BIO-SECURITY PREPAREDNESS CAPACITY IN RESPONSE TO MEDICAL DISASTERS AT GARISSA LEVEL FIVE HOSPITAL IN GARISSA COUNTY, KENYA

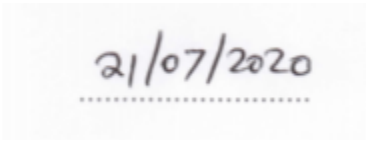
HASSAN ADAN JIMALE

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN GOVERNANCE, PEACE AND SECURITY IN THE DEPARTMENT OF GOVERNANCE, PEACE AND SECURITY STUDIES SCHOOL OF HUMANITIES AND SOCIAL SCIENCES OF AFRICA NAZARENE UNIVERSITY

JULY 2020

DECLARATION

I declare that this document and the research that it describes are my original work and that they have not been presented in any other university for academic work.

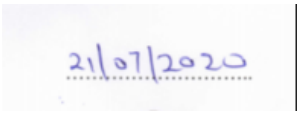


…… ……

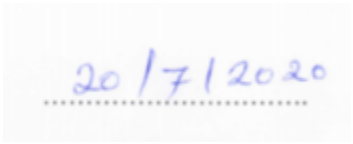
Hassan Adan Jimale Date

Reg. No.: 19JO3DMGP044

This research was conducted under our supervision and is submitted with our approval as university supervisors.



Dr. Duncan O. Ochieng, PhD Date



Dr. Martin Ouma, PhD Date

Africa Nazarene University

Nairobi, Kenya

DEDICATION

This thesis is dedicated to my daughters Tasmia, Saadia and Fatima as well as all Victims of Violence Extremism.

ACKNOWLEDGMENTS

All Praise is due to Almighty *Allah*, the Creator of the Heavens and the Earth. I am greatly indebted to my supervisors; Dr. Duncan Ochieng and Dr. Martin Ouma for their composed guidance, wisdom and unrelenting availability without which this progress would have been just a dream. I also wish to acknowledge Dr. Emily Okuto, Dr. Simon Muthomi, Mr. J. Mutungi and Susan Mathenge as well as the entire GPS department for their support and coordination. To my friends and colleagues, especially Dr. Adan Abass and A. Muthui, thank you for your motivation and support when darkness unveils. To my family for graciously granting me time to undertake this work, I am because of you. Many thanks also go to Garissa County Level Five Referral Hospital Medical Superintendent Dr, Ambrose Misore and his Quality Assurance officer - Mr. Mohamed Hussein as well the entire staff for their support during data collection.

ABSTRACT

Biosecurity is an emerging global security threat in the 21st century affecting public health and natural security in equal measures. In addition to outbreaks of Rift Valley and Haemorrhagic Fevers, Influenza Virus, Ebola, and the current Corona Virus Disease pandemic, advances in life sciences and globalization have expanded Kenya's vulnerability to biosecurity threats, including threats posed by novel and manipulate pathogens with pandemic potential. This study assessed the biosecurity preparedness capacity in response to medical disasters at Garissa Level Five Referral Hospital in Garissa County, Kenya. The specific objectives were to examine the effectiveness of the existing biosecurity regulatory framework, assess the level of preparedness and response capacity to biosecurity threat/disasters as well as evaluate ways of enhancing mitigation measures. The study was guided by the protection motivation theory and routine activity theory. It adopted a descriptive survey design with a target population of 202 divided into five strata stratified randomly to include medical officers, clinical officers, nurses, laboratory staff and hospital administrators from the Level Five Hospital. Simple random sampling was thereafter used for each stratum to select a sample of 139 respondents. A questionnaire was the main tool for data collection and Key Informants (KI) were purposively sampled and interviewed using an interview schedule guide to corroborate the findings from the questionnaire. Additionally, an observation checklist was administered to ascertain the parameters for medical disaster preparedness. After data collection and review for completeness, a total of 133 questionnaires were finally utilized in the analysis. Quantitative data was analyzed using percentages and frequencies while qualitative data analyzed using thematic analysis. From the study findings, there were biosecurity laws in Kenya including the Public Health Act, Biosafety and Biosecurity guidelines, Biosafety Act 2009, Biosafety Regulations 2011 and Health Amendment Act 2019. Most respondents (88%) were aware of biosecurity risks but not trained (62.4%) on biosecurity threats. Information about biosecurity risks was majorly obtained from reading (51.9%), social media (29.3%), policy statements from the Ministry (21.8%) and television or radio (18%). There were challenges faced in responding to biosecurity threats including lack of protective gear (55.6%), lack of policy guidelines (48.1%), lack of training (53.4%), lack of skills and knowledge (33.8%) and lack of drugs (7.5%). In conclusion, the level of preparedness for biosecurity threats among county hospitals is low. Since there are limited biosecurity frameworks in Kenya and the existing ones have not been implemented effectively to achieve the intended objectives, the study recommends biosecurity guidelines to be digitalized and made available to all health facilities. Also, there is a need for the introduction of hospital biosecurity monitoring and leakage detection systems. The study is beneficial to researchers and scholars in biosecurity preparedness studies, policymakers within the government, Garissa Level Five Hospital staff and the medical health care industry.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

OPERATIONALIZATION OF TERMS

Biosecurity: In the study, it is described as the measures that are taken to stop the acquisition, introduction, and spread of harmful biological agents to human, animal, and plant life (WHO, 2014).

Biosafety In the study, it is means the application of knowledge, techniques and equipment to prevent personal, laboratory and environmental exposure to infectious agents (WHO, 2014).

Biological Warfare: In the study, it implies conflict that emanates from acquisition, spread, and introduction of harmful biological agents such as bacteria, fungi, toxins from an organism as well as radioactive substances to human, animal, and plant life.

Bioterrorism: In the study, it implies a criminal act against unsuspecting civilians using pathogenic biological agents such as bio-warfare agents. It can be pre-meditated and intentional use of bacteria, fungi, or toxins from micro-organism and is aimed at intimidating the government and its citizens to accomplish political, economic, or social goals (Bachman, 2002).

Medical Disaster In the study, it implies serious disruption of the functioning of the health care facility and way life beyond the capacity of the health care facility or communities to cope on their own.

Mitigation measures In this study, it is described as a range of actions that might be put in place in an attempt to lessen the occurrence of cases and deaths resulting from a biosecurity threat.

Preparedness: In the study, it is described as activities and measures taken in advance to ensure effective management of threat(s) including the generation and dissemination of effective alerts for an early response as well as the evacuation of people and property from an area under threat(s).

Response It is defined in the study as steps taken by hospital staff to thwart a biosecurity threat that is already happening or is bound to happen to save the wellbeing of the people

ABBREVIATIONS AND ACRONYMS

APHL	:	Association of Public Health Laboratories.
AS	:	Al Shabaab.
ATPU	:	Anti - Terrorism Police Unit
BSL	:	Biosafety Level.
CBRN	:	Chemical Biological Radioactive Nuclear
CCTV	:	Closed Circuit Television
CDC		Centre for Disease Control
CDC	:	Centre for Disease prevention and Control.
COVID-19	:	Coronavirus Disease – 2019.
CVI	:	Content Validity Index
DCI	:	Directorate of Criminal Investigation
DV	:	Dependent Variable.
EVD	:	Ebola Virus Disease.
FAO	:	Food and Agricultural Organization.
FBI	:	Federal Bureau of Investigation.
GBD	:	Global Biosecurity Dialogue.
GMOs	:	Genetically Modified Organisms.
GPS	:	Global Positioning System.
HPA1 H5N1	:	Highly Pathogenic Avian Influenza virus.
ICBD	:	International Convention on Biological Diversity.
ICU	:	Intensive Care Unit
IHR	:	International Health Regulations.
ISSIL	:	Islamic States in Syria, Iraq and Levant.
IV	:	Independent Variable.

KEMRI	:	Kenya Medical Research Institute
KI	:	Key Informant.
KRCS		Kenya Red Cross and Society
LMOs	:	Live Modified Organisms.
NACOSTI	:	National Commission for Science and Technology and Innovation.
NCDCP	:	National Centre for Disease Control and Public.
NGAO	:	National Government Administration Officer
NMDU	:	National Disaster Management Unit
NPS	:	National Police Service
NSAR	:	National Select Agent Registry.
PMT	:	Protection Motivation Theory
PPE	:	Personal Protective Equipment
RAT	:	Routine Activity Theory
RVF	:	Rift Valley Fever
SARS	:	Severe Acute Respiratory Syndrome
SPSS	:	Statistical Package for the Social Sciences
UKHMGR	:	United Kingdom Her Majesty Government Report
UN	:	United Nations
UNCST	:	Uganda National Council for Science and Technology
UNSCR	:	United Nations Security Council Resolution 1540
USA	:	United States of America
USAMRU-K	:	United States Army Medical Research Unit-Kenya.
WBC	:	Biological Weapons Convention
WHO	:	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This study assesses the effects of the biosecurity preparedness capacity in response to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya and constructs biosecurity preparedness capacity as its Independent Variable (IV) and response to medical disasters as the Dependent Variable (DV). This chapter covers the background of the study, statement of the problem, objectives of the study and the research questions. The chapter also presents the significance of the study, scope of the study, limitation of the study, delimitations of the study, and the conceptual framework.

1.2 Background of the Study

History is replete with attempted use of bio-warfare. In 600 B.C., Athenian leader poisoned water supply at Kartha with noxious *Heleborus* plants roots extract (The Association of Public Health Laboratories, 2017) and in 1793, the British troops infected Native Americans with smallpox by giving them blankets used by sufferers of the disease, whiles others during World War II tried to release and use plague-infested fleas in parts of Chinese settlements (Farah *et al*., 2019). In 1346 in Feodisija, Ukraine, the first biological warfare was recorded which catalysed the onset of plague pandemic popularly known as Black Death of the 14th Century as the plague was carried by fleeing populations and rodents in ships infested with fleas with *Yersnia pestis* (causal bio-agent of plague) (Katz, Graeden & Kerr, 2018).

Biosecurity is a nascent area that is currently developing due to the global threat posed by bioterrorism to public health and national security as well (Brachman, 2012).

Current advances in life science technology as well as globalization have expanded society's vulnerability to such bio-risks (Mukhopadhyay, 2013), with no corresponding growth of multi-disciplinary interactions of bioscience and militaristic security. Mukhopadhyay (2013) argued that technological advances in life sciences have provided the know-how for systematic weaponization of pathogens and natural toxins. Twenty-first-century bio-warfare thus entails deliberate public health threats which, along with natural epidemics, have the prospects to endanger human livelihood by even targeting food supply systems across national borders (Wein &Liu, 2015). Suk *et al*. (2014) suggest the need to regulate scientific research and also come up with governance tools to militate against the risk of bioweapon development and bioterrorism.

In 2003, the morbidity of Severe Acute Respiratory Syndrome (SARS) in China and resulting death of about 286 persons as well as its rapid spread from Hong Kong in Asia to Canada in the West underscores the threat of disease outbreaks resulting from global inter-connectedness (Kaiser, 2018). An investigation by the World Health Organization (WHO) attributed this acquired infection of SARS to poor Biosafety Level (BSL) -BSL-3/4 laboratory practices and insufficient biosecurity preparedness capacity (WHO, 2014). The December 2019 Coronavirus Disease (COVID-19) outbreak in China is another case example of natural medical emergencies that needs biosecurity preparedness across the globe (Merab, 2020 January, 22; WHO, 2020). Due to global interconnectedness, outbreaks in China presents biosecurity risk to Kenya (WHO, 2020) as Kenya Airways plies twice a week flights to Guangzhou, China's third-largest city (Merab, 2020 January, 22).

In 2001 during the period of 9/11 World Trade Centre tower terror attacks, a series of letters containing lethal anthrax powder were mixed in mails sent to some cities in the United States of America (USA) which resulted in five (5) deaths (Silke, 2018). Additionally, Kaiser (2018) notes that failure to adhere to biosecurity preparedness issues such as incident reporting and recordkeeping in laboratories led to over 100 biosecurity incidences in the USA from 2003 to 2007. To curb biosecurity threat lapses in the USA, Texas A & M medical centre was fined $1 million for poor inventory and incident management (Kaiser, 2018). Furthermore, Gillum *et al.* (2018) observe that, at Dales, Oregon State of the USA, a Rajneeshee Religious Cult intentionally perpetrated the use of *Salmonella enteric* serovar *Typhimarum* in about 10 salad restaurants causing typhoid disease.

In Thailand, Jarunee *et al*. (2019) assessed biosafety in microbiological and biomedical laboratory biosafety level 2 (BSL-2). Although Jarunee *et al*. (2019) studies were centred on veterinary laboratories; they found out that despite national policies on laboratory biosafety and biosecurity, there were huge challenges in regards to harmonization and enforcement of these policies.

Shultza, Zelde, Esponolac and Andreas (2016) and WHO (2014) observed that, in West Africa, the Ebola Virus Disease (EVD) outbreak of 2013 that affected countries such as Sierra Leone, Liberia, and Guinea was different from the typical features of haemorrhagic outbreaks found in East Africa and health care professionals were ill-equipped to deal with (Shultza *et al*., 2016). At the end of 2015, after dampening the epidemic, Ebola samples scattered in several hospital laboratories established by different

stakeholders were consolidated at three bio-banks which were subjected to heightened security to mitigate against biosecurity threat (WHO, 2014; Shultza *et al*., 2016).

In Uganda Kirunda and Otimonapa (2014), assessed the level of biosecurity awareness and the existence of procedures, regulations, laws and policies on biosafety and biosecurity among different institutions and professions across regions and found out a low level of awareness in areas among the human health and public hygiene professionals. Reed (2010) and Heckert *et al*., (2011) postulates that low biosafety and biosecurity preparedness capacity, particularly in low-income countries including Uganda and Kenya, partly due to poor biosecurity funding (Reed, 2010).

Kenya's porous borders coupled with the geostrategic location and regional hegemonic and economic hub pushes her to high global interconnectedness and outbreaks which in turn present a health biosecurity threat to Kenya. In addition, Kenya's preparedness is compromised by various institutional factors i.e. corruption, limited capacity among others. Similarly, Islamic States in Syria, Iraq and Levant (ISSIL) sleeper cells in Kenya coupled with the *Al Shabaab* (AS) terror threat present a biosecurity threat to Garissa County since it has borne the brunt of terrorism. It is for this reason that the researcher assessed the effects of biosecurity preparedness capacity on response capability to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya.

1.3 Statement of the Problem

In Kenya, the most common diseases that are listed as endemic include diarrhoea of different etymology, viral haemorrhagic fevers, malaria, anthrax, influenza, acute febrile illness, Rift Valley Fever, Dengue Fever, Chikungunya virus among other infectious

diseases of which some are considered as emerging while others are rated re-emerging (Gitau, 2016; Juma *et al*., 2014).

In April 2016 an Anthrax attack threat was foiled by security agencies and arrested medical interns at hospitals in Makueni and Kilifi Counties, while two others disappeared from Kitale hospital (GoK, 2016). Conversely, Gitau (2016) notes that due to Kenya's institutional weakness, lack of preparedness as well as inadequate strategic vaccination and treatment reserves, the 2006/7 outbreak of Rift Valley Fever (RVF) affected 6 out the 8 regions of Kenya with reported human cases of 717 and 162 mortalities. Similarly, inadequate biosecurity legal framework, border security challenges and vulnerability to unnatural medical disasters have been noted. Additionally, Ndhine *et al*., (2016) observed among Kenya public hospital laboratories facilities and storage units had no access control and staff had low skills on biosecurity.

In addition to outbreaks of Rift Valley and haemorrhagic fevers, Ebola, and the current Coronavirus pandemic, advances in life sciences and globalization have expanded Kenya's vulnerability to biosecurity threats, including threats posed by novel and manipulate pathogens with pandemic potential (WHO, 2020). Kenya's national security agencies have not put in place a comprehensive program to address biosecurity issues and build biosecurity preparedness capacity and capability to respond to medical disasters as a priority area. It is for this reason that the researcher carried out this study at this study area.

1.4 Purpose of the Study

Most hospitals in Kenya have been exposed to natural disease outbreaks. The preparedness capacity and capability by level five hospitals' staff on response to unnatural biosecurity threat remains a challenge. The purpose of the study was to assess the effects

of biosecurity preparedness capacity and capability on response to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya.

1.5 Objectives of the Study

1.5.1 General Objective

The general objective of the study was to assess the biosecurity preparedness capacity and capability to respond to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya.

1.5.2 Specific Objectives

The specific objectives of the study were to:

(i) Examine the effectiveness of the existing regulatory framework for biosecurity in Kenya.

(ii) Assess the level of preparedness to medical disasters/biosecurity threat at Garissa level five hospital in Garissa County, Kenya.

(iii) Explore ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya.

1.6 Research Questions

The study was guided by the following research questions:

(i) What is the effectiveness of the existing regulatory frameworks for biosecurity in Kenya?

(ii) How is Garissa level five hospital in Garissa County, Kenya, prepared to medical disasters/biosecurity threat?

(iii) What are the ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya?

1.7 Significance of the Study

According to Lunenburg and Irby (2008), significance of the study refers to the importance of study findings, for instance, what the study will contribute and to who the study will be valuable. Similarly, it consists of an explanation of the work's importance as well as its potential benefits. It also defines what contribution a study will make to the extensive literature after it is completed. To researchers and scholars in biosecurity preparedness studies, the study would offer valuable knowledge on how to detect, prevent, prepare and respond to medical disasters/biosecurity threats. It would also improve on the scarce literature review on biosecurity preparedness in human healthcare setup as most scientific scholars focused on biosafety hence strengthen 21st Century public health emergency management.

To policymakers within the government, findings from this study may complement the Government of Kenya guidelines on biosecurity/biosafety and strengthen preparedness capacity in responding to medical disasters as regards to the handling of select agents that may harm hospital staff, environment and community. Garissa Level Five Hospital staff would be enlightened on finding out biosecurity preparedness capacity gaps to add value and contribute to the design and development of strategies in the areas of biosecurity and countering bioterrorism in Kenya and Garissa County in particular. Furthermore, and in line with the United Nations (UN) Resolution 1540 policies/guidelines, finding from this study would improve safe and secure ways of handling these agents in the medical health care industry.

1.8 Scope of the Study

As stated by Troidl *et al*. (2012), the scope of the study essentially refers to all the things that will be encompassed in the investigation. It openly describes the parameters under which the research will operate. It also entails the degree of content that will be included using the investigation so as to reach more rational conclusions and offer certain and reasonable answers to the study questions.

The scope of the study revolved around the assessment of biosecurity preparedness capacity and capability in detecting and responding to bio-terrorist instigated medical disasters at Garissa Level Five hospital, Garissa County, Kenya. The study was carried in Garissa County, specifically at Garissa County Level Five Hospital, which is located in the North-Eastern part of the Republic of Kenya bordering the Federal Government of Somalia to the East and Wajir County to the North. The study employed descriptive research design, survey and critical analysis methods. Questionnaires, interview guide as well as observation checklist were designed to answer research questions and objective. The study covers between 2011 when there were increased terror attacks, and are expected not to go beyond and July, 2020.

In this study, data was collected from Garissa level five hospital based medical officers, hospital administrators, laboratory technicians and other stakeholders involved in security and counter-terrorism issues within Garissa County. The study examined the effectiveness of the existing biosecurity regulatory framework in Kenya, established the awareness and preparedness as well as ability to mitigate and respond to biosecurity threat at Garissa level five hospital, Garissa, Kenya.

1.9 Limitation of the Study

Simon (2011) describes limitation as matters and events that arise during a study which are not under the control of the researcher and therefore might affect the general direction as well the final result of the research study. The following challenges were addressed as they influenced the scope of the study.

Due to recurrent terror incidences with Garissa County, the study was sensitive to the respondents and as such they became suspicious of the study. In addressing these challenges, the researcher explained the purpose of the study to the respondents and the value it would add to their wellbeing in order to build ownership. The study participants were informed that the study was free from personal or commercial interests and it was aimed at boosting national security/public health sector.

Harsh weather condition was also the norm within the study area. In order to overcome extreme heat, data collection was conducted in the morning and evening when temperatures were cooler. Data inaccessibility such as accessing confidential and classified data including healthcare venue entry restrictions was also a problem. The researcher overcame this by displaying research permits as a justification of presence at site in order to obtain significant research findings.

1.10 Delimitation of the Study

Simon (2011) defines delimitations as those parameters that are within the control of the researcher and that bound the scope as well as defines the limit of the study. Therefore, the researcher will deliberately make choices during the study planning to define boundaries such as what to include and what to exclude in the study (Kombo and Tromp, 2006). The participants of the study were only drawn from medical officers, nurses,

laboratory technologists, hospital administration and management as well as other healthcare staff. The study did not include patients who were attending the hospital as respondents. Sub-county hospitals staffs were not included in the study and were treated as additional informants. Five key informants were drawn from Regional Commissioner of Garissa office, Regional Counter-terrorism office in Garissa, Executive Committee member for health in Garissa, and officials from County Commissioner of Garissa office. The researcher delimited the study to the effectiveness of biosecurity preparedness capacity at Garissa Level Five Hospital to respond to medical disaster in Garissa County, Kenya.

1.11 Assumptions

Bell, Bryman and Harvey (2018), postulated that, for the research problem to exist, the research must assume some areas of the study. Without such assumptions, the research problem will not be. The study assumed that there was biosecurity preparedness plan at Garissa Level Five Hospital to respond to medical disaster(s) in Garissa County, Kenya. Thus, the research was undertaken under the assumptions that the respondents would be available during the study. Prior booking of appointment with respondents boosted study availability confidence. Another assumption was that the study participants would be honest and truthful in answering the questions. In the process of undertaking the study, other intervening factors on the variables were constants such as insecurity issues that came up. In this study, the researcher assumed that there would be normalcy. The relevant government agencies would grant the researcher study permits and on time.

1.12 Theoretical Framework

The study was guided by the Protection Motivation Theory and Routine Activity Theory.

1.12.1 Protection Motivation Theory

Protection Motivation Theory (PMT) was developed by Rogers in 1975 and relates to how entities process threats and choose responses as well as come up with coping behaviours in regards to the impending danger associated with the threat (Teodor, Henrik, & Jonas, 2015). PMT is pegged on three elements of fear appeals: (a) the magnitude of noxiousness of a depicted event (severity); (b) the likelihood of the event occurrence (vulnerability); and (c) the efficacy of response measures. PMT assumes that actors or individuals decide to undertake risk prevention activities based on self-driven motivation to mitigate oneself from perceived threats emanating from both natural and unnatural hazards, harmful biological agents, radiological and chemical threat as well as change in the environment. This means that individuals do a risk-benefit analysis and look at the likely benefit if the threat is removed or controlled (Gaston & Prapavessis, 2014).

The PMT anchors the research because it explains the way hospital medical staff and the administration are motivated in dealing with cautions emanating from biosecurity threat that might lead to unnatural medical disasters. Individuals' capacity to carry out bio-security precautions against a prevailing threat is dependent on his/her capability and that of the organization they work in. Thus individuals in the analysis of such appeals, deploy cognitive process to come up with response measures to deal with such threat. In this study the administration may adopt behaviours such as strict enforcement of biosecurity guideline policies compliance within the hospitals in order to ward off such threats.

Biosecurity incidences and attacks are done in a stealthy manner and occur unexpectedly. They are intended to cause heavy public fear, crippling the health care industry. PMT, therefore, attempts to elucidate the effects of biosecurity preparedness

capacity and capability to respond to medical disaster among medical staff at Garissa level five hospital. The theory does not put into consideration, the ecological and environmental parameters that boost the biosecurity preparedness capacity within the hospital, hence the introduction of the second theory of the study.

1.12.2 Routine Activity Theory

The Routine Activity Theory (RAT) was first proposed by Lawrence Cohen and Marcus Felson in an analysis of crime and routine activity in the USA in 1979. It is a sub-set of crime opportunity theory and focuses on situations of crime. The RAT postulates that there are three conditions for most crimes to happen: a likely offender, the existence of a suitable target, and the absence of a capable guardian. These three come together concerning time and space for crime to occur (Felson, 2013). Unlike other theories of crime, RAT studies crime as an event that has links to its environment and puts great emphasis on the ecological processes thus it explains more than the mere offenders. It has been argued that RAT assumes that crime can be committed by anyone who has the opportunity and fails to explain why other people do not commit crimes.

The application of the theory is such that it has been used to explain the studies of sexual crimes, robberies, burglaries among other crimes in the USA. The RAT may also explain why the intentional or unintentional outbreak of diseases. The environment within the healthcare system and routine activities of medical staff, authorities and the biosecurity preparedness capacity within Garissa level five hospitals might either predispose the community both in Garissa and the larger Kenya to or prevent the occurrence of unnatural disease epidemics. Moreover, a terrorist might acquire bio-warfare capabilities (Brachman, 2012) and select vulnerable targets if there is no enough guardianship to mitigate the threat

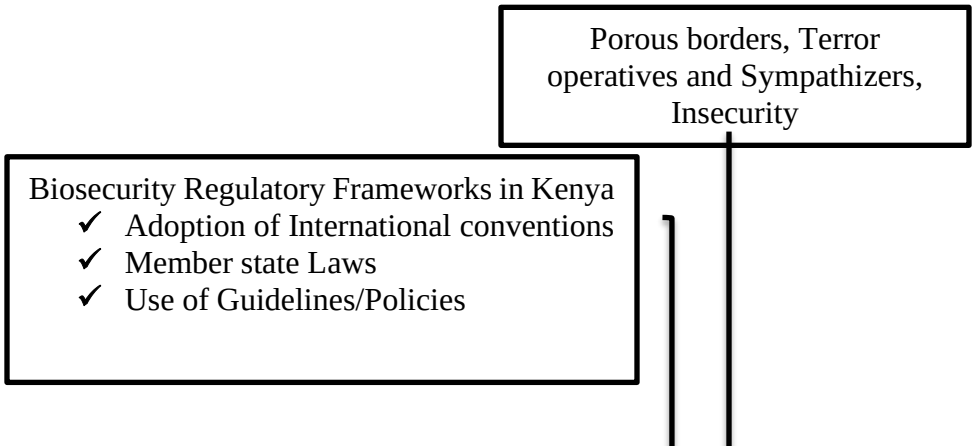
within the ecological niche of medical/healthcare system especially in Garissa County which is located in resource-limited underdeveloped country such as Kenya (Reed, 2010).

This theory explains why unnatural medical epidemics may occur and is important in explaining the specific objectives of Garissa hospital preparedness to biosecurity threat as well as evaluating the response capacity to medical disasters at Garissa Level Five Hospital, Garissa County, Kenya. In responding to disease outbreaks, RAT helps explain disease surveillance by epidemiologists and active contact tracing of suspected patients so that they are able to pinpoint the source of disease (Bakanaidze, Imnadze & Perkins, 2010). The theory, however, does not explain the motive(s) of bio-criminals.

1.13 Conceptual Framework

The conceptual framework explains the path of a construct of research by enhancing the empirical rigour of its findings (Kombo and Tromp, 2006). It is thus a structure that the researcher uses to best explain how the study naturally progresses (Dickson, Emal, & Adu-Agyem, 2018). In the determination of the biosecurity preparedness capacity and response to medical disasters at Garissa's Level Five Hospital in Garissa County, Kenya, this study constructs biosecurity preparedness capacity as the Independent Variable (IV and) response to medical disaster as Dependent Variable (DV) (Figure 1.1). As depicted in Figure 1.1, the IV measurable indicators of the study when manipulated influence behaviour of the DV measurable indicators.

Independent Variable (IV) Intervening Variables Dependent Variable (DV)



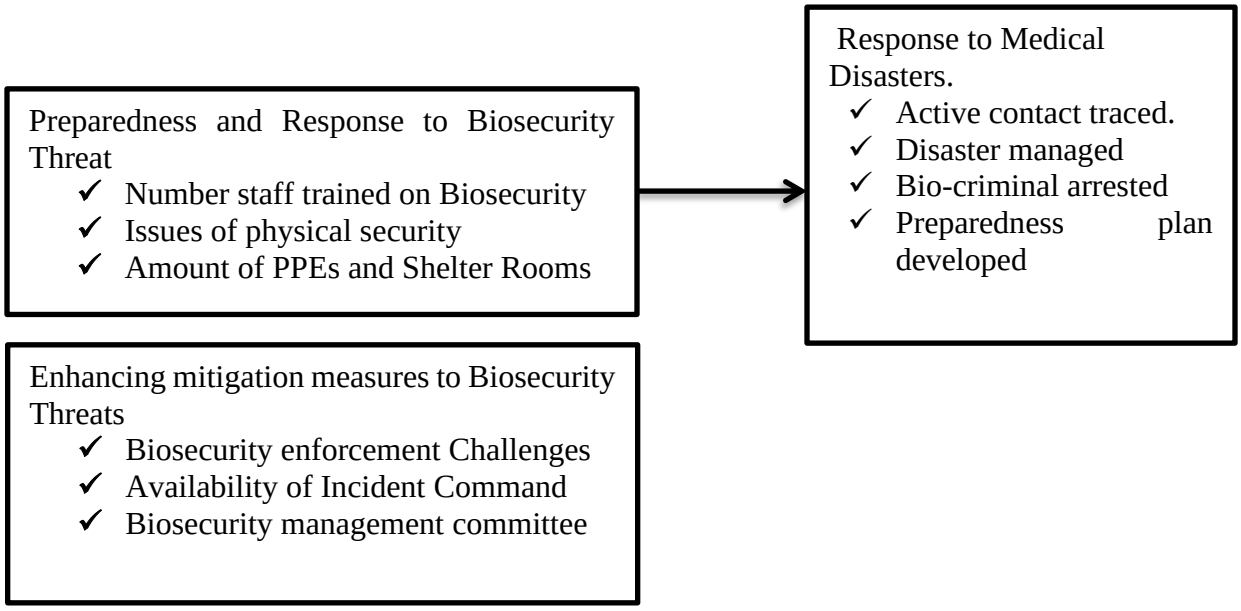


Figure. 1.1: Conceptual Framework
Source: Author (2020).

The three IVs and their corresponding objectives were measured as follows: The first specific objective of the study was to examine the effectiveness of existing biosecurity regulatory frameworks in Kenya and was measured by enumerating the international biosecurity convention and national biosecurity guidelines. The second specific objective of the study was to assess the preparedness capacity and capability to respond to biosecurity threat at Garissa Level Five Hospital, which was measured by indicators such as the number of staff trained on matters biosecurity, the existence of physical security as well as the availability of drugs stockpiles, enumeration of Personal Protective Equipment (PPE) and availability of shelter rooms. Finally, the third specific objective explored ways of mitigating against biosecurity threat at Garissa Level Five Hospitals and was measured by enumerating challenges of enforcing biosecurity guidelines and analysis of existence and effectiveness of biosecurity management committee as well as the structure of incident

command system that was in place, if any. The conceptual framework is shown in Figure 1.1.

Good hospitals biosecurity capacity and medical disaster preparedness plan by Garissa Level Five Hospital should be able to contain biosecurity threats in active surveillance, early detection, isolation, case management, contact tracing and prevention of the unnatural spread of dangerous biological agents, thereby averting possible accidental or incidental occurrence of a public health epidemic/medical disaster in Garissa County and by extension, Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature on aspects of the study as unravelled and discussed by various scholars, experts and analysts of biosecurity. This review is done on the objective of examining the effectiveness of the existing regulatory framework for biosecurity, examining the level of preparedness to biosecurity threat as well as to evaluate the response capacity to medical disasters/biosecurity threat. Additionally, other sections of the chapter include summary of reviewed literature and knowledge gap as discussed below.

2.2 Empirical Literature Review

This section presents reviews related literature on the subject studied as previously presented by various researchers, scholars, analysts and authors. The research draws materials from several sources that closely relate to the theme and the objectives of the study. In particular, empirical review is arranged in terms of the existing regulatory framework for biosecurity, preparedness to biosecurity threat as well as response capacity to medical disasters/biosecurity threat.

2.2.1 Regulatory Framework for Biosecurity

Gao (2019) in the study of biosafety strategies to protect global health observes, suggested the importance of establishing international guidelines and partnerships in order to assess and reduce biological threats/risks and challenge at source including laboratory hospital level. According to Gaudioso *et al*. (2009), biosecurity regulations have not been

adopted and implemented by many counties. Gaudioso *et al*. (2009), while analyzing biosecurity challenges also observed that some countries like Singapore, Denmark, Japan and South Korea have taken the first steps in establishing the regulatory requirements for biosecurity security and controls of pathogens and toxins. However, their study did not reveal the biosecurity status of the vulnerable countries in Africa and the sub-Saharan region in particular.

In 1983, the WHO published the first laboratory biosafety manual, but not until 2006 when WHO initiated the development of biosecurity guidance (Chua, Ellis, M., & Johnson, 2009). Furthermore, in 2005, WHO Assembly resolution 58.29, urged member states to implement an integrated approach to laboratory biosafety and biosecurity by reviewing regulatory protocols for ensuring safe handling of harmful biological materials (WHO, 2017; Prince and Otieno, 2014). Similarly, in 2004, the United Nations Security Council Resolution 1540 (UNSCR 1450), established binding regulations on all member states of UN to take and administer effective ways and means to mitigate the proliferation of weapon of mass destruction, their delivery and related materials by implementing laboratory biosecurity measures to secure biological agents (Bakanaide, Imnadze, and Perkins, 2010).

According to Nuclear Threat Initiative Report (NTI, 2018), the first annual Global Biosecurity Dialogue (GBD) was hosted in London and noted that biosecurity risks have become complex and global but many countries do not invest in biosecurity assistance and put in financial commitment. The dialogue in order to accelerate progress against the spread of weapons and materials of mass destruction resolved to address three areas including biosecurity and biosafety policy frameworks, biosecurity and biosafety

capabilities and emerging biological risks (NTI, 2018). In regards to models for building national action plans for health security and financing biosecurity, the NTI report states that the government of Netherlands and Finland have made concrete avenue to increase political goodwill and suggested the need to incorporate biosecurity experts in evaluation exercise.

Gaudioso, Gribble and Salerno (2009), described biosecurity regulatory frameworks as strategic and interlinked methods that include the legal, protocols and policy frameworks detailing actions, instruments and activities for the prevention, investigation and management of relevant bio-threats against human, animal and plant health and life, food safety, zoonosis, as well as the environment as a whole. According to Wagener and Bollaert (2013), global treaties and initiatives on Biosafety, Biosecurity, and Bioethics include Biological and Toxins Weapons Convention (WBC) of April 10^{th,} 1972, Cartagena Protocol on Biosafety, and Nagoya Protocol among others. The WBC of 1972 negotiated for global standards to restrict the access to harmful biological agents in a bid to reduce bioterrorism such that it reinforced the legal frameworks and prohibition in the development and stockpiling of biological as well as toxin weapons (Wagener and Bollaert, 2013). The WBC has 182 state-parties and demands that after every five years, state parties hold review conferences with its initial meeting held in 1980 and the last one was held in 2016 with the next one to be held in 2021 to discuss the way to strengthen the convention.

Suk *et al*. (2014) suggest that there was a need to regulate scientific research and also come up with governance tools to militate against the risk of bioweapon development and bioterrorism, after Scientists in Australia constructed an influenza virus strains in 2007, and infected mice leading to severe disease and death of mice. The strain was constructed

from published data of the 1918 influenza pandemic. According to Suk *et al.* (2014), advancement in human and pathogen genomics has both positive and negative global health effects and articulates increased possibility of deploying the knowledge in malign purposes without stringent biosecurity regulation measures.

In the USA, a protocol on biosafety in microbiological and biomedical laboratories guidance was first developed in 1984. The Centre for Disease Control and Prevention (CDC) (2019), report points that the guidance was reviewed in 2007 and sections on biosecurity were for the first time included during its fifth edition. Consequently, Wagener and Bollaert (2013) observed that after 2001, the US government enacted a raft of biosecurity legislation bearing criminal and civil penalties and allowing the department of health and human services as well as agriculture regulatory powers to come up with controls on the possession, use and transfer of biological agents. Kaiser (2018) states that the USA enacted the USA Patriot Act and the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 in regards to enacting laws and regulatory frameworks that enhance laboratory biosafety and biosecurity. These laws regulate the use, handling, transfer of certain listed select agents. Additionally, US federal agencies have their regulation too.

Mtui (2012) observes that existing national and international regulatory frameworks within the USA, Europe and other Western countries have concentrated on biosafety as well as biosecurity issues as opposed to African countries where biosecurity frameworks are slowly taking shape. According to Mtui (2012), the International Convention on Biological Diversity (ICBD) of 1992 is the father of biosafety systems. It acknowledges the usefulness of biotechnology and demands for safe handling of

biotechnology so that both human and environmental health is safeguarded. Article 19.3 of ICBD nurtured the basis for the development of the Cartagena protocol on biosafety (Kinderlerer, 2008). The Cartagena protocol was adopted on 29th of January, 2000 and became binding on the 11th of September, 2003. It regulates the trans-boundary movement of Live Modified Organisms (LMOs) whose aim is to ensure adequate level protection in the area of safe transfer, management and use of LMOs taking into account the risks to human health.

Similarly, according to Kingiri and Ayele (2009) and (Mtui, 2012) the overall agenda of ICPB is the idea of the precautionary principle, which state that "if policy action is deemed to cause risk of harm to human or environment, in the absence of scientific consensus that adverse effect will not arise, the burden of proof lies with those taking action" (Mtui, 2012). Pythoud & Thomas (2017) and Kinderlerer (2008) reveals that globally, about 143 states ratified the Cartagena Protocol on Biosafety but some GMO producing countries such as the USA, Canada, and Australia are yet to become members.

In Georgia, Bakanidze, Imnadze, and Perkins (2010) in their study on biosafety and biosecurity as an essential pillar of international health security and cross-cutting elements of biological non-proliferation states that Georgia, joined the BWC in 1995 and the National Centre for Disease Control and Public (NCDCP) is responsible for ensuring and advancing biosafety as well as biosecurity legislative framework and act as a focal point for International Health Regulations (IHR). Georgia's current comprehensive biosecurity framework for managing biological threat is borrowed from USA select agents rule and regulation and covers personnel registration, security threat surveys, emergency response, inventory keeping, and supervision.

In Thailand, Jarunee *et al*. (2019) assessed biosafety in microbiological and biomedical laboratory biosafety level 2 (BSL-2) and found out that despite national policies on laboratory biosafety and biosecurity, there were huge challenges in regards to harmonization and enforcement of these policies. This study was, however, largely centred on veterinary laboratories as opposed to human hospital-based laboratories, which is the goal of this study.

NTI (2018) states that the Africa Centre for Disease Control and Prevention (Africa CDC) will take new actions within partnership with US Centre for Disease Control (CDC) to build in biosecurity as part of its regional preparedness coordinating centre network. Furthermore, Canada has taken novel actions within the global partnership against the spread of weapons and materials of mass destruction to drive biosecurity agenda for sustainable regional models in African countries (Erenler, Guzel & Baydin, 2018).

Kinderlerer (2008) also argues that about 41 African countries are members of Convention Biological Diversity, however, only a few have biosafety and biosecurity regulations, and such limitations constitute a big challenge and hampers the legislative frameworks use and evaluation of biosecurity and biosafety**.**

Kirunda & Otimonapa (2014) observe that Uganda enacted the National Biotechnology and Biosafety Act in 2010 which is heavily biased towards the Cartagena Protocol on Biosafety and the handling of genetically modified crops. Daniele and Jessica (2007) further argued that the biosecurity agenda of Uganda was holistically drawn on guidelines of international frameworks such as BWC of 1972, the International Health Regulations of 2005, and the international office of epizootics.

Mtui (2012) critiqued that the Ugandan National Biotechnology and Biosafety Act in 2010 did not sufficiently address biosecurity regulation issues. The establishment of Uganda biosafety law and regulatory framework in the areas of GMOs risk management is a replica of many African countries. For example, South Africa, legislated GMO Act in 1997, whereas, Kenya approved her Biosafety Act in 2009 (Muriithi *et al*., 2018) with a similar absence of biosecurity laws.

In Tanzania, according to the Academy of Science of South Africa (2018) report named "the state of laboratory biosafety and biosecurity in the Southern African Development Community (SADC) regions workshop proceedings", the biosafety and institutional framework of Tanzania include the Biotechnology/Biosafety Policy of 2010; The Environment Management Act of 2004; The Tanzania National Biosafety Committee and the Tanzania National Biotechnology Advisory Committee. The report indicates that the Department of Environment is the custodian of biosecurity and biosafety issues and that Environmental Management Regulations of 2009 provides details of structural information on emergency responses to any unauthorized release of specific bio threats and agents.

In Kenya, Juma *et al*., (2014) in a survey of biosafety and biosecurity practices in the US Army Medical Research Unit-Kenya observed that biosafety regulations were enacted in Kenya in 2009, but only covered safe use of GMOs. Furthermore, Ndhine *et al*. (2016) in a Biosecurity Survey of Kenya carried out between November 2014 and February 2015, sought to gather data on the biosecurity level components on legislation and enforcement of biosecurity measures in Kenya. During the survey, a total of 86 hospital laboratory facilities were assessed and the study recommended the development of legal

frameworks in Kenya for effective controls including biosecurity regulations and procedures in order to reduce the risk of laboratories becoming a source of future biological harm.

Similarly, Muriithi *et al*. (2018) also undertook a survey assessing biosafety and biosecurity capacity building and its insights on the implementation of Kenya Medical Research Institute (KEMRI) Biosafety training model and observed that enforcement of biosafety guidelines was more prevalent than those of biosecurity guidelines within laboratories. While some of these studies were done to audit and assess laboratory biosafety and biosecurity in Kenya, they only concentrated around medical research institutions based in Nairobi and Kilifi Counties. Only one study done in Western Kenya (Ogaro et. al., 2018), compared biosafety compliance among public and private hospital laboratories citing better preparedness in private hospitals, this study will go further and study biosecurity regulatory framework compliance/capacity if any at Garissa level five hospital.

The Kenya Health Act (2017) and a draft of other legal frameworks such as The Kenya Medical Laboratory Technicians and Technologist Act (Cap 253A) and Public Health Act (Cap 242) as well as Health Amendment Act of 2014 and 2019 which provides regulations of health care services and health care providers, contractors and physical security for products including radioactive and biological products. Surprisingly, the Kenya health amendment laws of 2014 and 2019 majorly catered for the control and regulation of health professionals but not explicit on biosecurity and bioterrorism laws.

Kenya being a resource-limited third world country, there is limited data available or research done in the area of biosecurity legislation and regulatory frameworks and its status of implementation among level five public hospitals. Furthermore, Kenya has not

established a comprehensive program to securitize biosecurity issues and has not prioritized to put in place laws to control and regulate the same despite launching an array of overlapping counter-terrorism strategies since 2011. It is from this background the researcher undertook a study on the effectiveness of the existing biosecurity regulatory frameworks in Kenya and Garissa County level five hospital in particular.

2.2.2 Preparedness Capacity and Capability to Respond to Biosecurity Threat

CDC (2019) describes preparedness as activities and measures taken in advance to ensure effective management of public health threat(s) including the generation and dissemination of effective alerts for an early response as well as the evacuation of people and property from an area under threat(s). According to Meyerson and Peaser (2002), while analyzing for biosecurity preparedness comprehensive approach in the USA, suggested that the event of September 2011 and anthrax attack (Silke, 2018) has led to USA authorities and the general public to be more sensitive to their vulnerability to threats of harmful biological agents administered by individuals or criminals for political, religious, ecological or other ideological goals, with intent to cause harm and that can be summed as bioterrorism. In order to tackle the medical crisis, there is a need to embrace prevention as a top health sector priority. Significant progress has been achieved in detection, protection and decontamination of bio-weapon agents from critical facilities using advanced techniques, because, in the case of bio-attack huge populations will be affected and the collapse of the healthcare industry may follow (Parekh, 2019).

The Association of Public Health Laboratories (APHL, 2018) and CDC have heightened preparedness measures following the Zika virus out in the USA as well as the EVD outbreak in West Africa. During the Ebola response, glaring gaps were observed in

US laboratory biosafety practices particularly the capacity by some clinical laboratories to safely and correctly package and transfer specimens to public health laboratories as well as inadequate biosecurity programs in these clinical laboratories. This challenge was further heightened by the shipment of live *B. anthracis* by federal laboratories (APHL, 2018). Therefore, the APHL and CDC have addressed this challenge through the improvement of epidemiology and laboratory capacity for infectious disease and Hospital Preparedness Program (HPP) and Public Health Preparedness Cooperative agreement by collaborating with public health entities in order to strengthen infection control policies, re-engineer biosafety and biosecurity protocols and enhance surveillance of immigrant and global travellers.

Globally, in 2003, an investigation by WHO attributed morbidity of a severe acute respiratory syndrome (SARS) in China and resulting death of about 286 persons as well as its rapid spread from Hong Kong in Asia to Canada in the West to poor Biosafety Level (BSL)-BSL-3/4 laboratory practices and insufficient biosecurity preparedness capacity Kaiser (2018); WHO (2014). As stated by the Chinese SARS molecular epidemiology consortium report (2014), doctors were also ill-trained and not sure about atypical pneumonia presented by SARS and they downgraded the report that they submitted to the government. Consequently, delays in response were precipitated by the government of China public health bureaucracy where there was no early communication as well as response as a result, the disease spread to Hong Kong. To make the matter worse, the disease got Hong Kong by surprise and without initial alert that could have made the management to prepare in advance on how to handle the situation. Thereafter, naive travellers spread the disease pathogen globally.

Savoia *et al*. (2017) outlined and characterized public health systems studies in medical disaster and emergency preparedness in the USA between 2009 and 2015. The study reviewed and appraised the quality of data from 1584 articles obtained by 156 researchers from Medkine, Embase and Gray literature databases that researched organizational and economic aspects of medical disaster preparedness. The review revealed that 31 studies gave evidence that training increases effectiveness as well as the importance of drills for improved discussion making and coordination. Bruson *et al*. (2017), corroborates this study by linking better results on training done during an outbreak when the actual medical disaster has been encountered.

In addition, 36 researchers pointed to the value of communication as a tool used in disaster preparedness and management (Leinhos, Qari, & Williams, 2014). In addition, 48 studies postulated that the manner in which sustainable preparedness methods are developed includes planning efforts and flexibility and finally, 26 studies provided evidence on the benefits of measurement efforts such as community and organizational needs assessment as well as lessons learnt from response to critical incidents.

Whereas, according to Katz, Graeden and Kerr (2018), response includes those capabilities vital in redeeming and sustaining lives; diminish human, animal, plant and environmental effects; manage and stabilize the incident; protect property and the atmosphere; administer basic humanitarian assistance after an incident has happened and in the events of bio-security crimes, neutralize the unfolding activity and thwart or prevent follow-up attacks. In their study they argue that the capacity to make a timely, accurate and prompt decision in managing the incident will have an effect on how much lives are saved, extent of the spread of the outbreaks, and duration of holistic recovery.

Katz *et al*. (2018) discusses that response to and recovery from medical disaster incidents needs a process of generation of data, review and actions that lead to several coordinated and harmonized activities. Science and technology provide the knowledge and methods for effective response and recovery operations. During the process of response and recovery, decision depends on what is known about the biological threat, its transmission dynamics, mode/chain of infection and co-infection as well as other critical bio-intelligence that could change as the biological incident matures and concomitant response unfolding.

According to Casadevall and Relman (2010), a study on obstacles in the quest for biosecurity emphasized the idea to recognize early enough incidences of biological attacks/infection so as to boost prognosis of exposed individual to harmful pathogens. The study adds that the ideal first response should be the administration of prophylactic interventions before any symptoms appear. It is during incubation that interventions or treatment can prevent spread of infections; this is aimed at halting the progress of the disease. Casadevall and Relman (2010), argue that the biggest challenges to biosecurity threat, is that attacks are usually surreptitious and that victims of biological agents get exposed without knowing and at the same time makes initial response untimely.

Similarly, in a study by Khan (2011) on bio-preparedness and response, argued that due to surprise nature of biosecurity threats, attacks and incidences, initial identification of symptoms may not be easy as certain infections such those of *B. anthracis* are similar to those of influenza at least at the initial stages. Consequently, these challenges may result in delays in identifying, recording and reporting proper cases response. Katz *et al*. (2018) in their study of mapping stakeholders and policies in response to deliberate biological

events articulates that in order to have timely response to biological attacks and halt emerging medical disasters, hospitals need to have clear guidelines to record and report suspected cases to biosecurity preparedness establishments. Furthermore, Khan (2011) adds that clear lines of communication and continuous coordination among hospitals, law enforcement authorities as well as intelligence units are required to suppress emerging biosecurity threats.

According to Trump (2019), in his book Synthetic biology 2020: Frontiers in risk analysis and governance advised that during medical disasters, part of the response should be to install reliable communications pathways between government public health officials, emergency personnel, infection-control staff as well as infectious disease personnel in hospitals. Furthermore, Trump (2019) and Bruson *et al*. (2017) reiterated that collaborative regular briefing and sharing of data regarding planning response against medical disasters ought to be performed.

In a medical emergency survey study conducted in Canada which involved 1028 participants, it was observed that most emergency service providers have not been trained to recognize and work under chemical, biological, radiological, and nuclear (CBRN) polluted environments (Erenler, Guzel & Baydin, 2018). The incapacity is even worse in third world countries that ought to focus on programs that build public health preparedness capacity including online education programs. The survey further suggests the building of surveillance systems can equally be developed to provide new capabilities in response to public health emergencies. However, false alarms and increased cost may result from these efforts.

According to Gao (2019), in a study of biosafety strategies to protect global health, argued that China after the SARS epidemic of 2003, built a network of BSL-3 and BSL-4 laboratory infrastructure and instituted broad-spectrum surveillance for medical emergencies and harmful biological agents. Similarly, Han, Gu, Gao, Liu (2017), in an earlier study titled "China in Action: National strategies to combat against emerging infectious disease", observes that the establishment of laboratory network and the implementation regulations and strict guidelines in over 800 laboratories across China from district, regional, and national levels as well as sentinel hospitals has ensured bio-preparedness, provided early warning mechanism and prevention of spread of harmful biological agents (Gao, 2019).

In matters of biosecurity preparedness collaboration, Yeh *et al*. (2019) argues that Kazakhstan partnered with the USA since 2003 in the areas of countering the proliferation of weapons of massive destruction through the cooperative research program of the USA biological threat reduction program that covered mentorship, biological research support, and infrastructure to scientist based at Kazakhstan research institutes. The USA department of defense funded the program in order to eliminate bio-weapons, secure bio-agent that is in stores that could otherwise be targeted by bio-thieves. The program strengthened the capabilities of scientist while at the same time reduced the risks from biological threats and covered the areas of multi-pathogen zoonosis, brucellosis, and viral and rickettsia vector borne haemorrhagic fever. It also enhanced surveillance systems that monitor outbreaks of infectious disease that could bring about medical disasters and affect national security as well. The study did not extend into the hospital set up especially in the areas of one health and zoonosis.

According to Hersey *et al*. (2015), in a study on EVD documentation in West Africa where the first Ebola pandemic occurred indicated that an outbreak assessment in biosecurity preparedness starts when a case of an infection whose etymology is not known is reported and occurrences for more cases is a pointer to undertake further observance for new cases at critical times till the end of the epidemic. Hersey *et al*. (2015), suggested that awareness on harmful bio-agents should be encouraged among staff working in hospitals, medical laboratories, both private and public clinics as well as those establishments that are in direct or indirect contact with affected patients.

In Guinea and West African states in general, EVD studies by WHO (2014) in regards to early disease detection indicated that the initial cases of Ebola arose in December, 2013, however, public health authorities did not report the disease till March, 2014 almost four months after the outbreak (WHO, 2014, Harsey, *et al*., 2015). Several studies point out that this was due to gaps in both national and regional disease outbreaks detection and reporting systems coupled with global bio-surveillance networks challenges in reducing global medical disaster threats.

In Nigeria, Shobowale *et al*. (2015) undertook a survey of Biosafety Practices of Clinical Laboratories in Four Selected Clinical Laboratories and found out that private laboratories fared better in biosafety practices as comparative variables identified as unsafe biosafety practices in public laboratories such that consuming food in the laboratory (p value of 0.00 and odds ratio of 0.2), non-use of N95 masks (p value 0.04 and odds ratio of 3.9) and safety cabinet use (p value 0.05 and odds ratio of 2.8). Similarly, in Nigeria, a study done by Okonkwo and Udeze (2017) discussed the role of biological agents (both

parasitic and zoonosis) in bioterrorism and indicates the need to establish biosafety standard compliance in Nigeria and Africa in general.

Hospital laboratories in low income African countries such as Kenya have more biosafety programs and less biosecurity preparedness capacity (Shobowale *et al*., 2015; Ndhine *et al*., 2016). Despite launching an array of overlapping health amendment Acts of 2014 and 2019, aspects of biosecurity issues are still missing, with only enactment of Kenya Biosafety Regulations in 2009, that only covers safe use of GMOs.

Similarly, according to CDC (2019), in order to avoid logistical challenges and inadequate medications as well as resources, it encourages hospital professionals be familiar with bio-weaponry agents and in partnership with governmental agencies and should undertake training in preparedness and response programs to potential biosecurity issues. CDC guidelines direct that staff ought to document their suspicion and disseminate it to public health agencies including bio-security preparedness authorities.

Okonkwo and Udeze (2017) observes that terrorist groups in Africa as in the case of Boko Haram of Nigeria and Al-Shabaab of Kenya, have used traditional methods of attacks like gun attacks, kidnapping, suicide among others, thus they may change from the current methods of terrorist attack and engage in proliferation of harmful bioweapons.

Juma *et al*. (2014), in their study where they assessed the biosafety and biosecurity practices in the USA Army Medical Research Unit-Kenya (USAMRU-K), found out that no data existed in most government laboratories as regards to biosecurity and biosafety when handling such agents. Furthermore, Gitau (2016) observes that lack of preparedness and coordination as well as inadequate strategic vaccination and treatment reserves, resulted in human cases of 717 and 162 mortalities during the 2006/7 outbreak of Kenya’s

Rift Valley Fever (RVF). These statistics point to the need to invest in biosecurity threat preparedness and response to medical disasters in Kenya.

Nonetheless, according to GOK (2017), following WHO declaration of EVD outbreak in May 2017 due to death and suspected cases of the disease in Democratic Republic of Congo, Ministry of health Kenya had put in place critical preparedness measures including the release of notification to health workers across the Country to have high index suspicion. In addition, reactivation of rapid response team for increased surveillance and monitoring of travellers with travel history from Congo for EVD like symptoms, stocking of adequate personal protective gears at level five hospitals and the establishment of multiagency EVD coordination committee in the event of an outbreak is envisaged. Although this was an important preparedness drill, the disease was not reported in Kenya.

Finally, unnatural disease outbreaks can lead to medical disasters complicating already existing countries disease burden. Kenya as a state is surrounded by unstable states including sub-zones of federal government of Somalia, infested with Al-Shabaab terror groups and has previously been affected by bouts of terrorist attacks. The possibility of organized criminal cells including terrorist in these unstable environments using harmful biological agents as weapon of war can be devastating to the public health infrastructure as well as national security in general. As frontline border county, Garissa County's' biosecurity preparedness capacity and establishment of effective biosecurity program in order to prevent leakage of intentional acquisition, access, theft, abuse and inoculation of harmful biological agents into unsuspecting population is poorly documented. This study will therefore examine the biosecurity preparedness capacity and capability among medical

staff at Carissa's level five hospital and the whole hospital security infrastructures in general.

2.2.3 Enhancing Mitigation Measures to Biosecurity Threats

Inglesby, Nuzzo, O'Toole, & Henderson (2006) describe mitigations measures as range of actions that might be put in place in an attempt to lessen the occurrence of cases and deaths resulting from biosecurity threat such as in Influenza pandemic. Globally, SARS and Bovine Spongiform Encephalopathy were the biggest wake-up call and in 1997 a novel Highly Pathogenic Avian Influenza virus (HPA1 H5N1) arose near Hong Kong after birds-human transmission was reported (Schoch-Spana, *et al*., 2011). The high virulence of the virus in birds and its ability of high transmission into human population pressed the public health officials in Hong Kong to undertake enhanced mitigation actions as well as interventions including wiping out the whole country poultry population (Lakoff & Collier, 2008; CDC, 2019).

Moreover, according to Schoch-Spana (2001) and Schoch-Spana, Fitzgerald, Kramer (2015), in studies of implications of pandemic influenza for bioterrorism mitigation and tackling of Avian Influenza Virus, in most Asian countries, investment in epidemic management by increasing in disease surveillance and suppression of virus outbreaks was essential. While other scholars have argued for mitigation measures such as increased investment in vaccine research and production of stockpiles of antiviral drugs in hospitals and health facilities (Brunson, *et al*., 2017).

Saito *et al*. (2019), in a study on deployment of field based biological agents' monitors, indicates that early recognition is the core principle in minimizing casualties, initializing appropriate therapy while maintaining sufficient resources. The study suggests

that fast, cheap, portable and accurate technologies have to be enabled so that leakage of biological agents within facilities and at very low concentrations is detected so that likelihood of spread of these agents is managed and mitigated early enough. Furthermore, according to Farah *et al*. (2019), development of bio-surveillance and detection methods which is able to confirm agents in potent concentrations is a challenge. A review of current advances in the detection of organophosphorus chemical warfare agents based biosensor approaches focused on the establishment of nucleic acid-based sensors that is much sensitive that can be deployed inside critical installations (Veenema, 2018). The study further postulates that there is need to specify markers for specific agents that are appropriate for use within the healthcare facilities and emergencies departments for effective biosecurity mitigation measures.

Daschle and Gregg (2018), in their study titled budgeting for medical counter-measures and the need for preparedness, reveals that the USA Project Bio shield of 2004 preparedness plan initially covered anthrax, botulism, and smallpox, but later up-scaled to radiations, nuclear agents as well as viral haemorrhagic fever. Larsen and Gary (2017) stated that despite this preparedness and countermeasure plan to prevent as well as mitigate against those material identified by department of homeland security and intelligence community, there existed gaps in terms of insufficient drug making materials and drugs products. The Project Bio shield Special Reserve Fund was created through financial year 2018 (Daschle & Gregg, 2018) where by procurement of wide-spectrum drugs as well as threat diagnostic for biological, radiological and nuclear threats were planned in advance and appropriation of $28.9 Billion meant for enhanced mitigation approved. This

availability of resources and kind of forward planning is missing in Kenya and Africa in General.

Gillum *et al*. (2018), states that although biosecurity mitigation concepts are narrowly defined, FBI recommends that in order to prevent deliberate bio-agents' leakages, personnel vetting, personnel reliability and biosecurity training, cyber-biosecurity updates and standardization of best regulations and control measures as well as accountability of institutions are necessary. FBI has even employed WMD coordinators that are highly trained experts and certified to act on CBRN incidences. Similarly, in 2016 in United Kingdom, in order to counter deliberate biological threat, developed counter proliferation strategy that includes seeking to control access to harmful bio-agents, equipment and knowledge at global level as well as to making it difficult for nation/states or terrorist to acquire capabilities to develop biological weapons (UK HM Government, 2018).

Accordingly, Khan (2011) ventilates that research on public health preparedness and response since 9/11 and the establishment of a national health security structures indicated that biomedical intelligence is important as it reveals information from both local and global sources where emerging biological attacks and associated technologies in organizations, nations or individuals is shared. Thereafter, the information is analyzed for a particular harmful biological agent threat and evaluation on enemy capacity and motive is done for establishment of appropriate bio-preparedness capacity and mitigation measures to counter possibility of occurrence of medical disaster. This study however did not examine ways of mitigating against bio-criminals' activities within health care facilities.

In the USA and prior to 9/11 anthrax terrorist attacks, the USA government was prepared to handle nuclear threats and they displayed lack of interest in biological security

issues (Mowatt & Allison, 2010). The authors add that the counterterrorism leadership was dominated by nuclear scientists and few had expertise in public health and even fewer in medicine as there was rare interplay of the two disciplines. After the 9/11 attack, however, federal resources were made available so that medical emergency plans, capabilities, stocks were made available as well as underequipped hospitals alerted to develop biological threat response plans early enough to thwart medical disasters (DHS, 2018).

On the hand, Kaiser (2018), states that biosecurity mitigation measures also include legal action against bio-crime elements such as failure to adhere to biosecurity preparedness guidelines such as incident reporting and inventory systems. For example, USA's Texas A & M medical centre was fined $1 million for poor inventory and incident management, in order to curb biosecurity threat lapses in the USA (Kaiser, 2018). This study is deemed reactive and lacked proactive measures as much as these findings may discourage future biosecurity lapses.

Equally, Gillum *et al.* (2018) notes that in USA bioterrorist attack by Rajneeshee Religious Cult that occurred at Dales, Oregon State of the USA was successfully investigated albeit after two years. The cult intentionally perpetrated the use of *Salmonella enteric* serovar *Typhimarum* in about 10 salad restaurants causing typhoid disease in order to tilt the 1984 voting pattern to their advantage and win the Wasco County. As a result, 751 people contracted the typhoid. In an interagency response taskforce comprising Oregon state police, Federal Bureau of Investigation (FBI) and the judiciary, a search warrant was issued against Rajneeshpuran medical laboratory, leading to the characterization of a bacterium that matched the contaminant that infected the resident. This led to the conviction of the cult leaders in 1985.

In Africa, the first unsuccessful global response to Ebola was in West Africa that led to the deaths of more than 11,000 individuals (Shultza *et al*., 2016). The epidemic went on to overwhelm West Africa, brought about global fear and panic, caused devastation on global transportation, subsiding just after several placements of the global public health professionals, investments of billions of dollars, and the deployment of the United States military by Operation United Assistance (Cho & Chu, 2014). WHO (2014), established that by the end of 2015, after dampening the epidemic, Ebola samples, scattered in several hospital laboratories established by different stakeholders were consolidated at three bio-banks which were subjected to heightened security in order to mitigate against loss of agents and actualization of biosecurity threat.

In Kenya, security agencies foiled an anthrax attack in April, 2016 and arrested medical interns at hospitals in Makueni and Kilifi Counties, while two others disappeared from Kitale hospital (GoK, 2016). Likewise, during the Ebola pandemic of 2013-2016, epidemiologists were able to isolate, test and carry out contact tracing in real time in a suspected Ebola Virus Disease (EVD) case in Kericho town (WHO, 2014; Ziraba, 2019; Shultza, *et al.*, 2016) as health security was heightened at entry points by authorities in order to restrict movement of persons into the country and mitigate against occurrence of EVD in Kenya.

WHO report (2020) underscored the missing link in mitigating the spread of Coronavirus Disease - 2019 (COVID-19) and advised countries experiencing coronavirus and other biological disease pandemic that in order to contain the virus, active surveillance, early detection, isolations and quarantine, case management, contact tracing and prevention of spread as well as sharing of data with relevant government and international bodies is

important. Consequently, the Government of Kenya, response mechanism to handle the global coronavirus pandemic disease indicated that the monitoring procedures with which prognosis of specific COVID-19 positive case be handled by having a central command control and health care management system. The national emergency response committee update on COVID-19 response measures indicated establishment of central testing sites such as Nairobi's KEMRI influenza centre and Welcome Trust-KEMRI in Kilifi county and setting aside of Mbagathi District Hospital in Nairobi County as an isolation and quarantine area having 120 bed capacity to assist in establishment of coordinated mechanism of monitoring response progress in the Country.

According to Muriithi *et al*. (2018), Kenya's biosafety program under the Ministry of Health has established containment practices affecting those individuals within the laboratory environment to avoid accidental exposure to pathogens. However, the biosafety/biosecurity survey went short of including biosecurity elements to protect humans, animal, and plant life from intentional exposure. Nonetheless, Kenya been a third world country, ways of enhancing capacity as well as coordination efforts to flatten the curve of both in natural and unnatural biosecurity threat and disease pandemic has not been sufficiently studied and therefore, this study seek bring to the fore biosecurity threat preparedness capacity and capability to response to medical disaster in Garissa County Level Five Hospital.

2.3 Summary of Literature Review

The literature reviewed underpinned that biosafety and biosecurity is an essential pillar of international health security and cross-cutting elements of biological non-proliferation (Chua, 2009, Bakanaide, *et al*., 2010). The global environment in 1972

established WBC (Bakanaide, *et al*., 2010) and since 1983 WHO has been the forefront in promoting the significance of hospital based laboratory safety and developing international protocol on basic biological safety and promoting national codes of practice (Chua, 2009; WHO, 2016; NTI, 2018; Reed, 2000; Gitau, 2016, and Muriithi *et al*., 2018). According to Reed (2010), how best to address the unintentional (biosafety) and intentional (biosecurity) spread of infectious pathogens as well as safe and secure storage of pathogens within healthcare laboratories facilities varies from one country to another county and arise from insufficient biosecurity preparedness capacity (Kaiser, 2018; WHO, 2014). Yeh *et al*. (2019), notes that collaborative efforts such as those of USA Biological threat reduction programs have helped in building of biosecurity preparedness capacity. However, African states and specifically Sub-Saharan African have seldom benefitted.

Reed (2010) indicates that priorities setting and know-how are key factors in the response to bio-threats, with prior biosecurity preparedness plan and capacity such as drills, establishment of laboratory networks (Han *et al*., 2017), early warning systems and disease surveillance/intelligence (Khan, 2011); Gao, 2019), training (Bruson et. al., 2017), command control and communication (Leinhos, Qari, & Williams, 2014) and technology (Khan, 2011; Daschle & Gregg, 2018) being key in forestalling biological threat (Hersey *et al*., 2015).

In Africa, during the Ebola pandemic of 2013-2016, epidemiologists were able to isolate, test and carry out contact tracing in real time in a suspected EVD (Ziraba, 2019; Shultza, *et al.*, 2016). The theme of the literature reviewed is how to prevent both accidental and intentional exposure of bio-risk agents and actions taken to prevent the spread and inoculation of harmful organism through building regulatory, preparedness and response

capacity (Bakanaide, *et al*., 2010; Khan, 2011; Muriithi *et al*., 2018) and to medical disasters.

Biosecurity is a new area that is currently developing due to the global threat to public health and national security as posed by bioterrorism (Magaret, 2002). In the developed countries, high disease burden has led to increased improvement in diseases detection and control (Heckert, 2011), but not equal increase in biosafety and biosecurity preparedness capacity, particularly in low income countries such as Kenya coupled with poor biosecurity funding (Reed, 2010; Heckert, 2011). Equally, many countries are revising their legal, regulatory as well as institutional responses gaps to biosecurity threat (Heckert, Reed, Gmuender, Ellis and Tonui, 2011).

2.4 Knowledge Gap

Various scholars and reports have suggested actions including establishment and implementation of biosecurity regulatory framework to prevent the spread and establishment of harmful biological organism (Chua, 2009, Bakanaide, *et al*., 2010, Reed, 2000, and Heckert, *et al*., 2011). However, few focused on individual sector specific actions such as health, agriculture, and environment without proposing holistic development of a comprehensive and integrated biosecurity management system (Juma *et al*, 2014). Similarly, in Thailand a study on biosecurity issues concentrated on around livestock laboratories (Jarunee *et al*., 2019) and not public health hospitals.

Equally, in Kenya, there is huge data on biosafety than biosecurity (Juma *et al*., 2014; Muriithi *et al*., 2018). Despite its relevance to national security and public health, the subject of biosecurity in as far as health service providers are concerned has not

received significant attention in terms of data, capacity, preparedness and administrative responses,

As frontline border county, Garissa County's' biosecurity preparedness capacity and establishment of effective biosecurity program in order to prevent leakage of intentional acquisition, access, theft, abuse and inoculation of harmful biological agents into unsuspecting population is poorly documented, therefore prompting this study. Furthermore, in order to build on to other studies and form the foundation to come up with a compressive approach to improving biosecurity, this study therefore examined the biosecurity preparedness capacity on response to medical disaster among medical staff at Garissa Level Five hospital in Garissa County, Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design, study site, target population and the sample size that informed the data analysis and presentation of findings. The chapter also discusses the sampling procedure, data collection, analysis and how the findings attained were presented. Finally, the legal and ethical considerations that were considered in the study are also discussed.

3.2 Research Design

Kombo and Tromp (2006) describes research design as the holistic strategies that will be employed in undertaking the research and is indicative of the guiding blueprint in obtaining answers to the research problem. The research utilized a descriptive survey design in order to arrive at the desired research findings and adopted both quantitative and quantitative approaches to data collection. Philip and Pugh (1994) stated that descriptive studies clearly bring out facts for the formulation of critical knowledge and solution to significant problems, while Orodho (2003), notes that descriptive studying involves method of collection of data by interviewing or administrating of questionnaire to a sample of individuals.

Descriptive survey design was chosen for this study because it can establish the relationship between biosecurity preparedness capacity and effective response to biosecurity threat and medical disaster as well. For this study, the data was gathered on parameters that modulate assessment of biosecurity preparedness capacity in order to give a better understanding on the response capacity to medical disasters at Garissa level five

hospital in Garissa County, Kenya. The study adopted mixed methods, using both qualitative and quantitative approaches.

3.3 Study Site

According to Kothari (2008), research site is defined as the areas where the target population flourishes and is limited by a physical boundary. The study site where the research was conducted is Garissa County, Kenya (Appendix VII) which has a population of 841,353 persons and has an area of 44,736KM^2 (Kenya Population and Housing Census (KNBS), 2019). The County is located in the North Eastern part of the Republic of Kenya bordering Federal Government of Somalia to the East and Wajir County to the North and Tana River County to the South.

Garissa County hosts the only level five (5) referral hospital in the County and has also been home to the former provincial referral hospital that had catchment area of the entire three counties of defunct North Eastern Province namely Garissa, Wajir, and Mandera Counties. The level five hospital is a facility that provide county referral healthcare services, training for medical college students, carry out biomedical research as well as serve as attachment and internship centre for medical doctors as well as specialist.

Garissa County was selected because AS and *Al-Qaeda* motivated terror groups have previously targeted both local and international entities within Garissa County including gun attacks, use of Improvised Electronic Devices (IEDs) bombs, and suicide attacks on human targets. Garissa County has borne the brunt of terrorism where in 2015 over 147 Garissa University students were killed by AS terrorist and the terror threat continues to metamorphose (Anderson & McKnight, 2015). The possibility of insidious terror *modus operandi* changes coupled with porous borders and unstable Somalia with

protracted humanitarian refugee crisis as well as lack of proper vaccination mechanism for children makes the county prone to medical disasters and also propagation of biological weaponry (Anderson, & McKnight, 2015). It is in this vein that; Garissa County was purposively selected to give a better understanding of the effects of biosecurity preparedness capacity on response to medical disaster at as well as by Garissa level five hospital.

3.4 Target Population

Orodho and Kombo (2003), states that target population is described as set of groups of individuals, objects or events from which the sample is drawn. The study targeted Garissa County level five hospital staff such as medical officers, laboratory technologist, nurses, and administration that was based at the Level Five Referral Hospital, excluding those on attachment, internship programs and patients within the said study site. The target populations from which the sample was drawn are 202 Garissa Level Five Referral Hospital staff of various categories as indicated in Table 3.1.

Table 3.1: Target Population

Strata	Target Population	Percentage
Medical Officers	20	10
Clinical Officers	25	13
Nurses	120	59
Laboratory Staff	20	10
Hospital Administration	17	8
Total	**202**	**100**

Sources: Garissa County Integrated Plan; Garissa County Executive Committee Member-Health; Nursing Council of Kenya; Lenya Laboratory Technologist Association; Chief Executive Officer, Garissa Level Five Referral Hospital (2020).

The study also targeted 5 counter-terrorism security experts as well as security managers operating within Garissa County as key informants to give views about countering biosecurity and corroborate the findings from the questionnaire. The key informants were chosen from the group because they are presumed to be having in-depth knowledge on biosecurity preparedness capacity and on response to medical disasters.

3.5 Study Sample

According to Kombo and Tromp (2006), a sample is defined as a representative part from a larger whole group whose constituents are studied. It is the infinite part of a statistical population whose ingredients are examined in order to gain insight about the population. According to Wan (2019), the representative sample should not be too small or too large, although larger samples have more representative score. In this study the respondent of the study representing the whole included: medical officers, clinical officer, laboratory technologist, nurses, and hospital administrators.

3.5.1 Study Sample Size

The target population of the study was 202, and was considered not to be a large population. Since the study population is not large, according to Creswell (2003), when the target population is 250 or less, 68% of the population would give a good sample for the study. Since the target population in this study is 202, which is less than 250, 68% of the population was proposed and a sample size of $n = 139$ respondents was significant (Creswell, 2003; Kothari, 2004). The sample percentages for each stratum were determined using the stratum population percentage to the target population for example; the sample from the stratum of 20 medical officers will be 9.9% of 139 which is 12 medical officers.

This criterion was applied in determining sample sizes for the other remaining stratum with a few adjustments in the percentages as presented in Table 3.2.

As for the key informants, one regional National Government Administration Officer (NGAO), one regional Anti - Terrorism Police Unit (ATPU) officer, one health standards, quality assurance and regulations officer, and one National Police Service - Directorate of Criminal Investigation (NPS – DCI) Officer as well as one counter-terrorism analyst were interviewed.

Table 3.2: Sample Size

Strata	Target Population	Proportion	Sample Size
Medical Officers	20	10	14
Clinical Officers	25	13	17
Nurses	120	59	82
Laboratory Staff	20	10	14
Hospital Administration	17	8	12
Total	**202**	**100**	**139**

Source: Author (2020).

3.5.2 Sampling Procedure

According to Bryman and Bell (2015), stratified random sampling is used when target population does not constituent a homogenous group. As in the case of Garissa Level Five Hospital that has heterogonous hospital staff community, this study therefore deployed stratified simple random sampling method. The target population was divided into five strata such as medical doctors' stratum, clinical officers' stratum, laboratory technologist stratum, nurses' stratum and hospital administration stratum. Thereafter, from each stratum, simple random sampling was used to obtain the sample respondents. In

addition, purposive sampling was used to select five key informants who have information that was relevant to the study.

3.6 Data Collection

This section describes the development and piloting of research instruments, instrument validity, instrument reliability, and data collection procedure as well as data analysis.

3.6.1 Data Collection Instruments

Primary data was collected from the field using both structured and semi structured questions delivered in questionnaires (Appendix II) as well as key informant interview guide (Appendix III) format administered with the aid of one research assistant. According to Kerlinger (2008), questionnaires are predetermined questions delivered in the same language, structure and phrasing to sample respondents. They are simple and cheap to administer as well as easy to analyze. In this study, structured questionnaires were physically administered to sampled respondents in order to obtain the primary data. Secondary data was obtained from journals, laboratory data and books by reviewing existing literature.

The researcher interviewed key informants to obtain information to corroborate the findings from the questionnaires. Key informant interviews are tools usually administered to individuals who are experts in certain area and provided additional in-depth data (Kerlinger, 2008) so as to enrich information obtained through questionnaires. Additional research instruments included the use of observation checklist that was filled during laboratory/hospital physical security observation.

3.6.2 Pilot Testing of Research Instruments

The goal of piloting is to ensure thorough understanding of the research variables and to test the validity and reliability of the research instruments that will be used in the study (Kombo and Tromp, 2006). Sample research questionnaire was delivered to 17 respondents (10% of the sample size) selected from medical staff at Pumwani Maternity Hospital in Kamukunji Sub-County, in Nairobi City County. Similarly, Kamukunji Sub-County is demographically related to study site as it harbours sizeable Somali population and has also been targeted by terrorist groups. The researcher administered the instruments to the pilot sample and then scored the questions. In this view, reliability of instrument was boosted by grouping together questions that measure the same concept.

3.6.3 Instruments Reliability

Orodho (2003) and Mugenda & Mugenda (2003), explains that reliability is a measure of the degree to which a research instrument will yield consistent data after accepted test trials. Reliability is attained when a particular procedure gives similar results over a number of repeated trials (Creswell & Clark, 2017). The researcher achieved the aforementioned by administrating the same instrument more than once to the same group, in order to test and re-test the instrument. The researcher administered the instruments to the pilot sample and then scored the questions. In this view, reliability of instrument was boosted by grouping together questions that measure the same notion.

Moreover, reliability of the test instrument was measured by Cronbach Alpha Coefficient to determine internal consistency by checking inter-relation (Kerlinger, 2008). Thus, a reliability test coefficient result value of 0.79 was attained, and was considered significant for this study as well as measure the variables of the study.

3.6.4 Instruments Validity

According to Kombo and Tromp (2006), validity refers to the extent to which the instruments of data collection measures what it intends to measure. The preparation of the instrument and its content was based on the objective and research questions of the study. The format of the questions was considered to ensure clarity of direction of respondents. In order to establish validity of findings, the research used face validity and presented the instrument to experienced researchers and supervisors in the area of study and for trying to obtain accurate information.

Face validity is a subjective decision of whether measures of a certain concept will appear to measure what is intended to measure. In this regard, the researcher gave the data collection instruments to the supervisors and fellow researchers to be able to get their feedback on whether the measures were relevant in measuring what the researcher intended to measure. Furthermore, the instruments were derived strictly from the objectives and the variables. Content Validity Index (CVI) was be used in the study to measure the validity of the instruments. Content validity refers to how accurate an assessment or measurement tool taps into the various aspects of the specific construct questions (Creswell & Clark, 2017). A CVI coefficient of 0.87 was obtained, which was considered sufficient in the study.

3.6.5 Data Collection Procedure

The applicable clearance procedure was undertaken and clearance certificates/letter obtained from relevant authorities. This sated the stage of data collection. Primary data was obtained from the questionnaire administered. Semi-structured type of questionnaire was administered to a range of Garissa level five staff such as medical officers, nurses,

laboratory technologist and section of hospital administration. Additionally, key informant interviews were carried out with key informants purposively selected and interviewed at their own convenience using the interview schedule guide. Secondary data was collected by reviewing existing local and international literature on biosecurity capacity within the healthcare industry. Furthermore, observed biosecurity preparedness capacity parameters from certain facilities within the hospital premise were recorded by administration of an observation checklist. Data from the checklist also augmented analysis and discussion of study questionnaire findings.

3.7 Data Analysis

Primary data obtained from the questionnaire and key informants was quantitatively and qualitatively analyzed respectively. The quantitative data generated was analyzed using descriptive statistics (frequencies and percentages) with the help of software tool, Statistical Package for the Social Sciences (SPSS) version 23.0 and Microsoft Excel. The analyzed data findings were presented in tables and figures for ease of interpretation where possible and in accordance with the specific objectives of the study.

Qualitative data was presented in themes, analyzed and reported in verbatim to corroborate the findings from the questionnaires. Similarly, data from observation checklist corroborated questionnaire findings by bringing to the fore the physical preparedness measures that the hospital has put in place.

3.8 Legal and Ethical Considerations

In this study, ethical issues were addressed at each and every phase of the research study. Permission to conduct the study was obtained prior to the commencement of the study. Clearance approval letter for the research was obtained from the African Nazarene

University Post Graduate School and from the National Commission for Science and Technology and Innovation (NACOSTI), Garissa County Commissioner and the County Executive Committee Member Health and the Chief Executive Officer for Garissa Level Five Hospital. The clearance letter was given to all study participants including respondents based at Garissa Level Five Hospital and security experts for them to know that the study was approved by relevant government agencies. Moreover, utmost confidentiality before, during and after interviews was maintained by the researcher in order to conceal the real identity of respondents.

Consent was sought from respondent before administering research instrument. The reports generated would be availed on need to know basis and in order to safeguard against negative dual-use elements of the research as recommended by relevant bioethics scientific committees. Moreover, applicable security clearance protocols were used to build confidence and foster genuine responses from the various cadres of healthcare authorities and biosecurity specialist selected respondents. In addition, dissemination and presentation of the findings would be done during seminars, research workshops, publication in peer-reviewed journals and book chapters among others.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

The study purposed to assess the biosecurity preparedness capacity and capability to respond to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya. Specifically, the study examined the regulatory framework for biosecurity, the level of preparedness capacity and capability to respond to medical disasters/biosecurity threat and ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya. The chapter presents the response rate achieved, the demographic information and examines the questions as per the specific objectives. Analyses are conducted using SPSS version 23.0 and presented in tables and figures. Thematic analysis was adopted for qualitative data and reported in verbatim to validate the findings from the questionnaire.

4.2 Demographic Characteristics of the Respondents

The information on the characteristics of the respondents who took part in the study was sought. The information sought was the gender of the respondent, age, highest level of education attained, destination and years of experience. The response rate is also included to show the number of questionnaires that were returned and were legibly and completely filled and were therefore adopted for analysis in the study. These findings are presented in sub-sections 4.2.1 to 4.2.6.

4.2.1 Response Rate

The study targeted to collect data from 139 medical officers, clinical officers, nurses, laboratory staff and hospital administrators from Garissa Level Five Hospital.

Questionnaires were distributed to the sample and all questionnaires were returned, nonetheless, after review of the responses given for all questions, considering legibility, consistency, homogeneity and importantly completeness, 133 questionnaires had all questions completely responded to and were found suitable and eligible for analysis giving an overall response rate of 96% (Table 4.1). This response was excellent (more than 70%) as recommended by Kombo and Tromp (2006), and was hence considered excellent for analysis in the study.

Table 4.1: Response Rate

	Sample Size	Response	Response Rate
Medical Officers	14	12 (9%)	86%
Clinical Officers	17	17 (12.8%)	100%
Nurses	82	78 (58.6%)	95%
Laboratory Staff	14	14 (10.6%)	100%
Hospital Administration	12	12 (9%)	100%
Total	**139**	**133 (100%)**	**96%**

Source: Research Data (2020).

4.2.2 Gender of Respondents

The study sought to comprehend the gender distribution of respondents as gender is important in determining the type of workforce in Garissa Level Five Hospital. The findings shown in Figure 4.1, shows that 55% of the respondents are female while 45% are male. The findings imply that there are more female hospital staffs (medical officers, laboratory technologist, clinical officers, nurses, and administration) than the male staff. This can be attributed to the prevalence of female nurses in the Kenyan hospitals, who formed the majority (58.6%) of the respondents in the study.

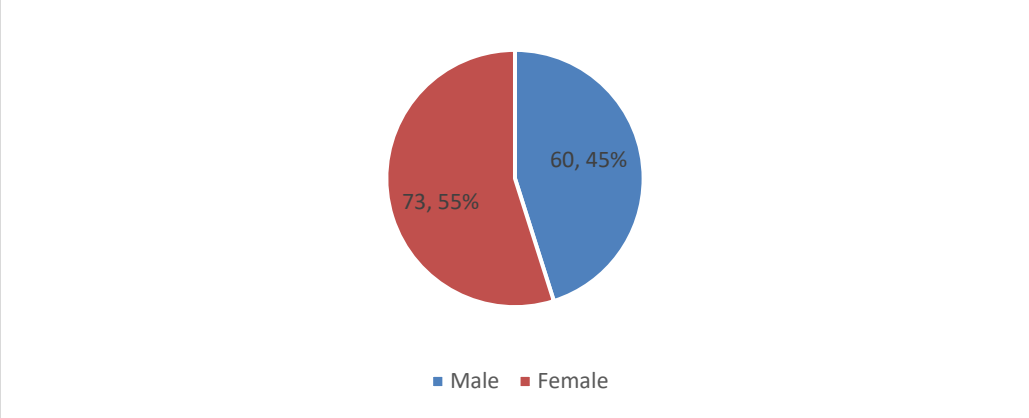


Figure 4.1: Respondents' Gender
Source: Research Data (2020).

4.2.3 Age of Respondents

The study sought to assess the age category of the respondents in order to determine the type of workforce in Garissa Level Five Hospital. The findings presented in Figure 4.2, indicate that 62% of the respondents are in the age category 18-35 years, 27% are in the age category of 36-50 years, 10% are in age category of 51-65 years while 1% are in the age category of more than 65 years. The findings show a youthful workforce in Garissa Level Five Hospital.

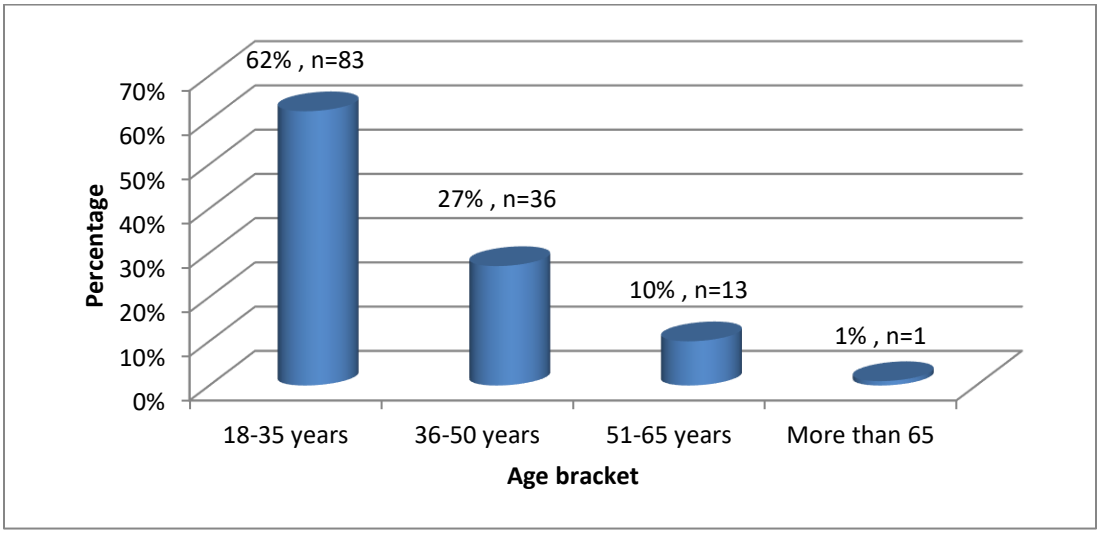


Figure 4.2: Age Bracket of Respondents
Source: Research Data (2020).

4.2.4 Level of Education/Academic Background

The level of education or academic background of the respondents was sought in the study in order to determine the capability of the respondents to answer questions postulated. The study findings presented in Figure 4.3, indicate that 61% of the respondents have attained college level education, while 39% have attained university education. The findings imply that the respondents have high levels of education, hence did not have problems answering the questions posited to them.

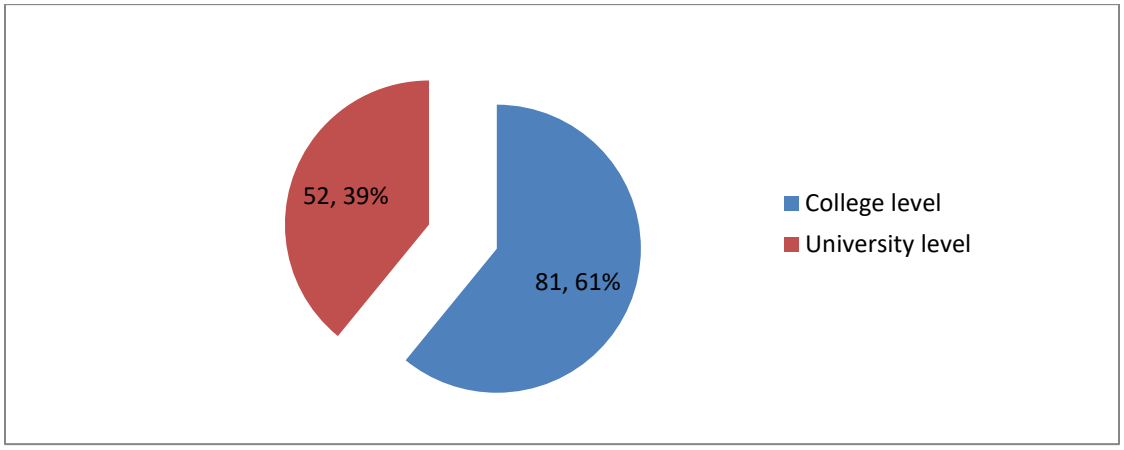


Figure 4.3: Respondents' Education Level
Source: Research Data (2020).

4.2.5 Designation of Respondent

The study sought to understand the designation of respondents in order to understand the respondents' role in the hospital and their contribution to the study. The findings presented in Figure 4.4, indicate that 59% of the respondents are nurses, 13% are clinical officers and 10% are laboratory staff, 9% are medical officers while 9% are hospital administration staff. This can be attributed to the sampling framework of the study.

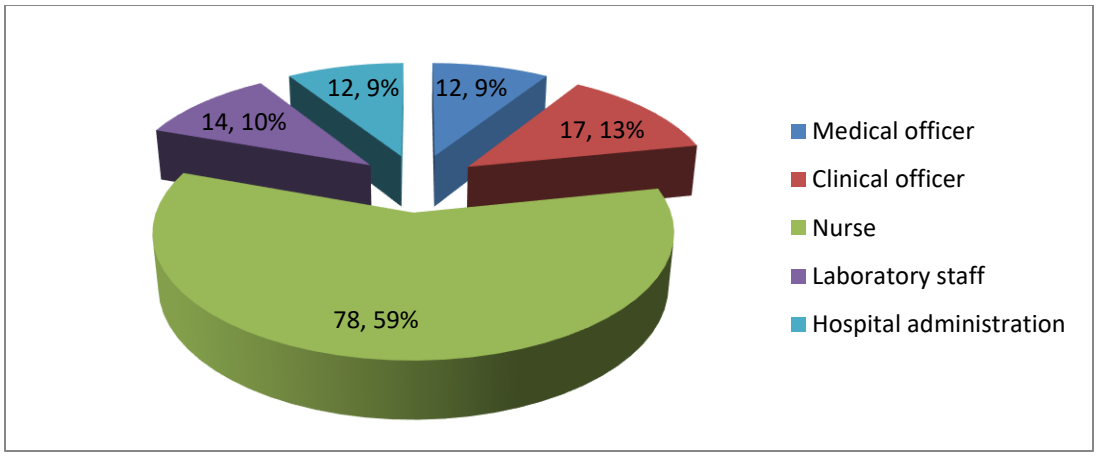


Figure 4.4: Designation of Respondent
Source: Research Data (2020).

The study also sought to determine the relevance of the designation of the respondents in relation to biosafety training. This was necessary to determine which hospital cadre was given priority in biosafety training. The study found that there was a significant relationship between designation of respondents and biosafety training (P = 0.020). In addition, the numbers for those not having been trained were higher in all cadres except for clinical officers and laboratory staff, with the vast majority of the laboratory staff having been trained. The findings are shown in Table 4.2.

Table 4.2 Designation and Biosafety Training

		hospital staff trained on biosecurity frameworks/laws/policies in Kenya		Total	P value
		Yes	No		
Designation	Medical officer	5	7	12	.020
	Clinical officer	9	8	17	
	Nurse	23	55	78	
	Laboratory staff	10	4	14	
	Hospital administration	3	9	12	
Total		50	83	133	

Source: Research Data (2020).

4.2.6 Years of Experience of Respondents

The study sought to assess the years of experience of respondents. Some of these groups are expected to have knowledge and skills which will enable them handle their tasks well and hence the need to assess the years of experience for the purpose of this study as this significantly distinguishes the level of skills and knowledge garnered by an individual through field experience which enables him/her to effectively deliver on their job description with ease. The findings presented in Figure 4.5 indicate that 38% of those who took part in have worked for 5-10 years, 34% have worked for less than 5 years while 28% have worked for more than 10 years. The findings imply a majority of the respondents had more than 5 years' experience (66%), hence have the skills to handle their tasks well.

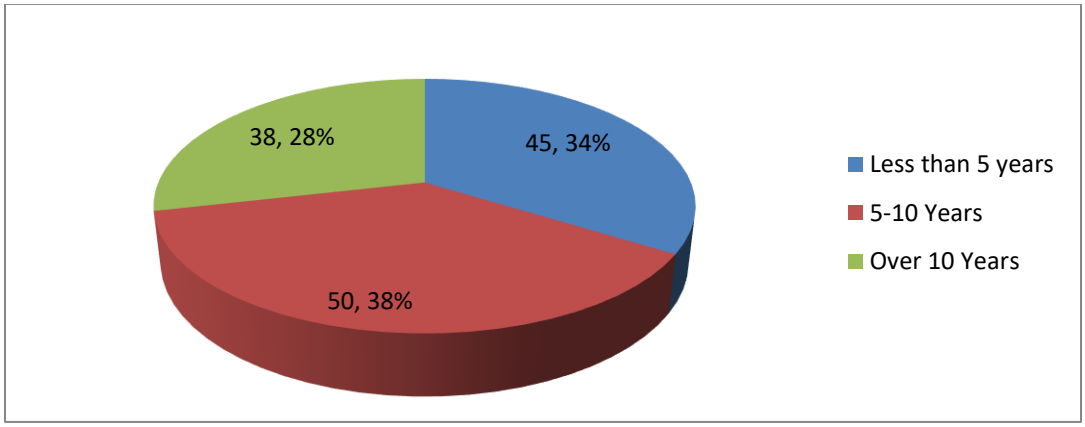


Figure 4.5: Respondents' Years of Experience
Source: Research Data (2020).

4.3 Presentation of Research Analysis and Findings

The study sought to assess the biosecurity preparedness capacity and capability to respond to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya. Precisely, the study examined the regulatory framework for biosecurity, the level of preparedness capacity and capability to respond to medical disasters/biosecurity threat and ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital

in Garissa County, Kenya. The findings of the study are presented in three sections (4.3.1 to section 4.3.3), each sub-section based on specific objectives of the study.

4.3.1 Regulatory Framework for Biosecurity

The first specific objective of the study was to examine the effectiveness of the existing regulatory framework for biosecurity in Kenya. The study first sought to determine whether the respondents were aware of the existing biosecurity laws in Kenya. The findings indicate that 88% of the respondents said there are biosecurity laws in Kenya while 12% did not know of the existence of the laws. The findings are shown in Table 4.3.

Table 4.3: Knowledge of Existing Biosecurity Laws in Kenya

	Frequency	Percentage
Yes	117	88.0
No	16	12.0
Total	**133**	**100.0**

Source: Research Data (2020).

The study sought to determine the existing biosecurity regulatory frameworks the respondents were aware of in Kenya. The multiple response findings indicate that Public Health Act, was the most known biosecurity regulatory framework, as identified by 69.2% of the respondents. Also, 32.3% of the respondents were aware of Biosafety and Biosecurity guidelines, 37.6% were aware of the Biosafety Act 2009, and 21.1% were aware of the Biosafety Regulations, 2011 while 18.8% were aware of the Health Amendment Act 2019. The findings are shown in Table 4.4.

Table 4.4: Existing Biosecurity Regulatory Frameworks

	Frequency	Percentage
Public Health Act	92	69.2
Biosafety and Biosecurity guidelines	43	32.3

The Biosafety Act 2009	50	37.6
The Biosafety Regulations, 2011	28	21.1
Health Amendment Act 2019	25	18.8

Source: Research Data (2020).

The responses obtained from key informants to support existing biosecurity regulatory frameworks the respondents were aware of in Kenya were as follows;

> The Kenya Government has enacted biosafety regulatory framework under the Biosafety Act and other related laws under the public health act but lacks Biosecurity laws (Source: Regional NGAO - Garissa).
> The government of Kenya has enacted laws which check the threats of bio-related security. Among them is the enactment of the Prevention of Terrorism Act No. 30 of 2012 which provides offences which guides the threats of terrorism (Source: Regional ATPU officer, on 3/6/2020 in Garissa Town).

The study also sought to determine whether the hospital staffs were trained on biosecurity frameworks/laws/policies in Kenya. The study findings presented in Table 4.5, indicate that 62.4% of the respondents indicated that they were not trained on biosecurity frameworks/laws/policies while 37.6% indicated that they were trained.

Table 4.5: Trained on Biosecurity Frameworks/Laws/Policies

	Frequency	Percentage
Yes	50	37.6
No	83	62.4
Total	**133**	**100.0**

Source: Research Data (2020).

For those who were trained, the study sought to determine when they were trained. The study found that 36% were trained more than five years as per the time of the study, 34% were trained less than three years as per the time of the study, while 30% were trained 3-5 years as per the time of the study. The findings are presented in Table 4.6.

Table 4.6: Period of Staff Training

	Frequency	Percentage
Less than 3 years ago	17	34.0
3 – 5 years ago	15	30.0
More than 5 years ago	18	36.0
Total	**50**	**100.0**

Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> Biosecurity laws are used in training units. Training of the hospital workers on biosecurity and biosafety guidelines is done at least once for officials involved. However, the effectiveness is very low actually to the extent that I can say that most or good numbers of citizens do not know anything pertaining to biosecurity (Source: Health standards, quality assurance and regulations officer, on 1/6/2020 at Garissa Level Five Hospital).
> Training of Garissa County Level Five Health workers on biosecurity standard operating procedures and guidelines and other specialized security agencies on biosecurity and counter-bioterrorism issues is not entirely done for all employees, but done on a few employees, which is not enough (Source: Regional ATPU officer, on 3/6/2020-Garissa Town).

The researcher sought to know who trained the staff on biosafety at Garissa Level Five Hospital in Garissa County. The findings indicated that 52% of the respondents were trained by government organizations, 44% were trained by both government and non-government organizations and 4% were trained by non-government organizations as shown in Table 4.7.

Table 4.7: Organization Responsible for Training

	Frequency	Percentage
Government organizations	26	52.0
Non-Government organization	2	4.0
Both Government and Non-Government organizations	22	44.0
Total	**50**	**100.0**

Source: Research Data (2020).

On the type of trainers, they had worked with in relation to biosecurity frameworks, the multiple response findings indicate that 33.8% of the respondents have worked with local trainers, 26.3%, 44% have worked with national trainers and 5.3% have worked with international trainers while 61.7% of the respondents have worked with no trainer at all as presented in Table 4.8.

Table 4.8: Type of Trainers

	Frequency	Percentage
Local Trainers	45	33.8
National Trainers	35	26.3
International Trainers	7	5.3
None	82	61.7

Source: Research Data (2020).

On whether there were standard operating procedures on biosecurity/biosafety within the hospital, the study found that 67% of the respondents identified existence of standard operating procedures on biosecurity/biosafety in the hospital, while 33% did not identify with the procedures, as presented in Figure 4.6.

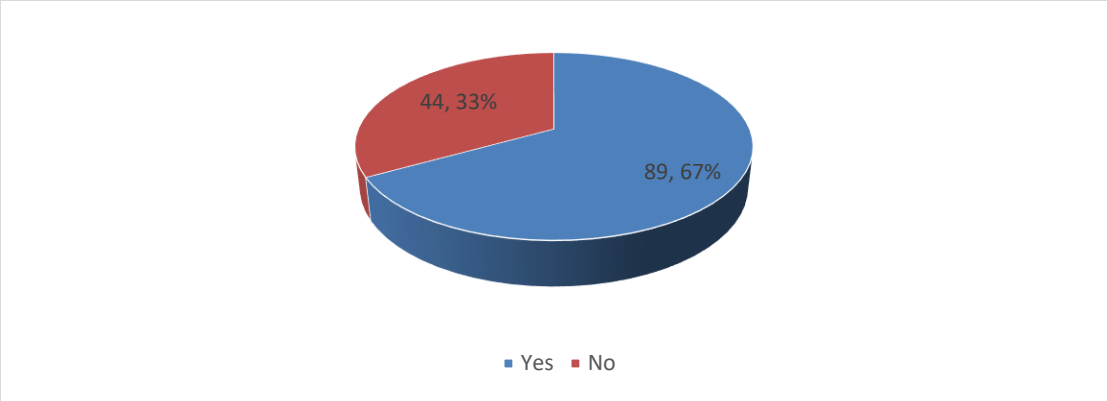


Figure 4.6: Standard Operating Procedures on Biosecurity
Source: Research Data (2020).

The responses obtained from key informants to support the existence of standard operating procedures especially after the COVID-19 pandemic were as follows;

> Following the nascent eruption of the Corona Virus (COVID-19) pandemic, the government enacted laws to check the spread of the virus, including measures by health facilities. Some of the laws regarding public health issues are: failing to keep social distancing of not less than one meter from one person to another in a public place including health facilities, being in a public place without wearing face mask, prohibition of public or private gathering, failing to provide washing station and failing to put in place measures of ensuring social distancing. The hospital has adhered to these standard operating procedures (Source: Regional ATPU officer, on 3/6/2020 in Garissa police station).
>
> Biosecurity regulatory frameworks have contributed to public health safety and reduced diseases (prevention). Compliance to standards has contributed to occupational safety and health of staff at the Hospital. It has also improved the practice of the laboratory staff in adherence to standard operating procedures and guidelines (Source: Health standards, quality assurance and regulations officer on 1/6/2020 with Garissa Level Five Hospital).

From those who identified the existence of standard operating procedures on biosecurity/biosafety in the hospital, the study sought to determine who in-charge of biosecurity laws and procedures was. The study found that 53.9% of the respondents

identified the County government, while 46.1% of the respondents identified the national government. The findings are presented in Table 4.9.

Table 4.9: Body In-Charge of Biosecurity Laws and Procedures Enforcement

	Frequency	Percentage
National government	41	46.1
County government	48	53.9
Total	**89**	**100.0**

Source: Research Data (2020).

4.3.2 Preparedness Capacity and Response to Biosecurity Threat

The second specific objective of the study was to assess the level of preparedness capacity and capability to respond to medical disasters/biosecurity threat at Garissa level five hospital in Garissa County, Kenya. The study first sought to determine the awareness on biosecurity risks in the health facility by the respondents. The findings obtained indicated that 81% of the respondents were aware of biosecurity risks in the health facility while 19% were not aware as indicated in Figure 4.7.

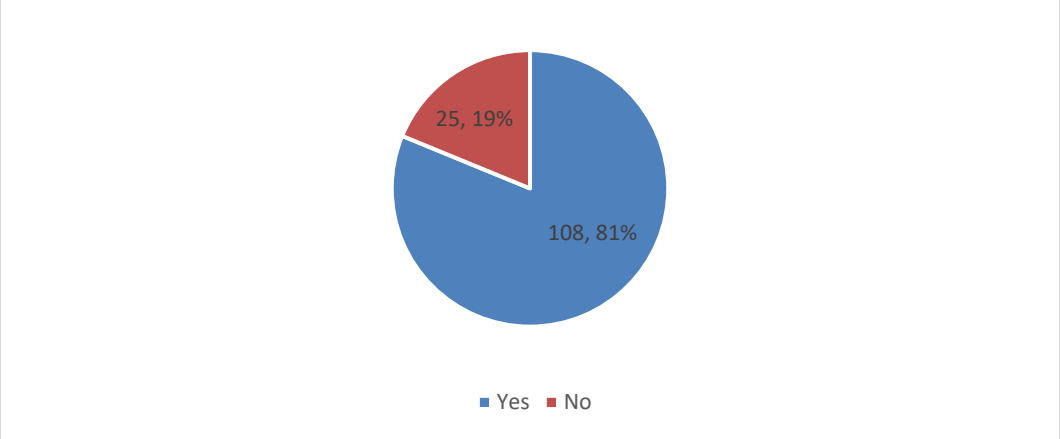


Figure 4.7: Awareness on Biosecurity Risks in the Health Facility
Source: Research Data (2020).

The study sought to find the source of information about biosecurity risks. The multiple response findings showed that 51.9% of the respondents said they obtained information about biosecurity from reading, 29.3% from social media, 21.8% from policy statements from the Ministry and 18% from television or radio while 5.3% obtained information from security agencies and NGOs/Civil Society. From observation, the study found out that there were biohazard warnings signs in the laboratory sections. The findings are presented in Table 4.10.

Table 4.10: Source of Information about Biosecurity Risks

	Frequency	Percentage
Reading	69	51.9
Television or radio	24	18.0
Social media	39	29.3
Policy statements from the ministry	29	21.8
Security agencies	4	3.0
NGOs/Civil Society	3	2.3

Source: Research Data (2020).

On whether the staff were aware of any action(s) that are required if certain biosecurity risk incidents occur, the study found that 70% of the respondents said they were aware of actions to be taken while 30% of the respondents were not aware, as presented in Figure 4.8.

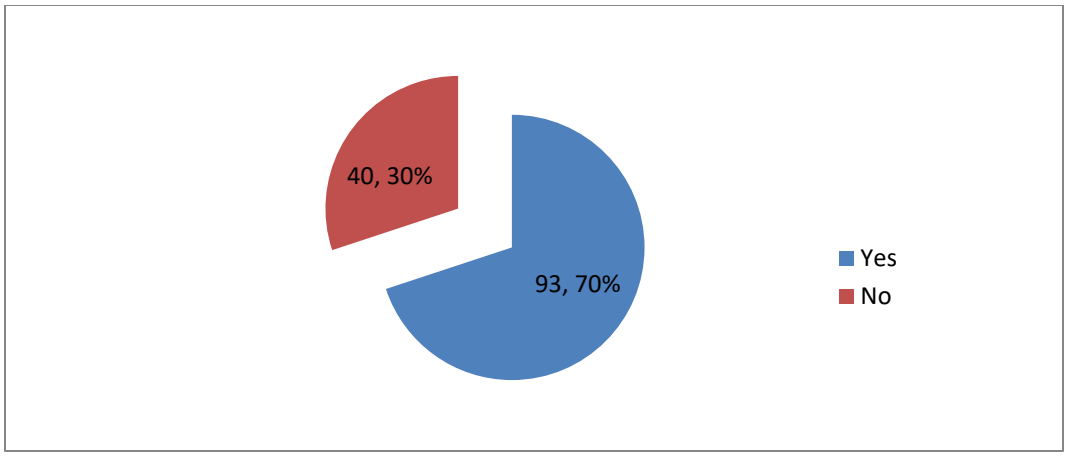


Figure 4.8: Awareness on Actions Required if Certain Biosecurity Incidents Occur
Source: Research Data (2020).

On the actions taken, the multiple response findings showed that 66.2% identified reporting the incidences to hospital management, 42.1% % identified reporting the incidences to biosecurity officer and 17.3% said reporting to police was the best option, as shown in Table 4.11.

Table 4.11: Actions Taken if Certain Biosecurity Incidents Occur

	Frequency	Percentage
Report to hospital management	88	66.2
Report to biosecurity officer	56	42.1
Report to police	23	17.3

Source: Research Data (2020).

On whether there were incidences of biological agents' leakage in the health facility, the study findings as presented in Figure 4.9, show 71% identified incidences of biological agents' leakage in the health facility while 29% did not know such incidences.

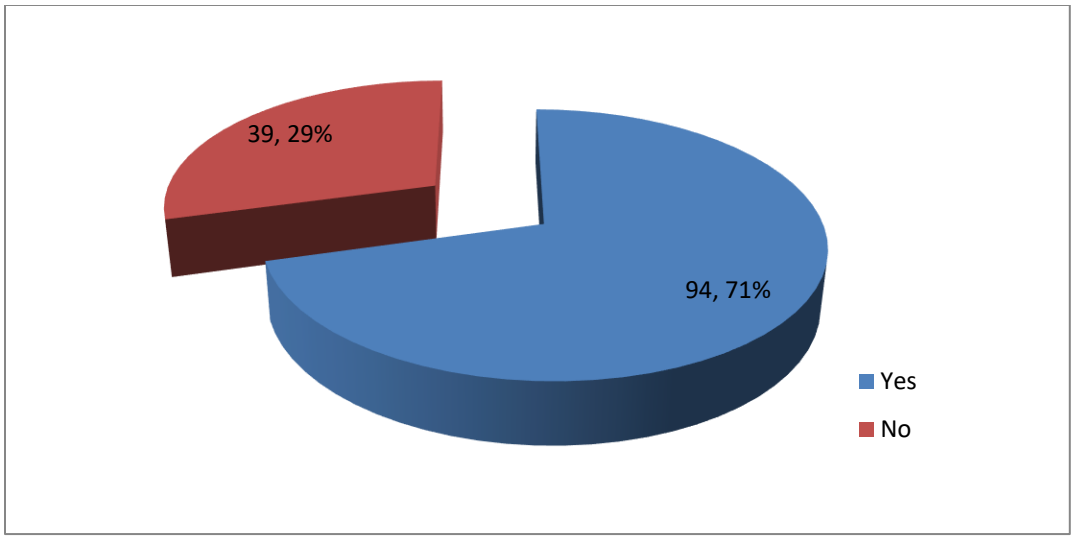


Figure 4.9: Incidences of Biological Agents' Leakage
Source: Research Data (2020).

On the effects of biological agents' leakage in the health facility, the multiple response question show that the effects presented in Table 4.12, included spread of diseases (44.4%), deaths (51.1%), and involvement of illegal weapons usage (29.3%). Additionally, incidences inventory and register was not observed from the observations undertaken.

Table 4.12: Effects of Biological Agents' Leakage

	Frequency	Percentage
Involvement of illegal weapons usage	39	29.3
Deaths	68	51.1
Spread of diseases	59	44.4

Source: Research Data (2020).

On the main sources of leakage of biological agents in the facility, from multiple responses, the study found that injection centres (52.6%), laboratories (48.1%), intensive Care Unit (ICU) section (22.6%), and stores (13.5%) were the main sources of leakage of biological agents in the facility, as shown in Table 4.13.

Table 4.13: Main Sources of Leakage of Biological Agents

	Frequency	Percentage
Laboratories	64	48.1
Stores	18	13.5
ICU section	30	22.6
Injection centres	70	52.6
Pharmacy	9	6.8

Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> The Garissa Level Five Hospital has a very low laboratory capacity to effectively handle biosecurity in the region. The hospital has inadequate occupational safety preparedness and matters biosecurity due to limited expertise as many people prefer to work in Nairobi. The areas handling drugs such as stores, ICU section, injection centres and pharmacies are therefore exposed to leakages (Source: Regional NGAO – Garissa, on 2/6/2020 with the Regional office Garissa).
>
> The preparedness capacity of Garissa Level Five Hospital is poor. Lacks adequate Personal Protective Equipment (PPE) and disinfectants for health personnel. Staffs at the hospital are not trained on biosecurity threats hence lack the capacity to respond to medical disaster. However, the hospital has a 24/7 emergency command and referral systems for coordination of outbreaks and disease management. (Source: Counter-Terrorism Analyst, on 1/6/2020 with the Regional office Garissa).

On whether the facility had select biological agent safety cabinets, the study found that 60.2% of the respondents said the facility did not have biological agent safety cabinets, while 39.8% of the respondents said the facility had biological agent safety cabinets (Figure 4.10).

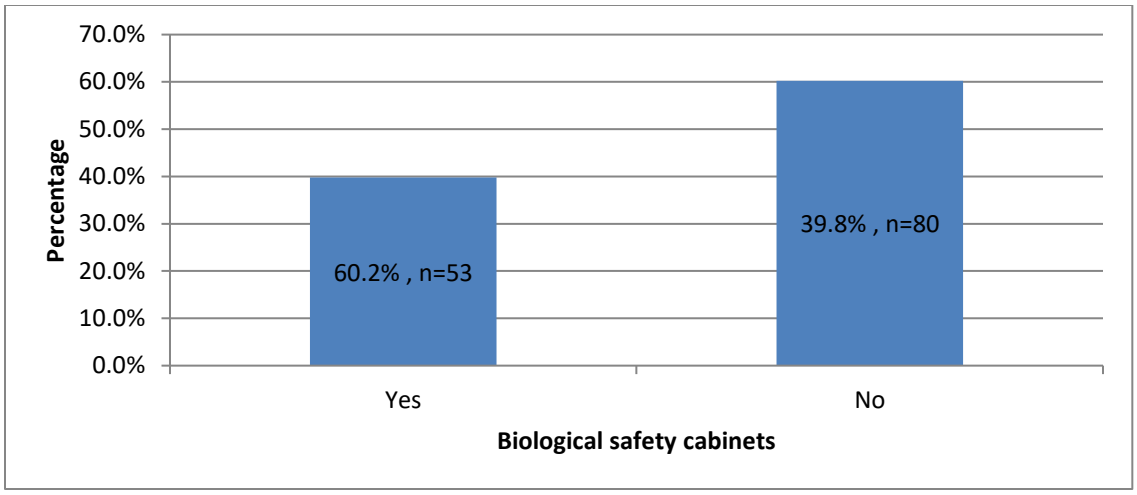


Figure 4.10: Existence of Biological Agent Safety Cabinets
Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> The hospital lacks adequate lockable biosafety cabinets and microbiological hoods. In the hospital waste management and segregation of medical waste guidelines are not followed hence possible biohazard leakages (Source: Counter-Terrorism Analyst, on 1/6/2020 with the Regional office Garissa)

For those who said the facility had select biological agent safety cabinets, the study sought to find out whether the cabinets were secure, and the findings indicated that 60.8% of the respondents identified the cabinets to be unsecure, while 39.2% indicated they were secure, as shown in Table 4.14. Furthermore, from observation the study found out that biological agent's safety cabinets and freezers did not have locks. However, the laboratory had biometric installed.

Table 4.14: Security of Cabinets

	Frequency	Percentage
Yes	20	39.2
No	31	60.8
Total	**51**	**100.0**

Source: Research Data (2020).

The study sought to determine whether there were Personal Protective Equipment (PPE) at the health facility. The findings indicate that 80% of the respondents identified existence of PPE, while 20% of the respondents did not indicate existence of PPE, as shown in Figure 4.11.

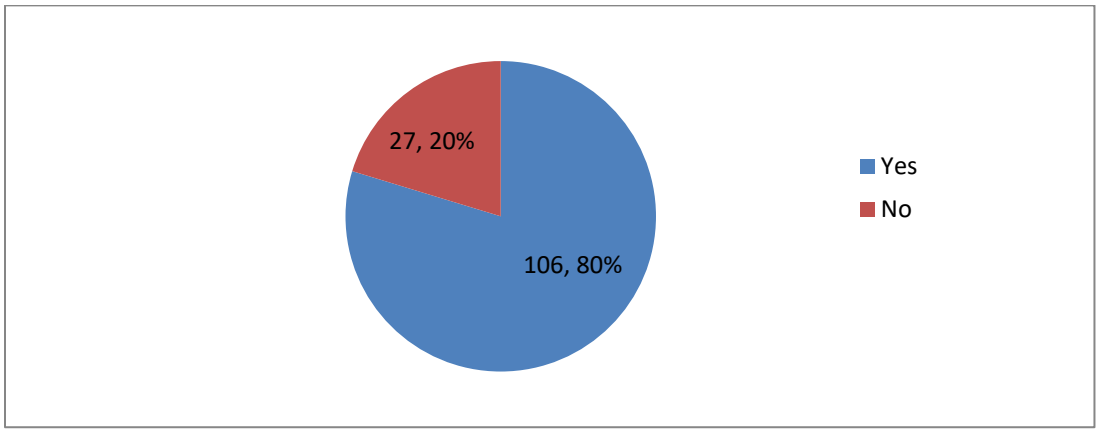


Figure 4.11: Existence of PPE
Source: Research Data (2020).

From multiple responses, the study sought to determine the types of PPE present. The study found that gloves was the major type of PPE used as indicated by 79.7% of the respondents, 48.9% of the respondents identified laboratory coats, 23.3% of the respondents identified head showers, and 16.5% of the respondents identified masks while 15.0% of the respondents identified goggles, as presented in Table 4.15.

Table 4.15: Types of PPEs Present

	Frequency	Percentage
Gloves	106	79.7
Lab coats	65	48.9
Head showers	31	23.3
Goggles	20	15.0
Masks	22	16.5

Source: Research Data (2020).

The study sought to determine whether the organization had biosecurity orientation programs for new officers. The study found that 75% of the respondents indicated the organization did not have biosecurity orientation programs for new officers, while 25% of the respondents indicated the programs were in place, as shown in Figure 4.12.

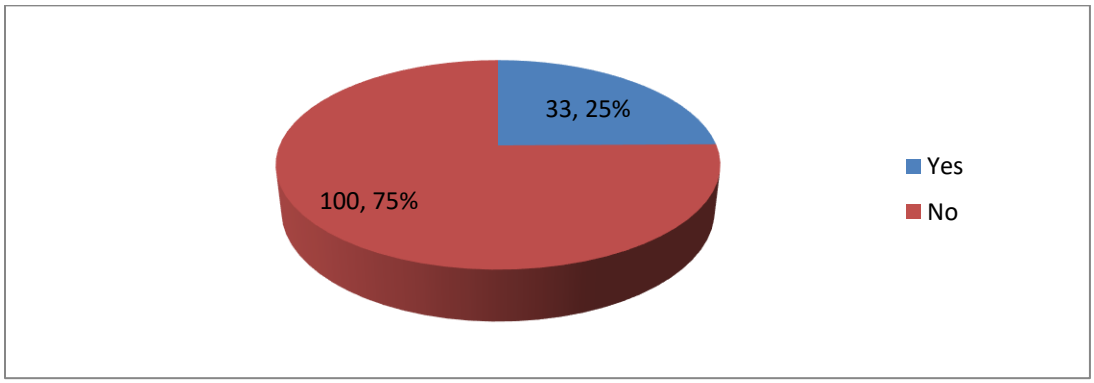


Figure 4.12: Existence of Biosecurity Orientation Programs for New Officers
Source: Research Data (2020).

From multiple responses, the study determined that formal training at the hospital was the most biosecurity orientation program for new officers as given by 32.3% of the respondents, training by biosafety association formed 2.3%, and national training formed 1.5%. The findings are presented in Table 4.16.

Table 4.16: Biosecurity Orientation Programs for New Officers

	Frequency	Percentage
Formal training at the hospital	43	32.3
National Training MoH Hq	2	1.5
Training by Biosafety Association	3	2.3
International Training	1	0.8

Source: Research Data (2020).

On whether the hospital had annual biosecurity awareness programs for all hospital staff and laboratory staff in particular, the study found that 26% of the respondents knew

of existence of annual biosecurity awareness programs while 74% of the respondents did not know of the programs, as presented in Figure 4.13.

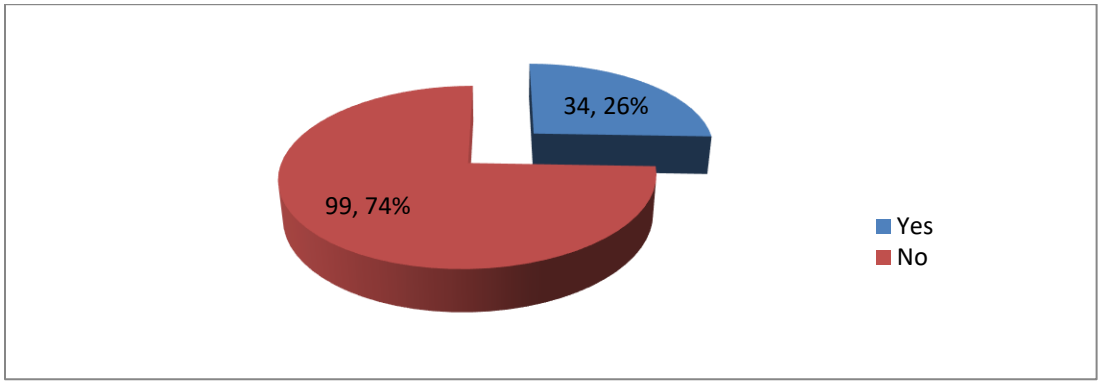


Figure 4.13: Existence of Biosecurity Awareness Programs
Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> There is lack of biosecurity awareness programs in the County. As a border County, Garissa is exposed to infiltration of contraband goods – most of these good are not inspected by relevant authorities for safety and suitability consumption. Moreover, Garissa being a Border County with neighbouring regions across the border do not have comprehensive immunization program thus disease outbreaks in this area such as polio or haemorrhagic fever might end up in the county and Kenya in general. Disease outbreaks along the Garissa-Somalia border is often compounded by huge refugee population that often pose both medical and humanitarian crisis in the County (Source: Regional NGAO – Garissa, on 2/6/2020 with the Regional office Garissa).
>
> The level of preparedness to biosecurity threats is low since most security agencies do not understand what biosecurity is and no sensitization or training has been done to educate people on biosecurity (Source: NPS – DCI officer, on 2/6/2020 with Garissa Police Station).

The findings on annual biosecurity awareness programs that existed for all hospital staff and laboratory staff showed that 53.2% of the respondents identified control of biological agents, 34% identified leakage detection mechanisms and 12.8% of the respondents identified responses to leakages, as presented in Figure 4.14.

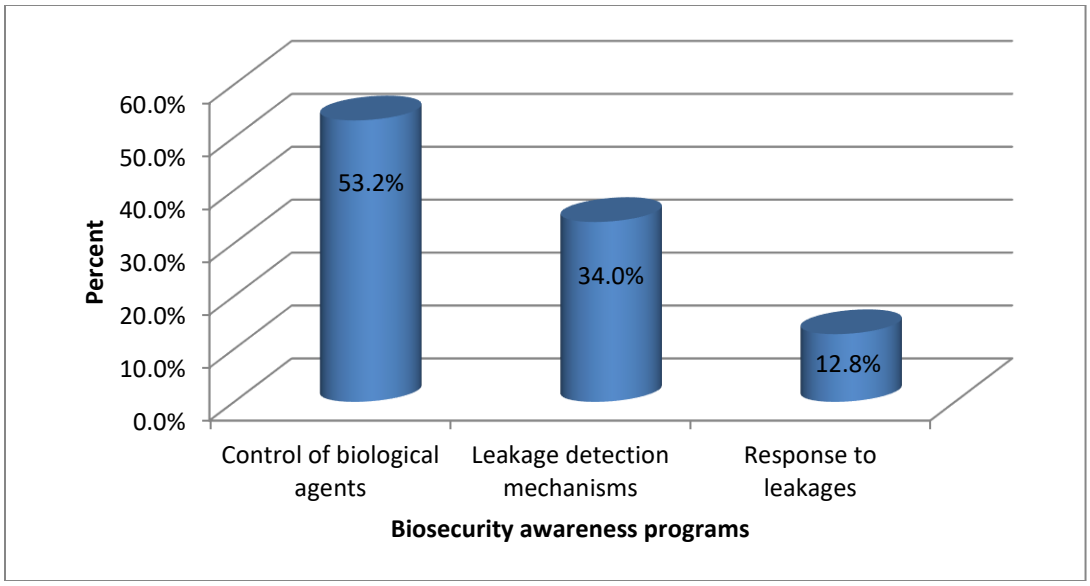


Figure 4.14: Annual Biosecurity Awareness Programs
Source: Research Data (2020).

On measures/capacity in place to respond to biosecurity threat, the study determined that most respondents did not know of the measures in place (55.6%), while others knew of the measures (44.4%) (Table 4.17).

Table 4.17: Existence of Measures/Capacity to Respond to Biosecurity Threat

	Frequency	Percent
Yes	59	44.4
No	74	55.6
Total	**133**	**100.0**

Source: Research Data (2020).

The study sought to determine the existing measures/capacity in place to respond to biosecurity threat within the hospital facility. The multiple response findings indicate that drugs stockpiles were the most known measure/capacity, as identified by 31.6% of the respondents. Also, 24.8% of the respondents identified well trained medical staff, 18.8% identified working equipment, and 7.5% identified command and control. The findings are shown in Table 4.18.

Table 4.18: Existing Measures/Capacity to Respond to Biosecurity Threat

	Frequency	Percentage
Drugs stockpiles	42	31.6
Well trained medical staff	33	24.8
Working equipment	25	18.8
Command and Control	10	7.5

Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> There is a level of preparedness but not optimal as required. Some capacity building has been done for stakeholders through Kenya Red Cross and Society (KRCS) and other agencies. On disaster preparedness the County has contingency plan and costed budget items through National Disaster Management Unit (NMDU) (Source: Regional ATPU officer, on 4/6/2020 within Garissa Police station).
> The laboratory is able to diagnose many pathogens. Additionally, the Garissa Level Five Hospital has referral system for specimens and samples to advanced laboratories such as of Kisumu Centre for Disease prevention and Control (CDC) and Moi Teaching and Referral Hospital (Source: Health standards, quality assurance and regulations officer).
> Garissa County Health department has disease surveillance unit which is functional. There is disease outbreak management team in place comprising of emergency response team based at the hospital. There is lack of biosecurity office (Source: Health standards, quality assurance and regulations officer, on 1/6/2020 with Garissa Level Five Hospital).
> There is the issue of obsolete equipment – there is need to upgrade to effectively address biosecurity and biosafety challenges. There is also lack of information to the members of the public as regards to biosecurity (Source: Regional NGAO – Garissa, on 2/6/2020 with the Regional office Garissa)).

The study also sought to determine the response period to biosecurity threat incident in the facility. The study findings presented in Figure 4.15, indicate that 73% of the respondents indicated that the response was within one hour of an incident, 10% indicated it was within one week of incident while 7% indicated that response was within one day of an incident occurrence.

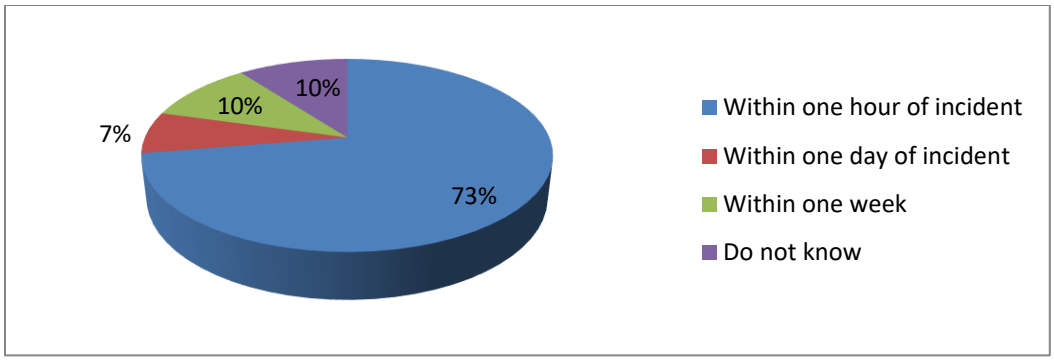


Figure 4.15: Response Period to Biosecurity Threat
Source: Research Data (2020).

The study sought to determine whether the Garissa level five hospital had quarantine or isolation rooms. The study found that 70% of the respondents indicated there were quarantine or isolation rooms, while 30% were not aware of the existence of quarantine or isolation rooms at the hospital. The findings are presented in Figure 4.16.

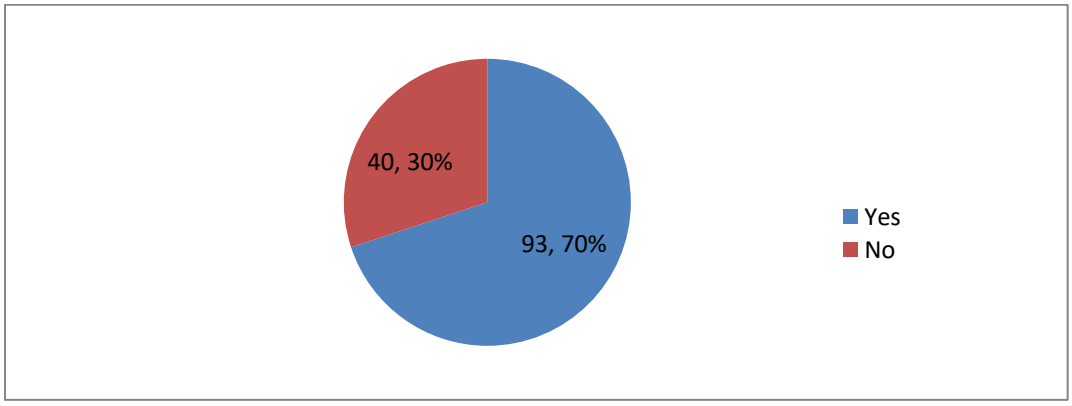


Figure 4.16: Presence of Isolation rooms
Source: Research Data (2020).

On how the quarantine or isolation was achieved in managing the biosecurity threat, the multiple response findings indicated that 65.4% of the respondents identified adequate bed capacity, 41.4% identified presence of shelter rooms and 21.8% identified well-equipped response teams as shown in Table 4.19. It was observed that the hospital had a 36 bed capacity isolations unit which was renovated in April, 2020 for COVID-19 patients.

Table 4.19: Management of Quarantine/Isolation

	Frequency	Percent
Adequate bed capacity	87	65.4
Presence of shelter rooms	55	41.4
Well-equipped response teams	29	21.8

Source: Research Data (2020).

The responses obtained from key informants had mixed claims as follows;

> The global COVID-19 pandemic has exposed Garissa health workers to develop ways to respond to new diseases such as establishment of quarantine centres. Suspect patients contact can now easily be traced, thanks to COVID-19 case management experiences whereby health workers can now work in close collaboration with security agencies in order to profile and identify all people in contact with suspected cases (contact tracing) (Regional ATPU officer, on 2/6/2020 within Garissa Police Station).
>
> There is the issue of obsolete equipment – there is need to upgrade to effectively address biosecurity and biosafety challenges. There is also lack of information to the members of the public as regards to biosecurity (Source: Regional NGAO – Garissa on 2/6/2020 within the Regional office Garissa).

The study also sought to determine if the drug stockpiles within the facility were enough. The multiple response findings indicated that 17.6% of the respondents said broad-spectrum antibiotics were enough, 16.9% said antivirals were enough and 71% said anti-protozoans were enough as presented in Table 4.20.

Table 4.20: Adequacy of Drug Stockpiles

	Frequency	Percentage
Broad-spectrum antibiotics	72	17.6
Antiviral	69	16.9
Anti-protozoan	29	7.1
Anti-poison	5	1.2

Source: Research Data (2020).

4.3.3 Mitigation Measures to Biosecurity Threat

The third specific objective of the study was to explore ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya. The study first sought to determine if the facility had biosecurity risk management office, and found that 64% of the respondents said the office was not in existence, while 36% of the respondents said there was a biosecurity risk management office, as presented in Figure 4.17.

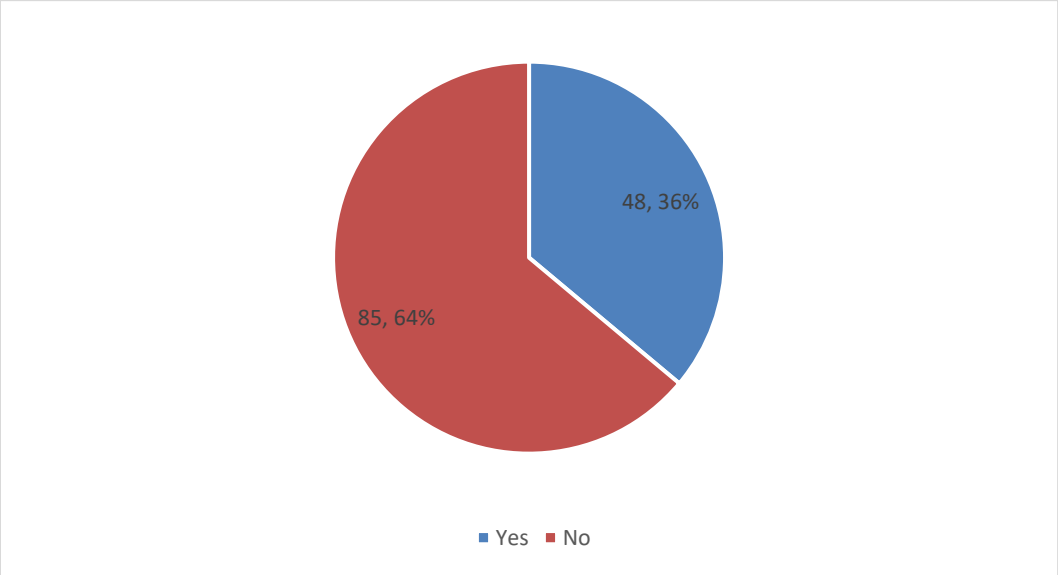


Figure 4.17: Biosecurity Risk Management Office
Source: Research Data (2020).

The study also sought to determine whether the hospital had designated emergency and planning operation centre. From the responses, 66.2% of the respondents indicated there existed designated emergency and planning operation centre, while 33.8% of the respondents indicated such centres did not exist. The findings are shown in Table 4.21.

Table 4.21: Designated Emergency and Planning Operation Centre

	Frequency	Percentage

Yes	88	66.2
No	45	33.8
Total	**133**	**100.0**

Source: Research Data (2020).

For those who identified the existence of incident management systems, they were asked if there was an incident management system committee in place. The findings obtained shows that 58% of the respondents indicated there was no incident management system committee, while 42% were aware of the existence of the committee. The findings are shown in Table 4.22.

Table 4.22: Management System Committee

	Frequency	Percentage
Yes	37	42.0
No	51	58.0
Total	**88**	**100.0**

Source: Research Data (2020).

The study also sought to determine if there were reporting and information management systems in place on biological agents. The findings obtained shows that 59% of the respondents indicated there were reporting and information management systems, while 41% were of a different opinion. The findings are shown in Figure 4.18.

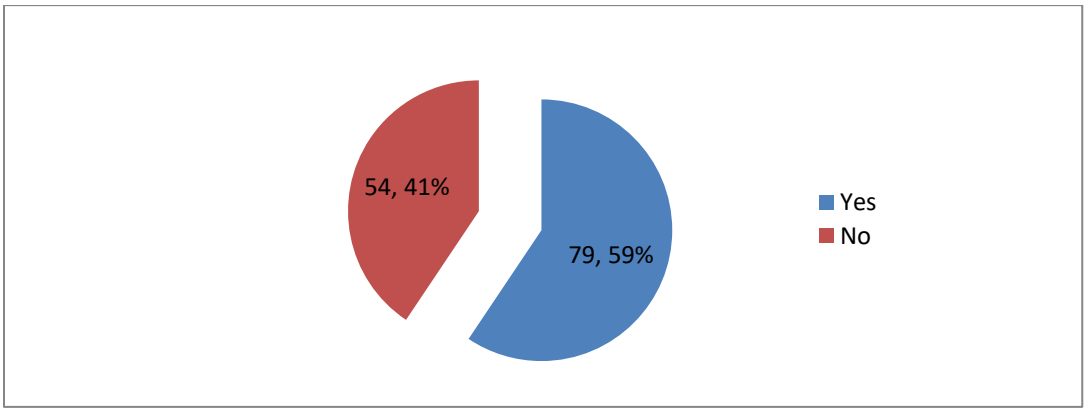


Figure 4.18: Reporting and Information Management Systems
Source: Research Data (2020).

For those who identified existence of reporting and information management systems in place, they were asked to state the types of information system in place. It was determined that 60.8% of the respondents identified biological agents' database, 13.9% identified biological detection system, 21.5% identified incident registry/inventory, while 3.8% identified general hospital database. The findings are presented in Table 4.23.

Table 4.23: Types of Information System in Place

	Frequency	Percentage
Biological detection system	11	13.9
Biological agents' database	48	60.8
Incident registry/Inventory	17	21.5
General hospital database	3	3.8
Total	**79**	**100.0**

Source: Research Data (2020).

The study sought to find whether the hospital staff who were trained on biosecurity incident management. The study found that 50% of the respondents indicated they were trained on biosecurity incident management while 50% of the respondents indicated they were not trained, as presented in Figure 4.19.

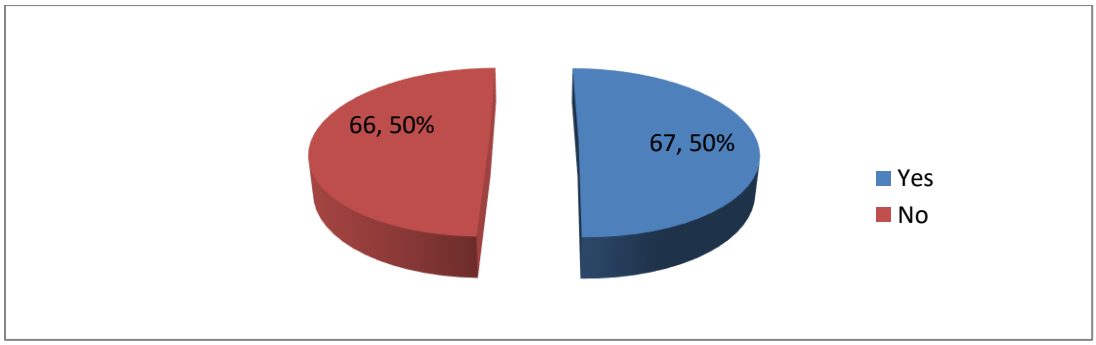


Figure 4.19: Training on Biosecurity Incident Management
Source: Research Data (2020).

For those who were trained, the findings showed that 59.7% of the respondents were trained once a year, 16.4% were trained once in two years, 13.4% were trained only once, 7.5% were trained twice a year and 3% had not been trained at all. The findings are presented in Table 4.24.

Table 4.24: Frequency of Training on Biosecurity Incident Management

	Frequency	Percentage
Once in two years	11	16.4
Once a year	40	59.7
Twice a year	5	7.5
No training at all	2	3.0
Trained only once	9	13.4
Total	**67**	**100.0**

Source: Research Data (2020).

On whether the existing biosecurity guideline and procedures in the hospital were enforced effectively, the study determined that 77% of the respondents indicated they were not enforced effectively while 23% of the respondents indicated enforcement was effective, as presented in Figure 4.20.

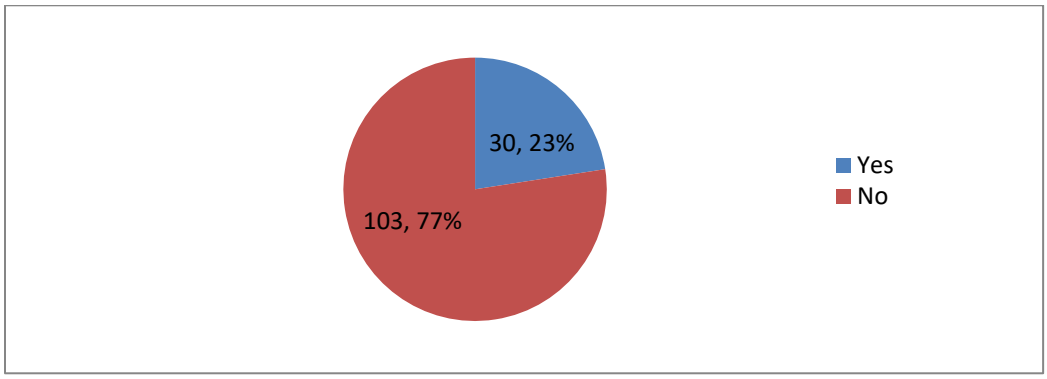


Figure 4.20: Effective Enforcement of Biosecurity Guideline and Procedures
Source: Research Data (2020).

For those who said enforcement was effective, the study sought to determine how effective the enforcement was. The study found that 50% of the respondents indicated the enforcement was effective, 20% indicated the enforcement was very effective, 16.7% indicated not effective and 13.3% did not know. The findings are presented in Table 4.25. However, the study observed that there were no copies of biosafety and biosecurity guidelines of 2014 in the hospital laboratory facility.

Table 4.25: Effectiveness of Biosecurity Guidelines and Procedures

	Frequency	Percentage
Very effective	6	20.0
Effective	15	50.0
Not effective	5	16.7
I don't know	4	13.3
Total	**30**	**100.0**

Source: Research Data (2020).

The study sought to find the challenges faced in responding to biosecurity threat. The multiple response findings showed that 55.6% of the respondents identified lack of protective gears, 48.1% identified lack of policy guidelines, 53.4% identified lack of training and 33.8% identified lack of skills and knowledge, 7.5% identified lack of drugs, while 5.3% indicated they have not come across any case. The findings are presented in Table 4.26.

Table 4.26: Challenges Faced in Responding to Biosecurity Threat

	Frequency	Percentage
No Protective gear	74	55.6
No policy guidelines	64	48.1
No training	71	53.4
No skill and knowledge	45	33.8
No drugs	10	7.5

Have not come across any case	7	5.3

Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> Whereas the main focus of the government has been to regulate and control genetically modified good so as to ensure safety of humans and animals, there have been challenges namely: Inadequate capacity and limited expertise to undertake risk assessment and management, inadequate regulatory frameworks to manage solid waste, uncoordinated regional biosafety regulatory frameworks as each county is operating differently thus need to harmonize and there is poor adherence to the law (Source: Regional NGAO – Garissa on 2/6/2020 with the Regional office Garissa).
> A very lean department of Biosafety and biosecurity is domiciled in the Ministry of Health but lacks policy and legal mandate in enforcement and quality assurances within health facilities. There is no multi-agencies approach to biosecurity hence negating it as only a health issue rather than security issues. There is also non-implementation of biosecurity protocols in the Kenya Health facilities (Source: Counter-Terrorism Analyst, on 1/6/2020 within the Regional office Garissa).

The study further sought to identify the features of a better prepared hospital to biosecurity threats. The multiple response findings showed that 66.2% of the respondents recommended better training, 42.1% recommended installation of biometrics at sensitive sites, 32.3% recommended installation Closed Circuit Television (CCTV) camera, 24.1% recommended vetting of certain personnel, 33.8% recommended securitization of key health sites while 5.3% did not know. The findings are presented in Table 4.27.

Table 4.27: Features of a Better Prepared Hospital to Biosecurity Threats

	Frequency	Percent
Better training	88	66.2
Installation of biometrics at sensitive sites	56	42.1
Installation CCTV camera	43	32.3
Vetting of certain personnel	32	24.1
Securitization of key health sites	45	33.8
Do not know	7	5.3

Source: Research Data (2020).

The responses obtained from key informants to support these claims were as follows;

> Training of Garissa County Level Five Health workers on biosecurity preparedness issues and the enlisting of biosecurity officers is essential. Undertaking of biosecurity drill, workshops and seminars for exchange of knowledge and capacity building (Source: Counter-Terrorism Analyst, on 2/6/2020 within the Regional office Garissa).

> Strengthening of health systems such as biosecurity standard operating procedures and guidelines leading to improvement on laboratory biosecurity is recommended. Also, strengthening the department of health standards, quality assurances, and regulations as well as establish biosecurity office. Providing and disseminating biosecurity toolkits to the health workers, improving the general laboratory biosecurity with lockable areas for biohazards and select agents and strengthening of biological waste disposal and management systems is recommended (Source: Health standards, quality assurance and regulations officer, on 1/6/2020 within the Garissa Level Five Hospital).

> Providing adequate PPE, spill over kits as well develop biosecurity standard operating procedures and improvement levels. Accreditation of the Hospital Laboratory to biosecurity and biosafety standards to required levels (Source: Health standards, quality assurance and regulations officer, on 1/6/2020 within the Garissa Level Five Hospital).
> Regular monitoring and evaluations of the hospital biosecurity levels as well as working with security sector when their biosecurity threats. Also, establishment of incidences registers for biosecurity/biosafety risk management at the Garissa Level Five Hospital (Source: Regional NGAO – Garissa, on 2/6/2020 within the Regional office Garissa).
> Undertaking training on biosecurity threat and medical disaster preparedness as practiced within the hospital. Also, have guidelines that staff and other people accessing hospital can read and understand on the guidelines to biosecurity (Source: NPS – DCI officer, on 2/6/2020 within Garissa Police station).

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the discussion of the findings, summary of findings after the analysis of the research, conclusion after interpreting the results and recommendations for practice and policy implication as well as areas for further research.

5.2 Discussion

This section discusses the results on the biosecurity preparedness capacity and capability to respond to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya. The presentation of this section is guided by study specific objectives on the regulatory framework for biosecurity, the level of preparedness capacity and capability to respond to medical disasters/biosecurity threat and ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya. Finally, the chapter presents discussions on how the findings relate to existing studies and findings from empirical studies.

A total of 133 out of 139 questionnaires had all questions completely responded to and were found suitable and eligible for analysis giving an overall response rate of 96%. The findings show that 55% of the respondents are female. The findings imply that there are more female healthcare workers than the male healthcare workers. This is consistent with the findings by Cannavo, La Torre, Sestili, La Torre and Fioravanti (2019) who found the female healthcare workers constitute 64% of the healthcare workers while the males formed 36%.

The findings also indicate that 62% of the respondents are in the age category 18-35 years. Similar findings were documented by Tran (2019) who found that most healthcare workers were aged more than 28 years. Hu and Yi (2016) also found that most healthcare workers were aged 25-44 in public hospitals. The study findings indicate that 61% of the respondents had attained college level education, while 39% had attained university education. The findings are similar to those by Rahmati, Esmaily and Bahrami (2017) who found that healthcare workers had attained at least Diploma levels of education. However, Hu and Yi (2016) found low educational levels of healthcare workers in rural areas in China, which show that this is not the general trend in the world.

The findings indicate that 59% of the respondents are nurses, 13% are clinical officers and 10% are laboratory staff, while 9% are medical officers, similar to hospital administration. The findings are in line with those of Oliver, Wilson and Malpas (2017) who found that nurses occupied up to 98% of the healthcare workers. Adhikari *et al*. (2016) also found the nurses to occupy 97.4% of the total healthcare workers in Nepal.

The findings indicate that most (38%) of those who took part in the study had worked for 5-10 years, showing good working experience. Similar findings have been posited by Brasaite, Kaunonen, Martinkenas and Suominen (2016) who found a mean length of workers in healthcare workers to be 23 years. In addition, Lamont *et al.* (2017) found mean length of work experience to be 21.4 years.

5.2.1 Regulatory Framework for Biosecurity

The study sought to determine whether the respondents were aware of the existing biosecurity laws in Kenya. The findings show that 88% of the respondents indicated there were biosecurity laws in Kenya. The study findings are consistent with a study by Hersey

et al. (2015), who found that health workers were aware of harmful bio-agents, and further posited that awareness of the laws should be encouraged among staff working in hospitals, medical laboratories, both private and public clinics as well as those establishments that are in direct or indirect contact with affected patients. Various laws including the Public Health Act (69.2%), Biosafety and Biosecurity guidelines (32.3%) Biosafety Act 2009 (37.6%), Biosafety Regulations 2011 (21.1%) and Health Amendment Act 2019 (18.8%) were cited in this study.

The study sought to determine whether the hospital staff were trained on biosecurity frameworks/laws/policies in Kenya. The study findings indicated that 62.4% of the respondents had not been trained on biosecurity frameworks/laws/policies. Further, 36% of those trained were trained more than five years ago. In contrast to the study findings, Savoia *et al*. (2017) argued that health care workers were trained on medical disaster and emergency preparedness in the USA. The study revealed that training increases effectiveness as well as the importance of drills for improved discussion making and coordination. Bruson *et al*. (2017) also found that training was carried out, and helped in linking better results especially when training is done during outbreak when the actual medical disaster has been encountered. Key informants were also in general agreement that training of Garissa County Level Five Health workers on biosecurity standard operating procedures and guidelines and other specialized security agencies on biosecurity and counter-bioterrorism issues is not entirely done for all employees, but done on a few employees. However, Erenler *et al*. (2018) supports the current study findings that in Canada, most emergency service providers have not been trained to recognize and work under chemical, biological, radiological, and nuclear polluted environments.

The researcher sought to know who trained the staff on biosafety at Garissa Level Five Hospital in Garissa County. The findings indicated that 52% of the respondents were trained by government organizations. In support of the study findings, Gillum *et al*. (2018) found that in order to prevent deliberate bio-agents' leakages, personnel vetting and biosecurity training of best regulations and control measures as well as accountability of institutions are necessary. Government coordinators that are highly trained experts and certified to act on such incidences offered the training to the health care workers. The key informants were also in general agreement that training of the hospital workers on biosecurity and biosafety guidelines is done at least once for officials involved by government officials.

On standard operating procedures on biosecurity/biosafety within the hospital, the study found that 67% of the respondents identified existence of such procedures in the hospital. In support of the findings, WHO report (2020) underscored the monitoring procedures with which prognosis of specific COVID-19 positive cases be handled by having a central command control and health care management system. Further, Ndhine *et al*. (2016) reported legal frameworks in Kenya for effective controls including biosecurity regulations and procedures in order to reduce the risk of laboratories becoming a source of future biological harm. The key informants were also in general agreement that that the hospital has adhered to these standard operating procedures.

The study sought to determine who in-charge of biosecurity laws and procedures was. The study found that the County government (53.9%), and the national government (46.1%) were in- charge. In support of the findings, Bakanidze *et al*. (2010) argued that the national centre for disease control and public is responsible for ensuring and advancing

biosafety as well as biosecurity legislative framework and act as focal point for international health regulations.

5.2.2 Preparedness Capacity and Response to Biosecurity Threat

The study sought to determine the awareness on biosecurity risks in the health facility by the respondents. The findings obtained indicate that 81% of the respondents were aware of biosafety risks. Information about biosecurity risks was majorly obtained from reading (51.9%), social media (29.3%), policy statements from the Ministry (21.8%) and television or radio (18%). In support of the findings, Khan (2011) agrees that biomedical information is important as it reveals information from both local and global sources where emerging biological attacks and associated technologies in organizations, nations or individuals is shared. Thereafter, the information is analyzed for a particular harmful biological agent threat and evaluation on enemy capacity and motive is done for establishment of appropriate bio-preparedness capacity and mitigation measures to counter possibility of occurrence of medical disaster.

On whether the staff were aware of any actions that are required if certain biosecurity risk incidents occur, the study found that 70% of the respondents indicated they were aware of actions to be taken. These included reporting the incidences to hospital management (66.2%), reporting the incidences to biosecurity officer (42.1%) and reporting to police (17.3%). In line with the findings, Trump (2019) advised that during medical disasters, part of the response should be to install reliable communications pathways between government public health officials, emergency personnel, infection-control staff as well as infectious disease personnel in hospitals. Further, Bruson *et al*. (2017) reiterated

that collaborative regular briefing and sharing of data regarding planning response against medical disasters ought to be performed.

On whether there were incidences of biological agents' leakage in the health facility, the study findings showed that 71% of the respondents identified incidences of biological agents' leakage in the health facility. In line with the findings, Saito *et al*. (2019) suggests that fast, cheap, portable and accurate technologies have to be enabled so that leakage of biological agents within facilities and at very low concentrations is detected so that likelihood of spread of these agents is managed and mitigated early enough. Further, Farah *et al*. (2019) noted the development of bio-surveillance and detection methods which is able to confirm agents in potent concentrations is a challenge. The study further postulates that there is need to specify markers for specific agents that are appropriate for use within the healthcare facilities and emergencies departments for effective biosecurity mitigation measures.

On the main sources of leakage of biological agents in the facility, the study found that injection centres (52.6%), laboratories (48.1%), ICU section (22.6%), and stores (13.5%) were the main sources of leakage of biological agents in the facility. In support of the findings, Gao (2019) underscored the importance of establishing international guidelines and partnerships in order to assess and reduce biological threats/risks and challenge at source including laboratory hospitals, stores and injection centres level. The key informants were of the general opinion that the Garissa Level Five Hospital has a very low laboratory capacity to effectively handle biosecurity in the region. The areas handling drugs such as stores, ICU section, injection centres and pharmacies are exposed to leakages.

On whether the facility had selected biological agent safety cabinets, the study found that 60.2% of the respondents indicated the facility did not have biological agent safety cabinets. For those who said the facility had select biological agent safety cabinets, the findings indicated that 60.8% of the respondents identified the cabinets to be unsecure. In line with the findings, Shobowale *et al*. (2015) found that private laboratories fared better in biosafety practices as compared to public laboratories such that safety cabinets in use were not safe in public laboratories. The key informants were of the general opinion that the hospital lacks adequate lockable biosafety cabinets and microbiological hoods. From the observation, the study found out that biosafety cabinets and freezers had no security locks.

The study sought to determine whether there were PPE at the health facility. The findings indicate that 80% of the respondents identified existence of PPE. These included gloves (79.7%), laboratory coats (48.9%), head showers (23.3%) masks (16.5%). In line with the findings, GOK (2017), argued that following WHO declaration of EVD outbreak in May 2017 due to death and suspected cases of the disease in DRC, Ministry of health Kenya had put in place critical preparedness measures including stocking of adequate personal protective gears at level five hospitals. Although this was an important preparedness drill, the disease was not reported in Kenya.

On whether the hospital had annual biosecurity awareness programs for all hospital staff and laboratory staff in particular, the study found that 26% of the respondents knew of existence of annual biosecurity awareness programs. In support of the findings, Muriithi *et al*. (2018) indicated that a training model and enforcement of biosafety guidelines was needed and could be more prevalent to biosecurity guidelines within laboratories. The key

informants were on general opinion that there is lack of biosecurity awareness programs in the County.

The study also sought to determine the response period to biosecurity threat incident in the facility. The study findings indicate that 73% of the respondents indicated that the response was within one hour of incident. In support of the findings, Katz *et al*. (2018) suggested that timely response capabilities are vital in redeeming and sustaining lives, manage and stabilize the incident, diminish human, animal, plant and environmental effects, protect property and the atmosphere and administer basic humanitarian assistance after an incident has happened. However, Shultza *et al*. (2016) noted the unsuccessful global response to EVD was in West Africa that led to the deaths of more than 11,000 individuals. The key informants were of the general opinion that the global COVID-19 pandemic has exposed Garissa health workers to develop ways to respond to new diseases such as establishment of quarantine centres. The study observed that isolation units with 36 bed capacity were renovated in April, 2020 to cater for COVID-19 patients. The units were initially used by TB and cholera patients.

5.2.3 Mitigation Measures to Biosecurity Threat

The study sought to determine whether the Garissa Level Five Hospital facility had biosecurity risk management office, and found that 64% of the respondents indicated the non-existence of the office. In support of the findings, CDC (2019) describes activities and measures taken in advance to ensure effective management of public health threats including the establishment of an office that deals with the generation and dissemination of effective early response to threat(s).

The study also sought to determine whether the hospital had designated emergency and planning operation centre. From the responses, it was found that the 66.2% of the respondents indicated there existed designated emergency and planning operation centre. In line with the findings, the Academy of Science of South Africa (2018) report indicate that the Department of Environment is the custodian of biosecurity and biosafety issues and that Environmental Management Regulations of 2009 provides details of structural information on emergency responses to any unauthorized release of specific bio-threats and agents in Tanzania. Establishment of a designated emergency and planning operation centre was key to emergency responses.

The study sought to determine if there were reporting and information management systems in place on biological agents. The findings obtained shows that 59% of the respondents indicated there were reporting and information management systems. For those who identified existence of reporting and information management systems in place, it was determined that biological agents' database (60.8%), biological detection system (13.9%) and incident registry/inventory (21.5%) were used. In line with the findings, Khan (2011) notes that clear lines of communication and continuous coordination among hospitals, law enforcement authorities as well as intelligence units are required to suppress emerging biosecurity threats. The incapacity is even worse in third world countries that ought to focus on programs that build public health preparedness capacity including online education programs. Khan (2011) further suggests the building of surveillance systems can equally be developed to provide new capabilities in response to public health emergencies.

The study sought to find whether the hospital staff were trained on biosecurity incident management. The study found that 50% of the respondents were trained on

biosecurity incident management. For those who were trained, the findings showed that 59.7% of the respondents were trained once a year, posing a challenge to new biosafety threats which keep arising. In support of the findings, Jarunee *et al*. (2019) found that despite national policies on laboratory biosafety and biosecurity, there were huge challenges in regards to harmonization and enforcement of these policies. The current study determined that 77% of the respondents said the existing biosecurity guideline and procedures in the hospital were not enforced effectively.

The study sought to find the challenges faced in responding to biosecurity threat. The findings showed that 55.6% of the respondents identified lack of protective gears, 48.1% identified lack of policy guidelines, 53.4% identified lack of training and 33.8% identified lack of skills and knowledge while 7.5% identified lack of drugs. In line with the findings, APHL (2018) noted challenges in laboratory capacity for infectious diseases, hospital preparedness programs and public health preparedness. It was recommended that in order to strengthen infection control policies, there was need for re-engineering biosafety and biosecurity protocols and enhancing surveillance of hospitals. The key informants were on general opinion that inadequate capacity and limited expertise to undertake risk assessment and management, inadequate regulatory frameworks to manage solid waste, uncoordinated regional biosafety regulatory frameworks as each county is operating differently thus need to harmonize and there is poor adherence to the law. It was observed that there were no manuals and biosecurity guidelines at the hospital.

The study further sought to identify the features of a better prepared hospital to biosecurity threats. The findings showed that better training (66.2%), installation of biometrics at sensitive sites (42.1%), installation CCTV cameras (32.3%) and vetting of

certain personnel (24.1%) were identified. In contrast of the findings, WHO (2020) advocated for better ways of enhancing capacity as well as coordination efforts at hospital, laboratory and community level in order to flatten the curve of both in natural and unnatural biosecurity threat and disease pandemic has not been sufficiently addressed. The key informants were of the general opinion that there should be regular monitoring and evaluations of the hospital biosecurity levels as well as working with security sector when their biosecurity threats. From observation, the study found out that there was existence of quality assurance and standards office for enforcement of quality controls within the hospital.

5.3 Summary of Findings

This study sought to assess the biosecurity preparedness capacity and capability to respond to medical disasters at Garissa Level Five Hospital in Garissa County, Kenya. Specifically, the study examined the regulatory framework for biosecurity, the level of preparedness capacity and capability to respond to medical disasters/biosecurity threat and ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya.

On the regulatory framework for biosecurity, the findings indicated there were biosecurity laws in Kenya including the Public Health Act, Biosafety and Biosecurity guidelines, Biosafety Act 2009, Biosafety Regulations 2011 and Health Amendment Act 2019. However, most heath care workers had not been trained on biosecurity frameworks. The findings revealed that most respondents were trained by government organizations. There were standard operating procedures on biosecurity/biosafety within the hospital. The

study also found that the County government and the national government were in- charge of biosecurity laws and procedures.

On preparedness capacity and response to biosecurity threat, it was found that most respondents were aware of biosecurity risks. Information about biosecurity risks was majorly obtained from reading, social media, policy statements from the Ministry and television or radio. The study found that most respondents were aware of actions to be taken if n biosecurity risk incidents occur. These included reporting the incidences to hospital management, reporting the incidences to biosecurity officer, and reporting to police. The study findings showed that most respondents identified incidences of biological agents' leakage in the health facility. The main sources of leakage of biological agents in the facility were injection centres, laboratories, ICU section and stores. However, their capacity was inclined toward biosafety as opposed to biosecurity. In addition, the facility did not have biological agent safety cabinets. Nevertheless, there were PPE. In addition, the response period to biosecurity threat incident in the facility was within one hour of incident.

On mitigation measures to biosecurity threat, the study found that the facility did not have a biosecurity risk management office. However, there existed designated emergency and planning operation centre. There were reporting and information management systems such as biological agents' database, biological detection system and incident registry/inventory. Slightly more than a half of the respondents were trained once a year, posing a challenge to new biosecurity threats which keep arising. There were challenges faced in responding to biosecurity threat including lack of protective gears, lack of policy guidelines, lack of training, lack of skills and knowledge and lack of drugs. Better

training, installation of biometrics at sensitive sites, installation CCTV cameras and vetting of certain personnel were recommended.

5.4 Conclusion

To answer the first research question which was, what are the existing regulatory framework for biosecurity in Kenya? the study concludes that there were biosecurity laws in Kenya although not clearly defined. However, effectiveness of the regulatory framework was low, accompanied by low training. In addition, there are limited biosecurity frameworks in the Kenya such that only biosafety laws exist which concentrate only on GMOs. The existing ones have not been implemented effectively to achieve the intended objectives. Biosecurity guidelines and manual are only available at accredited laboratory and are not known to many as they lack dissemination.

To answer the second research question which was what was the level of preparedness capacity and capability to respond to medical disasters/biosecurity threat at Garissa level five hospital in Garissa County, Kenya, the study concludes that the level of preparedness to biosecurity threat among county hospitals is low. There is therefore inadequate capacity to differentiate between natural and unnatural disease outbreak. Disease surveillance and pinpointing the source of disease outbreaks is weak due to lack of trained epidemiologist of public health disease intelligence.

To answer the third research question which was, what are the ways of enhancing mitigation measures to biosecurity threat at Garissa level five hospital in Garissa County, Kenya, the study concludes that that the facility did not have a biosecurity risk management office and lacked enough training for health care workers.

5.5 Recommendations

Based on the study findings, the discussion and the conclusion made, the study makes the following recommendations:

On the regulatory framework for biosecurity; since there are limited biosecurity frameworks in the Kenya and the existing ones have not been implemented effectively to achieve the intended objectives, the study recommends biosecurity guidelines to be digitalized and made available to all health facilities. Similarly, the level 5 hospital staff should be trained on biosecurity guidelines. In addition, there should be an introduction of a regulatory agency for biosecurity to enhance quality control and ascertain the status of health facilities and hospitals' laboratories. Equally, the national government need to fast tract the enactment of specific biosecurity laws so as to widen the scope of strategies in mitigating both natural and unnatural biosecurity threat.

On preparedness capacity and response to biosecurity threat, the study recommends introduction of hospital biosecurity monitoring and leakage detection systems. In addition, there is need for a biosecurity inspection/control committee to bridge the existing gaps in the handling of life threating pathogens. Furthermore, there is need to strengthen the existing quality assurance and standards office to better enforce the national guideline on biosafety and biosecurity guidelines.

On mitigation measures to biosecurity threat, the study recommends design, provision and implementation of biosecurity checklist at all sections and units within the hospital. In addition, there is need for stoking of biosecurity equipment and enhancing of their regular sterilization/maintenance. Further, collaboration with the County Government of Garissa to develop strategies for solid waste management including medical waste is

essential, as well as building a common approach with neighbouring countries to harmony in biosecurity issues.

5.6 Suggestion for Further Research

This study was only conducted in Garissa Level Five Hospital in Garissa County. This limited the scope of the study in coverage aspect. The study also measured the viewpoints of health care workers only; consequently, the views of residents (patients) and those affected by biosecurity threats, were not considered. The study therefore recommends that other studies be conducted on the same subject area using views of patients for comparative results in the future.

Based on specific objectives of the study, the study recommends future studies on the reasons why the regulatory framework is not effective. In addition, studies on how to improve and enact a functional preparedness capacity are needed. The study further recommends future studies on how mitigation measures to biosecurity threats can be unified in the country, especially now that the health sector is largely devolved to county governments.

REFERENCES

Academy of Science of South Africa Report (2018). *The state of laboratory biosafety and biosecurity in the Southern African Development Community (SADC) regions*: Pretoria, South Africa: Academy of Science of South Africa.

Adhikari, S., Paudel, K., Aro, A. R., Adhikari, T. B., Adhikari, B., & Mishra, S. R. (2016). Knowledge, attitude and practice of healthcare ethics among resident doctors and ward nurses from a resource poor setting, Nepal. *BMC medical ethics*, *17*(1), 68-74.

Anderson, D. M., & McKnight, J. (2015). Understanding Al-Shabaab: Clan, Islam and Insurgency in Kenya. *Journal of Eastern African Studies*, *9*(3), 536-557.

Bakanaide, L., Imnadze, P. and Perkins, D. (2010). Biosafety and Biosecurity as an essential pillar of international health security and cross-cutting elements of biological non-proliferation. *BMC Public Health, 10*(l), 1-12.

Bell, E., Bryman, A., & Harley, B. (2018). *Business Research Methods*. Oxford, UK: Oxford University Press.

Brachman, P. (2012). Bioterrorism: An Update with focus on Anthrax. *American Journal of Epidemiology, 155*(11), 981-987.

Brasaite, I., Kaunonen, M., Martinkenas, A., & Suominen, T. (2016). Health care professionals' attitudes regarding patient safety: cross-sectional survey. *BMC research notes*, *9*(1), 177-190.

Brunson, E. K., Chandler, H., Gronvall, G. K., Ravi, S., Sell, T. K., Shearer, M. P., Schoch-Spana, M. (2020). The SPARS Pandemic 2025-2028: A futuristic Scenario to Facilitate Medical Countermeasure communication. *Journal International crisis and Rick Communication Research, 3*(1),71-102.

Cannavo, M., La Torre, F., Sestili, C., La Torre, G., & Fioravanti, M. (2019). Work related violence as a predictor of stress and correlated disorders in emergency department healthcare professionals. *La Clinica Terapeutica*, *170*(2), 110-123.

Casadevall, A., & Relman, A. (2010). Microbial Threat List: Obstacles in the Quest for Biosecurity?. *Nat Rev Microbil*, *8*(2),149-154.

CDC (2019). *Public Health Emergency Preparedness and Response Capabilities, National Standards for State, Local, Tribal, and Territorial Public Health*. Retrieved from https://www.cdc.gov/cpr/readiness/00_docs/CDC_ PreparednesResponse CapabilitiesOctber2018_ Final_508.pdf . Accessed on 27/3/2020.

Chinese SARS Molecular Epidemiology Consortium (2004). Molecular evolution of the SARS coronavirus during the course of the SARS epidemic in China. *Science, 303*(5664), 1666-1669.

Clarke, V. R. and Cornish, K. D. (2014). *The Reasoning Criminal: Rational Choice Perspective on offending*. New Jersey: Transaction Publishers.

Creswell, J. (2003) (2nd ed.). *Research Design*: *Qualitative, Quantitative and Mixed Methods Approaches*. Lincoln, Nebraska: University of Nebraska.

Creswell, J., & Clark, V. P. (2017). *Designing and Conducting mixed methods research*. New York, USA: Sage Publication.

Cullen, F. T., Agnew, R., & Wilcox, P. (2006). *Criminology Theory: Past to Present: Essential reading*s. New York, NY: Oxford University Press,

Daschle & Gregg (2018). *Budgeting for medical counter-measures: An ongoing need for preparedness*. Washington, D.C. Bipartisan Policy.

DHS (2018). *Detecting Bioterrorist Attacks*. https://www.dhs.gov/biowatch-program., Department of Homeland Security. Accessed on 27th March, 2018.

Dickson, A., Emal, E. K., & Joe, A. A. (2018). Theoretical and Conceptual Frameworks: Mandatory Ingredients of Quality Research. *International Journal of Scientific Research. 7(1): 438:441*.

Erenler, A. K., Güzel, M., & Baydin, A. (2018). How prepared are we for possible bioterrorist attacks: An approach from emergency medicine perspective. *The Scientific World Journal*, *2018*(1), 22-29.

Farah, N. D., Jahwarhar, I. A., Knight, V. F., Wan, M. Z. Y., Keat, K. O., Noor, A. M. K, Norhana, A. H., Siti, A. M. (2019). A review of current advances in the detection of organophosphorus chemical warfare agents based biosensor approaches. *Sensing and Bio-sensing research*, *1*(26), 100-109.

Felson, M. (2013). *Routine Activity Approach. In Environmental Criminology and Crime Analysis*. Oxfordshire United Kingdom: Taylor Francis Group Pgs. 92-99.

Gao, F. G. (2019). For better world: Biosafety strategies to protect global health. *Elsevier, Biosafety and Health, 1*(1), 1-3.

Gaston, A. & Prapavessis, H. (2014). Using a Combined Protection Motivation Theory and health action process approach intervention to promote exercise during pregnancy. *Journal of Behavioral medicine, 1*(37), 173-184.

Gaudioso, J., Gribble, L. A, & Salerno, R. M (2009). Biosecurity: Progress and Challenges. *Journal of the Association for Laboratory Automation*, *1*(2), 22-31.

Gillum, D., Carrera, L.A.O., Mendoza, I.A., Bates, P., Bowen, D., Jetson, Z., Maldonado J., Mancini C., Miraldi M., O'Donnell M., and Kiani S. (2018). The Arizona Biosafety Workshop: An Open Dialogue about Biosecurity. *Applied Biosafety: Journal of ABSA International, 23*(4), 233-241.

Gitau, S. G. (2016). *Assessment of the healthcare providers' knowledge and capacity to detect Rift Valley Fever Infections in Maragua Sub-County of Murang'a County of Kenya*. Nairobi, Kenya: University of Nairobi Press.

GoK (2017). *Ebola Viral Disease preparedness measures in Kenya following the outbreak in Democratic Republic of Congo*. Nairobi, Kenya: Ministry of Health Press release.

GoK Report (2016). *Kenya should step up her Bioterrorism Surveillance*. Nairobi, Kenya: The Standardmedia.co.ke Accessed at 14th September, 2019 at 1200 hours.

GoK Report (2020): *Kenya's National Emergency Response Committees update on coronavirus response measures*. Nairobi Kenya: Government Press Printer.

Han, M., Gu, J., Gao, G. F., Liu, W. J. (2017). China in Action: National strategies to combat against emerging infectious disease. *Science China Life Science 60*(2), 1383-1385.

Heckert, A. R., Reed, J. Craig, G. K., Felix, M. E. and Tonui, W. (2011). International Biosafety and Biosecurity Challenges: Capacity in low-resource countries. *Applied Biosafety*, *16*(4), 2230-2239.

Hu, G., & Yi, Y. (2016). Is a decentralized continuing medical education program feasible for Chinese rural health professionals?. *Journal of educational evaluation for health professions, 13*(1), 24-34.

Inglesby, T. V., Nuzzo, J. B., O'Toole, T., Henderson, D. A. (2006). Disease mitigation measures in the control of pandemic influenza. *Biosecurity Bioterror, 4*(4), 366-375.

Jarunee, S., Somjai, K., Ruanchaimun, S., Patchimasiri, T., Banjong, J, and Blacksell S. D. (2019). Biosafety and Biosecurity Challenges Facility Veterinary Diagnostic Laboratories in Lower-Middle Income Countries in Southeast Asia: A Case Study of Thailand. *Applied Biosafety: Journal of ABSA International, 24*(4), 220-230.

Juma, W. B., Wadegu, M., Makio, A., Kirera, R., Eyase, F., Awinda, G., Kamanza, J., Schnabel, D., and Wurapa, K. E. (2014). *A Survey of biosafety and biosecurity practices in the United States Army Medical Research Unit-Kenya*. Nairobi, Kenya: Applied Biology.

Kaiser, J. (2018). Texas A&M to pay $1 Million for biosecurity breaches. *Science Now, 1*(1), 34-41.

Katz, R., Graeden, E., & Kerr, J. (2018). The complexity of biological events. *The Lancet Global Health*, *6*(2), 136-137.

Katz, R., Graeden, E., Abe, K., Attal-Juncqua, A., Boyce, M. R., & Eaneff, S. (2018). Mapping stakeholders and policies in response to deliberate biological events. *Heliyon*, *4*(12), 10-21.

Kerlinger, F. N. (2008). *Multiple Regressions in Behavioral Research*. New York, USA: Holt, Richart and Winston.

Khan, A. S. (2011). Public Health Preparedness and response in the USA since 9/11: a national health security imperative. *Lancet, 378*(1),953-956.

Kinderlerer, J. (2008). Cartagena Protocol on Biosafety. *Collection of Biosafety Reviews, 4*(1), 12-62. www.icgeb.org/biosafety/publications/collections/html.

Kingiri, A. and Ayele, S. (2009). Towards a smart biosafety regulation: The case of Kenya. *Environmental Biosafety Reviews*, *8*(1), 133-138.

Kirunda, H., & Otimonapa, M. (2014). Low level of awareness in biosafety and biosecurity among professionals in Uganda: a potential risk in the dual-use dilemma. *Journal of Bioterrorism and Biodefense*, *5*(1), 1-11.

KNBS (2019). *The 2019 Kenya Population and Housing Census Report*. Nairobi, Kenya. KNBS.

Kombo, D. K and Tromp L. A. D. (2006). *Proposal and Thesis Writing: An Introduction*. Nairobi, Kenya: Pauline Publications Africa.

Kothari, C. R (2008). *Research Methodology. Methods and Techniques*. New age International Publishers, New Delhi-India.

Kothari, R. (2004). *Research Methodology: Methods and Techniques*. Jaipur, New Delhi: Age International Publishers.

Lakoff, A. & Collier, S. J. (2008). *Biosecurity Interventions: Global Health and Security Question*. Columbia University Press, SSRC Book.

Lamont, S., Brunero, S., Perry, L., Duffield, C., Sibbritt, D., Gallagher, R., & Nicholls, R. (2017). 'Mental health day'sickness absence amongst nurses and midwives: workplace, workforce, psychosocial and health characteristics. *Journal of advanced nursing*, *73*(5), 1172-1181.

Larsen, C. J. and Gary, L. D. (2017). Project Bio shield and the biomedical advanced research development Authority: A 10 year progress report on meeting U.S preparedness objective for threat agents. *Clinical infectious diseases, 64*(2), *1430-4.*

Leinhos, M., Qari, S. H., Williams, J. M. (2014). Preparedness and emergency response research centers: using a public health systems approach to improve all-hazards preparedness and response. *Public Health Rep, 2*(4)*:*8-18.

Lunenberg, F. C., & Irby, B. J. (2008). Writing a successful thesis or dissertation: Tips and strategies for students in the social and behavioral sciences. *Corwin press, 1*(2), 22-31.

Mayerson, A. L. and Peaser, K. J. (2002). Biosecurity: Moving toward a comprehensive approach. *American Institute of Biological Sciences. Bioscience*, *52*(7), 1-12.

Merab, E (2020, January, 22). *Kenya at risk of virus as WHO ponder raising red alert.* Nairobi, Kenya: Daily Nation. Available at www.nation.co.ke. Accessed on 25/2/2020.

Mtui, G. (2012). Biosafety systems in Eastern and Central Africa. *African Journal of Environmental Science and Technology*, *6*(2), 80-93.

Mukhopadhyay, G. A. (2013). Public health, genomics, and bio-politics – human security vis-à-vis security 'exception". *African Journal of Political Science and International relations*, *2*(3), 22-29.

Muriithi, B., Bundi, M., Galata, A., Miringu, G., Wandera, E., Kathiko, C., Odoyo, E., Kamemba, M., Amukoye, E., Huqa Sora, S. M., Inoue, S., and Ichinose, Y. (2018). Biosafety and Biosecurity capacity building: Insights from implementation of NUITM-KEMRI Biosafety training model. *Tropical medicine and Health, 46*(30), 11-19.

Ndhine, E. O. Osoro, M. E., Olsen, N. K., Rugutt, M., Wanjohi, C. W., Mwanda, W., Steenhard, N. R., Hansen, J. E. S. (2016). *A Biosecurity Survey in Kenya*. November 2014 to February 2015. https://doi.org/10.1089/hs.2016.0009.

Nuclear Threat Initiative (2018). *Nuclear Threat Initiative Report*. http://nti.org/725P, Washington, USA: NTI Accessed on 25/3/2020 at 1200 hours.

Oliver, P., Wilson, M., & Malpas, P. (2017). New Zealand doctors' and nurses' views on legalising assisted dying in New Zealand. *NZ Medical Journal, 130*(1456), 10-26.

Orodho, A. J and Kombo, D. K (2003). *Research Methods*. Nairobi: Kenyatta University, Institute of Open Learning.

Orodho, A. J. (2003). *Essentials of Educational and social science research methods*. Nairobi: Masola Publishers.

Parekh, A. K. (2019). *Prevention First: Policymaking for a Healthier America*. Baltimore, MD: JHU Press.

Philip, J. S and Pugh, M. T. (1994). *Research Methodology: Methods and techniques*. New Delhi: Light Publishers.

Prince, R. J. and Otieno, P. (2014). In the shadow lands of global health: Observations from health workers in Kenya. *Global Public health, 1*(9), 927-945.

Pythoud, F., & Thomas, U. P. (2017). The Cartagena Protocol on Biosafety 1. In *Governing Global Biodiversity* (pp. 39-56). Abingdon, Routledge.

Rahmati, R., Esmaily, H., & Bahrami, H. R. (2017). Evaluation of the performance of the health care workers in giving consultation about the fertility promotion. *Journal of Midwifery and Reproductive Health, 5*(2), 911-918.

Reed, J. C. (2000). Bridging the Gap: The international Federation of Biosafety Association. Applied Biosafety. *Journal of the American Biological Safety Association, 15*(1) 3-5.

Riedel, S. (2004). *Biological warfare and bioterrorism: A historical review*. Texas, USA: Baylor University Medical Centre.

Saito, M., Uchida, N., Furutani, S., Murahashi, M., Espulgar, W., Nagatani, N., & Uzawa, H. (2018). Field-deployable rapid multiple bio sensing system for detection of chemical and biological warfare agents. *Microsystems & Nano-engineering*, *4*(1), 1-11.

Savoia, E., Lin, L., Bernard, D., Klein, N., James, L. P., & Guicciardi, S. (2017). Public health system research in public health emergency preparedness in the United States (2009– 2015): actionable knowledge base. *American journal of public health*, *107*(2), 1-6.

Schoch-Spana, M. (2001). Implications of Pandemic Influenza for Bioterrorism Response. *Clinical Infectious Diseases*, *316*(6): 1409-13.

Schoch-Spana, M., Fitzgerald, J., Kramer, B. R., & UPMC Influenza Task Force. (2015). Influenza vaccine scarcity 2004–05: Implications for Biosecurity and Public health preparedness. *Biosecurity and bioterrorism: biodefense strategy, practice, and science*, *3*(3), 224-234.

Shobowale, E. L., Elikwu C. J., Coker, A. O., Mutiu, P. O., Nwakide, V., Olusanya, and Osinupebi, A (2015). A survey of Bioasafety Practices of Clinical Laboratories in

Four Selected Clinical Laboratories. *Biosafety, an open access Journal, Medical Safe Global health, 4*(123), 22-29.

Shultza, J. M., Zelde, E., Esponolac, M. & Andreas, R. (2016). Distinguishing Epidemiological features of the 2013-2016 West Africa Ebola Virus Disease Outbreak. Disaster Health Briefing, *Taylor & Francis Group, 3*(3),78-88.

Silke, A. (2018). *Research on Terrorism: A review of the Impact of 9/11 and Global War on terrorism - Terrorism Informatics: Knowledge Management and Data Mining for Homeland Security*. London: Springer, pp 27-50.

Simon, M. K (2011). *Assumptions, Limitations, and Delimitations. Dissertation and scholarly research: Recipes for success*. Seattle, WA: Dissertation Success, LLC.

Slotved, H., Yatich, K. K., Edwardina, Ndhine, O., and Otoi, S. S. (2017). The Capacity of Diagnostic Laboratories in Kenya for Detecting Diseases. *Tropical Medicine and Health, 45*(10), 29-38.

Suk, J. E., Van Cangh, T., Beaute, J., Bartels, C., Tsolova, S., Pharris, A., ... & Semenza, J. C. (2014). The interconnected and cross-border nature of risks posed by infectious diseases. *Global health action, 7*(1), 25287.

Teodor, S., Henrik, K., & Jonas, H. (2015). A Meta-Analysis of studies on Protection Motivation Theory and Information Security. *International Journal of Information security and Privacy, (IJISP) 9*(1), 21-27.

The Association of Public Health Laboratories (2017). *Enhancing Biosafety and Biosecurity in the Nations' Public Health Laboratories: A Report of the APHL 2016 Biosafety and biosecurity Survey.* George Avenue, USA: Association of Public Health Laboratories.

Tran, B. N. (2019). *Workplace Bullying and Job Satisfaction in Higher Education: A Causal-Comparative Study* (Doctoral dissertation, St. Thomas University).

Troidl, H., Spitzer, W. O., McPeek, B., Mulder, D. S., & Martin, F. (2012). *Principles and Practice of Research: Strategies for surgical Investigators.* New York, NY, USA*:* Springer Science & Business Media.

Trump, B. D. (2019). *Synthetic Biology 2020: Frontiers in Risk Analysis and Governance*. London: Springer Nature.

United Kingdom Her Majesty Government Report (2018). *UK: Biological Security Strategy of 2018.*, London, UK: UK Government Publications,

Veenema, T. G. (Ed.). (*2018*). *Disaster nursing and emergency preparedness*. New York City, USA: Springer Publishing Company.

Wagener, S., and Bollaert, C. (2013). Biosafety, Biosecurity, and Bioethics Governance in Synthetic Biology: The "7P" Approach. *Applied Biosafety*, *18*(4), 1-7.

Wan, Z. (2019). *Participant selection and access in case study research: In Challenges and opportunities in qualitative research*. Singapore: Springer.

Wein, L. M. and Liu, Y. (2015). Analysing a bioterrorism attack on the food supply: The case of Botulin toxin in milk. *Proceedings of the National Academy of Sciences, 102*(28), 9984-9989

WHO (2014). Ebola Response team. Ebola virus disease in West Africa – the first 9 month of the epidemic and forward projections. *National English Journal of Medicine, 371*(2), 1481-1495.

WHO (2017). *Global Disease Burden*. ww.who.int/topics/global_burden_of_disease/en Accessed on 09/10/2019.

Wittek, R. (2015). *Rational Choice Theory*. New York, USA: Sage Publications Book.

Yeh, B. K., Parekh, K. F., Lyazzat, M., Ablay, S., Kairat, T., Zhanna, S., Allien, L. R., and Hay, J (2019). A Case History in Cooperative Biological Research: Compendium of Studies and Program Analyses in Kazakhstan. *Tropical Medicine Infectious Disease Review*, *1(*4), 130-136.

Ziraba A. (2019) *Kenya responds fast to Ebola scare, but cross-border risk remains high*. African Population and Health Research Centre. www.theconservation.com. Accessed on 28/3/2020.

APPENDICES

Appendix I: Introduction Letter

REQUEST FOR PARTICIPATION IN RESEARCH STUDY

I am an Africa Nazarene University student currently undertaking graduate research study on the effects of bio-security preparedness capacity on response to medical disasters at Garissa level five hospital in Garissa County, Kenya. I have selected you as one of my study respondents due to your in-depth knowledge and understanding in this area of research.

Kindly, allow me to engage with you an interview whose date will be communicated later and under the mentioned topic. If you chose to be my study participants, information you share during the interview as well as your identity will not be disclosed to anyone whatsoever and confidentiality remains utmost.

Upon your request, you will also be availed a copy of the report. Thank you for your cooperation and timely response. For any further communication, feel free to contact me through: 0796219621 or 19j03dmgp044@anu.co.ke

Yours Sincerely,

Hassan J. Adan

Student

Appendix II: Questionnaire for Garissa Level Five Hospital Respondents

Self-Introduction done and confidentiality of the information given: YES…... or NO……. (Tick)

This questionnaire is aimed at facilitating the research on the Effects of Bio-Security Preparedness Capacity on Response to Medical Disasters at Garissa Level Five Hospital in Garissa County, Kenya. Your response will be highly appreciated.

Instructions:

Please read each item in this questionnaire and fill in or tick in the spaces provided where appropriate.

SECTION A: DEMOGRAPHIC INFORMATION

1. What is your gender?

   Male [ ] Female [ ]

2. Age bracket?

   18-35 years [ ] 36-50 years [ ] 51-65 years [ ] More than 65 [ ]

3. Highest level of education?

   Primary [ ] Secondary [ ] College level [ ] University Level [ ]

   Other [ ] (Specify)……..

4. Designation?

   Medical officer [ ] Clinical officer [ ] Nurse [ ]

   Laboratory staff [ ] Hospital administration [ ]

5. Years of Experience?

   Less than 5 years [ ] 5-10 Years [ ] Over 10 Years [ ]

SECTION B: EFFECTIVENESS OF EXISTING BIOSECURITY REGULATORY FRAMEWORKS

6. Are there existing biosecurity laws in Kenya?

   Yes [ ] No [ ]

7. If yes in questions 8 above, what existing biosecurity regulatory frameworks are you aware of in Kenya?

   Public Health Act [ ]

   Biosafety and Biosecurity guidelines [ ]

   The Biosafety Act 2009 [ ]

   The Biosafety Regulations, 2011 [ ]

   Health Amendment Act 2019 [ ]

   Other [ ] (Specify)……

8. Have the hospital staffs trained on biosecurity frameworks/laws/policies in Kenya?

   Yes [ ] No [ ]

9. If yes in 9 above, when were the staffs trained?

   Less than 3 years ago [ ]

   3 – 5 years ago [ ]

   More than 5 years ago [ ]

10. Who trained the staff?

    Government organization [ ]

    Non-Government organization [ ]

    Both Government and Non-Government organizations [ ]

11. What type of trainers have you worked with in relation to biosecurity frameworks?

    (Choose all that apply)

    Local Trainers [ ]

    National Trainers [ ]

    International Trainers [ ]

    None [ ]

12. Are there standard operating procedures on biosecurity/biosafety within your hospital? Yes [ ] No [ ]

13. If yes in 13 above, please list the most common standard operating procedures in your facility?.....

14. Who is in-charge of biosecurity laws and procedures enforcement in the hospital?

    National government [ ]

    County government [ ]

    Other [ ] (Specify)…….

SECTION C: PREPAREDNESS CAPACITY AND RESPONSE TO BIOSECURITY THREAT

15. Are you aware of biosecurity risks in your health facility?

    Yes [ ] No [ ]

16. If yes, where did you obtain the information about biosecurity risks from? **(Choose all that apply)**

    Reading [ ]

    Television or radio [ ]

Social media [ ]

Policy statements from the ministry [ ]

Security agencies [ ]

NGOs/Civil Society [ ]

Other [ ] (Specify)……

17. Are staff aware of any action(s) taken that are required if certain biosecurity risk incidents occur?

    Yes [ ] No [ ]

18. If yes, state actions taken? **(Choose all that apply)**

    Report to hospital management [ ]

    Report to biosecurity officer [ ]

    Report to police [ ]

    Other [ ] (Specify)……

19. Are there incidences of biological agents' leakage in your health facility?

    Yes [ ] No [ ]

20. If yes, what are the incidents of biological agents' leakage that have occurred in your health facility?……

21. What are the effects of biological agents' leakage in your health facility? **(Choose all that apply)**

    Involvement of illegal weapons usage [ ]

    Deaths [ ]

    Spread of diseases [ ]

    Other [ ] (Specify) [ ]……

22. What are the main sources of leakage of biological agents in your facility, if any?

(Choose all that apply)

Laboratories [ ]

Stores [ ]

Waste section [ ]

Injection centres [ ]

Pharmacy [ ]

Other [ ] (Specify) [ ].....

23. What biological leakage detection mechanisms are in place in your health facility?

……

24. Does your facility have select biological agent safety cabinets?

Yes [ ] No [ ]

25. If yes in above, are the cabinets secure?

Yes [ ] No [ ]

26. If yes, how are the cabinets secured? .....

27. Do you have Personal Protective Equipment (PPE) at your health facility?

Yes [ ] No [ ]

28. If yes, specify types) of PPEs present. **(Choose all that apply)**

Gloves [ ]

Lab coats [ ]

Head showers [ ]

Goggles [ ]

Masks [ ]

Other [ ] (Specify) [ ].....

29. Does your organization have biosecurity orientation programs for new officers?

    Yes [ ] No [ ]

30. If yes, what biosecurity orientation programs exist for new officers? **(Choose all that apply)**

    Formal training at the hospital [ ]

    National Training MoH Hq [ ]

    Training by Biosafety Association [ ]

    International Training [ ]

    Other [ ] (Specify) [ ].....

31. Does your hospital have annual biosecurity awareness programs for all hospital staff and laboratory staff in particular?

    Yes [ ] No [ ]

32. If yes, what annual biosecurity awareness programs exist for all hospital staff and laboratory staff?

    Control of biological agents [ ]

    Leakage detection mechanisms [ ]

    Response to leakages [ ]

    Other [ ] (Specify) [ ].....

33. Are there measures/capacity in place to respond to biosecurity threat?

    Yes [ ] No [ ]

34. If yes, what measures/capacity are in place to respond to biosecurity threat within your facility/hospital? **(Choose all that apply)**

Drugs stockpiles [ ]

Well trained medical staff [ ]

Working equipment [ ]

Command and Control [ ]

Well Prepared [ ]

Not Prepared [ ]

Other (Specify) [ ].....

35. How quick do you respond to biosecurity threat incident in your facility i.e. what is the response period?

Within one hour of incident [ ]

Within one day of incident [ ]

Within one week [ ]

Do not know [ ]

Other (Specify) [ ].....

36. Does your hospital have quarantine/isolation rooms?

Yes [ ] No [ ]

37. If yes, how is quarantine/isolation achieved in managing the biosecurity threat? **(Choose all that apply)**

Adequate bed capacity [ ]

Presence of shelter rooms [ ]

Well-equipped response teams [ ]

Other (Specify) [ ].....

38. Which of the following drug stockpiles within your facility are enough? **(Choose all that apply)**

    Broad-spectrum antibiotics [ ]

    Antiviral [ ]

    Anti-protozoan [ ]

    Anti-poison [ ]

SECTION D: ENHANCING MITIGATION MEASURES TO BIOSECURITY THREAT

39. In your facility do you have biosecurity risk management office?

    Yes [ ] No [ ]

40. Does your hospital have designated emergency and planning operation centre?

    Yes [ ] No [ ]

41. If yes, is their incident management system committee in place?

    Yes [ ] No [ ]

42. Are there reporting and information management system in place on biological agent in your facility?

    Yes [ ] No [ ]

43. If yes in 23 above, state the types of information system in place?

    Biological detection system [ ]

    Biological agents' database [ ]

    Incident registry/Inventory [ ]

    General hospital database [ ]

Other [ ] (Specify) [ ].....

44. Have the hospital staff trained on biosecurity incident management?

Yes [ ] No [ ]

45. If yes, how often does the training take place?

Once in two years [ ]

Once a year [ ]

Twice a year [ ]

No training at all [ ]

46. Are existing biosecurity guideline and procedures in hospital enforced effectively?

Yes [ ] No [ ]

47. If yes, how effective has the compliance of biosecurity guidelines and procedures been in the hospital?

Very effective [ ]

Effective [ ]

Not effective [ ]

I don't know [ ]

48. If not effective, what can be done to improve the situation?

……

49. What are the challenges faced in responding to biosecurity threat? **(Choose all that apply)**

No Protective gear [ ]

No policy guidelines [ ]

No training [ ]

No skill and knowledge [ ]

No drugs [ ]

Have not come across any case [ ]

Other (Specify) [ ]……

50. In your opinion, what are the features of a better prepared hospital to biosecurity threats?

Better training [ ]

Installation of biometrics at sensitive sites [ ]

Installation CCTV camera [ ]

Vetting of certain personnel [ ]

Securitization of key health sites [ ]

Do not know [ ]

51. How can the challenges faced in responding to biosecurity threat be solved?

……

……

……

……

Appendix III: Key Informant Interview Guide for Government ministry officials

Title: Effects of Bio-Security Preparedness Capacity on Response to Medical Disasters at Garissa Level Five Hospital in Garissa County, Kenya.

INSTRUCTIONS

Please tick in the boxes provided after each question and write your answers in the space provided. If the provided spaces are not enough use the back of the same page to write your response.

SECTION A: PERSONAL DATA

Please answer the questions in this section by ticking the boxes provided and also writing in the spaces provided.

Ministry/Organization/department…….

Gender: Male [ ] Female [ ]: Tick Appropriately.

1. What is effectiveness of existing biosecurity regulatory frameworks in Kenya?
2. What is the level of preparedness to biosecurity threat at Garissa level five hospital in Garissa County, Kenya?
3. What is the response capacity to medical disasters/biosecurity threat at Garissa level five hospital in Garissa County, Kenya?

Thank you for your time – The end!!

Appendix IV: Hospital Observation Checklist

Observation checklists for the Garissa level five hospital facility include:

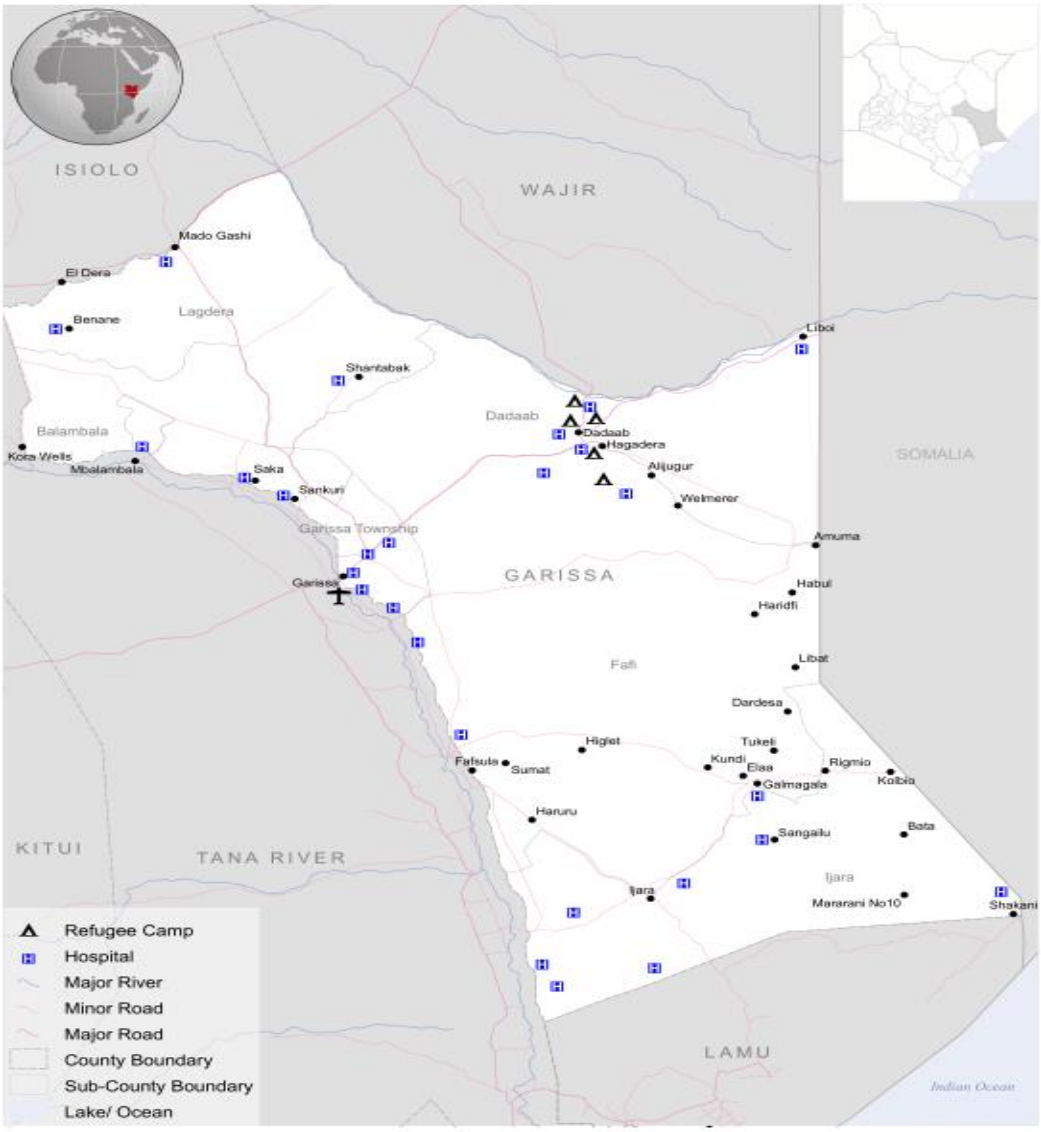
1. Presence of 24hrs private security guard seen? Yes [ ] No [ ]
2. Laboratory visitors' book present and visitors properly documented? Yes [] No [ ]
3. Are there visitor escort procedure system observed? Yes [ ] No [ ]
4. Is access to laboratory facility controlled? Yes[ ] No [ ]
5. Staff ID displayed? Yes [ ] No [ ]
6. Is there CCTV camera installed covering both exterior and interior? Yes [ ] No [ ]
7. Laboratory building has secure locking system and keys with designated person? Yes [ ] No [ ]
8. Biological agent storage and freezers locks observed? Yes [ ] No [ ]
9. Is visible, accessible fire extinguisher and fire alarm system in place? Yes [] No[]
10. First Aid Kit box observed? Yes [ ] No [ ]
11. Working areas: (a) Hand-washing sinks present? Yes [ ] No [ ]; (b). Have clearly labeled and chemical resistant shelves? Yes [ ] No [ ]
12. Well-lit and ventilated laboratory observed? Yes [ ] No [ ]
13. SOP and guidelines toolkits seen? Yes [ ] No [ ]
14. Color-coded waste disposal seen? Yes [ ] No [ ]
15. Sharp Box available? Yes [ ] No [ ]
16. Waste decontamination done? Yes [ ] No [ ]
17. Availability of: (a) Eye splashes and wash stations seen? Yes [ ] No [ ] (b). Eye goggles seen? Yes [ ] No [ ], (c). Gloves reaching upto elbows seen? Yes[ ]No [ ]
18. Functional autoclave seen Yes [ ] No [ ]

19. Biohazard warning seen? Yes [ ] No [ ]

20. Food consumed in the lab seen during visit? Yes [ ] No [ ]

21. Leakage, theft or biological occurrences incident book seen? Yes [ ] No [ ]

Appendix V: Map of the Study Area



Source: UNOCHA Garissa County Reference Map (2013).

Appendix VI: NACOSTI Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **115135**

Date of Issue: **09/June/2020**

RESEARCH LICENSE

This is to Certify that Mr.. HASSAN ADAN JIMALE of Africa Nazarene University, has been licensed to conduct research in Garissa on the topic: Effects of bio-security preparedness capacity on response to medical disasters at Garissa Level Five Hospital, Garissa County, Kenya for the period ending : 09/June/2021.

License No: **NACOSTI/P/20/5129**

115135

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix VII: University Research Approval Letter

AFRICA NAZARENE
UNIVERSITY

26th May 2020

RE: TO WHOM IT MAY CONCERN

Hassan Adan Jimale (19J03DMGP044) is a bonafide student at Africa Nazarene University. He has finished his course work and has defended his thesis proposal entitled: - ***"Effects of Bio-Security Preparedness Capacity on Response to Medical Disasters at Garissa Level Five Hospital in Garissa County, Kenya".***

Any assistance accorded to him to facilitate data collection and finish his thesis is highly welcomed.

Rodney T. Reed

Rodney Reed, PhD.
DVC Academic & Student Affairs.

Appendix VIII: County Government – Ministry of Health Approval Letter

COUNTY GOVERNMENT OF GARISSA

MINISTRY OF HEALTH

Tel: +254 020 2000 133/+254718799270
E-mail: info@healthgarissa.go.ke
abduldm45@gmail.com

County Health Headquarters
P O Box 40-70100
GARISSA-KENYA

When replying please quote
Ref No: CGG/CDHA/VOL. I (46)

26th May 2020

TO:
HASSAN JIMALE
(19JO3DMGP044)
AFRICA NAZARENE UNIVERSITY
P O Box 53067 - 00200
NAIROBI

Dear Hassan

RE: AUTHORIZATION TO CONDUCT RESEARCH IN GARISSA COUNTY

Approval has been granted for you to conduct the research on *"Effects of bio-secu preparedness capacity on response to medical disasters at Garissa Level Five Hospital, Ga County,"* in accordance with the request letter dated **26th May 2020.**

Upon completion of the study, the investigator shall provide a summary of findings as we pragmatic recommendations if any, to the County Department of Health.

For any information or data required, kindly liase with **Mr. Abdi Shale Abdi Tel No. 0720756720** or **Yussuf Ali Hassan Tel No. 0727350430.**

Any assistance accorded to him will be highly appreciated.

Thank you.

COUNTY HEALTH ADMINISTRATION & SANITATION

Abdullahi Daud.
Director of Health Administration and Finance.
Garissa County

Copy to

- Deputy Director Policy Planning
- County Research Coordinator
- Medical Superintendent – Garissa County Referral Hospital