UNIVERSITY FOR DEVELOPMENT STUDIES

RETROSPECTIVE STUDY OF SNAKEBITE CASES AT THE TAMALE TEACHING HOSPITAL

AUSTIN GIDEON ADOBASOM-ANANE

2018

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UDS/CHD/0057/12

A THESIS SUBMITTED TO DEPARTMENT OF PUBLIC HEALTH SCHOOL OF ALLIED HEALTH SCIENCES UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN COMMUNITY HEALTH AND DEVELOPMENT

FEBRUARY, 2018

DECLARATION

Student

I hereby declare that this thesis is the result of my original work and no part of this work has been submitted for a diploma or degree in this university or elsewhere.

Name: AUSTIN GIDEON ADOBASOM-ANANE

Signature: …………………………….. Date: ………………………

Supervisor

I hereby declare that the preparation and presentation of the dissertation was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

Name: DR. PAUL ARMAH ARYEE (PhD.)

Signature: ………………………… Date: ……………..................

ABSTRACT

Snakebite poisoning is a public health concern to persons in agrarian environments and the northern region of Ghana is no exception. Youthful male agricultural and field workers have been reported to be at higher risk of snakebite, hence necessitating a study to determine the full extent of the snakebite problem in the Tamale Teaching Hospital. The objective of this study was to determine the epidemiological characteristics of the snakebite cases that were reported at the Tamale Teaching Hospital. A retrospective review of snakebite cases reported to the Tamale Teaching Hospital between January, 2013 and June, 2014 was carried out. A total of 150 cases were reviewed and the data analysed using SPSS version 20 with all chart drawn using Microsoft Excel 2013. The results of the study were, the prevalence of snakebite cases reported at the hospital was 89/100,000 population. Majority of the victims were between 15-59 years (65%). Males (64.7%) were the majority with farmers (46%) being the most affected. The majority of cases occurred in February, March and September mostly from the rural areas with the East Gonja district having the highest. The lower limbs were the commonly bitten site with most occurring during the daytime (68.67%) and outdoors (75.33%). Pain, swelling and bleeding were the commonest clinical presentations of the victims whiles 68.67% of them used first aid. The carpet viper was the only positively identified snake. Of the 78.67% of the victims who received ASV, 6.78% adversely reacted. The outcome of the cases were 84% cured, 12% discharged against medical advice and 4% dead. In conclusion, snakebite prevalence is high at the TTH, affecting mainly young agricultural male workers in the rural parts of the region. The carpet viper is responsible for most bites and ASV administration was the mainstay of snakebite management.

ACKNOWLEDGEMENTS

My profound gratitude goes first of all to the Almighty God for His magnificent providence and protection throughout this work.

To Dr. Paul Armah Aryee (my supervisor), I am profoundly grateful for the timely supervision, criticism, feedback and fine tuning this work.

Dr. Adam Atiku, and Dr. Mumin have also helped with the conception of the research idea and provided immense support. For this I am most grateful.

My next gratitude goes to my parents, Mr. Abraham Jude Anane and Madam Cecilia Akua Nsoah for the upbringing to be the independent and responsible person I have become.

To my sweet and lovely wife, Eunice Acheampomaa Ameyaw, I am highly indebted for the love you have showered upon me and standing with me throughout this work.

I am also ever grateful to the following persons for their contributions in diverse ways to this work; Kwaku Anane, Morgan Mensah, Mary Opoku, Mary Heera Dzaku, Ankamah Christian and finally Gideon Joshua Tia.

DEDICATION

To my family and friends who have been with me through it all, I dedicate this work.

This work is also dedicated to the various individuals who have survived snakebite in Ghana and all health professionals who in their diverse expertise are working to address this neglected public health challenge.

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LIST OF ABBREVIATIONS

A/E	Accident and Emergency
AKI	Acute Kidney Injury
ASV	Anti Snake Venom
BOST	Bulk Oil Storage Transport
CHPS	Community Health Planning Services
CK	Creatine Kinase
COGM	Cost of Goods Manufactured
CT Scan	Computer Tomography Scan
DALYs	Disability Adjusted Life Years
DHL	DHL Express
DHMT	District Health Management Team
ED	Effective dose
EMS	Express Mail Services
EMU	Emergency and Medical unit)
FEDEX	Federal Express
GPHC	Ghana Population and Housing Census
GSS	Ghana Statistical Service
ICU	Intensive Care Unit
IgG	Immunoglobulin G
IM	Intra muscular
MED	Minimum Edematogenic Dose
MHD	Minimum Hemorrhagic Dose
MMD	Minimum Myotoxic Dose
RCC	Regional Coordinating Council
REGSEC	Regional Security Council

RHD	Regional Health Directorate
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
TTH	Tamale Teaching Hospital
UNICEF	United Nations Children's Fund
USD	United States Dollars
VICC	Venom-induced consumptive coagulopathy
WBT	Whole Blood-clotting test
WHO/AFRO	World Health Organisation- Africa Regional Office
WHO/SEARO	World Health Organisation- South East Asia Regional Office
WHO	World Health Organisation

DEFINITION OF TERMS

Antivenom: A serum which acts against the effects of venom.

Coagulation: A pathological condition that reduces the ability of the blood to coagulate, resulting in uncontrolled bleeding.

Coagulopathy: Blood clotting

Envenomation: The introduction of venom into a body by means of the bite or sting of a venomous animal.

Epidemiology: The branch of medicine that deals with the study of the causes, distribution, and control of disease in populations.

Haemorrhage: To bleed substantially.

Neglected Tropical Diseases: A diverse group of tropical infections which are especially common in low-income populations in developing regions of Africa, Asia, and the Americas. They are caused by a variety of pathogens such as viruses, bacteria, protozoa and helminths.

Prevalence: The total number of cases of a disease in a given population at a specific time.

Sequelae: Any complication of a disease (snakebite).

Time lag: The time interval between the time of snakebite and the time victim reported to the hospital.

Venom: A poisonous secretion of an animal, such as a snake, spider, or scorpion, usually transmitted to prey or to attackers by a bite or sting

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 INTRODUCTION

This section of the dissertation covers the background to the study, the problem statement, justification, the objectives, significance and scope of the study, the conceptual framework and the description of the study area.

1.1 BACKGROUND TO STUDY

Snakebite is a neglected public health problem mainly affecting rural populations where medical resources are sparse. Health workers in both rural and urban settings are ill prepared to deal with snakebite cases and effective antivenom is often not available (Brown *et al.*, 2010). Communities need to be educated about what to do and what not to do in case of snakebite, and prior to transferring a patient to professional medical care (WHO/AFRO, 2010). Snake bite is also a common cause of preventable morbidity and mortality in most parts of the world (WHO/SEARO, 2005).

Snakebites have been with humanity from time immemorial and every person who lives or works in the country side is exposed to this health hazard. The exact burden of human suffering attributable to snakebite is difficult to determine because bites occur most commonly in rural areas where the first impulse of many bite victims is to seek the help of a trusted traditional healer rather than go to a Western-style hospital where their attendance may be recorded and reported to a national authority (Warrell, 1992) as cited in (WHO/AFRO, 2010). Every year, about five million people suffer snake bite related morbidity and mortality with about 100,000 of these cases developing into sequelae as a result of envenomation (poisoning resulting from snakebite) (Chippaux, 1998).

In Africa, population groups are not equally affected by snakebite. Snake bite rate is not evenly distributed among different population groups in Africa. For example, children account for 20%-40% of most snakebite cases in most published studies (WHO, 2010).

Farmers and other agricultural workers are the most common victims. The occupational aspect of snakebite must be better appreciated as the targeted workers, which include farmers, plantation workers, herdsmen and hunters, are prime food producers and therefore particularly valuable members of the community (WHO, 2010).

Snakebite envenoming constitutes a serious medical condition that primarily affects residents of rural communities in Africa, Asia, Latin America, and New Guinea (WHO, 2007).

It is an occupational, environmental, and domestic health hazard that exacerbates the already impoverished state of these communities (Harrison *et al.,* 2009). Conservative estimates indicate that, worldwide, more than 5 million people suffer snakebite every year, leading to 25,000–125,000 deaths, while an estimated 400,000 people are left with permanent disabilities (Gutiérrez *et al.*, 2010). Eight thousand amputations are thought to be performed annually in Africa alone (Chippaux, 2011).

However, community-based surveys illustrate that the actual burden of human suffering is likely to be even greater (Rahman *et al.*, 2010; and Mohapatra *et al.*, 2011). Despite this global impact, snakebite has received little attention from the global health community, the pharmaceutical industry, governments, and public health advocacy groups, and has a disappointingly low priority in the global health research agenda (Gutiérrez *et al*., 2013)

Snakebite has been found by several studies to affect more males than females (Gutiérrez *et al.*, 2006; Habib, 2013) .This preventable health hazard has also been found to affect mostly the younger workforce who are mostly involved in agricultural, and pastoral activities to fend for their families. (Habib, 2013; More *et al*., 2015). This leads untold economic consequences since some of these bread winners become permanently disabled or at worst die from poorly managed snakebite envenomation. (Gutiérrez *et al*., 2010; Chippaux, 2011).

Snakebite was added to the list of 24 neglected tropical diseases by the World Health Organisation in 2007 (WHO, 2007). Available data on snakebite suggest that the highest incidences of snakebites are recorded in Asia, Southeast Asia and Sub-Saharan Africa which are mostly developing countries (WHO, 2007; Robert *et al*,. 2009). Robert *et al.*, (2009) found that the group of persons mostly affected by the menace of snakebite is the poor in rural parts of the developing countries around the globe. These people do not have a political voice and hence this imminent danger to their health is largely underestimated and neglected.

In Sub-Saharan Africa, Snakebite is endemic and thousands of people are affected by this problem on yearly basis. (Habib, 2013) The agrarian nature of the sub-region and the fact that most of the populations of the countries are rural dwellers makes the situation much more serious. Ghana is no exception when it comes to the snakebite menace. The country is bedeviled with the problem of snakebites especially in the farming communities in the northern and southern parts. The northern region of

Ghana, is mostly rural and the main occupation of the natives is agriculture, hence the increased exposure to the risk of snakebites.

1.2 PROBLEM STATEMENT AND JUSTIFICATION

Conservative estimates indicate that, worldwide, more than 5 million people suffer snakebite every year, leading to 25,000–125,000 deaths, while an estimated 400,000 people are left with permanent disabilities (Gutiérrez *et al*., 2010 and WHO, Africa Regional Office,2010). Eight thousand amputations are thought to be performed annually in Africa alone (Chippaux, 2011). However, community-based surveys illustrate that the actual burden of human suffering is likely to be even greater (Rahman *et al*., 2010; Mohapatra *et al*., 2011).

Snakebites tend to be high in areas which have agriculture as the major occupation of the people. This makes the northern parts of Ghana a typical place that is plagued by the phenomenon of snake bites and its attendant complications. Coupled with the fact that there are several challenges militating against the easy access to timely and appropriate healthcare services, snakebites pose serious threat to the victim and mostly result in lasting morbidity or mortality.

There are widespread reports of rampant snakebites in the Northern region of Ghana but not many studies have been conducted to actually ascertain the extent of the problem. This motivated the study at the Tamale Teaching Hospital which serves as the tertiary referral hospital for the northern region and beyond. The study aimed at identifying the pertinent epidemiological variables pertaining to snakebite such as the prevalence, distribution, management and the outcome of the cases that were recorded at the Tamale Teaching Hospital between the periods of January, 2013 to July, 2014 using a retrospective cohort of cases.

1.3 RESEARCH QUESTIONS

The following were the questions the study sought to answer about snakebite cases at the Tamale Teaching Hospital;

1. What is the prevalence of snakebite cases at the Tamale Teaching Hospital?
2. What is the distribution of the snakebite cases reported to the Tamale Teaching Hospital?
3. What were the circumstances of the snakebites at the Tamale Teaching Hospital?
4. How was the snakebite cases at the Tamale Teaching Hospital managed?
5. What was the treatment outcome of the snakebite cases at the Tamale Teaching Hospital?
6. What relationship exist between the time lag, length of hospital stay and the treatment outcome of the snakebite cases?

1.4 OBJECTIVES OF THE STUDY

1.4.1 GENERAL OBJECTIVE

To determine the epidemiology of snakebite cases at the Tamale Teaching Hospital

1.4.2 SPECIFIC OBJECTIVES

1. To determine the prevalence of snakebite cases reported to the Tamale Teaching Hospital
2. To assess the distribution of snakebite cases reported to the Tamale Teaching Hospital

3. To determine the circumstances of the snakebite cases reported at Tamale Teaching Hospital

4. To explore the management of the snakebite cases at Tamale Teaching Hospital

5. To determine the treatment outcome of snakebite cases at Tamale Teaching Hospital

6. To assess the association between time lag, length hospital stay and the treatment outcome

1.5 SIGNIFICANCE OF THE STUDY

This study on snakebite is relevant to the growth and development of the body of knowledge on the 'Neglected Tropical Diseases' in the Sub-Saharan region in particular and the world in general. The study findings threw more light on the public health problem of snakebite in the northern region of Ghana and could serve us the basis for any advocacy and intervention to mitigate the consequence of snakebite in Ghana. The study also lays the foundation for further research into the phenomenon of snakebite in the northern regions and beyond.

There is an obvious gap in the data available on the prevalence, distribution, circumstances, clinical management and outcome of snakebite cases in Ghana in general and Northern region in particular. This study was a baseline collection of data on these very important parameters of snakebites and hence provides the platform for further research into the morbidity and mortality burden of snakebites in the country. This study also provides evidence-based data on snakebites cases for verification and referencing in the Tamale Teaching Hospital. The study may also provide a need for the development of a treatment or management protocol for the Tamale Teaching Hospital and other hospitals in the northern parts of Ghana and beyond.

1.6 SCOPE OF THE STUDY

The scope of this study was to determine descriptively the epidemiological and clinical features of the snakebite victims who were treated at the Tamale Teaching Hospital with the hope of getting a fair idea of the extent of the snakebite problem in the northern region.

1.7 CONCEPTUAL FRAMEWORK

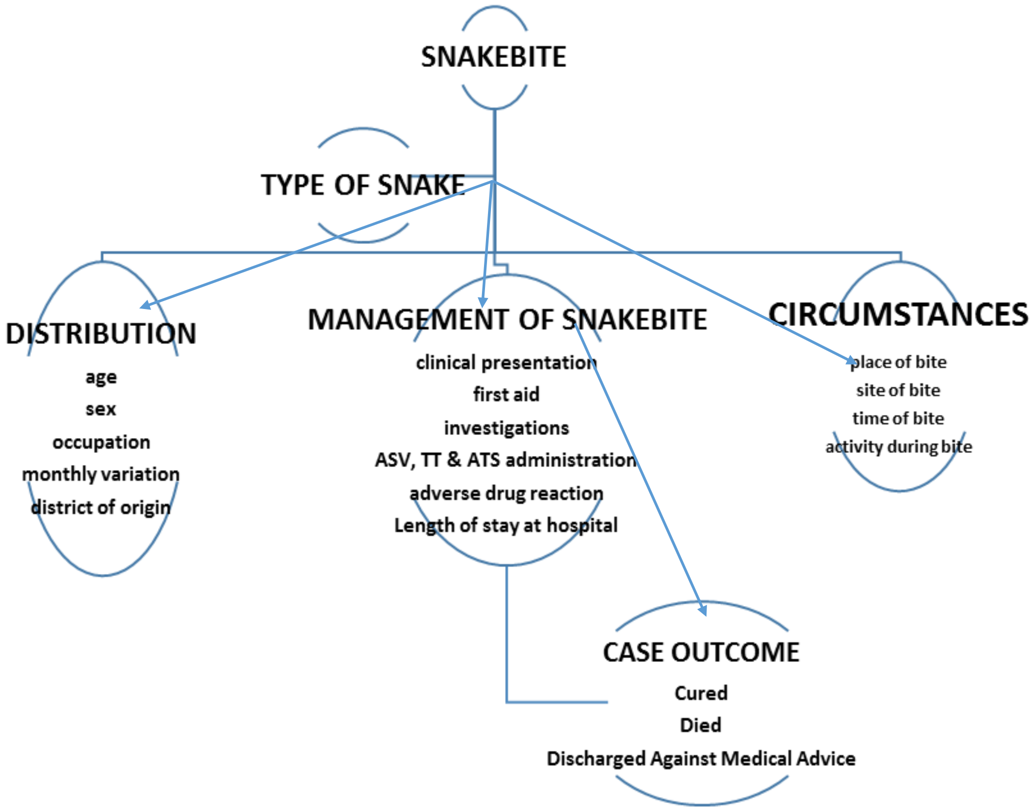

Figure 1.1: Conceptual Framework of Snakebite Study

Source: Field Survey, 2014 (Author's construct)

The concept of the public health problem of snakebite is situated in the context of which snake type was responsible for the envenomation influences the distribution of the problem (age, sex, occupation, monthly/seasonal variation of cases and the district of origin of the victims), the circumstances of the bite (place of bite, site of bite, time of bite, and activity during which the victim was bitten). The management of the cases (clinical presentation, first aid methods used by victims before reporting to the hospital, time lapse between bite and reporting to the hospital, initial laboratory investigations, ASV, TT/ATS, and antibiotic administration) would also influenced by the type of snake involved and ultimately the outcome of the cases after their treatment at the Tamale Teaching Hospital would also be dependent on how the cases were managed. (See figure 1.1 above).

1.8 STRUCTURE OF THIS THESIS

This thesis is organized into six chapters.

Chapter one comprises of the introduction, background to the study, the problem statement and justification, the general and specific objectives of the study, the significance of the study, the scope of the study, the conceptual framework, and vivid description of the study area.

In chapter two, relevant literature is reviewed and outlined by the APA system of annotation referencing. The literature review covered the areas such as the prevalence of snakebite, the distribution of snakebite in reference to age, gender, occupation, place of residence (rural or urban), the season in which the bite was suffered and the type of snake responsible for the bite. The circumstances surrounding the bite such as the part of the body bitten, the place where the victim was bitten, time of the bite and activity during which the bite was sustained and the time lag between the bite and hospital admission. The management of snakebite also covered the clinical presentations of snakebite victims depending on the various syndromes of known to be caused by specific snake species, the first aid methods used, recommended clinical management of snakebites and the outcome of the cases.

Chapter three is the methodology section where the study design and instruments, study population, sampling and sample size determination, the variables and data sources, the analysis and presentation, the measures for quality control, ethical considerations and the methodological limitations are outlined.

Chapter four describes the findings of the study in line with the specific objectives of the prevalence of snakebite, the distribution, and circumstances of the bites, the management and outcome of snakebite cases reported to the Tamale teaching hospital.

Chapter five discusses the research findings in the light of relevant scientific literature published on snakebite cases in Ghana and across the globe with reference to the specific objectives of the study.

The summary of key findings of this study, the conclusions based on the findings and recommendations in line with the conclusions are presented in chapter six.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter deals with the literature review of the study. The main purpose is to search for what other researchers have done and present it chronologically to the study objectives. The areas covered in the literature review include the prevalence of snakebite, the distribution of snakebite cases, the circumstances surrounding the snakebite cases, the clinical features and presentations of the various snakebites, the management of snakebites and the outcome of snakebite around the globe.

2.1 PREVALENCE OF SNAKEBITE

Snakebite envenoming is a common occurrence around the world especially in developing countries (WHO/AFRO, 2010). The World Health Organisation in 2009 added snakebite to the list of Neglected Tropical Diseases because of the enormous impact it has on the victims and the sheer number of people who suffer from snakebite around the globe (WHO, 2009). Snakebite is an established important cause of morbidity and mortality among the poor, rural tropical population (Warrell, 2010). Conservative estimates place the incidence of snakebites at about 5·4–5·5 million people being bitten by snakes each year, resulting in about 400000 amputations or permanent injuries, and between 20000 and 125000 deaths (Williams *et al.*, 2010).

Bites of venomous snakes cause significant morbidity and mortality in the rural tropics. Despite this, snakebite did not, until very recently, receive the attention it deserves as an important public health problem. The main reason for this was the paucity of robust epidemiological data on the disease burden associated with snakebite.(Ediriweera et al., 2016). The most recent estimates of the global burden of snakebite highlighted the need for good quality data on snakebite, particularly from nation-wide population-based studies (Kasturiratne *et al*., 2008).

The paucity of reliable data is partly related to inherent methodological difficulties, which include: poorly developed reporting and recording systems in countries with the highest burden, limitations in hospital-based data that often under-estimate the problem (Rahman *et al.*, 2010), and seasonal and geographical variation in bite incidence (Mohapatra *et al.*, 2011), all of which make extrapolations unreliable. Sound epidemiological data is relevant to both give credence to the magnitude of the problem and raise awareness of snakebite as an important but neglected public health issue, and to assist prioritization of resources for prevention and treatment. (Ediriweera *et al.*, 2016). Similarly, Snake bite injury data published by the World Health Organization estimates an incidence of five million snakebite cases worldwide each year (WHO, 2009). The incidence of snake bite mortality is particularly high in Africa, Asia, Latin America and New Guinea. In India alone there may be as many as 50,000 snake bite deaths each year (WHO, 2007) and about 32,000 snakebite deaths in Sub-Saharan Africa (Alirol *et al*., 2015).

Kasturiratne *et al*., (2008) estimated that the annual global totals for envenomings ranged from 421,000 to 1,841,000, and fatalities from 20,000 to 94,000. Based on the fact that envenoming occurs in about one in every four snakebites, between 1.2 million and 5.5 million snakebites could occur annually.

The true incidence or prevalence of snakebite envenoming worldwide proves difficult to determine due to the fact there are unreliable and insufficient epidemiological data available from the regions that the cases are most frequent (WHO, 2007;

WHO/AFRO, 2010; Habib *et al.*, 2015). This difficulty is due to the poor epidemiological reporting system in these mainly poor and rural settings coupled with the fact that the victims also prefer to use local herbs and treatments instead of going to the health centres where the records are obtained. Others also die on their way to these health centres or in their communities and as such are not captured by health records (Gutierrez *et al.*, 2006). Recent community based studies give a vivid idea that the global incidence could be far greater than has been reported earlier from the hospital-based studies. In the Eastern Terai region of Nepal, there were 162 snake bite deaths per 100,000 population per year (Sharma *et al.*, 2004) and in a region of Nigeria, the incidence of snakebites was 497 per 100,000 people per year, with a fatality rate of 12.2% (Habib, 2013). Extrapolating their findings to the population of the whole country of Sri Lanka, Ediriweera *et al.*, (2016) estimated the national numbers of snakebites, envenoming and deaths were 80514 (95% CI 71774–89254), 30543 (95% CI 26203–34883) and 464 (95% CI 45–884) respectively.

Analysis of the burden of human suffering attributable to these envenomings from a broader public health perspective reveals their greater impact. Evaluated using Disability Adjusted Life Years (DALYs), the impact of envenomings is very high (estimated in 2 million DALYs per year for sub-Saharan Africa) (WHO, 2007).

Studies in the developed countries however report much lower incidences of snakebites. Kreisfeld *et al.*, (2007) as cited in Tianyi *et al.*, (2017) found that there were 1512 snakebite hospitalisations between 2000 and 2002 in Australia, thus culminating in an annual crude rate of 3.9/100,000 population.

A study in the United States also revealed during the period 2001-2004, the estimated crude rate of snakebite presentations to emergency departments was 3.4 per 100,000 population, with an admission rate of 31% (O'Neil *et al*., 2007; WHO, 2009).

Chippaux, (2011) in his study on snakebites in Europe noted that they are rare medical emergency cases but may sometimes be severe and lead to complications. There was no significant variation in incidence from the north to the south of Europe. In the whole of Europe, including Russia and Turkey, the annual number of snakebite cases was estimated at 7992 (CI 95% = 6860–9178) bites, out of which approximately 15% were considered severe. The average number of deaths per annum was 4 (0.7–7.7) (Chippaux, 2011).

The tragedy of injury, disability and death from snakebite is something clinicians and community members witness daily in most parts of Africa, Asia and Latin America. The menace of snakebite is an ever present occupational and environmental hazard in these parts of the world especially among the poor and rural dwellers (Williams *et al*., 2010). Even though most of the cases are not accurately reported in these developing countries plagued by the snake bite canker, the current published reports and figures are still unacceptably high but this has not received the much needed funding and attention to mitigate its effects and impact on the poor (WHO/AFRO, 2010).

The snakebite estimates for Asia alone is in the regions of four million cases per year with an approximate 50% being from venomous snakes resulting about 100,000 deaths. (Kumar *et al*., 2014). The annual death rate due to snakebite envenoming in India is estimated to be 4.1/100,000 population. India has the highest number of deaths due to snake bites in the world with 35,000–50,000 people dying each year (More *et al*., 2015 and WHO, 2010a). In Nepal, snakebite incidence has been estimated to 20,000 annually and less than 200 deaths have been reported. (Gutiérrez *et al*., 2006). Pakistan has been estimated to be home to some 72 species of snakes and hence snakebites occur all over the country (Gutiérrez *et al*., 2006). In Vietnam from 1992 to 1998, an estimated 300000 snake bites were recorded per year, resulting in a death rate of 22%, which was predominantly seen among manual workers. (Dehghani *et al*., 2012).

Papua New Guinea is the country which has one of the highest number of snake species in the world (Halesha *et al*., 2013**).** In Iran, 69 species of snakes have been identified, of which 36 species are non-venomous, 25 species are venomous and 8 species are semi-venomous (Hansson *et al*., 2010; Hansson *et al.*, 2013). Snakebite is a serious public health problem in different parts of Iran, especially in rural areas. The recorded number of snakebites from 2001 to 2009, were approximately 5000 to 7000 per year, of which, approximately 7 deaths were reported each year. (Dehghani *et al*., 2012).

In the first ever direct estimates from a national mortality survey of 1.1 million homes in 2001–03 in India, Mohapatra *et al*., (2011) found 562 deaths (0.47% of total deaths) were assigned to snakebites, mostly in rural areas. This proportion represents about 45,900 annual snakebite deaths nationally (99% CI 40,900 to 50,900) or an annual age-standardised rate of 4.1/100,000 (99% CI 3.6–4.5), with higher rates in rural areas (5.4) and with the highest rate in the state of Andhra Pradesh (6.2). Annual snakebite deaths were greatest in the states of Uttar Pradesh (8,700), Andhra Pradesh (5,200), and Bihar (4,500). Thus, snakebite remains an underestimated cause of accidental death in modern India, (Mohapatra *et al*., 2011).

Snakebite envenoming comprises a major public health problem among communities of the savanna region of West Africa, notably in Ghana, Benin, Burkina-Faso, Cameroon, Nigeria and Togo (Chippaux *et al.*, 2007; Chippaux, 2008; Visser *et al.*, 2004). The precise incidence of snakebite is difficult to determine and is often underestimated but a global reappraisal estimated the occurrence in the West African region of 10,001 to 100,000 snakebite envenomings with an incidence of 8.9-93.3/100,000 persons per year (Kasturiratne *et al.*, 2008).

For this region, there is an estimated 1001 to 10,000 deaths and a mortality rate of 0.55.9/100,000 persons per year (Kasturiratne *et al.*, 2008). A more recent study using a meta-analytic approach estimated that over 314,000 bites, 7,300 deaths and nearly 6,000 amputations occur from snakebites annually in Sub-Saharan Africa (Chippaux, 2011; Habib, 2013).

Habib (2013) reports that in parts of the Nigerian savanna snakebite victims may occupy over 10% of hospital beds. For instance, in the Benue valley of Nigeria, the estimated incidence is as high as 497 per 100,000 population per year with 10 to 20% consisting of untreated mortalities. The saw-scaled or carpet viper *(Echis ocellatus)* has proved to be the most important cause of snakebite mortality and morbidity in the West African sub-region (Habib, 2013).

Visser *et al.*, (2004) in their study at the Mathias Hospital, Yeji-Ghana reported snakebites as an important cause of morbidity and mortality, with a case fatality rate of 11%(8/72).

Envenomation causes an estimated 1.8–2.5 million incidences per year with a mortality level of 100,000–125,000 persons annually and more than 100,000 individuals suffer from severe complications, which may end in amputation of the attacked limb (Molander *et al.*, 2012).

In a meta-analytic approach to his study of snakebite data in Sub-Saharan Africa from 1970-2010, Chippaux (2011) estimated the number of snakebite envenoming at 314,078 (CI 95% = 251,513–377,462), of which 95% occurred in rural areas. The annual mortality was estimated at 7,331 (5,148–9,568), of which 97% occurred in a rural environment. The annual number of amputations ranged from 5,908 to 14,614. Household surveys indicated that actual incidence and mortality were likely 3–5 times higher (Chippaux, 2011).

In another study, Brown (2012) reported the annual global incidence of clinically significant snakebite to be between 421,000 and 2.5 million with up to 500,000 occurring in Africa.

Several studies have established the fact that the largest number of snakebite envenoming occurs in developing countries, especially in Sub-Saharan Africa, Asia and Southeast Asia (WHO, 2007; Gutierrez, 2011).

2.2 DISTRIBUTION OF SNAKEBITE

This part of the literature review deals with the documented distribution of snakebite cases with regards to age, sex/gender, time of bite, site of bite among others.

2.2.1 SEX/GENDER DISTRIBUTION

Snakebite affects both males and females but not in equal proportions (WHO/AFRO, 2010). This trend has been verified in several studies across the globe (Gutiérrez *et al.*, 2006; Rao *et al.*, 2013; & Raina *et al.*, 2014).

Raina *et al.,* (2014) found in their study in India, that the majority of the snakebite victims were males. Other studies in the Southeast Asia region had similar results. For example, in their first ever direct estimates from a national mortality survey of 1.1 million homes in 2001–03, Mohapatra *et al*., (2011) found a higher number of snakebite mortality among males than females. A similar result was reported by Rao *et al*., (2013) as did Gutiérrez *et al*., (2006). Dehghani *et al*., (2012) found a predominant snakebite induced death rate of 22% among manual workers who are mostly males.

Even in Europe where the incidence of snakebite is a rare occurrence, coupled with a lesser male population. Gras *et al*., (2012)found males were more affected by the menace than females. Chen *et al*., (2011) in their study in Taiwan found a male preponderance of 62.3% of all the cases of snakebite which were studied. In another study in India, Ghosh, (2011) also found young males to the most affected by snakebite. Jamaiah *et al*., (2004) reported a higher incidence of snakebite in males (60.2%) in a study done in Malaysia.

In a study done in a hospital in north-central Nigeria, it was found that males dominated the number of cases admitted to the hospital on the account of snakebite (Godpower *et al*., 2011).

Kshirsagar *et al*., (2013) found in a study in rural India that male children (60.49%) were at a higher risk of being bitten by snakes as compared with female children (39.50%). More *et al*., (2014) found the same trend of male predominance in a study in Central India. Madhusudhana *et al.,* (2014) reported a male to female ratio of 18:4 in their study in North India. Deshpande *et al*., (2013) also found greater male (55.49%) patients than female (44.51%) patients. Adiga and Adiga, (2014) observed male preponderance in their study. As per the study by Dayananda *et al*., (2013) the patients were predominantly males (67.8%). Young agricultural workers, especially males, are the most highly affected group, making snake bite envenoming a greater concern for males' (WHO/AFRO, 2010). Bhalla, *et al*, (2014) mentioned similar findings in their study with males being 66% and females being 34%. (Kumar *et al*., 2014) also reported in their study a male preponderance of 73.6% and female 26.4%. Pandey *et al*., (2016) found 54% of the patients studied were male and 46% of the patients were female. Anitha *et al.,* (2017) also reported that males (76%) were more exposed to snake bite as compared to females (24%). The important imbalance of sex ratio of snakebites, while it is weak or absent for other venomous land animals, probably reflects the difference of risks, with regard to the distribution of animals and/or human activities. This could confirm that snakebites rather result from agricultural activities, assuming that they involve men more than women (Chippaux, 2015).

However, in a study in Kashmir, it was reported that the male to female ratio was 1:1 in the cases reviewed. (Ahmed *et al*., 2011). Another study in Nepal showed almost equal numbers of bites in females (50.3%) and males (49.7%) (Poudyal,*et al*., 2016). A female (64%) preponderance was also found by Kakaria *et al*., (2014)in a study in North-West India. Similarly, Alirol *et al*.,(2017) in their recent study reported 51.9% of the participants to be female with males being 48.1%.

2.2.2 AGE DISTRIBUTION

Studies that reported on age distribution of snakebites used varying age categorisations, whiles some are age group specific studies others covered all ages. Most however reported young men and working age class as the most affected

(Chippaux, 2011; Mohapatra *et al*., 2011; Ghosh, 2011; Ahmed *et al*., 2012; & Halesha *et al*., 2013). For instance, Chippaux (2011) in an extensive meta-analysis of literature on snakebite from 1970-2010 found the population most at risk was young men engaged in agricultural or pastoral labours. According to Mohapatra *et al*., (2011) snakebite deaths in India per their study peaked at ages 15-29. Gutierrez, *et al*., (2006) asserts that young agricultural workers particularly males and children are the most highly affected group. This finding is corroborated by Rao *et al*., (2013) who found higher incidence of snakebite in agricultural male workers aged 21 to 50 years. 'African populations are not equally affected by snakebite. Children account for 20%–40% of cases in most published studies' (WHO/AFRO, 2010). A study done in Kangar district Malaysia shows that prevalence of snake bites among the ages 10-39 was the greatest (Karunanayake *et al*., 2014).

Raina *et al*., (2014) also observed the patients of snake bite are mostly young and predominantly males. Snakebite was mostly recorded among persons with age ranging between 20 and 40 years (Ahmed *et al*., 2012). According to Pandey *et al*., (2016) the mean age of study participants was 35 years. Habib (2013) found the snakebites which are common in rural areas of tropical countries mainly affect the youth and agricultural workers who lacked political voice. Chippaux (2012) found that in Europe children are more affected by snakebite in spite of their respective proportion in the entire population. Chen *et al* (2011) reported the age range in their study in Taiwan to be 4-95 years. Most snakebite cases were seen in the age group of 10-19 years (33%) in a study conducted in West Malaysia (Jamaiah *et al*., 2004). Ghosh (2011) reported a higher rate of snakebite among the male and young population between 17 and 27 years old.

In a study of snakebite in children in rural India, Kshirsagar *et al*., (2013) found 'most of the bites were seen in children more than 5 years of age (89%). The average age for male children was 9.2 years and for female children was 8.6 years'. In another study in Central India by More *et al*., (2014) it was reported that most of the snake bites (30.6%) cases were in age group of 21 to 30 years followed by 31-40 years (22.0%). Dehghani *et al*., (2012) also found that the 'greatest rate of snake bites occurred among the 15-24 year old group, however, the lowest rate of snake bites were reported as 6% among the 10-14 and 45-54 year old patients. Snake bites were not occurred in the 0-4 and 5-9 year old age groups'. (Chaudhari *et al*., 2014) in another study in central India found the mean age to be 34.97 ± 14.07 years.

In the same line, Ahmed *et al*., (2011**)** in their study of snakebite envenomation in Children in Kashmir found the mean age of presentation was 8.9 years. Mean age was 31.16 years (range: 13-70 years) according to a study conducted by Madhusudhana *et al*., (2014) in north India. A similar study in southern India executed by Halesha *et al*., (2013) found the victims were predominantly males aged 20-40 years old. Deshpande *et al*., (2013) found the 'incidence of snake bite was most common in the age group of 21-30 years (27.36%), followed by 31-40 years and 11-20 years (20.27%). Adiga and Adiga, (2014) reported in their study that victims affected were mainly in their third decade (30 years). 'The most common snakebite population groups were children and young adults; 137 (56.4%) were less than 20 years old' (Wood *et al*., 2009). Majority of the snakebite cases reviewed was found to be between the ages of 21-50 .(Kumar *et al*., 2014). Anitha *et al*., (2017) reported that the majority of their victims were aged between their second and third decade of life.

2.2.3 OCCUPATIONAL DISTRIBUTION

Williams *et al*., (2010) asserts that for many people who live in the rural areas of Africa, Asia and Latin America, snakebite is an ever present occupational risk and environmental hazard. Snakebite is reported as the leading cause of morbidity and mortality among farmers, pastoralists, hunters and children according to the WHO/AFRO (2010). Deshpande *et al*., (2013) found similar trend as the majority of the snakebite victims in their study were farmers, plantation workers and laborers. It was found in a study by Chippaux (2011) that the population most at risk of snakebite was young men engaged in agricultural or pastoral labours.

Gutiérrez *et al*., (2006) reports that young agricultural workers, especially males as well as children are the most highly affected group. In their study, Rao *et al*., (2013) found similar higher incidence of snakebite among male agricultural workers. In Vietnam snakebite mortality was predominantly seen among manual workers (Dehghani *et al*., 2012). According to Harshavardhan *et al*., (2013) snakebite is a major medical emergency and an occupational hazard in India where farming is a major source of employment. WHO/SEARO (2010) showed that in South-east Asia, the risk of snakebite is strongly associated with certain occupations namely; farming (rice), plantation work (rubber, coffee), herding, hunting, fishing and fish farming, catching and handling snakes for food (in snake restaurants), displaying and performing with snakes (snake charmers).

WHO (2013) also presents that agricultural workers, women and children are the groups most at risk of snakebite. This is further stressed by WHO (2015) that the snakebite injury is often found among women, children and farmers in poor rural communities. The high-risk group of people suffering from snakebite according to Habib (2013) are mostly farmers, herdsmen and their rural-dwelling families. Habib

(2013) continued to report that in many tropical countries including Nigeria, snakebite mostly affects the youth and agricultural workers who lack a political voice to adequately represent their needs.

Kumar *et al.*, (2014) in their study also found the majority of snakebite victims were farmers (82.8%). Rao *et al.*, (2013) argues that persons working in agricultural fields are at risk of snakebite, because they neither employ advanced irrigation methods, nor take safety measures like wearing gloves, boots among others. Halesha *et al.*, (2013) reported in their study in Southern India that most of the victims were farmers (54.4%) and plantation workers (30.5%), confirming the suggestion that snake bite was an occupational hazard. Bhalla *et al.*, (2014) found the majority of the snakebites were among farmers in their study. Pandey *et al.* (2016) reported a similar trend in their Nepal study where farmers accounted for about 62% of the cases studied. Ziblim *et al.*, (2013) also reported in their study in the Northern region of Ghana that herbalists faced the challenge of snakebite during harvesting of medicinal plants. Anitha et al.(2017) found agricultural workers to be 70% of their study participants and another 10% and 4% being wood pickers and forestry workers respectively. This clearly affirms the popular notion that snakebite is predominantly an agricultural and outdoor occupational risk.

2.2.4 RESIDENTIAL DISTRIBUTION

Snakebite tends to be common in rural areas of tropical and subtropical nations than urban areas. This is clearly seen in a variety of studies conducted in various countries around the globe. Snake bite is considered as a neglected disease that afflicts the most impoverished inhabitants of the rural areas in the tropical developing countries (Halesha *et al.*, 2013). Raina *et al.*, (2014) reported that snake bite is an established important cause of morbidity and mortality among the poor, rural tropical population.

Mohapatra *et al*., (2011) also found that '562 deaths (0.47% of total deaths) were assigned to snakebites, mostly in rural areas.' Harshavardhan *et al*., (2013) found that in India the number snakebite mortality was high among predominantly young, healthy and the working populations in rural areas where agriculture was the major source of employment.

WHO (2013) published that snake bites are most common among people living in rural, resource-poor settings, who subsist on low-cost, non-mechanical farming and other field occupations. Snakebite injury is also often found among women, children and farmers in poor rural communities in low- and middle-income countries. (WHO, 2015). In another study, Halesha *et al*., (2013) it was found that in the tropics, snake bite is a rural and an occupational hazard among farmers, plantation workers, herders and hunters (81.1% from rural areas). Snake bite was noted pre-dominantly in the rural agricultural population of India, with male predominance. (David *et al*., 2012). Rural prevalence of snake bite was 117 out of 150 cases where as the prevalence in urban area was 33 out of 150 cases (Bhalla *et al*., 2014).

WHO/AFRO, (2010) referenced Warrell (1992) that bites occur most commonly in rural areas where the first impulse of many bite victims is to seek the help of a trusted traditional healer. In West Africa, snakebite envenoming comprises a major public health problem among communities of the savanna region notably in Benin, Burkina-Faso, Cameroon, Ghana, Nigeria and Togo according to Habib (2013); Habib *et al*.,(2015).

2.2.5 SEASONAL/MONTHLY DISTRIBUTION

There is significant seasonal variation in snakebite incidence that is attributable to climate, especially to rain fall and temperature, which determine annual cycles of agricultural activity (Gutiérrez *et al.*, 2006). Seasonal variation in the incidence of snake bite was observed in another study with maximum number of bites occurring in rainy season between June to October and highest number of cases during August (More *et al.*, 2014).

The bite environment was recorded in 43% of cases and it occurred outdoors—while working or sleeping in the open, during summer months with the predominant incidence being in the rainy season—June to September **(**David *et al*., 2012**).**

Ahmed *et al.,* (2012) in their study, found that all the cases recorded were in the months of April to November. Majority of which were recorded in the month of August and no case recorded between December and March. Similarly, most snakebite patients were bitten during the months of July to September in another study by Kshirsagar *et al.,* (2013).

Rao *et al*., (2013) also reported that the majority of snakebite occurred in rainy and summer months probably due to flooding of the holes, termite mounds during the rains and heating of the ground in summer, forcing the snakes to encroach and invade the surroundings of human dwellings.

According to Ahmed *et al*., (2011), envenomation was reported between May and August, which is an active season for vipers. Also Wood *et al*., (2009**)** reported data that showed a rising trend in snakebites in the summer months

Another study in India found that snakebite cases occurred most frequently in the summer and rainy seasons (Ghosh, 2011). Chaudhari *et al.,* 2014) also determined that 63.4% of bites occurred during rainy season in their study. Again, higher incidence of snakebite was found in summer (March to May), followed by monsoon (June to September) (Bhalla *et al.*, 2014*)*.

Dehghani R *et al.*, (2012), in a study conducted in the Kashan region of Pakistan revealed that the highest incidence of snake bites took place in summer and the lowest was in autumn with no snake bites were recorded in winter. Snake bite cases reached a peak in August, but no cases were recorded from November to March. Incidence of snakebites was highest in post monsoon in another study by Adiga and Adiga, (2014). The change in the seasonal incidence is not marked in northern Brazil while in south, incidence decreases be- tween April and May, and from September to October. (Chippaux, 2015).

2.2.6 SNAKE TYPES INVOLVED IN BITES

WHO (2009) estimates that there are over two thousand (2,000) species of snakes known worldwide, with about 400 of these being poisonous. These snakes belong to the families, Elapidae, Viperidae, Hydrophidae and Colubridae. Viper bites are more common than other poisonous snakebites in human beings (WHO/AFRO, 2009). Yasunaga *et al.,* (2011) reported that venomous snakes are widely distributed in almost all countries between latitudes 50°N and 50°S.

There are estimates of more than 3500 species of snakes found around the world of which less than 10% of which are venomous (WHO, 2009). However, Harshavardhan *et al.*, (2013) also reports that there are over 2,000 species of snakes are known worldwide, of which around 400 are poisonous and these snakes belong to the families, Elapidae, Viperidae, Hydrophidae and Colubridae. India is known to have about 216 snake species, out of which 52 are venomous (More *et al.*, 2015). On the African continent 400 snake species occur, most are relatively harmless.

Approximately 100 species are medically important, of which 30 are known to have caused human deaths. The venomous species of medical importance are members of the following four families: Atractaspididae, Colubridae, Elapidae and Viperidae (WHO/AFRO, 2010). These venomous snakes are spread across the African but some particular snake species are usually found in only one of the three vegetation zones-forest, savannah or desert. However, some species, may be found in both intermediate zones-woodland or semi-desert. (WHO/AFRO, 2010).

Elapids (cobras, kraits, mambas, among others) as well as vipers, and in some regions, sea snakes cause the highest incidence of snake bites in South Asia, Southeast Asia and sub-Saharan Africa (David Suresh *et al.*, 2012).

Out of the estimated 1,250, 000 deaths that occur out of 2,500,000 poisonous snake bites worldwide every year, India accounts for 10,000 deaths (Harshavardhan *et al.*, 2013). In Iran, 69 species of snakes have been identified, of which 36 species are non-venomous, 25 species are venomous and 8 species are semi-venomous (Dehghani *et al.*, 2012*)*. There are 72 species of snakes which can be found in different parts of Pakistan (Dehghani *et al.*, 2012*)*. In their study, Karunanayake *et al.*, (2014) found that nocturnal bites while sleeping were caused by common kraits (Bungarus careuleus) and Hump-nosed pit vipers (Hypnale hypnale) which accounted for highest number of snake bites in Sri Lanka.

In another study, Jamaiah *et al.*, (2004) reported that the snakes which were positively identified included the common cobras (Naja naja) (73%), Malayan pit vipers (Agkistrodon rhodostoma) (24%) and sea-snakes (3%).

According to More *et al., (2014*) the four snake species popularly known to be dangerously poisonous to man are spectacled cobra (*Naja naja*), common krait

(*Bungarus caeruleus*), saw-scaled viper (*Echis carinatus*) and Russell's viper (*Daboia russelii*) with the common krait being most common poisonous snake among them.

Most severe cases of snake bite envenoming are inflicted by species of the family Elapidae (cobras, kraits, mambas, Australasian species, and sea snakes) and the family Viperidae (rattlesnakes, lance-headed pit vipers, and true vipers). The species causing the largest numbers of bites and fatalities are Echis sp. (saw-scaled vipers) in northern Africa, Bothrops asper and B. atrox (lance-headed pit vipers) in Central and South America, and Naja sp. (cobras) and Bungarus sp. (kraits) in Asia .Many other species, although not responsible for a large number of cases worldwide, constitute a serious problem in specific regions (Gutiérrez *et al*., 2006).

The type of snake is designated as poisonous or non–poisonous depending upon the development of clinical features during a snakebite (Kshirsagar *et al*., 2013). Attempts to record reptilian fauna of Himachal Pradesh have revealed presence of venomous snakes like *T. albolabris* (white lipped pit viper), *G. himalayanus* (Himalayan pit viper) and *N. aoxiana* (black cobra) in addition to the common "Big 4" - the Indian cobra (*N. naja*), the common krait (*B. caeruleus*), the Russell's viper (*D. russelii*) and the saw-scaled viper (*E. carinatus*). It is important that snakes belonging to Viperidae group have been abundantly found up to an altitude of 4850 m" (Raina *et al*., 2014). Bhalla *et al*., (2014) also identified the cobra, viper, Krait, and *echis carinatus* as the snakes that had bitten the victims.

In West Africa, the carpet viper (*Echis ocellatus*) envenomation is a common occurrence with rapid loss of blood coagulability and spontaneous haemorrhage (Habib and Warrell, 2013). Godpower *et al*., (2011) in their study conducted in Nigeria determined that in 54 cases (75%) the snake was identified as a carpet viper

(*Echis ocellatus*), with the remainder unidentified. Snakes such as puff adders (Bitis arietans) also kill and injure many domestic dogs and grazing animals (WHO/AFRO, 2010).

In the West African savanna region, envenoming by *Echis ocellatus* is the leading cause of snake bite morbidity and mortality, but effective antivenoms are scarce and expensive (Abubakar*et al.*, 2010). The Puff adders (*Bitis arietans*) almost certainly a species complex, is thought to be responsible for the majority of serious venomous snake bites throughout Africa as a whole. Local swelling is often very extensive, commonly extending to involve the entire bitten limb and spreading to the trunk. This extravasation of plasma causes hypovolaemic shock, a common presenting feature (WHO/AFRO, 2010).

Gaboon vipers (*Bitis gabonica* and *Bitis rhinoceros*): These giant vipers, now believed to be two separate species western (*B. rhinoceros*) and eastern (*B. gabonica*), are the commonest causes of snakebite in some focal areas of the rainforest, for example in southern Nigeria. It is surprising that so few cases of envenoming have been reported in view of their wide distribution, prodigious size, enormous fangs and massive yield of highly potent venom. Local effects of envenoming may be less severe than those produced by puff adder bites, but swelling, bruising, blistering and necrosis are common. Systemic symptoms may be early and dramatic. Cardiovascular abnormalities, including hypotension and shock, arrhythmias and ECG changes, are reported. Spontaneous systemic bleeding is a common feature, while haemostatic abnormalities include thrombocytopenia and evidence of thrombin-like and fibrinolytic activities (WHO/AFRO, 2010).

Saw-scaled or carpet vipers (*Genus Echis*): This genus of vipers is of enormous medical importance. It is widely distributed in the northern third of Africa from Senegal in the west, to Egypt and the horn of Africa in the east, north to the countries bordering the Mediterranean and south to the Tana River in Kenya. Throughout this range, it is usually the most important cause of human snakebite morbidity and mortality. In Africa, bites are most common in West Africa, where *Echis ocellatus* is the most important species. In northern Nigeria, only 4% of patients admitted to the hospital with proven *Echis ocellatus* bite lacked signs of envenoming, the lowest rate of “dry bites” reported in any large case series of snake bites. The remainder had both local and systemic envenoming. Some 12% developed local blistering and 9% developed necrosis, sometimes requiring amputation or skin grafting. Local swelling and bruising may be extensive. Coagulopathy (attributable to venom prothrombin and Factor X- activators) was universal, resulting in persistent local bleeding and bleeding from recent wounds. In 55% of patients there was spontaneous systemic bleeding, usually from the gingival sulci. Thrombocytopenia was present in only 7%. Other common sites of spontaneous sytemic bleeding are nose, floor of the mouth, sub-conjunctival, gut, retroperitoneal, extrapleural, genito-urinary tract (haematuria), uterus in pregnant women (ante- and post-partum haemorrhage), subarachnoid and intracerebral. Renal failure is very uncommon unless the patient has suffered profound shock which may result in bilateral renal cortical necrosis which has been reported from Kenya (*Echis pyramidum*) and Saudi Arabia (*Echis coloratus*). In Nigerian studies, the case fatality of 3.6% was attributable to haemorrhagic shock (3 cases) and intracerebral haemorrhage (WHO/AFRO, 2010).

2.3 CIRCUMSTANCES OF THE SNAKEBITES

In this section, the researcher reviewed the relevant literature on studies conducted with regards to the various circumstances under which the snakebite occurred among others. These include the site of bite, place of bite, time of bite, activity during victim was bitten, the time of presentation to the hospital, and the time lag between bite and reporting to the hospital.

2.3.1 SITE OF BITE

The site of bite as used in this work refers to the part of the body that was bitten in the cases of snakebite reported. The sites usually implicated in snake bite cases include the upper limbs (hands), the lower limbs (legs), the trunk of the body and the head.

Several studies in other parts of the globe have found the lower limbs to be the most common site of bite in snakebite cases (Karunanayake *et al.*, 2014; Chaudhari *et al.*, 2014; Raina *et al.*, 2014).

According to a study done in Bangladesh, the most common bite site were the lower limbs (Rahman *et al.*, 2010) One hundred and ninety-seven (75.8%) had bite on lower limb and 62 (23.8%) on upper limbs. (Rahman *et al.*, 2010)

Lower limbs were the commonest site of bite which was followed-up by upper limbs. More exposed sites of the body were the commonly bitten sites as reported elsewhere. Bites on the uncommon sites like head and trunk are mostly due to nocturnal species biting people who are asleep (Raina *et al.*, 2014).

Kumar *et al.*, (2014), reported the site of bite in majority of the cases was in the lower limbs, next was in upper limbs and the least cases were in the head and neck region. Kshirsagar *et al.*, (2013) also found the lower limbs were the most common site of bites where marks were seen in 120 (74.04%) patients. This was followed by upper limbs which had 32 (19.75%) bite marks and other sites had 10 (6.17%) marks. Commonest site of snake bite was the lower extremity (65%) and followed by upper extremity (35%) (More *et al.*, 2015).

Karunanayake *et al.*, (2014) according to the findings of their study, revealed majority of bites occurred during the day-time and the lower limbs were the most common bitten site. Similarly, David *et al.*, (2012) found the bite site was mostly in the lower limbs.

The most frequently bitten site was lower limbs and foot happened to be the most common site (Raina S *et al.*, 2014). Halesha *et al.*, (2013) likewise found the lower limbs to be the most common bite site (67.2%). Rao *et al.*, (2013) reported similar findings with lower limbs being the frequent sites of bite, followed by upper limbs. Anitha et al. (2017) found the commonest site of bite was the low limb (78%) followed by the upper limb (20%). Monteiro *et al.*,(2012) similarly found 57% of the cases in their study sustained the bites on the lower limbs.

However, some other studies have found the upper limbs to be the most frequent site of bite. Site of Levantine viper bite was hand (in three) and foot (in two) as reported by Ahmed *et al.*, (2011). A study done in Jaffna peninsula Sri Lanka in 2011 mentions that 31% of patients were bitten on the fingers (Karunanayake *et al.*, 2014). Another study done in North Indian hospital have demonstrated that upper limbs were bitten in (47%) of victims (Alirol *et al.*, 2010; Karunanayake *et al.*, 2014.)

Tan *et al.*, (2010) reported an equal proportion of his study subjects being bitten both on the upper and lower limbs.

Patients bitten on the face and scalp region is not described in many previous studies done in other countries in the world. However a study done in North India has observed that 7% of bites occur in the region of head and neck (Sharma *et al.,* 2013; Karunanayake *et al.,* 2014). The finding of this study is similar to the finding of our study with regard to victims sustaining bites in the region of head and neck (Karunanayake *et al.,* 2014).

2.3.2 PLACE OF BITE

Snakebites usually occur in two categorical places, thus indoors and outdoors. Karunanayake *et al.,* (2014) reported in their Sri Lankan study that most of the indoor bites occurred while victims were sleeping on the floor and such nocturnal bites were caused by common kraits (*Bungarus careuleus*) and Hump-nosed pit vipers (*Hypnale hypnale*). In the same study, it was reported that the majority of Russell's viper (*Daboia russelii*) bites (80%) occurred at night while the victims were walking outdoors. In North India most of the bites (61%) occurred when patients were asleep. (Sharma *et al*., 2005; Karunanayake *et al.,* 2014)

David *et al.*, (2012) also found the bite environment was outdoors—while working or sleeping in the open, during summer months. Punguyire *et al.,(2013)* in their study at the Kintampo Municipal hospital, reported that almost all the cases they studied were bitten when they were walking through agricultural fields.

According to Alirol *et al*.,(2010), cobra bites typically occurs outdoors in the afternoons. In their study in a tertiary care centre in Southern India, (Halesha *et al*., 2013), reported that about 82.7% of the snakebites occurred outside. Similarly, 80% of the cases in another study in India were bitten outdoor while the victims were on the field, garden or the bus station(Rao *et al*., 2013). Increased human-snake interactions outdoors such as roads and agricultural fields tend to lead to high incidence of snakebites (Pandey *et al.*, 2016). Adiga & Adiga (2014) also found about 80% of the snakebite cases in their study in Karwar occurred outdoors and the 20% indoors. Unintentional child injuries such as snakebite occurs outdoors whiles the children are walking, playing or working in the fields. (Pant *et al.*, 2014). Vaiyapuri *et al.*, (2013) also reported over 79% and about 15% of their study cases occurred outdoors and indoors respectively.

2.3.3 THE TIME OF BITE

The time of bite corresponds to the outdoor activities and relative abundance of diurnal and nocturnal snakes (Raina *et al.*, 2014). Envenomation occurred during daytime according to Ahmed *et al.*,(2011). It was also reported that snakebite occurred mostly at day time (Rao *et al.*, 2013). Along the same line, Halesha *et al.*, (2013) found that most of the bites occurred during the day time (70.5%). Bhalla, *et al., (2014)* noted 12% cases during day time

Most saw-scaled viper (*Echis carinatus*) bites occurred in the night, outdoors (Gnanathasan *et al.*, 2012). Madhusudhana *et al.*, (2014) reported of snake bite in the night during sleep. In another study, the majority of the victims were bitten between 6 pm and 6 am outdoors (Karunanayake *et al.*, 2014). However a study done in Jaffna peninsula Sri Lanka by Kularatne *et al.*, (2012) shows most saw-scaled viper (*Echis carinatus*) bites occurred during daylight.(Rao *et al.*, 2013) reported in their study that about 80% of the fatal snakebite cases occurred during the daytime.

2.3.4 ACTIVITY DURING WHICH THE BITE WAS SUSTAINED

Farmers or people involved in farming related activities accounted for more than half of the victims of snakebites (Adiga and Adiga, 2014).

Snake bites are most common among people living in rural, resource-poor settings, who subsist on low-cost, non-mechanical farming and other field occupations. Agricultural workers, women and children are the groups most frequently bitten by snakes (WHO, 2013). Snake-bite is an occupational disease of farmers, plantation workers, herdsmen, fishermen, snake restaurant workers and other food producers (WHO/SEARO, 2010). Most of the victims were males at risk of snake bites while farming (Rao *et al.*, 2013). The risk of snake-bite is strongly associated with occupations: farming (rice), plantation work (rubber, coffee), herding, hunting, fishing and fish farming, catching and handling snakes for food (in snake restaurants), displaying and performing with snakes (snake charmers), manufacturing leather (especially sea snakes), and in the preparation of traditional (Chinese) medicines (WHO/SEARO, 2010).

2.3.5 TIME LAG BETWEEN THE BITE AND HOSPITAL ADMISSION OF THE CASES

The time lag refers to the difference between the time of bite and the time during which the victim reached the hospital for treatment. Rao *et al.*, (2013) said that the first one hour after the snakebite is the most crucial period to initiate treatment. It was found in their study that there was an average time lag of 2.5 hours, which was attributed to ignorance, callous attitude towards the dangerousness of the situation, indulgence in practice of unscientific methods of therapy and lack of transportation facilities (Rao *et al.*, 2013).

Ahmed, *et al.*, (2011) also reported the mean arrival time at hospital after bite to be 3.8 hours (range 2-6 hours). The time period (lag) ranged between 3 and 9 h approximately (mean ±SD was 5.3 ±1.4). The lag time gradually decreased from 2004 to 2009 (6.3 ± 2.2 in 2004 to 4.3 ± 1.3 in 2009,) (Ahmed *et al.*, 2012)

Majority of the patients could reach the hospital and got primary treatment within 12 hours of snake bite incidence. In the scientific literature, the mean time taken by the patients to receive hospital care ranged from 0.5 to 10 h (Kumar *et al.*, 2014). Early reporting to the hospital may reflect the proximity of health care facilities and better connectivity by roads in the area. Delayed arrival to the hospital could be one of the major causes of increased mortality. Factors that could delay seeking health care include lack of transport facilities and inability to afford transportation, trying traditional and folk medicine first rather than coming to the health care facilities. The mortality rate form snake bite is low, (Ahmed *et al.*, 2012) and if the victim is treated without losing too much time, this mortality is potentially preventable' (Kumar *et al.*, 2014). Anitha *et al.*, (2017) reported that most of their cases were admitted in the hospital between 2 to 4 hours of the bite and the maximum time lag was 48 hours.

Godpower *et al.*, (2011) in their study conducted in north-central Nigeria found the majority (44.61%) of the cases presented late (after 4 hours). Kshirsagar *et al.*, (2013) reported that mortality rate was higher when treatment was sought at longer time interval from the time of bite. Deaths occurred in patients who had presented more than 8 hours after the bite and all deaths occurred within 6 hours from admission to the hospital.

An average of 3.3hr passed between snakebite and initiation of antivenom therapy in this study. Thirty six percent of the victims received antivenom therapy within five or more hours. Only 14% of the patient received antivenom therapy within an hour. A prior epidemiological study noted that 27% of patients were treated within half an hour (Pandey *et al.*, 2016b). Similar previous studies have noted low rates of patients treated within 1hr (Sharma *et al.*, 2003; Magar *et al.*, 2013). However, delayed access to treatment centers remains a common reason for developing ptosis or other neuro-paralysis earlier prior to definitive treatment (Pandey *et al.* 2016a).

Overall, the time between the accident and the medical care is brief – less than three hours – for the most cases of envenomation, which explains the favorable clinical evolution in numerous cases (Chippaux, 2015).

2.4 MANAGEMENT OF SNAKEBITE CASES

This part of the literature review looks at the management of snakebites as captured by scientific literature.

2.4.1 CLINICAL PRESENTATIONS OF SNAKEBITE CASES

The clinical features developed after a snakebite usually depends on the type of snake species that is responsible for the bite. The common types of clinical manifestations can generally be classified into four main types depending on the kind of envenoming.

Four families of venomous snakes exist (Elapidae, Viperidae, Atractaspididae, and Colubridae), of which the elapids (such as mambas, cobras, and coral snakes) and viperids (such as rattlesnakes and other vipers) are responsible for the vast majority of envenomings (Gutiérrez, 2016). Generally, viperid venoms are cytotoxic, hemotoxic, and occasionally myotoxic, whereas elapid venoms primarily cause systemic neurotoxicity (Gutiérrez, 2016). The difference in clinical manifestations of viper and elapid venoms stem from the different families of toxins in the snake venom. Further, some of the venom toxins act independently of each other, whereas for others the toxicity is potentiated via toxin synergism(Laustsen, 2016). Neurotoxins must first pass the systemic circulation before reaching the relevant targets in the central nervous system and are therefore typically rather small in size. In contrast, toxins which induce tissue damage, including proteases, cytotoxins, and myotoxins, are larger proteins which primarily exert their destructive effects at the site of the bite. This difference in site of action for different toxins means that antivenoms against locally-acting toxins need to be able to reach distal sites and deep tissue , whereas rapid distribution in the circulatory system may be sufficient for effective delivery of antivenoms against systemic toxicity (Laustsen *et al.*, 2017).

2.4.1.1 CYTOTOXIC ENVENOMING

This is characterized by painful and progressive swelling with blood-stained tissue fluid leaking from the bite wound, hypovolaemic shock, blistering and bruising. The victim will complain of severe pain at the bite site and throughout the affected limb and painful and tender enlargement of lymph glands draining the bite site. Irreversible death of tissue may occur (necrosis/gangrene). Species that cause this type of envenoming include saw-scaled/carpet vipers, puff adders, Gaboon and rhinoceros vipers, and spitting cobras (WHO/AFRO, 2010). Anitha *et al.*, (2017) found pain and local swelling at the site of bite to be the commonest clinical symptoms in their study.

2.4.1.2 HAEMORRHAGIC ENVENOMING

This is characterized by bleeding from the gums; gastro-intestinal and genito-urinary tracts; and recent and partly healed wounds. Species involved include saw-scaled/carpet vipers, Gaboon and rhinoceros vipers, boomslang, and vine snakes." (WHO/AFRO, 2010). Bleeding at the site of bite was found in 70% of the study participants. (Anitha *et al.*, 2017). There is bleeding from wounds, the fang punctures and venepuncture sites because the blood is defibrinogenated and will not clots and platelet function is impaired. Venom haemorrhagins cause spontaneous systemic bleeding from gingival sulci and nose, haematemesis, rectal bleeding, melaena, haemoptysis, haematuria, retroperitoneal, extrapleural or intracranial haemorrhage, and, in pregnant women, ante-partum haemorrhage (WHO/AFRO, 2010).

The assessment of the neutralization of hemorrhagic activity is important for most viperid venoms, and also for some non-front fanged colubrid venoms of potential relevance in human envenomings, such as those of Dispholidus typus and Rhabdophis sp. Since its development in 1960, the rodent skin assay to assess hemorrhagic activity has become widely used for quantifying this effect and its neutralization. The test was originally developed in rabbits, although most groups currently use either rats or, more often, mice. Hemorrhagic activity is determined by injecting variable amounts of venom intradermally in the abdominal region of the animals. After a time interval, usually 2 hours, animals are sacrificed, their skin removed, and the size of the hemorrhagic lesion in the inner side of the skin is measured. Hemorrhagic activity is expressed as the Minimum Hemorrhagic Dose (MHD), defined as the dose of venom that induces a hemorrhagic area of 10 mm diameter. One limitation of this procedure is that similar hemorrhagic areas might show different intensities of hemorrhage. This can be circumvented by measuring the amount of hemoglobin present in the hemorrhagic lesion (Gutiérrez, *et al.*, 2017)

Snake venom contains proteases, phospholipases, collagenases, metalloproteinases, and thrombin-like enzymes. These interfere with normal blood clotting. They generate anticoagulant and coagulant effects.

The coagulant effect is due to the presence of the arginine esterase hydrolase, which has a similar action of thrombin on platelet aggregation. Snake venom also contains a factor X activator, which causes coagulopathy by platelet aggregation inhibition.

Venom-induced consumptive coagulopathy (VICC) results from activation of the coagulation pathway at various levels by procoagulant toxins. VICC is characterized by a prolonged 20-minute whole blood clotting test, prothrombin time, and activated partial thromboplastin time. VICC also causes a marked increase in the fibrinogen degradation products.

Metalloproteinases (ecarin and carinactivase) are prothrombin activators which act by reducing the levels of fibrinogen, factor V, and factor VII resulting in hemorrhages including cerebral hemorrhages. Hemorrhagin toxin causes VICC as well as direct endothelial injury which can lead to fatal intracerebral hemorrhage such as subarachnoid hemorrhage. Proteases destroy the wall of blood vessels, activate fibrinolysis, and cause serious hemorrhages. Prothrombinase complex in snake venom is composed of protease factor (f) Xa and cofactor (f) Va. These factors convert prothrombin to thrombin causing coagulopathy, which can result in brain parenchymal hemorrhages (Abdul Jalal, *et al.*, 2016).

2.4.1.3 NEUROTOXIC ENVENOMING

This is characterized by moderate or absent local swelling, progressive descending paralysis starting with drooping eyelids (ptosis) and paralysis of eye movements causing double vision. There may be painful and tender enlargement of lymph glands draining the bite site. The patient may vomit, the saliva may become profuse and stringy, and eventually there may be difficulties with swallowing and breathing.

Species involved include black and green mambas, nonspitting cobras and Berg adder (WHO/AFRO, 2010).

Neuromuscular paralysis due to snake envenoming is common, including envenoming by elapid snakes such as kraits (genus: Bungarus), cobras (genus: Naja and Ophiophagus), coral snakes (genus: Calliophis and Micrurus), taipans (genus: Oxyuranus), tiger snakes (genus: Notechis) and death adders (genus: Acanthophis). Snake venom induced paralysis becomes life threatening with progressive paralysis of the bulbar and respiratory muscles which requires prompt airway assistance and mechanical ventilation (Silva *et al.*, 2017 ; Ranawaka *et al.*, 2013).

Transient paraesthesiae of the tongue and lips, abnormalities of taste and smell, heaviness of the eyelids, increased salivation or a dry mouth, nausea and vomiting are followed by progressive, descending paralysis: bilateral ptosis, pupillary abnormalities, external and internal ophthalmoplegia, paralysis of the facial muscles, jaw, tongue, neck flexors (causing the "broken neck" sign) and other muscles innervated by the cranial nerves, dysphonia, difficulty in swallowing secretions and finally respiratory and generalized flaccid paralysis. Mamba bite envenoming causes paraesthesiae, sweating, gooseflesh, salivation, viscous respiratory tract secretions, diarrhoea, fasciculations and other involuntary muscle spasms and rapidly progressive paralysis (WHO/AFRO, 2010). Snake venom neurotoxins primarily target the neuromuscular junction of skeletal muscles of which the motor nerve terminal (pre-synaptic) and the nicotinic acetylcholine receptor at the motor-end plate (post-synaptic) are the major targeted sites. This is well supported by clinical observations that neurotoxic snake envenoming almost exclusively results in flaccid paralysis (Silva *et al.*, 2016a; Silva *et al.*, 2016 b) which is due to the blockade of neurotransmission at the neuromuscular junction by venom neurotoxins (Harris *et al.*, 2013; Barber *et al.*, 2013). Neuromuscular paralysis in snake envenoming varies from mild to life threatening, depending on the degree of envenoming (i.e., quantity of injected venom reaching the circulation), the composition of the venom and potentially early therapeutic interventions (Silva *et al.*, 2017).

The effectiveness of an antivenom can be defined as its ability to prevent the occurrence, or reverse the effects, of venom in the clinical setting (Ireland *et al.*, 2010). With respect to neurotoxicity, the effectiveness of the antivenom is the ability of antivenom to prevent the occurrence of neurotoxicity or to reverse established neurotoxicity in snakebite patients. It is important to consider that in addition to the efficacy of the antivenom, many other factors will contribute to the effectiveness of an antivenom. These include: (1) factors that govern the severity and the rate of development of envenoming, such as the depth of the venom injection and amount of venom injected; (2) factors related to antivenom such as the delay from the bite to antivenom administration, antivenom dose, infusion rate, the ability of the antivenom to distribute to peripheral tissues; (3) the nature and extent of neurotoxin-mediated damage such as irreversible motor nerve injury due to pre-synaptic toxins; and (4), the geographical variations of the venom composition. The variability in these factors among patients makes it difficult to achieve an objective and pure measure of effectiveness of an antivenom in the clinical setting (Silva *et al.*, 2017).

The efficacy of antivenom against a particular venom is due to the ability of antivenom molecules to bind with toxins in the venom (Ireland *et al.*, 2010). That is with respect to neurotoxicity, this is the ability of the antivenom molecules to bind with the neurotoxins in the venom. This is dependent on: (1) the avidity of the antivenom, which is a combined effect of the affinity constants of the different antibodies towards different toxins; (2) the relative abundance of antibodies in the antivenom against the individual neurotoxins; and (3) the relative abundance of the individual neurotoxins in the snake venom of interest. The ability of the antivenom molecules to bind with a specific venom can be quantified using an in vitro venom-antivenom binding assay, which provides useful insights into the overall ability of the antivenom to bind with the venom (Maduwage *et al.*, 2016; Silva *et al.*, 2017).

2.4.1.4 MYOTOXIC ENVENOMING

This is characterized by negligible local swelling, increasing generalized muscle pain and tenderness (myalgia) associated with features of neurotoxic envenoming and progressive descending paralysis culminating in paralysis of breathing. The species involved is the yellow-bellied sea snake (WHO/AFRO, 2010).

Mixed types of envenoming may occur. Mixed cytotoxic and neurotoxic bites occur in the case of the rinkhals but not with other spitting cobras. There can be mixed haemorrhagic and cytotoxic bites from saw scaled/ carpet vipers, North African desert vipers and puff adders (WHO/AFRO, 2010).

With regards to local symptoms and signs in the bitten part, there is immediate pain. Local bruising and bleeding from the fang punctures suggests a haemostatic disturbance (viper and certain colubrid bites). Swelling usually begins within 10-20 minutes. It may become extensive after viper and spitting cobra bites, involving the entire limb, adjacent areas of the trunk and the whole body in children. Regional lymph nodes draining the bitten part may become enlarged, painful and tender on palpation within 30-60 minutes. Blisters, blood- or fluid-filled, may appear, first near the fang marks within 12-24 hours. Demarcated pigmentation or depigmentation with anaesthesia and a distinctive smell of putrefaction are signs of necrosis. This progresses to frank necrosis with spontaneous sloughing of dead tissue or the need for surgical debridement (WHO/AFRO, 2010).

Many venoms of species of the families Elapidae and Viperidae induce local and, in some cases, systemic myotoxicity. Some elapid venoms, such as those of sea snakes and Australian terrestrial species, and the venoms of few viperids, such as the South American rattlesnake, induce systemic myotoxicity which may in turn contribute to acute kidney injury. Many viperid venoms cause local myonecrosis. Venom-induced myotoxicity can be studied by histological analysis of affected muscle tissue. Quantitatively, it is feasible to estimate the extent of myonecrosis by quantifying, in tissue sections, the total number of fibers and the number of necrotic fibers, which are usually identified by the presence of hypercontraction of myofibrils. Thus, a Necrotic Index can be obtained by dividing the number of necrotic fibers by the total number of muscle fibers. However, since histological analysis is time consuming and not all quality control laboratories have facilities to process tissues, an alternative assay is the quantification of the plasma or serum activity of the enzyme creatine kinase (CK), which is released from damaged muscle fibers to the circulation. Various venom doses are injected intramuscularly (i.m.) in the gastrocnemius or thigh muscles of mice and, after 3 h, a blood sample is collected and the CK activity of plasma or serum is determined. The Minimum Myotoxic Dose (MMD) is the amount of venom that increases four times the CK activity, as compared to mice injected with saline solution. For neutralization, a challenge dose of 3 MMDs is used, and neutralization is expressed as Median Effective Dose (ED50), thus, the volume of antivenom, or the venom/antivenom ratio, at which CK activity is reduced by 50% as compared to that of mice injected with venom alone. (Gutierrez *et al.*, 2017).

Edematogenic Activity-Edema at the site of venom injection is characteristic of envenomings by vipers, and by some cytotoxic elapids. This effect can be studied experimentally by injecting various doses of venom subcutaneously in the footpad of mice or rats. Then, at various time intervals, the increment in the volume of the pad is assessed by either plethysmometry or by measuring the thickness of the injected pad with a low-pressure spring caliper. These two techniques have largely replaced older methods based on determining the weight of footpads of mice after euthanasia since they only allow the determination of edema at one time interval. The Minimum Edematogenic Dose (MED) is the amount of venom that induces an increment of 30% in footpad volume or thickness 1 hour after injection. For neutralization, a challenge dose of six MEDs has been used, and antivenom efficacy (ED50) is the volume of antivenom, or venom/antivenom ratio, which reduces by 50% the edema induced by venom alone. (Gutierrez *et al.*, 2017).

2.4.1.5 SHOCK (HYPOTENSION) - VIPER BITES

The signs of shock are fall in blood pressure; collapse; cold, cyanosed and sweaty skin; and impaired consciousness. There is blurred vision, dizziness, syncope and collapse sometimes occurring very soon after the bite; these symptoms may be transient, recurrent, persistent, progressive, delayed and life-threatening (WHO/AFRO, 2010).

With regard to complications induced by snake bites, the majority of the cases, 77 (4.6%) cases had hypovolemic shock,(Yasunaga *et al.*, 2011). In moderate and severe cases, systemic manifestations occur, characterized mostly by bleeding, coagulopathy, acute kidney injury, and cardiovascular shock" (Gutierrez, 2014). A few patients of snake bite die out of terrible scare, apprehension and shock (Anitha et al., 2017).

The consequences of snake bites, such as pain and infection can be localized or systemic, they can also induce; shock, acute kidney injury, coagulation disorders of the vascular system, rhabdomy olysis and cardiac muscle damage (Chippaux, 2015).

The severity of envenomation is divided into three levels: mild, moderate and severe. In mild envenomation symptoms include; swelling, pain, and tenderness. A moderate envenomation includes local effects such as; swelling, pain, tenderness, and systemic effects such as; nausea, vomiting, tremor, mild hypotension with evidence of coagulopathy, but no clinical bleeding. In severe envenomation local complications develop, including all organs with systemic effects such as: shock, severe bradycardia, tachypnea, or respiratory failure and coagulation disorders characterized by bleeding, and other manifestations (Mahmood *et al.*, 2010; Dehghani *et al.* 2012). The cause of death was suspected cerebral bleeding with unconsciousness in three patients, general shock while still active bleeding (mostly in urine and gastrointestinal system) in eight patients and anaphylactic shock on antivenom use in one patient. An allergic reaction upon antivenom administration was observed in five patients, all had signs of anaphylactic shock and one patient also had a skin reaction. Two of the patients who reacted allergically died, one due to anaphylactic shock (Visser *et al.*, 2008).

Renal failure is very uncommon unless the patient has suffered profound shock which may result in bilateral renal cortical necrosis which has been reported from Kenya (*Echis pyramidum*) and Saudi Arabia (*Echis coloratus*). In Nigerian studies, the case fatality of 3.6% was attributable to haemorrhagic shock (WHO/AFRO, 2010).

2.4.1.6 ACUTE RENAL FAILURE

This is uncommon after bites by any of the terrestrial African snakes, but renal failure may develop if there has been profound hypotension or rhabdomyolysis (in neglected adder bites) (WHO/AFRO, 2010). Yasunaga *et al.*, (2011) reported from their study in Japan that 3.3% had acute kidney injury.

Raina *et al.*, (2014) found neuroparalysis as the most common presentation with some of the patients requiring mechanical ventilation. Acute kidney injury was observed in 22 (11%) patients and they belonged to the hemotoxic or the hemotoxic with local symptoms and signs group. One patient developed a compartment syndrome of calf region.

Blood urea or serum creatinine and potassium concentrations should be measured in patients who become oliguric, especially in cases with a high risk of renal failure (e.g. sea snakes and Colubridae). A snake-bitten patient should be encouraged to empty his/her bladder on admission. Urine should be examined for blood/haemoglobin and protein (by reagent sticks, stix test) and for microscopic haematuria and red cell casts. Severely sick, hypotensive and shocked patients may develop lactic acidosis (suggested by an increased anion gap), those with renal failure will also develop a metabolic acidosis (decreased plasma pH and bicarbonate concentration, reduced arterial PC02), and patients with respiratory paralysis will develop respiratory acidosis (low pH, high arterial PC02, decreased arterial PO2) or respiratory alkalosis if they are mechanically over ventilated (WHO/AFRO, 2010).

Ahmed *et al.*, (2012) also reported that the majority of the snakebite patients suffered severe envenomation. "Snake envenomation patterns, depending on the species, can vary among the four different families common in Iran, namely; Colubridae, Elapidae, Viperidae and Hydrophidae, which can cause a range of symptoms, mild envenomation, neurotoxicity, vasculotoxicity and myotoxicity (Dehghani *et al.*, 2012).

The main clinical features of *Echis ocellatus (carpet viper)* envenoming are systemic hemorrhage, incoagulable blood, shock, local swelling, bleeding and occasionally necrosis. All body systems may be affected; cardiac and hemodynamic abnormalities may result while the strongest predictor of mortality is central-nervous-system involvement with intracranial hemorrhage. Neurotoxicity has been reported following Egyptian cobra *(Naja haje)* bites in certain parts of the country. Occasionally, snakebite may lead to important complications such as amputation, blindness resulting from spitting cobra *(Naja nigricollis)* venom, opthalmia, fetal loss, and wound infection, tetanus and scarring with potential for malignant transformation, and psychological consequences such as excessive anxiety, stress, hysteria and worry (Habib, 2013).

According to Punguyire *et al.*, (2013) coagulopathy is a significant cause of both morbidity and mortality in these patients. Six patients had evidence of acute kidney injury at the time of discharge, and all received dialysis. CT scan brain showed infarction and hemorrhage in two cases each. Sixteen patients (18.4%) needed elective ventilation (Kumar *et al.*, 2014). Kshirsagar *et al.*, (2013**)** in their study divided the type of snakes into poisonous and non–poisonous depending upon the development of clinical features. 66.7% of the bites were due to poisonous snake and 33.3% of the bites due to non-poisonous snakes.

The WHO estimates that 10% of envenomings results in serious, non-fatal sequelae, while other reports have stated that 12,000–14,000 amputations and other sequelae result from snakebites in Africa annually (Warrell, 2007 ;Visser *et al.*, 2008). Other debilitating morbidities result from the neurotoxic, coagulopathic or necrotic components of different venoms, with clinical effects ranging from chronic ulceration, osteomyelitis, chronic renal failure, endocrine disorders, paralysis, stroke and blindness (Brown, 2012).

The severity of envenomation is divided into three levels: mild, moderate and severe. In mild envenomation symptoms include; swelling, pain, and tenderness. A moderate envenomation includes local effects such as; swelling, pain, tenderness, and systemic effects such as; nausea, vomiting, tremor, mild hypotension with evidence of coagulopathy, but no clinical bleeding. In severe envenomation local complications develop, including all organs with systemic effects such as: shock, severe bradycardia, tachypnea, or respiratory failure and coagulation disorders characterized by bleeding, and other manifestations (Dehghani *et al.*, 2012).

Snake bite remains a problem in the developing world. It has been estimated by the World Health Organisation that there are 15 to 20 thousand deaths per year in India (WHO/SEARO, 2009). Viperine envenomenation can lead to a severe clinical syndrome including haemolysis, coagulopathy, acute kidney injury, rhabdomyolysis and neurotoxicity (Shastri *et al.*, 2014).

Preclinical and antivenomics analysis confirmed efficacy of regionally appropriate antivenoms against *E. ocellatus* and related species' venoms in Sub-Saharan Africa but not against Asian *Echis carinatus* venom. Antivenoms raised against *E. carinatus* were ineffective in human studies. In West Africa, specific antivenom is effective in managing carpet viper envenoming (Habib and Warrell, 2012).

Rao *et al.*, (2013) reported that fang marks, local ecchymoses and internal hemorrhage, were the frequent demonstrable signs appreciated at autopsy of fatal snakebite cases.

2.4.2 FIRST AID METHODS SNAKEBITE VICTIMS USE

WHO recommended essential first-aid procedures for snakebites. The following are the recommendations by the World Health Organisation on the first aid for snakebite;

It is essential that first aid is carried out by bite victims themselves or bystanders, using materials that are immediately available. While instituting the following first aid procedures, organize transport to get the patient to a medical facility as soon as possible (e.g. use cellular phone and other forms of communication to call for help) (WHO/AFRO, 2010).

1. Move the victim to safety from the area where they might be bitten again and remove the snake if it is still attached but not with your bare hands. Sea snake victims should be removed from the water to prevent drowning.
2. Reassure the victim, who may be terrified. Reassurance is justified as most bites result in negligible or no envenoming and, even if the patient is envenomed, there is usually ample time to transport them to medical care. Deaths occur in hours after elapid bites, in days after viper bites.
3. Remove constricting clothing, rings, bracelets, bands, shoe etc from the bitten limb.
4. Immobilize the whole patient, especially the bitten limb, using a splint or sling. Muscular contractions anywhere in the body, but especially in the bitten limb, will promote the absorption and spread of venom from the site of the bite via veins and lymphatics; all movements should be avoided as far as possible.
5. The pressure-immobilization technique demands special equipment and training and is not considered practicable for general use in Africa. However, it might be feasible in certain specific settings such as institutions, zoos, fieldwork programmes or expeditions where the necessary equipment and highly trained

staff could be made available or in highly motivated communities. It is a safer alternative to the use of the highly dangerous tight (arterial) tourniquets that cause many gangrenous limbs throughout Africa.

6. Transport the patient as quickly and as passively as possible to the nearest facility available for medical care (health clinic, dispensary or hospital). Ideally, patients should be transported by stretcher, in a motor vehicle, on a bicycle (as a passenger), or by boat, or the patient can be carried using the "fireman's lift.
7. Avoid the many harmful and time- wasting traditional first-aid treatments (WHO/AFRO, 2010).

Rejected or controversial first aid methods are discussed below;

Cauterization, incision or excision, tattooing, immediate prophylactic amputation of the bitten digit, suction by mouth, vacuum pumps (Bush, 2004) or "venom-ex" apparatus, instillation of chemical compounds such as potassium permanganate, application of ice packs (cryotherapy), "snake stones" or electric shocks are absolutely contraindicated as they are all potentially harmful and none has any proven benefit. Do not wash, rub, massage or tamper with the bite wound in any way. These interventions may encourage systemic absorption of venom from the site, or they may introduce infection. Incisions provoke uncontrolled bleeding if the blood is incoagulable; may damage nerves, blood vessels or tendons; and introduce infection. Suction, chemicals and cryotherapy increase the risk of tissue necrosis. (WHO/AFRO, 2010)

A tight (arterial) tourniquet should NEVER be used! Tourniquet is one of the most popular first-aid methods in Africa and continues to cause terrible morbidity and even mortality in snakebite victims: tourniquet should not be used. The dangers of tourniquets are ischaemia and gangrene, if they are applied for more than about 2 hours; damage to peripheral nerves (especially the lateral popliteal nerve at the neck of the fibula); increased fibrinolytic activity; congestion and swelling; increased bleeding; increased local effects of venom; and, immediately after release, shock, pulmonary embolism or rapidly-evolving life-threatening systemic envenoming (WHO/AFRO, 2010).

Since species diagnosis is important, the snake should be taken along to hospital if it happens to have been killed. However, if the snake is still at large, do not risk further bites and waste time by searching for it. Even snakes which appear to be dead should not be touched with the bare hands but carried in a bag or dangling across a stick. Some species (e.g. rinkhals Hemachatus haemachatus) pretend to be dead (sham death), and even the fangs of a severed snake's head can inject venom! (WHO/AFRO, 2010).

One recent study of snakebite in Bangladesh noted that 86% of the victims go to a "snake charmer" to seek initial treatment, while only three percent go to medical doctor or hospital directly after the bite (Rahman *et al*,. 2010). Similarly, the use of traditional healing tactics prior to evidence-based clinical care (e.g. antivenom) is common in India 74% (Hati *et al*., 1992), 61% (Inamdar, *et al*., 2010), Pakistan 75% (Chandio *et al*., 2000) *et al*,. 2000), Kenya 68% (Snow *et al*., 1994), and Nigeria 81% (Godpower *et al*., 2011). Consistent with these previous reports, (Pandey *et al*. 2016) demonstrated that 41% of victims consulted traditional healers or attempted traditional healing methods by themselves (Pandey *et al*. 2016).

Karunanayake *et al*., (2014) in their study, reported that recommended first aid practices of reassurance and immobilization has been followed in 80% and 75% cases respectively and unaccepted first aid measures such as application of herbal medicines and tourniquet have been done in 5% and 9% of cases respectively. Incisions were not been made in any of the patients in their study. However, Rao *et al.*, (2013) reported a very high proportion (70%) of the victims in their snakebite fatality study used inappropriate first aid measures. These majority according to their report approached untrained traditional therapists, who employed unscientific procedures in the forms of putting local incisions, suctioning, application of plant extracts, mud, garlic, snake stones among others (Rao *et al.*, 2013).

Tourniquets have been reportedly used in 90% and 98% of victims in Nepal and Bangladesh respectively (Alirol et al., 2010). In Bangladesh and India, it has been reported that incisions are made in and around the bite site in 42% and 20% of cases respectively (Alirol *et al.*, 2010).

Godpower *et al.*, (2011) studied pre-hospital practices of 72 consecutive snake bite victims at a hospital in north-central Nigeria and found most subjects (58, 81%) attempted at least one first aid measure after the bite, including tourniquet application (53, 74%), application (15, 21%) or ingestion (10, 14%) of traditional concoctions, bite site incision (8, 11%), black stone application (4, 5.6%), and suction (3, 4.2%). The use of any first aid was associated with a longer hospital stay than no use (4.6 ± 2.0 days versus 3.6 ± 2.7 days, respectively, $P = 0.02$). The antivenom requirement was greater in subjects who had used a tourniquet ($P = 0.03$) and in those who presented late ($P = 0.02$). Topical application (Odds Ratio 15, 95% CI 1.4–708) or ingestion of traditional concoctions (OR 20, 95% CI 1.4–963) were associated with increased risk of death or disability. Ingestion and application of concoctions were associated with a longer time interval before presentation, a higher cost of hospitalization, and an increased risk of wound infection."

Halesha *et al.,* (2013) and Adiga and Adiga, (2014) after their snakebite studies recommended regular public health programmes regarding the prevention, pre – hospital management (first aid) and the importance of the early transfer to the hospital should be emphasized as well as medical personnel trained with the facilities improved so as to manage even complicated cases**.**

First aid measures include reassurance of patients and immobilization of the bitten limb with a splint or sling. First aid administrators should hasten the transfer of patients to a hospital along with the dead snake if found. Avoid harmful and time-wasting procedures such as incisions for application of native herbs, ice packs or electric shock, which have not yet been confirmed to be effective in controlled studies. Avoid the use of tourniquets, constricting bands etc., as they have been shown to have minimal or no beneficial effect unless the snake was identified as dangerously neurotoxic, such as *N. haje* and *Dendroaspis* spp., since it may worsen ischemia and necrosis (Habib, 2013).

About three fourth of the patients sought first aid in local clinics and peripheral hospitals prior to definitive treatment in the University hospital (research setting). Most of the cases were admitted within 24 h of the bite. Morbidity included cellulitis, neurotoxicity and haematotoxicity. Dual toxicity was observed in 30.4% of patients (David *et al.*, 2012).

Ghosh (2011) reported that first aid treatment of the bitten limb/area with broad-spectrum antibiotics, injection tetanus antitoxin and Supportive treatment with blood transfusion, ventilatory support, anticholinesterase and peritoneal dialysis may also be required. Reassurance and immobilization were the most common first aid types given to these patients in a study conducted by Karunanayake *et al.*, (2014).

More *et al.*, (2014) likewise reported that not receiving first aid, unavailability of anti-snake venom (ASV) at health centres, no transport facilities and lack of public awareness about the urgency and need of treatment were some of the external factors which may have increased the chances of mortality among the snakebite victims in their study.

A total of 69% (n=27) of the envenomation victims received some form of first aid. 54% used a single tourniquet, while 15% used a tight and/or multiple tourniquets. No victims adopted either of the WHO-recommended first aid methods (pressure immobilization bandaging or local compression pad immobilization). Sixteen patients (41%) practiced traditional healing treatments before arrival at the hospital, of these 16 victims, three victims (38%) died. Seven victims (44%) consulted local healers, two applied a "Garud Dhunga" or "Jagmohar" (snake stone), 3 consumed hot peppers or ethanol, one incised the bitten site, two used a topical paste of potash solution, and one used kerosene on the wound after consulting with local healers. Six (15%) victims sought medical treatment in the peripheral healthcare facilities (Pandey *et al.* 2016).

2.4.3 THE MANAGEMENT OF SNAKEBITE CASES

The severity of snakebite envenomings depends on several factors, namely: the volume of venom injected, the anatomical site of injection (bites on the head and trunk tend to be more complicated than those on the feet or hands), the size and physiological condition of the victim (bites in children tend to be more serious than in adults) and time elapsed between the bite and medical attention (Gutierrez, 2014).

Antivenoms are the only antidotal treatment available for snake envenoming and have been in clinical use for over a century. Antivenoms are a mixture of polyclonal antibodies which can be whole or fractionated, F(ab)2 or F(ab) IgG, raised against one (i.e.,monovalent) or several (i.e., polyvalent) snake venom(s) in animals such as horses, sheep, goats and donkeys (Silva *et al.,* 2017).

Antivenom is the mainstay of treatment of snakebite envenoming (Asita de Silva, *et al.,* 2016). Treatment of snakebite envenoming is primarily aimed at neutralizing the venom containing different kinds of bioactive protein molecules with specific antivenin (Rao *et al.*, 2013).

Snake bite is a major public health problem throughout rural communities in West Africa and leads to a significant number of deaths and disabilities per year. Even though effective antivenoms exist against the locally prevalent carpet viper and other poisonous snakes, they are generally not available in community settings, possibly because of their high acquisition cost (Habib *et al.*, 2015).

The efficacy of antivenoms to neutralize toxicity of medically-relevant snake venoms has to be demonstrated through meticulous preclinical testing before their introduction into the clinical setting. The gold standard in the preclinical assessment and quality control of antivenoms is the neutralization of venom-induced lethality. In addition, depending on the pathophysiological profile of snake venoms, the neutralization of other toxic activities has to be evaluated, such as hemorrhagic, myotoxic, edema-forming, dermonecrotic, in vitro coagulant, and defibrinogenating effects. There is a need to develop laboratory assays to evaluate neutralization of other relevant venom activities. The concept of the 3Rs (Replacement, Reduction, and Refinement) in Toxinology is of utmost importance, and some advances have been performed in their implementation. A significant leap forward in the study of the immunological reactivity of antivenoms against venoms has been the development of "antivenomics", which brings the analytical power of mass spectrometry to the evaluation of antivenoms. International partnerships are required to assess the preclinical efficacy of antivenoms against snake venoms in different regions of the world in order to have a detailed knowledge on the neutralizing profile of these immunotherapeutics (Gutiérrez *et al*,. 2017).

Although the dose of antivenom is not yet fixed, the indications are well-known. National snake bite management protocol 2008 (India) has recommended a maximum dose for hemotoxic and neurotoxic bites as 30 vials (300 ml) and 20 vials (200 ml) respectively (Raina *et al.*, 2014).

In a situation of worrying antivenom shortage in many tropical and sub-tropical regions with high snakebite mortality and morbidity rates, such knowledge on qualitative and quantitative set of homologous and heterologous venom proteins presenting antivenom-recognized epitopes and those exhibiting impaired immunoreactivity has the potential to facilitate the optimal deployment of currently existing antivenoms and to aid in the rational design of novel broad specificity antidotes (Pla *et al.*, 2017).

The COGM estimates (approx. USD 60–350 per treatment for processes using chromatography as purification method and approx. USD 50–190 per treatment for processes using caprylic acid precipitation as purification method) presented here compare favorably with the wholesale cost of SAIMR Snake Polyvalent Antivenom (USD 640 per treatment). Although the wholesale cost may not adequately reflect the COGM for SAIMR Snake Polyvalent Antivenom, our COGM estimates for recombinant production indicate that even with a fairly high margin for distribution, sales, and profit (45–92% depending on manufacturing strategy and purification method), that snakebite envenoming treatments based on recombinant antivenoms could be cost-competitive with current serum-based antivenoms (Laustsen *et al.*, 2017).

Ahmed *et al.*, (2012) published that, the total dose of ASV ranged from 5 to 23 vials and the mean ± SD dose of ASV was (12.3 ± 2.4). ASV dose was significantly more in patients with severe envenomation (19.6 ± 3.2 vials) than in mild (6.7 ± 1.9 vials) and moderate (10.7 ± 2.1vials) in their study. It was also reported that cardiac arrest was recorded in 10.2% (6/59) victims of whom 6.7% (4/59) sustained cardiac arrest in the accident and emergency (A/E), resuscitated and shifted to the Intensive Care Unit (ICU). Also 8.7% (5/59) victims developed ventilator- associated pneumonia, four (6.7%) suffered ASV reaction, five (8.5%) had hypotension and three (5.1%) victims developed renal failure. (Syed Moied Ahmed, Nadeem, Islam, Agarwal, & Singh, 2012). Definitive management may be required by the patients depending on complexity of the symptoms of envenomation.

Antivenom was administered to 75.9% of all patients who required definitive treatment; 22 (9.1%) received antivenom. Blood products (packed red cells, fresh-frozen plasma or platelets) were given in 6 cases; 3 required endotracheal intubation in the EMU (emergency and medical unit) 2 for severe neurotoxicity and 1 for anaphylaxis due to antivenom administration); and 11 (4.5%) required surgery including debridement of necrotic snakebite wounds, amputation of affected limbs or digits, or fasciotomy. All 4 cases of clinically diagnosed compartment syndrome received antivenom. One patient required a fasciotomy (Wood *et al.*, 2009).

Karunanayake *et al.*, (2014) also reported antivenom serum (AVS) was administered in 39% of venomous bites in their study. Likewise David *et al.*, (2012) found that all the cases received polyvalent ASV and the majority received 6–12vials of ASV. With about 9% of the patients requiring inotropic support and 8% needing blood transfusion. Fresh frozen plasma was needed in 8% of patients. Tetanus toxoid was administered in 95% of patients. Surgical intervention such as debridement with skin or flap cover, incision and drainage were carried out. One patient required amputation.

Adverse reactions to snake antivenom that is available are common in many parts of the world where snakebite is prevalent. Both acute (anaphylactic or pyrogenic) and delayed (serum sickness type) reactions occur. Acute reactions are usually mild but severe systemic anaphylaxis may develop, often within an hour or so of exposure to antivenom. Serum sickness after antivenom has a delayed onset between 5 and 14 days after its administration (Asita de Silva, *et al.*, 2016).

The parenteral administration of antivenoms is the mainstay of snakebite envenoming treatment. Concerted efforts by stakeholders are being made to ensure that antivenoms of adequate efficacy and safety are available world-wide (Gutiérrez *et al.*, 2011; Habib, *et al.*, 2015).

A study was conducted in Mathias Hospital, Yeji, in the Brong Ahafo region of Ghana, where snake bite cases are an important cause of morbidity and mortality, with a case fatality rate of 11% (8/72) (Visser *et al.*, 2008). They reported case management difficulties to include uncertainty about the assessment of the severity of envenoming, the dosage of antivenom, and the response to treatment. An intervention with several components was introduced: development of a treatment protocol, staff training, monitoring of compliance and patient education (Visser *et al.*, 2008).

There is a strong association between snakebite-induced mortality with poverty, mistaken identity, mismanagement by untrained village based traditional therapists, poor transportation facilities, delay at arrival to medical centres and improper dosing of anti-snake venom (Rao *et al.*, 2013). The epidemiological features and management of such cases vary from region to region (Dehghani *et al.*, 2012).

Acute kidney Injury (AKI) is an important consequence of a snake bite and its proper supportive management after the anti-venom administration is of utmost importance, for a good patient outcome (Harshavardhan *et al.*, 2013).

Adverse drug reaction to the anti-snake venom used in the management has been reported in several studies. The common types of adverse reactions include chills, rigors, nausea, vomiting among others (Wood *et al.*, 2009; Raina, et al., 2014). Wood *et al.*, (2009) reported that about 56.10% of patients who received ASV suffered adverse reactions. Whereas 12.7% of the patients in a study by Halesha *et al.*, (2013) were found to experience adverse reaction to the ASV, Raina *et al.*, (2014) reported this among only 7% of the patients in their study.

The highest percentage of adverse reactions to antivenom occurred in the 0 - 10-year age group, while most adults (85.7%) experienced no complications. Of the 8 patients under the age of 10 who received antivenom, only 2 (25%) had no adverse reaction. The highest proportion of anaphylactic reactions occurred in the 11 - 20-year age group (42.9%) (Wood *et al.*, 2009).

Pharmacological prophylaxis has been used to reduce acute adverse reactions to antivenom. Prophylactic use of hydrocortisone and antihistamines before infusion of antivenom is practised widely. Antihistamines counter only the effects of released histamine and do not prevent further release (Asita de Silva *et al.*, 2016).

The treatment of anaphylactic reactions to antivenom involves pharmacologic and non-pharmacologic interventions. Non-pharmacologic measures include temporarily stopping the antivenom infusion, airway management and fluid resuscitation. The mainstay of pharmacologic management is adrenaline given intramuscularly, which pharmacokinetic studies have shown to be superior to subcutaneous administration. Antihistamines and corticosteroids are no longer recommended for the treatment of anaphylaxis (Simons *et al.*, 2011; Simons *et al.*, 2013). Patients who do not respond to intramuscular adrenaline and fluid resuscitation may require intravenous infusions of adrenaline. When the reactions are controlled and the patient is haemodynamically stable the antivenom infusion is started again, initially at a slower rate. This may result in a recurrence of acute reactions, which might necessitate repeat administration of adrenaline. This is a challenge that clinicians managing snake envenomation have to face regularly in countries where snakebite is prevalent. (Lee and Vadas, 2011; Isbister *et al.*, 2006).

Severe adverse effects refer to anaphylactic shock in which the patient was at risk of death because of anti- venom administration (Hifumi *et al.*, 2014).

Typical laboratory investigations carried out in the management of snake bite cases include 20 minute whole blood clotting test (20 WBT), Full blood count, renal function test, clotting profile, liver function test.

The whole blood clotting test is carried out to rule out coagulopathy as a result of envenomation. (Ratnayake *et al*,. 2017). The full blood count test is carried out to ascertain the presence of anaemia or otherwise. Whereas the renal function test is to assess whether there is any kidney distress following the snakebite.

Anti-Tetanus Serum and Tetanus Toxoid are administered to check any infections that may arise from the contamination of the open wound owing to the snakebite.

2.5 OUTCOME OF THE IDENTIFIED SNAKEBITE CASES

The outcome of snakebite cases as captured by scientific literature may be death, completely cured, permanent disability or discharge against medical advice.

Godpower *et al.*, (2011) found that death occurred in 4.2%, disability in 18% and full recovery in 74% of the cases studied in Nigeria. Halesha *et al.*, (2013) reported a mortality rate of 3.8% in their study. Deaths accounted for 5% of the cases studied by Karunanayake *et al.*, (2014).

Out of 50 snake bite cases the Dehghani *et al.*, (2012) study, 10% recovered without using antivenin serum and 88% made a recovery with an infusion of antivenin. One case (2%) of death was reported in the study (Dehghani *et al.*, 2012). Habib and Abubakar (2011) also reported there were 94 deaths among 6687 victims (1.41%). Relative risk (RR) of mortality increased to 2.29 (95% CI 1.35-3.89) during a period when source of antivenom became unreliable. David *et al.*, (2012) reported an overall mortality rate of 7.5% whiles an age group analysis demonstrated maximum mortality in patients above 65 (20%) and <10 years (11%). A case fatality rate of 21% was reported by Pandey *et al.*, (2016).

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter highlights the methods used in the study and include the study area, the study design, the study population, study unit, sampling technique and sample size, ethical considerations among others.

3.1 STUDY AREA

3.1.1 LOCATION AND SIZE

The study was conducted in the Northern Region of Ghana. The Northern region, which occupies an area of about 70,384 square kilometres, is the largest region in Ghana in terms of land mass. It shares boundaries with the Upper East and the Upper West regions to the north, the Brong Ahafo and the Volta regions to the south, Togo to the east, and Côte d"Ivoire to the west (GSS, 2012).

3.1.2 TOPOGRAPHY AND DRAINAGE

The topography of the land in the region is mostly low lying except in the north-eastern corner with the Gambaga escarpment and along the western corridor. The region is drained by the Black and White Volta Rivers and their tributaries such as the Nasia and Daka rivers. The region has poor drainage system.

3.1.3 CLIMATE AND VEGETATION

The climate of the region is relatively dry, with a single rainy season that begins in May and ends in October. The amount of rainfall recorded annually varies between 750 millimetres and 1,050 millimetres. The dry season starts in November and ends in March/April with maximum temperatures occurring towards the end of the dry season

(March-April) and minimum temperatures in December and January. The harmattan winds, which occur from December to early February, have a considerable effect on temperatures in the region, making them vary between 14°C at night and 40°C during the day. Humidity is very low, aggravating the effect of the daytime heat. The rather harsh climatic conditions adversely affect economic activity in the region and in the health sector as well. Cerebrospinal meningitis thrive, almost to endemic proportions during this period. The region also falls in the onchocerciasis zone. Even though the disease is currently under control, a vast area is still under populated and under-cultivated due to past ravages of river blindness.

The main vegetation is grassland, interspersed with guinea savannah woodland, characterised by drought-resistant trees such as acacia, (Acacia longifolia), mango (Mangifera), baobab (Adansonia digitata Linn), shea nut (Vitellaria paradoxa), dawadawa, and neem (Azadirachta indica) (GSS, 2012).

3.1.4 POPULATION AND HOUSING

The region has an estimated population of 2,479,461 of which 1,229,887(49.6%) are males and 1,249,574 (50.4%) are females (GSS, 2012).

The region is well known for its architecture of round huts with conical thatched roofs.

There are four main types of dwelling units comprising of the separate isolated houses (Self Contained), the semi-detached houses, separate room (s) within a compound usually with common cooking facilities and several huts or buildings within a common compound. The majority of households are huts roofed with thatch which are commonly used as residential houses in the rural communities within the region.

3.1.5 POLITICAL AND ADMINISTRATIVE STRUCTURE

The main administrative structure in the region is the Regional Coordinating Council (RCC), headed by the Regional Minister, who is also the Chairman of the Regional Security Council (REGSEC).

Other members of the RCC include the Regional Coordinating Director, District Chief Executives and presiding members of the District Assemblies, and two representatives from the Regional House of Chiefs. All heads of decentralised departments are ex-officio members of the RCC. The Regional Coordinating Director is the Secretary to the Council. The region has twenty-six (26) districts of which Tamale is the only metropolitan. The region has 31 constituencies.

3.1.6 CHIEFTAINCY, ETHNICITY AND RELIGION

There are four paramount chiefs in the region. They are: the Ya-Na, who is the overlord of Dagbon in Yendi; the Nayiri of Mamprugu in Nalerigu; the Bimbilla Naa of Nanung in Bimbilla and the Yagbonwura of the Gonja Traditional area in Damongo. All the paramount chiefs are members of the Northern regional Chiefs and also the National House of Chiefs.

The popular festivals that are celebrated in the Northern region include the *Bugum* (fire) and *Damba* festivals. The *Bugum* festival is an annual festival celebrated by most of the ethnic groups of northern Ghana. It is celebrated in the lunar month of *Bugum* in Dagbani and Muharram in Arabic. *Bugum* is the first month of the lunar calendar of the Dagomba. The origin of the festival is shrouded in mystery as Islam and Dagbon cultures each claim to own it. There is, however, some inter-relationship between the two cultures as they have influenced each other with the passage of time.

The *Damba* on the other hand is both a dance and a festival and is the single most important festival celebrated across the northern of Ghana by the Dagomba, Mamprusi, Gonja, Nanumba and even the Wala in the Upper West Region." (GSS, 2012).

Among the Mole-Dagbon, the main ethnic group of the Northern region, the largest subgroups are the Dagomba and the Mamprusi, while the Kokomba, Basaari and Bimoba are the largest of the Gurma group. The Chokosi belong to the Akan while the Gonja and Chumburu belong to the Guan ethnic group.

The predominant languages that are spoken in the region are Dagbani, Gonja and Mampruli. The other languages are Likpakpa, Chokosi, Basaare, Kantosi, Moar, Chamba and Chumburu. (GSS, 2012).

3.1.7 EDUCATION, ECONOMY AND LIVING CONDITIONS

The Northern has several educational facilities including the Senior High Schools, Tamale Polytechnic, and two (2) Colleges of education among others. The region also has one Public university with several satellite campuses across the region with its medical school situated in tamale, the regional capital. Most these educational institutions are concentrated in the urban parts of the region.

The majority of people in the region are engaged in agriculture. Predominant crops produced in the region include: yam, maize, millet, guinea corn, rice, groundnuts, beans, soya beans and cowpea. At Gushie in the Savelugu-Nanton District, there is a large plantation of grafted mangoes by outgrowers. Bontanga in the Kumbungu District has a big irrigation dam where farmers engage in large-scale rice cultivation during the dry season.

Daboya, the capital of the North Gonja District is characterized by its salt mining and smock weaving activities. Buipe, the West Gonja District capital is also noted for its cement production and shea nut processing factory. A branch of the Bulk Oil Storage and transport (BOST) company is also located in Buipe which serves as a distribution point for the northern part of the country.

There is surface gold mining popularly known as "galamsey" in the Kui community in the Bole District which has attracted a lot of youth from many parts of the country. Many women in the region are engaged in retail trade. At Kukuo, a suburb of Tamale, there is a Teaching Hospital that not only provides health services for the people of the Metropolis and the region as a whole, but also serves as a referral point for patients from other health facilities. (GSS, 2012)

3.1.8 TRANSPORTATION AND COMMUNICATION

The urban and sub-urban parts of the region have fairly good road infrastructure while the rural parts of the region has deplorable road infrastructure. This makes transportation in the rural parts of the region difficult and also hinders health services activities such as outreach services and surveillance.

The opening up of more roads and culverts is very much needed to improve channels of transportation within the region especially to the 'overseas area'. The major transport services in the region include motorcycles, bicycles, tricycles (motor king) and taxi cabs which are used as vehicles for transportation of goods and people. Other private bus services link the Districts and towns with others (buses for long distance travels).

The urban parts of the region has courier services such as EMS, FEDEX, DHL and others that offer fast and reliable express services. The only operating airport serving the three Northern regions is located in the Sagnarigu District and offers services through airlines including the Antrak Airline, Starbow, Africa World Airline and flight 540. The location of the airport is significant for the development of the region since it serves as the gateway to international tourists who would travel to the Northern region by air as well as Ghanaians who travel from other regions to the northern regions by air. Some parts of the region have good telecommunication coverage from most of the telecommunication companies.

There are several radio stations in the region. This creates an avenue for quick dissemination of information. There are also internet services in the urban parts of the region.

3.1.9 WATER AND SANITATION

In the northern region, the urban and sub-urban parts main water supply is pipe-borne managed by the Ghana Water Company Limited in Tamale and other district capitals. The main challenge however is the insufficient supply of the water through rationing. Other sources of water used in rural communities without pipe-borne water include mechanized bore holes, wells, dams and dug-outs.

The sanitation status of the region is generally poor. The sanitation problems are complicated by the ever increasing population in the region and the poor wastes management systems coupled with the indiscriminate open defecation by most of the people.

This threatens the health of inhabitants from poor sanitation related diseases like cholera, malaria, typhoid among others.

3.1.10 HEALTH CARE SYSTEM

The health situation of the people in the district can be described as generally poor. This is largely due to the poor health practices (poor environmental sanitation, poor nutrition and poor housing conditions) and scarce health services within the districts. The northern region has health facilities both government and private in almost every district as well as Community-based Health Planning Services (CHPS) compounds. The health services provided by these facilities include clinical care, antenatal and child welfare services, immunization, post-natal services, family planning services and health education programmes. The Regional Health Directorate manages and coordinates all health activities in the region with the help of the District Health Management Teams (DHMT).

1.3.11 TAMALE TEACHING HOSPITAL

The Tamale Teaching Hospital is one of the new tertiary hospitals in the country. The hospital is located in Kukuo in the Eastern part of the Tamale Metropolis, Northern Region, Ghana and has a land area of about four hundred and ninety thousand square meters (490,000m^2)

The hospital was commissioned in 1974 as a regional hospital to serve as a referral center for the three northern regions of Ghana. The hospital provides comprehensive health services to the people of Tamale and its environs. The hospital is accredited to conduct the training of health professionals within the sub-region since 2007.

The mission of the hospital is to provide quality and affordable tertiary healthcare delivered by well-trained, highly motivated and customer friendly professional health staffs. The vision is to be the center of excellence for quality tertiary healthcare and medical education and research. The Tamale Teaching Hospital serves as tertiary referral institution for other facilities in the northern parts of the country. The hospital has staff strength of 1,915 with 218 doctors, 753 nurses and 187 orderlies. There are ten departments in the facility including public health, dental, surgery, Obstetrics and Gynecology, Out Patient Department, accident and emergency, paediatric, medicine, child health, and diagnostics.

The scope of the study however, is to draw conclusion on the snakebite problem that affects the northern region from the study at the Tamale Teaching Hospital. Hence the brief description of the northern region is as found in chapter one.

3.2 STUDY TYPE / DESIGN

This study is a descriptive retrospective review of snakebite cases recorded at the Tamale Teaching Hospital from January 2013 to July 2014. The patient folders of all snakebite cases that were reported to the Tamale Teaching Hospital through the Emergency unit and/or the Out-patient unit were retrieved and thoroughly examined and a structured questionnaire filled out for each folder. Variables such as the biographical data of the patient, the clinical presentations, and the type of first aid used, the clinical management of the snakebite, and the case outcome were extracted from the folders and analysed.

3.3 STUDY POPULATION

Tamale Teaching Hospital which is the setting of the study serves as a referral hospital for all the other hospitals in the Northern region and hence the cases studied were from all parts of the region. The Northern region has a relatively high proportions of the economically active population engaged as skilled agricultural, forestry and fishery workers forming 73.3% (GPHC, 2010).

The study population consisted of the total number of clients who attended the TTH for medical care as both out-patients and in-patient. According to the 2014 annual report from the TTH, total client attendance to the hospital within the study period , January, 2013 to July, 2014 was one hundred and sixty-nine thousand and sixty (169,060) (TTH, 2014).

3.4 STUDY UNIT

The study unit was the clients who reported to the Tamale Teaching hospital with cases of snakebite within the period under study, which is from January 2013 to July, 2014.

3.5 SAMPLE SIZE

The sample size for the study was equal to the number of snakebite cases recorded at the Tamale Teaching Hospital within the specified study period whose folders were successfully retrieved from the hospital records department. The sample size was 150 cases. This is illustrated as follows in figure 3.1;

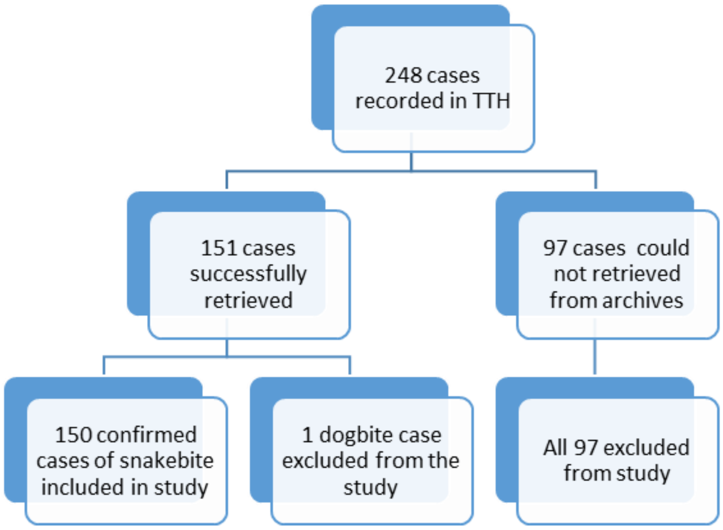

Figure 3.1 Sample size derivation Source: Field Survey, 2014

3.6 SAMPLING METHOD

Purposive Sampling was employed in deciding the cases to be reviewed in the hospital. A case was included in the study only if it was a confirmed case of snakebite.

3.7 VARIABLES AND DATA SOURCES

The variables of the study included independent variables such as the ages, the gender, occupation, the type of snake identified as responsible for the bite and the residence of the snakebite victims. The dependent variables of the study also include clinical signs and symptoms of snakebite cases, treatment outcome, the management of snakebite cases, the time lapse between the bite-admission of the cases, the first-aid methods used by clients, the seasonal variations of the number of cases reported. The source of data for this study was the snakebite patient folders at the Tamale Teaching Hospital.

3.8 ANALYSIS AND PRESENTATION OF RESULTS

The data collected was entered, cleaned and analyzed with the SPSS version 20.0. Frequencies of continuous and categorical variables, means and interquartile range of ages. Cross tabulations to determine statistical associations was done. Statistical associations of some variables were tested using Chi-square test and p-value at 5% significance level (two-tailed test).

The analyzed data were presented in frequency distribution tables, histogram and bar charts. Then the graphs and tables were redesigned using Microsoft excel and Word after the Statistical Package for Social Sciences analysis.

3.9 QUALITY CONTROL

The quality of the data captured was ensured by double checking each completed questionnaire for errors and omissions. The data was also double entered to rule out omissions and mistakes.

3.10 ETHICAL CONSIDERATIONS

Written permission was sought from the Tamale Teaching Hospital to use the patients' records of snakebite cases for this study. Ethical clearance was also sought from the Ethics committee of the Tamale Teaching Hospital for the study.

There were no obvious benefits or risks to the study subjects since the study was a retrospective review of the patients' folders in the hospital. There was no direct involvement of the study subjects. However, the findings of this study would contribute to the scientific knowledge of snakebite and its management in the Northern parts of Ghana.

This study is strictly for academic and research purposes and hence stringent measures were taken to protect the identities of the study subjects, thus ensuring anonymity and also keep all data and findings confidential. Only authorized personnel were granted access to study documentation containing personal information relating to study participants. All generated data was kept locked at the study site. All information obtained was in a form that did not identify individuals by name.

3.11 METHODOLOGICAL LIMITATIONS

The study was faced with some methodological limitations such as the following;

1. The retrospective study design was a major limitation of the study. Since the study involved the review of hospital records, it was difficult to retrieve the case records for all the snakebite cases recorded at the Tamale Teaching Hospital within the study period.
2. Some of the patient folders were not complete and hence some information needed for completing the study questionnaires could not be found. This accounted for some missing data in the data analysis.

CHAPTER FOUR

RESULTS

4.0 INTRODUCTION

This portion of the dissertation outlines the main findings of the study presented in line with the study objectives.

4.1 PREVALENCE OF SNAKEBITE AT THE TAMALE TEACHING HOSPITAL

Prevalence (P) of a disease was calculated as follows:

$$P = \frac{\text{Number of people with the disease or condition at a specified time}}{\text{Number of people in the population at risk at the specified time}} (\times 10^n)$$

P= 247/169,060*10^4 =146/100,000 population

The prevalence of snakebite cases in the Tamale Teaching Hospital waserefore **146/100,000** population (Total client attendance within study period).

4.2 SOCIO-DEMOGRAPHIC DISTIBUTION

The table below presents the socio-demographic features of the snakebite victims at the Tamale Teaching Hospital.

TABLE 4.1 SOCIO-DEMOGRAPHIC DISTRIBUTION OF SNAKEBITE CASES

SOCIO-DEMOGRAPHIC DISTRIBUTION OF SNAKEBITE CASES		
Variable		**Frequency (%)**
Age	0-14	45 (30.0)
	15-29	41 (27.3)
	30 – 59	57 (38.0)
	> 60	7 (4.7)
Gender	Male	97 (64.7)
	Female	53 (35.3)
Occupation	Farmer/Herdsman	69 (46.0)
	Student/Pupil	48 (32.0)
	Housewife	2 (1.3)
	Civil/Public Servant	4 (2.7)
	Trader	9 (6.0)
	Unemployed	18 (12.0)
Residence	Urban	28 (19.0)
	Rural	122 (81.0)

Source: Field Data, 2014

4.2.1 AGE GROUPS OF SNAKEBITE VICTIMS

The research sought to determine the age groups of the snakebite victims and their risk of snakebite in the northern region of Ghana. The findings are displayed in the above table.

The majority (38%) of the victims were in the age group 30-59years, followed by the 0-14 years age group (30%) and 15-29 years age group (27.3%). The above 60 years age group had the least reported cases (4.7%) in the study.

4.2.2 GENDER (SEX) OF SNAKEBITE VICTIMS AT TTH

The study was aimed at determining the gender distribution of the snakebite cases reported to the Tamale Teaching Hospital. The results on the sex distribution are as shown in the table above. The majority of the snakebite victims were found to be males (64.7%).

4.2.3 OCCUPATIONAL RISK OF SNAKEBITE

It was an objective of the study to determine the occupations of the snakebite victims and its risk of snakebite. The findings of the study are as follows; the majority of the snakebite cases were agriculture related workers (46%) followed by students/pupils (32%) and the unemployed (12%). Housewives had the least number of cases (1%) in the study.

4.2.4 DISTRICT/ RESIDENTIAL DISTRIBUTION OF SNAKEBITE CASES

The study sought to determine the distribution of the snakebite cases by the district of residence. The findings are shown in the following graph;

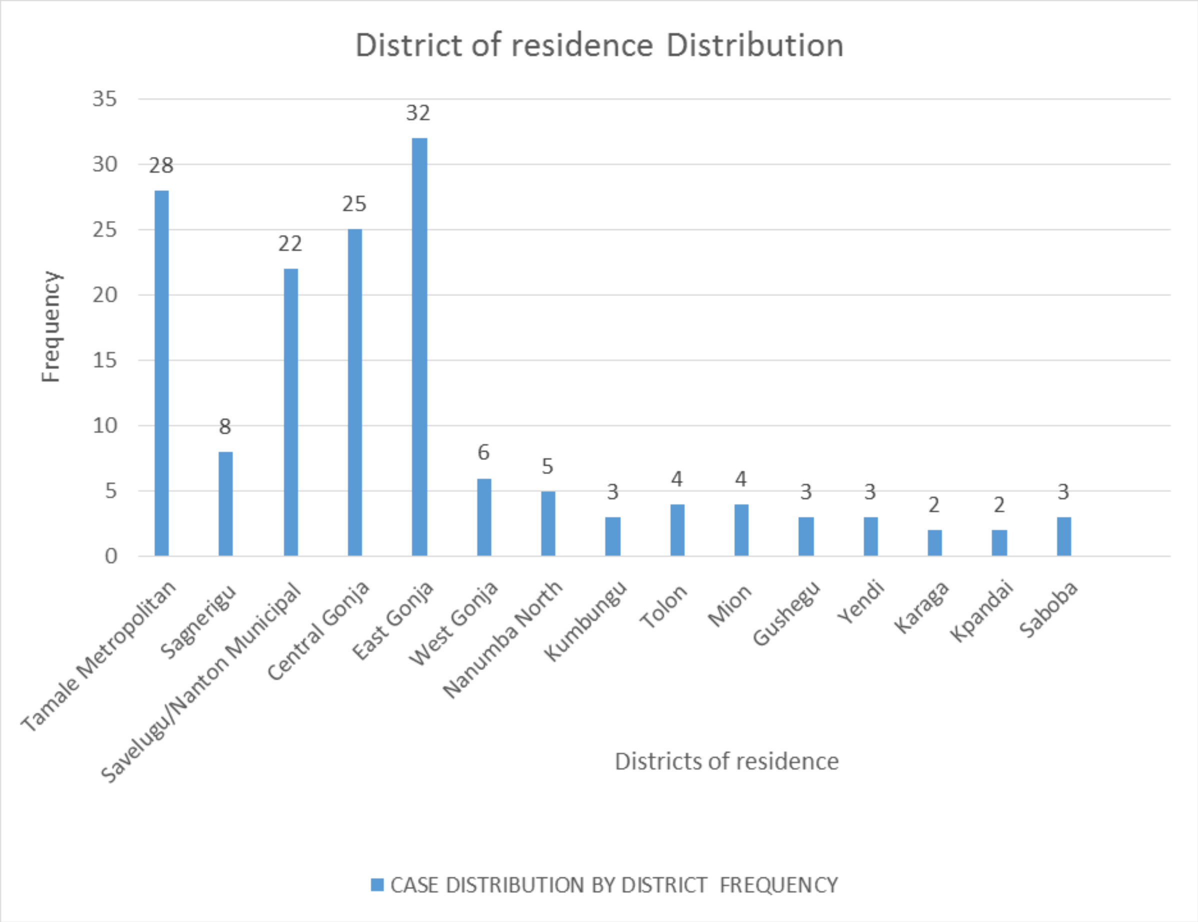

Figure 4.1: District Distribution of Snakebite Cases

The study found that the East Gonja district had the most cases (32) reported followed by the Tamale Metropolis (28) and Central Gonja district (25) in that order. The least cases were reported from Kpandai and Karaga districts (2). When classified into urban or rural environments, 81% of the victims were found to be from rural areas with the other 19% coming from urban area which is the Tamale metropolis.

4.3 SEASONAL/MONTHLY VARIATIONS OF THE NUMBER OF CASES

The research also determined the monthly distribution of the snakebite cases reported to the TTH. The results are shown in the graph below;

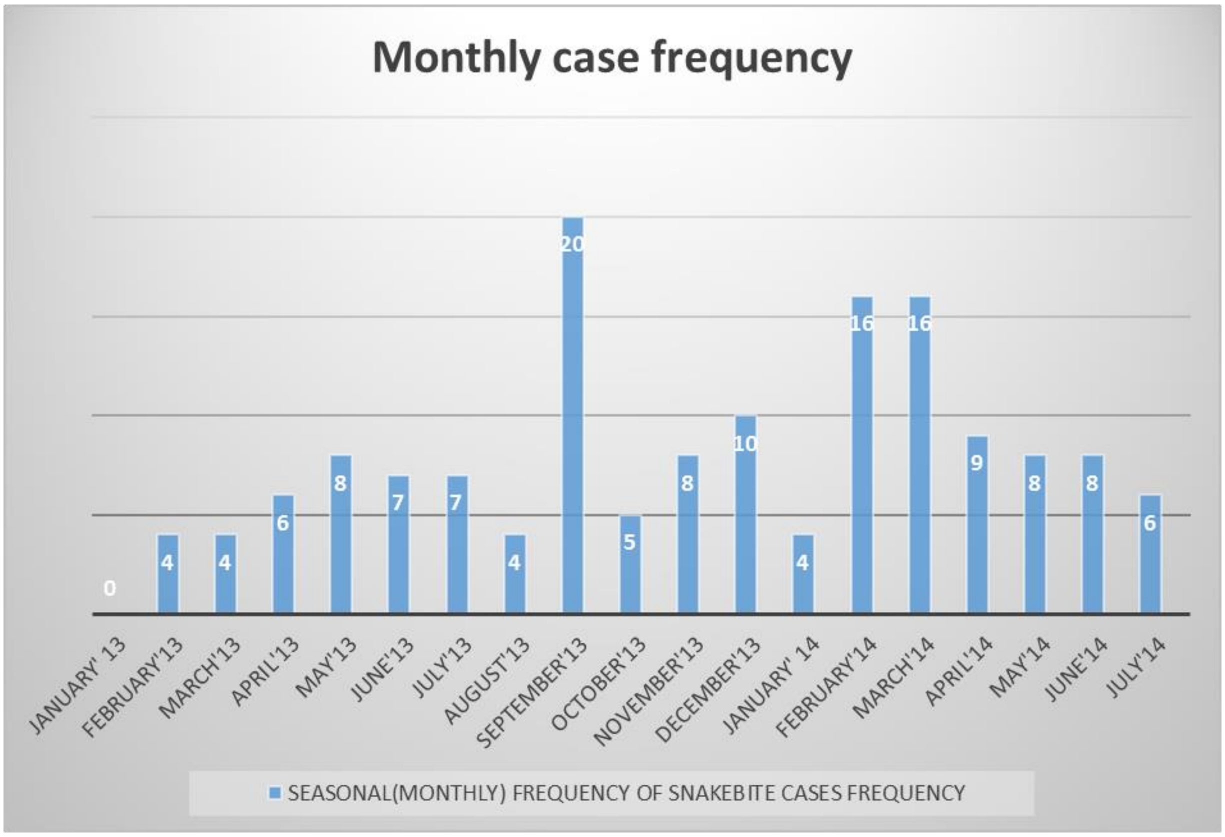

Figure 4.2: Monthly Case Distribution at TTH

The graph shows that the greatest number of cases (20) was recorded in September, 2013 followed by February, 2014 (16), and March, 2014 (16) and with no case recorded in January, 2013.

4.4 THE SITE OF BITES

The research sought to determine the site on the body of the bite in all the cases studied and the results are displayed in the graph below;

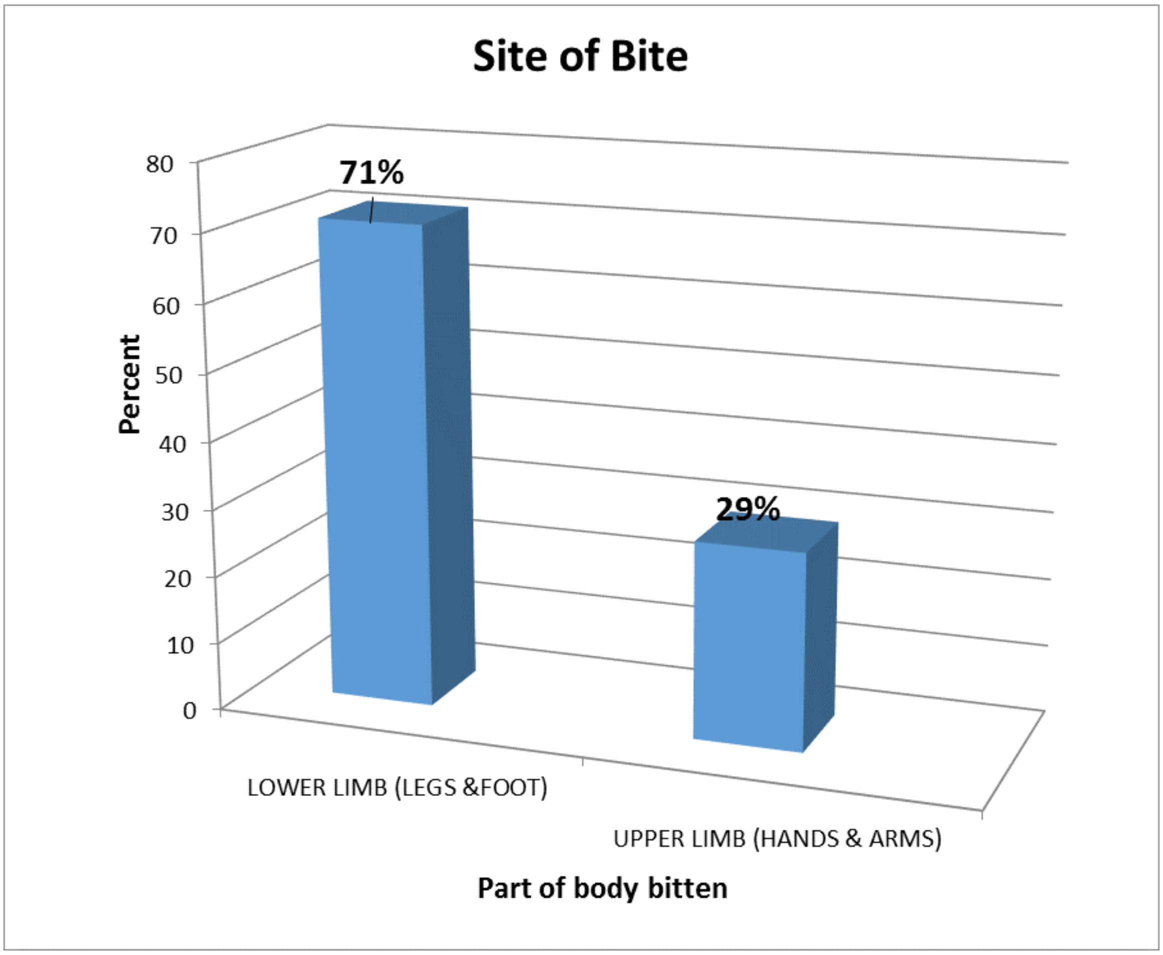

Figure 4.3: Site of Bite in Snakebite Cases at TTH

It was found that the majority of the cases at the TTH were bitten in the lower limbs as against the upper limbs with respect to the site of the bite.

4.5 PLACE OF BITE

The study determined the place where the victims got bitten by the snakes and the findings are shown below;

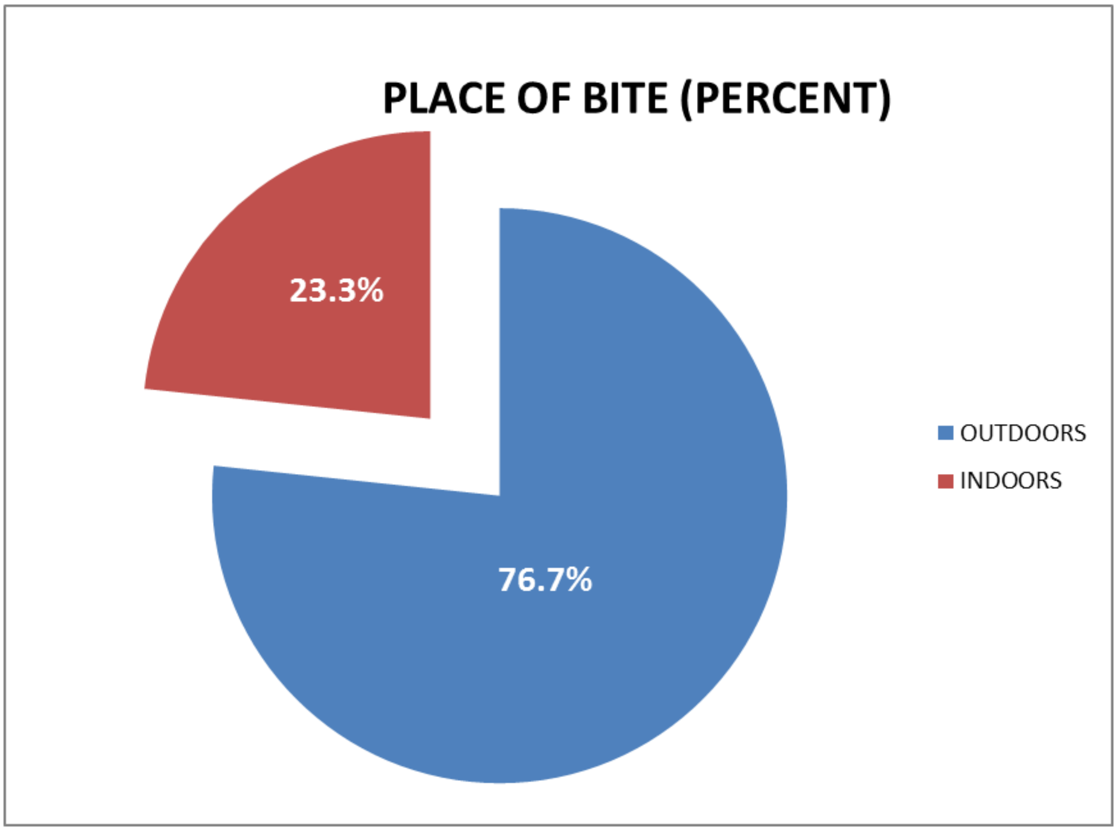

Figure 4.4: Place of Bite in Snakebite Cases

The pie chart shows a greater majority (76.7%) of the snakebites occurred outdoors than indoors (23.3%).

4.6 TIME OF BITE

The study also determined the time of the bite in the cases that were reported to the Tamale Teaching Hospital and the findings are as follows;

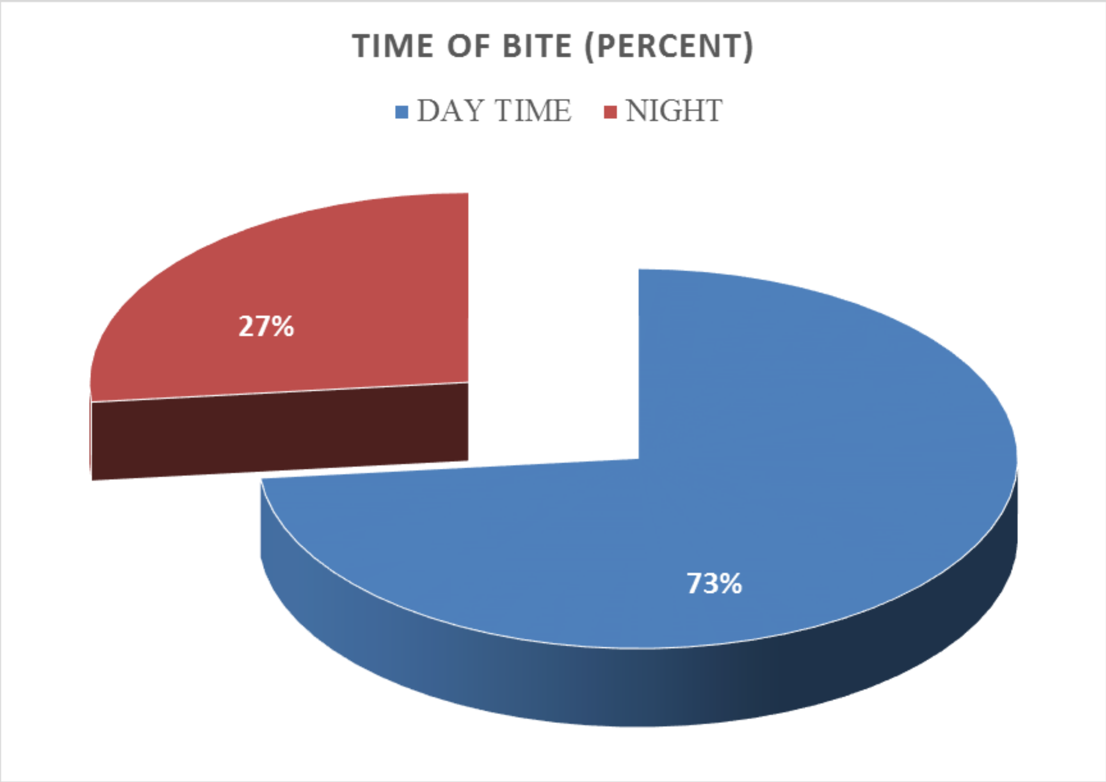

Figure 4.5: Time of the Bite

It was observed the majority of the bites occurred during the day time (73%) as compared to the number in the night (27%).

4.7 TIME OF PRESENTATION

The research sought to find out the time of presentation at the accident and emergency (A/E) department of the Tamale Teaching Hospital. The findings of the study are displayed in the graph below;

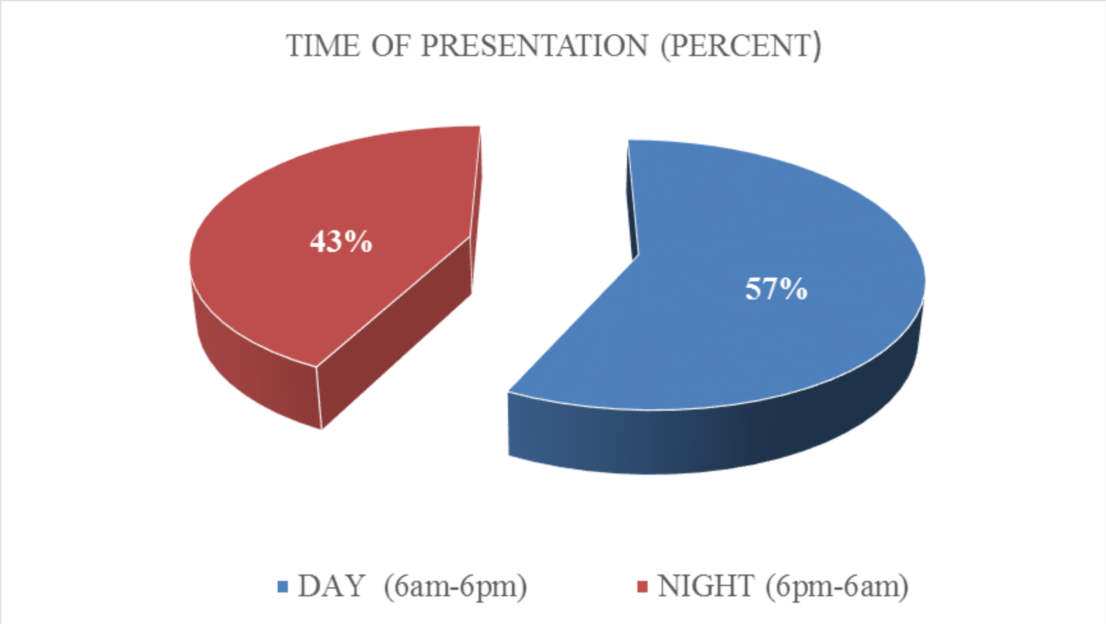

Figure 4.6: Time of Presentation at Hospital

It was found in the study that the majority (57%) of cases at the TTH reported to the hospital during the day than the night (43%).

4.8 THE TIME LAG BETWEEN THE BITE AND HOSPITAL ADMISSION

The study also looked at the time difference between the time of the bite and presentation at the hospital for medical care.

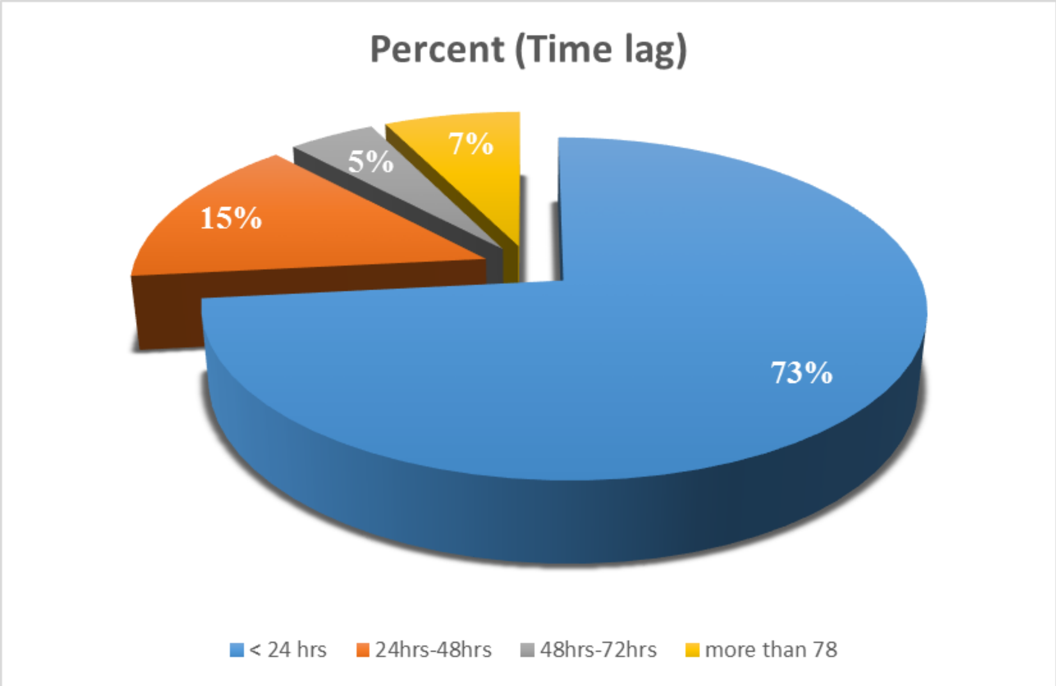

Figure 4.7: Time Lag between Bite and Hospital Presentation

The vast majority (73%) of the snakebite victims reported to the hospital within 24 hours of the bite. 15 % of the victims reported within 24-48hours. However, quite a number (7%) also reported very late after about 78 hours.

4.9 HOW CASES CAME TO THE HOSPITAL

The study also looked at how the snakebite victims came to the Tamale Teaching Hospital for medical care. This was to determine the health seeking behavior of the snakebite victims. The results are showcased in the table below;

Table 4.2: How the Victims came to the TTH

How the victim came to the Tamale Teaching Hospital		
	Frequency	Percent
Direct from the Community	107	71.3
Referred from another health facility	40	26.7
Referred from traditional healer	3	2
Total	150	100

Source: Field Survey (2014)

The majority (71.3%) of the snakebite cases came to the Tamale Teaching Hospital directly from their community and a good number (26.7%) were also referred from other health facilities. However, very few cases were referred to the TTH by traditional healers.

4.10 CLINICAL PRESENTATIONS OF SNAKEBITE CASES

The study conducted a probe into the clinical presentations (signs and symptoms) that the various cases manifested when they got to the hospital. The findings are shown in the following chart;

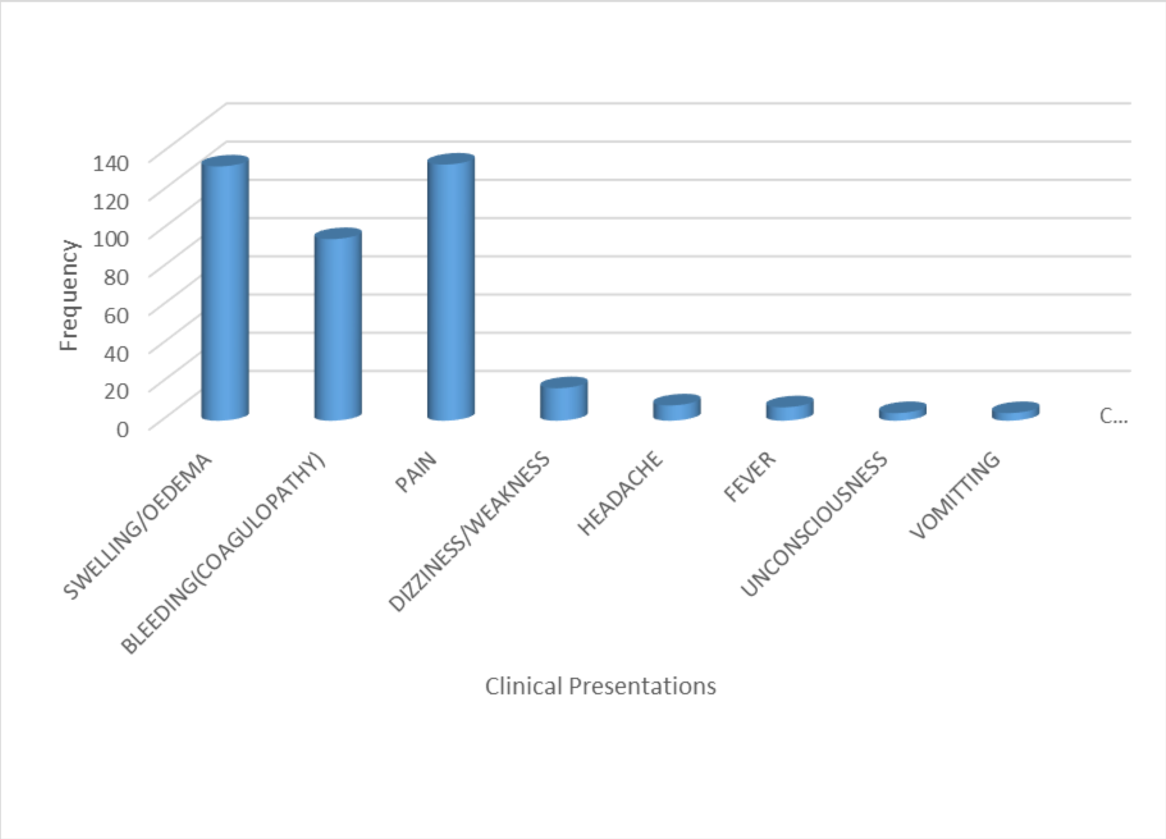

Figure 4.8: Clinical Presentations of Snakebite Victims

Most of the snakebite cases studied reported three major complaints namely; pain, swelling and bleeding. Few of the cases also reported dizziness, headache, vomiting and unconsciousness.

4.11 FIRST AID METHODS THE SNAKEBITE VICTIMS USED

The determination of whether the snakebite victims applied any form of first aid method was an objective of the study and the results were as follows;

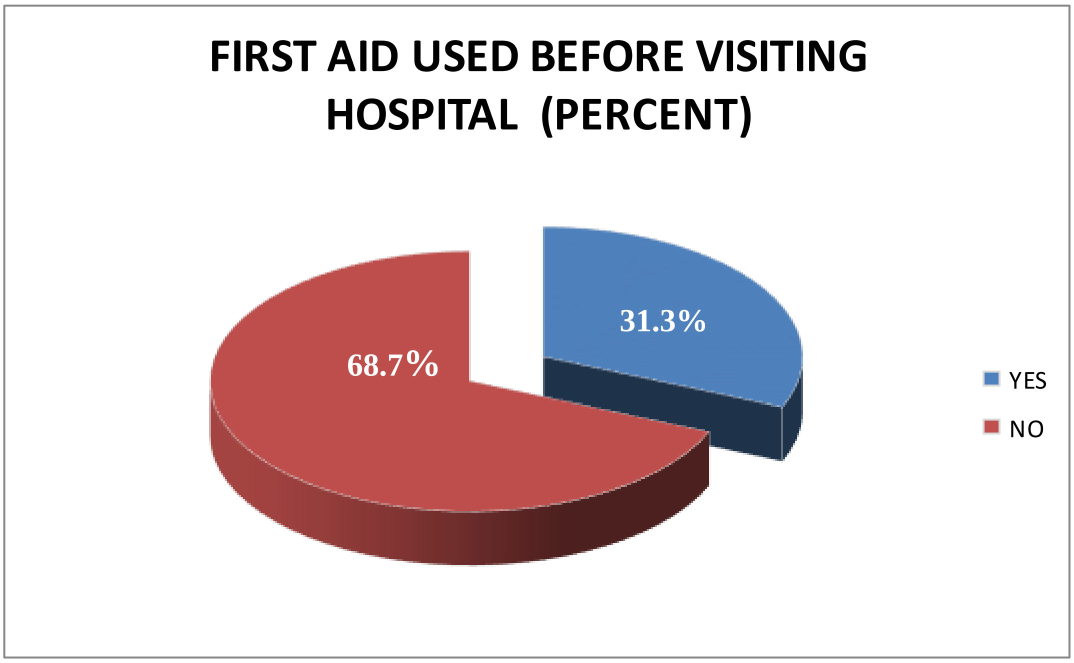

Figure 4.9: First Aid Used Before Visiting Hospital

The chart shows that most (68.7%) of the victims reporting to the hospital with snakebite did not use any form of first before coming to the hospital for medical care.

The others (31.3%) who used a form of first aid prior to the hospital presentation were also assessed to determine the method mostly used and the results are displayed the chart below;

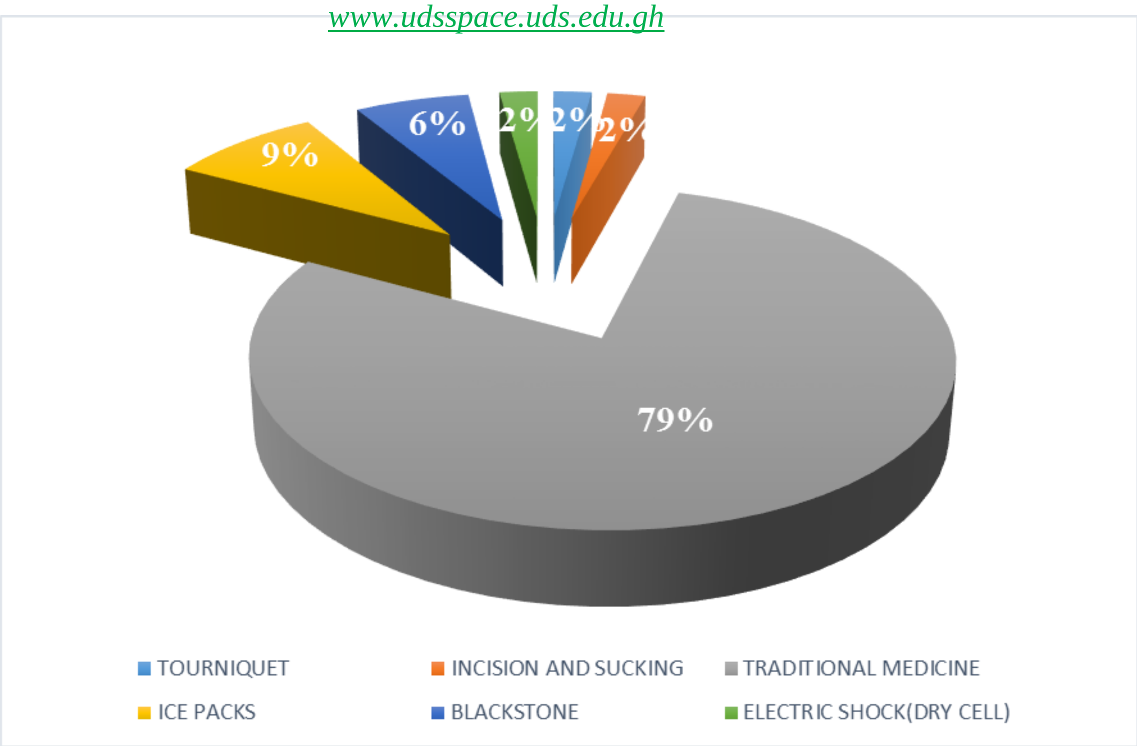

Figure 4.10: Type of First Aid Used

The study found that a vast majority (79%) of the people who used first aid preferred traditional medicine to the other methods such as tourniquet (6%), incision and sucking (2%), ice packs (2%).

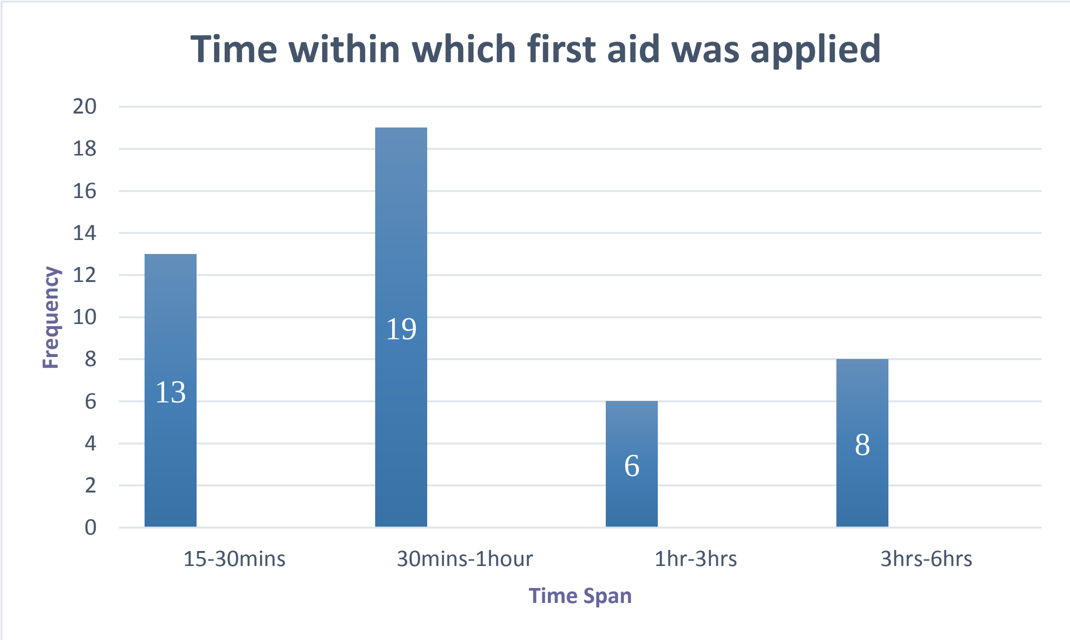

Figure 4.11: Time within which First Aid was applied

As shown in the chart above, the research also determined the time within which the first aid method was applied after the bite. It was found that the majority of the first aid was applied within 30 minutes to 1 hour after the bite.

4.12 TYPES OF SNAKES IDENTIFIED

It was an objective of the study to determine the snake type implicated in the cases reported to the Tamale Teaching Hospital. The findings are displayed in the graphs below;

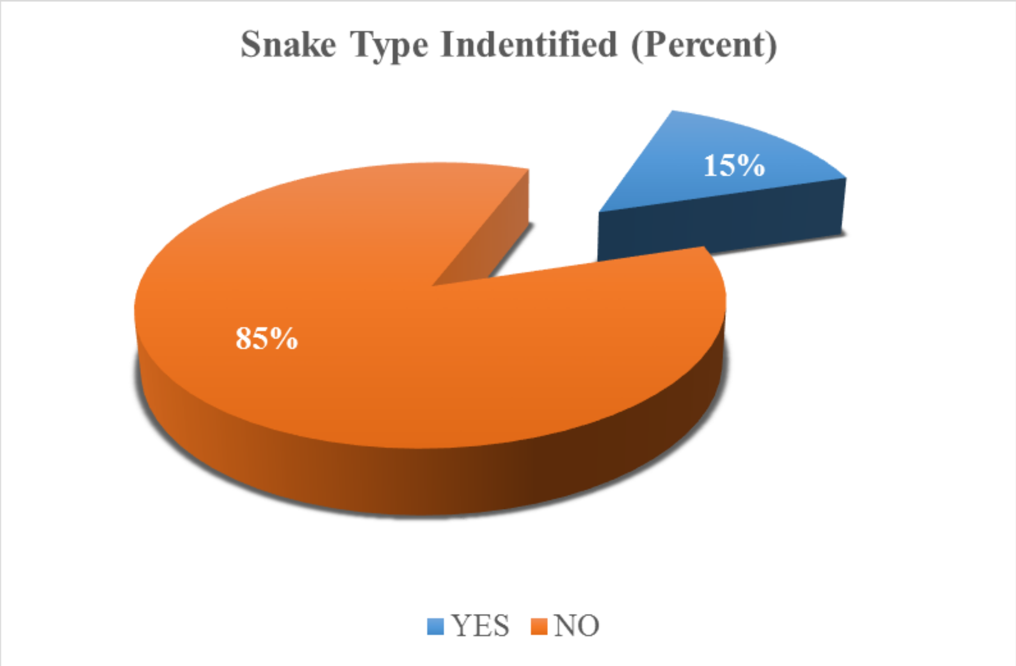

Figure 4.12 Identified Snake Type

The graph indicates that only a very small number (15%) of the cases reported were able to identify the type of snake that bit them. The remaining 85% of the snakebite victims could not identify the snake responsible for their bites.

Of those who were able to describe the type of snake that bit them, the specific snake identified was also analysed and the results are shown in the chart below;

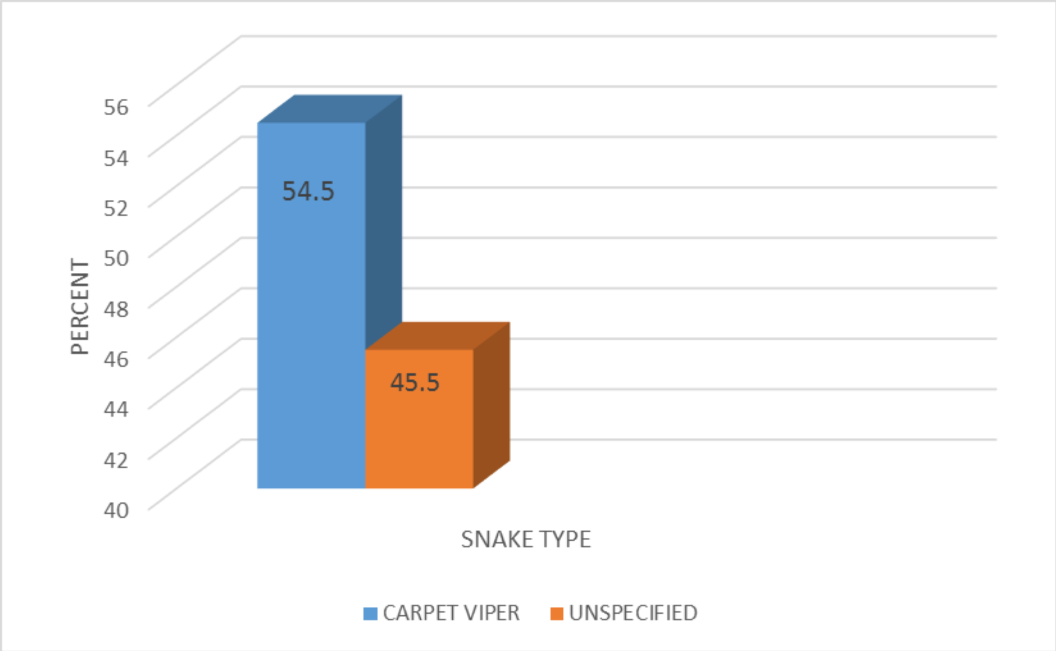

Figure 4.13: Specific Snake Type Identified

The graph above shows that an even smaller proportion of the cases that identified a snake type were able to specify a snake by name. The carpet viper (*Echis Ocellatus*) was the only snake identified by name. The other types of snakes involved was unspecified.

4.13 THE MANAGEMENT OF SNAKEBITE CASES

The study was aimed at determining the management of snakebite cases at the Tamale Teaching Hospital. The results of that inquiry are shown in the following graphs;

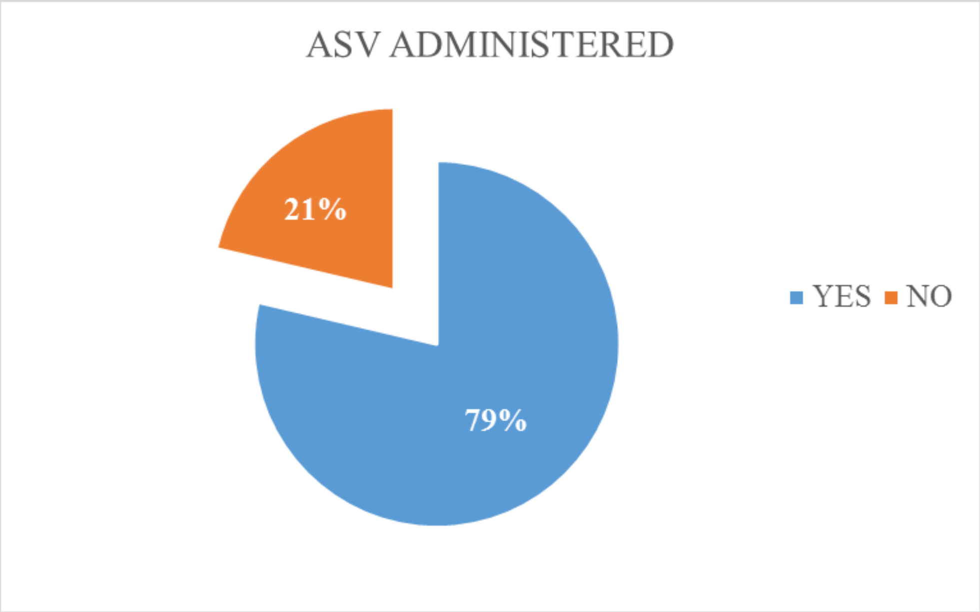

Figure 4.14: ASV Administered

It was observed in the study that ASV was administered to the majority (79%) of the snakebite cases managed at the Tamale Teaching Hospital.

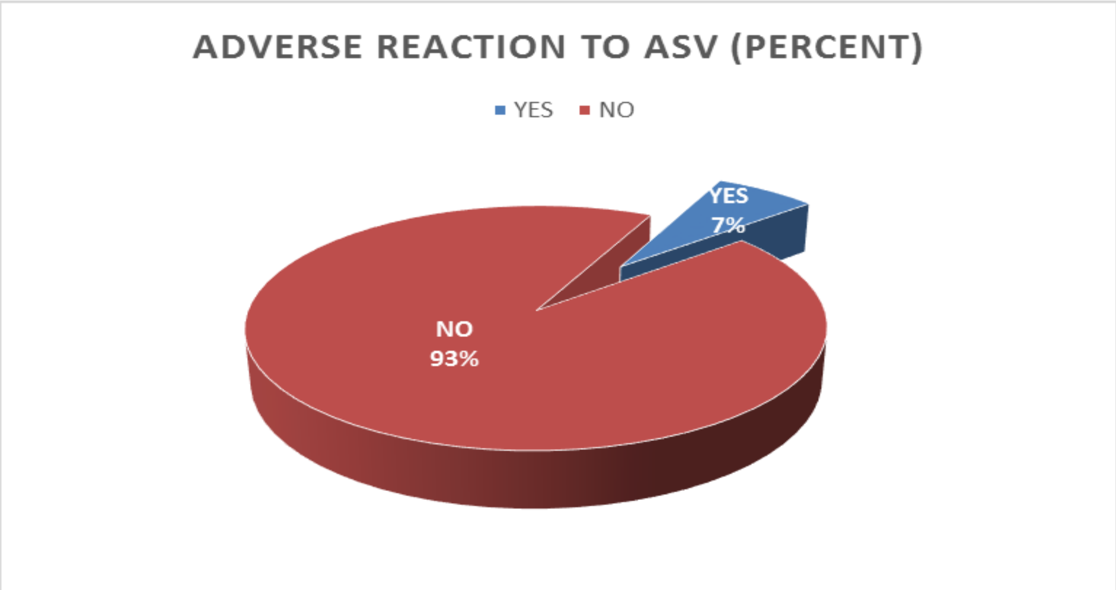

Figure 4. 15: Adverse Reaction to ASV Administered

The study also found that very small percentage (7%) of the snakebite victims who received ASV as part of the management of their snakebite experienced any adverse reaction to the ASV.

The adverse reaction to ASV was also analysed by age to determine the age group at most risk and the results are represented below;

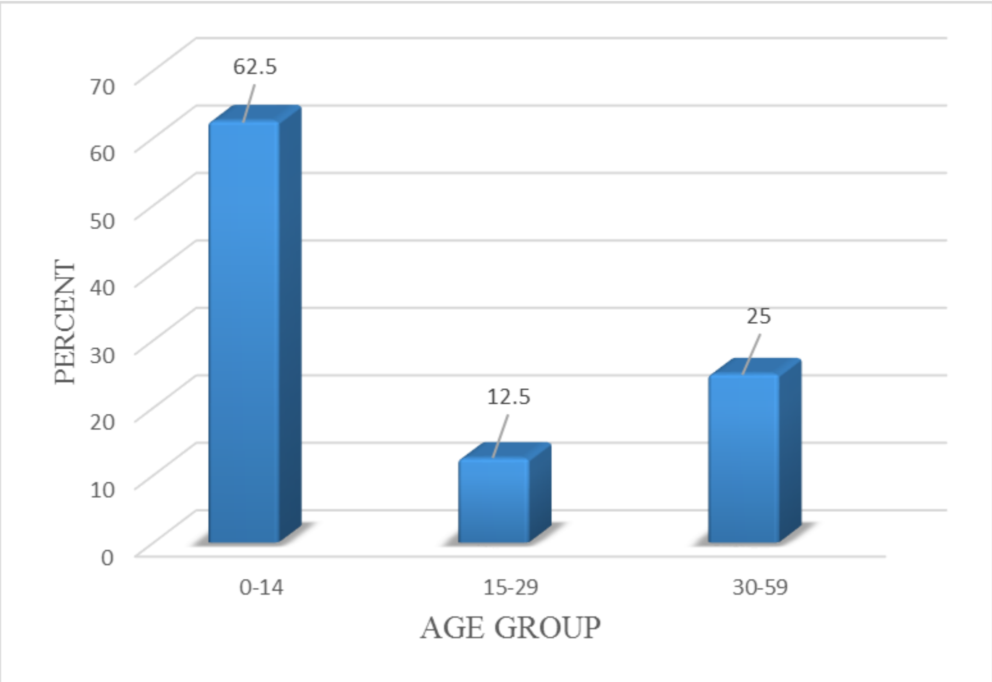

Figure 4.16: Adverse Reaction to ASV by age

This chart above shows the proportion of adverse reaction to ASV administration by age group. The majority (62.5%) of the victims who experienced the adverse reaction were in the 0-14 years age group.

Table 4.1: ATS/TT Administration

ATS/TT ADMINISTRATION			
		Frequency	Percent
	Yes	100	66.7
	No	50	33.3
	Total	150	100

Source: Field Data, 2014

The study also ascertained the use of ATS and TT vaccine in the management of snakebite cases and the results are shown in the table above. ATS/TT was administered in majority (66.7%) of the cases managed at the Tamale Teaching Hospital.

The study undertaken also considered the use of antibiotics in the management of snakebite cases and the results were as follows;

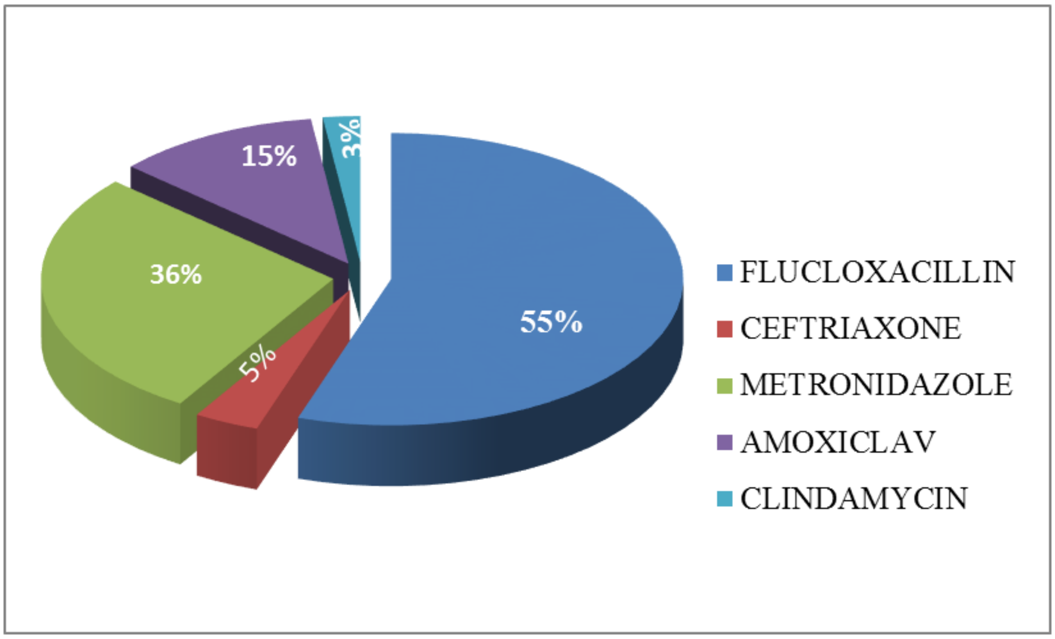

Figure 4.17: Antibiotics Administered

An antibiotic was administered in every reported cases. Flucloxacillin (55%) was administered in majority of the cases whiles clindamycin was least used in the management of snakebite cases at the Tamale Teaching Hospital.

The initial investigations carried out in the management of snakebite cases in the Tamale Teaching Hospital were also assessed and the findings presented in this chart.

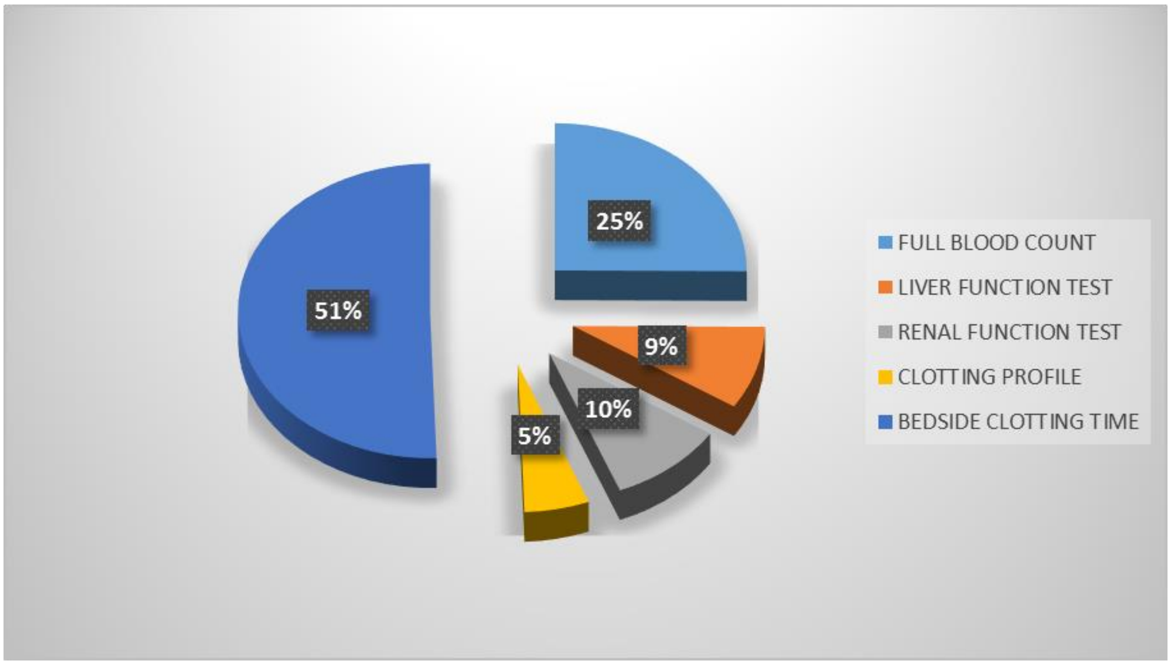

Figure 4.18: Initial Laboratory Investigations

The chart shows that bedside clotting time (51%) was the most important investigation carried out in majority of the cases followed by full blood count investigation (25%) and the least utilized investigation was the clotting profile (5%).

4.14 LENGTH OF HOSPITAL STAY

The research conducted considered the length of stay at the hospital per case and the findings are shown below;

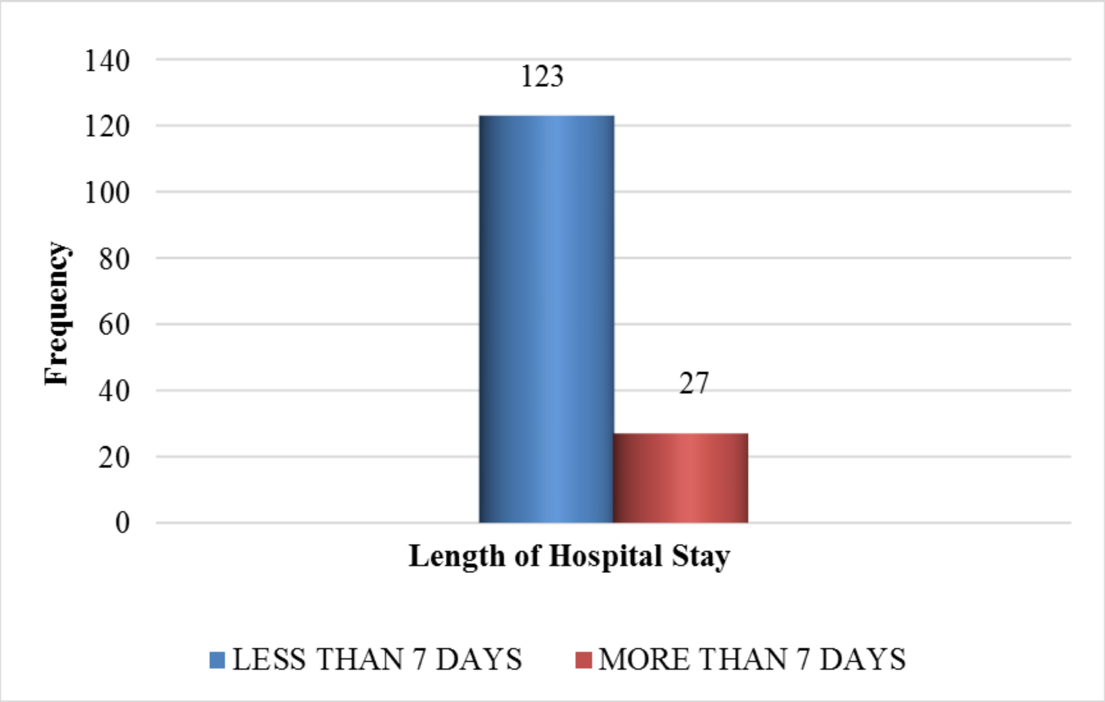

Figure 4.19: Length of Hospital Stay

It was found that a vast majority (82%) of the snakebite victims stayed in the hospital for less than 7 days. The remaining 18% of the snakebite victims stayed at the hospital for more than 7 days.

4.15 THE TREATMENT OUTCOME OF THE IDENTIFIED SNAKEBITE CASES

The outcome of the snakebite cases reported to the Tamale Teaching Hospital was also studied and presented as follows;

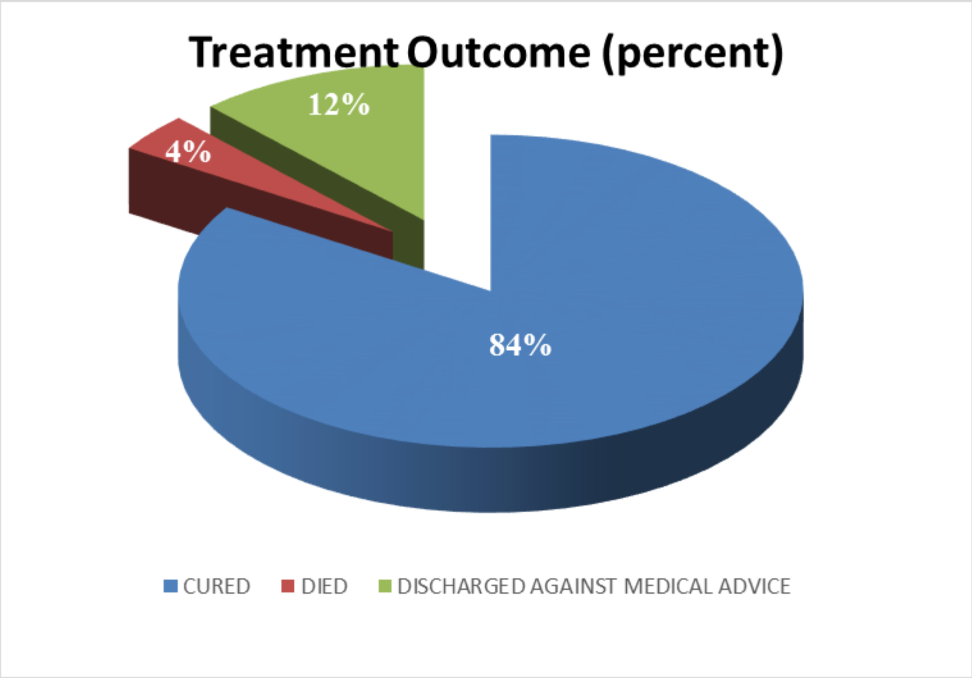

Figure 4.20: Outcome of Cases

The study revealed that majority (84%) of the cases managed at the hospital were cured, while a small number (12%) were discharged against medical advice. The number of deaths recorded was 4% in proportion to the number of cases.

4.16 ASSOCIATION BETWEEN TIME LAG WITH LENGTH OF STAY AND OUTCOME

The strength of the association between the time lag and low long the snakebite victim stayed on admission and eventually the treatment outcome was also assessed. The results are displayed in the tables below;

Table 4.4: Time lag, length of hospital stay

TIME LAPSE	LENGTH OF STAY*	
	< 7days	> 7 days
< 24	89(81.7)	20(18.3)
24-48	18(85.7)	3(14.3)
48-72	6(100.0)	0(0.0)
> 72	9(75.0)	3(25.0)
Total	122(82.4)	26(17.6)

* A chi square analysis show no significant difference (P= 0.585) with the different time lapse in reporting to TTH

Table 4.5: Time lag and treatment outcome

TIME LAPSE	OUTCOME*		
	Cured	Died	DAMA
< 24	93(85.3)	2(1.8)	14(12.8)
24-48	18(85.7)	1(4.8)	2(9.5)
48-72	5(8.3)	1(16.7)	0(0.0)
> 72	8(66.7)	2(16.7)	2(16.7)
Total	124(83.8)	6(4.1)	18(12.2)

* A chi square analysis show no significant difference (P= 0.126) with the different time lapse in reporting to TTH.

4.17 OTHER ASSOCIATIONS BETWEEN THE VARIABLES

Table 4.6: Use of First Aid and Time lag

	Time Lapse	Within 24 Hrs	Within 48 Hrs	Within 72 Hrs	> 72 Hrs	P-value*
Victim Use A First Aid Method	Yes	25	8	5	8	0.000
	No	83	12	1	4	

*A chi square analysis show a significant association (P< 0.05) with the time lapse and first aid use at TTH.

Table 4.7: Length of Stay and outcome

		Outcome				
		Cured	Died	Discharged Against Medical Report.	Total	P-Value*
Length Of Stay	Less Than 7 Days	106	6	11	123	0.030
	More Than 7 Days	20	0	7	27	
	Total	126	6	18	150	

*A chi square analysis show a significant association (P< 0.05) with the length of stay and outcome to TTH.

CHAPTER FIVE

DISCUSSION

5.0 INTRODUCTION

This section of the dissertation dealt with the discussion of the main findings of the study.

5.1 PREVALENCE OF SNAKEBITE

As several studies have established the fact that there is a large number of snakebites in developing countries especially Sub-Saharan Africa. The study area is therefore not an exception.

From the Tamale Teaching Hospital (TTH) archives, 247 snakebite cases were recorded within the study period. With the total client attendance of 169,060 (TTH, 2014) within this period, it was estimated to give a snakebite prevalence rate of 146 per 100,000 population in the Tamale Teaching Hospital for the study period.

This prevalence could be higher for the region during the study period than captured, because the facility used for the study, TTH is a tertiary referral facility handling mostly cases referred from the primary and secondary health facilities in the region. The estimated prevalence excluded those that were handled at the lower facilities and never referred to the TTH. It also excludes those who might have gone to seek alternative treatment from herbalists and spiritualists. Gutierrez *et al.,* (2006) also argued that some snakebite victims also die on their way to the health centres, such possibility could occur here too and are definitely not captured in the prevalence calculation in this study.

Together, these buttress the argument that the true incidence or prevalence of snakebite envenomation proves difficult to determine (WHO, 2007; WHO/AFRO, 2010; Habib *et al.,* 2015).

With all the possibilities of high levels of exclusions in the snakebite prevalence calculation in this hospital based study, the estimated prevalence of 146 per 100,000 population was still higher than the estimates from some developed countries such as Australia, 3.9 per 100,000 population (Kriesfeld *et al*,. 2007), United States of America, 3.4 per 100,000 population (O'neil *et al*,. 2007) and Europe (Chippaux, 2011).

The prevalence of 146 per 100,000 population is however, lower than that reported from other developing parts of the world. For instance, Habib (2013) in his community based study reported a prevalence of 467 per 100,000 population in Nigeria and Sharma *et al.,* (2004) reported a frightening 162 snakebite deaths per 100,000 population per year in the Eastern Terai region of Nepal. This high prevalence estimates affirms the notion that the largest number of snakebite envenoming occurs in the developing countries of Africa, Asia and South-East Asia (WHO, 2007; Gutierrez, 2011)

5.2 AGE DISTRIBUTION

The highest number of snakebite cases was reported by people within the 30-59 years range. This finding is similar to that of Rao *et al.,* (2013) which was reported persons 21-50 years and 20-40 years (Ahmed *et al.,* 2012 and Halesha *et al.,* 2013).

The most affected age group found in this study was in line with the 34.97±14.07 years as the mean age of snakebite victims in Chaudhari *et al.,* (2014) study in India.

Deshpande *et al*., (2013) and More *et al*., (2014) however reported ages 31-40 as the second most affected age group in their studies. Other studies, (Wood *et al*., 2009; Mohapatra *et al*., 2011; Karunanayake *et al*., 2014; Deshpande *et al*., 2013; More *et al*., 2015) reported the highest prevalence for a slightly younger age group. In this study, high numbers of cases were also reported from persons of the age groups 0-4 and 15-29 years with those 60 years and above being the least. This was also in line with other studies that suggest that snakebite victims are mostly the young and working class. This makes snakebite not only an issue of public health concern (Habib, 2013, 2015; Dehghani *et al.,* (2012); Chippaux *et al.,* (2007); Visser *et al.,* 2004) but also of labour and economic significance or challenge. This was also not far from the third decade estimation by Adiga and Adiga (2014).

5.3 GENDER DISTRIBUTION

Majority of the cases, 64.7% reported in this study were males. This was also in line with finding from studies across the globe. For instance, Chippaux (2012) reported higher male cases in Europe despite the lower male dominance among the cases in the continent. In Africa, Godpower *et al.* (2011) and Adiga and Adiga, (2014) acknowledged male dominance among cases studied. WHO/AFRO, (2010) report supported this claim.

In the South-East Asia, especially India, different proportions were reported in favour of male dominance. Thus, (60.49% by Kashirsagar *et al.*,2013; 55.49% by Deshpande *et al.* , 2013; 66% by Bhalla *et al.*,2014 and 67.8% by Dayananda *et al.*,(2013)

This male dominance is probably due to the fact that snakebites is associated with agricultural work, (see table 4.1), which is labour intensive and draws most of its labour force from the strong young males.

This finding was however contrary to the reported 1:1 (Ahmed *et al.,* 2011) male-female ratio in their Kashmir review and the 64% female victims in Kakaria *et al*., (2014) study.

5.4 OCCUPATIONAL DISTRIBUTION

It is obvious from table 4.1, that the occurrence of snakebites among farmers and herdsmen (agricultural workers) is highest in this study. This finding is synonymous to what was reported in other literature across the globe.

As Kumar *et al.,* (2013) argued that snakebite is a major problem among the poor rural population mainly farmers (82.8%). WHO/AFRO, 2010 explained that it is common among farmers and pastoralists and hunters. Deshpande *et al.,* (2013) made similar addition as farmers, plantation workers and labourers. Gutierrez *et al.,* 2006, Chippaux, (2011), Rao *et al.,* (2013) and others found snakebite cases higher among farmers or agricultural hire workers than people in any occupation group. Habib (2013) reported similar trends in Nigeria, West Africa.

This trend in occupational risk of snakebites is not surprising because farming and agricultural activities are mostly field works that bring the victims into direct contact with snakes' habitat. The mere fact that the majority of the snakebite of the cases in this study occurred outdoors (75.33 %) figure 4.9 and also during the daytime (68.67 %) figure 4.8 affirms that the victims were more likely to be on field when they were bitten.

The next occupational groups who were students/pupils (32 %) and the unemployed (12 %). These are persons who do not have any fixed occupational or work definition. They are likely to take casual labour from farms or on the fields as agriculture happened to be highest and readily available source of livelihood for people in the northern regions of Ghana (GSS, 2013). Traders, civil/public servants and housewives were persons or occupational groups who reported the lowest number of cases. Most of these persons hardly come into contact with the natural habitat of snakes, fields, hence the least incidence of cases. Fewer cases were reported occurring indoors, therefore less of the people who do not regularly work or come into contact with the open field was expected to be affected as the case in this study.

5.5 MONTHLY OR SEASONAL VARIATION

Within the 18 month period which the study covered, almost every month of the year had at least a case reported except January, 2013. September, 2013 had the highest cases (20) reported followed by February and March, 2014 with sixteen (16) cases each. Unlike others studies that reported zero snakebites cases seasons like winter (Dehghani *et al.*, 2012), this study captured cases throughout the year but varying proportion. Snakes being poikiotherms and their relatively less activeness during the very cold seasons of the year could be noticed in this study as no case and only four (4) snakebite cases were reported in January, 2013 and January, 2014 respectively. January is the coldest month of the year in the study location/region. Dehghani *et al.*, (2012) study implied same.

The trend findings that snakebite cases peak in the summer, the hottest season of the year (Wood *et al.*, 2009; Ghosh, 2011; David *et al.*, 2012; Kshirsagar *et al.*, 2013; Bhalla *et al.*, 2014) and in the rainy seasons (More *et al.*, 2015; David *et al.*, 2012; Rao *et al.*, 2013; Ghosh, 2011; Chaudhari *et al.*, 2014) were pronounced in this current study. For instance, the higher number of cases per month (16) were reported in February, March (the hottest months in Northern Ghana) and 20 cases in September (the wettest) month of the year in Northern Ghana.

The February and March high cases might be due to several factors. Among these factors may be the dwindled snake habitat resulting from the complete burning down of the vegetation cover, their natural home. This forces the snakes to seek alternate shelter, hence sneaking in reserved areas with high humans interactions. High temperatures may also compel the snakes to leave their natural or usual hideouts to move about, thus increasing encounters with humans. With little or no farming activities during the dry hottest months of the year, coupled with high unemployed in these areas, people especially the energetic males resort to hunting during this season to support their livelihood. This rather brings the hunters into dangerous encounters with snakes in their natural habitats.

The September cases might be due to the increased farming activity and the floods driving snakes out of their holes. The comparison of August- December to the other months might yield a clear or true picture because while the former was captured only once, the January-July was captured twice in the study.

5.6 DISTRICT DISTRIBUTION

More than two-thirds of the studied cases were reported from only four of the fifteen (15) districts studied (Tamale Metropolis, Savelugu/Nanton Municipal, Central Gonja and East Gonja districts). The highest number of cases (32) was reported from the East Gonja District.

This unequal distribution could be due to several reasons. It could be that TTH location in Tamale prompted victims within the metropolis to choose TTH as the first point of call, hence the high cases from the Tamale metropolis. Also trust in the local health facilities might have been low as most of the victims by-passed their district health facilities and reported directly at TTH without referral (see Table 4.2). Victims from the other districts (see map) might have had treatment from the nearest health facility in their districts/municipality. Most of them could have responded to treatment positively and be discharged and hence needed no referral to TTH. Similarly, those in Tamale and Savelugu/Nanton municipality who are close to Tamale might seize the proximity to TTH to access its services at first hand than their counterparts in the other districts further from Tamale.

The higher incidence or reported cases from the Central and East Gonja districts could be due to low or restricted access to ASV in the health facilities in the districts leading to higher referrals to the TTH. It could also be that victims from these areas report for orthodox treatment when bitten and therefore reporting more for documentation than those from the other districts. Good and accessible roads to Tamale as in the case of Central Gonja and Savelugu/Nanton districts could also influence the reporting of snakebite cases from these districts than the others.

Finally, it could also be the simple fact that there are more cases of snakebites in these areas than the other districts.

5.7 SITE OF SNAKEBITE (PART OF BODY BITTEN)

Most, 105 (70%) of the snakebite victims got bitten in the lower limbs (legs and feet). This is in accordance with the generally reported trends in scientific literature across the globe that, the lower limbs are the most common site of snakebites (Quereshi *et al.*, 2011; Raina *et al.*, 2014; Kumar *et al.*, 2014; Chaudhari *et al.*, 2014). For instance, Halesha *et al.*, (2013) and More *et al.*, (2014) reported 67.2% and 65%

respectively of their cases being lower limb bites. Kshirsagar *et al.*, (2014) reported a slightly higher percentage (74.04%) of lower limb bites among the cases studied.

This finding or trend might be due to the creeping nature of snakes, therefore increasing the chances of being stepped upon without notice. In such a case the snake defensively respond by biting to protect itself. The readily accessible part of the body to be bitten is then the feet and legs. Hiding in grasses, leaves and shrubs, the frightened snakes might attack legs and feet if the victim is not wearing any protective clothing.

The next most affected body parts were the upper limbs (hands and arms). This should not be surprising, as most of the victims are agricultural workers. They are likely to have unknowingly picked up the snakes as they work on the farms and get bitten in the hand and arms. Children may also out of curiosity pick up the snakes and end up getting bit in the hands or arms.

5.8 PLACE OF BITE

Over 75% of the snakebites in this study occurred outdoors with agricultural and field workers being the highest victims. Most of these bites might have happened while the victims were on the field working. One victim reporting going to fetch water and another engaged in open defecation. Most of the inhabitants of the study areas do not have their household water sources and toilets within their places of abode/residence. Going out to fetch water and attend nature's call puts the household members at increased risk of encountering snakes which could result in bites.

The bites that occurred indoors could be due to the fact that, these snakes invade the residence of the victims due to the storage some agricultural produce which tend to invite rodents which therefore attracts the snakes to feed on them. The presence of these snakes in the home could result in the indoor bites. Sleeping on the floor also increases the chances of indoor snakebites especially in the very hot seasons of the year.

5.9 TIME OF BITE

Majority, 105 (75%) of the victims indicated that they were between 6:00 am and 6:00 pm (daytime). This is the time the victims may probably be very active and even likely to be on the field (farms) working. This observation was not different from what was found in Ahmed *et al.*, (2014); Rao *et al.*, (2013) and Halessha *et al.*, (2013) studies that indicated that snakebite is high during the day. Even the Saw-scaled/carpet viper which bites was considered to occur in the night by Gnanathasari *et al.*, (2012) and Kularatne *et al.*, (2012) reported the majority of the bites occurs in the daytime in Sri Lanka.

The bites that occurred in the night may be due to people sleeping in the open space and on the floor during the warm months. It could also be due to the victims going out of the house at night to use the toilet facilities outside the house. Women who pick shea nuts at dawn also risk being bitten while engaged in the activities.

5.10 TIME OF PRESENTATION AT TTH EMERGENCY UNIT

The Tamale Teaching Hospital (TTH) as the only tertiary hospital in the three northern regions of Ghana, it is open to clients throughout the day. In this study, 87 (58.0%) of the snakebite victims reported to the hospital during the day (between 6:00am-6:00pm). The other 42% of the victims reported at night (between 6:00 pm - 6:00 am). This could be that most of the bites in this study (70%) occurred during the daytime. It could also be due to the fact that it was easier to get a means of transportation to the hospital from the various districts during the day. Thus, those who were bitten at night waited for the day to report to the TTH. Because of the distance of some districts to Tamale is far victims who started their journey early might get there at day break and the vice versa.

Despite the fact that as many as 70% got bitten during the daytime, only 58% of the victims reported during the daytime, only 58% of the victims reported during the day time. This short fall might be because the victims sort treatment from other sources before coming to the hospital. It could also be due to the delay in reaching the nearest health facility for most of these bites happened in the remote/rural places (East Gonja, Central Gonja) where access to means of transportation is a challenge. Others especially from primary and secondary health facilities might be due to the attempted effort of the staff at these facilities to treat the victims. It is also possible that some of the snakebite victims might not even have known that they were bitten by a snake only to feel pains or start bleeding and then report to the hospital. All these could possibly be reasons for the delayed reporting. The effect influencing factor for night arrival and delay in reporting could not be assessed by this study since it was retrospective and the health records used did not capture the reasons.

5.11 TIME LAG BETWEEN THE BITE AND HOSPITAL ADMISSION

It was encouraging to find out that 109 (72.7%) of the snakebite victims in this study were able to report to the hospital (TTH) within 24 hours of the incident. This might be due to their quick response to avoid any intermediary healthcare as can be seen from Table 4.2. Improving road network and access to means of transport to facilitate the movement of the snakebite victim to the TTH cannot be ruled out.

However, a good number of the victims in the study (37) reported after 24 hours with as much as 10 victims reporting to the TTH after 72 hours. Experts have argued that delay in accessing treatment after a snakebite could increase the fatality rate (Kumar *et al.*, 2014). Others estimated that patients who presented more than 8 hours after the bite could die and that death occurred within 6 hours from admission. (Kshirsagar *et al.*, 2013).

From literature, factors that affect reporting time includes proximity to health facility, better road connectivity, availability and affordability of transport facilities. (Kumar *et al.*, 2014). All these are poor in the study region, hence the late reporting to the TTH. The late reporting might also be attributed to the fact that an appreciable number of the victims (40) sort treatment from other health facilities prior to their referral to the TTH (see Table 4.1). Another reason that could be inferred from the study, is the use of treatment from herbalists and traditional healers prior to reporting the hospital after the situation worsens. This may be a contributing factor to the high numbers of late admissions to the hospital. A factor that might be over looked could be the readiness of the hospital staff to admit victims adding to the time lag.

5.12 HOW THE CASES CAME TO THE HOSPITAL

Direct reporting from the community was the most preferred by snakebite victims with 106 (70.7%) of the cases, followed by referral from other health facilities with 40 (26.7%) and 3 (2%) referrals from traditional healers. Being a tertiary or referral hospital, it was expected that most of the cases would have been referred from the primary and tertiary health facilities but that was not the case. Majority of the cases however came from communities outside the Tamale Metropolis, where TTH is located. Considering the myriad of factors such as poor road network, transportation difficulties and the possible non availability of ASV in the lower health facilities in the region, the decision to report directly to the TTH seems the best decision to be taken. However, this happening brings in to focus the confidence of the people in the ability of the primary and secondary health facilities at the district levels to deal with the menace of snakebite. This could be hinged on the perceived poor outcomes of snakebite cases at these facilities.

5.13 CLINICAL PRESENTATIONS OF SNAKEBITE CASES

The signs and symptoms presented by snakebite according to the experts depends on the type of snake responsible for the bite. In all cases one or multiple signs and symptoms were presented.

A greater majority of the cases/patients came in with pain and swelling/oedema (89.3%), tissue damage (necrosis) (88.7%). Most of the victims also reported bleeding (63.3%). Other clinical signs and symptoms were presented by a relatively smaller proportion of the victims. For instance, 17 (11.3%), 8 (5.3%), 7(5.7%), 4(2.7%) and 4 (2.7%) of the victims presented dizziness, headache, fever, unconsciousness and vomiting respectively. These alarming signs and symptoms may be due to complications out of the delay in initiating treatment owing to the late reporting to the hospital. A substantial number of the snakebite victims in this study were admitted to the TTH after 24 hours of the bite. This could mean the poisonous bites would have deteriorated and complications set in before reporting to the hospital.

Although the carpet viper was the only positively identified snake type by name, the varied clinical presentations could possibly be due to the involvement of snake type (WHO/AFRO, 2010). However, the presence of pain, swellings and bleeding confirm the carpet viper involvement claims by the victims. (WHO/AFRO, 2010). It is highly likely that all cases that were reported were driven by the development of clinical signs and symptoms to come to the hospital. As such cases with no or minimal clinical signs may not have been reported all and hence not captured in this study.

5.14 FIRST AID USAGE

Unlike what was reported by Godpower *et al.*, (2011) and Karunayake *et al.*, (2014) where 81% and 80% respectively of snakebite cases received some kind of first aid, only 47 (31.3%) of the victims in this study received any kind of first aid. This low figure might be under reported. With about 26.7% of the victims in this study being referred from other health facilities, they (victims) might have been given first aid which were not reported or not seen by these patients as first aid. Recommended first aid practices such as reassurance and immobilization (Karunanayake *et al.*, 2014) were not mentioned. The mentioned methods are among the first aid methods mentioned by scientific literature as not helping (Godpower *et al.*, 2011; Karunanayake *et al.*, 2014). Although More *et al.*, (2014) reported that not receiving first aid was among the factors associated with increased mortality among snakebite victims in their study, Godpower, *et al.*, (2011) reported increase need of ASV for those who used tourniquet. It was further reported that longer hospital stay, increased treatment cost, increased risk of wound infection, increased risk of disability and death were linked to the use of traditional concoction. (Godpower *et al.*, 2011). Herbal medicine and tourniquet were also criticised by Karunanayake *et al.*, (2014).

5.15 TYPE OF SNAKE RESPONSIBLE FOR BITES

Only 22(14.7 %) of the victims were able to give a little description of the type of snake responsible for their bite. Of the identified snake types, about 55% were able to identify the carpet viper (*Echis Ocellatus*). The carpet viper was the only snake positively identified by name in this study. The viperidae were among the four (4) families of snakes the WHO/AFRO (2010) gave as being of medical importance when it comes to envenomation in the African regions. It is also among the snakes that cause envenomation in other parts of the world. (WHO, 2009). Viper bites are said to be more common than other poisonous snakebites in human beings (WHO, 2010). The 55% found in this study is far lower than what was reported in the Godpower *et al.*, (2011) study where 75% of the snakes were identified as carpet viper (*Echis Ocellatus*). Godpower *et al.*, (2011) reported similar difficulties in the ability of snakebite victims to identify the snake type involved in their study in Nigeria. These findings confirm the argument that carpet viper (*Echis Ocellatus*) is the leading cause of snakebite morbidity and mortality in West African Savanna Region. (WHO/AFRO, 2010).

The high prevalence of carpet viper (*Echis Ocellatus*) envenomation may be due to its smallish stature and the ability to blend with the environment, making it difficult to notice their presence. Victims may unknowingly step on the snake or pick it up whiles engaged in their work in the field resulting in the bites as reported. The small stature of the carpet viper (*Echis Ocellatus*) and its relatively slower movement tends to make it unable to escape (flee) the encroaching human fast enough. These snakes thereby hide to strike back in self-defense when threatened by the human presence or activity.

It could also be due to the fact that their ubiquitous (abundant presence) nature in this region and their envenoming ability is well known by the people around the study region and therefore easily identified when it is involved. These factors could be responsible the ease of identification of the carpet viper (*Echis Ocellatus*) as against the other types of snakes.

The very low snake identification is a major challenge in the management of snakebite envenomation in the health care settings because it makes it difficult to determine which type of ASV to use. Clinicians tend to use polyvalent ASV instead of the monovalent ASV which is specific and much more efficacious in the management of snakebite envenomation. This could have resulted in the poor treatment outcomes in some cases in this study.

Although lacking literature, the poor snake identification might be due to poor/low knowledge of snakes and related issues. Lack of knowledge or interest in snakes makes it difficult for victims to identify snakes by name or give a vivid description to them even if they saw it. The victims or snakes out of fear may have fled the place where the bite happened making it impossible to see and identify the snake. Those bitten in the night or in their sleep may not even see the snake at all to describe it.

However, the varied clinical signs and symptoms presented by the victims (see figure 4.12) give a clue that other snake types besides vipers were involved. Beside the carpet viper, some of the descriptions given by the victims included black slender long snake with black spots; short snake with ash colour and black spots; black snake; multicolored snake; green snake; brown snake with dark spots; dark brown and black snake with flat head.

5.16 MANAGEMENT OF SNAKEBITES

As noted by Rao *et al.*, (2011), the management of snakebite envenoming is primarily aimed at neutralizing the venom with specific ASV. The ASV is administered parenterally (Gutierrez *et al.*, 2011 and Habib *et al.*, 2015). The treatment given to the victims of snakebite in this study was no different from other studies. About 78.7% (118) of the cases in this study received ASV as part of their treatment. As much as 31.3% of the studied cases did not receive ASV. The reasons were not explicitly given in the reviewed records but this could be due to the fact that not all snakebites were poisonous and that envenomation may not have occurred following the bite. Another possible reason could be the availability and affordability of the ASV by the victim may have resulted in the non-administration of the ASV. Again, the victims may have been discharged against medical advice or died before the ASV could be administered.

This notwithstanding, the 78.7% ASV administration rate is in line with what was captured by other studies elsewhere in the world. Wood *et al.,* (2009) and Karunanayake *et al.,* (2014) reported that 75.9% and 39% respectively of victims in their study received ASV as part of their management.

In this study, only 8 (6.8%) out of the 118 victims who received the ASV showed adverse reactions to the ASV. Some of the reported reactions included chills, rashes, vomiting, swollen face, headache, itching of skin and pain. Dizziness, seizures and rigors were also reported in few cases. Most patients experienced multiple adverse reaction signs with chills, rashes, vomiting and swollen face occurring in more patients than the others. Most (62.5%) of these were children less than 14 years. This finding is similar to that reported by other researchers. Adverse ASV reactions were reported in the studies of Wood *et al.,* (2009) to be about 56.10%, 12.7% by Halesha *et al.,* (2013), 7% by Raina *et al.,* (2014) and 6.7% by Ahmed *et al.,* (2012). The high ASV reaction among children in this was also noticed and reported by wood *et al.,* (2009). This could be due to the smaller body size of the children relative to the amount of ASV administered to neutralize the venom.

The snakebite victims in this study were also given drugs to manage other infections or complications. Ahmed *et al.*, (2012), Wood *et al.*, (2009) and Karunanayake *et al.*, (2014) reported similar practices in the management of snakebite cases in their studies.

Antibiotics (see figure 4.18) and ATS/TT (figure 4.2) were addition drugs administered to prevent further complications by infections. While 100 (66.7%) of the studied cases received ATS/TT, all the cases were given antibiotics with majority receiving flucloxacillin followed by metronidazole.

Identifying the specific snake involved is vital in deciding either to give ASV or not as well as the type of ASV to use. With very high difficulties in specific snake identification by victims and relatives, a series of laboratory investigations were carried out to aid in decisions in treatment options to utilize. Some of the major tests carried out for the cases in this study are summarised on figure4.22. Clotting profile, bedside clotting time, and full blood count tests might help to know whether the snake involved gives haemorrhagic envenoming, such as saw-scaled/carpet vipers, Gaboon and rhinoceros vipers, boomslang and vine snakes (WHO/AFRO, 2010).

Acute kidney injury is an important consequences of a snakebite (Harshavardhan *et al.*, 2013). Renal function test was therefore necessary to find the degree of kidney from the envenomation. Bedside clotting time was conducted for most of the most of the patients (132) as depicted in figure 4.22. This affirms the fact that the carpet viper (*Echis Ocellatus*) being the most common poisonous snake in Savanna West Africa is responsible for the most poisonous bites (Warrell, 2012; Habib and Abubakari *et al.*, 2010) The wide distribution of carpet viper in the study region's ecological zone

(WHO/AFRO, 2010) makes testing for blood clotting ability laudable especially in such cases as when the type of snake involved is not known.

5.17 OUTCOME OF THE IDENTIFIED SNAKEBITE CASE

The main outcomes of the health cases on admission in the Ghanaian health facilities are usually "cured and discharged" or "death" with referral being another option for the lower level (primary and secondary) health facilities. The TTH is a tertiary level referral hospital with enough facilities and personnel to give ultra-modern and advanced medical care to patients. At the TTH there are certain situations where the client or patient relative may decide to withdraw the patient from the hospital against medical advice. The three types of outcomes found in this study were "cured", "discharged against medical advice" and "death".

About 84% of the cases in this study were designated as cured upon discharge from the hospital. A whole 12% of the cases were discharged against medical advice and 4% died whiles on admission. This gives a very high case specific mortality rate of 4% of reported cases. It affirmed the concern that snakebite is a major public health problem in West Africa (Habib, 2013; Habib *et al.*, 2015) and a major cause of morbidity and mortality in some parts of the world. (WHO/AFRO, 2010).

The high fatality rate might even be higher or worse owing to the high number of cases that were discharged against medical advice. Most of these cases may be seen as having poor prognosis, hence the decision of the family members to withdraw the client. Another possibility may be the inability to keep up with the medical bills by the victim and the family.

About 82.7% (124) of the snakebite victims in this study spent less than seven (7) days on admission in the hospital. The other 17.3% (26) spent more than seven (7) days on admission with the longest stay being for 14- days. The shortest stay on admission was 1.day. This makes snakebite truly a public health issue of great importance (Habib *et al.*, 2015; WHO, 2007; Deghani *et al.*, 2012; Visser *et al.*, 2004; Chippaux *et al.*, 2007). Considering the number of days snakebite victims spend on admission makes snakebite cases put a lot more stress on the limited hospital facilities. The economic implications of snakebites go beyond the money used to pay for health services to its impact on their work and economic means of livelihood. The work of these victims lay fallow whiles they are on admission and puts a toll on the already limited resources of the family. Household and national productivity tend to suffer during these admissions periods. Worsening the situation is the fact that other family members may also have to take time off their work to cater for the victim on admission. The effect of snakebite on the future food security of the household as most of the persons affected are from rural farming households. The seriousness of the situation is worsened by the fact that most of the snakebites occur at the peak of the farming season of September.

5.18 ASSOCIATION BETWEEN TIME LAG, LENGTH OF HOSPITAL STAY AND OUTCOME

An analysis of the association between the time lag and the length of hospital stay by patients showed that 81.7% of the victims who reached the hospital within the first 24 hours stayed in the hospital for less than 7 days. However, only 75% of those who reached the hospital after 72 hours of bite were discharged from the hospital within 7 days. Similarly, the association between the time lag and the treatment outcome showed those who reported within the first 24 hours, 86.3% were cured, 1.8% died with 12.8% discharged against medical advice.

The chi square analysis of the two associations as can be seen from table 4.4 and table 4.5 however showed no significant differences between the length of hospital stay (p= 0.585) and the treatment outcome (p = 0.126) by patients who reported to the hospital by different time lapse.

5.19 OTHER ASSOCIATIONS BETWEEN THE VARIABLES

A chi square analysis showed the use of first aid by a snakebite victim was strongly linked with delayed reporting (more than 72 hours) to the hospital after the bite with a p-value of $p < 0.001$ (see table 4.6). This statistically significant association is seen in five (5) out of the six (6) mortalities in the study reporting after 72 hours and also used traditional medicine as first aid prior to reporting to the hospital.

Reporting to the hospital too late as in 72 hours after snakebite has less treatment benefit than the early reporting of within 24 hours of bite. This is clearly seen in decreasing proportion of patients discharged within 7 days and being cured on discharged with increasing lapse in time between snakebites and reporting to the hospital. Also, a closer look at the trend in victim death (see table 4.4, table 4.5 and table 4.6) showing increasing percentage dead with increasing delay in reporting snakebite to the TTH. Proportion of discharge against medical advice illustrates similar trend.

When the outcome was compared with length of stay, it was found out that, higher percentage of the outcome was recorded within seven days of admission into the hospital's care. The higher in proportion was found to be statistically significant by chi-square analysis with a p-value <0.05 ($p=0.030$) as depicted in table 4.7. All the deaths were recorded within seven days of admission. This implies that if a snakebite case would end in a cure or mortality, it was most likely going to happen within seven days of the incident or admission.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 INTRODUCTION

This section presents the summary of key findings, the conclusions drawn from the findings of the study and the recommendations to address the problem of snakebite cases in the northern region of Ghana.

6.1 SUMMARY OF KEY FINDINGS

The key findings of this study are summarised as follows;

- The prevalence of snakebite cases in the Tamale Teaching Hospital was 146/100,000.
- Snakebite is more common among males (65%), 15-59 years age group (65.3%), farmers (46%), rural dwellers (52.7% from East Gonja, Central Gonja and Savelugu districts) and more frequent in September (rainiest month in the study area).
- Majority of the snakebite victims were bitten on the lower limbs (71%), bitten outdoors (75.3%) during the daytime (68.7%).
- Most of the snakebite victims in this study reported to the hospital during the day (57.3%), within 24 hours of the bite (72.7%) and directly from the community (70.7%).
- Pain, swelling and bleeding were the commonest clinical presentations in the snakebite victims, most of these victims did not use any form of first aid methods (68.7%) and the carpet viper is the only snake type that was accurately identified as the snake that was responsible for bite.

- ASV, ATS/TT and antibiotics were the mainstay of snakebite management at the Tamale Teaching Hospital.
- Majority of the study subjects were discharged as cured (84%) with 12% of them being discharged against medical advice and 4% died.
- Most (82%) of the snakebite victims spent less than 7 days on admission and yet all the deceased subjects spent less than 7 days on admission.
- There was no significant association between the time lag, length of hospital stay and the outcome of a snakebite case in this study.
- High case specific mortality or case fatality rate was recorded with documented shorter hospital stay for the victims.
- There was a significant association between the outcome and length of hospital stay (p-value = 0.030).
- There was a very significant association between first aid use and time lag.

6.2 CONCLUSIONS

From the study results and discussion above, the following conclusions can be reached;

- The prevalence of snakebite cases is high at the Tamale Teaching Hospital and it could even be higher since hospital-based studies have been found to underestimate the true extent of the snakebite problem due to the fact that some victims may not report to the hospital.
- Snakebite is common among youthful male, rural dwelling farmers or herdsmen who are bitten while engaged in their agricultural activities during the daytime mostly on the lower limbs.

- There is a spike in the number of snakebite cases in September which is the month with the heaviest agricultural activities in the study area and also has the highest amount of rainfall which floods the hiding places of the snakes forcing them out, thereby increasing the human-snake interactions which ultimately results in bites.
- The carpet viper (*Echis Ocellatus*) was responsible for most of the bites in the study and this is supported by the clinical presentations of bleeding, swelling and pain at the site of bite typical of viper envenomation.
- The preference for traditional medicine as a first aid for snakebite is quite high among the snakebite victims at TTH and may contribute to the delay in reporting to the hospital for early initiation of ASV treatment which has proven to be effective.
- Most of the snakebite victims were discharged as cured but may have suffered some form of complication from the envenomation. It is also possible that the number of cases that were discharged against medical advice may have also died due to the poor prognosis of the cases hence indicating an increased number of deaths from snakebites.
- Delayed initiation of treatment for snakebite tends to lead to less favourable outcomes for the victims involved.

6.3 RECOMMENDATIONS

The following recommendations are made in line with the study of snakebite cases at the Tamale Teaching Hospital;

- The ministries of Health and Agriculture should embark upon the creation of public awareness on the need to use protective clothing such as by farmers and other at risk groups to be able to identify the common snake species in the country to facilitate treatment.
- The Ministry of Health should provide adequate subsidized and appropriate ASV (especially for carpet viper), adequate test kits and treatment protocol for the trained lower level health care providers in the districts to reduce the time lag in the initiation of treatment to enhance the outcome of snakebite cases.
- Recommended first aid methods of reassurance, immobility and early referrals should taught, advocated and encouraged in the communities by the Ministry of Health, Ministry of Agriculture and other Non-governmental Organisations (NGOs) in the country.
- Researchers, Non-Governmental Organisations, the Ministry of Health among others should advocate for the much needed attention and investment of resources to address the ever-present problem of snakebite in the rural parts of the northern in particular and the country as a whole.
- Training of medical doctors and health workers in the management of snakebites is urgently needed to improve the outcome of this neglected tropical disease.
- The relevant health authorities including the Ministry of Health and the World Health Organisation should explore the possibility of locally producing ASV for specific venomous snakes in Ghana, particularly the carpet viper.

- Other researchers with an interest in snakebite cases should carry out community-based epidemiological studies in the rural parts of Ghana to determine the full extent of the snakebite problem.

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APPENDICES

APPENDIX 3.1

STUDY QUESTIONAIRE

RETROSPECTIVE STUDY OF SNAKEBITE AT THE TAMALE TEACHING HOSPITAL

FOLDER NUMBER: …………………………… ***DATE OF ADMISSION***: ………………

SECTION A) **BIODATA/BACKGROUND INFORMATION**

This section is to collect biographic information about the study participant to enable us compare respondents and results. The data is for purely academic purposes and responses would remain anonymous.

PLEASE ANSWER THE FOLLOWING QUESTIONS BY WRITING THE ANSWER OR TICK (√) THE CORRECT OPTION

1. Age (completed years): ……… 2. Sex: ………3. Community/District: ……......./.......

4. Occupation: ……………………………

5. Marital status Single ☐ Married ☐ Divorced ☐ Widowed ☐ N/A (If less than 16 years old) ☐

SECTION B) **CLIENT AND SNAKEBITE HISTORY**

6. Time of presentation ………………………….

7. The site of the snake bite? ………………………………..

8. Where the victim got the snakebite? ………………………………………..

9. What activity was the victim engaged in when bitten? ……………………………

10. What was the time of the bite?

Midnight- 6am ☐ 6am-12noon ☐ 12 noon-6pm ☐ 6pm-Midnight ☐

11. What signs or symptoms were experienced by the victim after the bite?

Swelling/oedema at the site of bite ☐

Bleeding at the site of bite ☐

Pain ☐

Dizziness/weakness ☐

Unconsciousness/decreased consciousness ☐

12. Did the victim use a first aid method before coming to the hospital? ☐ Yes ☐ No

If No, go to question 16

13. If yes, what type of first aid was used? (Tick all that apply)

Tourniquet ☐ ☐ Using Ice packs
Incision and sucking at site ☐ ☐ Blackstone

Traditional medicine ☐

14. How long after the snakebite was the first aid applied? ....

15. Was the first aid applied effective? If Yes/No, why?
……………………………………………………………………………

16. What time lapse was between the snakebite and reporting to the hospital?
…………………………………………………………………………………………

17. How did the victim come to the Tamale Teaching Hospital?

Direct from the Community ☐

Referred from another health facility ☐

Referred from traditional healer ☐

SECTION C) **CLINICAL PRESENTATION AND MANAGEMENT OF SNAKEBITE**

18. What are the signs of envenomation presented by this snakebite case?

A. local swelling/ cellulitis ☐

B. Coagulopathy (bleeding at site) ☐

C. Necrosis (muscle breakdown) ☐

D. Shock (hypotension) ☐

E. Neurotoxic symptoms ☐

F. Paralysis ☐

G. Dizziness ☐

H. Pain at the site ☐

19. What was the site of bite?

…………………………………………………………………..

20. What type of snake bit the client? (if Known)

………………………………………..

21. What initial laboratory investigations were carried out? (Tick all applicable)

FBC ☐ Bedside clotting time ☐

LFT ☐

RFT ☐

Clotting Profile ☐

22. a. Was ASV given to the client? Y☐ No ☐

b. If yes, what type of ASV was used?

…………………………………………………........

c. How many units/ml were given? ………………………………………..

d. What reactions were seen in the client?

………………………………………………….

23. Was ATS/TT given? Yes ☐ No ☐

24. Which antibiotics were given?

…………………………………………………………….

25. What was the outcome of the case?

Cured ☐

Died ☐

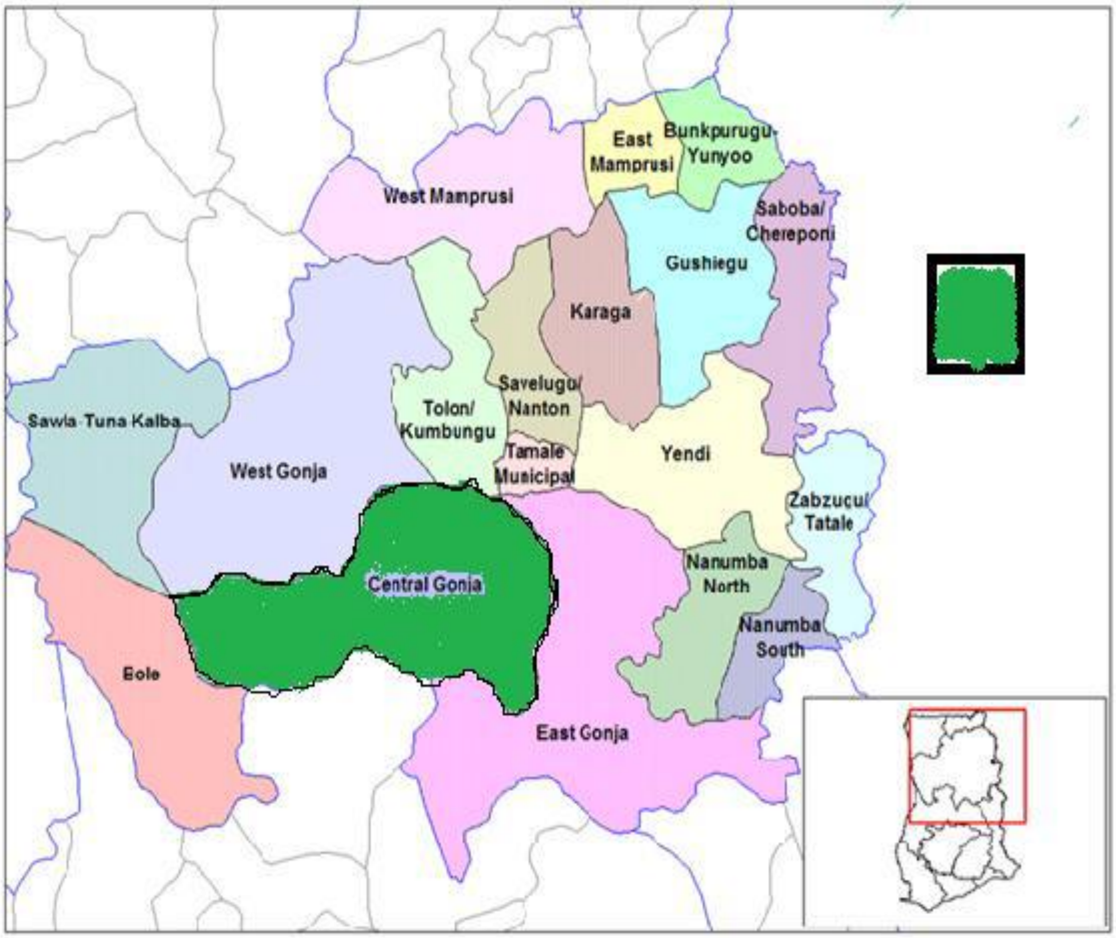
Discharged against medical advice ☐

26. Bedside clotting time upon discharge …………………………………………

27. What was the length of stay at the hospital?

…………………………………………………

APPENDIX 1.1



Map of Northern Region **Source: Ghana Statistical Service**

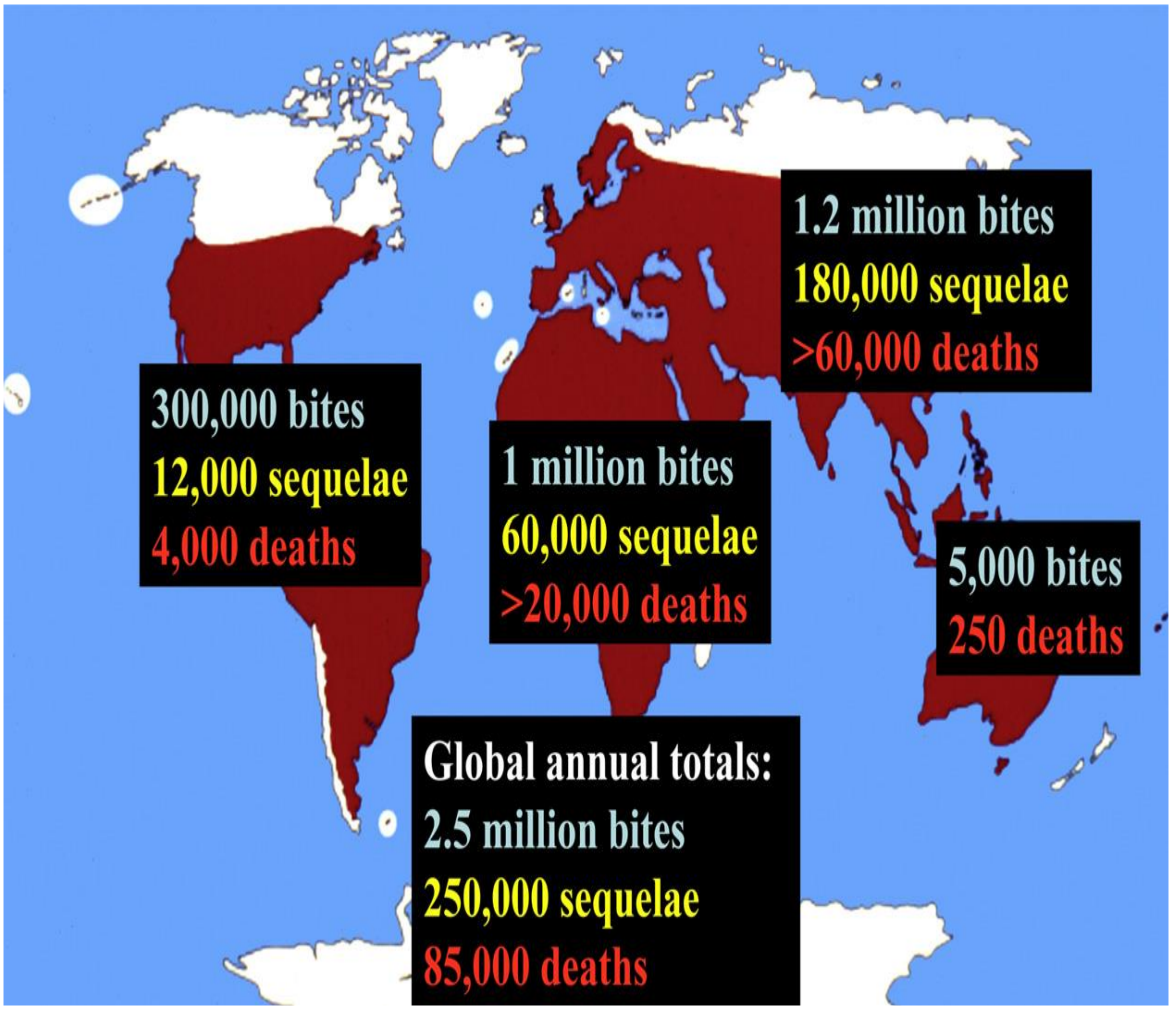
APPENDIX 2.1

Carpet Viper (*Echis Ocellatus*) **Source: Field Survey (East Gonja District), 2014**

APPENDIX 2.2

Farmer Holding a Carpet Viper (*Echis Ocellatus*) Source: Field Survey (2014)

APPENDIX 2.3



Map-Global Estimates of Snakebite Cases Source: Adapted from Gutie´rrez *et al.*, **(**2010)