	7 (30.4)	0.958
Antibiotics at PET							
No	180 (47.9)	NA	NA		172 (49.0)	6 (26.1)	
Yes	196 (52.1)	NA	NA	NA	179 (51.0)	17 (73.9)	0.033*
Culture positivity							
No	205 (55.1)				201 (57.3)	5 (21.7)	
Yes	168 (44.9)				150 (42.7)	18 (78.3)	0.001*

*Statistical significance at p≤0.05

4.4.1 Outcome I: Wound infection

The rate of wound infection amongst all participants was 52.9% (199/376). Of these, 130 (65.3%) were single-bite injuries while the rest were multiple wounds. Category II wounds formed the majority of the infected injuries, accounting for 75.9% (151) of those presented with infections. Infected wounds were commonest for those bitten on the lower limbs (66.3%), followed by the head / face (29.6%) and upper limbs (7.1%). A slight majority of the infected wounds were amongst those aged 15 and above. The rest of the details of the distribution of the infected wounds according to anatomical location are shown **Figure 4.9** below.

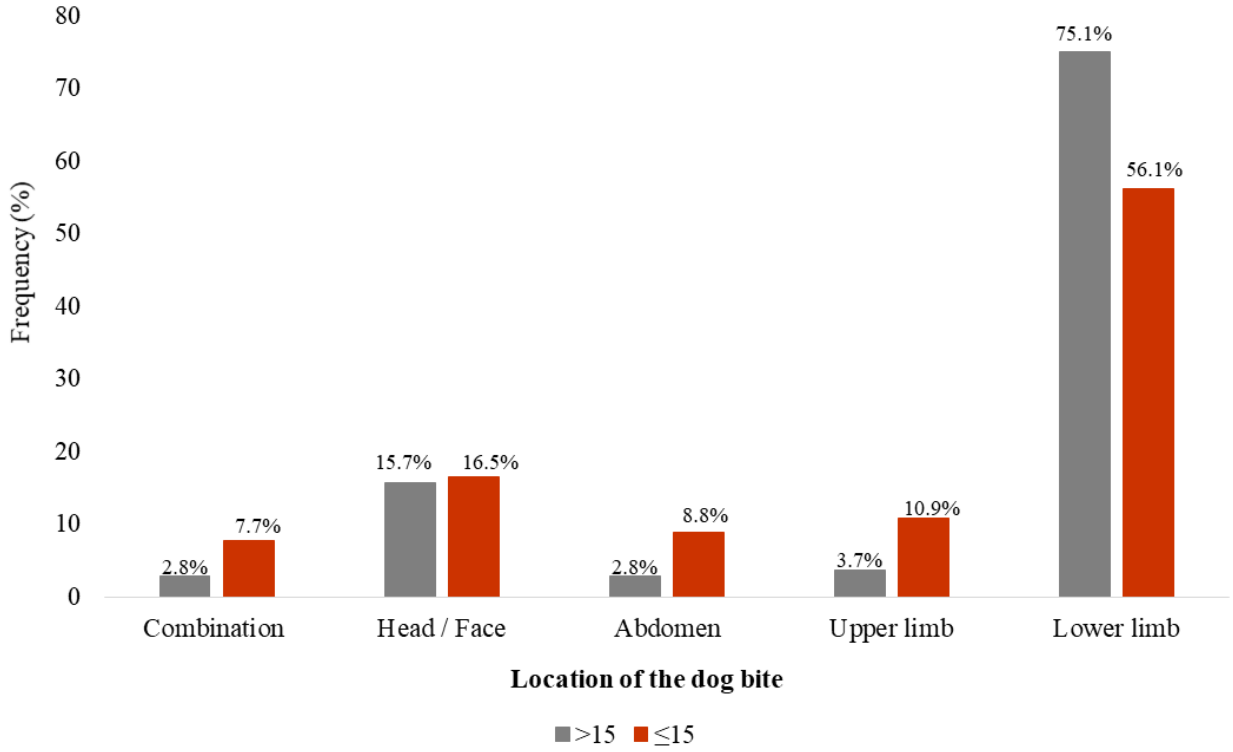

Figure 4.9: Infection rates according to anatomical location of DBWs and age of patients

As shown in **Table 4.25**, the rate of infections significantly differed according to whether the participant complied with preclinical guidelines or did not ($p \leq 0.001$). Of the 199 participants with infected wounds, only 6 (3.0%) had complied with the preclinical guidelines and reported

that they washed the wounds with water and soap and presented to a healthcare facility within 24 hours. In addition, the infection rates were also significantly different according to the wound severity (p = 0.03) with the Category II wounds more likely to be infected. Furthermore, those who had not received any treatment prior to reporting were more likely to present with infected wounds compared to those who had received some form of conventional treatment (p = 0.008). Of the 151 Category II wounds, 48% were purulent and 52% were non-purulent. Conversely, of the 48 Category III wounds, 31% and 44% were abscesses and purulent wounds, respectively, while the rest were non-purulent.

By the 7th day after the initiation of treatment, infection rates had generally dropped by 40%, leaving 121/199 (60.8%) infected. Of those who still had infected wounds by day seven, 56 were new infections (i.e. the wounds were non-infected at initiation but the infection was acquired within the first week). However, by the 28th day, only 23 (11.5%) had not healed.

4.4.1.1 Determinants of wound infection

As shown in **Table 4.25**, presenting with infected wounds did not significantly vary by sex; female compared to male, adjPR = 1.05 (95% CI: 0.87, 1.27; p = 0.622). Similarly, no significant associations were observed when in union vs not in union (p = 0.831); and delayed presentation to the healthcare facility for more than 24 hours, compared to less (p = 0.976). However, controlling for age, highest education attainment, employment status, having complied with UCG, wound severity, and having received prior treatment before reporting to the 2 PET centers, having complied with preclinical recommendations in the UCG significantly reduced the chances of wound infections by approximately half, adjPR = 0.59 (95% CI: 0.20, 0.79; p≤0.001). In addition, holding the patient age, highest education attainment, employment status, having

complied with UCG, and wound severity constant, having received prior treatment before reporting to the 2 PET centers was also significantly associated with a reduced prevalence of wound infection, adjPR = 0.77 (95% CI: 0.62, 0.96; p = 0.018). Furthermore, assuming the study participants had similar characteristics in the final model, wound severity, particularly category III wounds, was a significant determinant of wound infection at initial presentation (AdjPR = 1.20 (1.05, 2.45; p = 0.042). Lastly, having secondary education or higher as the highest education level attainment was marginally associated with an elevated prevalence of having a wound infection, adj.PR = 1.02 (95% CI: 1.01, 1.97; p = 0.049) as shown in **Table 4.25**.

Table 4.25: Multivariable analysis of factors associated with wound infection at initial presentation at 2 selected PET centers among 199 dog bite patients in Uganda.

Characteristics	Unadjusted PR, 95% CI	p-value	Adjusted PR, 95% CI	p-value
Sex				
Male	1.0			
Female	1.05 (0.87, 1.27)	0.622		
Age				
≤15 years	1.0		1.0	
>15 years	0.99 (0.82,1.20)	0.928	0.83 (0.65,1.06)	0.141
Marital status				
Not in union	1.0			
In union	1.02 (0.82, 1.27)	0.839		
Highest education level				
No formal education	1.0		1.0	
Primary	1.04 (0.78, 1.41)	0.793	1.14 (0.86,1.51)	
Secondary and above	1.16 (0.86,1.58)	0.330	1.02 (1.01,1.97)	0.049*
Employment status				
No	1.0		1.0	
Yes	0.88 (0.573,1.07)	0.200	0.95 (0.78,1.15)	0.602
Immunized against rabies				
No	1.0			
Yes	0.89 (0.64,1.44)	0.637		
Get dog information				
No	1.0			
Yes	0.96 (0.79,1.18)	0.706		
Socio-economic status				
Lower	1.0			

Middle	0.94 (0.72, 1.23)	0.665		
Upper	0.93 (0.75,1.16)	0.503		
Comply				
No	1.0		1.0	
Yes	0.54 (0.23,0.83)	≤0.001	0.59 (0.20,0.79)	≤0.001*
Delay				
No	1.0			
Yes	1.06 (0.82,1.22)	0.976		
Wound severity				
Category II	1.0		1.0	
Category III	1.18 (1.08,2.48)	0.032	1.20 (1.05,2.45)	0.042*
Prior treatment				
No	1.0		1.0	
Yes	0.74 (0.58,0.94)	0.013	0.77 (0.62,0.96)	0.018*

*Statistical significance at p≤0.05

4.4.2 Outcome II: Wound healing

In total, 374 observations were made for this outcome because two of the study participants were lost to follow up a few days after the initiation of PET. Generally, 23/374 (6.2%) of the study participants had delayed wound healing. This was described as the wound that the clinician declared as not resolved on the 28th day of the 5th anti-rabies virus dose. Six of the 23 had acquired the infection seven days after initiating PET. Also, among those with delayed wound healing (N = 23), there were more females (n = 15) than males, though the difference was not of statistical significance (p = 0.064). Additionally, more of those with positive cultures showed a tendency to have delayed wound healing compared to those that had negative cultures at initial presentation (p = 0.001).

Furthermore, it was observed that 16/23 of those whose wounds delayed to heal had more severe wounds (Category III). Among those with delayed healing, there were more patients who had received antibiotics at initial presentation than those who had not. However, at bivariate analysis, only wound severity, OR = 2.68 (95% CI: 1.83, 4.87; p≤0.001), receiving antibiotics at PET, OR

= 2.72 (95% CI: 1.05, 4.06; p = 0.040) and culture positivity, OR = 2.8 (95% CI: 1.75, 4.28; p = 0.002) were associated with delayed wound healing as shown in **Table 4.26**.

Table 4.26: Bivariate analysis of factors associated with delayed wound healing among 199 dog bite patients at 2 selected PET centers for in Uganda.

Characteristics	Unadjusted OR, 95% CI	p-value
Sex		
Male	1.0	
Female	2.26 (0.93,4.48)	0.070
Age		
≤15 years	1.0	
>15 years	2.01 (0.81,3.99)	0.135
Hospital		
Entebbe (Wakiso)	1.0	
Mulago (Kampala)	0.63 (0.26,1.49)	0.295
Religion		
Christian	1.0	
Non-Christian	0.83 (0.67,1.51)	0.742
Marital status		
Not in union	1.0	
In union	0.64 (0.34,1.92)	0.427
Highest education level		
No formal education	1.0	
Primary	1.58 (0.93,3.43)	0.564
Secondary and above	2.25 (0.98,4.48)	0.300
Household size		
≤4	1.0	
5-8	1.01 (0.84,2.44)	0.988
≤9	1.36 (0.88,2.56)	0.699
Employment status		
No	1.0	
Yes	0.83 (0.57,1.93)	0.669
Immunized against rabies		
No	1.0	
Yes	0.84 (0.51,2.59)	0.869
Get dog information		
No	1.0	
Yes	0.80 (0.62,1.94)	0.623
Socio-economic status		
Lower	1.0	
Middle	0.613 (0.52,2.19)	0.452
Upper	0.54 (0.41,1.55)	0.257
Comply		
No	1.0	
Yes	0.64 (0.48,1.20)	0.475
Delay		

No		
Yes	1.99 (0.94,2.35)	0.986
Wound severity		
Category II	1.0	
Category III	2.68 (1.83,4.87)	≤0.001
Prior treatment		
No		
Yes	1.03 (0.94,2.56)	0.958
Antibiotics at PET		
No	1.0	
Yes	2.72 (1.05,4.06)	0.040
Culture positivity		
No	1.0	
Yes	2.8 (1.75,4.28)	0.002

When the time-to-detection of healing was assessed according to different sub-categories of patients, the findings in **Table 4.27** below were obtained.

Table 4.27: Summary of results from the Log rank tests for key characteristics

	Characteristics	**Log-rank, *p-value***
1.	Preclinically complied with UCG Vs those that did not comply	0.029, *0.865*
2.	Wounds initially infected vs those that were not infected	4.254, *0.039*
3.	Category II dog bite wounds vs Category III DBWs	30.99, *<0.001*
4.	Had received prior treatment vs those that had not.	0.562, *0.453*

Time to detection of healing among patients that presented with clinically infected wounds was compared to those with non-infected wounds. The median time to detection among non-infected and infected wounds was 7 days and 14 days, respectively (Log Rank, Mentel - Cox p = 0.039). Therefore, there is evidence in the data to suggest that the hazard ratio between the infected and non-infected dog bite patients is different from 1, i.e., time to healing between the two groups is different, with those not infected healing faster, as shown in **Figure 4.10** below.

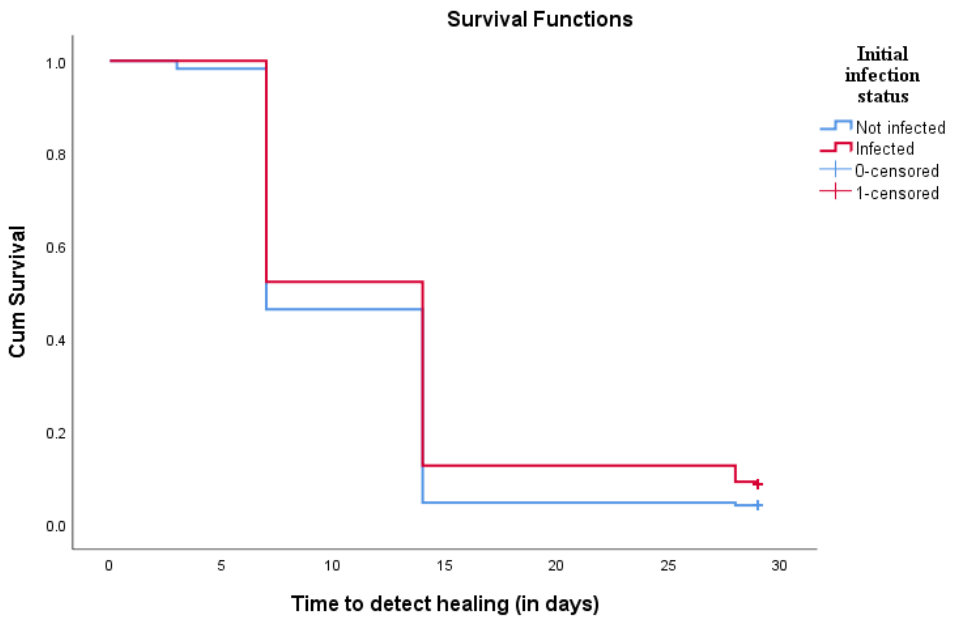

Figure 4.10: Kaplan-Meier curve showing the time to detection of healing between patients with infected and non-infected wounds

When time to detection of healing was compared for those who complied with UCG and those who did not, the median time was 7 days and 14 days, respectively. However, there is no evidence in the data to suggest that the hazard ratios between the two groups are different (Log Rank, Mentel - Cox p = 0.865). This means that the healing time to healing between those that complied and those that did not comply might not be significantly different as shown in **Figure 4.11**.

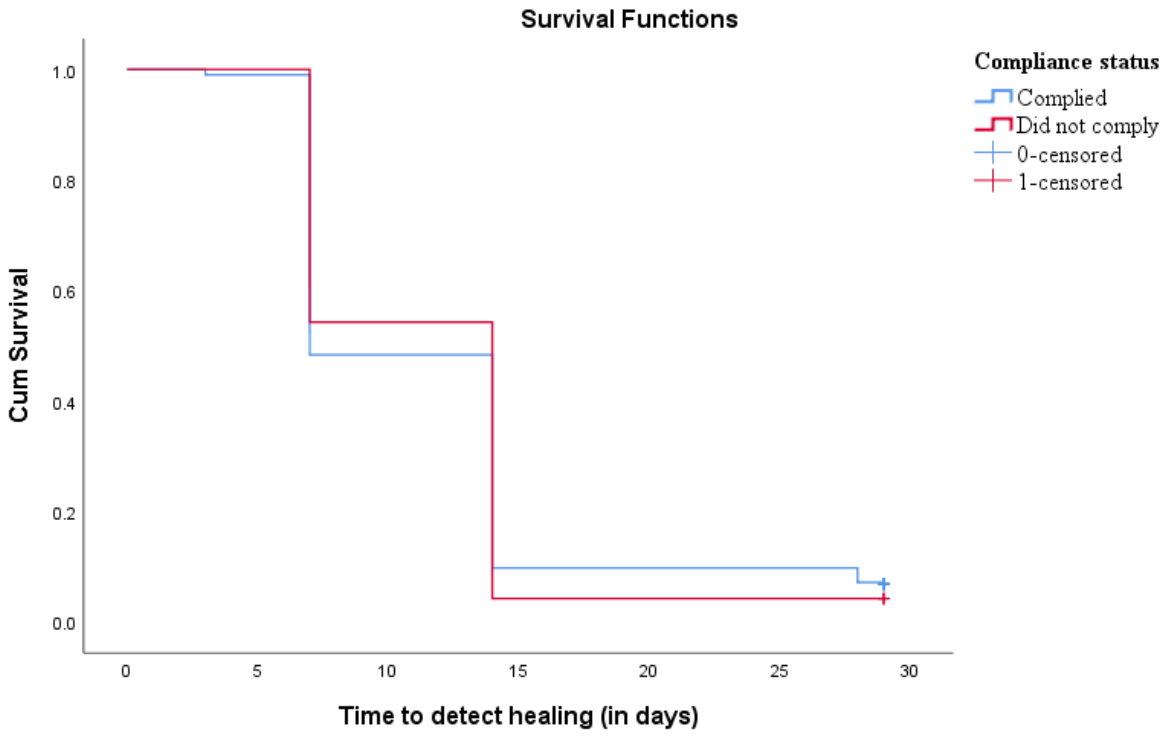

Figure 4.11: Kaplan-Meier curve depicting the time to detection of healing between patients who had preclinically complied with UCG and those who had not.

Further, the median time to healing detection among those with Category II wounds was 7 (95% CI: 6.6, 7.4) days compared to those with Category III wounds whose median healing detection was 14 days. The Log Rank (Mentel-Cox) p-value was <0.001 meaning that there is evidence in the data to suggest that the time to detection of healing is different between the two groups. Therefore, time to healing is different between those with Category II wounds compared to those with Category III DBWs with the latter having delayed healing as shown in **Figure 4.12**.

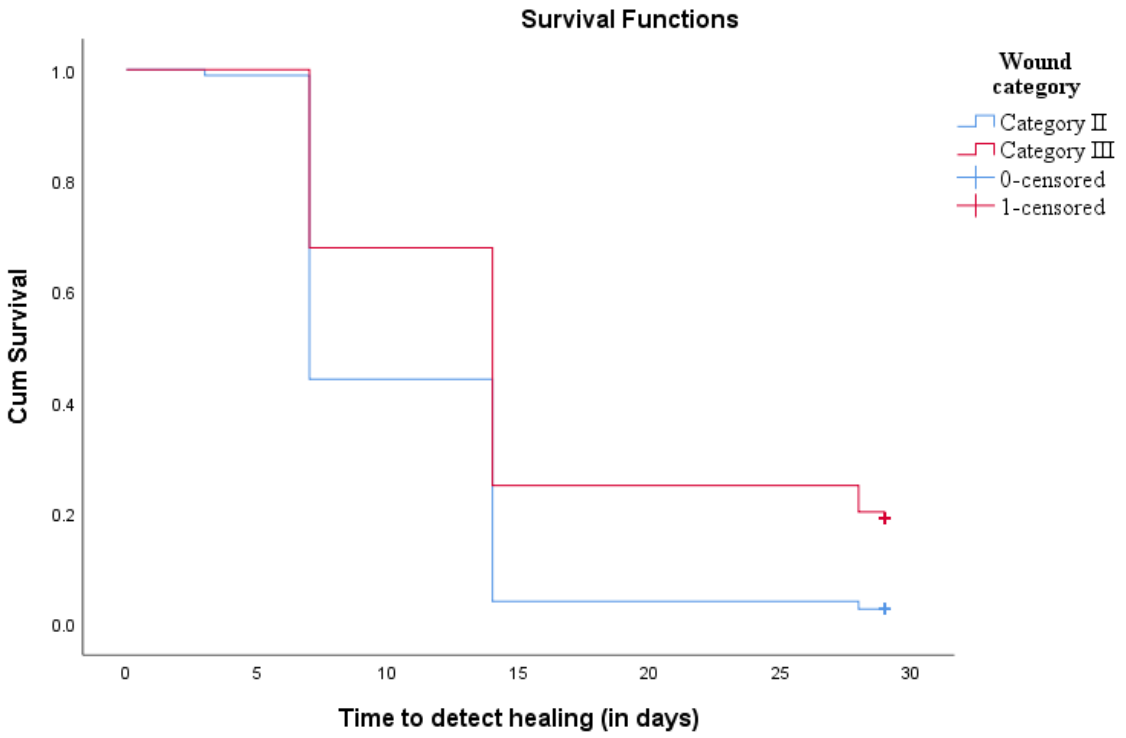

Figure 4.12: Kaplan-Meier curve showing the time to detection of healing between patients with Category II DBWs and Category III DBWs.

Additionally, the median time to detect healing among those who had received prior treatment was 7 (95% CI: 6.3, 7.7) days, while it was 14 (95% CI: 13.3, 14.7) days among those who had not received any treatment before seeking PEP. However, Log Rank (Mentel-Cox) p = 0.453 meaning that there is no evidence in the data to suggest that the time to detect healing between those who had received treatment and those who had not, prior to seeking PET at the two centers, is not different as shown in **Figure 4.13**.

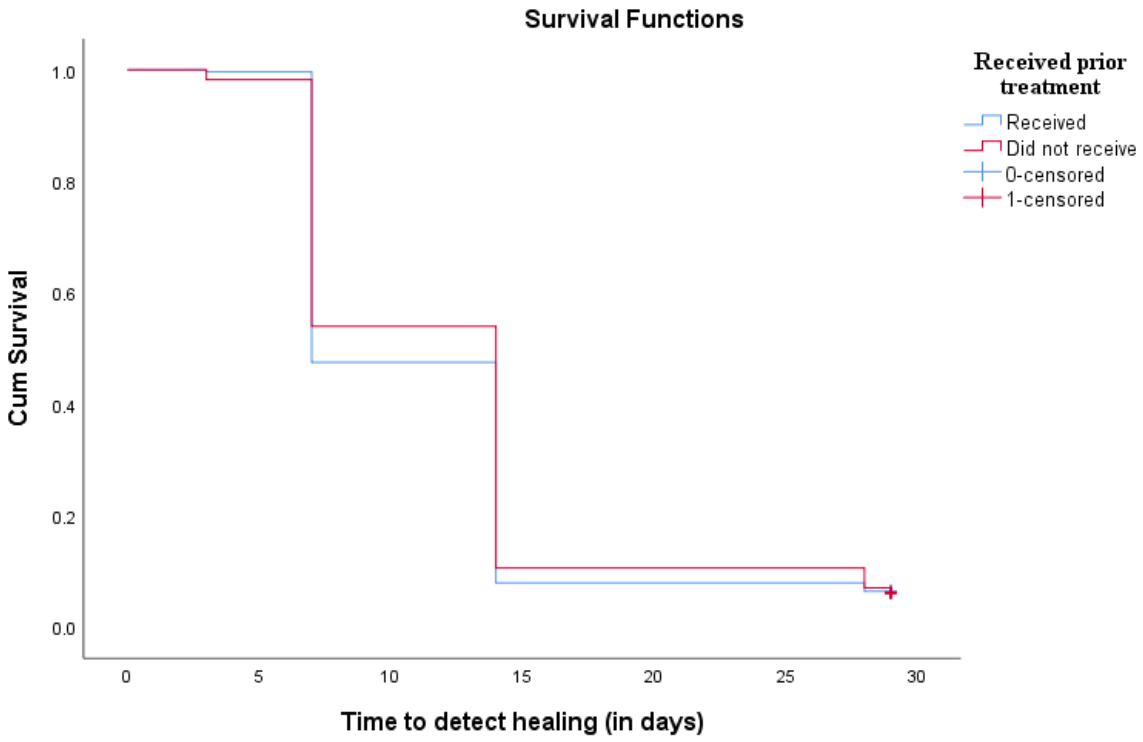

Figure 4.13: Kaplan-Meier curve illustrating the time to detection of healing between patients who had received prior treatment and those that did not.

4.4.3 Outcome III: Case reports of fatal suspected human rabies infection

4.4.3.1 Case report 1

An 11-year old girl was presented to one of the PET centers on June 3rd, 2019. She had been bitten on the left shoulder by a wandering dog close to two months earlier, on April 8th, 2019. It was later discovered that the biting dog had been run over by a vehicle on the road, approximately 2 days after going on a biting spree. The dog went on to bite two more people within the same community. After being bitten, the parents took her to the herbalist 21 kilometers away from home, bypassing a cost-free PET center which was 8 kilometers away before reaching the herbalist's premises. The herbalist put what appeared to be clay on the wound and the bleeding stopped, before applying a 'blackstone' for close to six hours.

Afterwards, on June 1st, 2019, the girl started complaining of a headache, fever, and a pricking but burning feeling, although the wound had visibly healed. When the signs and symptoms worsened on the third day, the parents took her to a nearby clinic. When the clinician was told the history of the dog bite, he administered ceftriaxone and dexamethasone before referring the girl to the PET center. When the girl arrived at the PET center, she had a high fever, anxiety, confusion, and difficult swallowing while drooling. The clinicians took the history of the patient and, given the information obtained about the dog, the patient was classified as a probable case of rabies. The patient was given a dose of the anti-rabies vaccine, sedatives, and ceftriaxone IV before a referral was made to the national referral hospital.

Upon arrival, the patient was admitted, and more sedatives were administered. Nevertheless, the patient continued to be in respiratory distress with continued salivation/drooling as well as paralysis of the limbs. Notably, no microbiological tests were undertaken to confirm the case as rabid. However, the general condition worsened that night of 3rd June and the caretakers decided to take her out of the hospital. By morning, it was discovered that the caretaker had smuggled the patient out of hospital at night. Upon further inquiry, it was revealed that the caretakers had taken the patient out of the hospital (without authorization) back to the herbalist. However, the patient died a day later at the herbalist's place and was buried two days later. The death happened 58 days after the dog bite event happened.

4.4.3.2 Case report 2

On October 5th, 2019, a 10-year-old male was presented to the out-patients department of one of the hospitals. He had signs of fever, respiratory distress, and nausea. No history of dog bite experience was reported or investigated. He was treated with antibiotics (metronidazole) and

analgesics / antipyretics (paracetamol). Two days later, the patient was brought back to the same hospital, but this time to the emergence medicine department. He had signs of difficulties in swallowing, fever, coughing, vomiting, confusion, and aggression as well as photophobia.

When the history of exposure was investigated, the caretaker reported that three weeks earlier he had been bitten by a dog on the hand by a neighbor's dog. The dog was lying near the entrance of the owner's home and approached the victim and bit him in the morning while going to school. In the evening, when he reported the incident to the parents upon returning home, the mother applied herbs to the wound. Since the wound did not appear to the parents to be serious, they did not take the victim to the hospital / PET center. When the signs and symptoms started, some of the community members thought it was rabies and reported the owner of the biting dog while inquiring about the dog. The owner reported that he did not know the whereabouts of the dog since it had disappeared some two weeks ago after turning violent.

When a complete blood count was done, it revealed an elevated white blood cell count of 15,400 per microliter. Muscle rigidity and general weakness were reported the following day after admission. The patient was given a tetanus toxoid, the anti-rabies vaccine and co-trimoxazole IV. On the 3rd day, another shot of ARV was administered. However, on the 4th day after admission, the patient passed away, and burial was conducted a day later, albeit without conducting a postmortem.

CHAPTER FIVE: DISCUSSION

7.1 Sub-study I: Preclinical practices

The sub-study investigated the epidemiology of dog bites and preclinical practices for the victims in the context of dog bite prevention and rabies prevention, respectively. The finding that there were more males than females is in concurrence with the majority of studies that have reported a preponderance of males (Aghahowa & Ogbevoen, 2010; Agrawal, Kumar, Singhal, Singh, & Bhagol, 2017). Some authors attribute this to personality variation between genders, with more males being subject to dog bites (Westgarth et al., 2018). Others have attributed it to males being frequently involved in day and night activities (Aghahowa & Ogbevoen, 2010). However, our findings contradict some studies which report that females are more likely to be bitten (Salomão et al., 2017).

Regardless of age, the leg was the most affected part of the body, followed by the hands and arms. Previous studies have documented limbs as the most bitten parts in Uganda, Nigeria and United Kingdom (Fèvre et al., 2005; Abubakar & Bakari, 2012; Mannion & Graham, 2016). This may be attributed to accessibility, especially for the legs, and the struggles that usually ensue during the bite. Such scuffles usually involve the use of arms and legs to ward off the dog. However, bites on the head were among children only, and this may be explained by their height/structure, which puts the head near the mouth of the dog. Likewise, some authors have attributed this to the small physiques of children, their inclination to provoke dogs and put their faces close to animals, as well as their limited motor skills to provide defense (Agrawal et al., 2017).

The majority of wounds were Category II involving skin scratches. This is expected, especially when the majority of wounds were singular in number and the extremities were the most affected parts. These parts are not only accessible by dogs, but they are easily movable in self-defense. Given that most of the victims were walking, it was unlikely that biting dogs got a firm grasp of the victim before disentanglement. Besides, dog attacks usually last a very brief duration, which explains why very severe and fatal bites are not a common finding in the literature, just like in our study. Such findings on severity are consistent with other studies (Ishaya, Habib, Van Rooyen, & Steinberg, 2020; Sahu, Preeti, Bhatia, & Singh, 2021) though they conflict with some (Bula-Rudas & Olcott, 2018; Li et al., 2021).

The owner of the biting dogs was not known in most cases (53.5%). This is perhaps because the majority of victims were bitten on the road or in public places like markets. Notably, the study area is mostly urban and characterized by rapid urbanization, a high population of people, and an abundance of garbage heaps that serve as a source of food for dogs and other un-owned animals. In addition, it might be due to some dog owners not chaining their dogs and leaving them to wander, posing a risk of bites to strangers. Some authors have attributed it to weak legislation on responsible dog ownership (Hergert & Nel, 2013). Just like in our study, the increased risk of bite events by such dogs compared to those with known owners has been reported in India (Anandara & Balu, 2017) and Nigeria (Abubakar & Bakari, 2012) though in Mozambique (Salomão et al., 2017), they play a minor role. This shows that the role of wandering dogs in the bites may vary with each setting.

For the majority of bites in the study, it was the victims that approached the dogs rather than the other way round. Territorial invasion easily forces dogs to bite out of self-defense. Such a risk

increases when dogs are in a pack or nursing young ones, as explained in the in-depth interviews for our study. Studies have widely reported increased dog aggression due to territorial invasion, especially by children (Marina Morgan & Palmer, 2007; Georges & Adesiyun, 2008). The findings in the current study are consistent with those of a related study in the United Kingdom, which reported 50% of the victims as having approached the biting dog (WHO, 2018c).

Before presentation to the hospital, only 18.6% of the patients had complied with recommended preclinical guidelines. It is recommended that dog bite vitims meticulously flush the wounds with water and soap and applying an antiseptic like povidone iodine if available (WHO, 2013b). The low level of compliance in our study may be due to inadequate knowledge of the guidelines. Moreover, many respondents expressed a lack of knowledge about what to do immediately after the dog bit them. However, our prevalence is comparable with that reported in India, which varied between 2 - 21% depending on the township (Jain & Jain, 2014). Nonetheless, in India, another study reported a higher rate (58%) than ours, though there was a significant rural-urban divide with the former performing worse (S. Sharma et al., 2016). This, combined with a 7% to 45% prevalence of wound washing with soap and water in Kenya and Ethiopia respectively, is evidence of how the practice varies across communities (Kabeta, Deresa, Tigre, Ward, & Mor, 2015; Penjor et al., 2020). It may also be indicative of the variations in the coverage and uptake of health education interventions across societies.

Of those who applied some substances before reporting for PET, only 23.8% applied an antiseptic as recommended in the UCG. A comparable proportion applied herbs, whereas others used antibiotics, black stone, charcoal, acid, powder made by burning the hair of biting dogs, split beans, paraffin, salt, monetary coins, and others. The investigation into the use of non-

recommended materials revealed that such practices were motivated by a variety of factors, including personal beliefs about efficacy, a lack of funds to pay for medical services, and community influences and advice. Such practices have previously been reported, with higher magnitudes reported in both community (Jain & Jain, 2014; S. Sharma et al., 2016) and hospital based surveys (Ezra Olatunde Ogundare et al., 2017).

Victims who were bitten by a dog with known ownership were 35% less likely to comply with the UCG. Sometimes it is intuitive that a person bitten by a dog whose owner is known might be more confident with regard to the health status of the dog compared to a dog they do not know. If the owner is known, it is easier to inquire about the health aspects of the dog, like the rabies vaccination status. However, this practice of victims assessing the risk of rabies to be low based on knowing the dog's ownership is dangerous and should be discouraged. Nonetheless, our findings are in concurrence with another study in Ethiopia, which found that the likelihood of a dog bite victim visiting a healthcare facility more than doubled when the victim was bitten by a dog of unknown ownership (Beyene et al., 2018).

Victims who were employed at the time of the bite were approximately one-and-a-half times more likely to comply with the guidelines than those who were not. This may probably be due to the fact that the employed tend to have higher education levels. Besides, employment has been associated with appropriate healthseeking behavior in some studies (Inche Zainal Abidin, Sutan, & Shamsuddin, 2014). Similarly, those who perceived the biting dog as being sick were more than twice as likely to comply compared to those who perceived them as being healthy. It is possible that victims associated the sickness perception with an increased risk of rabies and thus

followed the preclinical preventive measures. Besides, some studies have described the health status of a biting animal as a drive to PET compliance (Romero-Sengson, 2013).

Participants who had attained at least secondary education or higher were more likely to comply with preclinical guidelines compared to those with no formal education. People who are more educated tend to have a higher ability to interpret health education messages. Moreover, in our study, those with a secondary education or more were more likely to access information on dogs and dog bites than those with a lower level of education. Our findings and probable explanation are coherent with research that has suggested that people with higher education tend to have more knowledge about rabies than illiterate ones (Herbert et al., 2012; Diallo et al., 2019).

Patients aged over fifteen years were less likely to comply compared with those under 15 years. This finding is consistent with that of a study in China that found people aged >15 to be at a higher risk of failure to begin PEP (Guo et al., 2018). Prioritization of younger ones to receive healthcare was evident in this study. When asked why the daughter was sent to receive treatment while the mother stayed home, yet they had both been bitten by the same dog, the mother explained that the young one had more need for treatment. So, with limited resources and a lack of knowledge that treatment was free, priority seemed to be given to younger ones.

Patients who did not know whether the biting dog had gone on to bite other people were 65% less likely to comply. Cases of a single dog being responsible for multiple bite cases have been widely described (Tepsumethanon et al., 2004; Wilde, Lumlertdacha, Meslin, Ghai, & Hemachudha, 2016) and this is typical of wandering dogs. The finding that some people did not know may be a reflection of the care-free attitude of such individuals towards the risk of bite consequences. Not caring to find out whether the dog bit other people makes them less likely to

comply, as they may not know the value of ascertaining the status of the dog. Alternatively, not being aware that the dog went on to bite other people could just indicate that the victims were not aware that number of people bitten by a single dog may be related to rabies risk. Nonetheless, deeper inquiries revealed that some respondents did not comply even after knowing that the dog had gone on to bite other people. However, they attributed this to a lack of funds to seek treatment.

7.2 Sub-study II: Healthcare worker adherence to UCG

This qualitative study describes the practices of health workers with regard to the clinical management of dog bite wounds. The study reveals the underlying reasons for the adherence as well as non-adherence to the recommendations in the Uganda Clinical Guidelines (UCG) that are pertinent to dog bite clinical management. It was observed in this study that in both facilities, there was history taking; examination of the dog bite injuries; treatment of dog bite injuries; and follow-up of dog bite patients. However, in each of the components, there were varying levels of deviation. These gaps may compromise the treatment as well as the outcomes of the clinical management. The healthcare providers also describe the routine health system, healthcare worker, and patient challenges that they encounter during the management of dog bite patients.

The guidelines for management of animal bite cases in humans are provided in the Uganda Clinical Guidelines (UCG) (MoH, 2016b). These guidelines are adopted from WHO recommendations (WHO, 2014). The UCG recommend a thorough collection of epidemiological information on the history of exposure. This is intended to aid rabies risk assessment for all patients who have been exposed to canine rabies. In addition, authors have argued that an appropriate clinical history guides the decision-making process for initial wound care, active or

passive immunizations, obtaining cultures to determine specific pathogens, as well as antibiotic prophylaxis and therapy (Bula-Rudas & Olcott, 2018). In terms of history taking, it was observed that there was a consistent effort to investigate how the bite occurred, the duration since the event, whether the dog was provoked or not, and the vaccination status and whereabouts of the dog, if known. However, patient factors relating to risk of rabies, e.g., rabies immunization, were not investigated in 95% of the patients. In addition, the risk classification was not written down, so it was difficult to establish the clinician's basis for treatment. This is a potential source of indiscriminate PEP administration whose consequences include vaccine shortages and reduced affordability. In Tanzania, it was found that if PEP were to be administered indiscriminately to animal bite patients, including to those with little or no possibility of genuine exposure to the virus, a threshold could be reached whereby PEP administration is no longer cost-effective (Shim, Hampson, Cleaveland, & Galvani, 2009).

It was also observed that the medical history of patients was not deeply investigated. Assessment of co-morbidities (e.g. diabetes, obesity, protein energy malnutrition), medications (e.g. steroids, non-steroidal anti-inflammatory drugs or NSAIDs, anti-rejection medications), oncology interventions (e.g. radiation, chemotherapy), and lifestyle habits (e.g. smoking, alcohol abuse) is not done. These elements have a compromising effect on the immune system of the patient and thus affect wound healing (Anderson & Hamm, 2014; Williamson & Thomas, 2017). Alcoholism is particularly associated with increased susceptibility to infection by *Pasteurella* spps yet this bacteria is one of the most common in dog bite injuries (Dire, Hogan, & Riggs, 1994; Marina Morgan & Palmer, 2007). Therefore, by not assessing them, clinicians cannot accurately identify patients who are at an increased risk for wound infection. This means the basis for deciding which patients receive prophylactic antibiotics is arbitrary in the study sites.

This could lead to indiscriminate antibiotic use, with the associated risks and higher treatment costs for the patient.

Recommendations for post-exposure are dependent on the type of contact with the biting dog (WHO, 2014). However, in all cases observed, the clinicians did not record the risk category. This is against the background that they collected some of the information in line with the type of exposure that would have been used to categorize the rabies risk. Not recording the risk category might be because the clinicians could not decide on which category to put the patients in, or they might not have found it useful to make the record. Another explanation may be that, much as they knew the elements of risk, they did not know the risk categories in which to put the patients. The fact that the clinicians could not tell the difference between Categories I and II demonstrates the latter. Some other studies have also found that low knowledge of risk classification; failure to record the risk category by clinicians after assessment of dog bite wounds; and general PEP, were rampant occurrences in Haiti (Fenelon et al., 2017), Turkey (Koruk, Koruk, & Kutlu, 2011) and Bhutan (Penjor et al., 2020). Rabies risk assessment must be improved since Uganda is a rabies-endemic country where all dogs are taken to be potentially carrying the rabies virus. This will allow rational prescription of the ARV, which is free, if available, to all dog bite patients in Uganda.

Ancillary tests like radiology; complete blood counts; and culture and sensitivity tests were not done in the study sites. Imaging tests in dog bite cases are encouraged because they can facilitate the visualization of structures that are at risk of being affected by the bite (Bula-Rudas & Olcott, 2018). In addition, complete blood counts to detect incipient infections are not performed. When asked, the clinicians cited costs as barriers, but there was no effort to investigate whether patients

could afford it or not. The likely consequence of this is the blanket prescription and administration of antibiotics even when they are not necessary. However, some clinicians compensate for their inability to request CBCs by relying on clinical signs of infection, including redness, swelling, purulent secretion, pain, malaise, and fever. Further, the clinicians did not take tissue swabs or secretion samples for bacteriological culture, citing time and cost to the patient. This is clearly against UCG which state that antibiotics should be prescribed after culture and sensitivity tests (MoH, 2016b). Much as initial cultures of non-infected dog bite wounds may have no value in predicting subsequent wound infection (Boenning, Fleisher, & Campos, 1983; Malahias, Jordan, Hughes, Khan, & Hindocha, 2014), several authors have encouraged obtaining wound cultures to guide prescription for infected bites (Brook, 2003; Marina Morgan & Palmer, 2007).

Dog bites have the potential to lead to not only local wound infection but also tetanus or rabies. These could come from either the oral cavity/saliva of the dog, the skin flora of the victim, or the environment. In the study sites, tetanus vaccination status was not routinely assessed in favor of rabies, although it is recommended in the UCG. Indeed, only one clinician assessed patients for the need for tetanus prophylaxis. However, in a country where the population's serological immunity against tetanus is unknown, the likelihood of tetanus should also be at the forefront. In addition, cases of tetanus following dog bites have been described in the literature (Beltran et al., 2007; Radjou, Hanifah, & Govindaraj, 2012). In addition, situations where dog bite patients have presented with clinical tetanus rather than rabies have been documented (Radjou et al., 2012). This highlights the importance of a tetanus assessment in dog bites. Therefore, considerations for vaccines in cases of dog bites should routinely involve a thorough evaluation of the need for tetanus prophylaxis, especially in those contaminated with soil.

For rabies prophylaxis, it was being given to all patients assessed as having dog bite injuries, even if the risk wasn't classified. This poses very few risks of rabies since all exposures are assured of getting the vaccine. However, this leads to unnecessary costs associated with PEP, as observed in some studies (Andrade, Andrade, & Queiroz, 2019; Penjor et al., 2020). Further, just like some clinicians explained in this study, there is a tendency for patients to demand administration of the ARV. The fact that some clinicians comply with these demands means that there are prescriptions for ARV that are extracted under patient pressure. Studies on the influence of patient expectations and demands on the decisions of prescribers have found these to be associated with irrational prescribing and a lack of evidence-based practice (Lewis & Tully, 2011). The fact that some clinicians capitulated to patient demands for PEP resonates with another study which found that practitioners at times prescribe chiefly on the premise of maintaining a good relationship with their patients (Stevenson, Greenfield, Jones, Nayak, & Bradley, 1999). Much as patient's choice is important in the phenomenon of patient-centered-care, the capitulation by healthcare providers to inappropriate patient demands presents negative consequences for dog bite management and rabies control in general. It results in wasteful costs in the face of limited resources for service delivery.

Prophylactic vaccination with ARV follows the classical five-dose intramuscular (Essen) regimen administered on days 0, 3, 7, 14, and 28 into the deltoid muscle in both study sites. This is in conformity with the revised guidelines which recommended the fifth dose to be given on day 28, hence dropping the dose on day 90 (Tarantola et al., 2019). The adjustment of the regimen to terminate the vaccine after day 10 depending on the health of the biting dog is in line with the UCG (MoH, 2016b). A healthy dog after 10 days is a reassurance that it is not infected with rabies, and it is a universal practice to terminate post-exposure rabies prophylaxis if it had

been started for the bite victim (Tepsumethanon et al., 2004). However, the health providers noted that some patients usually do not return to report the outcomes of the observation of the dog. Therefore, they cannot tell with confidence if the patient dropped out of treatment for other reasons or if the dog was genuinely healthy. Besides, there are no systems in place for healthcare providers to contact patients to establish the results of the follow-up on the dog. This potentially presents a public health threat given that the health workers do not know the outcomes of the cases under their management.

Rabies immunoglobulin (RIG) is not given due to its unavailability and cost to the patient, even in the circumstances where it should have been given. The UCG recommend giving RIG to all high-risk rabies cases irrespective of the time between exposure and start of treatment (MoH, 2016b). However, even in cases where people were bitten by dogs exhibiting pathognomonic rabies symptoms, the RIG was not administered. This finding is in concurrence with other studies which found that in most rabies endemic countries, RIG is not regularly administered to deserving patients (Dhand & Ward, 2011; Wilde et al., 2016). Given that canine rabies is quite rare and RIG is increasingly available and affordable, the health facilities may be facilitated to stock a few doses for the severe-risk cases that need them most.

At the two study sites, antibiotics are given for both the treatment of established infections as well as for prophylactic purposes. More importantly, the UCG implore the healthcare providers to prescribe antibiotics based on the risk or presence of infection. In agreement with various authors, it is recommended that antibiotics should be administered in: moderate to severe wounds; wounds presented >8 hours; puncture wounds; wounds on hands, feet, or face; wounds with underlying structures involved; and wounds in immunocompromised patients (Stevens et

al., 2014; MoH, 2016b; Bula-Rudas & Olcott, 2018). In addition, the choice of antibiotic must be based on culture and sensitivity test results (MoH, 2016b). However, the practice in the study sites is to prescribe antibiotics therapeutically and prophylactically without sensitivity tests. The respondents said their decision is guided by availability, affordability, and the progress of wound healing.

Firstly, post-exposure antibiotic prophylaxis is still shrouded in unresolved controversy. Prophylactic antibiotics reduced the rate of infection in five of eight randomized trials. However, it was only in one of the studies that used amoxicillin/clavulanic acid-clavulanate that the difference was statistically significant (Cummings, 1994; Quinn et al., 2010; Jaindl et al., 2012). Besides, because only around 20% of all dog bites progress to infection (Callaham, 1988), superficial Category II DBWs that do not meet the high risk criteria should not trigger antibiotic prescriptions. Other authors have also found no evidence to justify routine antibiotic prophylaxis for dog bites at low risk of infection (Marina Morgan & Palmer, 2007). However, the prescription for prophylactic amoxicillin/clavulanic acid by healthcare providers in the study sites is supported by research as indicated above. Nonetheless, this is caveated by some authors who insist on no antibiotics for wounds presenting ≥24 hours without infection signs (Brook, 2003).

In this study, judicious use of antimicrobial agents was lacking as none of the patients was recommended for a culture and sensitivity test before antibiotics were prescribed for them. This finding is similar to another study on animal bite patients in Uganda, where 77% were given antibiotics but all without sensitivity testing (Fèvre et al., 2005). Whenever the decision is made to prescribe antibiotics, the culture and sensitivity tests must be done (Brook, 2003; Mannion &

Graham, 2016). Some authors argue that culturing the wound is usually only helpful if the wound has already abscessed or become infected (Hurt & Maday, 2018). They reason that swabbing a wound that is not infected results in the unnecessary identification and analysis of organisms that are colonizing the wound rather than causing an infection. However, contrary to this, analyses of both clinically infected and non-infected dog-to-dog bite wounds have found them to be culture positive (Meyers et al., 2008) much as pretreatment wound cultures are not predictive of bacterial species subsequently recovered from infected wounds (Hamil, Smeak, Johnson, & Dow, 2020). Therefore, for non-infected wounds, clinicians are probably right not to undertake sensitivity tests. For infected wounds, there are authors who protect the prescriptions that are not anchored on sensitivity tests. Such researchers recommend that culture and sensitivity tests be done, but if they are not available, empiric therapy based on amoxicillin/clavulanic acid and clavulanic acid may be used. This is because these antibiotics are active against most bite pathogens that can be isolated from bite wounds (Esposito et al., 2013). Nevertheless, this contravenes the UCG.

Health education about prevention of future dog bites is not done for the patients. The health workers cited time constraints, though they appreciated the importance of educating the patient beyond just how to take the medication. Researchers have opined that animal bite patients should be inspired through health education at the time of initiation of vaccination in order to promote better treatment outcomes (Vengatesan, Gudegowda, Sobagiah, & Krishnappa, 2016). Since communities lack consistent rabies prevention and control programs, this may be an opportunity to raise awareness. This may actually form a critical component of a rabies control program that may reduce the incidence of dog bites in high-risk sub-populations. Studies have shown that counseling animal patients about pet-related health hazards is important in reducing bites (Robert

Ellis & Carrie Ellis, 2014). Indeed, some countries have adopted a formal integrated bite case management (IBCM) program to counsel animal-bite victims on the risk of rabies (Etheart et al., 2017). However, counseling patients may not necessarily improve treatment compliance, as some authors have suggested (Tran et al., 2018).

The challenges described by the respondents were not unique; they cut across similar settings. Just like in this study, the failure to administer immunoglobulins and ARV in India, Bangladesh, Iran, and Kenya has been described. In these countries, the failure has been attributed to unavailability and stock outs as a result of a lack of funds both at health system and patient levels (Gogtay et al., 2014; Poorolajal et al., 2015; Ghosh et al., 2016; Wambura et al., 2019). An earlier study in Uganda also found the same (Fèvre et al., 2005), meaning that years down the road, the situation has not changed much. Similarly, in other developing countries, intermittent availability of PEP for bite patients seeking care; inability to afford the cost of PEP; distance between healthcare facilities; and poor health care seeking by bite patients are frequent bottlenecks in dog bite management (Dimaano et al., 2011; Permpalung, Wongrakpanich, Korpaisarn, Tanratana, & Angsanakul, 2013; Wambura et al., 2019). Where the challenges are driven by a lack of funds, cost-reducing strategies may be adopted, including the adoption of the cheaper ARV dose-saving intradermal route. This may be enhanced by incorporating the rabies vaccination into routine vaccination programs, at least for high-risk subpopulations. Further, where there are problems of deviations from recommended wound home care, integrated bite case management (IBCM) may be adopted.

7.3 Sub-study III: Burden of antimicrobial resistance associated with dog bite

In this study, the burden of wound infection was high as 52.9% of the patients presented with infected DBWs. This is in contrast with the majority of studies which have put the infection rates of DBWs between 5% and 25% (Brook, 2003; Rothe et al., 2015). However, it should be noted that the risk of infection depends on the nature and site of the wound as well as on individual patient characteristics. Therefore, the differences in study populations and setting might explain the variances in the infection rates between this and other studies. In addition, the infections being purulent in 54% and non-purulent in 23% of the participants of this study is comparable to the findings of a multicenter study in the USA. Although a smaller sample size was used, this study found that the purulence and non-purulence of DBWs were at 58% and 30%, respectively (Talan et al., 1999).

Contamination of DBWs results from the oral microflora of dogs as well as the environment. Therefore, a variety of organisms that generally result from the aerobic and anaerobic microbial flora of the oral cavity of the dog and the patient's own skin flora can be recovered from bite wounds. In this study, 84.4% of the swabs were culture positive, an outcome that is similar to other wound studies in Ethiopia and Nigeria (Pondei, Fente, & Oladapo, 2013; Mohammed, Seid, Gebrecherkos, Tiruneh, & Moges, 2017), though lower than others in similar settings (Wariso & Nwachukwu, 2003). Furthermore, in this study, 73% of the wounds yielded monomicrobial growth, while the rest had a mixture of aerobic and anaerobic bacteria. This result is lower than those found in other wound studies, though only slightly (Valarmathi, Pandian, & Senthilkumar, 2013; Mohammed et al., 2017), but higher than the 48% reported by Talan *et al* (1999). The rates of isolation in this study were 72.4% and 22.6% for aerobic and

anaerobic bacteria, respectively. Yielding more aerobic isolates is similar to earlier studies on dog bites (E. J. C. Goldstein, 1989), although other studies have isolated more anaerobic than aerobic bacteria (Mohammed et al., 2017).

Staphylococci, streptococci, and corynebacterium were the most common aerobic isolates. The most predominant gram-positive aerobe was *S. aureus*, at 30.4% of such aerobes. The isolation rate is just slightly higher than that obtained in similar wound studies in Nigeria and Italy (Giacometti et al., 2000; Ohalete, Obi, & EmeaKoroha, 2012). The slight differences of less than 5% may be explained by the different settings where the comparative studies were conducted in hospital settings on surgical wounds. Nonetheless, the rate in this study is lower than that reported in Ethipoia (Mulu, Moges, Tessema, & Kassu, 2006; Mohammed et al., 2017). Together with *S. pyogenes*, which was also fairly common in this study, *Staphylococcus aureus* is one of the organisms often considered responsible for cellulitis in wounds. These bacteria are rarely found in the dog's oral cavity and are considered part of normal skin flora (Abrahamian & Goldstein, 2011). However, the 8.8% rate of *S. intermedius* is higher than in previous isolations, which had rates of 2% but lower than other wound studies, which yielded the bacteria at 12% of the total isolates (Meyers et al., 2008; Abrahamian & Goldstein, 2011).

For gram-negative bacteria*, Pasteurella spp* were the most dominant. In this study, *P. maltocida* was the most frequently isolated bacteria. This is significantly different from other reports that have identified *P. canis* as the predominant isolate from dog bites (Escande & Lion, 1993; Talan et al., 1999). In addition, the prominence of *Pasteurella* contradicts earlier impressions that it is an uncommon pathogen in dog bite injuries (Aghababian & Conte Jr, 1980; Brook, 1987). However, our findings are in agreement with previous studies which identified *P. maltocida* as

being predominant over other species of *Pasteurella* (Meyers et al., 2008). Our findings nonetheless support the finding that *Pasteurella species* are among the most common canine oropharyngeal isolates, isolated in 12.5% - 87% of canines. Therefore, our data upholds *Pasteurella*'s reputation for pathogenicity and relevance in DBW infection (Talan et al., 1999). Importantly, although most species of *Pasteurella* are taken to be part of the normal flora of animal saliva, *P. canis* is distinctive because it is found only in the oral cavities of dogs. Having isolated some of it in wounds of patients that had complied with pre-hospital guidelines brings into question the efficiency of the application of the standard recommendations.

In this study, there were 36 isolates of *Capnocytophaga canimorsus.* This bacterium has been frequently reported as a common cause of serious infection associated with dog bites in humans (Brenner, Hollis, Fanning, & Weaver, 1989; Lion, Escande, & Burdin, 1996). It has been described as normal flora in 75% of the oral cavities of dogs (Suzuki, Kimura, Imaoka, & Yamada, 2010), and its association with severe infection following DBWs has been well described. It is therefore not surprising that it was possible to isolate it from mainly patients who had not washed their wounds prior to presentation at the PET centers. Furthermore, the most common gram negative anaerobes in this study included *Fusobacterium spp*, *Bacteroides spp*, and *Prevotella spp*. These anaerobes have also been isolated elsewhere and identified as predominant (Brook, 1987; Meyers et al., 2008). However, they are not known to be of any zoonotic significance, but they are thought to originate from the oral cavity of dogs.

The use of antibiotics in animal bite wounds is surrounded by considerable controversy. Much as some authors have found antimicrobial agents to be useful (Cummings, 1994), others have argued that they are not prophylactically effective (Medeiros & Saconato, 2001; Marina Morgan

& Palmer, 2007). It is for this reason that some studies have recommended antimirobial agents for therapeutic and not prophylactic purposes (P. Smith, Meadowcroft, & May, 2000). Much as this is the case, the UCG still call for their prophylactic use in DBW with a high risk of infection. However, for therapy, it is recommended that selection of an appropriate antimicrobial agent should be based on cultures from infected wounds, followed by antimicrobial susceptibility testing. This is why antibiotics, including metronidazole, methicillin, amoxicillin/clavulanic acid, doxycyline and cotrimoxazole are recommended in UCG but with the caveat that they are used after culture and sensitivity tests (MoH, 2016b). Nonetheless, such tests are not routinely performed for patients in clinical practice in the entire country. Missing the benefits of sensitivity tests poses significant risks to patients in terms of finances, side effects and development of antimicrobial resistance (M. R. Smith et al., 2003). Already, the latter has been widely reported in dog bite wounds (Meyers et al., 2008; Gustavsson et al., 2016).

Amoxicillin/clavulanic acid is the first-choice agent both for prophylaxis and treatment for DBW patients who are not penicillin allergic (Al Omran, Evans, Jordan, Yang, & Huq, 2020). The present study demonstrated that amoxicillin/clavulanic acid was resistant to only 14% of the isolates, which was lower in some earlier studies (Azene & Beyene, 2011; Mohammed et al., 2017). This study is therefore in agreement with other authors who have suggested that amoxicillin/clavulanic acid is one of the most effective antibiotic treatments for a dog bite as it covers the most likely polymicrobial aerobic and anaerobic organisms that infect dog bite wounds (M. G. Thomas, 2020). Besides, in older animal bite wounds, presenting 9 - 24 hours after injury, amoxicillin/clavulanic acid reduces the infection rate significantly (Brakenbury & Muwanga, 1989). However, the observed differences in the levels of susceptibility between amoxicillin/clavulanic acid and oxacillin may require further investigation. Furthermore, beyond

UCG, Metronidazole is recommended to treat infection in DBWs (Marina Morgan & Palmer, 2007; R. Ellis & C. Ellis, 2014) especially for those allergic to penicillin (Al Omran et al., 2020). In this study, all isolates were resistant to metronidazole. This is in conflict with some studies which have found it effective in treating anaerobic infections including, skin and soft tissues (Löfmark, Edlund, & Nord, 2010). However, in Tanzania, metronidazole had questionable activity in treating wound infection when compared to other studies, especially in bacteria isolated from the head and neck and other parts of the body (Rugarabamu, 2017).

In this study, isolation of some MRSA may support the growing concerns sorrounding the role of community-associated methicillin-resistant *S. aureus* (CA-MRSA) in skin and soft-tissue infections as well as whether MRSA is a key pathogen in infections following animal bites (Ogden et al., 2013). The isolation of MRSA from dog bite wounds is not surprising because several studies have reported its existence in dogs (Loeffler et al., 2005; Abdel-moein, El-Hariri, & Samir, 2012). Perhaps what is more concerning is that MRSA-associated infections in dogs and other pets are typically acquired from their owners and can potentially cycle between such animals and their human acquaintances (Oehler et al., 2009; Bender, Waters, Nerby, Olsen, & Jawahir, 2012). Worse still, some of the dogs carrying the bacteria may remain healthy thus the potential for undetected transmission (van Duijkeren et al., 2004). In addition, just like in this study, gram positive and gram negative bacteria resistant to trimethoprim/sulfamethoxazole have been isolated before from animal bites as well as other wounds (E. J. Goldstein, Citron, Vagvolgyi, & Finegold, 1986; Mohammed et al., 2017). Further, in this study, 29% of the isolates were multi-drug resistant (MDR). This is in contrast with other studies that have found multidrug resistance to be as high as 70% - 95% (Mulu et al., 2006). However, some of the MDR isolates like *P. mirabilis* have been reported before to be in circulation in Uganda (Anguzu &

Olila, 2007). The presence of such bacteria in Uganda may be due to the continued massive reliance on antimicrobials as a first-hand treatment option by physicians, hence the propagation of more resistant strains of the bacteria.

7.4 Sub-study IV: Outcomes of dog bite injuires

This study aimed at describing the outcomes of preclinical and clinical management of dog bite wounds given the variations in how patients and clinicians deviate from the recommendations given in the Uganda Clinical Guidelines (UCG). Wound infection, wound healing, and the occurrence of rabies were the outcomes that were assessed in the study. In the sample, there were more males than females, which is in agreement with similar hospital-based studies that were earlier conducted in Uganda and elsewhere (Fèvre et al., 2005; Tenzin et al., 2011). However, much as the male sex preponderance in dog bites is in line with most studies, it conflicts with one in the Caribbean that found female children more at risk, especially at the age below 9 years (Georges & Adesiyun, 2008). This may be explained by the differences in the ways people interact with dogs and the different types of dogs kept from society to society.

Most of the study subjects did not undertake or undergo proper first aid or preclinical practices. Besides, close to 40% of the respondents delayed presenting to the hospital for PEP. These findings are not different from those in India, where 41% did not report to PET centers on time (Joseph Jessy et al., 2013). However, a lesser proportion of dog bite victims (11%) reported for PEP beyond 24 hours in Switzerland (Pfortmueller et al., 2013). This may be explained by the variations in healthcare systems and programs between developed countries and developing nations. From the perspective of deviant preclinical practices after animal bites, studies in Africa

and Asia have reported them to be rampant, just like in this study (A. Sharma et al., 2007; Aghahowa & Ogbevoen, 2010).

Infection of dog bite wounds was higher among those that did not undertake proper first aid after the bite event. In addition, infection was the commonest outcome, just as found elsewhere (Esposito et al., 2013). Recommendations like washing of wounds are aimed at reducing the bacterial load as well as washing out the saliva that may contain the rabies virus (Esposito et al., 2013). Dog bite wounds usually result in polymicrobial infections due to aerobic and anaerobic bacteria that are introduced into the injury from the animal's oral flora, environment, and victim's skin (N. Thomas & Brook, 2011). This is the major reason for recommending flushing the wound under a running tap for several minutes, washing with soapy water or detergent, and particularly using wound disinfectants (such as 40 - 70% alcohol, tincture, or aqueous solution of povidone-iodine) (Marina Morgan & Palmer, 2007). Therefore, it is not surprising that wounds that were not washed tended to be presented when infected.

In this study, having received prior treatment before reporting to the 2 PET centers was significantly associated with reduced probabilities of wound infection. In practice, even when the medical center does not have the capacity to offer rabies prevention services, they at least offer wound care or appropriate first aid. Suitable first aid for a wound speeds up the healing process and reduces the risk of infection. This is because it will most likely involve the use of antiseptics and more rigorous wound irrigation, which results in a reduced bacterial burden. In addition, clinicians are more likely to direct the patient to a functional PET center to receive additional treatment in the form of PEP. Therefore, the practice of seeking medical care at the nearest healthcare facility, even if it does not offer PEP, should be encouraged among dog bite victims.

This study also found out that the more severe the dog bite wound, the greater the likelihood of being infected. Severity depends on the size and depth of the wound as well as the structures involved (Esposito et al., 2013). Wound depth has been identified before as one of the predictors of wound infection. In fact, studies have shown that a combination of old age, surgical debridement, wound depth, and patient gender would predict infection rates of 0.35% to 23.9% (Dire et al., 1994). Therefore, this study was in agreement with most of the research on trauma. In addition, the realization that a small proportion of patients develop wound infections while on treatment is not uncommon. In the USA, it was discovered that 4% of dog bite patients returned to the healthcare facility with soft tissue infections (Golinko et al., 2017). Besides, studies have shown that the absence of negative cultures initially does not mean that an infection will not develop later (E. J. C. Goldstein, 1989).

In this study, the findings suggest that infection prolongs the time to detection of healing. These findings agree with earlier studies which have explained that infection impairs the healing processes of the host (Avishai, Yeghiazaryan, & Golubnitschaja, 2017). Previous authors have explained that bacteria produce toxins that lead to the strong upregulation and protracted activity of pro-inflammatory cytokines, excessive inflammatory responses, and damage to the affected tissue. Subsequently, the inflammatory cells, together with the invaded bacteria themselves, play a pivotal part in overexpressing the matrix metalloproteases, degrading the extracellular matrix and growth factors overloading the wound bed. Besides, the bacteria may form biofilms that not only make them more resistant to antibiotic activity but also lead to impairment of key wound healing processes such as the formation of granulation tissue and re-epithelialisation of the host's injured tissue (J. A. Wilson & Clark, 2004; Demidova-Rice, Hamblin, & Herman, 2012).

The association of non-compliance with preclinical guidelines, wound severity, and having received prior treatment with delayed wound healing is expected. The first two factors may be working through the infection pathway to result in prolonged wound healing. Conversely, the latter may also be preventing infection, thus promoting faster wound healing. This linkage of preclinical practices to outcomes should be emphasized in the guidelines. Poor practices in wound management are likely to interfere with healing processes. Authors have highlighted that good outcomes will be obtained provided there is strict cleaning, debridement, wound repair, antibiotic cover, and immunization. In addition, delays in presentation and tissue loss are directly proportional to the infection rate and inversely proportional to the results (Bothra et al., 2011).

The two deaths that were as a result of suspected rabies were among those who did not seek timely PEP. Clinical rabies is not uncommon in low-income settings with endemic rabies (Samanta et al., 2016). However, most of the mortality is associated with failure to receive appropriate treatment at the right time (Ichhpujani et al., 2008). The two deaths occurred in children of low socioeconomic status, which emphasizes rabies as a disease of poverty. The way the parents/caretakers underlooked the seriousness of one of the cases and the way others thought that herbalists were indeed better than established conventional medicine points to ignorance or neglect of available knowledge. The caretakers of the victims might have acted out of ignorance by choosing not to seek proper and timely PEP for their children.

In summary, this study presents evidence that what dog bite victims do during the preclinical period and the way healthcare workers manage dog bite wounds have serious implications on treatment outcomes. Non-compliance with UCG as a result of patient, healthcare worker, or health system factors has the potential to result in rabies, delayed wound healing, and wound

infection. Importantly, the study highlights the need to think about other serious health implications of dog bites beyond the traditional problem of rabies. The high levels of antimicrobial resistance observed in this study are proof of other implications that should be dealt with when managing dog bite wounds.

7.5 Limitations of the study

The main limitation of this study may be self-reports about the events, which might have introduced recall bias through inaccuracies in detailing the events. However, the researchers made effort to verify the information where possible e.g., by triangulation of the participants' responses with medical charts. In addition, we used a hospital-based convenience sample, and this limits the representativeness of our results to the entire population of dog bite victims. This means that our study had more internal validity than external validity and the observed results represent the truth in the population that reported for PEP but not those that did not seek PEP. An example of this may be that there may be specific factors that influenced our respondents to report to the hospital but not those who stayed home and used domestic remedies. Notably, the part of the population that does not present for PEP may be ore likely to be at risk of negative health impacts from dog bites. Lastly, some factors that have been identified to influence wound infection and healing such as alcoholism, liver cirrhosis, asplenia, steroid therapy, rheumatoid arthritis, diabetes mellitus, and lymphoedema after radiotherapy were not investigated. Therefore, the findings should be interpreted within this context.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

This study assessed the preclinical care practices as well as the clinical management for dog bite injuries and their association with wound infection and other treatment outcomes in two high rabies burden districts in Uganda. From the findings, it can be concluded that:

i. Compliance with the recommended preclinical guidelines among bite patients was low, which may have resulted from inadequate awareness about the dangers of inappropriate treatments, including alternative treatments, and the limited availability or inaccessibility of therapy in the PET centers. These are potential bottlenecks to Uganda's progress not only on SDG 3 (health and well-being for all) but also on Zero-by-30 (Global Strategic Plan to Prevent Human Deaths from Dog-Transmitted Rabies by 2030).

ii. Clinical management of dog bite injuries was not fully adherent to the Uganda Clinical Guidelines as healthcare workers treating DBWs did not undertake risk assessments for rabies and bacterial infection.

iii. The infection rates for DBWs in Uganda are higher than those reported elsewhere, and *Staphylococcus aureus, Coagulase-negative staphylococci*, *Corynebactrium spp, Gemella morbillorium, Lactobacillus spp, Pasteurella spps,* and *Capnocytophaga canimorsus* are the most frequently involved pathogens in the infection of DBWs.

iv. There is a fairly high rate of multidrug resistance to antibiotics that are commonly used to treat dog bite wounds, especially metronidazole. This highlights DBWs and their management as potential sources of antimicrobial resistance.

v. Better outcomes of the management of dog bite injuries are predicted by what is done for patients as first aid at preclinical level.

8.2 Recommendations

i. There is a need for detailed, holistic, and targeted health education programs. Schools may be used to deliver these programs since nearly half of the dog bites are in children of school-going age. In addition, to create awareness within communities, regular messages on dog bites should be delivered using popular platforms such as radios, newspapers, and social media, depending on the specific audiences.

ii. The Integrated Bite Case Management (IBCM) strategy should be adopted to improve rabies risk assessment and make clinical management of dog bites less costly but more efficient. Once instituted, such strategies have the potential to be extended to other zoonoses and conditions that require one-health interventions.

iii. Training curricula for healthcare workers at all levels should include rabies prevention, control and management from a one-health perspective as a sustainable mechanism for anchoring IBCM in practice.

iv. Local authorities and the Ministry of Health should develop and implement a framework to regulate the activities of herbalists when it comes to the management of dog bite wounds.

v. Frequent and routine continuing medical education programs on rabies control and management should be conducted for healthcare providers to address skills gaps such as rabies and infection risk assessment.

vi. Dog bite wounds should also be included in the continuous surveillance of antimicrobial resistance during the routine antimicrobial resistance (AMR) programs to encourage rational use of antimicrobial agents.

vii. There is a critical need for the Government of Uganda (Ministry of Health) to make post-exposure prophylaxis (PEP) consistently available as well as undertake community awareness programs in order to promote its use and demand.

viii. Further research is needed to explain the variance in the in-vitro versus in-vivo performance of antimcrobial agents for the same patients and the interventions that have the potential to reduce the indiscriminate use of PEP inputs while decreasing the risk of rabies, infection and tetanus.

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APPENDICES

Appendix III: Consent and assent forms

Appendix IIIa: Informed consent form for dog bite patients (English)

PARTICIPANT INFORMATION AND CONSENT FORM

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Principal Investigator/ institutional affiliation: DR. STEVENS KISAKA, University of Nairobi, Institute of Tropical and Infectious Diseases (UNITID), College of Health Sciences, P.O. BOX 19676 - 00202 Nairobi Tel (+254) 020 4915060; Email: bmks@dr.com

1.0 Introduction

I would like to tell you about a study being conducted by the above listed researchers. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be a participant in the study. Feel free to ask any questions about the purpose of the research, what happens if you participate in the study, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions to your satisfaction, you may decide to be in the study or not. This process is called 'informed consent'. Once you understand and agree to be in the study, I will request you to sign your name on this form. You should understand the general principles which apply to all participants in a medical research: i) Your decision to participate is entirely voluntary ii) You may withdraw from the study at any time without necessarily giving a reason for your withdrawal iii) Refusal to participate in the research will not affect the services you are entitled to in this health facility or other facilities. We will give you a copy of this form for your records.

May I continue? YES / NO
This study has approval by the Mulago National Referral Hospital Ethics and Research Committee, protocol No. _____

2.0 What is this study about?

The study will assess your preclinical care practices, clinical management and outcomes of dog bite injuries. I am asking you for your consent to be interviewed as part of this study because you are a dog bite victim in the area covered by the study. This study will gather information on a) preclinical care practices undertaken for dog bite victims in comparison with recommended guidelines; b) adherence by health workers to recommended clinical guidelines for treating dog bite injuries; c) antimicrobial susceptibility profiles of selected bacteria isolated from dog bite wounds; and d) predictors for infection and other outcomes of dog bite injuries. There will be

approximately 360 participants in this study and they will be consecutively chosen. We are asking for your consent to consider participating in this study.

3.0 What will happen if you decide to be in this research study?

If you agree to participate in the study, the following things will happen: You will be interviewed by a trained interviewer in a private area where you feel comfortable answering questions. The interview will last approximately 25 minutes. The interview will cover topics such as circumstances of the dog bite and what you did or was done to you before coming to the hospital as a way of treating the bite. After the interview has finished, you will be asked to submit samples in form of a swab of the dog bite wound. We will also ask to follow the progress of your wound for at least 6 months. Lastly, we will ask for a telephone number where we can contact you if necessary. If you agree to provide your contact information, it will be used only by people working for this study and will never be shared with others. The reasons why we may need to contact you include asking you about the progress of wound towards healing.

4.0 Are there any risks or discomforts from participating in this study?

We will fill the questionnaire in a private and safe place for both you and the researcher. The only potential risk from participating in this study is that you may feel uncomfortable answering some of the questions that may deal with bite circumstances and what you did before coming to hospital. In addition, there may be some negligible pain as we swab the wound to get samples. In the most unlikely event that talking about yourself makes you feel uncomfortable, you are free to refuse to answer questions that make you feel uncomfortable, and you may choose to end the interview and your participation in the study at any time. The information you provide will be kept confidential.

5.0 Possible benefits of this study

There are no direct benefits that you may get from participating in this study. However, the information collected from this study may be helpful in improving the lives of everybody whether bitten by a dog or not. Your answers will help us in designing intervention programs suitable for communities to prevent dog bites as well as improve the treatment of those who are bitten.

6.0 What are your rights as a participant?

Your participation in this study is entirely voluntary. You can refuse to participate or stop at any time without giving any reason. Please remember that you are free to skip over any question you do not want to answer and you are free to stop answering questions at any time.

7.0 Confidentiality

All the information that you give in this study will be kept strictly confidential. The consent

forms that you will be asked to sign will be securely stored and access will be limited to the research team and study sponsors. The consent forms cannot be linked to the answers you give to the questionnaire. The results of the study will be presented in a respectful manner and no information which could enable anyone to identify you personally will be reported. If you would like to be kept informed of the progress of our project, we will be happy to share any reports or publication we produce with you.

8.0 Costs

There is no cost to you for participating in this study.

9.0 Compensation

There is no compensation due to you for filling this questionnaire or being interviewed for this study.

10.0 Has this study received ethical approval?

Yes, the Ethics Committee granted written approval for this study. You may contact them using the following details should you have any concerns or queries:
MREC Chairman (Dr. Fred Nakwagala) Contact Telephone number: +256 772-325869
Email: nakwagala@yahoo.com)

11.0 Information and contact person

If you have any questions about the study or any problems with the study you may contact Stevens KISAKA, the Principal Investigator at the following telephone number (+256 392 945 160). If you have any questions about your rights as a participant in this study, please contact the Chairman Mulago Hospital Research Ethics Review Committee, at the telephone number +256 772-325869.

12.0 Consent to Participate in Study

I hereby confirm that the person seeking my informed consent to participant in this study has given me information to my satisfaction. She/he has explained to me the purpose, procedures involved, risk and benefits and my rights as a participant in the study. I have had enough time to ask questions. I feel that my questions regarding participation in the study have been answered to my satisfaction. I have been told that the information I give to the study will together with other information gathered from other people, be anonymously processed into a research report and scientific publications.

I am aware that it is my right to withdraw my consent in this study without any prejudice. I hereby, freely and voluntary give my consent to participate in the study.

I agree to participate as a volunteer in this study.

_____	_____
Date	Name and Signature of participant
_____	_____
Date	Name and Signature of Witness
_____	_____
Date	Name and Signature of Principal Investigator

Thank you for your help and for agreeing to participate in this study

Appendix IIIb: Assent form for dog bite patients (English)

CHILD ASSENT FORM

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Investigator: DR. STEVENS KISAKA

We are doing a research about preclinical care practices, what you did to manage the dog bite wound, what the health workers are doing to it and also the outcomes of dog bite injuries This study has approval by the Mulago Hospital Research Ethics Review Committee, protocol No. _____

This research study is a way to learn more about what people do when they are bitten by the dog. We plan to enroll all the children that will be brought or come for treatment of the dog bite wound. If you decide that you want to be part of this study, you will be asked to respond to questions, give us a swab sample of the bite wound and be followed up for a period of six months to see the outcome of the wound**.** We will assess the wound each time you come for treatment as timetabled by the medical worker who will treat you.

There are some things about this study you should know. If you agree to participate in the study, the following things will happen: You will be interviewed by a trained interviewer in a private area where you feel comfortable answering questions. The interview will last approximately 25 minutes. The interview will cover topics such as circumstances of the dog bite and what you did or was done to you before coming to the hospital as a way of treating the bite. After the interview has finished, you will be asked to submit samples in form of a swab of the dog bite wound. We will also ask to follow the progress of your wound for at least 6 months. Lastly, we will ask for a telephone number where we can contact you if necessary. If you agree to provide your contact information, it will be used only by people working for this study and will never be shared with others. The reasons why we may need to contact you include asking you about the progress of wound towards healing.

We will ask you questions in a private and safe place for both you and the researcher. The only potential risk from participating in this study is that you may feel uncomfortable answering some of the questions that may deal with bite circumstances and what you did before coming to hospital. In addition, there may be some negligible pain as we swab the wound to get samples.

Not everyone who takes part in this study will benefit. A benefit means that something good happens to you. We think these benefits might be in using the study findings to improve the lives of all people bitten by dogs as well as prevent the bites.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. Your parents know about the study too.

If you decide you want to be in this study, please sign your name.

I, _____, want to be in this research study.

_____ _____

Date Signature of participant

_____ _____

Date Name and Signature of Witness

_____ _____

Date Name and Signature of Principal Investigator

Thank you for your help and for agreeing to participate in this study

Appendix IIIc: Informed Consent Form for dog bite patients (Luganda)

EBIKWATA KU KUNONYEREEZA KUNO EBIKUSOBOZESA OKWETABAMU

Omulamwa gw'okunonyereza: EBIKOLEBWA NGA EMBWA ERUMYE OMUNTU, OBUJANJABI OBUGABIRWA MU DDWALIRO NE BIKI EBIVA MUKUJANJABA EBIWUNDU EBIRETEBWA EMBWA MU WAKISO NE KAMPALA DISITULIIKITI MU YUGANDA

Akulira okunonyereza / Gyasinziira: DR. STEVENS KISAKA, University of Nairobi, Institute of Tropical and Infectious Diseases (UNITID), College of Health Sciences, P.O. BOX 19676 - 00202 Nairobi Tel (+254) 020 4915060; Email: bmks@dr.com

1.0 Okwanjula

Njagala okukutegeeza ku kunonyereza okukolebwa abantu abo abali waggulu. Nandyagadde okukubulira ebikwata ku kunonyereza kuno osobole okusalawo oba wandyagadde okukwetabamu. Beera wa ddembe okubuuza ebibuuzo ebikwata ku kunonyereza kuno, biki ebinakutukaako bwooba wetabyemu n'ebirala ebiri ku foomu eno oba ebikwata ku kunonyereza kuno ebitali birambulukufu. Bwetunaddamu ebibuuzo byo n'omatira, osobola okusalawo okwetabamu oba okugaana. Bwooba okirizza, tujja kukusaba okuteeka omukono ku foomu eno. Kino kijja kuba kiraga nti otegedde ebikwaata ku kunonyera kuno era nti: i) Okwetabaako kwo kivudde eri ggwe era tokakiddwa ii) Osobola okuva mu kunonyereza kuno obudde bwonna nga towadde na nsonga iii) Okugaana okwetaba mu kunony tekijja kukosa bujjanjabi bukuweebwa mu ddwaliro lino oba amalwaliro amalala. Ojja kusigaza kkopi ya foomu eno ogyekumire.

Tweyongereyo? YEE / NEDDA
Okunonyereza kuno kwayisiiibwa akakiiko akafuga empisa z'okunonyereza "Mulago Hospital Research Ethics Review Committee" era kwaweebwa nnamba. _____

2.0 Biki ebifa ku kunonyereza kuno?

Okunonyereza kuno kuli ku ebyo ebikolebwa nga embwa erumye omuntu, obujanjabi obugabirwa mu ddwaliro ne biki ebiva mukujanjaba ebiwundu ebiretebwa embwa. Nkusaba okirize obuzibwe ebibuuzo nga omu kwaabo abalumiddwa embwa. Tujja kufuna a) byewakoze nga tonajja mu ddwaliro okulaba oba bikwatagana n'ebyo ebirambikiddwa mu mateeka; b) engeri abasawo gyebajjanjabamu ebiwundu bino oba bagoberera ebyo ebirambikiddwa mu mateeka; c) obuwuka mu biwundu bwebwesamba eddagala; ne d) ne biki ebiviraamu okutana kw'ebiwundu ebyo. Abantu abawera 360 be bajja okwetaba mu kunonyereza kuno. Tusaba okirize okwetabamu.

3.0 Biki ebinabaawo nga osazeewo okwetaba mu kunoonyereza kuno?

Bwonokirizza, ebintu bino wammanga bye bijja okubaawo: Omuntu omutendeke mu kunonyereza kuno ajja kukubuuza ebibuuzo mu kifo ekyekusifu nga tewali muntu mulala awulira era wonawulirira emirembe nga oddamu ebibuuzo. Okubuzibwa ebibuuzo kijja kutwala eddakiika abiri mu ttaano. Ebibuuzo bijja kwekuusa ku mbeera gyewalumiddwaamu embwa n'ebyo bwewakoze nga tonajja mu ddwaliro. Nga ebibuuzo biwedde, tujja kuyisa ka ppamba ku kiwundu tusobole okwetegereza obuwuka obukirimu. Tujja kukulondoola okumala emyezi mukaaga tulabe ekiwundu bwekiwona. Ekisembayo, tujja kukusaba ennamba y'essimu tusobole okukutukirira naye ennamba eno bwooba ogituwadde, tujja kugikozesa ekyo kyetugikusabidde era tetujja kugigaba walala wonna oba okugiwa omuntu yenna.

4.0 Waliwo obuzibu bwonna oba ekintu kyonna ekisobola okumalako omuntu emirembe olw'okwetaba mu kunoonyereza kuno?

Foomu eno tujja kujijjuriza mu kifo ekikusifu era nga kiwa omunonyereza n'abetabye mu kunoonyereza kuno emirembe. Tusubira nti ekiyinza okureeta akatyabaga akatali k'amaanyi kwekukusaba okuddamu ebibuuzo ebyekuusa ku kulumibwa ebwa ne byewakola nga tonajja mu ddwaliro. Mpozzi ekirala nti oyinza okufunamu obulumi obutono nga tuyisa ka pamba ku kiwundu kyolina okulaba nga twekebejja obuwuka obulimu. Bwoba owulira nga okweyogerako kukumalako emirembe, oli wa ddembe okugaana okuddamu ebibuuzo by'owuliraa nti bikumalako emirembe era oli wa ddembe okuva mu kunonyereza kuno wonna woyagalira. Byonna byetugenda okwogerako mu kafubo kano bijja kukumibwa nga bya kyaama.

5.0 Ebirungi ebisuubirwa okuva mu kunonyereza kuno

Tewali kuganyurwaamu kwa mangu kugenda kujja wuwo ng'omuntu olw'okwetaba mukunoonyereza kuno. Wabula by'ogenda okutugamba awamu n'ebyabalala bigenda kutuyamba okulaba nga tusala amagezi okulongoosa obulamu bw'abo abalumiddwa awamu n'okuziyiza okulumibwa embwa. Byogenda okuddamu bigenda kutuyamba mukunoonyereza ku ngeri zetusobola okukozesa okwewala okulumibwa embwa mu byalo jetubeera wamu n'obujanjabi bw'abo abalumiddwa embwa

6.0 Olina ddembe ki nga eyetabye mu kunoonyereza kuno?

Okwetaba mu kunoonyereza kuno kiri eri ggwe. Osobola okugaana okwetaba mu oba okuvaamu obudde bwonna nga towadde na nsonga. Era ojjukizibwa nti oli wa ddembe okubuuka ebibuuzo byonna byotayagala kuddamu oba okulekeraawo okuddamu ebibuuzo wonna woba oyagalidde.

7.0 Obwekusifu

By'onatubuulira m kunoonyereza kuno bijja kukuumibwa nga bya kyaama. Foomu z'ogenda okussaako omukono nga otuwa olukusa okwogerako naawe tugenda kuzikuuma mu kifo ekikusifu era abanazirabako bajja kuba abo bokka abali ku ttiimu y'okunnonyereza kuno awamu n'abataddemu ssente okusobozesa okunoonyereza kuno. Ebinaava mu kunoonyereza kuno bigenda kutekebwatekebwa mu ngeri essamu abetabyemu ekitiibwa era tewali bikufaako ng'omuntu bigenda tutekebwa mu bivudde mu kunoonyereza. Bwoba osiimye okusigala nga otegezebwa wetutuuse mu kunoonyereza kuno naffe tuli basanyufu okugabana naawe ku alipoota awamu nabyonna ebiwandiiko ebinaava mu kunonyereza.

8.0 Ssente ez'etaagibwa

Tewali ssente zonna zikwetagisa kuleeta nga toneetaba mu kunoonyeeza kuno

9.0 Okusasulwa

Togenda kusasulwa kujjuza foomu oba okwogerako n'abantu baffe mu kunoonyereza kuno

10.0 Okunoonyereza kuno kwakkirizibwa akakiiko k'empisa z'ebyokunoonyereza?

Yee, akakiiko k'ebyempisa z'okunoonyereza kaawa okunoonyereza kuno olukusa okutandika n'okugendaa mu maaso. Osobola okufuna ab'akakiiko kano bw'oba olina ebibuuzo oba okumanya ebisingawo ng'okozesa emikutu gino wa mmanga:

MREC Chairman (Dr. Fred Nakwagala) Contact Telephone number: +256 772-325869
Email: nakwagala@yahoo.com)

11.0 Ebikwata ku banoonyereza abakulu n'abokutuukirira

Bwoba olina ebibuuzo ku kunoonyereza kuno oba bw'oba ofunye obuzibu bwonna obuva mu kunoonyereza osobola okutuukirira omunoonyereza omukulu ayitibwa Stevens KISAKA ku nnamba y'essimu (+256392945160). Bwoba olina ebibuzo ku ddembe lyo nga eyetabye mu kunoonyereza kuno, tukusaba otuukirire akulira Mulago Hospital Research Ethics Review Committee k nnamba +256 772-325869.

12.0 Okukkiriza okwetaba mu kunoonyereza kuno

Nzikiriza nti omuntu ansabye olukusa okukkiriza okwetaba m kunoonyereza kuno ampadde ebyo byonna byenetaaga okumanya ku kunoonyereza kuno mu bujjuvu era ndi mumativu. Anyinyonyodde omugaso gw'okunoonyereza kuno, byenaayitamu singa nzikiriza okwetabamu, obuzibu obuyinza okubaawo awamu n'eddembe lyange singa nzikiriza okwetabamu. Mpereddwa obudde obumala okubuuza ebibuuzo. Mpulira ebibuuzo byange ku kunoonyereza kuno biddiddwaamu bulungi era mmatidde. Ngambiddwa nti byenaba mbulidde abanoonyereza awamu nebinaava mu bantu abalala bijja kuvaamu alipoota awatali kunokolayo muntu kinnomu awamu n'ebiwandiiko ebirala ebinasomwa abantu.

Nkimanyi nti ddembe lyange okujjayo okukkiriza kwange okwokwetaba mu kunoonyereza kuno awatali kutisibwatisibwa. N'olwekyo, nzikiriza awatali kukakibwa kwonna okwetaba mu kunoonyereza luno

Nzikiriza okwetaba mukunoonyereza nga kivudde eri nze era awatali kusasulwa.

_____	_____
Ennaku z'omwezi	Amanya n'omukono gw'eyetabye mu kunoonyereza
_____	_____
Ennaku z'omwezi	Amanya n'omukono gwo'yo abaddewo
_____	_____
Ennaku z'omwezi	Amanya n'omukono gw'omunonyereza omukulu

Webale nnyo okukkiriza okwetaba mu kunoonyereza kuno nobuyambi bwonna bwowaddeyo.

Appendix IIIc: Assent form for dog bite patients (Luganda)

CHILD ASSENT FORM

Omulamwa gw'okunonyereza: EBIKOLEBWA NGA EMBWA ERUMYE OMUNTU, OBUJANJABI OBUGABIRWA MU DDWALIRO NE BIKI EBIVA MUKUJANJABA EBIWUNDU EBIRETEBWA EMBWA MU WAKISO NE KAMPALA DISITULIIKITI MU YUGANDA

Akulira okunonyereza / Gyasinziira: DR. STEVENS KISAKA, University of Nairobi, Institute of Tropical and Infectious Diseases (UNITID), College of Health Sciences, P.O. BOX 19676 - 00202 Nairobi Tel (+254) 020 4915060; Email: bmks@dr.com

Tukola okunoonyereza kubyabaawo ng'olumiddwa embwa nga essira tulittade kw'ebyo by'ewakola nga tonnaba kufuna bujanjabi mu ddwaliro, byewakola okulabirira ekiwundu ekyava ku kulumibwa embwa, abasawo byebakoze okukuyamba mu mbeera eyo awamu nebitera okuva mu kulumibwa embwa. Okunonyereza kuno kwayisibwa akakiiko akafuga empisa z'okunonyereza "Mulago Hospital Research Ethics Committee" era kwaweebwa nnamba. _____

Mu kunonyereza kuno tugenda kweyongera kuyiga kw'ebyo ebikolebwa nga embwa erumye omuntu, obujanjabi obugabirwa mu ddwaliro ne biki ebiva mukujanjaba ebiwundu ebiretebwa embwa. Tuteekateeka okulaba nga abaana bonna abaletebwa mu ddwaliro okujjanjaba ebiwundu ebiletebwa okulumwa embwa betaba mu kunonyereza kuno. Bwosalawo okwetaba mu kunoonyereza kuno ojja kusabibwa okuddamu kubibuuzo. Nga ebibuuzo biwedde, tujja kuyisa ka ppamba ku kiwundu tusobole okwetegereza obuwuka obukirimu era tujja kukulondoola okumala emyeezi mukaaga tusobole okulaba ekiwundu bwekiwona. Buli lwonaddanga mu ddwaliro okufuna obujjanjabi, tujja kwetegereza ekiwundu okusinziira ku musawo anakujjanjaba byanaaba asazeewo.

Bino byolina okumanya ku kunoonyereza kuno. Bwonokirizza okwetaba mu kunoonyereza, ebintu bino wammanga bye bijja okubaawo: Omuntu omutendeke mu kunonyereza kuno ajja kukubuuza ebibuuzo mu kifo ekyekusifu nga tewali muntu mulala awulira era wonawulirira emirembe nga oddamu ebibuuzo. Okubuzibwa ebibuuzo kujja kutwala eddakiika abiri mu ttaano. Ebibuuzo bijja kwekuusa ku mbeera gyewalumiddwaamu embwa n'ebyo bwewakoze nga tonajja mu ddwaliro. Nga ebibuuzo biwedde, tujja kuyisa ka ppamba ku kiwundu tusobole okwetegereza obuwuka obukirimu. Tujja kukulondoola okumala emyezi mukaaga tulabe ekiwundu bwekiwona. Ekisembayo, tujja kukusaba ennamba y'essimu tusobole okukutukirira naye ennamba eno bwooba ogituwadde, tujja kugikozesa ekyo kyetugikusabidde era tetujja kugigaba walala wonna oba okugiwa omuntu yenna. Essimu eno ejja kukozesebwa okukubuuza ku mbeeraa yekiwundu kyo n'ewekituuse mu kuwona.

Ojja kubuzibwa ebibuuzo mu kifo ekikusifu era ekikuwa emirembe awamu n'omunoonyereza. Obuzibu bwokka bwetusuubira okubawo bwebwokuba nti oyinza okubuzibwa ebibuuzo

nebikuwulizisa bubi oba nebikumalako emirembe nga byekuusa ku mbeera jewalumwaamu embwa nebyewakola nga tonajja mu ddwaliro. Era oyinza okuwulira obulumi obutonotono nga tuyisa ka pamba ku kiwundu okwekebejja obuwuka obukirimu.

Si nti buli eyetaba mu kunoonyereza kuno ajja kuganyirwaamu. Okuganyirwaamu kitegeeza nti waliwo ekirunji ekijja okukutuukaako olwokwetaba mu kunoonyereza kuno. Wabula okuganyirwamu kujja kujjira mu kukozesa ebivudde mu kunoonyereza kuno okwongera okutumbula embeera y'obulamu bw'abo abalumiddwa embwa ate n'okulaba nga tuziyiza okulumibwa ebwa eyo jetubeera.

Okunoonyereza nga kuwedde, tujja kuwandiika alipoota kwebyo byetuzudde naye tetujja kuteekamu linnya lyo oba ekintu kyonna ekiraga nti wetabamu.

Sikyatteeka nti olina okwetaba mu kuno okunoonyereza. Bwoba toyagala kwetabamu, tewali buzibu. Bwosalawo okuva mu kunonyereza kuno nga tutandise nakyo si musango. Bazadde bo okunoonyereza kuno nabo bakumaanyiiko.

Bwoba nga osazeewo okwetaba mu kunoonyereza kuno tukusaba owandiike wano erinnya lyo.

Nze _____njagala okwetaba mu kunoonyereza kuno.

_____	_____
Ennaku z'omwezi	Amanya n'omukono gw'eyetabye mu kunoonyereza
_____	_____
Ennaku z'omwezi	Amanya n'omuko gwo'yo abaddewo
_____	_____
Ennaku z'omwezi	Amanya n'omuko gw'omunonyereza omukulu

Webale nnyo okukkiriza okwetaba mu kunoonyereza kuno

Appendix IIId: Informed consent form for health workers

PARTICIPANT INFORMATION AND CONSENT FORM

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Principal Investigator/ institutional affiliation: DR. STEVENS KISAKA, University of Nairobi, Institute of Tropical and Infectious Diseases (UNITID), College of Health Sciences, P.O. BOX 19676 - 00202 Nairobi Tel (+254) 020 4915060; Email: bmks@dr.com

1.0 Introduction

I would like to tell you about a study being conducted by researcher above. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be a participant in the study. Feel free to ask any questions about the purpose of the research, what happens if you participate in the study, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions to your satisfaction, you may decide to be in the study or not. This process is called 'informed consent'. Once you understand and agree to be in the study, I will request you to sign your name on this form. You should understand the general principles which apply to all participants in a medical research: i) Your decision to participate is entirely voluntary ii) You may withdraw from the study at any time without necessarily giving a reason for your withdrawal iii) Refusal to participate in the research will not affect the services you are entitled to in this health facility or other facilities. We will give you a copy of this form for your records.

May I continue? YES / NO
This study has approval by the Mulago National Referral Hospital Ethics and Research Committee, protocol No. _____

2.0 What is this study about?

The study will assess preclinical care practices, clinical management and outcomes of dog bite injuries. I am asking you for your consent to be interviewed as part of this study because you participate in the clinical management of dog bite patients. This study will gather information on a) preclinical practices undertaken for dog bite victims in comparison with recommended guidelines; b) adherence by health workers to recommended clinical guidelines for treating dog bite injuries; c) antimicrobial susceptibility profiles of selected bacteria isolated from dog bite wounds; and d) predictors for infection and other outcomes of dog bite injuries. It is our intention to interview all health workers that attend to dog bite patients and they will be consecutively chosen. We are asking for your consent to consider participating in this study.

3.0 What will happen if you decide to be in this research study?

If you agree to participate in the study, the following things will happen: You will be interviewed by a trained interviewer in a private area where you feel comfortable answering questions. The interview will last approximately 25 minutes. The interview will cover topics such as what patients do before coming to the hospital as a way of managing the bite and how this affects the treatment you give them. We will record the conversation using a voice recorder and a note book.

4.0 Are there any risks or discomforts from participating in this study?

We will undertake the interview in a private and safe place for both you and the researcher. The only potential but minimum risk from participating in this study is that you may feel uncomfortable answering some of the questions that may deal with what your patients have been discussing with you. In the most unlikely event that discussing anything makes you feel uncomfortable, you are free to refuse to answer questions that make you feel uncomfortable, and you may choose to end the interview and your participation in the study at any time. The information you provide will be kept confidential.

5.0 Possible benefits of this study

There are no direct benefits that you may get from participating in this study. However, the information collected from this study may be helpful in improving the lives of everybody whether bitten by a dog or not. Your answers will help us in designing intervention programs suitable for communities to prevent dog bites as well as improve the treatment of those who are bitten.

6.0 What are your rights as a participant?

Your participation in this study is entirely voluntary. You can refuse to participate or stop at any time without giving any reason. Please remember that you are not to respond to any question you do not want to answer and you are free to stop answering questions at any time.

7.0 Confidentiality

All the information that you give in this study will be kept strictly confidential. The consent forms that you will be asked to sign will be securely stored and access will be limited to the research team and study sponsors. The consent forms cannot be linked to the answers you give to the questionnaire. The results of the study will be presented in a respectful manner and no information which could enable anyone to identify you personally will be reported. If you would like to be kept informed of the progress of our project, we will be happy to share any reports or publication we produce with you.

8.0 Costs

There is no cost to you for participating in this study.

9.0 Compensation

There is no compensation due to you for filling this questionnaire or being interviewed for this study.

10.0 Has this study received ethical approval?

Yes, the Ethics Committee granted written approval for this study. You may contact them using the following details should you have any concerns or queries: MREC Chairman (Dr. Fred Nakwagala) Contact Telephone number: +256 772-325869
Email: nakwagala@yahoo.com)

11.0 Information and contact person

If you have any questions about the study or any problems with the study you may contact Stevens KISAKA, the Principal Investigator at the following telephone number (+256 392 945 160). If you have any questions about your rights as a participant in this study, please contact the Chairman Mulago Hospital Research Ethics Review Committee, at the telephone number +256 772-325869.

12.0 Consent to Participate in Study

I hereby confirm that the person seeking my informed consent to participant in this study has given me information to my satisfaction. She/he has explained to me the purpose, procedures involved, risk and benefits and my rights as a participant in the study. I have had enough time to ask questions. I feel that my questions regarding participation in the study have been answered to my satisfaction. I have been told that the information I give to the study will together with other information gathered from other people, be anonymously processed into a research report and scientific publications.

I am aware that it is my right to withdraw my consent in this study without any prejudice. I hereby, freely and voluntary give my consent to participate in the study.

I agree to participate as a volunteer in this study.

_____ _____

Date Name and Signature of participant

_____	_____
Date	Name and Signature of Witness
_____	_____
Date	Name and Signature of Principal Investigator

Thank you for your help and for agreeing to participate in this study

Appendix IIIe: Informed consent form for veterinarians

PARTICIPANT INFORMATION AND CONSENT FORM

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Principal Investigator/ institutional affiliation: DR. STEVENS KISAKA, University of Nairobi, Institute of Tropical and Infectious Diseases (UNITID), College of Health Sciences, P.O. BOX 19676 - 00202 Nairobi Tel (+254) 020 4915060; Email: bmks@dr.com

1.0 Introduction

I would like to tell you about a study being conducted by researcher above. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be a participant in the study. Feel free to ask any questions about the purpose of the research, what happens if you participate in the study, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions to your satisfaction, you may decide to be in the study or not. This process is called 'informed consent'. Once you understand and agree to be in the study, I will request you to sign your name on this form. You should understand the general principles which apply to all participants in a medical research: i) Your decision to participate is entirely voluntary ii) You may withdraw from the study at any time without necessarily giving a reason for your withdrawal iii) Refusal to participate in the research will not affect the services you are entitled to in this health facility or other facilities. We will give you a copy of this form for your records.

May I continue? YES / NO
This study has approval by the Mulago National Referral Hospital Ethics and Research Committee, protocol No. _____

2.0 What is this study about?

The study will assess preclinical care practices, clinical management and outcomes of dog bite injuries. I am asking you for your consent to be interviewed as part of this study because as a veterinarian, you have a public health role in preventing dog bites. This study will gather information on a) preclinical practices undertaken for dog bite victims in comparison with recommended guidelines; b) adherence by health workers to recommended clinical guidelines for treating dog bite injuries; c) antimicrobial susceptibility profiles of selected bacteria isolated from dog bite wounds; and d) predictors for infection and other outcomes of dog bite injuries. It is our intention to interview veterinarians whose sub-counties register both the most and least number of dog bites and they will be purposively chosen. We are asking for your consent to consider participating in this study.

3.0 What will happen if you decide to be in this research study?

If you agree to participate in the study, the following things will happen: You will be interviewed by a trained interviewer in a private area where you feel comfortable answering questions. The interview will last approximately 25 minutes. The interview will cover topics such as what patients do before coming to the hospital as a way of managing the bite and how this affects the treatment you give them. We will record the conversation using a voice recorder and a note book.

4.0 Are there any risks or discomforts from participating in this study?

We will undertake the interview in a private and safe place for both you and the researcher. The only potential but minimum risk from participating in this study is that you may feel uncomfortable answering some of the questions that may deal with your work. In the most unlikely event that discussing anything makes you feel uncomfortable, you are free to refuse to answer questions that make you feel uncomfortable, and you may choose to end the interview and your participation in the study at any time. The information you provide will be kept confidential.

5.0 Possible benefits of this study

There are no direct benefits that you may get from participating in this study. However, the information collected from this study may be helpful in improving the lives of everybody whether bitten by a dog or not. Your answers will help us in designing intervention programs suitable for communities to prevent dog bites as well as improve the treatment of those who are bitten.

6.0 What are your rights as a participant?

Your participation in this study is entirely voluntary. You can refuse to participate or stop at any time without giving any reason. Please remember that you are not to respond to any question you do not want to answer and you are free to stop answering questions at any time.

7.0 Confidentiality

All the information that you give in this study will be kept strictly confidential. The consent forms that you will be asked to sign will be securely stored and access will be limited to the research team and study sponsors. The consent forms cannot be linked to the answers you give to the questionnaire. The results of the study will be presented in a respectful manner and no information which could enable anyone to identify you personally will be reported. If you would like to be kept informed of the progress of our project, we will be happy to share any reports or publication we produce with you.

8.0 Costs

There is no cost to you for participating in this study.

9.0 Compensation

There is no compensation due to you for filling this questionnaire or being interviewed for this study.

10.0 Has this study received ethical approval?

Yes, the Ethics Committee granted written approval for this study. You may contact them using the following details should you have any concerns or queries: MREC Chairman (Dr. Fred Nakwagala) Contact Telephone number: +256 772-325869
Email: nakwagala@yahoo.com)

11.0 Information and contact person

If you have any questions about the study or any problems with the study you may contact Stevens KISAKA, the Principal Investigator at the following telephone number (+256 392 945 160). If you have any questions about your rights as a participant in this study, please contact the Chairman Mulago Hospital Research Ethics Review Committee, at the telephone number +256 772-325869.

12.0 Consent to Participate in Study

I hereby confirm that the person seeking my informed consent to participant in this study has given me information to my satisfaction. She/he has explained to me the purpose, procedures involved, risk and benefits and my rights as a participant in the study. I have had enough time to ask questions. I feel that my questions regarding participation in the study have been answered to my satisfaction. I have been told that the information I give to the study will together with other information gathered from other people, be anonymously processed into a research report and scientific publications.

I am aware that it is my right to withdraw my consent in this study without any prejudice. I hereby, freely and voluntary give my consent to participate in the study.

I agree to participate as a volunteer in this study.

_____ _____

Date Name and Signature of participant

_____	_____
Date	Name and Signature of Witness
_____	_____
Date	Name and Signature of Principal Investigator

Thank you for your help and for agreeing to participate in this study

Appendix IIIf: Informed consent form for traditional healers (Luganda)

EBIKWATA KU KUNONYEREEZA KUNO EBIKUSOBOZESA OKWETABAMU

Omulamwa gw'okunonyereza: EBIKOLEBWA NGA EMBWA ERUMYE OMUNTU, OBUJANJABI OBUGABIRWA MU DDWALIRO NE BIKI EBIVA MUKUJANJABA EBIWUNDU EBIRETEBWA EMBWA MU WAKISO NE KAMPALA DISITULIIKITI MU YUGANDA

Akulira okunonyereza / Gyasinziira: DR. STEVENS KISAKA, University of Nairobi, Institute of Tropical and Infectious Diseases (UNITID), College of Health Sciences, P.O. BOX 19676 - 00202 Nairobi Tel (+254) 020 4915060; Email: bmks@dr.com

1.0 Okwanjula

Njagala okukutegeeza ku kunonyereza okukolebwa abantu abo abali waggulu. Nandyagadde okukubulira ebikwata ku kunonyereza kuno osobole okusalawo oba wandyagadde okukwetabamu. Beera wa ddembe okubuuza ebibuuzo ebikwata ku kunonyereza kuno, biki ebinakutukaako bwooba wetabyemu n'ebirala ebiri ku foomu eno oba ebikwata ku kunonyereza kuno ebitali birambulukufu. Bwetunaddamu ebibuuzo byo n'omatira, osobola okusalawo okwetabamu oba okugaana. Bwooba okirizza, tujja kukusaba okuteeka omukono ku foomu eno. Kino kijja kuba kiraga nti otegedde ebikwaata ku kunonyera kuno era nti: i) Okwetabaako kwo kivudde eri ggwe era tokakiddwa ii) Osobola okuva mu kunonyereza kuno obudde bwonna nga towadde na nsonga iii) Okugaana okwetaba mu kunony tekijja kukosa bujjanjabi bukuweebwa mu ddwaliro lino oba amalwaliro amalala. Ojja kusigaza kkopi ya foomu eno ogyekumire.

Tweyongereyo? YEE / NEDDA

Okunonyereza kuno kwayisiiibwa akakiiko akafuga empisa z'okunonyereza "Mulago Hospital Research Ethics Review Committee" era kwaweebwa nnamba.

_____

2.0 Biki ebifa ku kunonyereza kuno?

Okunonyereza kuno kuli ku ebyo ebikolebwa nga embwa erumye omuntu, obujanjabi obugabirwa mu ddwaliro ne biki ebiva mukujanjaba ebiwundu ebiretebwa embwa. Nkusaba okirize obuzibwe ebibuuzo nga omu kwaabo abalabirira oba okujanjaba abo embwa berumye. Tujja kufuna a) ebikolebwa nga tebanagenda mu ddwaliro okulaba oba bikwatagana n'ebyo ebirambikiddwa mu mateeka; b) engeri abasawo gyebajjanjabamu ebiwundu bino oba bagoberera ebyo ebirambikiddwa mu mateeka; c) obuwuka mu biwundu bwebwesamba eddagala; ne d) ne biki ebiviraamu okutana kw'ebiwundu ebyo. Abantu abawera 360 be bajja okwetaba mu kunonyereza kuno. Tusaba okirize okwetabamu.

3.0 Biki ebinabaawo nga osazeewo okwetaba mu kunoonyereza kuno?

Bwonokirizza, ebintu bino wammanga bye bijja okubaawo: Omuntu omutendeke mu kunonyereza kuno ajja kukubuuza ebibuuzo mu kifo ekyekusifu nga tewali muntu mulala awulira era wonawulirira emirembe nga oddamu ebibuuzo. Okubuzibwa ebibuuzo kijja kutwala eddakiika ng'abiri mu ttaano. Ebibuuzo bijja kwekuusa ku ngeri gy'olabiriramu abalumiddwa embwa. Tujja kukwata eddoboozi lyo ku katambi naye tujja kubikuuma nga bya kyaama.

4.0 Waliwo obuzibu bwonna oba ekintu kyonna ekisobola okumalako omuntu emirembe olw'okwetaba mu kunoonyereza kuno?

Emboozi yaffe tujja kujinyumiza mu kifo ekikusifu era nga kiwa omunonyereza n'abetabye mu kunoonyereza kuno emirembe. Tusubira nti ekiyinza okureeta akatyabaga akatali k'amaanyi kwekukusaba okuddamu ebibuuzo ku ebyo byokola ku balumiddwa. Bwoba owulira nga okwogera bino kukumalako emirembe, oli wa ddembe okugaana okuddamu ebibuuzo by'owuliraa nti bikumalako emirembe era oli wa ddembe okuva mu kunonyereza kuno wonna woyagalira. Byonna byetugenda okwogerako mu kafubo kano bijja kukumibwa nga bya kyaama.

5.0 Ebirungi ebisuubirwa okuva mu kunonyereza kuno

Tewali kuganyurwaamu kwa mangu kugenda kujja wuwo ng'omuntu olw'okwetaba mukunoonyereza kuno. Wabula by'ogenda okutugamba awamu n'ebyabalala bigenda kutuyamba okulaba nga tusala amagezi okulongoosa obulamu bw'abo abalumiddwa awamu n'okuziyiza okulumibwa embwa. Byogenda okuddamu bigenda kutuyamba mukunoonyereza ku ngeri zetusobola okukozesa okwewala okulumibwa embwa mu byalo jetubeera wamu n'obujanjabi bw'abo abalumiddwa embwa

6.0 Olina ddembe ki nga eyetabye mu kunoonyereza kuno?

Okwetaba mu kunoonyereza kuno kiri eri ggwe. Osobola okugaana okwetaba mu oba okuvaamu obudde bwonna nga towadde na nsonga. Era ojjukizibwa nti oli wa ddembe okubuuka ebibuuzo byonna byotayagala kuddamu oba okulekeraawo okuddamu ebibuuzo wonna woba oyagalidde.

7.0 Obwekusifu

By'onatubuulira m kunoonyereza kuno bijja kukuumibwa nga bya kyaama. Foomu z'ogenda okussaako omukono nga otuwa olukusa okwogerako naawe tugenda kuzikuuma mu kifo ekikusifu era abanazirabako bajja kuba abo bokka abali ku ttiimu y'okunnonyereza kuno awamu n'abataddemu ssente okusobozesa okunoonyereza kuno. Ebinaava mu kunoonyereza kuno bigenda kutekebwatekebwa mu ngeri essamu abetabyemu ekitiibwa era tewali bikufaako ng'omuntu bigenda tutekebwa mu bivudde mu kunoonyereza. Bwoba osiimye okusigala nga

otegezebwa wetutuuse mu kunoonyereza kuno naffe tuli basanyufu okugabana naawe ku alipoota awamu nabyonna ebiwandiiko ebinaava mu kunonyereza.

8.0 Ssente ez'etaagibwa

Tewali ssente zonna zikwetagisa kuleeta nga toneetaba mu kunoonyeeza kuno

9.0 Okusasulwa

Togenda kusasulwa kujjuza foomu oba okwogerako n'abantu baffe mu kunoonyereza kuno

10.0 Okunoonyereza kuno kwakkirizibwa akakiiko k'empisa z'ebyokunoonyereza?

Yee, akakiiko k'ebyempisa z'okunoonyereza kaawa okunoonyereza kuno olukusa okutandika n'okugendaa mu maaso. Osobola okufuna ab'akakiiko kano bw'oba olina ebibuuzo oba okumanya ebisingawo ng'okozesa emikutu gino wa mmanga:

MREC Chairman (Dr. Fred Nakwagala) Contact Telephone number: +256 772-325869
Email: nakwagala@yahoo.com)

11.0 Ebikwata ku banoonyereza abakulu n'abokutuukirira

Bwoba olina ebibuuzo ku kunoonyereza kuno oba bw'oba ofunye obuzibu bwonna obuva mu kunoonyereza osobola okutuukirira omunoonyereza omukulu ayitibwa Stevens KISAKA ku nnamba y'essimu (+256392945160). Bwoba olina ebibuzo ku ddembe lyo nga eyetabye mu kunoonyereza kuno, tukusaba otuukirire akulira Mulago Hospital Research Ethics Review Committee ku nnamba +256 772-325869.

12.0 Okukkiriza okwetaba mu kunoonyereza kuno

Nzikiriza nti omuntu ansabye olukusa okukkiriza okwetaba mu kunoonyereza kuno ampadde ebyo byonna byenetaaga okumanya ku kunoonyereza kuno mu bujjuvu era ndi mumativu. Anyinyonyodde omugaso gw'okunoonyereza kuno, byenaayitamu singa nzikiriza okwetabamu, obuzibu obuyinza okubaawo awamu n'eddembe lyange singa nzikiriza okwetabamu. Mpereddwa obudde obumala okubuuza ebibuuzo. Mpulira ebibuuzo byange ku kunoonyereza kuno biddiddwaamu bulungi era mmatidde. Ngambiddwa nti byenaba mbulidde abanoonyereza awamu nebinaava mu bantu abalala bijja kuvaamu alipoota awatali kunokolayo muntu kinnomu awamu n'ebiwandiiko ebirala ebinasomwa abantu.

Nkimanyi nti ddembe lyange okujjayo okukkiriza kwange okwokwetaba mu kunoonyereza kuno awatali kutisibwatisibwa. N'olwekyo, nzikiriza awatali kukakibwa kwonna okwetaba mu kunoonyereza luno.

Nzikiriza okwetaba mukunoonyereza nga kivudde eri nze era awatali kusasulwa.

_____	_____
Ennaku z'omwezi	Amanya n'omukono gw'eyetabye mu kunoonyereza
_____	_____
Ennaku z'omwezi	Amanya n'omukono gwo'yo abaddewo
_____	_____
Ennaku z'omwezi	Amanya n'omukono gw'omunonyereza omukulu

Webale nnyo okukkiriza okwetaba mu kunoonyereza kuno nobuyambi bwonna bwowaddeyo.

Appendix IV: Interview questionnaire on factors associated with preclinical care practices undertaken by dog bite patients

Appendix IVa: English version

Date (DD/MM/YY) _____

Time respondent had reported to hospital: _____

A. Research site / Hospital name: _____Hospital code: _____

B. Respondent details

Name code of patient: _____

Residence codes: Village_____Sub county _____

Landmark to home (please describe): _____

Contact details: Telephone 1_____ Telephone 2_____

Name of next of kin: Surname _____ last name _____

Contact details of next of kin: Telephone 1_____ Telephone 2_____

Date of birth: Can tell ❑ Cannot remember ❑ Prefers not to say ❑

If can tell: Date of birth (DD/MM/YY): _____

If exact date of birth cannot be recalled, what month and year were you born? (MM/YY) _____

C. Human factors

Sex: Male ❑ Female ❑

Tribe _____

Religion: Christian ❑ Moslem ❑ Other _____ (please specify)

Highest education level attained: No formal education ❑ Primary ❑ Secondary ❑ Certificate / Diploma ❑ Degree and above ❑

Marital status : Single never married ❑ Single divorced / widowed ❑ Married ❑ Prefer not to say ❑

Height of respondent (cm) _____

Weight of respondent (kg) _____

How many people stay in the household with you? _____

Do the people staying in your household include your spouse? Yes ❑ No ❑

Are there teenage children in your home? Yes ❑ No ❑

If yes, how many teenage children in your home? _____

Are you employed? Yes ❑ No ❑ If yes, please specify type of employment

_____

What is your caretaker's sex? Male ❑ Female ❑

What is your caretaker's education level? No formal education ❑ Primary ❑ Secondary ❑ Certificate / Diploma ❑ Degree and above ❑

Are you a Current dog owner? Yes ❑ No ❑

If yes, how many dogs do you own ? _____

If yes, what type / breed of dog? _____

What do you use the dog for? _____

How many years have you been owning the dog (s)? _____

If no, have you ever owned a dog? Yes ❑ No ❑

If yes, where do the dogs stay? Have own house ❑ Out in the compound ❑ Share house with people ❑ Roam around in the village ❑

Do you know of any close relative of yours who own a dog? Yes ❑ No ❑

Have you ever been bitten by a dog before this bite? Yes ❑ No ❑

If yes, in which year did this bite happen ? _____

For this current bite, did you believe before that a dog could attack and bite you ? Yes ❑ No ❑

Were you immunized against rabies prior to being bitten by the dog? Yes ❑ No ❑

If yes, when were you immunized (month and year)? _____

D. Dog factors

What was the sex of the dog? Male ❑ Female ❑ Don't know ❑

What is the age of the biting dog (months) _____

Was the biting dog sick? Yes ❑ No ❑

Was the biting dog exhibiting fear of people? Yes ❑ No ❑

What is the dog used for? Security ❑ Pet ❑ Stray ❑ Dont know ❑

Was the dog vaccinated to the best of your knowledge? Yes ❑ No ❑ Dont know ❑

Was the dog spayed / neutered / castrated? Yes ❑ No ❑ Don't know ❑

Was the dog on the leash? Yes ❑ No ❑

Has this dog ever bitten someone else before biting you? Yes ❑ No ❑ Don't know ❑

Did this dog bite another person after biting you? Yes ❑ No ❑ Don't know ❑

E. Dog bite circumstances

E1: Before the bite

What day did the dog bite you? (DD/MM/YY) _____

What time of day did the dog bite you? Morning ❑ Evening ❑ Night ❑

At what particular time did the dog bite you ? (12-hour format) _____

What it raining when you were attacked by the dog ? Yes ❑ No ❑

If the attack happended at night, was there a visible moon ? Yes ❑ No ❑

Were you bitten by your own dog? Yes ❑ No ❑

If yes, how long had you stayed with the dog before the bite (months) _____

If yes, was this dog borne in your home ? Yes ❑ No ❑

If yes, do you usually allow this dog into the presence of visitors ? Yes ❑ No ❑

Does this dog usually leave the compound unaccompanied? Yes ❑ No ❑

If no, do you know the owner of the dog? Yes ❑ No ❑

If yes, who is the owner ? Neighbor ❑ Person known to me ❑ Community dog ❑

Were you bitten while on the property of the dog owner ? Yes ❑ No ❑

Was the owner around while the dog was attacking you? Yes ❑ No ❑

How would you describe the size of the dog? Small ❑ Medium ❑ Large ❑ Very large ❑

Do you know the breed of the dog ? Yes ❑ No ❑

If yes, what breed was the dog ? _____

Did you previously know the biting dog? Yes ❑ No ❑

If yes, can you describe the dog? History and type

_____

Did the dog look sick to you? Yes ❑ No ❑

Where were you? Own home ❑ Home of another person known to me ❑ Home of another person not known to me ❑ On the road ❑ Other ❑, please specify _____

Were you in company of another person / people? Yes ❑ No ❑

If yes, what is your relationship with these / this person (s)?

_____

What were you doing just before the dog bit you? Walking ❑ Seated ❑ Chasing it away ❑ Feeding it ❑ Other ❑, please specify _____

What was the dog doing just before the bite? Please describe _____

Did you try to interpret the mood of the dog before the attack? Yes ❑ No ❑

Could you describe to me how you thought the dog's demeanor / mood was just before the bite?

_____

E2. During the bite

Did you approach the dog or did it approach you? I approached it ❑ It approached me ❑

Was the dog stationary or moving / mobile? _____

What was the purpose of the interaction with the dog around the time of the bite?

_____

Did you try to fend off the dog as it attacked you? Yes ❑ No ❑

Where did it bite you? Leg ❑ Hand ❑ Arm ❑ Head ❑ Abdomen ❑ Other, please specify

_____

How many times did it bite you? One ❑ Two ❑ Three or more ❑

How do you describe the depth of the wounds? Walking ❑ Seated ❑ Chasing it away ❑ Feeding it ❑ Other ❑, please specify _____

Why do you think that the dog bit you? _____

What makes you think that? _____

Do you get information about dogs? Yes ❑ No ❑

Where do you get information about dogs from? Friends ❑ Books ❑ School ❑ Family ❑ Other ❑ please specify_____

Do you think that the bite was intentional? Yes ❑ No ❑

Do you think that anybody is to blame for the bite happening? Yes ❑ No ❑

If yes, who? _____

E3. After the bite

How would you describe the damage the bite did to you?

_____

What did you do to the dog after the bite? Chased it away ❑ Killed it ❑ Nothing ❑ It ran away by itself ❑ Other please specify_____

If it was killed, what happened to the carcass ? Decapitated ❑ Buried ❑ Left to rot ❑ I don't know ❑ Other, please specify _____

Are you aware the head of the dog had to be taken for examination ? Yes ❑ No ❑

If yes, was the head take for examination? Yes ❑ No ❑

If not own dog, how did the owner react? _____

How did the owner's reaction make you feel? _____

How did the bite affect the rest of your day? _____

F. PRACTICES

Did you do anything to the wound immediately after the bite? Yes ❑ No ❑

If yes, what did you do? Washed with water and soap ❑ Washed with water only ❑ Did not wash ❑ Other, please specify _____

Did you apply anything to the wound immediately after the bite? Yes ❑ No ❑

If yes, what did you apply to the wound? _____

Did you think you needed any medical help after the bite? Yes ❑ No ❑

If yes, what did you do? _____

Why did you choose to do that? _____

G. SES variables

Could you tell me if you have the following in your house;

Item	Yes	No
Radio		
Television		
Cell-phone		
Bicycle		
Motorcyle		
Motor vehicle		
A piece of land		
Large farm animals like cattle, goats and sheep		
Small farm animals like poultry		
A manufactured bed		

What is the nature of the walls of their house? No bricks ❑ Unburnt bricks ❑ Burnt bricks with mud ❑ Burnt bricks/stones with cement ❑ Other, please specify _____

Appendix IVb: Luganda version

EBIBUUZO EBIKWATA KU NSONGA EZIVIIRAKO ABALUMIDDWA EMBWA OKUKOLA EBYO BYE BAKOLA NGA TEBANAGENDA MU DDWALIRO

Onnaku z'omwezi leero (Olunaku/Omwezi/Omwaka) _____

Obudde omulwadde lwazze mu ddwaliro: _____

A. Erinnya ly'eddwaliro: _____Namba y'eddwaliro: _____

B. Ebikwata ku mulwadde

Amannya (mu bwekusifu): _____

Ekifo mwobeera (mu bwekusifu): Ekyaalo_____ Eggombolola:_____

Ekiraga wobeera (nyonyola): _____

Essimu: Esooka _____ Endala _____

Eyebuzibwaako nga muntu wa mulwadde: Erinnya ly'ekika _____
Ezzungu_____

Essimu z'oyo eyebuzibwaako: Esooka_____ Endala_____

Wazaliibwa ddi: Nzijukira ❑ Sijukira ❑ Ssandyagadde kukubulira ❑

Bwooba ojjukira: Amazaliibwa (Olunaku/Omwezi/Omwaka): _____

Bwooba tojjukira lunaku lwe wazaliibwa, mwezi ki era mwaka ki lwewazaalibwa?
(Mwezi/Mwaka) _____

C. Ensonga ez'obuntu

Enkula: Musajja ❑ Mukyala ❑

Eggwanga _____

Eddiini: Mukurisitaayo ❑ Musiraamu ❑ Ekirala _____ (laga ekirala)

Obuyigirize obusembayo waggulu: Teyasoma ❑ Pulayimale ❑ Sekendule ❑ Satifukeeti / Dipulooma ❑ Diguli n'okweyongerayo ❑

Obufumbo : Tafumbirangaako ❑ Simufumbo naye yayawukana oba yafiirwa munne ❑ Mufumbo ❑ Teyandyagadde kutubulira ❑

Obuwanvu (cm) _____

Obuzito (kg) _____

Obungi bwa bantu bobeera nabo ewaka _____

Bobeera nabo kuliko omubeezi? Yee ❑ Nedda ❑

Ewaka wobeera waliwo abaana abatiini? Yee ❑ Nedda ❑

Bwewaba ewaka waliwo abatiini, bali bameka? _____

Olina omulimu? Yee ❑ Nedda ❑ Bwooba olina omulim, tukusaba ogutugambe_____

Akulabirira mu ki? Musajja ❑ Mukazi ❑

Akulabirira wabuyigirize ki? Teyasoma ❑ Pulayimale ❑ Sekendule ❑ Satifikeeti / Diplooma ❑ Diguli n'okwambuka ❑

Olina embwa gy'okuuma? Yee ❑ Nedda ❑

Oba olina embwa, ziri mmeka? _____

Oba olina embwa, ya kika ki (nganda oba nzungu)? _____

Embwa gyolina ya mugaso ki? _____

Embwa ogikumidde / oziikumidde bbanga ki? _____

Bwooba tolina mbwa kati, wali obadde nayo? Yee ❑ Nedda ❑

Bwooba olina embwa, zibeera wa? Mu nyumba yaazo ❑ Mu luggya ❑ Zisula naffe mu nyumba ❑ Zitayaaya ku kyaalo ❑

Waliyo ow'oluganda lwo gw'omanyi nga alina embwa? Yee ❑ Nedda ❑

Wali olumiddwaako ebwa ebbanga eriyise nga eno tenakuluma? Yee ❑ Nedda ❑

Oba wai olumiddwaako, kyaliwo mwaka ki? _____

Luno oluluma olubaddewo kati: wali okisubiira nti embwa esobola okukuluma? Yee ❑ Nedda ❑

Wali ogemeddwa rabies / obulwadde bw'embwa obw'eddalu nga embwa tenakuluma? Yee ❑ Nedda ❑

Oba wali ogemeddwa, gwali mwezi ki era mwaka ki? _____

D. Ensonga ezekuusa ku mbwa eyakulumye

Obutonde bw'embwa? Nsajja ❑ Nkazi ❑ Simanyi ❑

Embwa eno ya bukulu ki (mu myeezi, bwooba omanyi) _____

Embwa yabadde ndwadde? Yee ❑ Nedda ❑ Simanyi ❑

Embwa yabadde eraga nti etya abantu? Yee ❑ Nedda ❑

Embwa eno yamugaso ki? Kukuuma waka ❑ Yakuzanyisa ❑ Etayaaya ❑ Simanyi ❑

Mukumanya kwo, embwa eno baali bagigema? Yee ❑ Nedda ❑ Simanyi ❑

Embwa eno baali bagigema okuzaala (okulaawa)? Yee ❑ Nedda ❑ Simanyi ❑

Embwa eno yaki kulujegere oba kumuguwa? Yee ❑ Nedda ❑

Embwa eno yali erumye ku muntu omulala nga tenakuluma? Yee ❑ Nedda ❑ Simanyi ❑

Embwa eno yalumye omuntu omulala nga emaze okukuluma? Yee ❑ Neddao ❑ Simanyi ❑

E. Ensonga ezetoloorera ku kulumwa ko

E1: Nga embwa tenakuluma

Embwa yakuluma lunaku ki? (Olunaku/Omwezi/Omwaka) _____

Embwa yakuluma ssaawa meka? Ku makya ❑ Lwa ggulo ❑ Kiro ❑

Embwa yakuluma ssaawa mekka ddala? (12-hour format) _____

Embwa yakuluma enkuba ettonya? Yee ❑ Nedda ❑

Embwa bweeba yakuluma kiro, waaliyo omwezi waggulu mu bwengula? Yee ❑ Nedda ❑

Embwa eyakuluma, yiyo? Yee ❑ Nedda ❑

Oba yiyo, wali wakamala nayo bbanga ki (myeezi)? _____

Oba yiyi, yazalibwa waka wo? Yee ❑ Nedda ❑

Oba yiyo, otera okugita nga waliwo abagenyi? Yee ❑ Nedda ❑

Embwa eno etera okuva ewaka nga teri na muntu? Yee ❑ Nedda ❑

Oba embwa eno siyiyo, omanyi nyini yo? Yee ❑ Nedda ❑

Bwooba omanyi yini yo, yaani? Mulirwana ❑ Twemanyi ❑ Yakukyaalo ❑

Embwa yakulumidde wa nyini yo? Yee ❑ Nedda ❑

Embwa yakulumye nga nyini yo waali? Yee ❑ Nedda ❑

Obunene bw'embwa eno obunyonyola otya? Ntono ❑ Yakitema ❑ Nene ❑ Nene nyo ❑

Omanyi ekikula ky'embwa eno? Yee ❑ Nedda ❑

Oba omanyi ekikula kyaayo (breed), kitubuliire _____

Embwa eno wali ogimanyi nga tenakuluma? Yee ❑ Nedda ❑

Bwooba wali ogimanyi, tunyonyole ebogikatako _____

Embwa eno yakulabikidde ng'endwadde? Yee ❑ Nedda ❑

Embwa yakulumidde wa? Ewaffe ❑ Awaka w'omuntu omulala gwemanyi ❑ Awaka w'omuntu omulala gwe simanyio ❑ Mu luguudo ❑ Walala ❑, tubuliire ewalala _____

Yakulumye li n'omuntu omulala oba abantu abalala? Yee ❑ Nedda ❑

Oba wabadde n'omuntu omulala, omuyita otya? _____

Wali okola ki nga embwa tenakuluma? Nga ntambula ❑ Nga ntudde ❑ Nga ngigoba ❑ Nga ngiriisa ❑ Ekirala ❑, tubuliire ekirala _____

Embwa yabadde ekola ki nga tenakuluma? Nyonyola _____

Wagezaako okusoma embbera y'embwa (oba nyiivu) nga tenaba kukwangaanga? Yee ❑ Nedda ❑

Tubuliire embeera y'embwa eno gyayabaddemu nga tenakulumba _____

E2. Mu kiseera nga embwa ekuluma

Gwe wasemberede embwa oba yeyakusemberedde? Nze nagisemberedde ❑ Yeyamsemberedde ❑

Embwa yabadde mu kifo kimu oba nga etambula? _____

Okwetaba n'embwa eno kyabadde kigendererwaki? _____

Wagezezaako okwerwanako nga embwa ekuluma? Yee ❑ Nedda ❑

Yakulumye wa? Kugulu ❑ Kibatu ❑ Mukono ❑ Mutwe ❑ Lubuto ❑ Walala, tubuliire ewalala

_____

Embwa yakulumye emirundi emeka? Gumu ❑ Ebiri ❑ Esatu n'okusoba ❑

Ekiwundu okuyingira munda okinyonyola otya? Kiyingidde nnyo ❑ kyakitema ❑ Kiri kungulu

Olowooza lwaki embwa yakulumye? _____

Lwaki olowooza bwootyo? _____

Ofuna obubaka bwonna obwekuusa ku mbwa? Yee ❑ Nedda ❑

Obubaka obukwata ku mbwa obujja wa? Mikwano ❑ Bitabo ❑ Ssomero ❑ Ob'oluganda ❑ Walala ❑ nyonyola ewalala _____

Olowooza okukuluma kyabadde kigenderere? Yee ❑ Nedda ❑

Olowooza waliwo omuntu yenna owokuvunaana ku kulumwa kwo? Yee ❑ Nedda ❑

Oba waali, y'ani? _____

E3. Nga embwa emaze okukuluma

Ekiwundi kino oba ebiwundu bino obyogerako otya? _____

Wakoze ki nga embwa emaze okukuluma? Nagigobye ❑ Yatiddwa ❑ Tewali ❑ Yadduse ❑ Ekirala, kinyonyole _____

Bweeba yatiddwa, omutulumbi gwabadde ki? Bagitemyeeko omutwe ❑ Yazikiddwa ❑ Yalekeddwa awo ❑ Simanyi ❑ Ekirala, nyonyola _____

Okimanyi nti omutwe gw'embwa gulina okutalibwa okwekebejjebwa? Yee ❑ Nedda ❑

Bwooba okimanyi, omutwe gwatwaliddwa okugwekebejja? Yee ❑ Nedda ❑

Bweeba nti embwa teyabadde yiyo, nyiniyo yakozeewo ki? _____

Wawulidde otya ku kikolwa kya nyini yo? _____

Ebiwundi byakosezza bitya olunaku lwo? _____

F. EBYAKOLEDDWA NGA EMBWA EMAZE OKUKULUM

Olina kywakoze ku kiwundu nga embwa emaze okukuluma? Yee ❑ Nedda ❑

Oba yee, wakoze ki? Nayozezza ekiwundu ne ssabuni nga ali mu mazzi ❑ Nayozezza n'amazzi gokka ❑ Sayozezza ❑ Ekirala, nyonyola _____

Olina kyawatadde ku kiwundu nga embwa emaze okukuluma? Yee ❑ Nedda ❑

Oba yee, wataddeko ki? _____

Walowozezza nti wetaaga obujanjabi nga embwa emaze okukuluma? Yee ❑ Nedda ❑

Oba yee, wakoze ki? _____

Lwaki wasazeewo okukola ekyo? _____

G. Ebikwaata ku bugagga bwo

Mbulira oba ewaka wo waliyo ebintu bino wammanga;

Ekintu	Yee	Nedda
Leediyo		

Tivvi	
Akasimu	
Akagaali	
Pikipiki	
Motoka	
Ettaka	
Ebisolo ebinene nga ente, embuzi, endiga	
Ebisoo ebitono nga enkoko	
Ekitanda ekibajje	

Ebisenge by'enyumba byazimbibwa naki? Si na bulloka ❑ Bulooka ezitali njokye ❑ Bulooka enjokye n'akadongo ❑ Bulooka enjokye ne sementi ❑ Ekirala, nyonyola _____

Appendix V: In-depth interview guide on preclinical care practices undertaken by dog bite patients (for the patients)

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Date: ---------- Time: ----------

Interviewee ID: ----------

"Good morning / good afternoon / good evening. I am _____ (introduce self).

This interview is being conducted to get to deeply understand what you did after the dog bit you but before presenting to the health facility. I am especially interested in what motivated you to manage the dog bite wound the way you did.

If it is okay with you, I will be tape recording our conversation. The purpose of this is so that I can get all the details but at the same time be able to carry on an attentive conversation with you. I assure you that all your comments will remain confidential. I will be compiling a report which will contain all patient comments without any reference to individuals. If you agree to this interview and the tape recording, there is no need to sign another consent form since all was explained to you at the beginning.

Ground rules

Before we start I would like to remind you that there are no right or wrong answers in this discussion. We are interested in knowing what you think, so please feel free to be frank and to share your point of view. It is very important that we hear your opinion.

1. Why do you think the dog bit you?
2. What could you have done to prevent the dog from biting you?
3. What threatens you about this dog bite injury?
4. How has the bite affected your life?

5. What did you do to the wound after the dog bit you? Please explain.
6. Why did you do what you did? Please explain.
7. Could you please explain anything you know about infection of dog bite wounds?
8. Who decided that you come to the hospital to receive treatment?
9. Do you know of any dangers that may accrue from not reporting the injuries to hospital?
10. Why did it take you so long to report to health facility?
11. Anything you know about rabies? Probe for transmission, prevention and consequences.
12. Why were you not vaccinated against rabies? Please explain.
13. Are you planning to do anything in the future to prevent another bite from happening? Please explain.
14. Let's summarize some of the key points from our discussion. Is there anything else?
15. Do you have any questions?

Thank you for taking the time to talk to me!!

Appendix VI: Key informant interview guide on preclinical care practices undertaken by dog bite patients (for healthworkers)

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Date: ---------- Time: ----------

Interviewee ID: ----------

My name is _____ from University of Nairobi Institute of Tropical and Infectious Diseases and Makerere University School of Public Health. I am working on a research that is trying to establish the practices of dog bite victims before they come to report to the health facility. The findings of this research may be used to create awareness of what people have to do in case they are bitten by dogs. They may also be used to improve the treatment and care that such patients receive when they come for medical attention. This is because an important step in caring for dog bite victims is establishing whether they followed the recommended guidelines of irrigating the wound with water and soap before seeking medical care. The themes that emerge from the interview process will inform our planned recommendations. The key informant interview itself will be confidential. Nothing you say will be personally attributed to you in any reports that result from this interview. All of our reports will be written in a manner that no individual comment can be attributed to a particular person. Your knowledge will be very valuable and the interview will last only 20 minutes if you consent. Do you have any questions or concerns before we begin?

1. What challenges do you think the dog bite victims face in regard to management of the bite wound?
2. In what ways do dog bite victims drift away from guidelines of dog bite wound management before seeking medical care?
3. From your own perspective, why do you think some dog bite victims do not adhere to the guidelines?

4. In what ways does not adhering to the guidelines affect the patients?
5. If the patient does not adhere to these guidelines before seeking medical care, how does it affect your work as a health worker?
6. How have you tried to ensure that the dog bite victims adhere to preclinical guidelines?
7. Do you have any additional comments about the preclinical care for dog bite victims that we haven't already discussed?

Thank you for taking the time to talk to us!!

Appendix VII: Key informant interview guide on preclinical care practices undertaken by dog bite patients (for veterinarians)

Title of study: PRECLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA

Date: ---------- Time: ----------

Interviewee ID: ----------

My name is _____ from University of Nairobi Institute of Tropical and Infectious Diseases and Makerere University School of Public Health. I am working on a research that is trying to establish the practices of dog bite victims before they come to report to the health facility. The findings of this research may be used to create awareness of what people have to do in case they are bitten by dogs. They may also be used to improve the treatment and care that such patients receive when they come for medical attention. This is because an important step in caring for dog bite victims is establishing whether they followed the recommended guidelines of irrigating the wound with water and soap before seeking medical care. The themes that emerge from the interview process will inform our planned recommendations. The key informant interview itself will be confidential. Nothing you say will be personally attributed to you in any reports that result from this interview. All of our reports will be written in a manner that no individual comment can be attributed to a particular person. Your knowledge will be very valuable and the interview will last only 20 minutes if you consent. Do you have any questions or concerns before we begin?

1. Tell me about your involvement and role in the community when it comes to dog bites.
    - Activities to prevent dog bites
    - Roles of the veterinarian when a person is bitten
2. From your knowledge and experience in the community, what do people do after being bitten by a dog? Investigate for;
    - Compliance to preclinical guidelines by Ministry of Health

- Reporting mechanisms in place
- Practices to try to treat the wounds

3. Why do you think the victims do such things? (ask on the specific practices individually)
4. What challenges do you think the dog bite victims face in regard to management of the bite wound?
5. From your own perspective, why do you think some dog bite victims do not adhere to the guidelines?
6. In what ways does not adhering to the guidelines affect the patients?
7. If the patient does not adhere to these guidelines before seeking medical care, how does it affect your work as a veterinarian?
8. How have you tried to ensure that the dog bite victims adhere to preclinical guidelines?
9. Do you have any additional comments about the preclinical care for dog bite victims that we haven't already discussed?

Thank you for taking the time to talk to us!!

Appendix VIII: Key informant interview guide on preclinical care practices undertaken by dog bite patients (Traditional healers)

Omulamwa gw'okunonyereza: EBIKOLEBWA NGA EMBWA ERUMYE OMUNTU, OBUJANJABI OBUGABIRWA MU DDWALIRO NE BIKI EBIVA MUKUJANJABA EBIWUNDU EBIRETEBWA EMBWA MU WAKISO NE KAMPALA DISITULIIKITI MU YUGANDA

Ennaky z'omwezi: ----------Obudde: ----------

Addamu ebibuuzo: ----------

Errinya nze _____ okuva mu Yunivasite y'e Nairobi e Kenya n'e Yunivasite y'e Makerere mu ssomero ly'ebyobulamu eby'olukale. Ndi mu kunonyereza ku biki abantu embwa bezirumye bywbakola nga tebanagenda mu malwaliro gano amazungu. Ebinaava mu kunonyereza bisobola okukozesebwa okwongera okubangula abantu mu kiki kyebalina okukola nga embwa zibalumye. Bisobola no kukozesebwa okusitula omutindo gwe ngeri gyebajanjabwamu. Byonatubulira byonna bijja kukumibwa nga bya kyaama eri teri binavaamu bijja kutekebwaako kakwaate ku ggwe. Alipoota yaffe tujja kugiwandiika mu ngeri etalaga nti ggwe wayogera ebyo. By'omanyi bya muwendo gyetuli era okubuuza kwaffe kujja kutwaala eddakiika nga abiri bwoba okkirizza okwetaba mu kubuliriza kuno. Olina kye wandyagadde okubuuza nga tetunatandika?

1. Abalwadde bojjanjaba bava wa?
    - Ebyalo ne district
2. Mw'abo b'ojanjaba mulimu embwa beziba zirumye. Obakolera ki nga bazze ewuwo?
3. Lwaki okola ebintu ebyo ku bantu embwa bezirumye?
4. Bagenda okujja baba basoose kukola ki?
5. Waliwo abakomawo ne bakugamba nti bawonye? Olabira ku ki nti bawonye?
6. Lwaki abantu bajja ewuwo ne batagenda mu ddwaliro?
7. Olowooza lwaki embwa ziruma abantu?
8. Waliwo obulabe bwonna bwomanyi obuva ku mbwa okuluma omuntu? Lwaki olowooza nti buno bulabe?
9. Wandyagadde kiki ekiba kikolebwa okutangira embwa okuluma abantu?

10. Olina byosobola okwongera ku mboozi yaffe eno by'olowooza nti tetubikutteeko?

Tukwebaza okutuwa obudde okwogerako naffe!!

Appendix IX: Observational checklist for clinical care practices during the treatment of dog bite injuries

A. Wound characteristics at presentation

Site of the wound on body (Choose all that apply) Legs ❑ Thigh ❑ Hand ❑ Arm ❑ Abdomen ❑ Back ❑ Head ❑ Face ❑ Other, please specify _____

For any choice above, state the side of the body (left or right) as appropriate

_____

Type of wound (s) Scratch ❑ Deep open ❑ Deep puncture ❑ Other, please specify

_____

Depth of wound (in millimeters) _____

Width of wound (in millimeters) _____

Category of wound (s) Category I ❑ Category II ❑ Category III ❑

Number of bite wounds: One ❑ Two ❑ Three and more ❑

Is the wound bandaged? Yes ❑ No ❑

Was any prior medical treatment given? Yes ❑ No ❑

If yes, specify the treatment _____

If yes, where was the treatment given from? _____

Who gave the treatment above? _____

Wound management at the health facility / study site

B. First aid

Did the wound contain any dirt or foreign bodies? Yes ❑ No ❑

Was the wound washed with clean soap and water? Yes ❑ No ❑

Was the wound rinsed? Yes ❑ No ❑

Was the wound left to dry? Yes ❑ No ❑

Was there bleeding? Yes ❑ No ❑

Was the bleeding stopped? Yes ❑ No ❑

What was used to stop the bleeding? _____

Was an antiseptic applied? Yes ❑ No ❑

If yes, which one? Chlorhexidine solution 0.05% ❑ Hydrogen peroxide solution 6% ❑ Povidone iodine solution 10% ❑ Other, please specify _____

C. Supportive therapy

Was the swelling around the wound significant? Yes ❑ No ❑

If yes, did the health worker treat patient for shock? Yes ❑ No ❑

If yes, what was done to treat shock? _____

Were any analgesics given to the patient? Yes ❑ No ❑

If yes, what analgesic was administered to the patient? _____

Was the patient immobilized? Yes ❑ No ❑

If yes, what was done to immobilize the patient? _____

D. Tetanus prophylaxis

Was the tetanus immunization history of the patient taken? Yes ❑ No ❑

If yes, what is the status? Patient previously immunized ❑ Patient not previosuly immunised ❑ Patient did not know ❑ Patient preferred not to reveal ❑

Was any tetanus treatment given? Yes ❑ No ❑

If yes, what was given? Tetanus Immune Globulin (TIG) ❑ Tetanus Toxoid Vaccine (TTV)

Reason why the choice above was considered (ask health worker)

_____

E. Antibiotic therapy

Were antibiotics administered to the patient? Yes ❑ No ❑

If yes, why were the antibiotics administered? Wound was moderate to severe ❑ Wound was presented after >8 hours ❑ Puncture wound (s) ❑ Wounds on hands, feet, or face ❑ Wounds involved underlying structures ❑ Patient immunocompromised ❑ Other, please specify

_____

If no, why were antibiotics not given? _____

If yes, was the choice of antibiotic based on culture & sensitivity test results? Yes ❑ No ❑

Which antibiotic was given? Amoxicillin/clavulanic acid ❑ Metronidazole ❑ Doxycycline ❑ Cotrimoxazole ❑ Other, please specify _____

F. Administration of Rabies Vaccine (RV)

Was the vaccination history of rabies taken for the patient? Yes ❑ No ❑

If yes, was the patient vaccinated prior to the bite occurring? Yes ❑ No ❑

If yes, how many doses of the vaccine has the patient ever received before the bite occurred?

_____

When was the last dose administered before the bite occurred? (Month / Year)

_____

In this bite, was the rabies vaccine (RV) administered? Yes ❑ No ❑

If yes, why? _____

If no, why? _____

Was the rabies immunoglobulin (RIG) administered? Yes ❑ No ❑

If no, why? _____

If no, is there a scheduled date on which it will be administered? Yes ❑ No ❑

If yes, what date will RIG be administered? (DD/MM/YY)

_____

If yes, where was it administered? (Tick all that apply) Infiltrated in the wound ❑ Infiltrated around the wound ❑ Infiltrated around the wound ❑ Injected IM at a site distant from the site of RV inoculation ❑

What type of RIG was used? Human rabies immunoglobulin (HRIG) ❑ Equine rabies immunoglobulin (ERIG) ❑

Of the RV and RIG, what was given first? RIG ❑ RV ❑

Was the wound sutured? Yes ❑ No ❑

Did the medical worker that attended to the patient wear gloves during the interaction with the patient? Yes, through interaction with patient ❑ Yes, for sometime ❑ Not at all ❑

Did the medical worker that attended to the patient wear any eye protection equipment during the interaction with the patient? Yes, through interaction with patient ❑ Yes, for sometime ❑ Not at all ❑

If rabies vaccine was given, what type was administered?

_____

What is the projected schedule for the vaccine? _____

In which part of the body was the vaccine administered? Deltoid / Shoulder ❑ Gluteal / Buttocks ❑ Other, please specify _____

For any of the choice above, which side of the body was the vaccine administered? Left ❑ Right ❑

How many doses of the vaccine have been given on this first day?

_____

Was the patient hospitalized? Yes ❑ No ❑

If yes, what reason (s) did the medical worker give for the hospitalization of the patient?

_____

If no, is the patient scheduled to return for treatment? Yes ❑ No ❑

If yes to above, when is the next appointment? (DD/MM/YY)

_____

SUMMARY OF OBSERVATIONS DURING TREATMENT OF DOG BITE INJURIES IN THE HOSPITAL

ASPECT	**Tik if done, cross-out if not done**	**COMMENTS, if any.**
HISTORY		
Bite history recorded (breed of dog, circumstances,		
Risk of rabies assessed (vaccination of dog and victim)		
Risk of tetanus assessed (vaccination of victim)		
Immunocompromising factors, such as splenectomy, cirrhosis and steroid therapy		
Preclinical care given for the bite wound (irrigated with soap, application of any treatments)		
EXAMINATION		
Careful documentation with diagrams of the wound		
Assess size and depth of the wound		
Degree of crush injury		
Devitalised tissue, nerve or tendon damage		

Involvement of bones and joints		
Full wound examination and debridement, with local or general anaesthetic, if necessary		
Radiography to exclude dental fragments, fractures, and bony damage, or in scalp wounds in children		
TREATMENT		
Wound irrigated with tap water or normal saline		
Foreign bodies (e.g. teeth) removed		
Thorough wound toilet and debridement done, where necessary		
Closure of the wound delayed, where possible		
Antibiotics administered depending on risk factors for infection		
Wound swab for culture was done		
Bite wound reviewed within 24-48 hours, especially if antimicrobial prophylaxis was administered.		
Tetanus prophylaxis administered.		
Rabies prophylaxis administered.		

Appendix X: In-depth interview guide on adherence to clinical guidelines by medical workers during treatment of dog bite patients

"Good morning / good afternoon / good evening. I am _____ (introduce self).

This interview is being conducted to get to understand what you do when treating dog bite injuries at this health facility. I am especially interested in what motivates what you do when managing the dog bite wounds.

If it is okay with you, I will be tape recording our conversation. The purpose of this is so that I can get all the details but at the same time be able to carry on an attentive conversation with you. I assure you that all your comments will remain confidential. I will be compiling a report which will contain all respondents' comments without any reference to individuals. If you agree to this interview and the tape recording, please sign the consent form as explained to you.

Ground rules

Before we start I would like to remind you that there are no right or wrong answers in this discussion. We are interested in knowing what you think, so please feel free to be frank and to share your point of view. It is very important that we hear your opinion.

1. What is your age?
2. What is your sex?
3. What is your professional ground?
4. Are you vaccinated against rabies yourself? Describe.
5. For how long have you been treating dog bite patients?
6. What type of treatment do you give the patients?
7. Please describe in detail, the steps you undertake when a patient is presented to you.
8. What steps do you take to prevent infection of the dog bite wounds?
9. What type of therapy do you give patients to prevent progression to rabies? Describe.
10. What circumstances prevent you from following the established guidelines?
11. Do you think it is important to inform patients if guidelines are not followed? Explain.
12. What may be the consequences of not following treatment guidelines?

13. Is there anything we have not discussed that you would want to talk about in line with management of dog bite injuries?

Thank you for taking the time to talk to me!!

Appendix XI: Laboratory sample form for dog bite wounds: bacterial isolates and their antimicrobial susceptibility

A. Sample details

- Patient Code / Laboratory Sample Number: _____
- Sample Collection Date: _____Sample Collection Time: _____
- Sample Collector Name: _____ Sample Collector Phone: _____
- Health Facility Name: _____
- Sampling Point / Area of wound: _____
- Sample acceptance: Accepted ❑ Rejected ❑
- Reasons for rejection: _____

B. Bacterial growth

Aerobic: Yes ❑ No ❑ Anaerobic: Yes ❑ No ❑

C. Bacteria isolated

Aerobic bacteria	Anaerobic bacteria

D. Susceptibility of micro-organisms isolated to antibiotics expressed as either Sensitive or Resistant

No	Bacterial species	Amoxicillin/clavulanic acid	Metronidazole	Doxycycline	Cotrimoxazole

Key: S = sensitive, R = resistance, I = Intermediate; zone diameter in standard millimeter units

Appendix XII: Follow up data tool to investigate treatment outcomes for dog bite injury patients

Date of data collection (DD/MM/YY): _____

Date of previous visit (DD/MM/YY): _____

Time respondent had reported to hospital: _____

A. Hospital name: _____Hospital code: _____

B. Respondent details

Name of patient: Surname _____ last name _____

Residence: Village_____ Sub county _____

C. Wound care

C1. Describe how you took care of the wound since the last visit: _____

_____

_____

_____

_____

C2. Did you apply anything to the wound in addition to the medication that was given to you?

Yes ❑ No ❑

C3. If yes, what did you apply to the wound? _____

_____

_____

C4. If yes, why did you choose to apply additional medicaments? _____

_____

_____

_____

C5. How do you assess the progress of the wound towards healing? _____

_____

_____

D. Assessment for infection of wounds

Parameter for Wound Inspection	Finding	Points	Score
Serous exudate	0%	0	
	1-20% of wound affected	1	
	20-39%	2	
	40-59%	3	
	60-79%	4	
	>=80%	5	
Erythema	0%	0	
	1-20% of wound affected	1	
	20-39%	2	
	40-59%	3	
	60-79%	4	
	>=80%	5	
Purulent exudate	0%	0	
	1-20% of wound affected	2	
	20-39%	4	
	40-59%	6	
	60-79%	8	
	>=80%	10	
Separation of deep tissues	0%	0	
	1-20% of wound affected	2	
	20-39%	4	
	40-59%	6	
	60-79%	8	
	>=80%	10	

Parameter	Finding	Points	Score
Antibiotic therapy for wound infection (additional treatment)	not given	0	
	given	10	
Drainage of pus under local anesthesia (additional treatment)	not done	0	
	done	5	
Debridement of wound under general anesthesia (additional treatment)	not done	0	
	done	10	
Isolation of pathogenic bacteria	none	0	
	present	10	
Stay as inpatient	not prolonged	0	
	prolonged (over 14 days)	5	

ASEPSIS score = SUM (points from 4 wound inspection parameters) + (points for antibiotics) + (points of pus drainage) + (points for wound debridement) + (points for bacterial isolation) + (points for prolonged hospitalization)

Appendix XIII: Ethical approvals for the study

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
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Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 04 FEB 2019 KNH/UoN-ERC P. O. BOX 20723 - 00202 NAIROBI

Ref: KNH-ERC/A/36

4th February, 2019

Stevens Kisaka
PhD Candidate
Reg. No.W80/52986/2018
Institute of Tropical and Infectious Diseases (UNITID)
College of Health Sciences
University of Nairobi

Dear Stevens

RESEARCH PROPOSAL – PRE-CLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA, UGANDA (P687/09/2018)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 4th February 2019 – 3rd February 2020.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e) Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

For more details consult the KNH- UoN ERC website **http://www.erc.uonbi.ac.ke**

Yours sincerely,

PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
The Director, Institute of Tropical and Infectious Diseases (UNITID), UoN
Supervisors: Prof. Sam Thumbi Mwangi, Prof. Fredrick E. Makumbi

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Our Ref: SS 4911 **25th March 2019**

Dr. Stevens Kisaka
Makerere University Kampala
Kampala

Dear Dr. Kisaka,

Re: Research Approval: Pre – Clinical Care, Clinical Management and Outcomes of Dog Bite Injuries in High Rabies Burden Districts of Wakiso and Kampala, Uganda

I am pleased to inform you that on **15/03/2019**, the Uganda National Council for Science and Technology (UNCST) approved the above referenced research project. The Approval of the research project is for the period of **15/03/2019** to **15/03/2021.**

Your research registration number with the UNCST is **SS 4911.** Please, cite this number in all your future correspondences with UNCST in respect of the above research project.

As Principal Investigator of the research project, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the research protocol or the consent form (where applicable) must be submitted to the designated Research Ethics Committee (REC) or Lead Agency for re-review and approval **prior** to the activation of the changes. UNCST must be notified of the approved changes within five working days.
3. For clinical trials, all serious adverse events must be reported promptly to the designated local IRC for review with copies to the National Drug Authority.
4. Unanticipated problems involving risks to research subjects/participants or other must be reported promptly to the UNCST. New information that becomes available which could change the risk/benefit ratio must be submitted promptly for UNCST review.
5. Only approved study procedures are to be implemented. The UNCST may conduct impromptu audits of all study records.
6. An annual progress report and approval letter of continuation from the REC must be submitted electronically to UNCST. Failure to do so may result in termination of the research project.

LOCATION/CORRESPONDENCE

Plot 6 Kimera Road, Ntinda

COMMUNICATION

TEL: (256) 414 705500
FAX: (256) 414 234579

Uganda National Council for Science and Technology

(Established by Act of Parliament of the Republic of Uganda)

Below is a list of documents approved with this application:

	Document Title	Language	Version	Version Date
1.	Research proposal	English	N/A	December 2018
2.	Informed consent forms	English and Luganda	N/A	December 2018
3.	Child assent forms	English and Luganda	N/A	December 2018
4.	Interview questionnaires	English and Luganda	N/A	December 2018
5.	Interview guides	English and Luganda	N/A	December 2018
6.	Observational checklist for clinical care practices during the treatment of dog bite injuries	English	N/A	December 2018
7.	Laboratory sample form for dog bite wounds: bacterial isolates and their antimicrobial susceptibility	English	N/A	December 2018
8.	Follow up data tool to investigate treatment outcomes for dog bite injury patients	English	N/A	December 2018
9.	Health education leaflet on prevention and management of dog bite injuries	English and Luganda	N/A	December 2018

Yours sincerely,

Isaac Makhuwa
For: Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Copied to: Chair, Mulago Hospital, Research Ethics Committee

TELEPHONE: +256-41554008/1
FAX: +256-414-5325591
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Website: www.mulago.or.ug

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO...

MULAGO NATIONAL REFERRAL HOSPITAL
P.O. Box 7051
KAMPALA, UGANDA

THE REPUBLIC OF UGANDA

14th January, 2019

Dr. Stevens Kisaka
Principal Investigator
PhD Candidate
University of Nairobi

Dear Kisaka

Re: Approval of Protocol MHREC 1518: "Pre-Clinical Care, Clinical Management and Outcomes of Dog Bite Injuries in High Rabies Burden Districts of Wakiso and Kampala".

The Mulago Hospital Research and Ethics Committee reviewed your proposal referenced above and granted approval of this study on its sitting held on 12th December, 2018.The conduct of this study will therefore run for a period of one (1) year from 12th December, 2018 to 11th December, 2019.

This approval covers the protocol and the accompanying documents listed below;

- Informed consent form for dog bite patients (English & Luganda languages)
- Assent form for dog bite patients (English & Luganda Languages)
- Informed consent form for health workers
- Informed consent form for veterinarians
- Informed consent form for traditional healers (Luganda)
- Interview questionnaire (English &Luganda languages)
- Key informant interview guide for health workers
- Key informant interview guide for veterinarians
- Observational checklist for clinical care practices during the treatment of dog bite injuries

This approval is subjected to the following conditions:

1. That the study site may be monitored by the Mulago Hospital Research and Ethics Committee at any time.
2. That you will be abide by the regulations governing research in the country as set by the Ugandan National Council for Science and Technology including abiding to all reporting requirements for serious adverse events, unanticipated events and protocol violations.
3. That no changes to the protocol and study documents will be implemented until they are reviewed and approved by the Mulago Hospital Research and Ethics Committee.

4. That you will submit this approved protocol and all accompanying documents for approval to UNCST before starting the study. In case of studies involving drug and medical devices, approval must be obtained from the National Drug Authority before starting the study.
5. That you provide quarterly progressive reports and request for renewal of approval at least 60 days before expiry of the current approval.
6. That you provide an end of study report upon completion of the study including a summary of the results and any publications.
7. That you will include Mulago Hospital in your acknowledgements in all your publications.

I wish you the best in this Endeavour.

APPROVED
APPROVAL DATE · EXPIRY DATE
12 DEC 2018 11 DEC 2019
MULAGO RESEARCH ETHICS COMMITTEE

DR. NAKWAGALA FREDERICK NELSON
CHAIRMAN- MULAGO HOSPITAL RESEARCH & ETHICS COMMITTEE.

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IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO...

MULAGO NATIONAL REFERRAL HOSPITAL
P.O. Box 7051
KAMPALA, UGANDA

THE REPUBLIC OF UGANDA

11th March, 2019.

Dr. Stevens Kisaka
Principal Investigator
Institute of Tropical and Infectious Disease
University of Nairobi, Kenya.

Dear Kisaka,

Re: Approval of Amendments for Protocol MHREC 1518: "Pre-clinical Care, Clinical Management and Outcomes of Dog Bite Injuries in High Rabies Burden Districts of Wakiso and Kampala, Uganda. Protocol Version 2.0".

The Mulago Hospital Research and Ethics Committee reviewed your request for approval of the amendments made to the above protocol. Therefore, the Committee hereby grants approval of the amendments till your anniversary date of 4th December, 2019

Summary of amendments made to the study as recommended by UNCST;

1. Added the parental/guardian informed consent form to the protocol, Version 1.0.

This approval is subject to the following conditions:

1. That the study site may be monitored by the Mulago hospital research and ethics committee at any time
2. That you will abide by the regulations governing research in the country as set by the Ugandan National Council for Science and Technology including abiding to all reporting requirements for serious adverse events, unanticipated events and protocol violations.
3. That you will submit this approved protocol and all accompanying documents for approval to UNCST before starting the study. In case of studies involving drug and medical devices, approval must be obtained from the National Drug Authority before starting the study.
4. That no changes to the protocol and study documents will be implemented until they are reviewed and approved by the Mulago Research and Ethics Committee.
5. That you provide quarterly progressive reports and request for renewal of approval at least 60 days before expiry of the current approval.
6. That you provide an end of study report upon completion of the study including a summary of the results and any publications.

I wish you the best in this Endeavour.

APPROVED
APPROVAL DATE 05 DEC 2018 EXPIRY DATE 04 DEC 2019
MULAGO RESEARCH ETHICS COMMITTEE
IRC

DR. NAKWAGALA FREDERICK NELSON
CHAIRMAN- MULAGO HOSPITAL RESEARCH & ETHICS COMMITTEE.
Vision: "To be the leading centre of Health Care Services"

Appendix XIV: Administrative approvals of the study

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MULAGO NATIONAL REFERRAL HOSPITAL
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KAMPALA, UGANDA

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO...

THE REPUBLIC OF UGANDA

DIRECTOR MULAGO HOSPITAL COMPLEX 6/2/19 RECEIVED

Dr. Nakwagala
Please handle
6/2/19

22nd January, 2019.

The Executive Director
Mulago National Referral Hospital

Dear Sir,

RE: RECOMMENDATION FOR ADMINISTRATIVE CLEARANCE.

The Mulago Hospital Research & Ethics Committee has reviewed the protocol entitled **MHREC 1518: "Pre-clinical Care, Clinical Management and Outcomes of Dog Bite Injuries in High Rabies Burden Districts of Wakiso and Kampala, Uganda"** by Dr. Stevens Kisaka as the lead Principal Investigator.

The study got an initial approval from Mulago Hospital Research & Ethics Committee for a period of one (1) year from 12th December, 2018 to 11th December, 2019

The study has met the following obligations;

1. Paid the MHREC Administrative review fees of 500,000/=
2. Paid institutional bench fees of 1,000,000/=
3. Agreed to comply with all institutional policies and regulations of Mulago national referral hospital
4. Agreed to provide end of study report and acknowledge Mulago hospital in all publications

The study is therefore recommended for your provision of administrative clearance by Mulago national referral hospital.

Yours sincerely;

22/01/19

DR. NAKWAGALA FREDERICK NELSON
CHAIRMAN- MULAGO HOSPITAL RESEARCH & ETHICS COMMITTEE.

Copied to;

1. **Dr. Stevens Kisaka**
2. **Head – Emergency Medicine Department MNRH.**

DR KISAKA
ADMINISTRATIVE CLEARANCE PROVIDED BY MNRH
11/2/19

Vision: "To be the leading centre of Health Care Services"

Stevens Kisaka,
Institute of Tropical and Infectious Diseases,
College of Health Sciences,
University of Nairobi, Kenya
February 25th, 2019

The hospital is very willing to collaborate with the student on the study

MEDICAL SUPERINTENDENT
ENTEBBE HOSPITAL
P. O. BOX 29, UGANDA
ENTEBBE
DATE 26/02/19

The Medical Superintendent,
Entebbe General Referral Hospital,
Entebbe Town,
Wakiso District, UGANDA

SUBJ: REQUESTING PERMISSION TO USE HOSPITAL AS A RESEARCH SITE

Dear Sir / Madam,

I am a Doctoral student in Institute of Tropical and Infectious Diseases, University of Nairobi, Kenya. My research is focussed on "PRE-CLINICAL CARE, CLINICAL MANAGEMENT AND OUTCOMES OF DOG BITE INJURIES IN HIGH RABIES BURDEN DISTRICTS OF WAKISO AND KAMPALA". The study has been cleared by the Institutional Review Board at Mulago National Referral Hospital (see protocol attached).

This study will gather information mainly on pre-clinical care, clinical management and outcomes of dog bite. Participants will mainly be dog bite patients and medical workers caring for them. This study is intended to provide information that may help to strengthen the dog bite prevention and treatment services in Kampala, Wakiso and the country at large.

I am therefore requesting you to provide administrative permission for this proposed study and guide me accordingly. Your clearance of the same will be highly appreciated. The necessary documentation is attached.

Thanking you,

Yours faithfully,

Dr. Stevens Kisaka
PhD Student,
UNIVERSITY OF NAIROBI

Appendix XV: Dissertation submission permission document

UNIVERSITY OF NAIROBI
FACULTY OF HEALTH SCIENCES

OFFICE OF THE ASSOCIATE DEAN, POSTGRADUATE STUDENTS & RESEARCH

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Telegrams: Varsity Nairobi
Email:assocdean-fhs@uonbi.ac.ke

Our Ref: W80/52986/2018

December 7, 2021

Stevens M. B Kisaka
Department of Medical Microbiology
Faculty of Health Sciences

Dear Kisaka,

NOTICE OF INTENT TO SUBMIT YOUR Ph.D THESIS

We wish to acknowledge receipt of your notice of intent to submit your Ph.D thesis dated October 4, 2021 entitled; ***"Pre – clinical care, clinical management and outcomes of Dog Bite injuries in high rabies burden districts of Wakiso and Kampala, Uganda"***. We also wish to acknowledge receipt of the abstract of the thesis. Please submit a soft copy of the thesis to the **Chairman, Department of Medical Microbiology.**

In addition you should run and submit an anti – plagiarism test on your thesis whose tolerance levels should be 15% and below.

Please note that you will be expected to show proof of acceptance for publication of two (2) papers in referred journals as a requirement for full Ph.D students before graduation.

We look forward to receiving a soft copy of your thesis within three (3) months from the date of this letter subject to having received and approved by Committee of Examiners from the Chairman.

Yours sincerely,

ASSOCIATE DEAN POSTGRADUATE STUDENTS AND RESEARCH, FACULTY OF HEALTH SCIENCES UNIVERSITY OF NAIROBI

PROF. EVELYN WAGAIYU
ASSOCIATE DEAN
POSTGRADUATE STUDENTS & RESEARCH

CC. Chairman, Department of Medical Microbiology
Dr. Sam Thumbi Mwangi

.../EC

Appendix XVI: Abstracts of the four (04) papers published from the study

PLOS ONE

RESEARCH ARTICLE

Epidemiology and preclinical management of dog bites among humans in Wakiso and Kampala districts, Uganda: Implications for prevention of dog bites and rabies

Stevens Kisaka[1,2,3]*, Fredrick E. Makumbi[2], Samuel Majalija[3], Alexander Bangirana[4], S. M. Thumbi[1,5,6]

1 University of Nairobi Institute of Tropical and Infectious Diseases, Nairobi, Kenya, **2** School of Public Health, Makerere University, Kampala, Uganda, **3** College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala, Uganda, **4** Department of Emergency Medicine, Mulago National Referral Hospital, Kampala, Uganda, **5** Rabies Free Africa, Washington State University, Pullman, Washington, United States of America, **6** Paul G Allen School for Global Animal Health, Washington State University, Pullman, Washington, United States of America

* bmkstevens@gmail.com

OPEN ACCESS

Citation: Kisaka S, Makumbi FE, Majalija S, Bangirana A, Thumbi SM (2020) Epidemiology and preclinical management of dog bites among humans in Wakiso and Kampala districts, Uganda: Implications for prevention of dog bites and rabies. PLoS ONE 15(9): e0239090. https://doi.org/10.1371/journal.pone.0239090

Editor: Wen-Jun Tu, Chinese Academy of Medical Sciences and Peking Union Medical College, CHINA

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Data Availability Statement: Data for the study cannot be shared publicly because the data contains potentially identifying information. The restriction has been imposed by the Mulago National Referral Hospital Research and Ethics Committee, Uganda, (MREC), an IRB that approved the study. Data are available from MREC (Email: nakwagala@yahoo.com) for researchers who meet the criteria for access to confidential data.

Abstract

In rabies endemic areas, appropriate management of dog bites is critical in human rabies prevention. Victims must immediately wash bite wound for 15 minutes with water, soap, and a disinfectant before seeking medical care. This study investigated the epidemiology of dog bites and the determinants of compliance to these pre-clinical guidelines requirements among dog bite victims from high rabies-burden areas of Wakiso and Kampala, Uganda. An explanatory sequential mixed-methods study design was used. Quantitative data were collected from 376 dog-bite patients at two healthcare facilities. Qualitative data were also collected through 13 in-depth interviews with patients, healthcare workers, herbalists, and veterinarians. Qualitative data were analyzed using a deductive thematic approach. Generalized linear models were used to determine factors associated with compliance. Nearly half (190, 51%) of the patients were from Wakiso District and 293 (77.9%) had grade II wounds. Most of the wounds (171, 45.5%) were on the legs. Two-thirds of the bites occurred in public places. Only 70 (19%) of the bite patients had complied with pre-clinical guidelines. Nearly half of the patients had applied substances that were not recommended e.g. herbs (47/193), antiseptics (46/193), "black stone" (25/193), and unknown creams (10/193). Factors negatively associated with compliance included: being aged 15 years or older, adjPR = 0.70 (0.47–0.92) and knowing the dog owner, adjPR = 0.65 (0.36–0.93). However, attainment of secondary or higher education, adjPR = 1.76 (1.24–3.79), being in employment, adjPR = 1.48 (1.09–2.31), perception that the dog was sick, adjPR = 1.47 (1.02–2.72) and knowledge about the dog's subsequent victim(s) adjPR = 0.35 (0.17–0.70) were positively associated with compliance. High occurrence of dog bites in public places by free-roaming dogs suggests the need for deliberate promotion of responsible dog ownership. Additionally, targeted health education may be required to improve the low compliance to pre-clinical guidelines.

PLOS ONE

RESEARCH ARTICLE

"As long as the patient tells you it was a dog that bit him, why do you need to know more?" A qualitative study of how healthcare workers apply clinical guidelines to treat dog bite injuries in selected hospitals in Uganda

Stevens Kisaka[1,2,3]*, **Fredrick E. Makumbi**[2], **Samuel Majalija**[3], **Alexander Kagaha**[4], **S. M. Thumbi**[1,5,6]

1 University of Nairobi Institute of Tropical and Infectious Diseases, Nairobi, Kenya, **2** School of Public Health, Makerere University, Kampala, Uganda, **3** College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala, Uganda, **4** School of Public Health, University of the Witwatersrand, Johannesburg, South Africa, **5** Rabies Free Africa, Washington State University, Pullman, Washington, United States of America, **6** Paul G Allen School for Global Animal Health, Washington State University, Pullman, Washington, United States of America

* bmkstevens@gmail.com

OPEN ACCESS

Citation: Kisaka S, Makumbi FE, Majalija S, Kagaha A, Thumbi SM (2021) "As long as the patient tells you it was a dog that bit him, why do you need to know more?" A qualitative study of how healthcare workers apply clinical guidelines to treat dog bite injuries in selected hospitals in Uganda. PLoS ONE 16(7): e0254650. https://doi.org/10.1371/journal.pone.0254650

Editor: Sharon Mary Brownie, Waikato Institute of Technology, NEW ZEALAND

Received: December 20, 2020

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Published: July 14, 2021

Data Availability Statement: Data for the study cannot be shared publicly because the data contains potentially identifying information. The restriction has been imposed by the Mulago National Referral Hospital Research and Ethics Committee, Uganda, (MREC), an IRB that approved the study. Data are available from MREC (Email: nakwagala@yahoo.com) for researchers who meet the criteria for access to confidential data.

Abstract

Dog-mediated rabies is on the increase in Uganda despite the availability of post-exposure prophylaxis (PEP). PEP procedures are expounded in the Uganda Clinical Guidelines (UCG) of 2016. We assessed adherence by health workers to UCG while managing dog bites in two PEP centers and obtained insights into motivations of their practices. Using qualitative methods, we observed the health worker-patient encounters, reviewed medical records, and interviewed 14 health workers that were involved in managing dog bite injuries. We used deductive thematic analysis to identify codes in themes developed from UCG. We found that much of the history of the bites was taken, but it was neither verified nor written down on the patient's file. Classification of wounds was inaccurate and ancillary laboratory assessments like culture and sensitivity tests were not conducted in all cases. Although antibiotics were given for both treatment and prophylactic purposes, the prescription was based on availability and affordability, not UCG recommendations. Rabies immunoglobulin (RIG) was not administered to deserving patients due to unavailability and high costs to the patient. Anti-rabies vaccine (ARV) was prescribed indiscriminately and some health workers attributed this to pressure from patients. Health education regarding prevention of dog bites was not given to patients due to time constraints on the side of the providers as a result of high caseloads at the emergency departments. Challenges to adherence to guidelines were identified as frequent ARV stock outs; inadequate cooperation among health facilities; and insufficient knowledge and skills on how injuries and rabies should be managed. We conclude that clinical management of dog bites is not fully in line with UCG. We argue that adoption of an integrated bite case management and cost-saving strategies as well as continuing medical education programs on rabies control and management could improve the clinical management of dog bites.

AAS Open Research

AAS Open Research 2021, 4:49 Last updated: 31 OCT 2022

Check for updates

RESEARCH ARTICLE

REVISED Delays in initiating rabies post-exposure prophylaxis among dog bite victims in Wakiso and Kampala districts, Uganda [version 2; peer review: 2 approved]

Stevens Kisaka [1-3], Fredrick Makumbi[2], Samuel Majalija[3], Gloria Bahizi[2,4], SM Thumbi [1,5]

[1]University of Nairobi Institute of Tropical and Infectious Diseases, University of Nairobi, Nairobi, 00254, Kenya
[2]School of Public Health, Makerere University, Kampala, 00256, Uganda
[3]College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala, 00256, Uganda
[4]Department of National Disease Control, Ministry of Health, Uganda, Kampala, 00256, Uganda
[5]Paul G Allen School for Global Animal Health, Washington State University, Washington, 001, USA

v2 **First published:** 15 Oct 2021, **4**:49
https://doi.org/10.12688/aasopenres.13311.1
Latest published: 29 Nov 2021, **4**:49
https://doi.org/10.12688/aasopenres.13311.2

Abstract

Background

Although rabies in dog bite patients is preventable through timely initiation of post-exposure prophylaxis (PEP), a number of barriers to achieving PEP exist. This study investigated the delays to initiation of PEP among dog bite patients in the emergency departments of two PEP centers in Uganda.

Methods

A cross-sectional study was conducted among dog-bite patients that presented to two selected rabies PEP centers. A semi-structured questionnaire was used to collect data. Delay to receive PEP was defined as reporting for PEP beyond 24 hours after the bite event. Generalized linear models were used to calculate prevalence ratios and the 95% confidence intervals as a measure of association between delay and patient factors.

Results

Out of 376 participants, just over half (53.5%) were males. The majority of participants (54.0%) were 15 years or older and 28.5% had no formal education. Just over three-quarters (77.9%) had category II dog bite wounds. Nearly 40% delayed to receive PEP, and median (inter quartile range) lag time between bite event and seeking medical care of 18 (41) hours. Compared to education level of secondary or above, patients with no formal education (adj. PR=4.06, 95% CI: 2.69 - 6.10) or primary education (adj.PR=2.15, 95% CI: 1.37 - 3.35), belonging to the lowest socio-economic tertile as compared to the highest (adj.PR=1.58, 95% CI: 1.10 - 2.28), knowing the owner of the

Open Peer Review

Approval Status ✓ ✓

	1	2
version 2 (revision) 29 Nov 2021	✓ view	✓ view
version 1 15 Oct 2021	✓ view	

1. **Enock Madalitso Chisati**, Kamuzu University of Health Sciences (KUHeS), Blantyre, Malawi

2. **Claude T. Sabeta**, World Organisation for Animal Health (WOAH), Pretoria, South Africa
University of Pretoria, Pretoria, South Africa

Any reports and responses or comments on the article can be found at the end of the article.

Kisaka *et al.*
Antimicrobial Resistance & Infection Control (2022) 11:142
https://doi.org/10.1186/s13756-022-01181-0

Antimicrobial Resistance and Infection Control

RESEARCH **Open Access**

The potential for the double risk of rabies and antimicrobial resistance in a high rabies endemic setting: detection of antibiotic resistance in bacterial isolates from infected dog bite wounds in Uganda

Stevens Kisaka[1,2,3*], Fredrick E. Makumbi[2], Samuel Majalija[3], Moses Muwanga[4] and S. M. Thumbi[1,5,6]

Abstract

Background: Post-exposure treatment for dog bites in humans aims at alleviating the risk of rabies and promoting wound healing. Wound healing may be complicated by bacteria. This study identified the different bacteria and their antibiotic susceptibilities in infected dog bite wounds (DBWs) in Uganda.

Methods: A cross-sectional study was conducted among 376 dog bite patients. Wound swabs from patients with infected DBWs were collected and inoculated into recommended media. They were cultured for both aerobic and anaerobic bacteria. All isolated bacteria were identified based on colony characteristics, gram stain, and standard biochemical tests. Molecular identification was performed for strains that were resistant to three or more antibiotics. Antibiotic susceptibility testing was conducted using the disc diffusion method following the modified Kirby-Bauer method. The data were analysed using Stata version 15 software.

Results: Approximately half of the patients (52.9%, 199/376) presented with infected wounds. Majority of the swabs (84.4%, 168/199) were culture positive, and yielded a total of 768 isolates where about half (52.9%, 406/768) were gram positive bacteria, and about two-thirds (64.6%, 496/768) were recovered from category II wounds. Among the gram positive bacteria, 339 (83.5%) were aerobes where *Staphylococcus aureus* (103, 30.4%), Coagulase-negative staphylococci (68, 20.1%), and *Corynebacterium spp* (33, 9.7%) had the highest prevalence. For the 362 Gram negative isolates, 217 (59.9%) were aerobes and the commonest isolates were *P. maltocida* (64, 29.5%), *Capnocytophaga canimorsus* (36, 16.6%) and *P. canis* (26, 12.0%). Gram-positive isolates were resistant to metronidazole (93.6%), oxacillin (68.5%), ceftriaxone (14.6%) and amoxicillin/clavulanic acid (14.0%). Gram negative isolates were resistant to metronidazole (100%), ampicillin (30.7%), oxacillin (29.3%), and doxycycline (22.9%). Multidrug resistance was in 105 (29.0%) and 121/406 (29.8%) of the gram-negative and gram-positive isolates, respectively. All gram-positive isolates were susceptible to vancomycin and ciprofloxacin.

Conclusions: Infection rates of DBWs in Uganda are high and the dominant bacterial isolates are *Staphylococcus aureus, Pasteurella spps*, and *Capnocytophaga canimorsus*. Multidrug resistance to commonly used antibiotics is high.

*Correspondence: bmkstevens@gmail.com

[1] University of Nairobi Institute of Tropical and Infectious Diseases, Nairobi, Kenya
Full list of author information is available at the end of the article