IMPLEMENTATION OF INFECTION PREVENTION AND CONTROL MEASURES AGAINST NOSOCOMIAL TUBERCULOSIS AMONG HEALTHCARE WORKERS IN MUHORONI SUB-COUNTY, KISUMU COUNTY, KENYA.

BY

ODINI VINCENT ADEN

A THESIS SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, COLLEGE OF HEALTH SCIENCES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH (MPH)

MOI UNIVERSITY

JUNE, 2018.

DECLARATION

Declaration by the candidate

This thesis is my original work and has not been presented for the award of a degree in any other university. No part of this thesis may be reproduced without the prior written permission of the author and/or Moi University.

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

Odini Vincent,

SPH/PGH/06/11

Declaration by the Supervisors

This thesis has been submitted for examination with our approval as University Supervisors.

Signature: ……..... Date: ……..

Professor Lameck Diero,

Department of Internal Medicine,

School of Medicine,

Moi University,

Eldoret, Kenya.

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

Professor David Ayuku,

Department of Behavioural Sciences and Ethics,

School of Medicine,

Moi University,

Eldoret, Kenya.

DEDICATION

This work is dedicated to my parents; my father Cephas Odini and my mother Serah Odini. It is also dedicated to everyone who supported me in one way or another during its development.

ACKNOWLEDGEMENT

First and foremost, I would like to express my gratitude to the almighty God for the far I have come. I would like to appreciate my parents for their constant moral and financial support, their prayers, mentorship and guidance. I would also like to thank my siblings Larissa and Lynda for their unfailing love and support.

I am greatly indebted to my supervisors, Professor Lameck Diero and Professor David Ayuku for their constant encouragement, advice, constructive criticism and valuable suggestions throughout the development of this work.

I appreciate the support, co-operation and information I received from the County Director of Health, Kisumu County, Dr. Dickens Onyango. I am also grateful to the SCMOH for Muhoroni Sub-County, the Facility in Charges and all staff serving at the health facilities which I visited within the Sub-County.

I would like to recognize my classmates, for the mutual support, peer uphold and encouragement. I wish to specially thank my colleagues Faiza and Alfred.

Finally, I would like to appreciate the informative lessons and advice from my lecturers at Moi University School of Public Health.

May God Bless you all.

ABSTRACT

IMPLEMENTATION OF INFECTION PREVENTION AND CONTROL MEASURES AGAINST NOSOCOMIAL TUBERCULOSIS AMONG HEALTHCARE WORKERS IN MUHORONI SUB-COUNTY, KISUMU COUNTY, KENYA.

Background: Transmission of tuberculosis in healthcare settings to both patients and healthcare workers (HCWs) has been reported from virtually every country of the world, regardless of local TB incidence (Baussano et al., 2011). TB is mainly caused by *Mycobacterium tuberculosis.* The rate of nosocomial transmission of TB has increased commensurate with the evolving HIV epidemic. There are three levels of TB infection prevention and control (TB-IPC) measures at the health facility setting. The three levels are administrative control measures, environmental control measures, and personal protective measures in order of priority.

Objectives: The broad objective was to assess implementation of TB-IPC measures among HCWs at health facilities in Muhoroni sub-county. The specific objectives were to evaluate the implementation of administrative, environmental and personal protective TB-IPC measures, to determine the factors associated with implementation of TB-IPC measures and to determine if the HCWs had any training on TB-IPC.

Methods: The study was carried out in Muhoroni sub-county in Kisumu County, Kenya. A descriptive cross-sectional study design was used. Sample size was calculated using the Fisher's formula. Subsequently, Mugenda and Mugenda's correction formula was applied. Multistage sampling was used which involved application of purposive, proportionate and simple random sampling. Data was collected using two interviewer administered questionnaires and an observation checklist. Data analysis was done using standard statistical software, R. Categorical variables were summarized as frequencies and corresponding percentages. Continuous variables were summarized as mean, corresponding standard deviation, median and inter quartile range (IQR). Association between categorical variables was assessed using Fisher's exact test and Wilcoxon rank-sum test.

Findings: Slightly more than half, 82 (58.6%) of the HCWs routinely asked patients about cough upon entering the facility. Out of the 15 facilities, 10 (66.7%) had a TB-IPC plan present. Close to half, 63 (45.0%), of the respondents kept the windows open sometimes when examining patients with 5 (3.6%) reporting that they never kept them open. A significant proportion of HCWs reported not to wear an N-95 respirator while only 65 (46.4%) wore a lab coat while working at the facility. Slightly over two-thirds, 95 (67.9%), reported to have ever received training on TB-IPC. Statistical analysis revealed that the support staff were less likely to implement TB-IPC measures compared to other cadres. HCWs at the FBOs/Mission hospitals were more likely to implement TB-IPC measures compared to those serving at the dispensaries.

Conclusion: Implementation of administrative, environmental and personal protective IPC measures by HCWs in Muhoroni sub-county was found to fall short of the recommended standards in the National TB-IPC guidelines. The proportion of HCWs who had received training on TB-IPC was inadequate. HCWs serving at the larger facilities were more likely to implement TB-IPC measures compared to their counterparts at the lower level facilities.

Recommendations: At individual level, there is need for HCWs to be provided with more education on TB-IPC. Each health facility should have a TB-IPC plan and a functional TB-IPC committee. At policy level, implementation of the National TB-IPC guidelines across the country should be enforced and evaluation done on a regular basis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ACH	Air changes per hour
AFB	Acid Fast Bacillus
AIDS	Acquired Immune Deficiency Syndrome
AIIR	Airborne Infection Isolation Room
BCG	Bacille Calmette Guerin
BSCII	Biological Safety Cabinet class II
CDC	Centers for Disease Control and Prevention
CME	Continuous Medical Education
CNR	Case Notification Rate
CO	Clinical Officer
DLTLD	Department of Leprosy, Tuberculosis and Lung Diseases
DOTS	Directly Observed Treatment Short course
EPI	Expanded Program on Immunization
HAI	Hospital Acquired Infection
HCWs	Health Care Workers
HEPA	High Efficiency Particulate Air filters
HIV	Human Immunodeficiency Virus
IEC	Information Education and Communication
IGRAs	Interferon Gamma Release Assays
ILO	International Labour Organization
IPC	Infection Prevention and Control
IPT	Isoniazid Preventive Therapy
IQR	Interquartile Range
IREC	Institutional Research and Ethics Committee

IUATLD	International Union against Tuberculosis and Lung Disease
KNBS	Kenya National Bureau of Statistics
LMICs	Low and Middle Income Countries
LTB	Latent Tuberculosis
LTBI	Latent Tuberculosis Infection
MDG	Millennium Development Goals
MDR	Multi-Drug Resistant
MDR-TB	Multi-Drug Resistant Tuberculosis
MO	Medical Officer
MOH	Ministry of Health
MoPHS	Ministry of Public Health and Sanitation
MOSS	Ministry of Health and Social Sciences
MTB	*Mycobacterium tuberculosis*
NACC	National AIDS Control Council
NIOSH	National Institute of Occupational Safety and Health
NLTP	National Leprosy and Tuberculosis Program
PEPFAR	President’s Emergency Plan for AIDS Relief
PHO	Public Health Officer
PLWHA	People Living with HIV/AIDS
PPD	Purified Protein Derivative
PRP	Personal Respiratory Protection
PTB	Pulmonary Tuberculosis
QFT-GIT	Quantiferon Tuberculosis Gold in Tube assay
SCH	Sub-County Hospital
SCMOH	Sub-County Medical Officer of Health

SCTLC	Sub-County Tuberculosis and Leprosy Coordinator
SPSS	Statistical Package for Social Sciences
TB	Tuberculosis
TBI	Tuberculosis Incidence rate
TBIS	Tuberculosis Information System
TB-IPC	Tuberculosis Infection Prevention and Control
TST	Tuberculin Skin Test
UNAIDS	United Nations Joint Programme on HIV and AIDS
USA	United States of America
USFDA	United States Federal Drug Agency
UVC	Ultraviolet Cleaner
UVGI	Ultraviolet Germicidal Irradiation
VCT	Voluntary Counselling and Testing
WHO	World Health Organization
XDR-TB	Extensively Drug-Resistant Tuberculosis

OPERATIONAL DEFINITION OF TERMS

Healthcare Worker – A worker who delivers services at a health facility and has direct contact with tuberculosis patients or with the patients' body substances during diagnosis. For the purposes of the study, the healthcare workers have been categorized into six cadres as follows: medical officers, clinical officers, nurses, public health officers, social workers and support staff.

Support staff – A worker who serves at a health facility by providing additional healthcare services which complement the clinical care given to the patient. Support staff in the study include cough monitors, social workers, nutritionists, adherence counsellors, pharmaceutical technicians, records clerks and janitors.

Health Facility – A healthcare centre where healthcare services are offered. In the study, the health facilities offer both tuberculosis diagnostic and treatment services.

Infection Prevention and Control Measure – Any intervention put in place by healthcare workers to prevent the transmission of tuberculosis in the health facility setting.

Nosocomial – Hospital acquired infection. In the study, it refers to tuberculosis which is transmitted to healthcare workers while serving at their workstations.

CHAPTER ONE

INTRODUCTION

1.1. Introduction

Transmission of tuberculosis (TB) in healthcare settings to both patients and Healthcare workers (HCWs) has been reported from virtually every country of the world, regardless of local TB incidence (Baussano et al., 2011). The nosocomial transmission of multi-drug resistant TB (MDR-TB) and extensively drug resistant TB (XDR-TB) further highlights the need for effective TB infection prevention and control (TB-IPC) measures (Nodieva et al., 2010; Basu et al., 2007). Occupational tuberculosis can lead to the loss of skilled workers and impact health care service adversely, which has serious consequences in association with recent spread of MDR-TB strains (Joshi et al., 2006).

Tuberculosis remains a serious health problem in many countries (WHO, 2013). HCWs have higher exposure to TB than the general population and therefore have an occupational risk for TB infection. TB-IPC aims to reduce the transmission risk in healthcare facilities and to lower the risk of infection for HCWs, patients and other facility users. Control programs to prevent nosocomial TB should be established in hospitals to reduce the risk for HCWs. In TB high burden countries, however, occupational risk for TB has often been neglected and concealed by the high prevalence in the general population (Joshi et al., 2006).

Tuberculosis remains a public health challenge in Kenya. In 2007, 116,729 new TB cases were reported. The impact of the HIV epidemic and increasing prevalence of drug-resistant disease on the picture of TB today, have highlighted the urgency of addressing TB-IPC practices in all settings where diagnosed and undiagnosed TB patients receive care or other services (DLTLD-Kenya, 2009).

1.1.1. Background Information on Tuberculosis

Tuberculosis is mainly caused by *Mycobacterium tuberculosis* and the main source of infection is untreated smear-positive Pulmonary Tuberculosis (PTB) patients discharging the bacilli. It mainly spreads through the airborne route when the infectious patient expels droplets containing the bacilli. It can also be transmitted by consumption of raw milk containing *Mycobacterium bovis* (Harries & Dye, 2006).

Tuberculosis mostly affects young adults in their most productive years. However, all age groups are at risk. About one-third of the world's population has latent TB (LTB), which means that they have been infected by TB bacteria but are not (yet) ill with disease and cannot transmit the disease. People infected with TB bacteria have a lifetime risk of 10% of falling ill with TB (WHO, 2012).

HCWs are thus more likely to have latent TB due to the nature of their work which exposes them to patients who may be highly infectious when they visit the health facilities seeking for medical care. The lifetime risk of developing active TB is 5 - 10 % according to a study by Harries & Dye, (2006). Other studies, however, revealed that it could be higher because of the underlying conditions like HIV infection, diabetes and other medical conditions that suppress immunity as well as poor socioeconomic status (Federal Ministry of Health of Ethiopia, 2006).

The prevalence of TB is on the increase globally and in 2009, the estimated number of TB cases was 14 million with 1.3 million annual deaths. The Sub-Saharan Africa region recorded the highest deaths. In South Africa, the prevalence of TB infection is the highest in the world; 511cases/100,000 population (WHO, 2010). A study conducted in Cape Town, South Africa among the general population revealed that in every third taxi which is a major means of mass transport system in South Africa,

there is a TB patient. In Sub-Saharan Africa, HIV and TB have combined to fuel a sub-epidemic MDR-TB and XDR-TB outbreak (Gandhi et al., 2006).

HCWs have an increased risk of acquiring TB as they are exposed to the disease in their community as well as at their place of work (Baussano et al., 2011, Joshi et al., 2006, Menzies et al., 2007). In South Africa, workplace acquired TB is an important occupational disease among HCWs. According to the 2006 compensation fund claims, TB in HCWs, whilst generally underreported, is the third most commonly reported occupational disease in South Africa (South African Department of Labour, 2006). A review of the data submitted to the Compensation Commissioner, by HCWs, regarding hospital acquired infections from January 2007 to December 2009 in the Limpopo Province of South Africa found that TB was the most common hospital acquired infection (HAI); with 47 (83.9 %) of the 56 reported cases of infectious diseases being TB cases (Malangu & Legothoane, 2013).

In 2008, Kenya was ranked 13th among the 22 countries with high TB burden globally (WHO, 2008). The number of reported TB cases had increased tenfold from 11,625 in 1990 to 116,723 cases in 2007 but slightly declined to 103,981 in 2011 (DLTLD-Kenya, 2011). The average annual increase over the 10 years preceding 2011 was 4% for all forms of TB. However, in the last 5 out of the 10 years, there was an annual decrease of about -2%. Case Notification Rates (CNR) increased from 53/100,000 population for all forms of TB and 32/100,000 population for sputum smear-positive PTB cases in 1990 to 264/100,000 population and 94/100,000 population respectively in 2011 (DLTLD-Kenya, 2011).

1.1.2. Tuberculosis in the Era of HIV/AIDS

The rate of nosocomial transmission of TB to HIV- infected patients and to HCWs has increased commensurate with the evolving HIV epidemic (O' Donnell et al., 2010; Joshi et al., 2006). This increase is invariably correlated with weak IPC practices (Gandhi et al., 2010). There has long been a call for better TB-IPC practices in high HIV and TB prevalence settings. Unfortunately, in many contexts, TB-IPC remains a neglected issue.

The Sub-Saharan African region has remained the epicenter of the twin epidemics of HIV/AIDS and TB and bears a disproportionate burden in the morbidity and mortality attributable to both diseases globally. Though the region constitutes only 11% of the world's population, it harbored 29% of the global TB burden and 34% of related mortality by the end of the year 2006 (WHO, 2007).

The resurgence of TB worldwide is due, in part, to the emergence of HIV. This is of particular concern in South Africa, which has a longstanding HIV epidemic with an estimated prevalence of 17% which is among the highest in the world. It is estimated that in South Africa, up to 80% of individuals with TB are co-infected with HIV (UNAIDS, 2010; Gandhi et al., 2006).

Endemic HIV contributes to the spread of MDR-TB in South Africa (WHO, 2011). Currently, South Africa is the epicenter of an epidemic of MDR-TB and HIV, which in some cases originated and continues to spread in health care facilities (Gandhi et al., 2016). Nosocomial transmission of MDR-TB presents a serious occupational hazard for South African HCWs (Farley et al., 2012). Since HIV infection increases susceptibility to TB infection and disease, the high reported prevalence of HIV infection among South African HCWs (13–20%) further predisposes them to

occupationally acquired TB (Naidoo & Jinabhai, 2006; Menzies et al., 2007; Connelly et al., 2007). These HIV-infected HCWs have an increased risk for acquiring TB as well as for progressing from latent TB to active clinical disease (Kranzer et al., 2010).

By the mid-1990s, it was clear that the prevalence of HIV was high in Kenya, especially in the western districts bordering Lake Victoria. It was also known that HIV infection was an important risk factor for TB disease. In 1994, a survey of HIV infection in smear-positive TB patients was carried out. In a sample of 1364 TB patients from 17 districts, the median prevalence of HIV was 36% (26−45%; IQR). However, in some districts in Western Kenya, up to 80% of TB patients were HIV-positive (WHO, 2011).

The HIV epidemic has posed new challenges to the traditional approaches to TB control in Kenya. It is widely acknowledged that TB is the most common opportunistic infection and a leading cause of death in persons living with HIV/AIDS (PLWHA). Between 30% and 40% of PLWHA living in high burden TB settings will develop TB in their lifetime. Since a lot of patients visiting health care facilities have low immunity, and most of them are unaware, transmission of TB within health care settings is real. In addition, a considerably large number of HCWs could be infected with HIV or with TB and transmission to and from them is also real (DLTLD-Kenya, 2009).

1.1.3. Background Information on Infection Prevention and Control

Occupational infections particularly HAIs are a serious problem in the healthcare sector worldwide. They represent a risk to both patients and HCWs. It is estimated that between 5% and 10% of patients admitted to acute care hospitals acquire at least one infection. Over the last decade, the incidence has been documented to be

increasing particularly in the United States and Europe (Hopmans et al., 2007; Klevens et al., 2007; Pittet et al., 2008).

The risk of nosocomial transmission of TB is high in sub-Saharan Africa, where TB and HIV prevalence are high (Gandhi et al., 2006; O'Donnell et al., 2010). This risk is greater when larger numbers of infectious smear-positive TB patients are managed at health-care facilities that don't have effective IPC measures (WHO, 2009). Globally, standard precautions of IPC are considered an effective means of protecting HCWs, patients and the public and reducing nosocomial infections.

The United Nations Millennium Development Goals (MDG) 6, target 8 relating to TB, The Stop TB Global plan and the United States of America's President's Emergency Plan for AIDS Relief (PEPFAR) in partnership, targeted to reduce TB mortality and prevalence by half in 2015. Directly Observed Treatment Short Course (DOTS); an adherence enhancing and fundamental strategy has been implemented over the years in all TB centres with much success in TB control worldwide (WHO, 2010).

The first priority of TB-IPC at the healthcare facility setting is the use of administrative control measures (managerial and work practices). These prevent the generation of infectious droplet nuclei containing *M. tuberculosis* bacilli in order to reduce the exposure of the HCWs to airborne *M. tuberculosis.* This means ensuring early recognition of patients who are TB suspects or have confirmed TB disease, rapid diagnostic investigation of TB suspects, separation of potentially infectious TB patients from other patients, and prompt initiation of appropriate treatment (DLTLD-Kenya, 2009).

Environmental control measures that are used to reduce the concentration of droplet nuclei in the air are second in priority. These range from inexpensive methods such as maximizing natural ventilation, to more costly measures such as ultraviolet germicidal irradiation (UVGI). Protection of HCWs from inhaling infectious droplets through the use of personal protective equipment comes third in order of priority. Such infection control measures involve surgical or procedure masks for suspected and untreated patients and respirators for HCWs. It is important that these three levels of IPC are applied concurrently for them to be effective (DLTLD-Kenya, 2009).

However, risk of transmission remains high in low and middle- income countries (LMICs). In these countries, limited resources preclude widespread adoption of expensive interventions such as mechanical ventilation systems and ultraviolet lights (Menzies et al., 2007). Furthermore, even low-cost strategies to reduce TB transmission in healthcare facilities are seldom implemented (Pai et al., 2006).

In Kenya, serious concerns have been raised on IPC practices among HCWs due to lack of regular updates on current IPC practices. Studies have shown poor decontamination of instruments and ineffective IPC practices often lead to outbreaks of nosocomial infections (Muchina, P.W. & Muchina, E.N., 2009; Inyama et al., 2009).

1.1.4. Background Information on the Study Site

Muhoroni sub-county is one of the seven sub-counties that form Kisumu County. The study was carried out in 15 health facilities in the sub-county which offer both TB diagnostic and treatment services. The sub-county was selected for the study given the high prevalence of TB in the area mostly due to the high prevalence of HIV in the region. HIV prevalence in Kisumu at 19.9% was 3.4 times higher than the national

prevalence. Kisumu County contributed to 9.5% of the total number of people living with HIV in Kenya and was ranked third highest nationally. Furthermore, Kisumu County had the highest TB prevalence in the country at 360/100,000 population (NACC, 2016). The HCWs therefore face an increased risk of exposure to TB at their workstations given constant interaction with patients from the catchment which has high TB/HIV burden. Muhoroni sub-county was also chosen given the long distances from its health facilities to Kisumu City which is the hub for distribution of most medical supplies.

1.2. Problem Statement

Healthcare workers are at increased risk of TB infection and disease compared to the general population. The burden of TB coupled with the scarcity of trained HCWs places an additional burden on the healthcare work force. More than 50% of HCWs worldwide are estimated to be infected with latent TB and are estimated to have a two- to three-fold increased risk of developing TB disease and a five- to six-fold risk of developing drug resistant TB (O'Donnell et al., 2010). An investigation of TB among staff at a large urban hospital in Kenya found that, from 2001 through 2005, TB case rates among the staff were 2–3.5 times higher than rates in the general population (Dalal et al., 2006).

Nosocomial TB is a major concern for the safety of both HCWs and patients. Interest to eliminate TB transmission in health facilities is increasingly growing in importance. This is due to the association between TB and HIV and the emergence of multi-drug resistant TB and extensively-drug resistant TB. Nosocomial TB can lead to long term disabilities and additional financial burdens. The high cost of treatment has undesirable negative implications to HCWs and their families and can has the adverse

eventuality of death. Proper implementation of IPC measures must be a top priority for settings and institutions that are committed to providing quality and reliable healthcare.

In Kenya, there is a policy document which outlines guidelines on TB-IPC in healthcare settings but implementation of the same has not been emphasized upon. Enforcement and evaluation of the implementation of TB-IPC measures across the country has not been seriously undertaken. TB transmission in healthcare facilities can be significantly reduced with the implementation of effective TB-IPC measures. Considering the importance of safeguarding the health of HCWs at our health facilities, effective IPC against nosocomial TB is a major contemporary issue with urgent need to be addressed.

Studies conducted in multiple settings in sub-Saharan Africa have found that TB infection and disease occur frequently among HCWs. However, there is a gap in knowledge, more so in Kenya, with regard to the extent to which HCWs implement IPC measures and as to whether they have been adequately enlightened in the first place to be able to implement them. There is limited literature on these pertinent areas of concern within the country. The study sought to assess implementation of stipulated TB-IPC measures in Muhoroni sub-county which has a high TB/HIV disease burden. It therefore attempted to fill in the existing gaps and by doing so, contributed to the scientific body of knowledge.

1.3. Justification of the Study

Occupational TB has the potential to disrupt, if it is not already disrupting, the provision of quality healthcare services by HCWs. This is as a result of absenteeism, decreased morale and in extreme cases loss of HCWs. TB among HCWs is therefore

capable of worsening the existing health human resource problems of LMICs. The World Economic Forum has identified TB in the workplace as an important disruption to business and a cause for concern (World Economic Forum, 2008).

Several studies have documented the risk of TB transmission from patients to HCWs and from patients to patients in low, medium and high resource settings. However, there is limited empirical data on the implementation of the three priority areas of IPC by HCWs in healthcare settings in Kenya. This study aimed at evaluating the implementation of administrative, environmental and personal protective measures at health facilities based in Muhoroni sub-county. In addition, the study sought to identify factors associated with implementation of the IPC measures and to determine if the HCWs had received any training on TB-IPC.

The study was conducted in Muhoroni sub-county in Kisumu County which has a high prevalence of TB mostly due to the high HIV disease burden in the region. The findings of the study will facilitate informed decision making in formulating evidence based interventions where necessary. Subsequently, it will provide a basis for enforcing implementation of TB-IPC measures through relevant policies and guidelines besides providing an appropriate platform on which further related studies can be conducted in future.

1.4. Research Questions

1. What is the level of implementation of administrative, environmental and personal protective TB infection prevention and control measures among HCWs in Muhoroni sub-county?
2. What are the factors associated with implementation of TB infection prevention and control measures among HCWs in Muhoroni sub-county?

3. What training, if any, have the HCWs at health facilities in Muhoroni sub-county had on TB infection prevention and control?

1.5. Research Objectives

1.5.1. Broad Objective:

The broad objective of the study was to:

Assess the implementation of TB infection prevention and control measures among HCWs at health facilities in Muhoroni sub-county.

1.5.2. Specific Objectives:

The specific objectives of the study were to:

1. Evaluate the implementation of administrative, environmental and personal protective TB infection prevention and control measures among HCWs in Muhoroni sub-county.
2. Determine the factors associated with implementation of TB infection prevention and control measures.
3. Determine if the HCWs had any training on TB infection prevention and control.

1.6. Assumptions of the Study

The study was based on the following assumptions:

- The TB-IPC measures in place at health facilities in Muhoroni sub-county were inadequate and HCWs were at great risk of nosocomial TB.
- Poor administrative TB-IPC measures increased risk of HCWs being infected with TB at their workplace.
- Environmental TB-IPC measures were inadequate at the health facilities.

- Personal protective measures played a key role in TB-IPC.
- HCWs lacked any training on TB-IPC.
- It was possible to improve TB-IPC at healthcare facilities in Muhoroni sub-county if appropriate measures were taken.

1.7. Significance of the Study

Findings from the study offered vital information on TB-IPC measures at health facilities in Muhoroni sub-county besides making a positive contribution to the scientific body of knowledge. They will be useful in informing decision making towards improvement of TB-IPC measures in place at health facilities within the sub-county. The information can be used in the formulation of appropriate intervention strategies aimed at combating nosocomial TB among HCWs. It is also anticipated that the findings will form an appropriate platform for similar studies in the future.

1.8. Scope and Limitations of the Study

1.8.1. Scope

The study was limited to Muhoroni sub-county which is part of the larger Kisumu County, Kenya. It focused on implementation of TB-IPC measures at health facilities in the sub-county.

1.8.2. Limitations

The study assessed implementation of TB-IPC measures among HCWs in Muhoroni sub-county. Consequently, the findings cannot be generalized to HCWs serving at other health facilities across Kenya.

Data collected did not include follow up surveys and it is therefore unknown if improvement in implementation of TB-IPC measures by the HCWs would lead to less risk of nosocomial TB among them. Time for carrying out the research was also limited.

1.9. Chapter Summary

This chapter elaborated on background information on TB, the global TB situation, TB in the era of HIV/AIDS, situation of TB in Kenya and also on the study site which is Muhoroni sub-county in Kisumu County, Kenya. The chapter also presents the statement of the problem, justification, research questions and research objectives. Assumptions of the study as significance are also highlighted. The chapter concludes by outlining the scope and limitations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

Although the International Union against Tuberculosis and Lung Disease (IUATLD) and the World Health Organization (WHO) issued recommendations for IPC within health facilities, implementation of many of the recommended practices, such as engineering controls, are precluded by resource constraints. There is considerable interest in finding simple yet effective measures to prevent nosocomial TB in health care settings. Many multiple studies have documented the risk of TB transmission from patient to HCWs and from patient to patient in low, middle and high income resource settings (Joshi et al., 2006).

Nosocomial transmission of drug-resistant TB and the risk to HCWs has re-emerged in HIV endemic and resource limited settings in Eastern European countries (Sotgiu et al., 2009), the former Soviet Union (Woith et al., 2012) and South Africa (Pillay et al., 2012). Molecular epidemiology studies suggest that a high proportion of drug-resistant TB strains are primarily acquired through nosocomial transmission rather than secondary acquisition which is caused by treatment failure.

Tuberculosis IPC was found to be insufficient in most areas of China. With a high TB prevalence and limited resources, China focuses largely on case detection and treatment using the DOTS strategy. In some areas, even low-cost strategies to reduce TB transmission in healthcare facilities are seldom implemented (He, 2010). Based on the data collected by the Tuberculosis Information System (TBIS), Ministry of Health, Malaysia (2008), the incidence rate of active TB disease among HCWs was higher compared to the general population in 2003 until 2006 with the reported

incidence rate of 73.4-77.7 per 100,000 among HCWs and 60.3-62.6 per 100,000 in the general population respectively. There was an increasing trend in the number of HCWs diagnosed with active TB disease from 31 in 2002 to 123 in 2006 (MOH-Malaysia, 2008).

Despite the availability of national and international recommended TB control measures, Dara et al. (2015) indicated that hospitals in South Africa implemented inadequate IPC measures, which suggested that there was an ongoing substantial risk of TB transmissions in public hospitals. The National Department of Health's (NDOH) 2011 discovery, which indicated that more than half of all XDR-TB infections in South Africa were acquired in public hospitals confirmed the presence of this health risk. In addition, Robinson et al. (2007) reported that TB nosocomial infection was a serious cause of morbidity and mortality in children hospitalized for the treatment of TB in Cape Town, South Africa. Furthermore, Singh et al. (2007) found that lack of TB-IPC in institutions was a neglected yet significant factor fueling the MDR-TB and XD-RTB outbreaks in KwaZulu-Natal. Similarly, Tshitangano (2014) discovered that HCWs implemented ineffective TB control measures. The reasons for the adoption of ineffective TB control measures were not clear.

Healthcare workers in South Africa work under extremely difficult conditions. This is as a result of the challenges facing the healthcare system, including amongst others the shortage of HCWs across the board, increasing population, high burden of disease especially HIV and TB, and deteriorating healthcare infrastructure. The numerous challenges that faced HCWs would then suggest that the country's healthcare authorities were doing their utmost to create a conducive working environment for HCWs. This applied more so with regard to prevention of occupationally acquired TB

since it is a major public health problem in South Africa and requires vigilance (Ntshanga S. & Mabaso M., 2009) in the workplace. Within the healthcare system, the risk for occupationally acquired TB disease is even higher among HCWs co-infected with HIV in South Africa (Kranzer et al., 2010).

Transmission of TB in health care facilities constitutes a serious threat to HCWs and other facility users. TB-IPC measures are aimed at reducing TB transmission risk in health care facilities. Attention to the implementation of TB-IPC measures in health care facilities has increased in recent years due to the spread of MDR and XDR-TB in hospitals (Gandhi et al., 2006). The HIV epidemic and integration of HIV and TB services have further contributed to renewed attention for TB-IPC implementation (Bock et al., 2007).

2.2. Administrative Infection Prevention and Control Measures

Administrative measures include among others the establishment of relevant committees, the appointment of staff members to guide the infection control efforts, the provision and keeping of relevant registers, the development, implementation and review of tuberculosis control plans (Menzies et al., 2007). Closely aligned to the administrative measures are clinical control measures that aim to ensure that people with TB symptoms are promptly identified, separated and treated. These controls included the availability of a cough symptom check, the education of patients on coughing etiquette as well as the separation of suspected TB patients (Claasens et al., 2013).

2.2.1. Infection Prevention and Control (IPC) Plan

All health facilities are visited by patients with TB in their often prolonged process of seeking diagnosis and cure. All health facilities should therefore have a written IPC plan to ensure the stepwise implementation of TB-IPC measures and compliance with relevant work practices and SOPs. Facility risk assessment reports, resources and other guiding documents are needed to provide input to the IPC plan (MOSS-Namibia, 2014).

Each health facility should have a TB-IPC plan which outlines the strategy used to implement TB infection control activities. The plan should detail every step that needs to be taken in the facility to ensure that the administrative, environmental and personal protective controls are implemented. The plan should also name the person responsible for each intervention. The TB-IPC plan should be updated as the committee identifies necessary changes to ensure better IPC or when there are changes in staff members (HATIP, 2013).

All relevant stakeholders should be involved in the development and review of the TB-IPC plan. The plan should be implemented and monitored according to its recommendations. In certain settings, having a TB-IPC plan for TB alone might not be feasible so if the facility already has a TB-IPC committee, TB-IPC measures form part of the more general IPC plan (DLTLD Kenya, 2009).

2.2.2. Infection Control Committee

In the hospital, the first step in setting up a viable IPC programme is to set up an infection control committee. It is an essential administrative requirement for effective control of nosocomial infections. The infection control committee should be a

multidisciplinary team made up of representatives from different cadres of staff serving within the facility.

2.2.3. Patient Management

FAST Strategy

FAST is an IPC strategy which prioritizes rapidly diagnosing and putting patients on effective treatment. ***FAST***, which stands for **F**inding TB cases **A**ctively, **S**eparating safely, and **T**reating effectively, focuses HCWs on the most important IPC practices.

• **Finding TB Patients:** The most infectious TB patients are the undiagnosed cases who often transmit bacilli in the clinics and waiting areas, infecting HCWs, patients and other users of the facility. HCWs have to find, diagnose and effectively treat these patients in order to stop further transmission of TB.

• **Actively Finding Cases:** Undiagnosed patients with TB may present themselves to the health facility for reasons unrelated to TB. They may not mention cough, fever, night sweats or weight loss - symptoms which may or may not be associated with pulmonary TB. The FAST approach encourages health facilities to assign "cough monitors" to all waiting areas or entrance points to identify persons with symptoms suggestive of TB, such as a current cough.

• **Separating Safely:** While waiting for evaluation, patients identified by cough monitors should be separated temporarily from other patients in a well-ventilated area to prevent further spread of TB. The sputum must be collected outdoors and away from others, and tested promptly for TB.

• **Treating Effectively:** Prompt and effective treatment is an important step in preventing the transmission of TB. Patients become non-infectious soon after starting effective TB treatment (MOSS-Namibia, 2014).

2.2.3.1. Early Identification and Detection of Cases

Administrative measures aiming to diagnose, isolate and treat (presumptive) TB patients promptly are considered basic measures applicable to all facilities. However, some studies have identified several gaps in the diagnostic and treatment initiation process. HCWs do not necessarily test for TB in individuals presenting with respiratory symptoms (Boss et al., 2013).

Rates of nosocomial transmission appear to be highest when the diagnosis of TB in hospitalized patients is delayed, when patients are not receiving adequate therapy, or when there is unrecognized drug resistance. The most infectious TB patients are those with smear-positive pulmonary disease, and diagnosis should be performed as quickly as possible on all TB suspects.

2.2.3.2. Triage of Patients

Patients in special groups which include those known to be HIV positive, the very young and old should be given preference in care. Triaging symptomatic patients to the front of the line for the services should be done. In an integrated service delivery setting, known HIV patients should be separated from smear positive TB patients. Known HIV positive clients in the community should be frequently monitored for TB and referred promptly (DLTLD-Kenya, 2009).

In a study undertaken by Kagee, A. & Delport, T. (2010), findings revealed that it is important for IPC policies and practices to be reinforced among HCWs serving at health facilities in South Africa since long waiting times were common. Triaging and the rapid movement of TB suspects and known TB patients through the clinic helps to reduce the risk of transmission (Bock et al., 2007).

2.2.3.3. Separation and Isolation

Patients who are identified as TB suspects or cases by the screening questions should be directed to another separate room away from other patients. They should be requested to wait in a separate well-ventilated waiting area and provided with a surgical mask or tissues to cover their mouths and noses while waiting (DLTLD-Kenya, 2009). In hospitals with a transfer-out policy, there should be at least one separate, well-ventilated area (WHO, 2006) or a single room with the door closed, away from high-risk patients where patients can be maintained until they are transferred (Public Health Agency of Canada., 2013).

Implementing many of the recommended engineering controls is not feasible in most healthcare facilities because of the high cost of such measures which include negative-pressure isolation rooms. However, separation or segregation of smear-positive TB patients in rooms with simple mechanical exhaust ventilation like window fans could be feasible in some settings. At such centres, patients with infectious TB, especially XDR and MDR-TB, must not be admitted to the same wards as patients with HIV infection (Yuan et al., 2008).

Separation of TB patients reduces the time during which these patients share the same waiting room or ward with other facility users. This measure therefore reduces the risk of TB transmission. It is therefore recommended that patients with presumptive TB be prioritized for attention before other patients. This reduces the time TB patients spend in the facility, which is considered an important TB-IPC measure (WHO, 2009).

Delayed diagnosis occurs in almost half of all hospitalized patients in whom respiratory TB disease is subsequently detected. This often results in significant

exposure for HCWs and other patients. Certain locations within the hospital, such as emergency departments, are a frequent point of first contact with the healthcare system for people with undiagnosed respiratory TB disease (Beggs et al., 2010).

In a study carried out by Buregyeya et al. (2013), it was mentioned that there was reluctance among HCWs to screen for patients with cough and separate them from others. Some HCWs reported that they were hesitant to tell a patient that they were suspecting TB and separate them from other patients when the TB diagnosis was not confirmed. Others felt that asking for cough at the reception point was part of history taking which should be done in the consultation room and not in public like in the waiting area. TB suspects were left seated with the other patients until it was their turn to go into the consultation room on a 'first come first serve' basis.

Lack of TB isolation wards means that infectious patients are placed together with non-infectious ones. Basu et al. (2007), revealed that in South Africa, non-XDR TB patients were frequently admitted to the wards with other patients who had TB disease thus putting them at risk of contracting super nosocomial infection in the form of XDR-TB. WHO (2014) stressed that placing potentially infectious TB patients in same areas with other patients without TB, especially those who are immune-compromised (for example AIDS, diabetes or babies), posed an increased risk of transmitting TB infection. Similarly, public health experts cited in Amon et al. (2015) noted that holding MDR and XDR-TB patients in overcrowded hospitals with inadequate ventilation increases the risk of nosocomial TB. WHO (2014) emphasizes that when an infectious TB patient is isolated, movement and transportation should be limited.

2.2.3.4. Diagnosis and Referral

Tuberculosis diagnostic tests should be done onsite or, if not available onsite, the facility should have an established link with a TB diagnostic and treatment site to which symptomatic patients can be referred (DLTLD-Kenya, 2009**).** Unfortunately, Presumptive TB patients are often not separated from other patients. After tests confirm TB diagnosis, treatment is not always initiated promptly (Claasens et al., 2013).

2.2.3.5. Discharge Plan

For inpatient and outpatient settings, a discharge plan should be coordinated with the patient. This may include a patient who is a HCW with TB disease. The TB-control program of the local, district or provincial health facilities should be involved too. If applicable, co-management of patients with HIV or other diseases should be coordinated with the applicable local, district or provincial health facilities. For MDR-TB, trained HCWs should be identified in referral sites who will be able to manage the patient according to the national MDR-TB guidelines (DLTLD-Kenya, 2009).

2.2.3.6. Health Education

To minimize the spread of droplet nuclei, any coughing patient with a respiratory infection – in particular, patients with or suspected of having TB – should be educated in cough etiquette and respiratory hygiene. This entails the need to cover their nose and mouth when sneezing and or coughing. Cough etiquette also reduces transmission of larger droplets, hence contributing to control of other respiratory infections. Such etiquette also applies to HCWs, visitors and families. Physical barriers can include a piece of cloth, a tissue or a surgical mask which should be properly disposed of as part of respiratory hygiene practice. If such physical barriers are not available, best

practice suggests that the mouth and nose should be covered with the bend of the elbow or hands, which must then be cleaned immediately. There should be a strong focus on behaviour-change campaigns for this recommendation (WHO, 2009).

2.2.4. Surveillance for TB among HCWs

The surveillance for TB among HCWs is recommended by the WHO for IPC programs (WHO, 2009). It is necessary for IPC and occupational health (OH) services to collaborate to ensure that HCWs receive routine screening for TB and to better protect HCWs and patients. Increasing the proportion of HCWs who receive regular TB symptomatic screening may improve case finding among this at risk population and thus reduce transmission.

Although the incidence of TB may be declining in many countries, there remains a risk of transmission in hospitals due to delayed diagnosis, inadequate facilities and also, in some countries, an increasing proportion of HCWs (Choudhary et al., 2006). Unfortunately, in Iran, there is no TB-IPC program for HCWs. Previously, there was a need for more emphasis on TB control measures and regular staff screening (Hashemi et al., 2008). Current study results have raised alarm for the need of appropriate interventions.

Most high-income countries screen HCWs periodically for latent tuberculosis infection (LTBI) as part of their TB-IPC program (Jensen, 2005). However, this practice is unusual in most LMICs. For many years the tuberculin skin test (TST) was the only test available for diagnosis of LTBI. However, the Interferon Gamma Release Assays (IGRAs) and T-cell based assays have recently become available and provide alternative diagnostic test for LTBI. Two commercially available IGRAs have been approved for use by the United States Federal Drug Agency (USFDA). They are

the Quanti- Feron-TB Gold In-Tube (QFT-GIT) assay and the T-SPOT TB assay. IGRAs have several advantages over the TST: they require only one visit, are not affected by BCG vaccination. They also have less cross-reaction with non-tuberculous mycobacteria, are less subjective in measuring results and can be repeated without boosting. However, there is a lack of data on how IGRAs perform when used for serial testing, especially in LMICs.

However, new data suggested that IGRAs hold promise for serial testing of HCWs and can overcome some of the limitations of serial tuberculin testing (Pai et al., 2006). A recent study in India showed that in a setting with intensive nosocomial exposure, HCWs had strong interferon-gamma responses that persistently stayed elevated even after treatment for latent infection (Pai et al., 2006). Persistence of infection or re-exposure might account for this phenomenon.

Surveys of HCWs using IGRAs in other high burden countries, such as India, Russia and Viet Nam have also found high TB prevalence rates ranging from 40% to 47%. A survey in the Republic of Georgia found a prevalence of 60% (Drobniewski et al., 2007; Lien et al., 2009). Surveys of HCWs in LMICs employing international standard purified protein derivative (PPD) have found TB prevalence ranging from 33% to 79% (Joshi R et al., 2006). Limited data comparing IGRA with TST results in high-burden countries suggested that IGRA testing generally results in similar prevalence estimates (Zwerling et al., 2012). Use of IGRAs among HCWs is limited by high conversion and reversion rates, which are important considerations in serial testing scenarios (Zwerling A et al., 2012). Data is sparse on the added value of IGRAs in predicting active TB beyond that of TST (CDC, 2010).

2.2.5. HIV status of HCWs

There is no clear evidence that people infected with *M. tuberculosis* are more infectious if they are co-infected with HIV. However, there will often be rapid development of active TB disease. Moreover, HIV-related TB disease will often have atypical clinical manifestations, leading to delayed diagnosis (Crofts et al., 2010).

In a sample of hospital-based HCWs in Kwa Zulu-Natal, South Africa, HIV infection was the strongest independent risk factor for active TB disease. This finding supported previous findings from a sample of HCWs in Kenya (Galgalo et al., 2008). HIV is a well-known risk factor for TB, especially in persons with latent TB infection (LTBI) or who have been newly infected with TB. Furthermore, it is estimated that the risk for TB is up to 20 times greater in those living with HIV, thus placing HCWs living with HIV at a much greater risk for active TB (Getahun et al., 2010; Granich et al., 2010).

Hospitals should consider setting up occupational health and safety services. This includes confidential voluntary counselling and a package of care for persons who are found to be HIV-positive. At the very least, HIV-positive HCWs should not work in either general wards or TB wards, but in safer parts of hospitals. HCWs posted to general medical wards or TB wards, and laboratory staff that work with mycobacterial specimens could be offered confidential HIV testing with pre and post-test counselling. If diagnosed HIV-seropositive, they should be moved to other safer areas within the hospital. Laboratory staff should be transferred from mycobacterial work.

Healthcare workers and community members should be encouraged to know their HIV status. This could be achieved through providing accessible, acceptable and confidential VCT, including periodic retesting to staff. HIV-infected healthcare

providers and the community members are at increased risk of developing TB disease if exposed in the workplace, and additional precautions should be taken to protect them. Immuno-compromised HCWs should be given opportunities to work in areas with a lower risk of exposure to TB and should be provided with isoniazid preventive therapy (IPT) where indicated (DLTLD-Kenya, 2009).

2.3. Environmental Infection Prevention and Control Measures

Environmental control measures are about methods that are used to reduce the concentration of infectious agents in the air, and the methods to control the direction of potentially infectious air. They are related to the buildings' design and construction. Some of these measures include adequate ventilation systems, airflow and air circulation directing systems as well as ergonometric postures taken by HCWs in relation to airflow, and the existence of windows and ultraviolet irradiation equipment. The measures are strongly recommended for the prevention of the spread of TB within health facilities by the National Department of Health of South Africa (NDOH, 2011).

Health care workers are at increased risk of TB infection and disease compared to the general population. Other patients, non-medical staffs in health care settings are also at risk. Health care settings especially presenting risk of TB transmission include those where undiagnosed pulmonary TB patients with cough are in close contact with patients and HCWs. Overcrowding and poorly ventilated environments increase this risk. Waiting rooms or corridors where patients wait to receive medical care including medical wards where undiagnosed TB patients lie are often areas of particular risk (DLTLD-Kenya, 2009).

2.3.1. Ventilation

In hospitals, clinics, community care centres and correctional facilities where people congregate and share indoor air (in the same room or via the building ventilation system), the risk of *M. tuberculosis* transmission can be increased if ventilation and other IPC measures are inadequate. In addition, exposure to people with active, undiagnosed and untreated respiratory TB disease has resulted in high rates of positive TST results in HCWs (Menzies et al., 2007). Reported TB outbreaks within health care facilities are often due to failure to implement appropriate TB-IPC measures. These observations have heightened concerns and resulted in the formulation of recommendations for the prevention of health care associated transmission of *M. tuberculosis* to HCWs, patients and visitors (Public Health Agency of Canada., 2007).

The type of environmental control measures for each facility will depend on the design of the facility, climate of the area, socioeconomic status of the catchment population, patient load, and available resources. In order to maximize the benefits, efforts to improve ventilation should involve consultation with a person trained in environmental control measures and TB-IPC. Necessary environmental control measures should be included in the IPC plan (DLTLD-Kenya, 2009).

Adequate ventilation in health-care facilities is essential for preventing transmission of airborne infections, and is strongly recommended for controlling spread of TB. The choice of ventilation system should be based on assessment of the facility and informed by local programmatic, climatic and socioeconomic conditions. In health-care facilities that have natural ventilation, effective ventilation should be achieved by proper operation and maintenance on a regular schedule. Simple natural ventilation may be optimized by maximizing the size of the opening of windows and locating

them on opposing walls. Well-designed, maintained and operated fans which offer mixed-mode ventilation can help to obtain adequate dilution when natural ventilation alone cannot provide sufficient ventilation rates (WHO, 2009).

It should be noted that working with open doors and windows has its challenges. HCWs keep doors closed for patient privacy. In some cases, the windows cannot always open, as other studies also found (Buregyeya et al., 2013). Weather conditions and security are also relevant considerations when working with open doors and windows. Nevertheless, natural ventilation has good potential to reduce airborne transmission at little cost (Escombe et al., 2007).

Ventilation recommendations for airborne infection isolation rooms (AIIRs) and select areas in hospitals are of critical importance because of their impact on reducing the risk for health care associated transmission of *M. tuberculosis*. Increasing air changes per hour (ACH) from 1 ACH to 6 ACH will result in four to five times more rapid clearing of infectious microorganisms from the air within a room. However, further increases above 6 ACH will have progressively less effect, and increases above 12 ACH may provide minimal additional benefit (Beggs et al., 2010). In general, as air exchange rates are increased, there are increased costs for building and maintaining the ventilation system (Knibbs et al., 2011).

Formerly known as a negative pressure isolation room, an AIIR is a single occupancy patient care room used to isolate persons with a suspected or confirmed airborne infectious disease. Environmental factors are controlled in AIIRs to minimize the transmission of infectious agents that are usually transmitted from person to person by droplet nuclei associated with coughing or aerosolization of contaminated fluids. AIIRs should provide negative pressure in the room so that no air flows out of the

room into adjacent areas. They should also direct exhaust of air from the room to the outside of the building or recirculation of air through a high efficiency particulate air (HEPA) filter before returning to circulation (Manitoba Health, 2010).

Mirtskhulava et al. (2015) found a strong association between ventilation, air movements in buildings and the transmission of infectious diseases such as TB. According to the WHO (2014), ventilation rates lower than 2 ACH were associated with higher TST conversion rates amongst staff. Conversely, a higher ventilation rate is able to provide a higher dilution of airborne pathogens and consequently reduces the risk of air-borne infections. Mechanical ventilation delivering negative pressure and 12 ACH is the standard of care for respiratory TB isolation. However, poorly maintained mechanical ventilation systems have been widely documented in resource-rich settings and implicated in several TB outbreaks.

Keeping PHC windows and doors closed for most of the day impedes ventilation. HCWs should be encouraged to keep windows and doors open at all times. Jensen et al. (2005) found that when the doors and windows were opened, half of the rooms surveyed had a median ACH of >12, which is the preferred minimum number of air changes for TB transmission control. Escombe et al. (2007) showed that one can achieve a median ACH of 28 with doors and windows opened. Moreover, it was recommended that health facilities should be built with windows and doors directly opposite each other for cross-ventilation (Bock et al., 2007).

Waiting areas, sputum collection areas, examination rooms, and wards should be "open" to the environment in that they should be established in covered open areas or in areas with open windows. Additionally, windows or other openings may be installed that would allow for more ventilation. Windows and openings should be

placed on outer walls such that air moves to the outdoors, not into other wards or waiting areas. The open areas should be equal to at least 10% of the area of the room; >20% is preferable (DLTLD-Kenya, 2009).

2.3.2. Ultraviolet Germicidal Irradiation (UVGI)

In high-risk settings where optimal ventilation cannot be achieved through natural or mechanically-aided means, properly designed, placed and maintained shielded UVGI units should be considered as an effective control measure. Ultraviolet radiation inactivates *M. tuberculosis* organisms when they are adequately exposed to the light for long enough and close enough. Effective use of UVGI ensures that TB bacilli contained in infectious droplet nuclei is exposed to a sufficient dose of UV radiation at 253.7 nm to result in inactivation (MOSS-Namibia, 2014).

There is good evidence that short wave ultraviolet germicidal irradiation (UVGI) has excellent bactericidal activity against *M. tuberculosis* and can reduce infectious droplet concentrations, depending upon the room volume and type of lights used. Upper-room UVGI is considered a supplement or adjunct to ventilation. The use of UVGI has been controversial because of potential skin cancer and eye damage. However, the risk of skin cancer with new, commercially available UVGI units is essentially eliminated. Possible eye complications can be avoided by proper installation of these units above head height, as well as a schedule of regular inspection and maintenance (CDC, 2009).

UVGI can be considered for health facilities managing MDR-TB, particularly in areas where climate conditions preclude the utilization of natural and mechanical ventilation and in large wards with high patient numbers. If this model is used, responsibility should be assigned to ensure the lamps are cleaned, maintained and

monitored by measuring UV intensity. This will avoid adverse exposure. The lamps work better in clean air without much dust or humidity. Natural sunlight is not very effective in killing TB bacilli and should not be fully relied upon in TB-IPC. Sunlight passing through windows does not kill TB bacilli (MOSS-Namibia, 2014).

2.4. Personal Protective Infection Prevention and Control Measures

Respiratory protection is an important aspect for protecting HCWs against TB nosocomial infection. It goes hand in hand with administrative and environmental measures. This measure is important in high risk areas such as MDR treatment centres and those handling suspected MDR specimens. High risk areas also include surgical centers handling bronchoscopy, autopsy measures, sputum induction and other aerosol generating procedures (DLTLD-Kenya, 2009).

Respirators (‘N95 masks’) are the last line of defense against nosocomial TB infection for HCWs. Unfortunately, even the combination of administrative and environmental controls can never provide 100% safety. Respiratory protection is therefore needed in specific areas and during the performance of specific tasks so as to supply the desired level of safety. The main limitation of respirators is that they may not be practical to wear at all times and are often not used when unsuspected (untreated) TB patients are being seen. In addition, in order to be effective, respirators need to fit properly and to be worn correctly with each use, which is not always the case (MOSS-Namibia, 2014).

Respiratory protection of HCWs involves the use of a respirator with a filter class equivalent to or higher than an N95, to prevent inhalation of aerosols containing infectious microorganisms. The most widely used respirators by HCWs in North America are the NIOSH-certified half-face piece disposable respirators with an N95

filter class, commonly referred to as N95 respirators (PHAC, 2007; PHAC, 2013). Masks are worn by HCWs to protect their skin and mucous membranes in the nose and mouth from droplets from an infected patient or source. Masks are not designed for respiratory protection of HCWs as they are less than 50% effective in filtering small droplet nuclei (1–5 microns) containing *M. tuberculosis* (Dharmadhikari et al., 2012).

The use of masks by patients (Buregyeya et al., 2012) and the use of respirators by HCWs have an alienating or depersonalizing effect. They reduce the HCWs' ability to provide compassionate care. Wearing a mask by patients or a respirator by HCWs should become acceptable to both. The Ugandan TB-IPC guidelines make a clear effort to change existing practice. Patients should be enlightened to understand that HCWs may wear personal protective equipment sometimes, or that they may be asked to wear a mask in order to protect others. Safety without stigma should be the goal. A request to wear a mask or provide sputum outside the healthcare facility or in a well-ventilated room should not be stigmatizing, but should be part of a safer clinic for everyone (MOH-Uganda, 2011).

2.5. Laboratory Safety

The most important factor in the prevention of laboratory-acquired infection is good technique on the part of the individual worker. Specialized equipment may aid good laboratory practice but does NOT replace it. Aerosols may be produced in the TB laboratory when handling leaking specimens, opening sample containers, and preparing smears. When care and appropriate techniques are used, handling sputum presents a minimal risk of acquiring infection to a technician. For laboratory staff, the greatest risk of infection involves sputum collection. People with suspected TB may

cough and in doing so, spread TB bacilli in tiny droplets in the air which may infect others when they are inhaled. Precautions must be taken to minimize this exposure (DLTLD-Kenya, 2009).

2.5.1. Administrative controls

In 2009, WHO updated its TB-IPC in healthcare facilities policy (WHO, 2009). The policy includes three sets of measures to prevent TB transmission grouped by level of importance. Administrative measures reducing delays in diagnosis and treatment of (presumptive) TB patients are critical first level measures. Overall managerial activities facilitate the implementation of TB-IPC measures.

2.5.2. Environmental controls

Collecting sputum represents the greatest hazard to a laboratory technician because infectious aerosols may be produced by coughing. A coughing patient who comes into the laboratory, should be asked to cover their mouth. Wherever possible, specimen should be collected outside where air movement will rapidly dilute infectious droplets and UV rays from the sun will rapidly inactivate TB bacilli. Sputum specimens should never be collected in laboratories, toilets, waiting rooms, reception rooms or any other enclosed space. The laboratory technician is required to stand well clear and upwind when a patient is collecting a sputum sample (DLTLD-Kenya, 2009).

After smears have been processed, all infected materials including closed sputum containers should be disposed in a discard bag made of polyethylene, if available. Applicator sticks used for smearing should also be discarded immediately after use. Since all sputum specimens are considered potentially infectious, all materials used in the procedure should be treated as contaminated (DLTLD-Kenya, 2009).

All clinical waste should be secured in an approved way and identified with a coded tie or label to indicate source of waste. Bags should not be closed by an overhand knot. Good practice is to ‘swan neck’ the bags by twisting the top and then turning it over on itself. The bag should then be secured with tape and tie. Bags should not be more than ¾ full. Areas where clinical/hazardous waste is produced should have foot-operated bins for waste stored in bags (Department of Health and Health Protection Agency, 2013).

The following are also important in the laboratory setting and form part of environmental infection control measures:

(i) Laboratory Fume Hoods

The least expensive ventilated cabinet for laboratories is the Laboratory Fume Hood. This type of environmental control is designed for the purpose of worker protection (no protection of the environment or the product i.e. the specimen). These devices, like biological safety cabinets, are designed to minimize worker exposures by controlling emissions of airborne contaminants, including aerosols (DLTLD-Kenya, 2009).

(ii) Biological Safety Cabinets (BSCII)

BSCII are relatively expensive and are designed to contain airborne microorganisms in laboratories working with MDR or liquid suspensions of *M. tuberculosis*. When used with appropriate laboratory practices, the spread of aerosolized microorganisms can be minimized through the use of a biological safety cabinet.

Laboratories working with MDR or liquid suspensions of *M. tuberculosis* should be equipped with a ventilated cabinet or a BSC class II. All efforts must be made to ensure the BSC class II is functioning properly by regular inspection (DLTLD-Kenya, 2009).

2.5.3. Personal Protective Measures

Personal Respiratory Protection (PRP) involves the use of particulate respirators by HCWs including those working at the laboratory. Although gloves do not provide any appreciable protection against airborne transmission of *M. tuberculosis,* they should be used all the time when handling sputum. Sputum just like any other fluid may contain other infectious agents. If gloves are used, there should be a guaranteed supply. Reusing single use gloves is not advised. Gloves should not be worn outside the laboratory. They should be discarded at any interruption of smear preparation. Hand washing and careful techniques are mandatory for safe laboratory practice in all countries. Laboratory coats must also be worn at all times when working in the laboratory. Laboratory coats of various sizes should be provided and cleaned by the laboratory organization. They should be tied at the back, not the front, and be made from water-resistant materials to avoid liquids soaking into the gown. Laboratory coats must NOT be worn outside of the laboratory (DLTLD-Kenya, 2009).

2.6. Factors Associated with Implementation of Infection Prevention and Control Measures

Hospital-associated transmission of TB from patient to HCW is believed to be the most likely cause of transmission at the health facility setting. This is likely due to poor or non-existent TB-IPC measures, especially in low-resource settings (Menzies et al., 2007; Baussano et al., 2011). Little is known about other specific occupational

risk factors for TB among HCWs. Some researchers have identified HIV infection, time spent with patients, job designation, duration of service, work location and failure to wear personal protective equipment to be significant risk factors for TB infection (Galgalo et al., 2008; Mathew et al., 2013).

Conceptually, several individual characteristics of HCWs, institutional and managerial systems in place as well as regulatory frameworks affect the implementation of TB-IPC measures (Loveday et al., 2008).

2.6.1. Cadre of HCWs

Studies have found higher rates of TB among certain HCW occupations. In a study done in India by Mathew et al. (2013), results showed a >2-fold greater odds of TB among various levels of nursing cadre as compared to other occupations. However, although the majority of cases of active TB in the sample were among nursing staff (46%), their risk for TB did not differ significantly from other cadres of staff. In another study, the risk for acquiring TB was found to be higher among HCWs in in-patient TB facilities, patient attendants, nurses and clinical officers (Joshi et al., 2006).

2.6.2. Level of Health Facility

Reid et al. (2012) found that characteristics associated with greater likelihood of practicing triage included private vs. primary facilities and anti-tuberculosis treatment available on-site vs. off-site. Furthermore, they documented that characteristics associated with lower prevalence of respirator availability included private vs. primary facility.

In a study carried out by Gilks (2006), bivariate analysis demonstrated that tertiary sites which were invariably also larger sites were more likely to have adopted TB-IPC plans. They were also more likely to have implemented triage practices than smaller primary care facilities. These measures were also more prevalent at facilities with on-site anti-TB treatment than those where TB treatment was only available off-site. Smaller primary care sites were less likely to have written IPC plans. Over half of the sites included in the analysis were primary care facilities reflecting the move to decentralize HIV care and treatment across sub-Saharan Africa.

2.6.3. Years of Service

Pai et al. (2006) documented that there was a 3-fold higher prevalence of LTBI among HCWs with more than 10 years of employment. In a prospective study conducted in an institution among nursing students, TST positivity was strongly associated with time spent in healthcare after adjusting for age at entry into healthcare. HCWs with frequent patient contact and those with a body mass index (BMI; kg/m2) less than 19 were at increased risk of acquiring active TB. Nosocomial transmission of TB was prominent in locations, such as medical wards and microbiology laboratories (Mathew et al., 2013).

A study in south India reported a 47.5 % prevalence rate of LTBI amongst young nursing trainees. The skin test positivity was strongly associated with time spent in healthcare after adjusting for age at entry into healthcare work (Christopher et al., 2010).

2.7. Training and Knowledge of HCWs

Woith et al. (2010) maintain that each person working in a high-risk TB environment should have a high level of TB awareness and knowledge. Menzies et al. (2007) point

out, that most TB control activities require minimum training that can often be incorporated into routinely held staff meetings. The Department of Health in South Africa (2007) requires that each HCW and staff member, including any lay workers, must receive job category-specific training conducted before initial assignment. Continuing education is very important and should be provided to all employees and volunteers annually.

All facility staff and volunteers, including those who do not provide TB care directly, should be trained on the risks of TB transmission. This should be done at least every six months and for all new staff in the facility. Each staff member should be made aware of the details of the IPC plan and be encouraged to monitor its implementation. As every person is responsible for TB-IPC, knowing the strategy of the IPC plan will ensure that all staff hold each other accountable for the successful implementation of the plan. All staff and volunteers working at health facilities should be educated on the symptoms of TB to ensure that they get tested for TB and treated where necessary. Quick reference materials in a form such as brochures, posters, pamphlets, or job aids can also assist dissemination of the facility's TB-IPC plan (HATIP, 2013).

Management has the responsibility for ensuring that all staff and volunteers are trained by a person with experience in training and familiar with the risks, practices and legal requirements of IPC. Records should be kept and maintained. Those responsible for training should ensure that staff use appropriate protective clothing and are provided with appropriate waste receptacles and equipment (Department of Health and Health Protection Agency, 2013).

TB-IPC is only effective if each HCW working in a facility understands the importance of TB-IPC work practices. They should also understand their role and responsibility for implementing and following safe work practices and SOPs. Each HCW should receive instructions appropriate to their job category. All facility staff and volunteers, including those who do not directly provide TB care, should undergo training and re-training on the risks of TB transmission. This should be done at least every six to twelve months and for all new staff in the facility (MOSS-Namibia, 2014).

A review of KAP surveys for TB conducted in other countries, and international guidelines established to assist TB control efforts, strongly support the need to specifically target HCWs for training so as to increase their knowledge and competence in the management of TB cases (Al Maniri, 2008). In Oman, a low incidence setting, poor levels of knowledge were found among general practitioners (Al Maniri, 2008) whereas in Argentina which is another low incidence setting, a study found that almost 100% of their physicians correctly recognized the main symptoms associated with TB (Dato & Imaz, 2009). Regular training is thus essential to ensure the HCWs are reminded of various aspects of the disease.

Unfortunately, a number of studies from other countries have found that HCWs do not always have sufficient knowledge and the right attitude to adopt acceptable practices for preventing the spread of TB (Farley et al., 2011; Dheda et al.,2010; Victor et al., 2007; Pillay & Sturm, 2007). A study to investigate factors that contribute to TB control by Tshitangano et al. (2010) confirmed that HCWs lacked sufficient knowledge needed to help them choose and implement appropriate TB control measures. Sissolak et al. (2011) identified inadequate TB-IPC training for staff and

patients as a factor associated with potential nosocomial transmission in South Africa. Similarly, Jarand et al. (2010) stated that knowledge level of TB-IPC among HCWs may influence the prevalence of nosocomial TB infection.

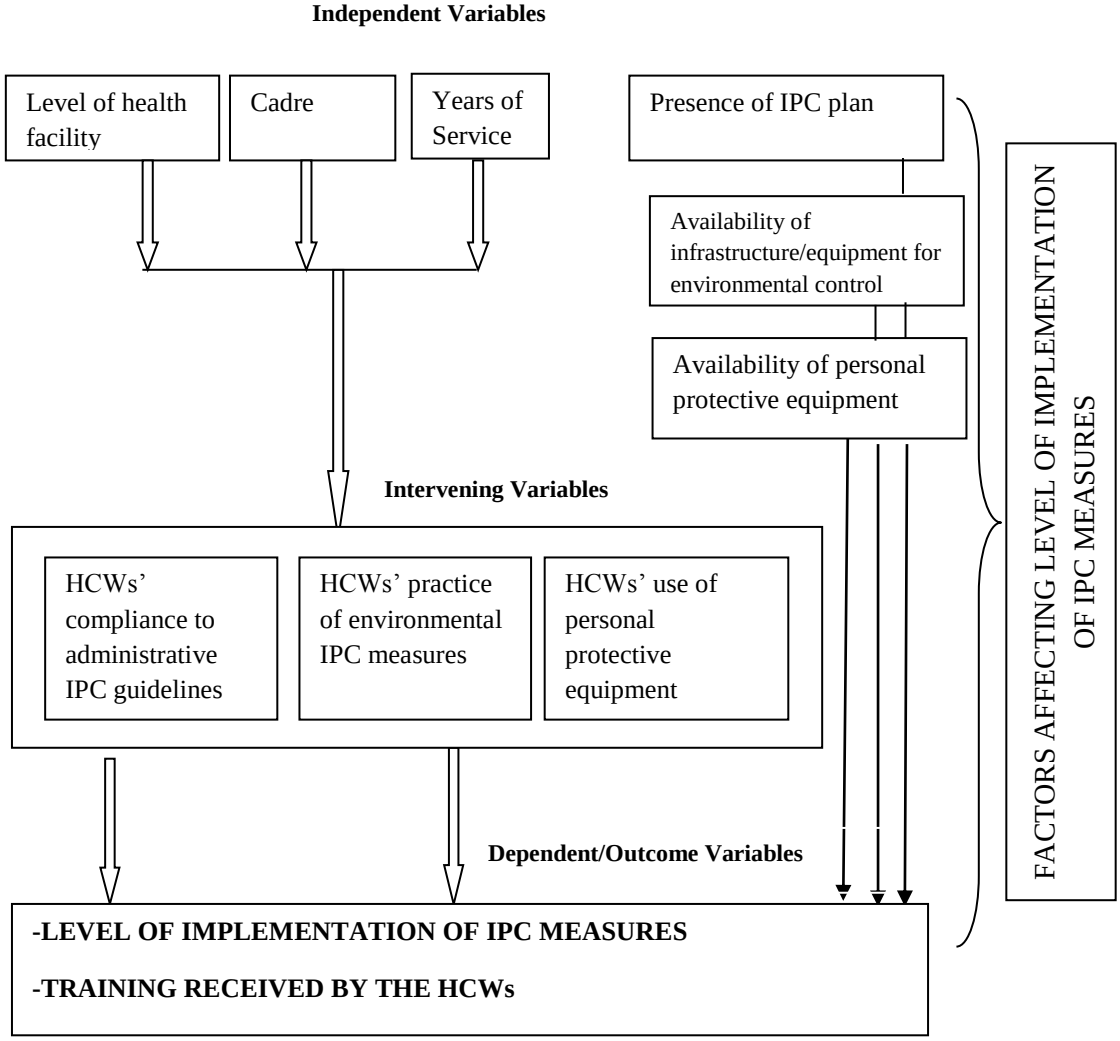
According to Healthcare Information for All (HIFA, 2015), gross lack of knowledge about the basics on how to manage common diseases is often associated with suboptimal, ineffective and dangerous health care practices. Oluwole (2008) found lack of information to be a barrier to efforts to triage people with TB symptoms in Nigeria.

In Kenya, the 2009 National Guidelines for Tuberculosis Infection Prevention were developed and 30 MOH staff were trained on TB-IPC procedures. Forty nine members of staff were trained through two provincial IPC trainings to conduct local facility risk assessments and develop policy for administrative, environmental, and personal protection measures applicable to all levels of health care facilities. This was undertaken bearing in mind the need for capacity building on TB-IPC measures among HCWs across the country (MOH-Kenya, 2009).

2.8. Consequences of Poor Infection Prevention and Control Measures

In most of the world, more so in developing countries, respiratory infection control in health care facilities remains inadequate (WHO, 2009). The rising number of outbreaks have turned attention to the need to reduce TB transmission in health care facilities (WHO, 2010). New World Health Organization guidelines on TB-IPC were released in 2009 and called on countries to institute programs to screen for TB regularly among HCWs and to routinely record and report this data (WHO, 2009). The nosocomial transmission of MDR-TB and XDR-TB further highlights the need for effective TB-IPC measures (Nodieva et al., 2010).

2.9. Conceptual Framework



(Source: **Researcher, 2016**).

The conceptual framework for this study was designed to show relationship between the independent, intervening and dependent variables as follows:

Independent Variables: This category included: the level of health facility, cadre of the HCWs and years of service. Other independent variables included the presence of an IPC plan as the key administrative TB-IPC measure, the availability of infrastructure and equipment to facilitate implementation of environmental TB-IPC measures and the availability of personal protective equipment for use by the HCWs.

Intervening Variables: This category formed the link between the independent variable and the level of implementation of the TB-IPC measures. It included the HCWs' compliance to TB-IPC guidelines under administrative TB-IPC measures, the HCWs' practice of environmental TB-IPC measures and the HCWs' use of available personal protective equipment.

Dependent Variables: This category represented the outcome variables which included the level of implementation of TB-IPC measures and the training received by the HCWs.

2.10. Chapter Summary

From the literature review, it was evident that there were various vital TB-IPC measures which if put in place, can effectively control nosocomial TB at health facilities. However, it was realized that there was a gap in knowledge of the extent to which these measures exist and were functional in health facilities in Kenya. The study therefore attempted to fill in the gap. Evaluation of the TB-IPC measures will assist policy makers and other stakeholders to know the status of these facilities with regard to controlling spread of hospital acquired TB. This will facilitate initiation of appropriate interventions.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents the methodology that was used in implementing the study: the area of study, research design, study population, sampling procedure and sample size. It also elaborates on the instruments that were used in the collection of required data, data collection procedures and finally how data was analyzed, presented and plans for dissemination. Ethical considerations that were adhered to in the course of the study are also outlined.

3.2. Study Area

The study was carried out in Muhoroni sub-county which is one among seven sub-counties that form Kisumu County. The county is one of the new devolved counties of Kenya. Its borders follow those of the original Kisumu District, one of the former administrative districts of Nyanza Province. Its headquarters is Kisumu City. It had a population of 968,909 according to the 2009 National Census. The land area of Kisumu County totals 2085.9 km² (KNBS, 2010).

Kisumu County borders Siaya County to the West, Vihiga County to the North, Nandi County to the North East and Kericho County to the East. Its neighbour to the South is Nyamira County and Homa Bay County is to the South West. The county has a shoreline on Lake Victoria, occupying northern, western and a part of the southern shores of the Winam Gulf. The county has annual rainfall that ranges between 1200 mm and 1300 mm. The area is characterized by hot and wet climate with a mean annual temperature of 23^0C and temperature range of between 20^0C and 35^0C.

Kisumu County is most known for its association with Lake Victoria, the largest lake in Africa. The lake contributes a very large part to the economy of the county since it supports the fishing and fish processing industry which constitutes the county's main economic activity. Agriculture is also a common economic activity with heavy presence of sugarcane and rice irrigation industries (KNBS, 2010).

Muhoroni sub-county was selected for the study based on the fact that the area covered by Kisumu County at large has been marked as a high HIV prevalence setting and has subsequently reported high TB disease burden over the years. HIV prevalence in Kisumu at 19.9% was 3.4 times higher than the national prevalence. The TB prevalence at 360/100,000 population was the highest in the country (NACC, 2016). The number of HIV and TB cases presenting at the health facilities across the county is therefore large with Muhoroni sub-county reporting one of the leading morbidity rates. In addition, with Muhoroni sub-county's geographical location being the furthest from Kisumu City, most of the facilities were situated at considerable distances from where medical supplies and equipment for the region are dispatched and distributed.

There were a total of 20 health facilities in Muhoroni sub-county which offered TB services. The study was conducted in 15 of these facilities which were both TB diagnostic and treatment sites. The other 5 facilities did not offer diagnostic services and only served as drug collection centres for TB patients on treatment.

3.3. Study Population

Table 1: Study Population

The table below illustrates the distribution of the HCWs in Muhoroni sub-county and their respective health facilities:

	CADRE OF HCWs						
	MOs	**COs**	**Nurses**	**Lab Staff**	**PHOs**	**Support Staff**	**TOTAL**
Muhoroni Co. Hospital	1	2	3	1	0	2	**9**
Rachar Nursing Home	1	2	8	2	0	4	**17**
St. Vincent Health Centre	0	2	6	2	0	5	**15**
Mama Philista Nursing Home	0	2	2	2	0	2	**8**
Nyangoma SCH	0	2	6	1	1	2	**12**
Muhoroni SCH	1	7	12	4	2	6	**32**
Masogo SCH	0	3	5	1	2	3	**14**
Ogra Medical Centre	1	3	3	2	0	5	**14**
Kibigori Dispensary	0	1	2	1	1	3	**8**
Chemelil Health Centre	0	1	5	1	0	3	**10**
Tamu Health Centre	0	1	3	1	1	4	**10**
Koru Mission Hospital	1	2	4	2	0	4	**13**
Miwani Dispensary	0	1	2	1	0	2	**6**
Ogen Dispensary	0	1	3	1	0	2	**7**
Chemelil Co. Health Centre	1	4	9	2	0	5	**21**
TOTALS:	**6**	**34**	**73**	**24**	**7**	**52**	**196**

The study targeted HCWs in 15 TB diagnostic and treatment centres in the sub-county. They were 196 in number. The HCWs included medical officers, clinical officers, nurses, laboratory staff, public health officers and support staff.

3.4. Study Design

The study adopted a descriptive, cross-sectional design. The cross-sectional survey was carried out in 15 health facilities which offered both TB diagnostic and treatment services in Muhoroni sub-county. HCWs working at the facilities under study were interviewed on various aspects of TB-IPC to capture information at a given pre-determined point in time. The design was economically and logistically feasible given the time frame within which the study was to be implemented.

3.5. Sample size Determination

There were 20 health facilities in Muhoroni sub-county which offered TB services. Out of the 20 health facilities, 15 offered both diagnostic and treatment services thus were purposively sampled for the study. The other 5 facilities served only as drug collection centres and did not have a laboratory where screening for TB was conducted. The study involved the assessment of diagnostic services offered at the facility level thus was interested in the laboratory component.

The sample size (n) for the HCWs was obtained using 95% confidence interval and a significance level of 5%. The Fisher's formula was used as shown below:

$$n = \frac{Z^2 \, \hat{p}(1-\hat{p})}{e^2}$$

Where:

Z= confidence interval

p= proportion of target population who adequately implement IPC measures

1-p= proportion of target population who do not adequately implement IPC measures

n= desired sample size

e= acceptable sampling error

$$\text{Sample size} = \frac{1.96^2 \times 0.5\ (1-0.5)}{0.05^2} = 384.16$$

Therefore desired sample size = 384.

A prevalence of 50% of the HCWs who adequately implemented IPC measures was used since there was no documented prevalence from available literature that could otherwise be applied.

Mugenda and Mugenda recommend the use of the following correction formula if the population is less than 10, 000:

$$nf = \frac{n}{1 + (n/N)}$$

Where:

nf = desired sample size when the population is less than 10,000

n= desired sample when the population is more than 10,000

N= estimate of the population size

Therefore, using the above correction formula sample size:

$$nf = \frac{384}{1 + (\frac{384}{196})}$$

nf = 127.7

Therefore the desired sample size = 127.7.

Based on the above, the appropriate sample size for the study is 127.7. However, to deal with non-respondence, an additional 10% (n=127.7) was added. Thus, the expected total sample size was increased to 140.

3.6. Sampling Procedures

Multistage sampling technique was applied. In the first stage, purposive sampling was used in selecting 15 health facilities which offered both TB diagnostic and treatment services from the 20 that offered TB services within Muhoroni sub-county. The second stage involved proportionate or quota sampling which was used to determine the number of HCWs to be interviewed from each facility and the appropriate number to be drawn from each cadre. Simple random sampling was then used to select specific HCWs to be interviewed.

3.6.1. For the HCWs:

Proportionate/Quota sampling was applied to determine the number of HCWs to be interviewed from each facility. It was also used to determine the appropriate number of HCWs to be interviewed from each cadre within each facility.

This was done by calculating a sampling fraction which is the ratio of sample size to study population size.

- Sampling fraction = Sample size ÷ Study population

Therefore the sampling fraction:

- Sampling fraction = 140 ÷ 196

  = 0.71

The sampling fraction of 0.71 was applied across all figures in the study population to ensure that sampling is done proportionally across each facility and cadre.

The following table illustrates the number of HCWs that were interviewed from each cadre within each facility after application of the sampling fraction.

Table 2: Number of HCWs Interviewed

	CADRE OF HCWs						
	MOs	**COs**	**Nurses**	**Lab Staff**	**PHOs**	**Support Staff**	**TOTAL**
Muhoroni Co. Hospital	0	1	2	1	0	1	**5**
Rachar Nursing Home	1	1	6	1	0	3	**12**
St. Vincent Health Centre	0	1	4	1	0	4	**10**
Mama Philista Nursing Home	0	1	1	1	0	1	**4**
Nyangoma SCH	0	1	4	1	1	1	**8**
Muhoroni SCH	1	5	10	3	2	5	**26**
Masogo SCH	0	2	4	1	1	2	**10**
Ogra Medical Centre	1	2	2	1	0	4	**10**
Kibigori Dispensary	0	1	1	1	1	2	**6**
Chemelil Health Centre	0	1	4	1	0	2	**8**
Tamu Health Centre	0	1	2	1	1	3	**8**
Koru Mission Hospital	0	1	3	1	0	3	**8**
Miwani Dispensary	0	1	1	1	0	1	**4**
Ogen Dispensary	0	1	2	1	0	1	**5**
Chemelil Co. Health Centre	1	3	7	1	0	4	**16**
TOTALS:	**4**	**23**	**53**	**17**	**6**	**37**	**140**

Simple random sampling using the staff lists as the sampling frame was used to identify specific HCWs. The staff lists were provided by the Facility in charges of the respective facilities. During the process of sampling, the names of the participants in each of the cadres were written on a piece of paper and shuffled. The names were then picked randomly to form the sample in a series of draws. The aim was to ensure that each respondent had an equal chance of being selected. In the event that a HCW who did not meet the eligibility criteria was picked, a repeat draw was carried out to identify another. The repeat draw was also done to replace respondents who declined to participate in the study. This was done to ensure the minimum requirement for the sample size is met.

3.6.2. For the Facility in charges:

The Facility in charges at each study site were interviewed giving a total of 15 respondents.

3.6.3. For the Observation Checklist

An observation checklist was filled for each facility giving a total of 15.

3.7. Eligibility Criteria

3.7.1 Inclusion Criteria

1. HCWs that were available at the facility during implementation of the study.
2. HCWs who had been working at the facility for a minimum of three months. This period of three months was essential so as to accommodate for staff change-over in some of the health facilities.

3.7.2 Exclusion Criteria

1. HCWs who were absent from duty during the time of the study i.e. those on leave (annual leave, maternity/paternity leave, sick leave).

3.8. Data Collection Methods

3.8.1. Data Collection Tools

Data collection was done with the aid of an observation check list and two interviewer administered structured questionnaires. One questionnaire was administered to the HCWs while the other was administered to the Facility in charge at each of the facilities. The additional questionnaire for the Facility in charges sought to gather information from an administrative perspective. The Facility in charges were also interviewed as HCWs since they handled patients as they worked with the other HCWs within the facilities. Their duties were not limited to their managerial role.

Interviewer administered questionnaires were deemed appropriate for the study since there was some technical content which needed detailed explanation by the researcher more so when administering to the respondents who may not be well versed with TB-IPC. The sample size for the study was also manageable. The questionnaires were developed after comprehensive review of the Kenya National TB-IPC guidelines and recommendations. The questionnaires had questions which required the HCWs and Facility in charges to give reports on implementation of TB-IPC measures and if they had received any training on TB-IPC. Quantitative data was collected through closed questions.

Data from the facilities was gathered through direct observation by the researcher. Aspects of TB-IPC that were assessed in this way included different aspects of administrative infection control measures like separation and isolation of TB patients,

environmental control measures like availability of natural ventilation and sunlight in TB consultation rooms and use of personal protective equipment in different parts of the facility including the laboratory.

3.8.2. Data Collection Process

Data collection was done from mid-August 2015 through to early December 2015. A period of one week was spent at each of the facilities to allow for sufficient time to observe implementation of different TB-IPC measures. Potential eligible participants were identified. Consent was then sought and a brief explanation of what the study entailed given. Those who consented to participate were interviewed. There was no incentive given for accepting to participate. The responses were recorded in the interviewer administered questionnaires.

3.9. Data Management

Questionnaires filled were first sorted by the researcher. In order to facilitate analysis, the data collected was entered into the standard statistical software, R. Data cleaning was undertaken before running frequencies.

3.10. Data Analysis

Data analysis was done using standard statistical software, R. Categorical variables were summarized as frequencies and the corresponding percentages. Continuous variables that assumed the Gaussian distribution were summarized as mean and the corresponding standard deviation. An example of such variables was the age of the respondents. Continuous variables that violated the Gaussian assumptions were summarized as median and the corresponding inter quartile range (IQR). The variable of years of service of the HCWs was summarized in this manner. Gaussian

assumptions were assessed empirically using Shapiro Wilk test and graphically using normal probability plots. Results were presented using tables, pie charts and graphs.

Association between categorical variables was assessed using Fisher's exact test because the expected cell counts were less than 5 in some of the created 2x2 tables. Two sample Wilcoxon rank-sum test was used to compare medians across the levels of a binary variable.

3.11. Test for Validity and Reliability of the Research Instruments

3.11.1. Pilot Study

This was done with the objective of subjecting the research instruments to trial so as to gauge their appropriateness and thus validity and reliability. The research instruments were administered to a sample of population with characteristics similar to the study population. Two health facilities in the neighbouring Nyando sub-county were visited for this purpose. They were Ahero Sub-County Hospital and Nyakongo Health Centre. 14 respondents were interviewed from the two facilities which was 10% of the study sample size. From observations made during the pilot study, the data collection instruments were adjusted accordingly before data collection for the main study was rolled out.

3.12. Ethical Considerations

Formal approval was sought from the Institutional Research and Ethics Committee (IREC) of Moi University and the Moi Teaching and Referral Hospital before commencing the main study. The approval number for the study was 0001460.

The following ethical issues were put into consideration:

- Participation by respondents was voluntary and no HCW at the facilities was coerced to take part in the study. There was neither victimization nor intimidation of those who declined to participate. Written informed consent was sought from willing and eligible participants.
- Official permission to conduct the study was sought from the relevant offices which included those of the Kisumu County Director of Health, the Muhoroni sub-county Medical Officer of Health and the Facility in charges at each site.
- Information gathered was treated with utmost confidentiality and only for the purpose of the study. Names of the respondents were not recorded anywhere to ensure anonymity.
- Data records were stored safely and will be kept for a period of at least five years for reference purposes after which they shall be destroyed.
- The rights and dignity of all respondents were respected and protected. They were free to withdraw from the study at any time without jeopardizing their rights as healthcare staff serving at the facilities.
- There was no risk or physical harm incurred for participation in the study.

3.13. Dissemination of Study Findings

Results derived from implementation of the study will not only be used for the purpose of preparation of the MPH thesis but will also be published in a peer-reviewed journal for advancement and sharing of scientific information. The findings will also be presented in appropriate seminars to facilitate further sharing of information.

Findings will also be availed to relevant stakeholders like the Kisumu County Director for Health and the Facility in charges of the health facilities under study to facilitate evidence based interventions.

3.14. Chapter Summary

This chapter described the research methodology that was applied during implementation of the study. The intended study area, population and design were presented in detail. Determination of sample size and sampling procedures were also explained. The process of data collection was elaborated upon with the preparation for the same, tools used and processes that were applied explained. Presentation and analysis of both descriptive and inferential statistics after data collection were described. The chapter defined how the testing for validity and reliability of the research instruments was carried out. Ethical considerations that guided implementation of the study were also comprehensively laid out.

CHAPTER FOUR

STUDY FINDINGS

4.1. Introduction

This chapter provides details of the findings and results of evaluation of implementation of administrative, environmental and personal-protective measures by HCWs in Muhoroni sub-county. Associations between independent and dependent variables are highlighted. The chapter also gives findings on investigation to determine if the HCWs had any training on TB-IPC measures.

4.2. Socio-demographic Characteristics of the Respondents

A total of 140 participants aged an average of 35.8 ± 7.0 years participated in the study. Over half of the participants were male. The median number of years of service was 8.0 (IQR: 4.0, 14.0) years. Majority of the participants, 53 (37.9%) were nurses. Clinical officers were 23 (16.4%), medical officers were 4 (2.9%) while the support staff cadre comprised of 37 participants (26.4%).

Table 3: Sociodemographic characteristics of the HCWs

Variable	n (%) or Mean ± SD or Median (IQR)
Age	35.8 ± 7.0
Male	80 (57.1%)
Years of service	8.0 (4.0, 14.0)
Cadre	
COs	23 (16.4%)
Lab staff	17 (12.1%)
MOs	4 (2.9%)
Nurses	53 (37.9%)
PHOs	6 (4.3%)
Support staff	37 (26.4%)

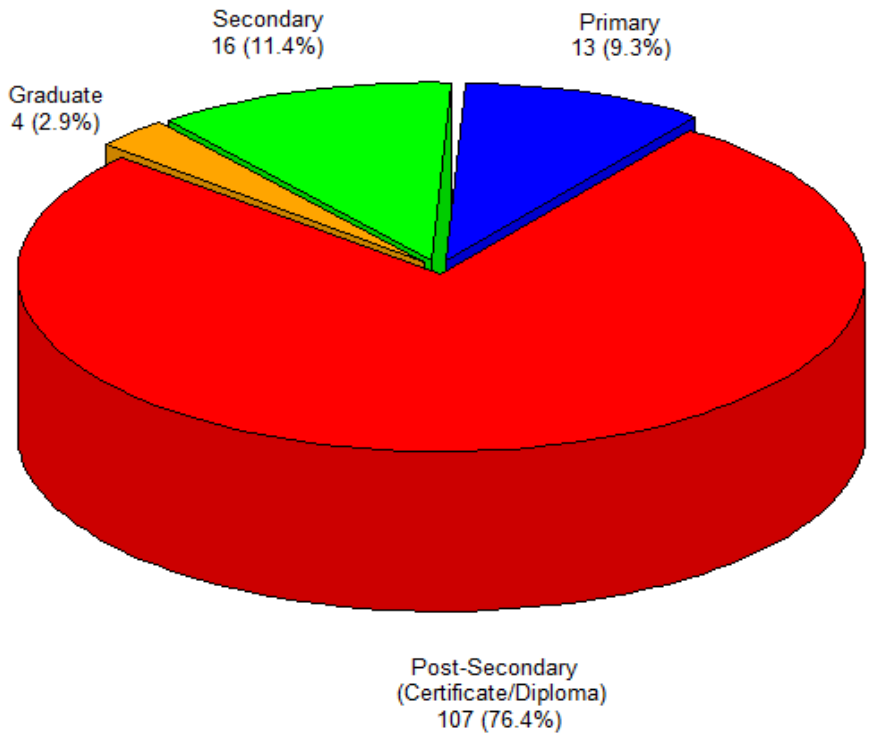


Figure 1: Highest level of education of the respondents

The highest level of education attained by the HCWs was distributed as shown in Figure 1. More than three quarters of the participants, 107 (76.4%) had post-

secondary education. Of this number, 23 (21.5%), 15 (17.9%), 53 (49.5%), and 6 (5.6%) were clinical officers, laboratory staff, nurses, and PHOs respectively. The rest, 8 (7.5%) were support staff. All the four participants that were graduates were medical officers. All the 16 (11.4%) participants with secondary level of education as well as all the 13 participants with primary level of education (9.3%) were support staff.

4.3. Distribution of HCWs according to Health Facility

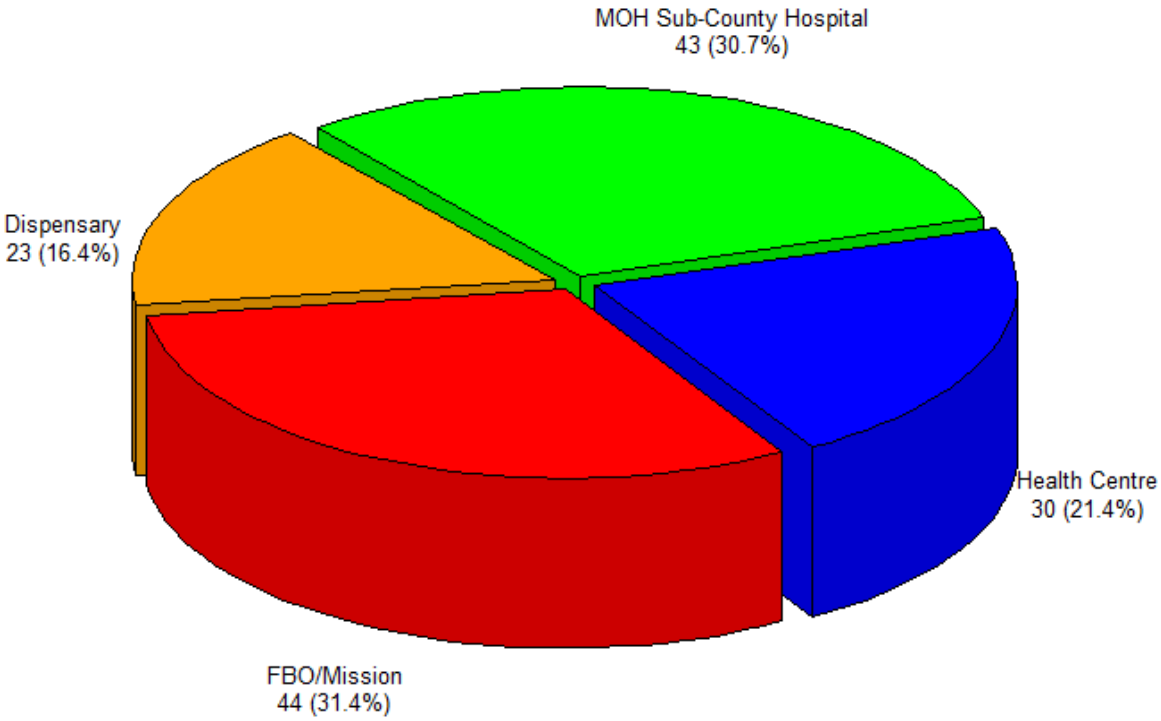


Figure 2: Distribution of HCWs

The participants who participated came from various health facilities. Those who came from dispensaries, FBO/Mission, MOH SCH and health centers consisted of 23 (16.4%), 44 (31.4%), 43 (30.7%), and 30 (21.4%) respectively.

4.4 Implementation of Administrative Infection Prevention and Control Measures

Table 4: Administrative control measures

Variable		n (%)
Routinely asked patients about cough upon entering the facility.		82 (58.6%)
Carried out triaging of patients based on cough symptoms upon their arrival at the health facility.		81 (57.9%)
Separated and isolated patients with severe cough symptoms from others.		28 (20.0%)
Contributed towards an organized patient flow system at the health facility.		132 (94.3%)
Average duration of time that a patient with cough symptoms takes to have sputum collected for diagnosis at the health facility.		
	< 1 hour	94 (67.1%)
	1-6 hours	34 (24.3%)
	12-24 hours	12 (8.6%)
Facilitated health education sessions on infection control for patients at the health facility.		140 (100%)
Frequency of facilitation of the health education sessions on infection control.		
	Daily	13 (9.3%)
	Weekly	122 (87.1%)
	Monthly	5 (3.6%)

More than half of the respondents (58.6%) reported to routinely ask patients about cough upon their entry to the facility, and 81 (57.9%) reported that they carried out triaging of patients based on cough symptoms as they arrived at the health facility.

One fifth of the participants reported that they separated and isolated patients with severe cough symptoms from others. Average duration of time a patient with cough symptoms took for sputum to be collected for diagnosis was < 1 hour according to two thirds of the respondents. It was found that a worrying proportion of 8.6% took between 12 and 24 hours for sputum to be collected for diagnosis.

All the respondents reported that they facilitated health education sessions on TB-IPC measures for patients. This sessions were facilitated on a weekly basis according to 122 (87.1%) of the respondents.

4.5. Implementation of Environmental Infection Prevention and Control Measures

Table 5: Environmental Control Measures

Variable	n (%)
Frequency of keeping the windows open at the patient waiting area (if enclosed).	
Sometimes	22 (15.7%)
Always	4 (2.9%)
Never	2 (1.4%)
N/A (Not enclosed)	112 (80.0%)
Frequency of opening the windows and the door when examining patients at the chest clinic	
Sometimes	63 (45.0%)
Always	40 (28.6%)
Never	5 (3.6%)
N/A (Did not examine patients due to cadre)	32 (22.9%)
Frequency of health facility getting crowded with patients	
Sometimes	113 (80.7%)
Always	25 (17.9%)
Never	2 (1.4%)
Rooms at the health facility reported to have been fitted with any kind of mechanical ventilation	56 (40.0%)
Practised segregation of different types of medical waste	112 (80.0%)
Disposed different types of wastes separately in line with recommended guidelines	
No	36 (25.7%)
Yes	77 (55.0%)
N/A (Not directly involved in waste disposal)	26 (18.6%)

One hundred and twelve respondents reported that the patient waiting areas at their facilities were open while 22 (15.7%) reported that they sometimes kept the windows open while at the patient waiting area. The latter applied to respondents who served at facilities which had enclosed patient waiting areas.

While examining patients at the chest clinic, 63 (45.0%) of the respondents reported to sometimes keep the windows and doors open, and 40 (28.6%) reported to always keep them open. There were 5 (3.6%) who never kept either the windows or door open while examining patients at the chest clinic.

The respective facilities were reported to be sometimes crowded by 113 (80.7%) respondents while 25 (17.9%) of the respondents reported that they observed their facilities to be always crowded.

Fifty six, representing 40.0% of the respondents reported that the rooms at the health facility were fitted with some kind of mechanical ventilation.

Over three quarters of the respondents reported that they disposed different types of wastes separately in line with recommended guidelines.

One hundred and twelve, 80.0%, of the respondents reported that they practised segregation of the different types of medical waste.

4.6. Implementation of Personal Protective Infection Prevention and Control Measures

Table 6: Use of personal protective equipment by HCWs

Variable	n (%)
Used N-95 respirators while attending to patients	
No	130 (92.9%)
Yes	9 (6.4%)
N/A	1 (0.7%)
Reasons if didn't (n=130)	
Not available	128 (98.5%)
Not necessary	2 (1.5%)
Wore a lab coat while working at the facility	65 (46.4%)
Reasons if didn't (n=75)	
Not available	10 (13.3%)
Not necessary	3 (4.0%)
Not enough	62 (82.6%)
Used gloves when attending to patients	
No	83 (59.3%)
Yes	56 (40.0%)
N/A	1 (0.7%)
Reasons if Didn't (n=83)	
Not available	4 (4.8%)
Not necessary	5 (6.0%)
Not enough	74 (89.2%)
Personal protective equipment always readily available for use at the health facility	33 (23.6%)

Less than 10% of the respondents reported that they used N-95 respirators while attending to patients while 130 (92.9%) reported that they didn't. The reasons for not using N-95 respirators among those who didn't included lack of availability cited by 128 (98.5%) and the assumption that they were not necessary as cited by 2 (1.5%).

Sixty five, 46.4%, of the respondents reported to wear a lab coat while working at the facility. Among the 75 who reported otherwise, 62 (82.6%) reported that they were not enough while 10 (13.3%) said they were not available. Three (4%) thought that wearing a lab coat was not necessary.

Two fifths of the respondents, 56 (40.0%), reported that they used hand gloves while attending to patients. Those that reported not to use gloves, 83 (59.3%) cited insufficiency as the causative reason.

Of the 140 respondents, 33 (23.6%) reported that personal protective equipment were always available for use at their respective health facility.

4.7. Training of the HCWs on Infection Prevention and Control

Table 7: Training of the HCWs

Variable	n (%)
Ever received training on IPC Measures against TB in the health facility setting.	95 (67.9%)
Thought IPC measures against TB were necessary at the health facility	139 (99.3%)
Had the IPC policy guidelines within reach at the health facility	74 (52.9%)
Put into practice IPC measures known in day to day working at the health facility	33 (23.6%)

Two thirds of the respondents, 95 (67.9%), said that they had ever received training on IPC measures against TB in the health facility setting. The trainings included facility based CMEs, full course trainings, and seminars or workshops according to 67 (70.5%), 1 (1.1%), and 27 (28.4%) of the respondents respectively (Figure 3).

Almost all the respondents were of the opinion that IPC measures against TB were necessary at the health facility in order to avoid spread of TB between patients and staff.

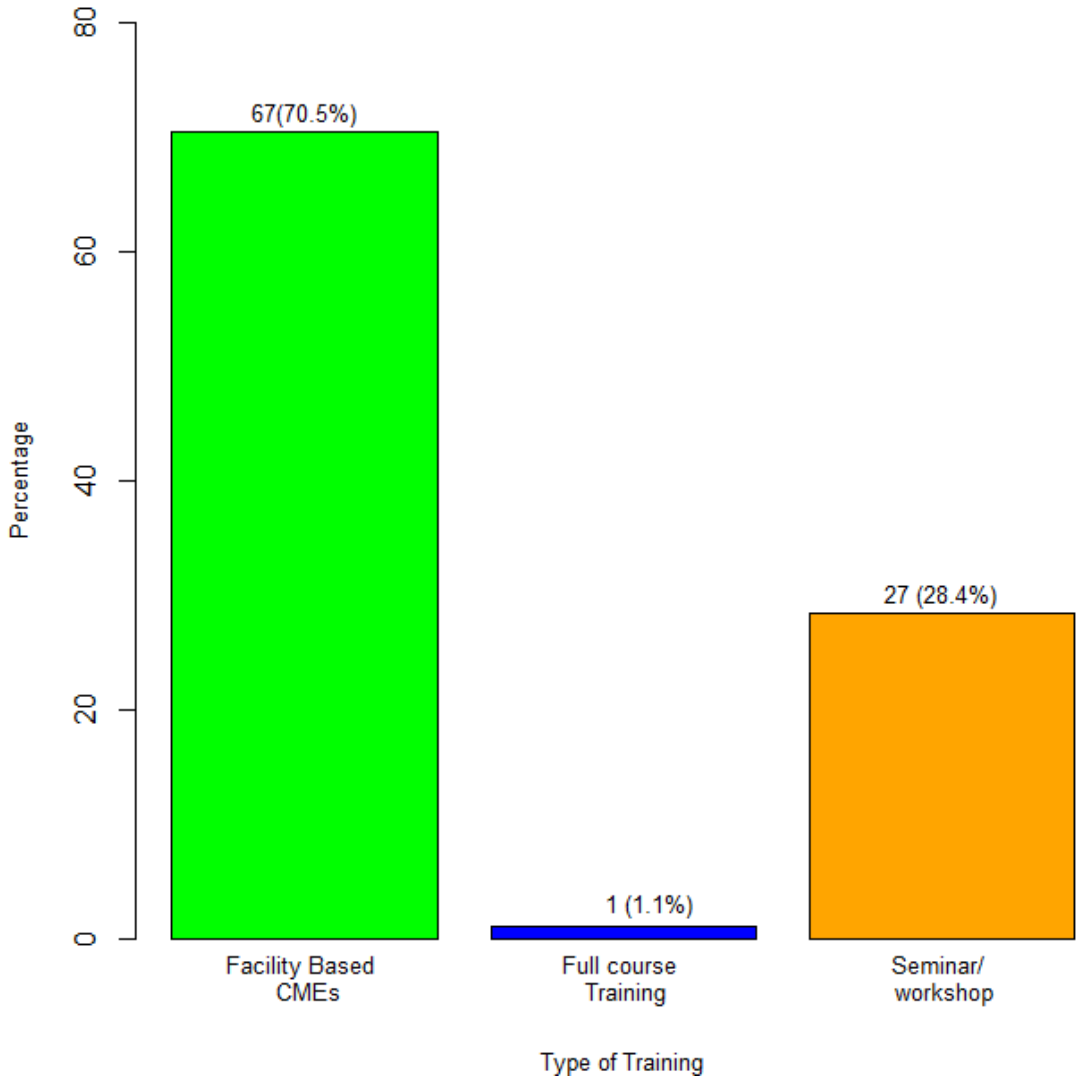


Figure 3: Type of training on TB-IPC received by the HCWs

Slightly above half of the respondents, 74 (52.0%), said that they had the TB-IPC policy guidelines within reach at their health facility. More than two thirds of those who had the guidelines, 51 (68.9%) said that they last referred to the guidelines more than a month before (Figure 4). Twenty three, representing 31.1%, reported to have referred to the guidelines less than a month before.

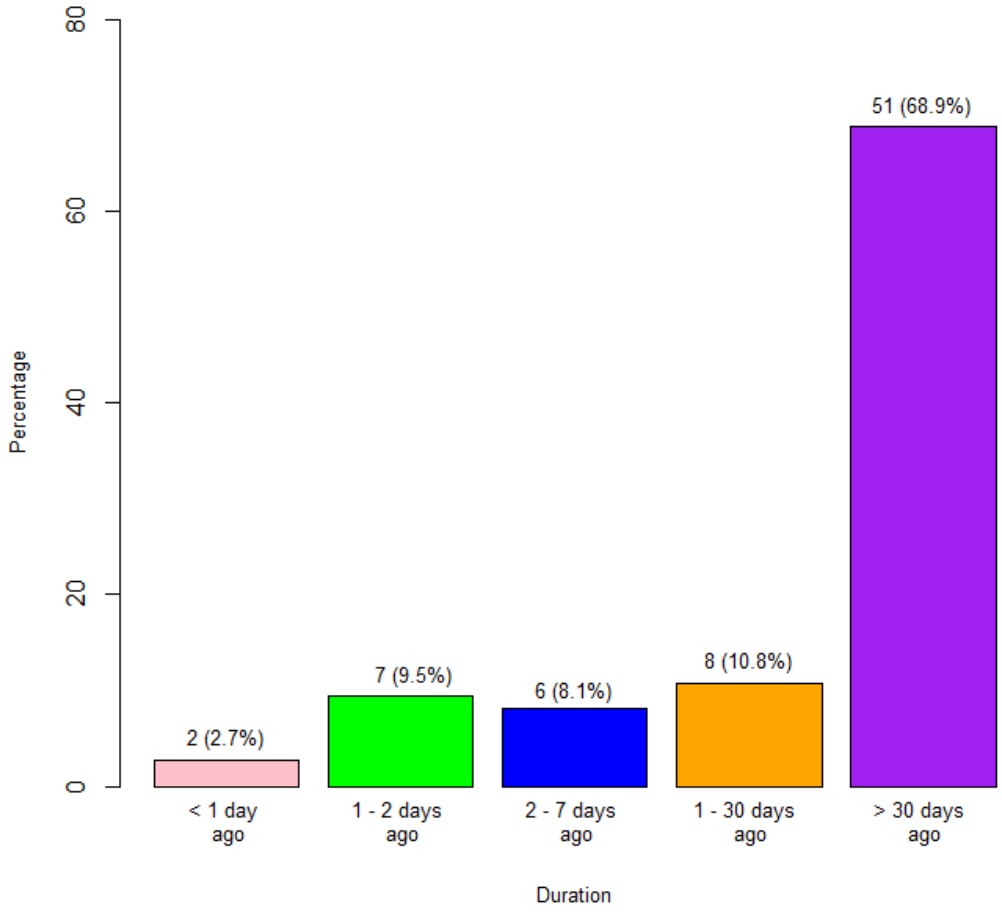


Figure 4: Time the HCWs last referred to the national guidelines

Thirty three, 23.6%, put into practice the IPC measures they knew in their day to day working at the health facility (Table 5).

4.8. Information from the Facility in charges

Table 8: Responses of the Facility in charges

Variable	n (%)
Type of Health facility	
Dispensary	4 (26.7%)
FBO/Mission	5 (33.3%)
Health Centre	3 (20.0%)
MOH SCH	3 (20.0%)
Presence of IPC committee or person designated at the health facility.	7 (46.7%)
Presence of IPC plan or checklist at the health facility.	11 (73.3%)
Any plan to develop an intervention programme if was not present (n=4)	
None	4 (100%)
Ever done training of staff on TB-IPC.	9 (60.0%)
Health personnel at the health facility disseminated health information on TB-IPC to patients.	15 (100%)
Presence of tracking system in place for all TB patients seen at the facility, all referrals and sputum smear results.	15 (100%)
Challenges faced by the health facility in adhering to stipulated TB-IPC measures.	
Lacked training on TB-IPC.	1 (6.7%)
Lacked training on TB-IPC and poor attitude.	1 (6.67%)
Lacked training on TB-IPC & inadequacy of some self-protective equipment.	4 (26.7%)
Lacked training on TB-IPC, inadequacy of some self-protective equipment & lack of resources.	9 (60.0%)
Facilities that were aware of the national TB-IPC policy and guidelines	15 (100%)
Facilities which had a copy of the guidelines available	10 (66.7%)
Facilities which had an isolation room for patients with severe cough symptoms	3 (20.0%)
Health staff received TB evaluation	
No	15 (100%)
Health staff offered HIV test annually	
No	15 (100%)
Health staff placed on ART if positive	N/A
HIV+ staff offered IPT	N/A
HIV+ staff reassigned to work in low-risk sections of the facility	N/A
Health authorities from the National TB Program visit the facility	15 (100%)
Latest time of visit by health authorities:	
Within:	
Last week	2 (12.3%)
Last month	13 (86.7%)

A total of 15 Facility in charges were interviewed. One third were from FBO/mission health facilities, 4 (26.7%) were from dispensaries.

Seven participants, representing 46.7%, reported that their facilities had an IPC committee or person designated to spearhead IPC at the health facility. 11 (73.3%) reported that there was an IPC control plan or checklist. The four facilities which did not have an IPC plan had also not put in place any initiative to develop an intervention programme.

Nine, 60.0%, of the key informants said that training of staff had ever been done on TB-IPC. In all the health facilities, health personnel disseminated health information on TB-IPC to patients. All the respondents reported to have a tracking system in place for TB patients seen at the facility, all referrals made and sputum smear results.

Challenges faced by the health facilities in adhering to stipulated TB-IPC measures included lack of training on TB-IPC, poor attitude among HCWs, inadequacy of some self-protective equipment, and lack of resources.

All the Facility in charges reported awareness of the national TB-IPC policies and guidelines. Of this number, only 10 (66.7%) had the guidelines available at the health facility. One fifth of the Facility in charges reported that they had an isolation room for patients with severe cough symptoms.

According to all the Facility in charges, HCWs serving in their respective facilities did not receive TB evaluation and were not offered any HIV test annually.

All the Facility in charges reported that health authorities from the National TB Program usually visited their facilities. The last time a visit was conducted was within the last week and within the last month according to 2 (12.3%) and 13 (86.7%) of the Facility in charges respectively.

4.9. Information on the Health Facilities

Table 9: Observation checklist results for administrative and environmental control measures

Variable	n (%)
ADMINISTRATIVE INFECTION CONTROL MEASURES AT THE HEALTH FACILITY	
Type of health facility	
Dispensary	4 (26.7%)
FBO/Mission	5 (33.3%)
Health Centre	3 (20.0%)
MOH Sub County Hospital	3 (20.0%)
IPC Plan present	10 (66.7%)
Triaging of patients based on cough symptoms	6 (40.0%)
Separation and isolation of patients done	3 (20.0%)
Timely diagnosis carried out	9 (60.0%)
Duration of Diagnosis (sputum turn-around time)	
0 - 6 hours	13 (86.7%)
12 – 24 hours	2 (13.3%)
Sputum collected in open area	13 (86.7%)
Prompt Initiation of Treatment	9 (60.0%)
Signage of cough etiquette	14 (93.3%)
ENVIRONMENTAL CONTROL MEASURES AT THE HEALTH FACILITY	
Adequate ventilation and lighting in Patient Waiting area (Ventilation deemed adequate if the windows cover atleast 20% of the total surface area of the room)	
No	3 (20.0%)
N/A	12 (80.0%)
Adequate ventilation and lighting in consultation room	
No	9 (60.0%)
Yes	6 (40.0%)
Adequate ventilation and lighting in medical wards	
No	3 (20.0%)
Yes	7 (46.7%)
N/A	5 (33.3%)
Presence of mechanical ventilation in rooms	
No	9 (60.0%)
Yes	6 (40.0%)
Type of ventilation in consultation room	
Natural	14 (93.3%)
Natural & mechanical ventilation	1 (6.7%)
Setup of consultation room in relation to type of ventilation	
Not recommended	6 (40.0%)
Recommended (Airflow → HCW →Patient)	9 (60.0%)
Crowding of patients at the health facility (Observed through the course of one week)	
No	9 (60.0%)
Yes	6 (40.0%)

The health facilities that were subjected to the checklist were 15, of which 26.7% were dispensaries and 33.3% were FBO/Mission health facilities.

It was established that 10 (66.7%) had the IPC plan present, 6 (40.0%) of the health facilities triaged patients based on cough symptoms, and 3 (20.0%) separated and isolated patients with severe cough symptoms.

It was observed that timely diagnosis was carried out in 9 (60.0%) of the health facilities. In 13 (86.7%) of the health facilities visited, it was noted that diagnosis of TB took at most 6 hours and between 12 to 24 hours in 2 (13.3%) health facilities. Sputum was collected in an open area in 13 (86.7%) health facilities and prompt initiation of treatment was observed to be done in 9 (60.0%) health facilities. Signage of cough etiquette was observed in 14 (93.3%) health facilities.

Adequacy in ventilation and lighting in the patient waiting area was not applicable to 12 (80.0%) of the health facilities since the patient waiting areas in those facilities was open. However, 3 (20.0%) facilities lacked proper ventilation and lighting in their patient waiting areas which were enclosed.

It was observed that there was no adequate ventilation and lighting of the consultation room in 9 (60.0%) health facilities while six, 40.0%, had adequate lighting and ventilation.

The medical wards were not adequately ventilated and lit in 3 (20.0%) of the health facilities. Adequacy in ventilation and lighting was, however, not applicable to 5 (33.3%) of the facilities since they did not have medical wards. Mechanical ventilation was available in 6 (40.0%) but not 9 (60.0%) of the health facilities. Natural ventilation was observed in 14 (93.3%) of the health facilities while both

mechanical and natural ventilation observed in one health facility. Setup of the consultation rooms in relation to available ventilation was observed to violate recommended guidelines in 6 (40.0%) but conformed in 9 (60.0%) of the health facilities.

Crowding of patients was observed in 6 (40.0%) of the health facilities with 9 (60.0%) not having crowding. Observation was carried out at each facility over the course of one week.

Table 10: Observation checklist results for use of self-protective control measures and laboratory safety

Variable	**n (%)**
USE OF SELF-PROTECTIVE IPC MEASURES BY HCWS	
Used N-95 Respirators	2 (13.3%)
Used Lab Coats	4 (26.7%)
Used hand gloves	4 (26.7%)
LABORATORY SAFETY	
Adequate natural ventilation and lighting	4 (26.7%)
Mechanical ventilation in place and in use	5 (33.3%)
Biological Safety Cabinet available	10 (66.7%)
Used appropriate lab coats	0 (0.0%)
Used N-95 respirators	2 (13.3%)
Used Gloves	14 (93.3%)
Good quality of specimens processed (seal of sputum container intact; sputum is mucopurulent)	14 (93.3%)
Hand washing facilities available	8 (53.3%)
Proper waste Disposal	6 (40.0%)
Waste segregation	11 (73.3%)

Personal protective equipment was not being utilized well by the HCWs. It was observed that only 2 (13.3%), 4 (26.7%), and 4 (26.7%) used N-95 respirators, lab coats, and hand gloves respectively.

The laboratories were observed to have adequate natural ventilation and lighting in 4 (26.7%) of the health facilities while 5 (33.3%) had mechanical ventilation. A biological safety cabinet was available in 10 (66.7%) of the health facilities.

There was no health facility that had staff working at the laboratory using appropriate lab coats. N-95 respirators were observed to be in use in only 2 (13.3%) of the health facilities while hand gloves were in use in 14 (93.3%) of the facilities.

Good quality specimens were observed to be processed in 14 (93.3%) of the health facilities and 8 (53.3%) had hand washing facilities available. Waste disposal was done properly in 6 (40.0%) of the health facilities. Segregation of medical waste was observed in 11 (73.3%) of the health facilities.

4.10. Factors Associated with Implementation of IPC Measures.

4.10.1. Association between Cadre and Implementation of IPC Measures

Table 11: Association between Cadre and implementation of IPC Measures

		Cadre						
	N	CO N = 23	Lab staff N = 17	MO N = 4	Nurse N = 53	PHO N = 6	Support staff N = 37	Fisher's Exact test (P-value)
Administrative control measures								
Triaging of patients carried out upon their arrival at the health facility:	140	15 (65.2%)	9 (52.9%)	4 (100.0%)	34 (64.2%)	1 (16.7%)	18 (48.6%)	0.085
Patients with severe cough symptoms separated and isolated from others:	139	4 (17.4%)	3 (17.6%)	1 (25.0%)	9 (17.3%)	0 (0.0%)	11 (29.7%)	0.579
Environmental control measures								
Windows open in waiting bay (Always/Sometimes vs. Never):	28	3 (100.0%)	3 (75.0%)	1 (100.0%)	10 (100.0%)	2 (100.0%)	7 (87.5%)	0.564
Windows open in chest clinic (Always/Sometimes vs. Never):	108	23 (100.0%)	16 (100.0%)	4 (100.0%)	53 (100.0%)	1 (100.0%)	6 (54.5%)	<0.001
Segregation of waste:	138	19 (82.6%)	14 (82.4%)	4 (100.0%)	42 (82.4%)	4 (66.7%)	29 (78.4%)	0.894
Self-protective measures								
Used N95 respirators while attending to patients:	139	2 (8.7%)	2 (11.8%)	0 (0.0%)	4 (7.5%)	0 (0.0%)	1 (2.8%)	0.777
Wore lab coat:	140	15 (65.2%)	17 (100.0%)	4 (100.0%)	22 (41.5%)	0 (0.0%)	7 (18.9%)	<0.001
Personal protective equipment readily available:	139	5 (21.7%)	6 (35.3%)	1 (25.0%)	11 (21.2%)	0 (0.0%)	10 (27.0%)	0.635

Compared to the other cadres, the support staff were less likely to have the windows of the chest clinic open ($p<0.001$), and less likely to wear lab coats while attending to patients ($p<0.001$).

4.10.2. Association between Level of Health Facility and Implementation of IPC Measures

Table 12: Association between Level of Health Facility and Implementation of IPC Measures

		Health facility level			
		DISP. N = 23	FBO/MISSION N = 44	HEALTH CENTRE N = 30	MOH SCH N = 43	Fisher's Exact test (P-value)
Administrative control measures						
Triaging of patients carried out upon their arrival at the health facility:	140	1 (4.3%)	44 (100.0%)	9 (30.0%)	27 (62.8%)	<0.001
Patients with severe cough symptoms separated and isolated from others:	139	0 (0.0%)	27 (61.4%)	1 (3.4%)	0 (0.0%)	<0.001
Environmental control measures						
Windows open in waiting bay (Always/Sometimes vs. Never):	28		12 (100.0%)	13 (100.0%)	1 (33.3%)	0.008
Windows open in chest clinic (Always/Sometimes vs. Never):	108	17 (100.0%)	31 (91.2%)	22 (100.0%)	33 (94.3%)	0.473
Segregation of waste:	138	2 (8.7%)	43 (100.0%)	27 (90.0%)	40 (95.2%)	<0.001
Self-protective measures						
Used N95 respirators while attending to patients:	139	0 (0.0%)	9 (20.9%)	0 (0.0%)	0 (0.0%)	<0.001
Wore lab coat	140	6 (26.1%)	30 (68.2%)	12 (40.0%)	17 (39.5%)	0.004
Personal protective equipment readily available:	139	0 (0.0%)	30 (68.2%)	0 (0.0%)	3 (7.1%)	<0.001

Faith-based organizations and mission hospitals as well as the MOH sub-county hospitals were more likely to triage the patients ($p<0.001$) compared to the dispensaries and health centres. The faith-based organizations/mission hospitals were more likely to isolate patients with severe cough symptoms ($p<0.001$).

The windows at the enclosed patient waiting areas were always or sometimes open according to all of the respondents from the FBO/mission hospitals ($p = 0.008$). The FBO/Mission hospitals, and the health centres were more likely to be segregating waste ($p<0.001$) in comparison to the dispensaries.

Participants from all the health facilities reported that they were less likely to use N95 respirators while attending to patients except from the FBO/mission hospitals ($p<0.001$). Participants from the FBO/mission hospitals were more likely to wear a lab coat while working at the facility ($p=0.004$). Personal protective equipment was more likely to be always readily available for use at the FBO/mission hospitals ($p<0.001$) as compared to the dispensaries and health centres.

4.10.3. Association between Years of Service of the HCWs and Implementation of IPC Measures

Table 13: Association between Years of Service and Implementation of IPC Measures

			Years of service Median (IQR) N = 140	Wilcoxon rank-sum test (P-value)
Administrative control measures				
Triaging of patients carried out upon their arrival at the health facility	59	No	8.0 (4.0, 13.5)	
	81	Yes	9.0 (4.0, 14.0)	0.939
Patients with severe cough symptoms separated and isolated from others	111	No	8.0 (4.0, 14.0)	
	28	Yes	7.0 (4.0, 11.0)	0.497
Environmental control measures				
Windows open in waiting bay	26	Always/Sometimes	9.5 (5.0, 15.0)	0.531
	2	Never	7.0 (5.5, 8.5)	
Windows open in chest clinic	103	Always/Sometimes	9.0 (5.0, 14.0)	0.164
	5	Never	4.0 (3.0, 5.0)	
segregation of waste	26	No	7.0 (3.2, 12.0)	
	112	Yes	8.5 (4.0, 13.2)	0.310
Self-protective measures				
Used N95 respirators while attending to patients	130	No	8.0 (4.0, 14.0)	
	9	Yes	8.0 (3.0, 11.0)	0.345
Wore lab coat	75	No	8.0 (4.5, 14.0)	
	65	Yes	8.0 (4.0, 12.0)	0.544
Personal protective equipment readily available	106	No	8.5 (4.0, 14.8)	
	33	Yes	8.0 (4.0, 11.0)	0.405

There was no evidence of any relationship between the years of service of the HCWs and implementation of administrative, environmental and personal protective TB-IPC measures.

4.11. Factors Associated with Training of HCWs on IPC Measures

Association was done between cadre, health facility category, and years of participant's experience with training of participants on IPC measures against TB. The results were as follows:

Table 14: Factors Associated with Training of HCWs

	Trained		
	No	**Yes**	**P**
Cadre			
CO	4 (17.4%)	19 (82.6%)	
Lab staff	4 (23.5%)	13 (76.5%)	
MO	0 (0.0%)	4 (100.0%)	<0.0001[f]
Nurse	9 (17.0%)	44 (83.0%)	
PHO	2 (33.3%)	4 (66.7%)	
Support staff	26 (70.3%)	11 (29.7%)	
Level/category of health facility			
Dispensary	18 (78.3%)	5 (21.7%)	
FBO/Mission	11 (25.0%)	33 (75.0%)	<0.0001[f]
Health Centre	8 (26.7%)	22 (73.3%)	
MOH sub-county Hospital	8 (18.6%)	35 (81.4%)	
Years of service	5.0 (3.0, 12.0)	10.0 (5.0, 15.0)	0.233[W]

[f]Fisher's exact test;
[w]two - sample Wilcoxon rank-sum test.

There was evidence of association between cadre of the HCWs and receipt of training ($p<0.0001$). The receipt of training was high among the nurses, clinical officers, and medical officers. Only 30.0% of the support staff had received any training.

Health facility level was associated with training of staff ($p<0.0001$). The MOH sub-county hospitals and FBO/mission hospitals were more likely to have staff that had undergone training compared to dispensaries and health centers.

There was no evidence of any relationship between the years of service and receipt of training ($p=0.233$).

CHAPTER FIVE

DISCUSSION OF STUDY FINDINGS

5.1. Introduction

This chapter elaborates on the interpretation of the study findings, relating them to the study objectives. It explains the significance of the findings and explores their relevance as well as outlines how they compared to other published research studies.

5.2. Administrative Infection Prevention and Control Measures

Administrative control measures are the most important among the three levels of TB-IPC. It is important that great consideration is put in ensuring that these measures are adequately implemented in the hospital setting to prevent nosocomial TB.

5.2.1. Information from HCWs

It is important to carry out triaging of patients immediately they enter the health facility. This assists in identifying those with cough symptoms and who may be infectious if left for prolonged periods of time with the other patients. Slightly more than half of the respondents, 81 (57.9%) reported that they undertook triaging of patients in their individual capacity at their respective health facilities. This contradicted findings of a study done by Mphahlele et al. (2009) in South Africa whereby triage of patients upon entry was not practised in any of the health facilities assessed due to lack of awareness on importance of the same. However, the results were in line with findings of another study by Reid et al. (2012), which found that triaging was done by 60.0% of HCWs in facilities that were investigated.

Isolation of patients more so with severe cough symptoms ought to be carried out to avoid possible spread of the germ to other patients as well as HCWs serving at the

facility. Only 28 (20.0%) of the respondents carried out isolation of patients based on severe cough symptoms. This contrasted a study done in South Africa where cohorting of patients was not practised in any of the facilities assessed and TB patients shared waiting rooms with other patients upon entry (Mphahlele et al., 2012). In another study done in South Africa by Kanjee et al. (2011), TB cases were not prioritized in the outpatients/admissions department and there was no separate waiting area for TB patients. Only the male TB ward had an isolation unit for drug-resistant TB cases.

All the respondents 140 (100.0%) reported that they facilitated health education sessions for patients at the health facility. There was difference in frequency of facilitation with majority, 122 (87.1%) doing it on a weekly basis, 9.3% doing it on a daily basis and only 5 (3.6%) on a monthly basis. In a study done in Mozambique by Brouwer et al. (2015), it was found that 91.0% of staff gave health education on different aspects of TB and instructed patients on sputum collection. This was carried out after being sensitized on TB-IPC.

5.2.2. Information from Facility in charges

Eleven out of fifteen of the health facilities (73.3%) assessed had an IPC plan or checklist on site. Only 7 (46.7%) of the facilities had an IPC committee or a person designated to oversee implementation of IPC measures. This was much lower in comparison to results of an assessment conducted in 2011 of three district hospitals with specialized MDR-TB wards in Kwa-Zulu Natal. It found that all three hospitals had a written TB-IPC policy and a dedicated TB-IPC committee (Tudor et al., 2013). Findings also contradicted those of another study done in South Africa by Franz et al. (2010), where none of the clinics investigated had a written TB-IPC plan.

Furthermore, the findings contrasted those of a study also done in South Africa by Malangu et al. (2015), whereby the major shortcomings identified at health facilities were the non-existence of a TB-IPC committee and a TB-IPC plan as well as the lack of evidence that the control plan had been reviewed.

In 2011, a TB-IPC assessment of 337 public health facilities in South Africa reported that only 61.0% of the facilities had a written TB-IPC policy and 65.0% of these facilities had a committee or person in charge of TB-IPC in the facility (Peters et al., 2012). In a different study carried out in Nigeria by Ogbonnaya et al. (2011), only 8.3% of facilities had a documented TB-IPC policy whereas 16.7% had an IPC committee and 41.7% had an infection control officer.

Training of staff on IPC was found to have been organized and carried out in 9 (60%) of the health facilities. The finding contrasted that of a study done in South Africa, which found out that annual IPC training was available in 38.0% of the facilities which were involved in the study (Farley et al., 2012).

The HIV epidemic has impacted greatly on the issue of TB among HCWs. The HIV epidemic has resulted in an increase in patient burden in health care facilities, particularly at the primary care level. The increased patient burden, particularly with regard to very sick patients with HIV-related TB, has increased HCWs exposure to occupational diseases such as TB. In addition to this, data from a number of studies show that 11-20% of HCWs are HIV-positive (Kranzer et al., 2010; Connelly et al., 2007). Findings derived from the 15 facilities in Muhoroni sub-county highlighted that none of the health facilities had provision for annual evaluation of HCWs for both TB and HIV. None had any documentation on the same. This was of serious concern since WHO recommends regular evaluation of HCWs for TB and HIV. The HCWs

found to be HIV positive should be placed on ART, offered IPT against TB and reassigned to work in low-risk sections of the facility. The findings were divergent with those of a study done by Farley et al. (2012) whereby 50.0% of the facilities conducted annual TB screening of HCWs. Furthermore, the findings also contrasted those of five other studies reported on TB screening in HCWs (Claassens et al., 2013; Dwadwa et al., 2010; Farley et al., 2012; Tudor et al., 2013; Tshitangano et al., 2013).

The Joint WHO-ILO-UNAIDS Policy Guidelines on improving HCWs' access to HIV and TB prevention, treatment, care and support services. It outlines various recommendations with regard to policy, access to care, workplace practices, adequate budgeting and the need for monitoring and evaluation (Naidoo et al., 2012). The guideline promotes the strengthening of occupational health policy to better protect HCWs and advocates for regular screening, improved infection control, and access to prophylactic and effective treatment for those at risk of or infected with TB and HIV (WHO-ILO-UNAIDS., 2010).

Only 3 (20.0%) of the Facility in charges across the health facilities revealed that there was an existing isolation room for patients with severe cough symptoms. The findings were in line with those of a study done in South Africa which found that TB cases were not prioritized in the outpatients/admissions departments of the health facilities in question. There was also no separate waiting area for TB patients due to lack space (Kanjee et al., 2011).

5.2.3. Observed Administrative Infection Prevention and Control Measures

Slightly more than half of the health facilities, 9 (60%), were observed to prioritize timely diagnosis of patients at the waiting area. This was in contrast with findings from a study done in Nigeria where only 8.3% of the facilities had HCWs

intermittently checking for patients with cough in the waiting hall (Ogbonnaya et al., 2011). A considerably higher percentage of health facilities in Muhoroni sub-county, 10 (66.7%), were observed to have an IPC plan in place. This was in line with the Kenya national guidelines on TB-IPC.

Having a comprehensive IPC plan and overseeing its proper implementation is important for TB-IPC. In a study done in the Philippines, among the ten components assessed, 28.1% of the health centres did not implement an IPC plan as required. This represented a relatively higher proportion of health centres from the two cities involved in the study. This could be attributable to the fact that there was no specific TB-IPC policy, hence, was not regulated through the NTP guidelines (Guohong et al., 2009). Another study done in Mozambique found out that guidelines for diagnosis and treatment of presumptive TB patients were not present in all facilities which participated (Brouwer et al., 2015). Findings from both studies carried out in the Philippines and Mozambique contradicted those of this research.

It was observed that less than half, 6 (40%), of the health facilities carried out triaging of patients based on cough symptoms. Triaging is vital to ensure that the infectious patients are prioritized and attended to promptly so as to considerably reduce the time of exposure in contact with other patients as well as HCWs at the facility. In a study done by Franz et al. (2010) in South Africa whose findings were not in line with those of this research, 20.0% of facilities triaged patients on entry, 20.0% prioritized attendance of coughing patients, 27.0% masked coughing patients and 13.0% ensured that drug-resistant patients attended clinic on specific days.

There was a significantly higher proportion of health facilities, 13 (86.7%), which ensured collection of sputum was done in an open area. It is necessary to adapt this

practice so as to minimize the chance of spread of the TB germ as compared to doing the same in an enclosed space without proper ventilation and adequate sunlight. The proportion was higher than that of a study done by Franz et al. (2010), in which sputum was collected outside in 73.0% of the health facilities.

Nine (60.0%), of the health facilities were observed to promptly initiate diagnosis and subsequent treatment of patients eliciting cough symptoms. Special steps should be taken in settings other than TB clinics. Patients with symptoms suggestive of undiagnosed or inadequately treated TB disease should be promptly referred so that they can receive a medical evaluation.

An overwhelming majority of the health facilities, 14 (93.3%), displayed signage of cough etiquette. This was alluded to the availability of Information, Education and Communication (IEC) materials which are supplied by the Ministry of Health in sufficient quantities. The observation was in sharp contrast to a study done in South Africa where only 40.0% of health facilities displayed patient education on cough hygiene (Franz et al., 2010). In another study done in Nigeria, no facility had IEC materials reminding patients and HCWs of the possibility of TB transmission in the health care setting (Ogbonnaya et al., 2011).

5.3. Environmental Infection Prevention and Control Measures

5.3.1. Information from HCWs

Twelve (80%) of the health facilities had an outdoor patient waiting area. This was appropriate in controlling congestion and ensuring adequate sunlight which is essential in minimizing risk of spread of the TB germ from patients who may be infected and are contagious. This contrasted documentation from a similar study done in South Africa where 47.0% of facilities were found to have outdoor waiting areas

(Franz et al., 2010). In another study done in Nigeria, all the patient waiting halls were open and well ventilated (Ogbonnaya et al., 2011).

A larger proportion of the HCWs, 63 (45.0%), reported to keep the windows open sometimes when attending to and examining patients in the chest clinic. A smaller proportion, 40 (28.6%) reported to keep the windows open at all times while 5 (3.6%) never kept them open. These findings contradicted those from a study done in the Western Cape Province of South Africa where none of the facilities had windows opened on both sides of the TB consulting room (Mphahlele et al., 2012). In another study done by Naidoo et al. (2012), all of the clinics assessed relied on natural ventilation but in the majority of the clinics the windows remained closed the whole day. Zelnick et al. (2013), also documented that although HCWs interviewed in their study were aware that windows should be kept open, the open window policy was not consistently observed in cold weather and some rooms in the healthcare facilities did not have windows.

A significant proportion of HCWs, 113 (80.7%), interviewed revealed that their respective health facilities were sometimes crowded with patients. Twenty five (17.9%) reported that their facilities were always crowded. In a study in Nigeria, Ogbonnaya et al., (2011), found out that 25.0% of consultation rooms in the health facilities involved in their specific study were overcrowded.

Less than half of the health facilities, 56 (40.0%), had their rooms fitted with any kind of mechanical ventilation. This compared differently with results from a study done in South Africa where health facilities investigated had the following in terms of environmental infrastructure: 27.0% had ultra-violet light, none had a ultra-violet light maintenance plan, 27.0%, and 20.o% had extraction fans that worked (Tudor et al.,

2012). In another study done in Nigeria, no facility was seen to have mechanical ventilation in terms of air cleaners since they are expensive to acquire (Ogbonnaya et al., 2011).

5.3.2. Observed Environmental Infection Prevention and Control Measures

Having natural or mechanical ventilation contributes to prevention of TB transmission by minimizing the concentration of TB infectious droplets in the air. Only 6 (40%) of the consultation rooms across the health facilities were observed to have adequate ventilation and lighting. Ventilation of the rooms was assessed by observing the size of the windows in comparison with the overall surface area of the room.

The type of ventilation was also put into consideration. Fourteen (93.3%) of the consultation rooms in the health facilities relied on natural ventilation only 1 (6.7%) depended on both natural and mechanical ventilation. Furthermore, less than half of the medical wards, 7 (46.7%), were observed to have sufficient ventilation. These findings did not resonate with those of a study done in Mozambique whereby using a pragmatic '20% rule', 52% of the rooms assessed had adequate ventilation (Brouwer et al., 2015). However, they were consistent with those of another study done in the Philippines where ventilation in some of the consultation rooms and waiting areas was not in good condition (Guohong et al., 2009).

The setup of consultation rooms in relation to available ventilation in 9 (60.0%) of the health facilities adhered to the format recommended by the NLTP guidelines. This drew contrast with findings from a research conducted by Malangu et al. (2015) where staff members failed to comply with the requirement to sit with their backs towards the direction of airflow; only in 23.6% of facilities was this requirement complied with.

Six (40.0%) of the health facilities were observed to have mechanical ventilation in the rooms. This was mostly in form of electric fans. The findings are in line with those of a study done in South Africa where 40.0% of the facilities used mechanical ventilation. However, there was no provision of standby generators in case of power outages. The same was the case with the health facilities in Muhoroni sub-county which had mechanical ventilation. None of the facilities in both studies had upper-room ultra-violet germicidal irradiation (Mphahlele et al, 2012).

Safety in the laboratory is without doubt a key component of TB-IPC in the health facility setting. Laboratories in only 4 (26.7%) of the facilities were observed to have adequate natural ventilation and lighting while 5 (33.3%) had mechanical ventilation in place. About two-thirds of the laboratories had a biological safety cabinet available as recommended by WHO to facilitate safe processing of specimens without exposing the laboratory workers to risk of infection. Good quality specimens were observed at the laboratories in 14 (93.3%) of the health facilities. Eight (53.3%) of the facilities were observed as having the recommended hand washing facilities within the laboratory. According to the national guidelines on TB-IPC, proper disposal of waste more so in the laboratory is a vital function. Only 40% of the laboratories across the health facilities practised proper waste disposal with 11 (73.3%) having an appropriate and functional waste segregation system in place.

5.4. Personal Protective Infection Prevention and Control Measures

5.4.1. Information from HCWs

Only 9 (6.4%) of respondents reported to normally use N-95 respirators while attending to patients. This was alluded to the fact that they were not available in all

but one of the health facilities. This drew sharp contrast with a study done in South Africa where N-95 respirators were available and in use in 80.0% of the facilities (Mphahlele et al., 2012).

Healthcare workers are aware of the policy regarding the use of N95 respirators but they rarely use the respirators due to the following reasons: not consistently available in some health care facilities, high level of discomfort when wearing the respirator, lack of fit testing and training in use of the respirator (Zelnick et al., 2013). Findings from the study are in line with this since a significant proportion of the HCWs, 74 (89.2%) reported that they did not use personal protective equipment always since they are not consistently in adequate supply at the health facilities. The findings were also consistent with those of a study done by Farley et al. (2012) where HCWs at all training levels were witnessed in 21 (88%) facilities entering drug-resistant TB wards without N-95 respirators. No facility offered fit-testing for use of these respirators. Furthermore, when visits did occur inside the wards, no facility offered N-95 respirators to visitors.

A small proportion, 33 (23.6%) of the respondents reported that personal protective equipment was always readily available for use at the health facility. This differed from the outcomes of studies by Franz et al. (2010) which found that 67.0% of the clinics always had N-95 respirators and by Farley et al. (2012) where personal protective equipment including N-95 respirators was uniformly available in all of the facilities assessed.

5.4.2. Observed Personal Protective Measures

A worryingly small proportion of facilities, 2 (13.3%) were observed to have staff who were using N-95 respirators during the visits to the fifteen health facilities within Muhoroni sub-county. This result is somewhat in line with that of a study done in South Africa in which 88% of the facilities' HCWs of all levels were seen without N-95 respirators (Farley et al., 2012). Similarly, in another study done by Franz et al. (2010), only 30.0% of HCWs had respirators in use. However, the findings contradicted that of a study carried out in Mozambique which found that three quarters of the HCWs had N-95 respirators. Despite a much larger proportion of the HCWs having the N-95 respirators, only 36.0% knew how to use it correctly (Brouwer et al., 2015.) In yet another study, 22.0% of the clinics had N-95 masks available for use but on risk assessment days, none of the nurses were seen to wear them when attending to patients (Naidoo et al., 2012).

5.5. Factors Associated with Implementation of Infection Prevention and Control Measures

5.5.1. Information from HCWs

Findings from the study revealed that the faith-based organizations/mission hospitals were more likely to triage patients ($p<0.001$) compared to the dispensaries and the health centres. This resonated with findings from a study carried out by Reid et al. (2012) which showed that characteristics associated with greater likelihood of practising triage included private vs primary facilities with the primary facilities being of a lower level. The Faith-based organizations/mission hospitals were also more likely to isolate patients with severe cough symptoms ($p<0.001$).

Tests of association showed that there was greater likelihood of implementation of administrative TB-IPC measures at the larger health facilities like the MOH sub-county hospital as compared to the smaller ones which included the dispensaries. These findings were in line with those from a study done by Gilks (2006), whereby bivariate analysis demonstrated that tertiary sites, which were invariably also larger sites, were more likely to have adopted TB-IPC plans. These measures were also more prevalent at facilities with on-site anti tuberculosis treatment than those where TB treatment was only available off-site.

Findings showed that participants from all of the health facilities responded that they were less likely to use N-95 respirators while attending to patients except from the FBO/Mission hospitals ($p<0.001$). Personal protective equipment was more likely to be always readily available for use at the health facility ($p<0.001$) at the MOH sub-county hospital and FBO/mission hospitals as compared to the dispensaries and health centres. These findings were consistent with those from a study done by Reid et al. (2012) which showed that characteristics associated with a greater prevalence of particulate respirator availability included urban vs. rural location as well as tertiary vs. primary facility.

5.6. Training Received by the Healthcare Workers

5.6.1. Information from HCWs

Studies investigating knowledge, attitude and practice of HCWs suggest the need for regular TB-IPC training programs (Kanjee et al., 2011; Kanjee et al., 2012; Farley et al., 2012). In another study, TB-IPC training was compulsory at 20% of the facilities (Mphahlele et al., 2012). Findings from this study showed that majority of the

respondents, 95 (67.9%), reported to have ever had training on IPC measures against TB in the health facility setting.

Slightly above half of the HCWs, 74 (52.9%), were aware of the TB-IPC guidelines and had them within reach at their respective health facilities. This was not in agreement with a study done by Dwadwa et al. (2010) where HCWs were reasonably knowledgeable of TB-IPC policy and practice. 99.3% of the respondents interviewed thought that IPC measures against TB were necessary in the fight against nosocomial spread. This was in line with a study done by Kanjee et al. (2011) in which all of the HCWs agreed that it was important to prevent the spread of TB in the hospital and that TB-IPC tasks were important. However, there was great contradiction with another research done by Kanjee et al (2012), which found that a third of the HCWs surveyed "would not be bothered very much by catching TB." Almost a quarter (22.8%) of the surveyed HCWs thought that TB-IPC was worthless.

None of the respondents reported that they lacked any training on IPC. This was not in tandem with results from a study done by Adams (2012) where a considerable proportion (38%) reported having had no training to protect themselves from infection while 43.0% reported having had no training to prevent spread of TB between patients.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

The study's main objective was to evaluate the implementation of IPC measures against nosocomial TB among HCWs at health facilities in Muhoroni sub-county. This therefore enabled the formulation of recommendations in the bid to improve implementation of IPC measures geared towards reduction of risk of TB infection in the hospital setting. This chapter elaborates upon the conclusions arrived at and the recommendations suggested for action so as to improve on the status of implementation of these TB-IPC measures.

6.2. Conclusion

Implementation of administrative TB-IPC measures by HCWs in Muhoroni sub-county was found to fall below the recommended standards in the national TB-IPC guidelines. Slightly over half of the HCWs carried out triaging of patients based on cough symptoms upon their arrival at the health facility while only 10 facilities had an IPC plan present.

Environmental infection control measures were not being put into practice across the facilities in Muhoroni sub-county. Less than half of the HCWs in Muhoroni sub-county kept the window open sometimes when examining patients with some admitting that they never kept the windows open when attending to patients. A smaller proportion of the health facilities was observed to have adequate ventilation and lighting in the consultation rooms and medical wards.

There was dismal use of personal protective equipment by the HCWs since a very small proportion was observed to be wearing N-95 respirators, lab coats and hand gloves during the time spent at the health facilities.

Compared to the other cadres, the support staff were less likely to implement TB-IPC measures. FBOs, mission hospitals and the MOH sub-county hospital were more likely to implement TB-IPC measures compared to the dispensaries and the health centres. There was no evidence of any relationship between the years of service of the HCWs and implementation of TB-IPC measures.

The proportion of HCWs who had received training on TB-IPC was inadequate. Two thirds of the respondents reported to have had some form of training. Majority of those who had received training did so through facility based CMEs with close to one-third having attended a training seminar/workshop. The proportion that had undergone a full training course on TB-IPC was significantly low.

There was evidence of association between cadre of the HCWs and receipt of training which was more likely among the nurses, clinical officers, and medical officers. Health facility level was associated with training of staff with the MOH sub-county hospital and FBO/Mission hospitals more likely to have staff that had undergone training compared to dispensaries and health centers. There was no evidence of any relationship between the years of service and receipt of training.

6.3. Recommendations

Based on the foregoing findings and conclusions, the following are recommendations made in the bid to improve implementation of TB-IPC measures among HCWs serving at TB diagnostic and treatment sites in Muhoroni sub-county.

6.3.1. Individual Level

1. There is need for HCWs to be provided with more education on administrative TB-IPC measures since they rank highest in ensuring chances of TB spread in the hospital setting are minimized.
2. It is common practice for HCWs to be engaged in their duties without putting on personal protective wear despite the equipment being available at the health facility. They include N-95 respirators, gloves and lab coats. The use of these equipment by HCWs should be a mandatory requirement and compliance to the same must be enforced.
3. The HCWs should be enthusiastic to attend any training on TB-IPC that is organized at the facility level or at the County level whenever an opportunity arises. On-job training can also play a big role in ensuring that the individual HCW is knowledgeable on TB-IPC measures.

6.3.2. Health Facility Level

1. Adequate administrative measures like early diagnosis and segregation of infectious TB patients, improved ventilation and increased sunlight in waiting rooms of health facilities, education and training of HCWs in appropriate TB-IPC measures and competent management systems to ensure that vital TB-IPC measures are implemented are some of the issues that need to be addressed to reduce the risk and prevent transmission of TB to HCWs (Baussano et al., 2011; Joshi et al., 2006). Each facility should develop an IPC plan and have a functional IPC Committee as well as designated individual tasked with overseeing implementation of IPC measures.

2. The health facility administration should work with the county government to ensure the facilities are consistently stocked with sufficient relevant personal protective equipment. Renovation of buildings to meet stipulated standards is also necessary.
3. Annual evaluation for TB and HIV among HCWs should be introduced at the health facilities in Muhoroni sub-county. HCWs identified as HIV positive should be put on IPT and reassigned to work in low-risk departments within the facility.
4. Facilities should organize for more training opportunities. Findings from the study indicate that majority of HCWs who had received training on IPC did so through facility based CMEs. Regular and frequent in-service training and short courses must be organized to equip and improve the knowledge of HCWs on TB-IPC. HCWs directly linked to TB-IPC must be trained in educating and helping patients to adhere to the protocols.

6.3.3. Policy Level

1. Implementation of the National TB-IPC Guidelines should be enforced by the national government across the country using different mechanisms. Copies should be availed to each facility to facilitate ease of reference by the HCWs. As most health facilities lack an IPC plan, the incorporation of such an IPC plan into local NLTP guidelines can help to ensure standardized implementation.
2. There should be intensified supervision by the county governments as well as national government to ensure TB-IPC guidelines are implemented to the latter. Regular supervision should be strengthened. Supervision and

monitoring should specifically include the TB-IPC component so that relevant weaknesses such as issues on practice can be effectively addressed. Moreover, there is a need to strengthen advocacy specifically at the county government level to address constraints associated with logistics.

3. Research needs to be conducted on adherence and compliance to TB-IPC in all health facilities in the country. This will enable informed decision making when formulating policies to guide the roll-out and implementation of evidence based interventions.

6.4. Areas for Further Research

1. Similar studies should be carried out in other sub-counties in Kenya to determine the level of implementation of TB-IPC measures across different facilities.
2. Further studies should be carried out to determine more factors that influence the implementation of TB-IPC measures among HCWs serving at different health facilities both within and outside the country.
3. Studies should be done to identify challenges facing HCWs in implementation of TB-IPC measures in different health facilities in Kenya and across the globe.
4. This study was confined to Muhoroni sub-county and it focused on HCWs serving at TB diagnostic and treatment sites. Its findings cannot therefore be generalized to describe other populations. An extensive study that would cover randomly selected health facilities across Kenya is thus recommended which will then determine if the findings from the study can apply more broadly across the country.

REFERENCES

Adams, S., Ehrlich, R., Ismail N., Quail, Z., Jeebhay, M.F. (2012). Occupational Health Challenges Facing the Department of Health: Protecting employees against tuberculosis and caring for former mineworkers with occupational health disease. South Africa: S*outh African Health Review*, Health Systems Trust.

Alice, W. G., Simon, M. K., Elijah, N., Ngalo, Z.O. (2015). Health Care Workers Adherence to Infection Prevention Practices and Control Measures: A Case of a Level Four District Hospital in Kenya. *American Journal of Nursing Science,* Vol. 4, No. 2, pp. 39-44. doi: 10.11648/j.ajns.20150402.13.

Al-Maniri, A. (2008). Tuberculosis suspicion and knowledge among private and public general practitioners: Questionnaire Based Study in Oman. *BioMed Central Public Health,* Vol. 8; 105-111.

Amon, J.J., Girard, F., Keshavjee, S. (2015). Limitations on human rights in the context of drug-resistant tuberculosis: *Health and Human Rights: At International Journal,* 11(1): 10.

Basu, S., Andew, J.R., Poolman, E.M., Gandhi, N.R., Shah, N.S., Moll, A. (2007). Prevention of nosocomial transmission of extensively drug-resistant tuberculosis in rural South African district hospitals: An epidemiological modelling study. *Lancet,* 370: 1500-1507.

Baussano, I., Nunn, P., Williams, B., Pivetta, E., Bugiani, M., Scano, F. (2011). Tuberculosis among health care workers. *Emerging Infectious Diseases,* 17(3): 488-94.

Beggs, C.B., Shepherd, S.J., Kerr, K.G. (2010). Potential for airborne transmission of infection in the waiting areas of healthcare premises: stochastic analysis using a Monte Carlo model. *BioMed Central Infectious Diseases*, 10:247.

Berger, D., Bratu, E. (2006). Tuberculosis Knowledge, Attitudes and Practices in Romania: A Patient Centred Assessment; *Romanian Association for Cognitive Science*; Volume X, No. 1: 93 –104.

Bock, N., Jensen, A., Miller, B., Nardell, E. (2007). Tuberculosis Infection Control in Resource-Limited Settings in the Era of Expanding HIV Care and Treatment. *Journal of Infectious Diseases*. 196: S108-S113. DOI: https://doi.org/10.1086/518661

Boss, J.C., Smalbraak, L., Macome, A.C., Gomes, E., van Leth, F., Prins, J.M. (2013). TB diagnostic process management of patients in a referral hospital in Mozambique in comparison with the 2007 WHO recommendations for the diagnosis of smear-negative pulmonary TB and extra-pulmonary TB. *International Health,* 5: 302–308.

Brouwer, M., Coelho, E., Dores Mosse, C.D., Brondi, L., Winterton, L., (2014). Healthcare Workers' Challenges in the Implementation of Tuberculosis Infection Prevention and Control Measures in Mozambique. *Public Library of Science ONE,* 9(12):e114364. doi:10.1371/journal.pone.0114364.

Brouwer, M., Coelho, E., das Dores Mosse, C., van Leth, F. (2015). Implementation of tuberculosis infection prevention and control in Mozambican health care facilities. *International Jounal of Tuberculosis and Lung Disease,* 19(1):44-9.

Buregyeya, E., Nuwaha, F., Verver, S., Criel, B., Colebunders, R. (2013). Implementation of tuberculosis infection control in health facilities in Mukono and Wakiso districts, Uganda. *BioMed Central Infectious Diseases,* 13: 360. doi:10.1186/1471-2334-13-360.

Buregyeya, E., Mitchell, E.M.H., Rutebemberwa, E., Colebunders, R., Criel, B. (2012). Acceptability of masking and patient separation to control nosocomial Tuberculosis in Uganda: a qualitative study. *Journal of Public Health* 20: 599–606. doi:10.1007/s10389-012-0503-1.

Center for Disease Control and Prevention. (2005). Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings. *Morbidity and Mortality Weekly Report,* 54:1-142.

Center for Disease Control and Prevention. (2005). *Tuberculosis Behavioral and Social Science Research Forum: Planting the Seeds for Future Research*. Atlanta, Georgia.

Center for Disease Control and Prevention. (2009). Environmental control for tuberculosis: basic upper-room ultraviolet germicidal irradiation guidelines for healthcare settings. *Report No. Department of Health and Human Services (National Institute for Occupation Safety and Health).* Publication No. 2009-105.

Center for Disease Control and Prevention. (2010). Updated guidelines for using interferon gamma release assays to detect *Mycobacterium tuberculosis* infection—United States. *Morbidity and Mortality Weekly Report* Recommended Report. 59 (RR-5): 1–25.

Central TB Division, Directorate General of Health Services. (2005). *Tuberculosis India RNTCP Status report.* New Delhi, India: Ministry of Health and Family Welfare.

Chakaya, J.M., Meme, H., Kwamanga, D., Githui, W.A. (2005). Planning for PPM-DOTS implementation in urban slums in Kenya: knowledge, attitudes, and practices of private health care providers in Kireba slum, Nairobi. *International Journal of Tuberculosis and Lung Disease,* 9: No. 4.

Choudhary, M., Ramirez, L., Long, R., Simmons, K.B., Blair, D.C., Forbes, B.A. (2006). A university hospital's 10-year experience with tuberculin testing: value of the 2-step tuberculin skin test. *American Journal of Infection Control*, 34(6):358–61. doi: 10.1016/j.ajic.2005.12.017.

Christopher, D.J., James, P., Daley, P., Armstrong, L., Isaac, B.T., Thangakunam, B. (2011). High annual risk of tuberculosis infection among nursing students in South India: a cohort study. *Public Library of Science One*, 6:e26199.

Claassens, M.M., du Toit, E., Dunbar, R. (2013). Tuberculosis patients in primary care do not start treatment. What role do health system delays play? *International Journal of Tuberculosis and Lung Disease*, 17: 603– 607.

Claassens, M.M., van Schalkwyk, C., du Toit, E. (2013). Tuberculosis in healthcare workers and infection control measures at primary healthcare facilities in South Africa. *Public Library of Science One*, 8(10).

Connelly, D., Veriava, Y., Roberts, S., Tsotetsi, J., Jordan, A., DeSilva, E. (2007). Prevalence of HIV infection and median CD4 counts among health care workers in South Africa. *South African Medical Journal.* 97(2): 115-20.

Creedon, A.A. (2005). Healthcare workers hand decontamination, practices with recommendation, and practices with recommendation guidelines. *Journal of Advanced Nursing*, 51 (93), 208-216.

Crofts, J.P., Andrews, N.J., Barker, R.D. (2010). Risk factors for recurrent tuberculosis in England and Wales, 1998-2005. *Thorax*, 65:310-4.

Dalal, S., Galgalo, T., Cain, K. (2006). Risk of tuberculosis among staff at a Nairobi hospital: the price of serving the community, Kenya 2005. *Program and abstracts of the XVI International AIDS Conference.* Geneva: International AIDS Society.

Dara, M., Acosta, C.D., Melchers, N.V., Al-Darraji, H.A., Chorgoliani, D., Reyes, H., Migliori,G.B. (2015). Tuberculosis control in prisons: Current situation and research gaps. *International Journal of Infectious Diseases*, 32: 111-117.

Dato, I. and Imaz, S. (2009). Tuberculosis Control and the Private Sector in a Low Incidence Setting in Argentina. *Revised Salud Pública.* 11 (3): 370-382,

Department of Health. (2011). *The Multi-drug Resistant Tuberculosis-policy Framework on Decentralized and Deinstitutionalized Management for South Africa.* Pretoria: Government Printers.

Department of Health and Health Protection Agency. (2013). *Prevention and Control of Infection in Care Homes – an information resource.* London: The Healthcare Infection Society.

Department of Labour. (2006). *Annual Report.* Pretoria: Government Printers.

Department of Leprosy Tuberculosis and Lung Diseases. (2009). *Guidelines for Tuberculosis Infection Prevention in Kenya*. Nairobi: Government Press.

Department of Leprosy Tuberculosis and Lung Diseases. (2011). *Guidelines for Tuberculosis Infection Prevention in Kenya*. Nairobi: Government Press.

Dharmadhikari, A.S., Mphalele, M., Stoltz, A. (2012). Surgical face masks worn by patients with multidrug-resistant tuberculosis – impact on infectivity of air on a hospital ward. *American Journal of Respiratory and Critical Care Medicine,* 185:1104-9.

Dheda, K., Shean, K., Zumla, A., Badri, M., Streicher, E.M., Page-Shipp, L. (2010). Early treatment outcomes and HIV status of patients with extensively drug-resistant tuberculosis in South Africa: a retrospective cohort study; 375:1798–807.

Drobniewski, F., Balabanova, Y., Zakamova, E., Nikolayevskyy, V., Fedorin, I. (2007). Rates of latent tuberculosis in health care staff in Russia. *Public Library of Science Medical*, 4: e55.

Dwadwa, T., Telisinghe, L., Charalambous, S. (2010). Health worker access to HIV/TB prevention, treatment and care services in Africa: situational analysis and mapping of routine and current best practices. *BioMed Central*, 16: 416

Edwards, R., Charani, E., Sevdalis, N., Alexandrou, B., Sibley, E. (2012) Optimisation of infection prevention and control in acute health care by use of behaviour change: a systematic review. *Lancet Infectious Diseases*, 12, 318–329. doi:10.1016/S1473-3099(11)70283-3.

Escombe, A.R., Moore, D.A.J., Gilman, R.H. (2005). The infectiousness of tuberculosis patients coinfected with HIV. *Public Library of Science Medical*, 5: e188.

Escombe, A.R., Oeser, C.C., Gilman, R.H., Navincopa, M., Ticona, E., Pan, W. (2007). Natural Ventilation for the Prevention of Airborne Contagion. *Public Library of Science Medical* 4(2): e68. https://doi.org/10.1371/journal.pmed.0040068.

Farley, J.E., Ram, M., Pan, W., Waldman, S., Cassell, G.H., Chaisson, R.E. (2011). Outcomes of multi-drug resistant tuberculosis (MDR-TB) among a cohort of South African patients with high HIV prevalence. *Public Library of Science One*, 6:e20436.

Farley, J.E., Tudor, C., Mphahlele, M. (2012). A national infection control evaluation of drug-resistant tuberculosis hospitals in South Africa. *International Journal of Tuberculosis and Lung Disease*, 16(1): 82-9.

Federal Democratic Republic of Ethiopia (2006). *Tuberculosis, Leprosy and TB/HIV Prevention and Control Programme.* Addis Ababa: Government Press.

Franz, K., Tudor, C., Mphalele, M., Dorman, S., Van Der Walt, M., Farley, J.E. (2010). A descriptive evaluation of infection control at HIV centers within drug resistant TB hospitals in South Africa. *American Journal of Infection Control, 38* (5): E54-E5.

Galgalo, T., Dalal, S., Cain, K.P. (2008). Tuberculosis risk among staff of a large public hospital in Kenya. *International Journal of Tuberculosis and Lung Disease*, 12:949–54.

Gammon, J., Heulwen, M. S., Gould, D. (2008). Review of Evidence of Sub-optimal Compliance of Health Care Practitioners to Standard Infection Control Precautions. *Journal of Clinical Nursing*, 17, 157-67.

Gandhi, N.R., Moll, A., Sturm, A.W., Pawinski, R., Govender, T. (2006). Extensively drug-resistant tuberculosis as a cause of death in patients co-infected with tuberculosis and HIV in a rural area of South Africa. *Lancet*, 368:1575–1580.

Getahun, H., Gunneberg, C., Granich, R., Nunn, P. (2010). HIV infection-associated tuberculosis: the epidemiology and the response. *Clinical Infectious Diseases*, 50(suppl 3):S201–7.

Gilks, C.F., Crowley, S., Ekpini R. (2006). The WHO public-health approach to antiretroviral treatment against HIV in resource limited settings; 368: 505–510. *Lancet*, 368, (9534): 505-510.

Granich, R., Akolo, C., Gunneberg, C., Getahun, H., Williams, P., Williams, B. (2010). Prevention of tuberculosis in people living with HIV. *Clinical Infectious Diseases*, 50 (3): S215–22.

Greenaway, C., Sandoe, A., Vissandjee, B. (2011). Tuberculosis: evidence review for newly arriving immigrants and refugees. *Canadian Medical Association Journal*, 183:E939-E951.

Guohong, C., Asaua, F., Yoko, F., Miwa, H., Qingzhong, J., Michael, M.,…Phoutnalong, V. J. (2009). Risk Assessment on TB Transmission in Health Center Settings of Marikina and Paranaque Cities, Philippines. *National Institute of Public Health*, 58 (1).

Harries, A.D., Dye C. (2006). Tuberculosis. *Annals of Tropical Medicine and Parasitology*, 100(5-6):415-31.

Hashemi, S.H., Mamani, M., Jamal-Omidi, S., Alizadeh, N., Nazari, M. (2008). Prevalence of tuberculosis infection among health-care workers in Hamedan, West of Iran. *International Journal of Infectious Diseases*, 12(1):ee338. doi: 10.1016/j.ijid.2008.05.902.

HATIP. (2013). *HIV and AIDS Treatment in Practice*, 201:268. Doi: 10.1186/s12879-015-0999-4.

Healthcare Information for All. (2015). A Global Campaign: Healthcare Information For All By 2015. From <www.hifa2015.org>

He, D. (2010). Infection control and the burden of tuberculosis infection and disease in health care workers in china: a cross-sectional study. *BioMed Central Infectious Diseases,* 10:313.

Hopmans, T. E., Blok, H. E., Troelstra, A., & Bonten, M. J. (2007). Prevalence of hospital-acquired infections during successive surveillance surveys conducted at a University hospital in the Netherlands. *Infection Control Hospital Epidemiology, 28,* 459-465. http://dx.doi.org/10.1086/512640.

Hustins, W. C., Dente, B. M., O'boyle, C., O'Reurke, E.J., Goldmann, D. A. (2005). Hospital Infection prevention and control: a model for improving the quality of hospital care, low- and middle – income countries. London: Churchill Livingstone.

Inyama, H. K., Revathi, G., Musandu, J., Odero, T. (2009). The incidence of nosocomial infections: Kenyatta National Hospital- Intensive Care Unit. *Kenya Nursing Journal*, 38 (1), 31-43.

Jackson, M., Harrity, S., Hoffman, H., Catanzaro, A. (2007). A survey of health professions students for knowledge, attitudes, and confidence about tuberculosis, 2005; *BioMed Central Public Health*; Vol. 7.

James, P., Christopher, D.J., Premkumar, B., Armstrong, L., Zwerling, A., Pai M. (2010). Serial testing for tuberculosis infection in a cohort of Indian nursing students: QFT conversions and reversions. Paper presented at: Immune responses for the diagnosis of tuberculosis, *European Respiratory Society Annual Congress*; September 18-22; Barcelona, Spain.

Jarand, J., Shean, K., O'Donnell, M., Loveday, M., Kvasnovsky, C., van der Walt, M. & Dheda, K. (2010). Extensively drug-resistant tuberculosis (XDR TB) among health care workers in South Africa. *Tropical Medicine and International Health*, 15(10): 1179-1184.

Jensen, P.A. (2005). Where should infection control programs for tuberculosis begin? *International Journal of Tuberculosis and Lung Disease*, 9: 825.

Jensen, P.A., Lambert, L.A., Iademarco, M.F., Ridzon, R., (2005) Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings. *Morbidity and Mortality Weely Report, Recommended Report* 54: 1–141.

Jindal, S.K. (2009). Tuberculosis in health care workers. In: Sharma SK, Mohan A, editors. *Tuberculosis*. (2nd ed.). New Delhi. *Jaypee Brothers Medical Publishers Pvt Ltd*, pp634-45.

Jingtao, W. (2011). Tuberculosis infection control in rural South Africa: Survey of knowledge, attitude and practice in hospital staff. *Journal of Hospital Infection,* 79(4): 333-338.

Joshi, R., Reingold, A.L., Menzies, D., Pai, M. (2006). Tuberculosis among Health-Care Workers in Low- and Middle-Income Countries: A Systematic Review. *Public Library of Science Medical*, 3(12): 2376-2391.

Kagee, A., Delport, T. (2010) Barriers to adherence to antiretroviral treatment: The perspectives of patient advocates. *Journal of Health Psychology*, 15(7): 1001–1011.

Kamulegeya, A., Kizito, A.N., Balidawa, H. (2013). Ugandan medical and health sciences interns' infection control knowledge and practices. *Journal of Infectious Diseases in Developing Countries,* 7: 726–733.

Kanjee, Z., Amico, K.R., Li, F., Mbolekwa, K., Moll, A.P., Friedland, G.H. (2012). Tuberculosis infection control in a high drug-resistance setting in rural South Africa: information, motivation, and behavioral skills. *Journal of Infectious Diseases Public Health,* 5(1): 67-81.

Kanjee, Z., Catterick, K., Moll, A.P., Amico, K.R., Friedland, G.H. (2011). Tuberculosis infection control in rural South Africa: survey of knowledge, attitude and practice in hospital staff. *Journal of Hospital Infection,* 79(4): 333-8.

Kenya National Bureau of Statistics. (2010). ***2009*** *Population and Housing Census.* Kenya National Bureau of Statistics; Nairobi.

Khan, K., Rea, E., McDermaid, C. (2011). Active tuberculosis among homeless persons, Toronto, Ontario, Canada, 1998-2007. *Emerging Infectious Diseases*; 17:357-65.

Klevens, R. M., Edwards, J. R., Richards, C. L. Jr., Horan, T. C., Gaynes, R. P., Pollock, D. A. (2007). Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Public Health Report, 122*, 160-166.

Knibbs, L.D., Morawska, L., Bell, S.C. (2011). Room ventilation and the risk of airborne infection transmission in 3 health care settings within a large teaching hospital. *American Journal of Infection Control*; 39:866-72.

Kranzer, K., Bekker, L.G., van Schaik, N. (2010). Community health care workers in South Africa are at increased risk for tuberculosis. *South African Medical Journal*, 100(4): 224, 226.

Lien, L.T., Hang, N.T., Kobayashi, N. (2009). Prevalence and risk factors for tuberculosis infection among hospital workers in Hanoi, Viet Nam. *Public Library of Science ONE,* 4: e6798.

Loveday, M., Thomson, L., Chopra, M., Ndlela, Z. (2008). A Health Systems Assessment of the KwaZulu Natal Tuberculosis Programme in the Context of Increasing Drug Resistance. *The International Journal of Tuberculosis and Lung Disease,* Vol 12 (9): 1042-1047.

Malangu, N. & Legothoane, A. (2013). Analysis of Occupational Infections among Health Care Workers in Limpompo Province of South Africa. *Global Journal of Health Science,* Vol. 5, No. 1.

Malangu, N. & Mngomezulu. (2015). Evaluation of Tuberculosis Infection Control Measures Implemented at Primary Healthcare facilities in Kwazulu-Natal Province of South Africa. *BioMed Central Infectious Diseases,* 15:117. DOI 10.1186/s12879-015-0773-7.

Manitoba Health. (2010). Routine Practices and Additional Precautions, Preventing the Transmission of Infection in Healthcare.

Mathew, A., David, T., Thomas, K. (2013). Risk factors for tuberculosis among healthcare workers in South India: a nested case-control study. *Journal of Clinical Epidemiology*. 66:67–74.

Mazurek, G.H., Jereb, J., Vernon, A., LoBue, P., Goldberg, S. (2010) Updated guidelines for using Interferon Gamma Release Assays to detect Mycobacterium tuberculosis infection-United States. *Morbidity and Mortality Weekly Report,* 59: 1–25.

Menzies, D., Joshi, R., Pai, M. (2007). Risk of tuberculosis infection and disease associated with work in health care settings. *International Journal of Tuberculosis and Lung Disease,* 11:593-605.

Menzies, D., Lewis, M., Oxlade, O. (2008). Costs for tuberculosis care in Canada. *Canadian Journal of Public Health* 2008, 99:391-6.

Ministry of Health (2008). *National tuberculosis control programme, Disease Control Division, Kenya*. Nairobi: Government Press.

Ministry of Health (2008). *National tuberculosis control programme, Disease Control Division, Malaysia.* Kuala Lumpar: Government Press.

Ministry of Health and Social Services, Namibia. (2014). Tuberculosis Infection Control Guidelines. (2nd ed.). Windhoek: Government Press.

Ministry of Health of the People's Republic of China. (2010). Nationwide anti-tuberculosis drug resistant baseline surveillance in China (2007–2008). Beijing: People's Medical Publishing House Press.

Ministry of Health of the Republic of Uganda. (2011). *Uganda National Guidelines for Tuberculosis Infection Control in Health Care Facilities, Congregate Settings and Households.* Kampala: Ministry of Health. Available: http://www. who.int/hiv/pub/guidelines/Uganda hiv tb.pdf.

Ministry of Public Health and Sanitation. (2009). *Guidelines for tuberculosis infection prevention in Kenya. Division of leprosy, tuberculosis and lung disease, Kenya.* Nairobi: Government Press.

Ministry of Public Health and Sanitation, Ministry of Medical Services. (2010). Republic of Kenya; *National Infection Prevention and Control Guidelines for Health Care Services in Kenya.* Nairobi: Government Press.

Mirtskhulava, V., Kempker, R., Shields, K.L., Leonard, M.K., Tsertsvadze, T., del Rio, C.,…Blumberg, H.M. (2015). Prevalence and risk factors for latent tuberculosis infection among health care workers in Georgia. *The International Journal of Tuberculosis and Lung Disease,* 12(5): 513 519.

Mphahlele, M., Tudor, C., van der Walt, M., Farley, J.E. (2012). An infection control audit in 10 primary health-care facilities in the Western Cape Province of South Africa. *International Journal of Infection Control,* 8(3).

Muchina, P.W., Muchina, E.N. (2009). Transmitting infection: Testing disinfectants used in maternity units. *African Journal of Midwifery and Women's health*, 3(1), 12-14.

Muecke, C., Isler, M., Menzies, D. (2006). The use of environmental factors as adjuncts to traditional tuberculosis contact investigation. *International Journal of Tuberculosis and Lung Disease*, 10:530-5.

Mulder, C., Harting, J., Jansen, N., Borgdorff, M.W., van Leth F. (2012). Adherence by Dutch public health nurses to the national guidelines for tuberculosis contact investigation. *Public Library of Science One*, 7: e49649. doi:10.1371/journal.pone.0049649.

Naidoo, S. & Jinabhai, C.C. *(*2006*).* TB in health care workers in KwaZulu-Natal, South Africa. *International Journal of Tuberculosis and Lung Disease,* 10*:* 676–682.

Naidoo, S., Seevnarain, K., Nordstrom, D.L. (2012). Tuberculosis infection control in primary health clinics in eThekwini, KwaZulu-Natal, South Africa. *International Journal of Tuberculosis and Lung Disease,* 16(12): 1600-4.

National AIDS Control Council. (2016). *Kenya HIV County Profiles.* Nairobi: Government Printers.

National Department of Health. (2011). *Annual Report.* Pretoria: Government Printers.

Nodieva, A., Jansone, I., Broka, L., Pole, I., Skenders, G. (2010). Recent nosocomial transmission and genotypes of multidrug-resistant Mycobacterium tuberculosis. *International Journal of Tuberculosis and Lung Disease,* 14: 427–433.

Ntshanga, S., Mabaso, M. (2009). A pilot study to assess workplace tuberculosis control activities in four districts in KwaZulu-Natal, South Africa. *Public Health*, 123(9):623–624.

O'Donnell, M.R., Jarand, J., Loveday, M., Padayatchi, N., Zelnick, J. (2010). High incidence of hospital admissions with multidrug-resistant and extensively drug-resistant tuberculosis among South African health care workers. *Annals of Internal Medicine*, 153:516–522.

Ogbonnaya, L.U., Chukwu, J.N., Uwakwe, K.A., Oyibo, P.G., Ndukwe, C.D. (2011). The status of tuberculosis infection control measures in health care facilities rendering joint TB/HIV services in "German Leprosy and Tuberculosis Relief Association" supported states in Nigeria. *Nigerian Journal of Clinical Practice*. 14(3): 270-5.

Oluwole, O.C. (2008). Awareness, knowledge and practice of breast self- examination amongst female health workers in Nigeria. *Sudan Journal of Medical Sciences*, 3(2): 99-104.

Pai, M., Gokhale, K., Joshi, R., Dogra, S., Kalantri, S., Mendiratta, D.K. (2005). Mycobacterium tuberculosis infection in health care workers in rural India: comparison of a whole-blood interferon gamma assay with tuberculin skin testing. *Journal of the American Medical Association*, 293:2746-55.

Pai, M., Kalantri, S., Aggarwal, A.N., Menzies, D., Blumberg, H.M. (2006). Nosocomial tuberculosis in India. *Emerging Infectious Diseases*, 12:1311–18.

Peters, A., Heunis C., de Jager, P., Mametja, D., Dlamini, S., Chehab, J. (2012). TB infection control assessment at Public Health Facilities in South Africa.

Pillay, M., Sturm, A.W. (2007). Evolution of the extensively drug-resistant F15/ LAM4/KZN strain of Mycobacterium tuberculosis in KwaZulu-Natal, South Africa. *Clinical Infectious Diseases*; 45:1409–14.

Pillay, S., Meyer-Rath, G., Schnippel, K., Long, L., MacLeod. W., Sanne, I., Stevens W. (2012) The Impact and Cost of Scaling up GeneXpert MTB/RIF in South Africa. *Public Library of Science ONE* 7(5): e36966. https://doi.org/10.1371/journal.pone.0036966.

Pittet, D., Allegranzi, B., Storr, J., Bagheri Nejad, S., Dziekan, G., Leotsakos, A., Donaldson, L. (2008). Infection control as a major World Health Organization priority for developing countries. *Journal of Hospital Infections, 68,* 285-292. http://dx.doi.org/10.1016/j.jhin.2007.12.013.

Pittet, D., Donaldson, L. (2005). Clean care is safer care: the first global challenge of the WHO world alliance for patient safety. *Infection Control Hospital Epidemiology*, 26(11):891–4.

Public Health Agency of Canada. (2007). *Canadian Tuberculosis Standards*. (6th ed.). Ottawa: Canadian Lung Association.

Public Health Agency of Canada. (2013). *Routine practices and additional precautions for preventing the transmission of infection in healthcare settings*, Ottawa: Canadian Lung Association. Available on: PHAC. http://www.phac-aspc.gc.ca/nois-sinp/guide/pubs-eng.php.

Reid, M.J., Saito, S., Nash, D., Scardigli, A., Casalini, C., Howard, A.A. (2012). Implementation of tuberculosis infection control measures at HIV care and treatment sites in sub-Saharan Africa. *International Journal of Tuberculosis and Lung Disease*. 16(12):1605-12.

Robert, J., Affolabi, D., Awokou, F., Nolna D., Manouan, B.A.P. (2013). Assessment of organizational measures to prevent nosocomial tuberculosis in health facilities of 4 sub Saharan countries in 2010. *Infection Control Hospital Epidemiol*ogy 34: 190–195. doi:10.1086/669085.

Robinson, A., Nel, E.D., Donald, P.R., Schaaf, H.S. (2007). Nosocomial Infections in HIV-infected and HIV-uninfected Children Hospitalized for TB. http://www.safpj.co.za/index.plp/safpj/articles/view articles/ 727.

Roth, V, R., Garrett, D.O., Laserson, K.F. (2005). A multicenter evaluation of tuberculin skin test positivity and conversion among health care workers in Brazilian hospitals. *International Journal of Tuberculosis and Lung Disease, 9:1335*– 1342.

Singh, J.A., Upsur, R., Padayatchi, N. (2007). XDR-TB in South Africa: No time for denial or complacency. *Public Library of Science Medical,* 4(1): e50-54.

Sissolak, D., Marais, F., Mehtar, S. (2011). TB Infection Control Prevention and Control Experiences of South African Nurses – A Phenomenological Study. http://www. biomedcentral.com/content/pdf/147-2458-11-262.pdf.

Soltan, V., Henry, A., Crudu, V., Zatusevski, I. (2008). Increasing tuberculosis case detection: lessons from the Republic of Moldova, *Bulletin of the World Health Organization*: No.86.

Sotgiu G, Ferrara G, Matteelli A et al. (2009) Epidemiology and clinical management of XDR-TB: a systematic review by TBNET. *European Respiratory Journal* 33, 871–881.

Trajman, A., Menzies, D. (2010). Occupational respiratory infections. *Current Opinion on Pulmonary Medicine,* 16:226-34.

Tshitangano, T., Pengpid, S., Peltzer, K. (2010). Factors that Contribute to Tuberculosis Control in Primary Health Care Services at Mutale Primary Health Care Sub-District o the Limpopo Province, South Africa. *Journal of Human Ecology,* 29 (2): 75-85.

Tshitangano, T. (2013). The management of latent tuberculosis infection in health care workers at hospitals in Vhembe district. *Occupational Health Southern Africa.* 19 (5): 14-9.

Tshitangano, T. (2014). Measures practiced by health care workers to minimize the risk of contracting TB at rural hospitals of Vhembe District. *Southern African Journal of Infectious Diseases*, 29(2): 65.

Tudor, C., Farley, J.E., Mphahlele M. (2012). A National Infection Control Evaluation of Drug-resistant Tuberculosis Hospitals in South Africa. *International Journal of Tuberculosis and Lung Disease,* 2012; **16(1):** 82-89.

Tudor, C., van der Walt, M., Hill, M.N., Farley, J.E. (2013). Occupational health policies and practices related to tuberculosis in health care workers in KwaZulu-Natal, South Africa. *Public Health Action,* 3(2): 141-5.

Tudor, C., van der Walt, M., Margot, B. (2014). Tuberculosis among health care workers in KwaZulu-Natal, South Africa: a retrospective cohort analysis. *BioMed Central Public Health*, 14:891.

UNAIDS. (2010). Global Report: UNAIDS report on the global AIDS epidemic. Geneva, Switzerland.http://www.unaids.org/globalreport/documents/20101123_GlobalReport_full_en.pdf

Victor, T.C., Streicher, E.M., Kewley, C., Jordaan, A.M., van der Spuy, G.D. (2007). Spread of an emerging Mycobacterium tuberculosis drug-resistant strain in the Western Cape of South Africa. *International Journal of Tuberulosis and Lung Disease*, 11:195–201.

Wasswa. (2015). Implementation of Infection Control in Health Facilities in Arua District, Uganda: A cross-sectional Study. *BioMed Central Infectious Diseases*, 15:268. Doi: 10.1186/s12879-015-0999-4.

Woith, W.M., Volchenkov, G., Larson, J.L. (2010). Russian healthcare workers' knowledge of tuberculosis and infection control. *International Journal of Tuberculosis and Lung Diseases,* 14(11): 1489-1492.

Woith, W.M., Volchenkov, G., Larson J.L. (2012). Barriers and Facilitators Affecting Tuberculosis Infection Control Practices of Russian Health Care Workers. *International Journal of Tuberculosis and Lung Disease*, 16: 1092–1096. doi:10.5588/ijtld.10.0779.

World Economic Forum. (2008). Protecting your workforce from tuberculosis: a toolkit for an integrated approach to TB and HIV for businesses in South Africa. *Geneva: World Economic Forum, Global Health Initiative.*

World Health Organization. (2005). *Global tuberculosis control. Surveillance, planning, financing. WHO Report.* Geneva: The Organization.

World Health Organization. (2006). *Global Tuberculosis Control, WHO Report.* Geneva: World Health Organization.

World Health Organization. (2007). *Global Tuberculosis Control, WHO Report.* Geneva: World Health Organization.

World Health Organization. (2009). *WHO policy on TB infection control in health-care facilities, congregate settings and households.* Geneva: World Health Organization, 11–15.

World Health Organization. (2010). *The Joint WHO-ILO-UNAIDS policy guidelines on improving health workers access to HIV and TB prevention, treatment, care and support services.* Geneva: World Health Organization.

World Health Organization. (2011). *Global Tuberculosis Control, WHO Report.* Geneva: World Health Organization.

World Health Organization. (2012). *Global Tuberculosis Control, WHO Report.* Geneva: World Health Organization.

World Health Organization. (2013). *Global Tuberculosis Control, WHO Report*. Geneva: World Health Organization. Available: http://www.who.int/tb/publications/global_report/en/.

World Health Organization. (2014). *Global Tuberculosis Control, WHO Report.* Geneva: World Health Organization.

Yuan, C.C., Enarson, D.A., Fujiwara, P.I., Deun, A.V., Jyh, L.J. (2008). Strategies of Extensively Drug-resistant TB Risk Management for Health Workers and Other Care Givers. *Expert Review Respiratory Medicine*, 2:47-54.

Zelnick, J., Gibbs, A., Loveday, M., Padayatchi, N., O'Donnell, M. (2013). Health-care workers' perspectives on workplace safety, infection control, and drug-resistant tuberculosis in a high-burden HIV setting. *Journal of Public Health Policy.* 34(3): 388-402.

Zwerling, A., van den Hof, S., Scholten, J., Cobelens, F., Menzies, D., Pai, M. (2012). Interferon-gamma release assays for tuberculosis screening of health care workers: a systematic review. *Thorax*, 67: 62–70.

APPENDICES

Appendix 1: Consent Form

(To be read and interpreted to the volunteer and questions answered in the language in which the volunteer is fluent)

STUDY TITLE: IMPLEMENTATION OF INFECTION PREVENTION AND CONTROL MEASURES AGAINST NOSOCOMIAL TUBERCULOSIS AMONG HEALTHCARE WORKERS IN MUHORONI SUB-COUNTY, KISUMU COUNTY, KENYA.

INVESTIGATOR: Odini Vincent, Masters student at Moi University – School of Public Health, P.O. Box 4606 – 30100, Eldoret, Mobile phone number: 0721976350.

Email: vincentodini@gmail.com.

Introduction to the Respondent

I am a postgraduate student undertaking a Master's degree in public health at the Moi University, School of Public Health. This study forms part of the basic requirement for my degree course. I would like to kindly request you to spare around 30 minutes of your time to respond to the following questions.

Purpose and Background of the study

This study aims to assess the implementation of Infection Prevention and Control Measures against hospital acquired TB among healthcare workers in Muhoroni sub-county.

Benefits

There will be no direct benefits from participating in the study. However, findings made will benefit health care workers at their health facilities and also policy makers.

Risk

No physical risk or physical harm will be incurred by obliging to participate in the study. However, questions that may seem to intrude into personal privacy and may be embarrassing will be explained comprehensively prior to the interview process.

Confidentiality

The rights and dignity of all participants will be protected and respected. All information will be treated with utmost confidentiality. The respondent should not write his/her name on any part of the questionnaire to ensure anonymity.

Questions

In case of any further questions, comments or complaints relating to the research, the investigator can be contacted on mobile number 0721976350 or through the email address vincentodini@gmail.com.

Immediate Inquiries: Do you have any inquiries about the study? If yes, the interviewer responds to the question(s).

If no or after questions asked are answered: Are you willing to be interviewed? If:

a. No (Thank the person for considering the request).

b. Yes (Interview the participant or make an appointment to interview him/her later).

CONSENT

I, the undersigned hereby agree to participate in this study. I was taken through this consent form and understood its content.

Signature ……Date ……..

Appendix 2: Questionnaire for HCWS:

SERIAL NUMBER ☐ **DATE ……**

NAME OF HEALTH FACILITY
.....

CATEGORY OF HEALTH FACILITY:

MOH SCH ☐

FBO/MISSION ☐

HEALTH CENTRE ☐

DISPENSARY ☐

SOCIO-DEMOGRAPHIC INFORMATION

1. Age in years
.....

2. Gender:

   i. Male ☐

   ii. Female ☐

3. Cadre:

   i. MO ☐

   ii.CO ☐

   iii. Nurse ☐

   iv. Lab Staff ☐

   v. PHO ☐

   vi. Support Staff ☐

4. Level of Education

   i. Primary ☐

   ii. Secondary ☐

   iii. Post-Secondary (Certificate/Diploma) ☐

   iv. Graduate ☐

   v. Postgraduate ☐

5. Number of years of service.....

INFORMATION ON ADMINISTRATIVE CONTROL MEASURES

(Tick or fill in spaces provided)

1. Do you as an individual HCW routinely ask patients about cough upon their entry to the facility?

   i. Yes ☐
   ii. No ☐

2. Do you as an individual HCW carry out triaging of patients based on cough symptoms upon their arrival at the health facility?

   i. Yes ☐
   ii. No ☐

3. Do you as an individual HCW separate and isolate patients with severe cough symptoms from others?

   i. Yes ☐
   ii. No ☐

4. Do you as an individual HCW contribute towards ensuring that there is an organized patient flow system at the health facility?

   i. Yes ☐
   ii. No ☐

5. Based on your observation, what is the average duration of time a patient with cough symptoms takes to have sputum collected for diagnosis at the facility?

   i. < 1 hour ☐

   ii. 1-6 hours ☐

   iii. 6-12 hours ☐

   iv. 12-24 hours ☐

   v. > 24 hours ☐

6. Do you facilitate provision of health education to patients at the health facility?

   i. Yes ☐

   ii. No ☐

If answer is yes, how often?

   i. Daily ☐

   ii. Weekly ☐

   iii. Monthly ☐

INFORMATION ON ENVIRONMENTAL CONTROL MEASURES

1. How often do you keep the windows open while at the patient waiting area (if enclosed)?

   i. Sometimes ☐

   ii. Always ☐

   iii. Never ☐

   iv. N/A (not enclosed) ☐

2. How often do you open the windows and door when you are examining patients at the chest clinic?

   i. Sometimes ☐

   ii. Always ☐

   iii. Never ☐

3. How often, based on your experience, is the health facility crowded with patients?

i. Sometimes ☐

ii. Always ☐

iii .Never ☐

4. Are the rooms at the health facility fitted with any kind of mechanical ventilation?

i. Yes ☐

ii. No ☐

5. Do you practise segregation of the different types of medical waste at the health facility?

i. Yes ☐

ii. No ☐

6. If yes, do you dispose the different types of wastes separately in line with recommended guidelines?

i.Yes ☐

ii. No ☐

iii. N/A ☐

INFORMATION ON USE OF PERSONAL PROTECTIVE EQUIPMENT

1. Do you use N95 respirators when attending to patients?

i. Yes ☐

ii. No ☐

If "No", give the main reason

i. Not available ☐

ii. Not necessary ☐

2. Do you wear a lab coat when working at the facility?

i. Yes ☐

ii. No ☐

If "no" give the main reason

i. Not available ☐

ii. Not necessary ☐

iii. Not enough ☐

3. Do you use gloves when attending to patients?

i. Yes ☐

ii. No ☐

If "No" give the main reason

i. Not available ☐

ii. Not necessary ☐

iii. Not enough ☐

4. Are personal protective equipment always readily available for use at the health facility?

i. Yes ☐

ii. No ☐

TRAINING OF THE HEALTHCARE WORKERS

1. Have you ever received training on Infection Control Measures against TB in the health facility setting?

i. Yes ☐

ii. No ☐

If "yes" what kind of training was received?

i. Facility based CMEs ☐

ii. Seminar/Workshop ☐

iii. Full course training ☐

2. Do you think infection control measures against TB are necessary at the health facility?

i. Yes ☐

ii. No ☐

3. Do you have the TB-IPC policy guidelines within your reach at the health facility?

i. Yes ☐

ii. No ☐

If "yes" when is the last time you referred to it?

i. <24 hours ago ☐

ii. 24-48 hours ago ☐

iii. 48hours-1 week ago ☐

iv. 1 week -1 month ago ☐

v. > 1 month ago ☐

4. Do you put into practice the infection control measures you know in your day to day working at the health facility?

i. Yes ☐

ii. No ☐

Appendix 3: Questionnaire for Facility in Charges

SERIAL NUMBER ☐ **DATE ……**

NAME OF HEALTH FACILITY .....

CATEGORY OF HEALTH FACILITY:

MOH SCH ☐

FBO/MISSION ☐

HEALTH CENTRE ☐

DISPENSARY ☐

1. Is there an Infection Control Committee or Infection Control focal person at the health facility?
   i. Yes ☐
   ii. No ☐
2. Is there an Infection Control Plan or checklist at the health facility?
   i. Yes ☐
   ii. No ☐

   If not, is there a plan to develop an intervention programme?
   i. Yes ☐
   ii. No ☐
   iii. N/A ☐

3. Has a training of staff been done on TB infection control?
   i. Yes ☐
   ii. No ☐
4. Do health personnel at the health facility disseminate health information on TB infection control to patients?
   i. Yes ☐
   ii. No ☐

5. Is there a tracking system in place for all TB patients seen at the facility, all referrals and all sputum smear results?
   i. Yes ☐
   ii. No ☐

6. What are the challenges faced by the health facility in adhering to stipulated infection control measures?
   i. Lack of training on IPC ☐
   ii. Poor attitude among HCWs ☐
   iii. Inadequacy of self-protective equipment ☐
   iv. Lack of resources ☐

7. Are you aware of the national infection control policy and guidelines?
   i. Yes ☐
   ii. No ☐

   Is there a copy at the health facility? (Ask for a copy to confirm)
   i. Yes ☐
   ii. No ☐

8. Does the facility have an isolation room for patients with severe cough symptoms?
   i. Yes ☐
   ii. No ☐

9. Do health staff receive TB evaluation?
   i. Yes ☐
   ii. No ☐

   If answer to above question is yes, how often?
   i. Monthly ☐
   ii. Annually ☐
   iii. Biannually ☐
   iv. N/A ☐

10. Are health staff offered HIV test annually?
    i. Yes ☐
    ii. No ☐
11. If answer to question 10 is "yes," are they placed on ART if HIV+?
    i. Yes ☐
    ii. No ☐
    iii. N/A ☐
12. If answer to question 10 is "yes," are those who turn out to be HIV+ offered IPT?
    i. Yes ☐
    ii. No ☐
    iii. N/A ☐
13. If answer to question 10 is "yes," are those who turn out to be HIV+ reassigned to work in low-risk sections of the facility?
    i. Yes ☐
    ii. No ☐
    iii. N/A ☐
14. Do health authorities from the National TB Program visit the facility to assess and monitor implementation of infection prevention and control measures?
    i. Yes ☐
    ii. No ☐
15. If answer to question 14 is Yes, How often?
    i. Weekly ☐
    ii. Fortnightly ☐
    iii. Monthly ☐
    iv. Annually ☐
    v. N/A ☐
16. When did health authorities last visit?
    i. < 1 week ago ☐
    ii. 1 week – 2 weeks ago ☐
    iii. 2 weeks- 1 month ago ☐
    iv. 1 month – 6 months ago ☐
    v. > 6 months ago ☐

Appendix 4: Non-Participant Observation Check List

SERIAL NUMBER ☐ **DATE ……**

NAME OF HEALTH FACILITY .....

CATEGORY OF HEALTH FACILITY:

MOH SCH ☐

FBO/MISSION ☐

HEALTH CENRE ☐

DISPENSARY ☐

ADMINISTRATIVE INFECTION CONTROL MEASURES AT THE FACILITY

1. Presence of IPC Plan
   i. Yes ☐
   ii. No ☐
2. Triaging of patients based on cough symptoms
   i. Yes ☐
   ii. No ☐
3. Separation and isolation of patients
   i. Yes ☐
   ii. No ☐
4. Timely diagnosis carried out
   i. Yes ☐
   ii. ii. No ☐
5. Duration of Diagnosis (sputum turn-around time)
   i. 0-6hrs ☐
   ii. 6-12 hrs ☐
   iii. 12-24 hrs ☐
   iv. iv. >24 hrs ☐
6. Sputum collected in open area
   i. Yes ☐
   ii. No ☐

7. Prompt Initiation of Treatment

   i. Yes ☐

   ii. No ☐

8. Signage of cough etiquette

   i. Yes ☐

   ii. No ☐

ENVIRONMENTAL CONTROL MEASURES AT THE FACILITY

1. Adequate ventilation and lighting in patient waiting area

   i. Yes ☐

   ii. No ☐

   iii. N/A ☐

2. Adequate ventilation and lighting in consultation room

   i. Yes ☐

   ii. No ☐

3. Adequate ventilation and lighting in medical wards

   i. Yes ☐

   ii. No ☐

   iii. N/A ☐

4. Presence of mechanical ventilation in rooms

   i. Yes ☐

   ii. No ☐

5. Type of ventilation in consultation room

   i. Natural ☐

   ii. Natural and Mechanical ☐

6. Setup of consultation room in relation to type of ventilation

   i. Not Recommended ☐

   ii. Recommended ☐

7. Crowding of patients at the health facility

   i. Yes ☐

   ii. No ☐

USE OF PERSONAL PROTECTIVE CONTROL MEASURES BY HCWS IN CHEST CLINIC

1. N-95 Respirators
   i. In use ☐
   ii. Not in use ☐
2. Lab Coats
   i. In use ☐
   ii. Not in use ☐
3. Gloves
   i. In use ☐
   ii. Not in use ☐

LABORATORY SAFETY

1. Adequate natural ventilation and lighting
   i. Yes ☐
   ii. No ☐
2. Presence of mechanical ventilation
   i. Yes ☐
   ii. No ☐
3. Availability of Biological Safety Cabinet
   i. Yes ☐
   ii. No ☐
4. Appropriate lab coats in use
   i. Yes ☐
   ii. No ☐
5. N95 respirators
   i. In use ☐
   ii. Not in use ☐
6. Gloves
   i. In use ☐
   ii. Not in use ☐

7. Quality of specimens being processed
   i. Poor ☐
   ii. Good ☐
8. Presence of hand washing facilities
   i. Yes ☐
   ii. No ☐
9. Waste Segregation
   i. Yes ☐
   ii. No ☐
10. Proper waste disposal
   i. Yes ☐
   ii. No ☐

Appendix 5: IREC Approval Letter

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2015/109.
Approval Number: 0001460.

13th August, 2015

Mr. Vincent Odini,
Moi University,
School of Public Health,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
13 AUG 2015
APPROVED
P.O. Box 4606-30100 ELDORET

Dear .Mr. Odini,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Assessment of Infection Prevention and Control Measures against Nosocomical Transmission of Tuberculosis among Health Care Workers at Health Facilities in Muhoroni Sub County Kisumu County Kenya".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1460*** on 13th August, 2015. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 12th August, 2016. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

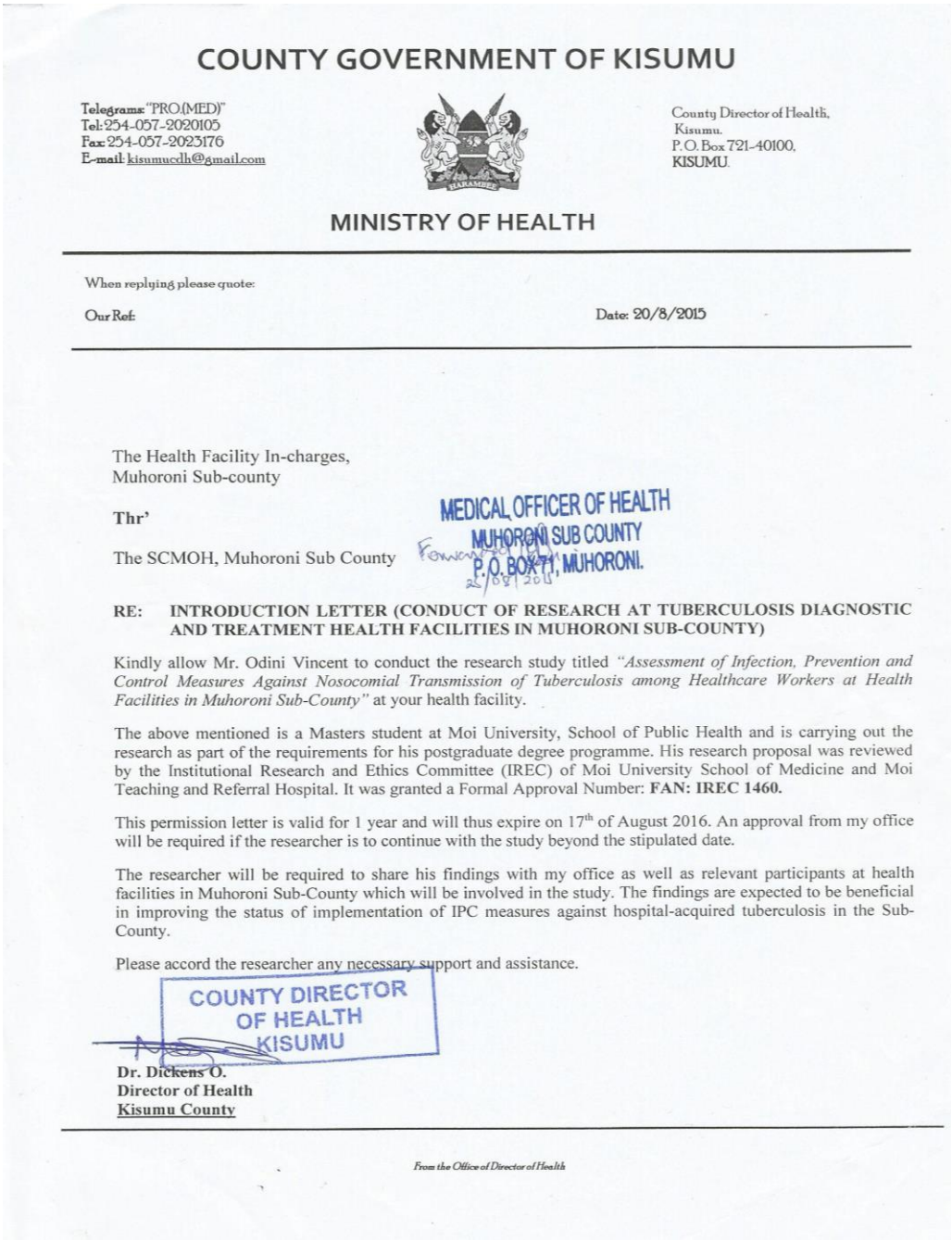
You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc Director - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

Appendix 6: MOH Approval Letter



COUNTY GOVERNMENT OF KISUMU

Telegrams: "PRO.(MED)"
Tel: 254-057-2020105
Fax: 254-057-2023176
E-mail: kisumucdh@gmail.com

County Director of Health,
Kisumu.
P.O. Box 721-40100,
KISUMU.

MINISTRY OF HEALTH

When replying please quote:

Our Ref:

Date: 20/8/2015

The Health Facility In-charges,
Muhoroni Sub-county

Thr'

The SCMOH, Muhoroni Sub County

MEDICAL OFFICER OF HEALTH
MUHORONI SUB COUNTY
P.O. BOX 71, MUHORONI.

RE: INTRODUCTION LETTER (CONDUCT OF RESEARCH AT TUBERCULOSIS DIAGNOSTIC AND TREATMENT HEALTH FACILITIES IN MUHORONI SUB-COUNTY)

Kindly allow Mr. Odini Vincent to conduct the research study titled *"Assessment of Infection, Prevention and Control Measures Against Nosocomial Transmission of Tuberculosis among Healthcare Workers at Health Facilities in Muhoroni Sub-County"* at your health facility.

The above mentioned is a Masters student at Moi University, School of Public Health and is carrying out the research as part of the requirements for his postgraduate degree programme. His research proposal was reviewed by the Institutional Research and Ethics Committee (IREC) of Moi University School of Medicine and Moi Teaching and Referral Hospital. It was granted a Formal Approval Number: **FAN: IREC 1460.**

This permission letter is valid for 1 year and will thus expire on 17th of August 2016. An approval from my office will be required if the researcher is to continue with the study beyond the stipulated date.

The researcher will be required to share his findings with my office as well as relevant participants at health facilities in Muhoroni Sub-County which will be involved in the study. The findings are expected to be beneficial in improving the status of implementation of IPC measures against hospital-acquired tuberculosis in the Sub-County.

Please accord the researcher any necessary support and assistance.

COUNTY DIRECTOR
OF HEALTH
KISUMU

Dr. Dickens O.
Director of Health
Kisumu County

From the Office of Director of Health