APPROPRIATENESS OF PERSONAL PROTECTIVE EQUIPMENT AGAINST BIO-HAZARDS EXPOSURE IN PUBLIC PRIMARY HEALTHCARE FACILITIES IN MOMBASA COUNTY, KENYA

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Appropriateness of Personal Protective Equipment against Bio-Hazards Exposure in Public Primary Healthcare Facilities in Mombasa County, Kenya

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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Benson Kaguthi Macharia

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

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DEDICATION

This Thesis is dedicated to all members of my family.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
BBP	Blood-Borne Pathogens
CDC	Communicable Disease Control
DOSHS	Directorate of Occupational Safety and Health Services
HBeAg	Hepatitis B e antigen
HBV	Hepatitis B Virus
HCP	Health Care Personnel
HCV	Hepatitis C virus
HCW	Health Care Worker
HIV	Human Immunodeficiency Virus
HVA	Hazard Vulnerability Analysis
ILO	International Labour Organization
IPC	Infection Prevention and Control
MCDIP	Mombasa County Development Integrated Plan
MoH	Ministry of Health
NEMA	National Environmental Management Authority

NIOSH	National Institute of Occupational Health and Safety
OCoB	Office of the Controller of Budget
OSH	Occupational Safety and Health
PEP	Post Exposure Prophylaxis
PHF	Primary Healthcare Facilities
PPE	Personal Protective Equipment
WHO	World Health Organization

DEFINITION OF TERMS

Biological hazards: Also known as bio-hazards refer to biological substances that pose a threat to the health of a worker in health care facilities and community. This can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can affect human health posing a significant risk to health care and community care workers if not properly controlled (OSH-MOH, 2014)**.**

Blood-borne pathogens: Microorganisms that can cause disease when transmitted from an infected individual to another individual through blood and certain body fluids (Oregon-OSHA, 2014).

Hazard: An inherent property of a substance, agent, source of energy or situation having the potential of causing undesirable consequences e.g. chemicals, slippery floor, work while standing on a ladder (Kenya Law Reports, 2014).

Health facility: A specifically designated site including buildings and the surroundings where medicine is practiced (OSH-MOH, 2014).

Healthcare worker: A person (e.g. nurse, physician, pharmacist, technician, mortician, dentist, student, contractor, attending clinician, public safety worker, emergency response personnel, health-care waste worker, first-aid provider or volunteer) whose activities involve contact with patients or with blood or other body fluids from patients (CDC, 2014).

Hierarchy of Controls: Concept used by the industrial hygiene profession to prioritize prevention interventions. Hierarchically these include; engineering controls, work practice controls, administrative controls, and personal protective equipment (ILO, 2006).

Medical sharps injury: An exposure event occurring when any object used in the healthcare setting including, but not limited to, needles, scalpels, broken glass, broken capillary tubes, and exposed ends of dental wires penetrates the skin (Allwinn *et al*., 2008).

Near-misses: Unplanned event that does not result in injury, illness, or damage – but has the potential to do so (OSH-MOH, 2014).

Needlestick: Penetrating stab wounds caused by needles (Allwinn *et al*., 2008).

Occupational disease: Any disease or disorder that occurs as a result of work or working conditions (OSH-MOH, 2014).

Personal Protective Equipment (PPE): Equipment designed to protect workers from serious workplace injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. (NCGC, 2012).

Post-exposure prophylaxis: The immediate provision of medication following an exposure to potentially infected blood or other body fluids in order to minimize the risk of acquiring infection (Kimberly *et al.*, 2013).

Recapping: This is the act of replacing a protective sheath on a needle (Ngesa, 2008).

Risk assessment: An organized process used to describe and estimate the amount of risk of adverse human health effects from exposure to a toxic chemical or other hazard (how likely or unlikely it is that the adverse effect will occur) (OSH-MOH, 2014).

Risk: The probability that damage to life, health, and/or the environment will occur as a result of exposure to a given hazard (OSH-MOH, 2014).

Safety culture: The ways in which safety is managed in the workplace, and often reflects "the attitudes, beliefs, perceptions and values that employees share in relation to safety (OSH-MOH, 2014).

ABSTRACT

Health facilities are sources of bio-hazards to healthcare personnel (HCP). Personal protective equipments (PPE) are among the key preventive control measures. The main objective of this research was to determine the efficacy of PPE as a safeguard against HBV, HCV, and HIV exposure amongst HCP at Public Primary healthcare facilities in Mombasa County. The study sought to assess the range and quality standards of PPEs available, adherence to PPE safety guidelines, and the rates of occupational exposures to HIV, HBV, and HCV amongst HCP in these facilities. The study adopted a Descriptive Cross-sectional design by utilizing structured questionnaires, observation guides, and lab assays as data collection tools. A simple random sampling approach was used in selection of the respondents. They included Clinical Officers, Lab Technicians, Nurses, Medical assistants, and Housekeepers. Laboratory assays were conducted to determine the quality standards of the PPE sampled from the facilities based on KEBS standards. The data was analyzed using the Statistical Package for the Social Sciences (SPSS), version 23.0 and presented using pie charts, contingency tables, and bar charts. This study found that amongst the PPE, the uptake and compliance to gloves usage was the highest at 93.3%. There was significant association between range of PPE and utilization of available protective gear [X^2 (4) = 5.69, p≤0.5 (0.17)]. In conclusion, hand PPE are the most available (70.4%), they met the KEBS accepted quality standards, but are not appropriate in preventing sharp related injuries. PPE are not suitable as apparatus but are effective when implemented as a policy. Prevalence of exposure to blood-borne pathogens was found to be 69.1% and the highest mode of exposure was sharp related injuries at 44.7%. The management of PPFs should ensure sustainable supply of PPE and HBV vaccine by reviewing the procurement processes, ensure availability of safety guidelines and facilitate regular training.

CHAPTER ONE

INTRODUCTION

1.1 Background

Health facilities are places that provide health care and they range from small clinics and doctor's offices to urgent care centers and large hospitals with elaborate emergency rooms and trauma centers (Medlineplus, 2014). The Primary healthcare facilities offer mainly the first line health care services and may include health centers, dispensaries, clinics, and community health organizations (ehealth, 2015). The healthcare delivery structure in Kenya is organized across six levels of care. At the lowest end is the community level (Level 1), dispensaries (Level 2), and health centres (Level 3) all offering the primary care services. Next are the county referral health services (Level 4 and 5) and at the highest level is the national referral health services (Level 6) (MoH, 2014). Dispensaries are usually the system's first line of contact with patients, although in some cases health centres or even hospitals. The health centres by and large provide the ambulatory health care which covers preventive and curative services, mostly tailored to local needs (Muga *et al.,* 2006). This research focused on Level 2 (Dispensaries) and Level 3 (Health Centres) healthcare facilities.

Table 1.1: Hierachy of Kenyan Health Facilities

1	• COMMUNITY CENTRES
2	• **DISPENSARIES**
3	• **HEALTH CENTRES**
4	• SUB-COUNTY REFERRAL HOSPITALS
5	• COUNTY REFERRAL
6	• NATIONAL REFERRAL HOSPITALS

Source: MOH, 2014

Healthcare personnel are defined as all paid and unpaid persons working in health-care settings who have the potential for exposure to patients and/or to infectious materials, including body substances, contaminated medical supplies and equipment, contaminated environmental surfaces, or contaminated air (Shuchat & Shefer, 2011). Healthcare workers (HCWs) health and wellbeing is critical since it influences the quality of care provided by health workers. Generally, HCWs encounter an increased risk of contracting infections from vast exposure to pathogens at their working environment. Most of the time, the threat is either unexpected or not immediately apparent, which makes risk assessment particularly difficult (WHO, 2010). In order to tackle this danger innovative ways of building the capacity of health workers need to be developed. The innovative ways should be in line with the principles of the Occupational Health and Safety Act, 2007 (OSHA, 2007). These include: eliminative measures such as simple standard hygiene practices, technical protective measures such as engineering controls, organizational measures and Personal Protective Equipment (PPE) measures. Engineering controls and work practices are the principal methods used to prevent infection in healthcare setting of Hepatis B, Hepatitis C, Human Immunodeficiency Virus, and other blood-borne pathogens. PPE also are vital because most of the times exposure to these pathogens remain a threat even after applying these controls (Oregon OSHA, 2014).

Blood-borne pathogens have the potential of causing severe illness and fatality. The most common blood-borne pathogen infections are HBV, HCV, and HIV (Oregon-OSHA, 2014). The universal precautions initiative must be observed as a first step to prevent these infections. It is an approach to infection control in which all human blood and other potentially contagious materials are handled as if they were already confirmed to be infectious for blood-borne pathogens (NCGC, 2012).

PPE prevents contact with an infectious agent or body fluid that may contain an infectious agent, by creating a barrier between the potential infectious material and the healthcare worker (Minnesota Health Department, 2015). According to the American College of Emergency Physicians (ACEP), proper protection for all HCWs on PPE against chemical, biological, and radiological elements is a critical component of ensuring their safety in the high risk environment they operate from which requires thorough analysis before deciding on which PPE to use (ACEP, 2015). Key elements in the selection process for appropriate PPE levels and decontamination facilities include: Cooperating strategically with local response agencies, professional associations, accrediting bodies, governmental agencies, and others. (In Kenya we have the office of Director of Occupational Health and Safety Services (DOHSS), National Environmental Management Authority (NEMA), Kenya Bureau of Standards (KEBS), Public Health Inspectorate, and Ministry of Health (MoH) among other agencies]; and carrying out routine hospital hazard vulnerability analysis (HVA) consistent with community threats (ACEP, 2015).

Health workers need to be trained on appropriate use of PPE and the significance of utilizing them efficiently. Routine refresher training courses are also very important in line with the principles of the Occupational Health and Safety Act, 2007 (OSHA, 2007). ACEP strongly advocates for governments to invest in adequate research to determine a scientific basis for PPE level and decontamination procedures at hospitals and health care facilities. Some of the PPE commonly used in the healthcare settings include: gloves, gowns, masks, goggles, face shields, respirators all coming in different form and design depending on the tasks and suitability (ACEP, 2015).

1.2 Statement of the Problem

The hospital working environment is complex and demanding and can pose significant risks to staff safety (Doyle, 2013). The 2013-2017 Mombasa County Integrated Development Plan (MCDIP) stipulates that the challenges in the health sector include inadequate personnel with a doctor to patient ratio of 1:11875, and a nurse to population ratio of 1:18678. These values are way lower than WHO recommended doctor patient ratio of 1:600 (MCDIP, 2013). This puts pressure on efforts to meet the welfare of HCP adequately. Recent increased risk rates of Hospital Acquired Infections (HAIs) imply infection prevention and control is vital for both patient and personnel safety (MoH, 2012). There are an estimated 100 HIV, 1000 HCV, and over 6,000 HBV infections that occur yearly in Kenya among HCWs due to sharps injury (Taegtmeyer *et al.*, 2008). Chronic hepatitis B badly affects more than 350 million persons globally (WHO, 2013). Kenya is classified by the WHO as a highly endemic area with a prevalence of more than 8% where the highest globally is about 10%. HBV poses a higher risk to the healthcare workers because it is 100 times more infectious than HIV and 30 times more infectious than the HCV (Lule *et al.,* 2014). HCV has got no vaccine and the best control measure of infection available is through prevention.

The HCWs in Mombasa County are subjected to a community risk with a HIV prevalence standing at a high 8.1% weighed against a national 6.3% (MCDIP, 2013). Increased post exposure prophylaxis (PEP) uptake among HCWs and HIV sero-prevalence rates among patients justify HCP concerns about the risk of exposure hence vigilance when handling blood and other potentially infectious material (OPIM) (Taegtmeyer *et al.,* 2008). Most of HCWs in Kenya face the risks of HAIs due to inadequate access and/or use of PPE. For instance, about 71% & 58% of medical waste handlers across Kenya lack respirators and appropriate gloves (USAID, 2012). It is also notable that counterfeits are a threat on public health and there is a high possibility that counterfeit PPE could reach the health facilities through the supply chain (Inyangala *et*

al., 2006). Counterfeit hardly meet the required quality standards and hence the need for quality assurance checks. The findings of this study will help to identify the level of protection provided by PPE and areas that require improvement in terms of PPE policy implementation. The study will further lay a scientific basis for further research on PPE level of protection and decontamination procedures for a safer working environment in health facilities.

1.3 Justification

The aim of this study was to explore the effectiveness of personal protective equipment in preventing HIV, HBV, and HCV infections among HCP working in primary public healthcare facilities in Mombasa County. The latest reports available shows an increase in the number of HCWs accessing Post Exposure Prophylaxis (PEP) antiretroviral drugs due to occupational exposures such as needle-stick injuries that put the workers at risk of infection by blood-borne pathogens such as Hepatitis and HIV (MoH, 2014). Accidental occupational exposure to potentially contaminated blood and body fluids can have dire consequences for HCP because of the risk of sero-conversion, mainly to positivity for HIV, HBV, or HCV (Kuruuzum *et al.*, 2008). The study focused mainly on primary health facilities (PHFs) because they are disadvantaged by the low operation budget performance in the Mombasa County health sector at about 48%. This is according to Office of the Controller of Budget (OCoB, 2013). After thorough analysis, the findings from this study will be shared with Mombasa County Directorate of Health services and Director of Occupational Health and Safety Services who will make informed decisions on PPE policy implementation e.g. research work on improving the efficacy and quality standards of PPE, budgetary and technical boost, and ways of enhancing the PPE program with other remedial measures.

1.4 Research Questions

1. What are the different types of Personal Protective Equipment available for use by healthcare workers against blood-borne biohazards in Mombasa County primary healthcare facilities?
2. Do the healthcare personnel adhere to Personal Protective Equipment guiding principles at primary healthcare facilities in Mombasa County?
3. Does the quality of hands personal protective equipment available at the primary health facilities meet the Kenya Bureau of Standards specifications?
4. What are the prevalence rates of occupational exposure to blood-borne biohazards amongst healthcare workers at primary health facilities in Mombasa County?

1.5 Hypothesis

H_0 The quality of examination and surgical gloves available at the primary health facilities in Mombasa County do not meet the acceptable quality standards with reference to the Kenya Bureau of Standards specifications.

1.6 Objectives

1.6.1 Main Objective

To determine the suitability of Personal Protective Equipment as a safeguard against blood-borne biohazards exposure amongst Health Care Personnel at Public Primary Health facilities in Mombasa County.

1.6.2 Specific Objectives

1. To assess the provision and use of Personal Protective Equipment available at the primary health facilities in Mombasa County.
2. To evaluate the adherence to the use of Personal Protective Equipment by healthcare personnel at the primary healthcare facilities in Mombasa County.
3. To determine the quality of examination and surgical gloves available at the primary health facilities with reference to the Kenya Bureau of Standards specifications.
4. To establish the prevalence rates of occupational exposure to blood-borne biohazards amongst healthcare workers at primary healthcare facilities in Mombasa county.

1.7 Conceptual Framework

The conceptual framework model illustrates how the findings from the determination of range of PPE, the modes of exposure to HIV, HBV, and HCV and the PPEs available to curb the routes of exposure, and assessing the quality standards of PPE (Gloves) will determine the effectiveness of PPE in preventing exposure to blood-borne pathogens.

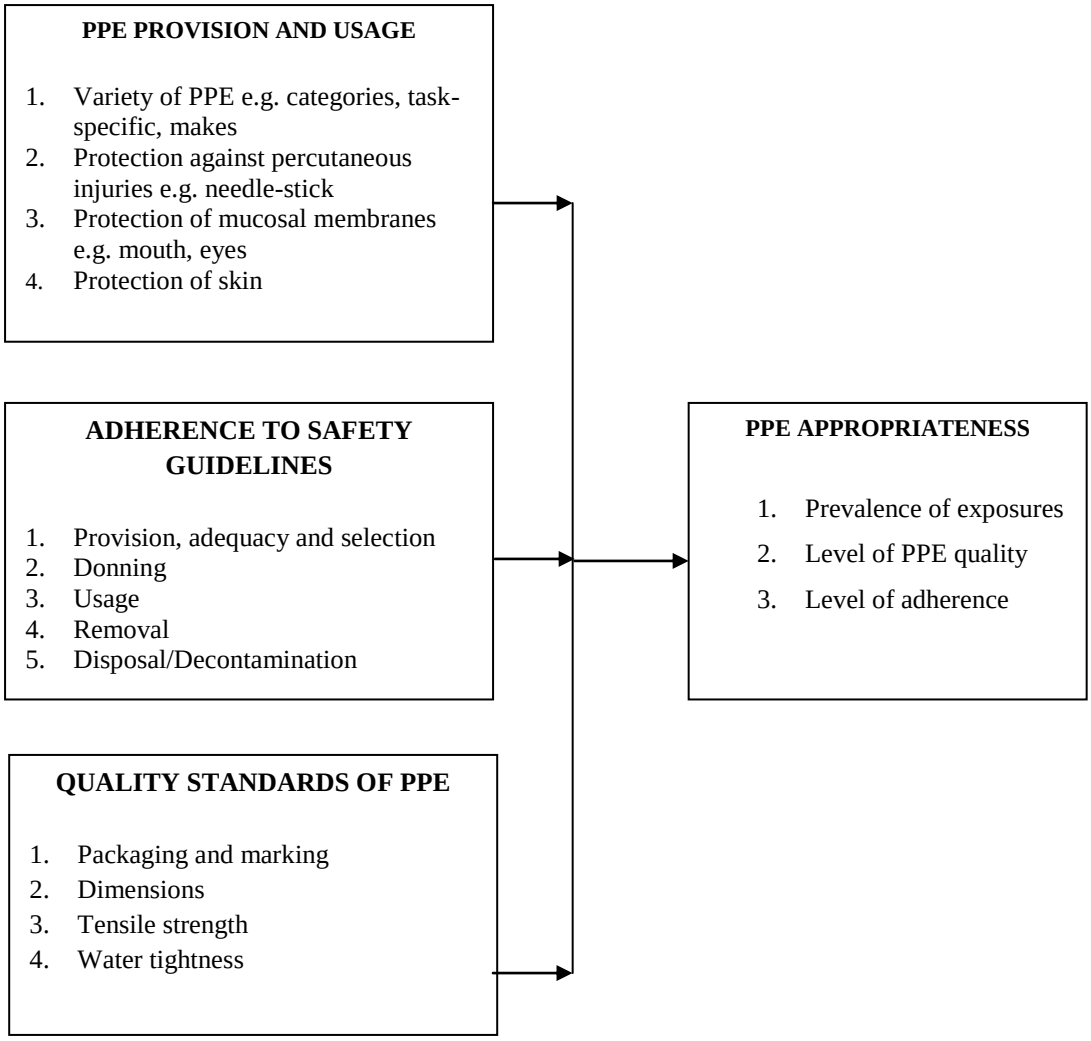

Figure 1.1: Conceptual Framework

1.8 Scope

Mombasa County is located in Southeastern part of Kenya and consists of four Sub-Counties (Appendix XIX). The County has 49 public owned health facilities out of which a total of 33 are public primary healthcare facilities (eHealth, 2014). This study focused on the 33 PHFs out of which five groups of HCP namely: Clinical Officers, Lab Technicians/Technologists, Nursing, Medical assistants e.g. dressers, and Housekeepers

were targeted for primary data collection. Studies to establish modes of exposure and the range of PPE were conducted on sampled health facilities and personnel. To establish the incidence rates of HCP exposure to the threat of blood-borne and other body fluids pathogens for the reported and unreported cases were used as the main sources of data by utilizing a structured questionnaire. The research was conducted within a period of four months from May to August 2016.

1.9 Limitations

The research being chronological in nature, most of the responses depended on memory there may have been obscurity in recalling the events relevant to the study. However, the research focused on the events from the last three years of which they could easily remember. The lab assays confirmed some of the responses by the participants. Secondly the, resources for conducting the research were limited only to level two and three healthcare facilities. Better outcomes of PPE efficacy would have been realized by covering the Coast General Hospital and other levels of healthcare facilities since they attend to majority of the patients in the county and with a bigger number of various HCP. Due to limited resources, the assays on quality standards of the PPE at KEBS was only restricted to gloves as opposed to all forms of PPE available which would have given a more comprehensive conclusion. The other forms of PPE were evaluated using the questionnaires. Furthermore, the commonest mode of exposure to blood and OPIM was through sharp related injuries whose main PPE available was latex rubber gloves.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review is under the following subheadings: Types of Healthcare PPE, Modes and routes of Exposure to blood-borne pathogens, Personal Protective Equipment Guidelines, PPE Quality Standards, and Related studies. The literature data search utilized a combination of key words and phrases from these subheadings.

2.2 Types of Healthcare PPE

Personal protective equipment in a healthcare setting may include different types of gloves, gowns, laboratory coats, face shields or masks, eye protection, pocket masks, safety boots, respiration protectors, footwear, and other protective gear and clothing. The cardinal rule is that, PPE selected must be appropriate for the task, must be readily accessible to workers, and should be available in appropriate sizes (OSHA-USA, 2011).

2.2.1 Gloves

Gloves protect users against contact with hazardous materials and they are vital in healthcare environment for health and safety of HCWs. They protect the skin from toxic chemicals that can be absorbed through the skin, friction, extremes temperatures' and importantly from biological pathogens that can lead to infection (Imperial, 2005). There are typically two types of healthcare gloves: Medical examination and surgical gloves. Examinations gloves help prevent contamination between caregivers and patients and are used during procedures that do not require sterile conditions, for example drawing blood for a blood test. Primary purpose of surgical gloves is to act as a protective barrier to prevent possible transmission of diseases between healthcare professionals and patients during surgical procedures. Some of the other differences between surgical and

medical examination gloves are: Manufacturing of surgical gloves requires a higher level of quality standards, surgical gloves are sterile and individually packaged in pairs, and they have a more precise range of sizing than medical examination gloves (DermNet, 2015).

Surgical and examination gloves made from latex and synthetic rubbers are ever-present in occupations where exposures to blood and bodily fluids are anticipated. Even though primarily intended to serve as a shield against such fluids, these rubber gloves are basically the only puncture safeguard that a healthcare worker has (Dombrowski *et al.*, 2012). However, it is important to remember that the use of gloves is not a substitute for effective hand washing. Rubber gloves normally offer very little resistance to needle puncture, but practices such as double gloving offers some extra protection against needle injury or blood exposure (Edlich *et al*., 2003). The puncture mechanism of rubber has been modeled and understood using fracture mechanics (Nguyen *et al.*, 2009). The gloves can be disposable or reusable depending on the type and properties of materials used to manufacture them. The choice of disposable glove should be made following a thorough risk assessment of the task, the risk to the HCW and the risk to service recipients. A variety of sizes must be made available to ensure a correct fit and comfort (Northumberland, 2013).

Table 2.1: Types of gloves

TYPE	MATERIAL	USE	FEATURES	REFERENCES
Latex	Synthetic rubber	Handling blood and OPIM, chemical solvents	Possible latex allergies	Appendix XX
Nitrile	Synthetic rubber	Handling blood and OPIM, chemicals e.g. chlorinated solvents	Puncture/chemical resistance, and tensile strength superior to latex. No allergies	Appendix XXI
Neoprene	Synthetic rubber	Handling most chemicals (acids, alcohols, caustics, detergents etc) blood, and OPIM	Similar performance as natural rubber, an alternative for HCP allergic to latex	Appendix XXII
Vinyl	Poly vinyl chloride	Short low-risk procedures	Poor blood barrier protection, poor resistance to degradation by chemicals	Appendix XXIII
Polythene	Polythene	Food handling	Not suitable in healthcare environment, likely to rip or split	
Leather	Tanned natural material	Handling medical sharps wastes	Available in a vast range of thickness, styles	Appendix VII, Fig. XI

- Source: Imperial, 2005; Northumberland, 2013

Re-usable gloves offer greater protection than disposables against abrasion and other physical hazards, are less likely to tear in use and will resist chemical attack for longer. They are mostly utilized by healthcare waste handlers. Re-usable gloves usually have a longer cuff length than a disposable glove made with the same material, and so offer better protection against liquid slopping over the top of the glove. If frequently re-used the gloves should be periodically maintained and meticulously inspected for any damages. By selecting the right glove for the task at hand, by understanding the limitations of the selected glove and by knowing how to use them, gloves can help eliminate most dangerous exposures (Imperial, 2005).

2.2.2 Protective Clothing – Lab Coats, Gowns, Aprons, and Coveralls

The necessity for and the kind of isolation gown selected is based on the nature of the patient interaction, including the anticipated degree of contact with transmittable material and probability of blood and body fluid penetration of the barrier. Clinical and laboratory coats or jackets worn over personal clothing for comfort and/or purposes of identity are not considered PPE (OSHA-USA, 2012). There are four types of laboratory protective attire available in a wide variety of materials and designs: Laboratory coats, Laboratory gowns, Laboratory aprons, and Coveralls as shown in Table 2.2. However, scrub outfits made of natural or manmade fabrics are equivalent to usual clothes and can’t be considered protective laboratory apparel.

Table 2.2: Types of protective clothing

TYPE	MATERIAL	USE	FEATURES	REFERENCES
Lab coats	Spun fabrics (Re-usable/disposable), polyester/cotton blend	Protects against splashes and undergarments contamination	Pockets and slits free, Snaps closures but not zips/buttons	Appendix XXXIII
Lab gowns	Polypropylene	Worn over lab coats to provide extra protection	Usually treated with powder and liquid resistant material	Appendix XXX
Lab aprons	Rubberized fabric, disposable plastic	Worn over lab coats at high risks of sprays and splashes of chemicals, blood and OPIM	Resistant to corrosive chemicals, should be stored safely free from dust	Appendix VII, Fig. XV, Fig. XVI
Lab coveralls	Man-made non-spun fabrics e.g. tyvek and tychem	Designed to cover the entire street clothing for extra leg protection	Snap or zipper closures, Zippers provide better protection (fine powder/aerosols)	Appendix VII, Fig. XVII

- Source: Imperial, 2005; Tufts, 2010

2.2.3 Face Masks, Shields and Goggles

Face masks (Appendix XXXI) and eye protection must be worn where there is a risk of blood, body fluids, secretions or excretions splashing into the face and eyes (NCGC, 2012). Facemasks serve as barriers during invasive procedures to protect the mucous membranes of the nose and mouth from splash. Personal eyeglasses and contact lenses are not considered adequate eye protection. NIOSH states that, eye protection must be comfortable, allow for sufficient peripheral vision, and must be adjustable to ensure a secure fit (CDC, 2005). Protective eyewear includes clear plastic goggles, safety goggles

(Appendix XXXIII), and face-shields (Appendix XXXII). They should be worn during procedures that involve splashing and spatter of saliva and blood or that has the potential for creating projectiles, such as an amalgam. Eyewear protects the eyes from damage and from microbes which can be transmitted through the conjunctiva. Spectacles do not provide eye protection. If face shields are not available, goggles and a mask can be used together as a substitute. Eyewear, if appropriately used, can offer protection against physical splashing of infected substances into the eyes (although not on 100% of occasions). Unfortunately, poor compliance is a setback when it comes to eye protection (MoH-GoK, 2010).

2.2.4 Boots and other safety foot wears

Waste handlers, lab technicians, maternity personnel, and incinerator operators should be provided with protective footwear to protect from falling debris, potential blood-borne pathogens contained in medical waste, and occupational heat exposure (PATH *et al.*, 2010). There is very limited evidence regarding the use of footwear as PPE for standard infection control purposes in non-theatre healthcare settings (HPS, 2012). Some experts have recommended that they should be worn when gross contamination through splashes or spills of body fluids is anticipated (NCGC, 2012). Protective footwear for waste handlers should be: made from cut-resistant materials, slip-resistant sole, puncture-resistant sole, protective against minimal impact, fit with comfort, durable, capable of being disinfected, availability in various sizes to fit all waste handlers, and for incinerator operators boots should be made from heat-resistant materials when available. The foot wear include steel-toe safety boots (Appendix XXXIV), slip-on shoes (Appendix XXXV), poly-vinyl chloride (PVC) safety boots, etc.

2.3 Incidences and routes of exposure to blood-borne pathogens

Occupational exposure to blood can result from percutaneous injury (needle-stick or other sharps injury), mucocutaneous splashing (splashing of blood or other body fluids into the eyes, nose, or mouth) or blood contact with non-intact skin. Needle-stick injury is the most common form of occupational exposure to blood and the most likely to result in infection (Sabbah *et al.,* 2012). The most common causes of needle-stick injuries are recapping and unsafe collection and disposal of sharps. Health care workers in areas such as operating, delivery, and emergency rooms and laboratories have a higher risk of exposure. Cleaners, health care waste collectors, and others whose duties involve handling OPIM are also at risk. (MoH-Kenya, 2010).

HCP working in traditional health care workplaces face a serious danger that may threaten their life where accidental exposure may lead to infections by BBPs particularly HBV, HCV, and HIV (Sabbah *et al.,* 2013). Studies indicate that the average risk of sero-conversion after a single percutaneous exposure to an infected blood is approximately 2% for HCV, 6% - 60% for HBV, and 0.1% - 0.3% for HIV. Over 90% of these infections take place in low-income countries (Sangwan, 2011).

2.3.1 Human Immunodeficiency Virus

The risk of occupational transmission of HIV to medical personnel has been recognized since 1984. Correct estimation of the likelihood of transmission following occupational exposure is limited by the relative infrequency with which HIV transmission to HCWs is reported. The estimated risk of HIV transmission following a single needle-prick exposure is estimated to be approximately 0.3% (95% confidence interval [CI], 0.2%–0.5%) and that after a mucous membrane exposure to be approximately 0.09% (95% CI, 0.006%–0.5%) (Taegtmeyer *et al.,* 2008). The needle-stick injuries and other sharps pose a greater risk of transmission than through splashes to mucosal membranes which is in turn less than in non-intact skin exposure. The risk after exposure to fluids or

tissues also has not been quantified but is expected to be lower than that for blood exposures. There is a high risk of exposure whenever non-intact skin or mucous membranes through splashes to the eyes, nose, or oral cavity come in contact with a potentially infected body fluid from a source that is HIV-positive or has unknown HIV status. Body fluids that can transmit HIV include blood; genital secretions; cerebrospinal, amniotic, peritoneal, and pleural fluids (Gerberding *et al.*, 2005).

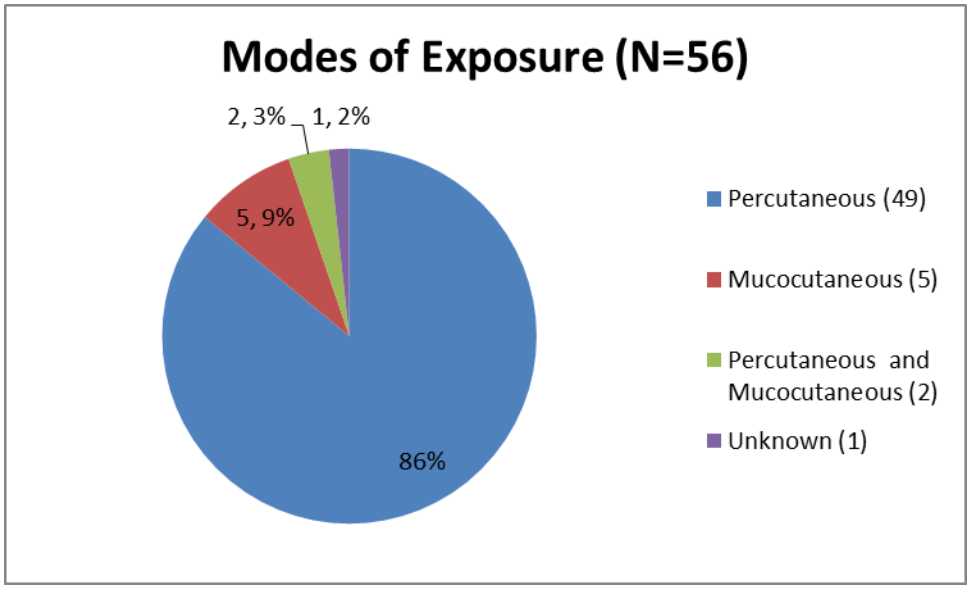

Figure 1.1: HIV modes of transmission, -Source: hiv.uw.edu

The likelihood of HIV infection following exposure is affected by the following factors: type of contact—intact skin or broken skin, quantity of blood, disease status of source patient, disease status of person injured (terminal illnesses and acute or recent infections), host defenses, and access to PEP (MoH-GoK, 2010). Exposure to a source patient with an undetectable serum viral load does not remove the possibility of HIV transmission or the need for PEP and follow-up testing. While the risk of transmission

from an occupational exposure to a source patient with an undetectable serum viral load is thought to be very low, PEP should still be offered (OSHA-USA, 2011).

2.3.2 Hepatitis B Virus

The word hepatitis comes from the Ancient Greek word *hepar* (root word *hepat*) meaning 'liver', and the Latin *itis* meaning inflammation (MNT, 2015). Hepatitis can be caused by drugs, toxins, autoimmune disease, and infectious agents, including viruses (OSHA-USA, 2011). Hepatitis B is a liver disease caused by the hepatitis B virus (HBV). Hepatitis B, previously called "serum hepatitis," is a life threatening blood-borne pathogen and a major risk to workforce in occupations where there is exposure to blood and OPIM. Healthcare Personnel who have a realistic anticipation of exposure to blood and OPIM on the job should be offered hepatitis B vaccine. This does not include administrative staff (receptionists, clerical and billing staff, etc.), as these individuals are not expected to be at risk for blood exposure (Moyer *et al.*, 2005).

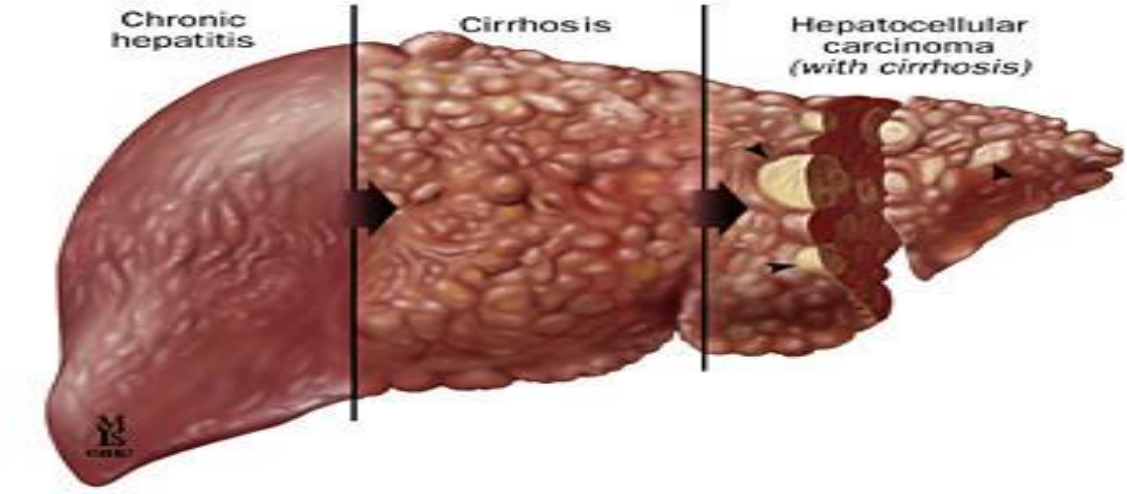

Figure 1.2: Stages of Hepatitis B , -Source: medthical.com

Hepatitis B is typically a sexually transmitted disease. It is also spread by contact with infected blood, semen, and OPIM. Other than unprotected sexual intercourse with an infected person, HBV is commonly transmitted through usage of contaminated syringes e.g. among drug addicts and people who inject steroids; needlestick injuries among HCWs; sharing unsterilized needles, as might be the case when getting a tattoo; sharing personal items, such as a toothbrush or razor, with an infected person; mother to baby through breast milk; blood donation; and last but not least being bitten by an infected person (MNT, 2015). HBV infection is a well recognized occupational risk for HCP (NCGC, 2012). The risk of HBV infection is primarily related to the degree of contact with blood in the work place and also to the hepatitis B e antigen (HBeAg) status of the source person. In studies of HCP who sustained injuries from needles contaminated with blood containing HBV, the risk of developing clinical hepatitis if the blood was both hepatitis B surface antigen (HBsAg)- and HBeAg-positive was 22%–31%; the risk of developing serologic evidence of HBV infection was 37%–62%. By comparison, the risk of developing clinical hepatitis from a needle contaminated with HBsAg-positive, HBeAg-negative blood was 1%–6%, and the risk of developing serologic evidence of HBV infection, was 23%–37% (Wicker, *et al.*, 2008).

Although percutaneous injuries are among the most efficient modes of HBV transmission, these exposures probably account for only a minority of HBV infections among healthcare workers. In addition, HBV has been demonstrated to survive in dried blood at room temperature thus, HBV infections that occur among HCP with no history of non-occupational exposure or occupational percutaneous injury might have resulted from direct or indirect blood or body fluid exposures that inoculated HBV into cutaneous scratches, abrasions, burns, other lesions, or on mucosal surfaces. Blood contains the highest HBV titers of all body fluids and is the most important vehicle of transmission in the health-care setting. HBsAg is also found in several other body fluids, including breast milk, bile, cerebrospinal fluid, feces, nasopharyngeal washings, saliva, semen, sweat, and synovial fluid (Leigh *et al.*, 2007). However, the concentration of

HBsAg in body fluids can be 100–1000—fold higher than the concentration of infectious HBV particles. Therefore, most body fluids are not efficient vehicles of transmission because they contain low quantities of infectious HBV, despite the presence of HBsAg (Gerberding *et al.,* 2005).

2.3.3 Hepatitis C Virus

Hepatitis C is a liver disease caused by the hepatitis C virus (HCV). It is the most common chronic blood-borne infection globally and is mainly transmitted through large or repeated direct percutaneous exposures to blood (Oregon-OSHA, 2014). Most people who are chronically infected are not aware of their infection because they are not clinically ill. Infected people can infect others and are at risk for chronic liver disease or other HCV related chronic diseases. Currently there is no vaccine against hepatitis C (OSHA-USA, 2011). HCV is not transmitted efficiently through occupational exposures to blood. The average incidence of anti-HCV sero-conversion after accidental percutaneous exposure from an HCV-positive source is 1.8% (range: 0%–7%) with one study indicating that transmission occurred only from hollow-bore needles compared with other sharps (Leigh *et al.,* 2007).

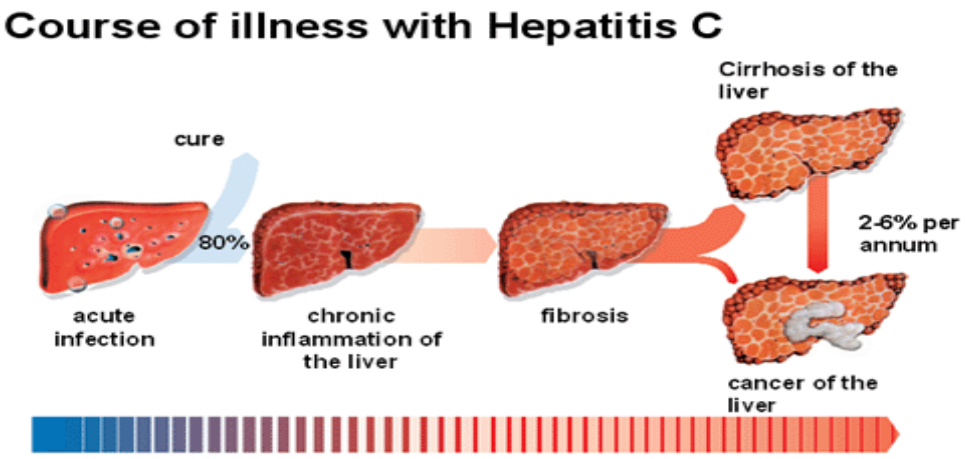

Figure 1.3: Course of illness with HCV, -Source: healthdummy.com

Transmission rarely occurs from mucous membrane exposures to blood, and no transmission in HCP has been documented from intact or non-intact skin exposures to blood. Data are limited on survival of HCV in the environment (Ebnother *et al.*, 2008). In contrast to HBV, the epidemiologic data for HCV suggest that environmental contamination with blood containing HCV is not a significant risk for transmission in the health-care setting, with the possible exception of the hemodialysis setting where HCV transmission related to environmental contamination and poor infection-control practices have been implicated. The risk for transmission from exposure to fluids or tissues other than HCV-infected blood also has not been quantified but is expected to be low (Wicker *et al.*, 2008).

2.4 Personal Protective Equipment Guidelines

Globally, the prevention and control of infections are fundamental pillars of medical care in all health care settings. The changing pattern of infections and the emergence of multi-drugs resistance microbes highlight the need for all HCP to comprehend and put

into practice evidence-based infection prevention and control practices that will protect patients and HCP from HAIs (MoH-GoK, 2010).

2.4.1 Health and Safety Executive (HSE) Provisions for Medical Gloves - United Kingdom

HSE provides that although within the hierarchy of controls elimination and engineering controls should have priority, PPE should be used in combination to other controls. The European Standards include EN 420, EN 388, EN 1082, and EN 374 which will be discussed in detailed under gloves quality standards. HSE guidelines advocate for nitrile or vinyl gloves but still appreciate the fact that latex gloves are still used in large numbers due to their efficacy and relatively low cost and thus recommend the use of powder free and low protein content materials to help prevent latex allergy. HSE emphasizes on the correct donning, removal, and disposal of gloves to minimize the risk of cross-contamination. It summarizes by stating the importance to remember that glove use is not a replacement for good hand hygiene, and the two should work together to protect the wearer and any other party, such as a patient (HSE, 2010).

2.4.2 Occupational Health and Safety Act – OSHA 2007

The Occupational Safety and Health Act, 2007 (OSHA, 2007) was enacted by the Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplace. The Act provides that it will be the duty of every employer to prevent his employees from being exposed to hazardous substance. Where it is not reasonably practical to prevent the exposure, it will be the duty of every employer to control the exposure of employees from hazardous substances by limiting the amount and duration of exposure. Further, the Act directs that where it is not reasonably practical to ensure that the exposure of an employee is adequately controlled; the employer should provide the employee with suitable respiratory and skin protective equipment and protective clothing. The employer should also facilitate the training,

instructions and supervision on PPE use and ensure the equipment is kept in good condition and efficient working order while the reusable are decontaminated and sterilized (KLR, 2010).

2.4.3 National Infection Prevention and Control Guidelines for HIV, HBV, and HCV

For HCWs to provide high-quality health care services and prevent unnecessary HAIs, strict adherence to simple and cost-effective Infection Prevention and Control (IPC) practices such as hand hygiene must be observed (MoH-GoK, 2010). The guidelines advocates for appropriate usage of gloves by HCP when conducting blood transfusion, handling blood and OPIM specimens, phlebotomy, invasive examination of patients, and surgical operations. Prior to transfusion, all donated blood should be screened for blood-borne pathologies, antibodies, antigens to HIV-1 and 2, hepatitis B and C viruses, and syphilis, malaria, and others (MoH-GoK, 2010). National Infection Prevention and Control Guidelines provide that disposable gloves should be worn when there is a risk of contact with potentially infectious material, changed after completing each task, and shouldn't be washed or reused but instead disposed correctly. Face Protection Equipment for face protection must be worn for anticipated splashes or sprays of infectious or other HAZMATs when microorganisms are manipulated outside the facilities. The guidelines call for elimination of the use of needles where safe and effective alternatives are available and when used engineering controls should be applied (MoH-GoK, 2010).

In case of accidental exposure, health care workers should always have immediate access to PEP regardless of the location or type of work they do (MoH-GoK, 2010). PEP services need to be documented at several levels. A national registry should be maintained to document the extent and outcomes of PEP use. At the local level, incident reports are critical for reviewing when and how exposure occurs and for identifying

safety concerns and possible preventive measures. Record-keeping systems should be kept as simple as possible. Secure systems for storing data and controls on access to medical records should be developed (MoH-GoK, 2010).

2.4.4 Occupational Safety and Health Policy Guidelines for the Health Sector in Kenya

The OSH policy guidelines for the health sector in Kenya provide that selection of PPE's be done according to the risk assessment for specific work areas. Other general guidelines for using PPE include: selection of appropriate PPE; fitting of the HCP; usage of the right PPE for the right purpose; avoiding any contact between contaminated PPE and surfaces or people outside the workstation; discarding PPE appropriately; prohibits sharing of PPE or carrying home and that the reusable should be cleaned within the working area. The policy further recommends the type of PPE should be specified for the work area and type of contaminant originating from the activities, processes and procedures. For instance, for the morgue and orthopedic HCWs, the policy recommends that in addition to routine protective gear, extra PPE (surgical caps, hoods, shoe covers, boots, etc) should be worn if blood exposure is anticipated during autopsies or orthopedic surgery. The PPE program should also be reviewed if the employee will be required to wear protective equipment where it was not the case at the start (OSH-MOH, 2014)**.**

2.5 Gloves Quality Standards

The extent to which gloves will protect healthcare personnel from transmission of blood-borne pathogens (e.g., HIV, HBV, and HCV) following a needle-stick or other puncture that penetrates the glove barrier has not been determined (Siegel *et al.,* 2007). Previous studies provided evidence that gloves used for clinical practice leak when apparently undamaged. In terms of leakage, gloves made from natural rubber latex performed better than vinyl gloves in laboratory test conditions (BSI, 2009). Expert opinion supports the

view that the integrity of gloves cannot be taken for granted and additionally, hands may become contaminated during the removal of gloves (CDC, 2013). Therefore, the use of gloves as a method of barrier protection reduces the risk of contamination but does not eliminate it and hands are not necessarily clean because gloves have been worn (NCGC, 2012).

2.5.1 Europe EN Standards for Gloves

European Standards (ENs) are documents that have been ratified by one of the three European Standardization Organizations (ESOs), recognized as competent in the area of voluntary technical standardization as for the EU Regulation 1025/2012. EN 420 standards defines the general requirements for glove design and construction, innocuousness, comfort and efficiency, marking and information applicable to all protective gloves. For each specific test, a glove is given a performance level of between 0 and 4, and by which it is graded. 0 indicates that the glove is either untested or falls below the minimum performance level. A performance level X means that the test method is not suitable for the glove sample. Higher numbers indicate higher levels of performance (Ansell, 2011).

EN 374 standards specifies the requirements of gloves for protection against chemicals and/or micro-organisms. Specific requirements are that gloves need to be: sealed against penetration of liquids according to method in EN 374-2 which is a pass/fail test, and permeation resistance to chemicals tested according to method EN 374-3. Each combination of glove/chemical is classified according to the time the glove resists to permeation of the chemical (Imperial, 2005). EN 388 standards applies to gloves that protect against physical and mechanical hazards. It specifies requirements for resistance to damage from abrasion, puncture, tearing and cutting (HSE, 2010). Last but not least, there is the EN 455 standard. Gloves that have been tested according to this standard are assessed for suitability for use in health care. A glove that conforms to EN 455 will

provide adequate protection against infectious hazards, but not chemical resistance (Imperial, 2005).

2.5.2 ISO Quality Systems for Gloves

ISO (The International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. The relevant rubber medical glove standards are developed by the ISO Technical Committee TC 45, Sub Committee SC 4 (ISO, 2008).

ISO 11193-1:2008 specifies requirements for packaged sterile, or bulked non-sterile, rubber gloves intended for use in medical examinations and diagnostic or therapeutic procedures to protect the patient and the user from cross-contamination. It also covers rubber gloves intended for use in handling contaminated medical materials and gloves with smooth surfaces or with textured surfaces over all or part of the glove. ISO 11193-2:2006 is intended as a reference for the performance and safety of rubber examination gloves. It does not cover the safe and proper usage of examination gloves and sterilization procedures with subsequent handling, packaging and storage procedures (ISO, 2015). ISO 10282:2014 specifies requirements for packaged sterile rubber gloves intended for use in surgical procedures to protect the patient and the user from cross-contamination. It is applicable to single-use gloves that are worn once and then discarded. It does not apply to examination or procedure gloves. Other standards developed by ISO which are relevant to the glove industry are those related to Quality Systems, ISO 9001: Quality systems for design, development, production, installation and servicing and ISO 13485:2003 Medical devices quality management systems (Kossan, 2015).

2.5.3 American Society for Testing and Materials (ASTM) Testing Methods for Gloves

ASTM International, known until 2001 as the American Society for Testing and Materials (ASTM), is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. Some 12,575 ASTM voluntary consensus standards operate globally (Kossan, 2015) (Appendix IV) summarizes the ASTM Standards applicable to medical gloves.

2.5.4 Kenya Bureau of Standards for Medical Gloves

A Kenyan Standard is a document established by consensus and approved by the Kenya Bureau of Standards (KEBS), which provides, for common and repeated use, rules, guidelines or characteristics for products and services and associated processes or production methods, aimed at the attainment of the most favorable degree of order in a given context. Standards, hence, help to ensure the quality, comparability and compatibility of products and services (KEBS, 2015). The main function of the testing services at KEBS is to provide tests in areas of Chemistry, Food, Microbiology, Material Engineering and Textiles. The tests on products are carried out against national standards, International standards, specific Government and other client specifications. The purposes for testing include: valuing of goods for trade, checking for conformity to standards, investigation on complaints, checking for composition and strength of materials, confirming presence or absence of banned ingredients, performance, and safety tests (KEBS, 2015).

The Kenya Standards that apply to gloves in healthcare settings include: KS ISO 21171:2006 for medical gloves determination of removable surface powder under the hospital equipment, medical devices, instruments and related tools; KS ISO 13999-1:1999 for protective clothing gloves and arm guards protecting against cuts and stabs

by hand-knives under medical and Hygienic Textile Products; KS ISO 11193-1:2002 for single-use medical examination gloves made from rubber latex or rubber solution; KS ISO 11193-2:2006 for single-use medical examination gloves made from poly (vinyl chloride under the hospital equipment, medical devices, instruments and related tools; and KS ISO 10282:2002 for single-use sterile rubber surgical gloves; KS 1524-2:2001 for specification for disposable surgical and examination gloves which was withdrawn and replaced by KS ISO 11193-1:2008); and KNWA 2409-10:2012 for gloves meant for healthcare waste handling under health care wastes management commodities.

2.6 Related Studies

According to a study by Gerberding *et al*. (1993), needle size and penetration depth were found to be significantly associated with transfer volume. They also observed that glove material reduced the transferred blood volume by 46%-86%. However, since transfer volumes were within the same magnitude for all conditions, they established that virus titer in the source blood may be a better predictor of needlestick infectivity than is exposure volume. They concluded that gloves may exert some protective effect and should be worn whenever needles are handled.

Sabbah *et al.* (2013), in a cross-sectional survey study to describe the prevalence and the risk factors for occupational exposure to Blood and Body Fluids (BBF) among HCWs, it was found that more than a half of HCWs admitted that they don't use gloves all the time for every activity of care. Nursing workforce was ascertained to be more aware than physicians that needles should not be recapped after use. About a third of HCWs declared having had at least one occupational exposure to BBF; and only about two thirds of all accidental exposures were reported. Percutaneous injuries were established to be the most frequently reported and accidental exposure to BBF to be more frequent amongst experienced and older people (OR = 3.42; p= 0.03).They concluded that exposure to BBF represents an important and frequently preventable occupational

hazard for HCWs that requires continuous training of HCWs, and a comprehensive approach for prevention and management.

According to Goodno and Rogers (2000) in a study to evaluate interventions that reduce or prevent needlestick injuries in health care occupations, it was found that there is a decrease in glove or skin perforations when double gloves or combinations of gloves were used by surgeons and their assistants. Protective devices were evaluated in three studies and significant reductions in glove perforations were found with the use of a needleless intravenous system and surgical assist device. In conclusion, few randomized controlled trials were found to have been employed to evaluate the effectiveness of interventions to reduce needlestick injuries in health care occupations. The majority of the studies evaluated interventions during surgical procedures, rather than during patient care on nursing units, probably because the latter is more difficult to observe.

2.7 Ethical Considerations

Upon approval of this research proposal, the researcher will seek clearance for data collection from the Pwani University Ethical Review Committee and the County Director of Health, Mombasa. The research will consider the 'non-identifiable' approach of confidentiality in data collection and storage. Anonymity of participants regarding their health status will also be safeguarded by use of codes instead of names. Prospective participants will be informed of the aim of the study and be allowed to voluntarily take part without being subjected to any pressure whatsoever. Furthermore, they will be provided with a consent form to fill and sign upon agreeing to participate in the study.

2.8 Critique of the Existing Literature

Most of the published retrospective cohort studies have not addressed conclusively the aspect of selection and recall bias in their research work. Most of work reviewed on effectiveness of PPE was done in developed world and has based their studies on

practical scenarios in their respective countries. This is however against the rationale of a background of high prevalence of some of the infections in question in the developing countries. For more comprehensive findings and conclusions the studies ought to have been conducted in some third world countries where there are many other confounding factors that could affect the efficacy of PPE use in healthcare facilities. These factors could include awareness, education, availability of resources, lack of adequate enforcement, etc. For instance, due to lack of adequate awareness and enforcement, most of the occupational exposure incidents and accidents go unreported and therefore most of the documented data is not accurate. HIV/AIDS still being a stigma all over the world, the studies have failed to convincingly address the issue of lack of compliance by the subjects where this topic is involved.

2.9 Research gaps

The literature review hardly revealed any studies on effectiveness of PPE in healthcare facilities in Mombasa County and only a handful of related studies nationally. With Kenya's heath sector still facing various challenges to meet the expectations of the healthcare personnel and the public, further studies need to be conducted to address the working conditions of HCP in public healthcare facilities. Studies need to be done to evaluate effectiveness and availability of other preventive control measures such as administration and engineering control.

CHAPTER THREE

METHODOLOGY

3.1 Research design

This study adopted a Descriptive Cross-sectional design. The advantage of descriptive cross-sectional studies is that the information is available immediately and can be carried out within a short period of time (Dicker *et al.,* 2007). A cross-sectional study design is applied when the researcher is interested in investigating exposure to risk factors and outcomes as well as estimating the prevalence of the outcome within relatively a short time in a population or a subgroup within a population in respect to an outcome and set of risk factors, (Levin-Kate, 2006).

3.2 Population

The majority of the healthcare facilities in Mombasa County are public and private primary healthcare establishments. The public facilities are currently managed by Mombasa County Government (MCIDP, 2013). There are 49 public owned health facilities as indicated by the latest list on the Ministry of Health website. Out of the 49, there are a total of 33 public PHFs which include dispensaries and health centres (eHealth, 2014). This study involved sampling of the 33 public Primary healthcare Facilities out of which the subjects namely: Clinical Officers, Lab Technicians/Technologists, Nursing, Medical assistants (e.g. phlebotomists and dressers), and Housekeepers were targeted for the primary data collection.

3.3 Sample size and Sampling Technique

The study was conducted amongst HCWs working in 33 primary healthcare facilities in the 6 sub-counties within Mombasa County (Kisauni, Nyali, Changamwe, Jomvu Mvita, and Likoni). A multi-stage random sampling approach was used in selection of the

subjects. First, each sub-county was proportionately allocated the sample size according to the population of the health facilities using the simple random method. Next, the sampling of HCP was conducted within the subject facilities after proportionately allocating them according to the population of each job cadre. The sample size consisted of Clinical Officers, Lab Technicians/Technologists, Nursing workforce (Registered Nurses and Nurses), and Housekeepers (Cleaners and Waste handlers). Medical gloves samples were also obtained randomly from each of the subject health facilities.

Respondents were arrived at by using Atchleys formula (Saunders & Thornhill 2009).

$$n = \frac{z^2 p(1-p)}{d^2}$$

n= desired sample size

p= proportion in target group or prevalence estimated to have the measured character.

Z= reliability co-efficient or standard normal deviation at the required confidence level

d= the level of statistical significance or degree of freedom, so if

z= reliability co-efficient (1.96)

p= prevalence (50%)

d= degree of freedom (0.05)

$$n = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2}$$

The required sample will be

$$n = 384$$

But since target population is way below 10,000 the final sample estimate (n_f) was calculated using

$$n_f = \frac{n}{1 + {}^{n}/_{N}}$$

Where N is the estimated study population and n is the required sample size.

Estimated study population, N= 297

Therefore, the final sample size estimate, n_f;

$$n_f = \frac{384}{1 + {}^{384}/_{297}} = 167$$

$$Specific\ sample\ size = \frac{Number\ of\ health\ facilities\ in\ each\ Sub\ County}{Total\ number\ of\ health\ facilities} \times Sample\ size$$

The sampled facilities were then distributed as shown in Table 3.1.

Table 3.1: Sample Distribution of Healthcare Facilities per Sub-County

Sub-County	Population	Specific sample size
Kisauni	6	2
Mvita	9	3
Nyali	6	2
Jomvu	5	2
Changamwe	3	1
Likoni	4	1
	33	**11**

$$Specific\ sample\ size = \frac{Specific\ job\ cadre\ population\ in\ a\ facility}{Total\ of\ the\ specific\ job\ cadre\ population} \times Sample\ size$$

The samples were distributed as shown in Table 3.2

Table 3.2: Respondents distribution of HCP per facility per Sub-County

Sub-County	Sample size	Code	Specific Job Cadre sample size					
			Clinicians	Nurses	Lab Technicians	Medical Assistants	Waste Handlers	Total
Kisauni	2	A	3	5	2	3	2	15
		B	2	4	2	1	2	11
Mvita	3	C	3	5	2	1	2	13
		D	4	4	3	1	2	14
		E	2	3	2	1	3	11
Nyali	2	F	3	4	3	1	2	13
		G	3	5	2	2	2	14
Jomvu	2	H	3	4	3	2	3	15
		I	3	5	2	3	3	16
Changamwe	1	J	3	4	3	3	2	15
Likoni	1	K	2	5	1	2	2	12
Total	**11**		**31**	**48**	**25**	**20**	**25**	**149**

3.4 Sampling Frame

At least one waste handler and one of the other HCWs were observed while carrying out their duties from each of the sampled facilities. This study design applied the principle of random selection hence reducing the selection bias.

3.5 Instruments

Structured questionnaires were utilized to determine the range of PPE used at the PHFs, adherence to PPE guiding principles, and prevalence rates of exposure. Observation guides were also utilized to monitor the activities of the HCP as they performed their duties. Laboratory assays on physical and biological aspects were conducted to determine the quality standards of sampled gloves. This required drawing vital guidelines from the Kenya Bureau of Standards (KEBS), National Infection Prevention and Control Guidelines for Health Care Services in Kenya, Occupational Safety and Health Act (2007) and the Public Health act (2012).

3.6 Data Collection Procedure

Data collection was conducted upon receiving approval from the County Director of Health, Mombasa and the Ethical Review Committee. The primary data collection methods involved laboratory assays of PPE, and structured questionnaires based on available studies and the international guidelines (Sabbah *et al*., 2013; WHO, 2010). The questionnaires were administered after obtaining participants' consent. PPE samples (surgical and examination gloves) were obtained from the respective procurement departments of the sampled facilities (10) with the consent of the facilities' management. From each of the two types of gloves, a pack from each of the three sizes namely Small (6.5), Medium (7.5), Large (8.5) were obtainable as samples. These were the most commonly procured and consumed sizes.

3.6.1 Laboratory assays for single-use medical gloves

The lab tests were guided by the procedures provided in the KS ISO 11193-1:2002 Standard for single-use medical examination gloves made from rubber latex or rubber solution. The standard was intended as a reference for the performance and safety of medical latex gloves by analyzing their physical properties which include packaging, dimensions, tensile strength, and water tightness to check porosity. The gloves were sampled and inspected in accordance with ISO 2859-1. The ISO 2859-1 provides sampling schemes indexed by acceptance quality limit (AQL). The quality measure used was percent nonconforming or the number of nonconformities per 100 items. ISO 2859-1 was developed primarily for the inspection of a continuing series of lots all originating from the same production or servicing process. In this case, it was assumed that gloves from each fifty-pairs pack of medical examination latex gloves were from the same batch. An assumption was also made that sterile gloves in each of a one-pair pack were from the same batch and conformed to similar manufacturing and quality conditions. Where test pieces were required they were taken from the palm or back of gloves. The inspection levels and acceptance quality limits (AQL) were to conform to the ones specified in Table 3.3.

Table 3.3: KEBS Acceptance Quality Limits

Properties	Inspection level	Acceptance quality limits
Physical dimensions (width, length, thickness)	S-2	4.0
Water tightness	G-1	2.5
Force and elongation at break	S-2	4.0

- Source: KEBS

3.6.1.1 Packaging and Marking

The packaging of the gloves was physically examined for the following details: Size, Name of the Manufacturer or Trademark, Quality Mark, Usage, Risk Protection Level (Minimal, Irreversible, Intermediate), and Latex Allergy Warning.

3.6.1.2 Dimensions

The gloves were measured to conform to the dimensions for palm width and length shown in figure 3.1. The measurement of length was taken by hanging the glove on a suitable mandrel with a tip radius of 5mm and then the shortest distance between the tip of the second finger and the cuff termination was measured. The width measurement was taken with the glove lying on a flat surface from the midpoint between the base of the index finger and the base of the thumb. The thickness at any given point on the glove was determined by measuring the thickness of the double wall of an intact glove with a pressure on the foot of 22 ±5Kpa at a point of the second finger and the approximate centre of the palm. Then the single thickness was reported as half the double-wall thickness which was to comply with the dimensions provided in Table 3.4.

Table 3.4: KEBS Dimensions

Size	Nominal size	Width (w) (mm)	Minimum Length (l) (mm)	Manimum thickness (mm)	Maximum thickness (mm)
≤6	Extra small (X-S)	≤80	220	Smooth area 2.00	Smooth area 2.00
6.5	Small (S)	80±5	220		
7	Medium (M)	85±5	230		
7.5	Medium	95±5	230		
8	Large (L)	100±5	230		
8.5	Large (L)	110±5	230		
≥9	Extra large (X-L)	≥110	230	Textured area 2.03	Textured area 2.03

-Source: KEBS, 2016

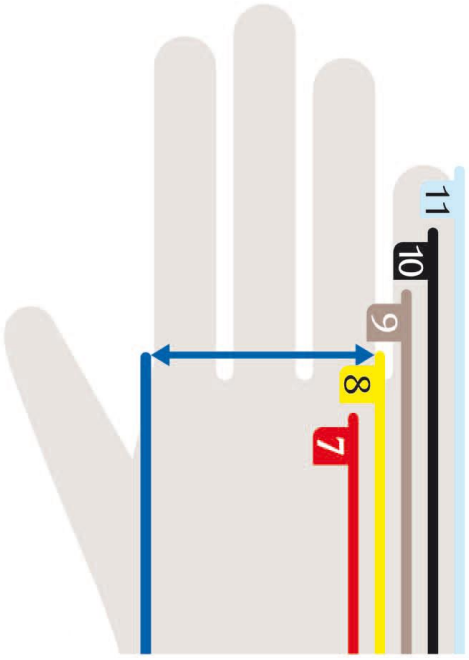

Figure 3.1: Gloves dimensions; Source : Ansell, 2011

3.6.1.3 Tensile strength

Tensile properties were measured by taking 3 pieces from each glove and using the median value as the test results. Test pieces were taken from the palm or back of gloves. The samples were then subjected to two tests: (i). Force at break and elongation at break before accelerated ageing which was determined using two dumb bell test pieces (ISO 37) and the results expected to comply with the requirements given in Table 3.5. (ii). Force at break and elongation at break after accelerated ageing where samples before being subjected to tensile tests were prepared first by ageing them at 70 $\pm 2^0$C for 168±2h and then cut from the gloves.

Table 3.5: Tensile strengths

Characteristics	**Requirement**	
	Type 1	Type 2
Minimum force at break before accelerated ageing (N)	7.0	7.0
Minimum elongation at break before accelerated ageing (N)	650	500
Minimum force at break after accelerated ageing (N)	7.0	7.0
Minimum elongation at break after accelerated ageing (N)	500	400

-Source: KEBS, 2016

3.6.1.4 Water tightness

To test for water tightness apparatus were set as shown in Figure 3.1 to accommodate 1000ml of water and held on a holding device in a vertical position as shown in Figure 3.2**.** The procedure involved attaching the glove to the circular mandrel by a suitable device so that the glove couldn't extend more than 40mm over the mandrel. One liter of water at a maximum temperature of 36^0C was poured into the hollow mandrel and any water splashed on the surface was removed. The procedure was to ensure 40mm of the water rose to within 40mm of the cuff end and thereafter any immediate leaks were noted. If leaks were not noted immediately observations were made at intervals of 2 to 4 minutes for percolations. Leaks within 40mm of the cuff end were disregarded.

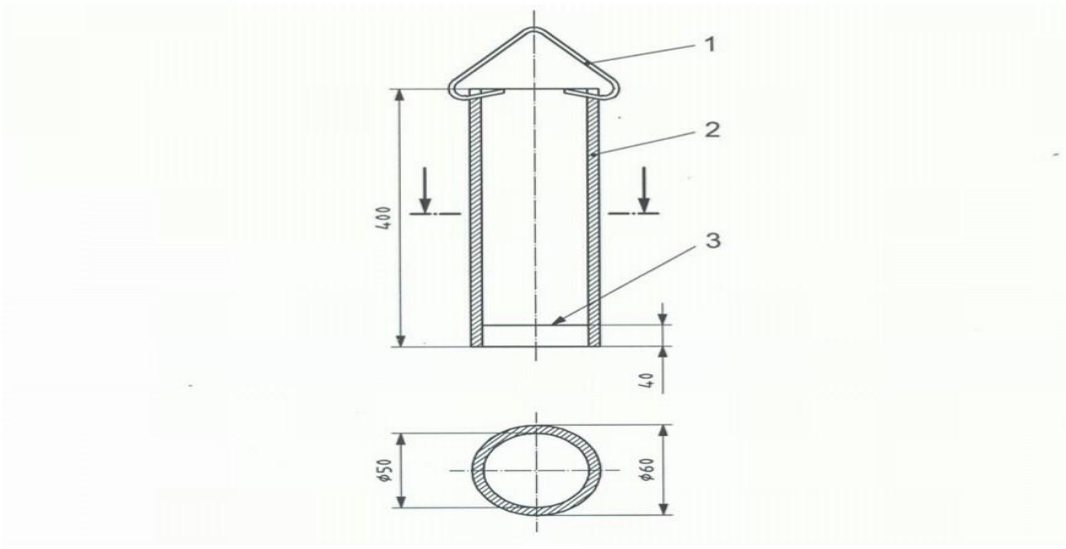

Figure 3.2: Mandrel; -Source: http://www.kebs.org

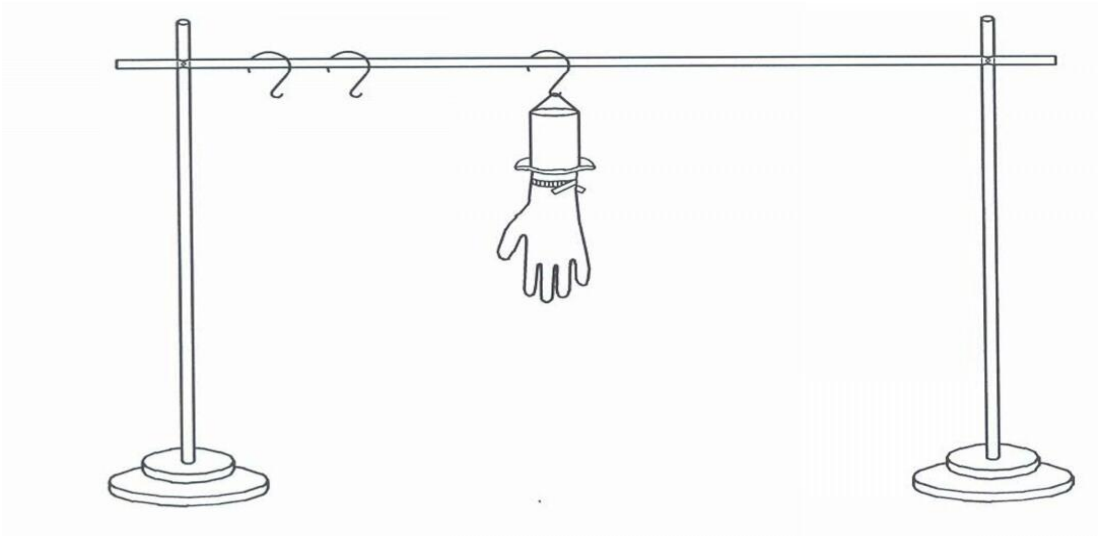

Figure 3.3: Holding device, --Source: http://www.kebs.org

3.7 Pilot Test

The pilot test involved a structured questionnaire conducted at the Mlaleo Health Centre in Kisauni Sub-County. This health facility is the largest in Kisauni Sub-County in terms of patients received and conformed to the criteria described in the sampling technique (ehealth, 2014).

3.8 Data Processing and Analysis

The data obtained from the questionnaires was cleaned, coded, and tabulated. The data was then analyzed using the Statistical Package for the Social Sciences, version 23.0. Recent local and international research work by various global organizations on occupational health and PPE utilization guidelines (e.g. CDC, NEBOSH, etc) to improve the working conditions of healthcare personnel were consulted to validate the collected data. The data was presented using frequency tables, pie charts, and bar charts.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the analyzed results (SPSS Version 23.0) of the study are presented using descriptive statistics, tabulated by means of frequency tables, pie charts, bar charts, and discussed under five main sub-sections: (1) Social demographics, (2) Range of PPE, (3) Work safety provisions and adherence, (4) Performance and standards of PPE and, (5) Exposure to potentially infectious material. The sub-sections were derived from the five sectioned questionnaire specifically designed for this study.

4.2 Results

The presented findings are those drawn from 149 out of the 167 administered questionnaires with a response rate of 89.2% which conforms to other related studies (Ngesa, 2008; Wafula, 2012). The participants were derived from all the targeted job cadres, namely: Clinical officers, Nursing workforce, Lab technicians, Medical assistants and Housekeepers (Waste managers). PPE (gloves) samples were obtained randomly from 10 out of the 33 target facilities which is approximately a third of the total population (Mugenda & Mugenda, 2012).

4.1.1 Social and other demographics of the study population

Amongst the 149 respondents 47.7% (71) were male and 52.3% (78) female. This can be a reflection of the higher population of nursing workforce traditionally dominated by the female gender. The majority of the participants were in the 31-40 years age bracket at 38.9% (58), followed by the 21-30 group at 23.5% (35). There were 11 (7.4%) respondents between 18-20 years of age, 29 (19.5%) aged 41-50 years, and 16 (10.7%) above the age of 50. The marital status for those who reported as being single, married,

separated or divorced stood at 42.3% (63), 40.3 (60), 10.1% (15), 7.4% (11) respectively. The respondents were predominantly diploma holders (52.3%) an indication of the academic qualification for most HCP at primary healthcare facilities. Others were Bachelor's degree holders (14.1%), Masters (3.4%), and Certificate holders at 13.4% (20). The housekeeping personnel had mainly primary (10.1%) and secondary (6.7%) level of education. Up to 32.2% (48) of the participants were from the nursing workforce. Others were clinical officers (20.8%), Lab technicians (16.8%), Medical assistants (13.4%), and Housekeepers/ Waste handlers at 16.5% (25). Appendix V provides a summary of the traits under social and other demographics of the study population.

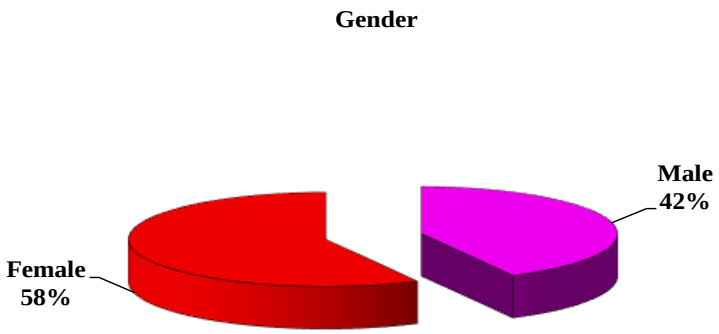

Figure 4.1: Gender distribution

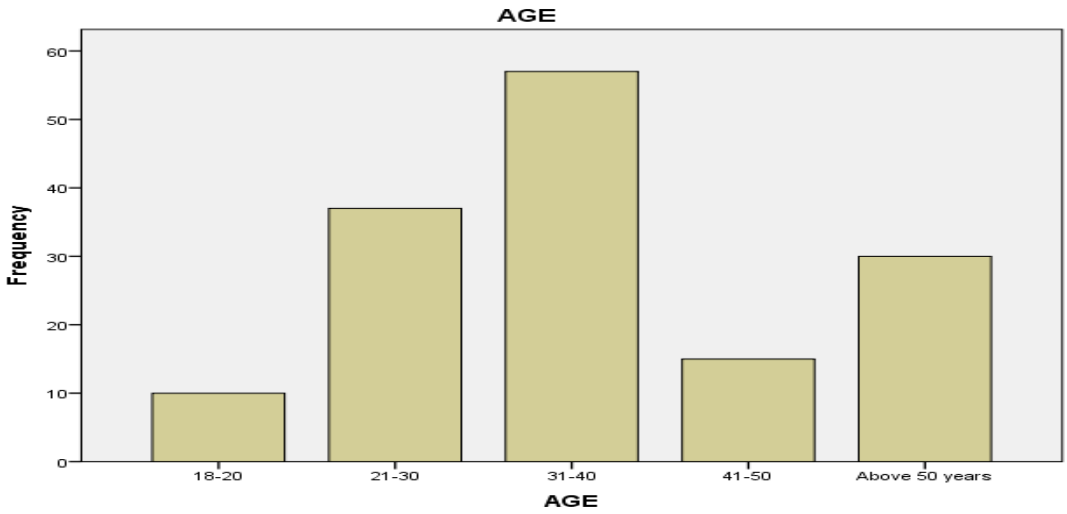

Figure 4.2: Age distribution

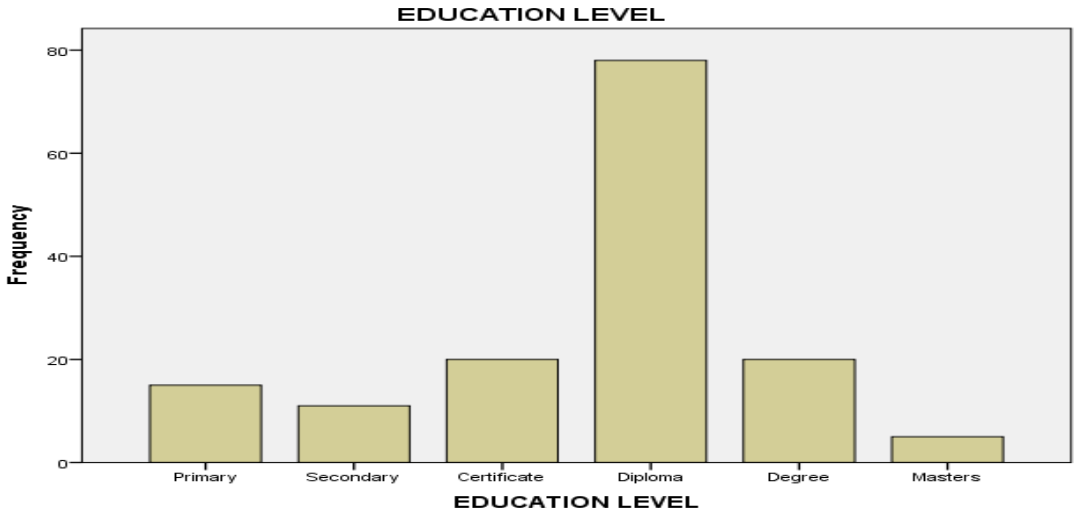

Figure 4.3: Educational level distribution

4.1.2 Range of Personal Protective Equipment

In this study, 93.3% (139/149) reported to have been provided with hands protective equipment, which are gloves. 66.4% (99) of the participants reported to have been provided always with examination and sterile (surgical) gloves. Re-usable gloves were least reported at 10.1% (15). According to the respondents, protective gowns were the second most common category of PPE at 82.6% (123). The lab coats accounted for the most commonly used protective clothing either alone at 37.6% or in combination with aprons (10.7%). Disposable gowns and aprons were hardly available with only 7.4% (11) of the participants indicating to have access to. About 14.1% (21) of the respondents pointed out that they are not provided with or don't use protective clothing. None of the participants in the waste handling job cadre waste reported to have been provided with the overalls. Provision of facial protective facilities was reported to be available by 84 out of the 149 respondents (56.4%) and foot wear by 62 (41.6%). Dust masks accounted for the highest reported facial protection devices at 24.2% or together with surgical face masks (18.8%). The least reported category of PPE was eye protective equipments (14.8%) with 85.2% reporting not to have them available. 10.2% (16) indicated to have been using or provided with goggles in combination with other facial protective devices (dust and surgical masks) whereas none of the respondents reported to have ever used face shields. Appendix VI summarizes these statistics.

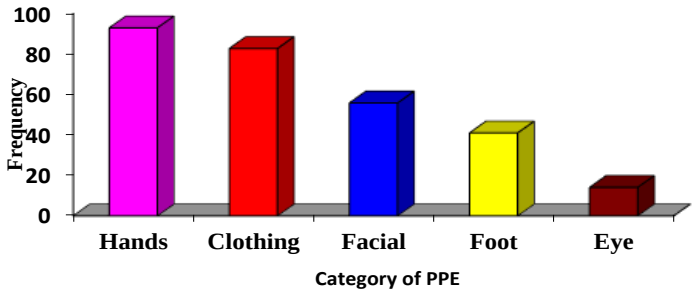

Figure 4.4: Categories of PPE

4.1.3 Adherence to Work Safety Provisions

Majority of the respondents indicated to have a work experience of between 1-10 years (53%) at the primary level healthcare facilities with approximately 86.6% (129) having reported to work for 5-8 hours daily. Only about 13.4% reported to go beyond the normal working hours (8 hours). Majority of the clinical officers and nurses reported to work in both examination and treatment workstations (66.4%). Lab technicians were confined mostly to the laboratories (13.4%) which included the phlebotomy. Waste handlers or housekeepers indicated to be working in almost all the workstations where they did the cleaning, removal of medical wastes and disposal (20.2%). A summary of the findings are found in Appendix VIII.

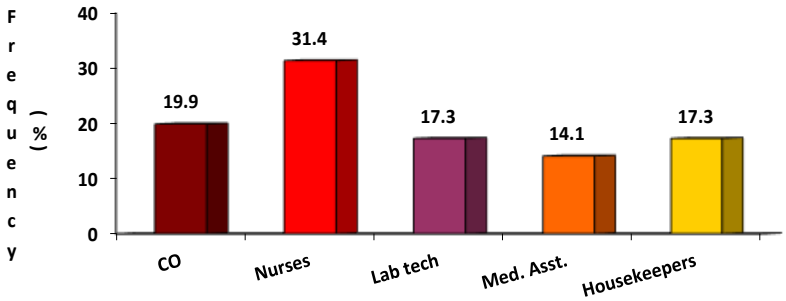

Figure 4.5: Distribution of job cadres

4.1.3.1 Adherence to work safety guidelines

Majority of the participants (79.9%) reported to have undergone pre-job training on infection prevention control whereas about 34.9% (52) as the majority reported to have been getting refresher training on PPE usage at least twice a year. Another 28.2% (42) were trained at least once a year, 20.1% on quarterly basis, and 16.8% (25) never to have undergone any training since hiring. Most of the respondents pointed out to have been handling metal and glass sharps (52.3%) and about 46 (30.9%) to have been handling bones, metal, and glass sharps. 72.5% (108) reported to have been provided with sharps disposal guidelines. All the respondents indicated that they require hands PPE, protective gowns, and facial protection at their workstations. A majority 71.8% (102) pointed out that they require eye protection in their line of duty whereas 55% (82) indicated that they do not require foot protection. 123 out of the 149 respondents (81.6%) reported that the PPE supplies at the facilities are not adequate enough. Only 20.8% of the respondents admitted to have been using the PPE always when carrying out their duties with the majority 79.2% (118) reporting to occasionally use the PPE available.

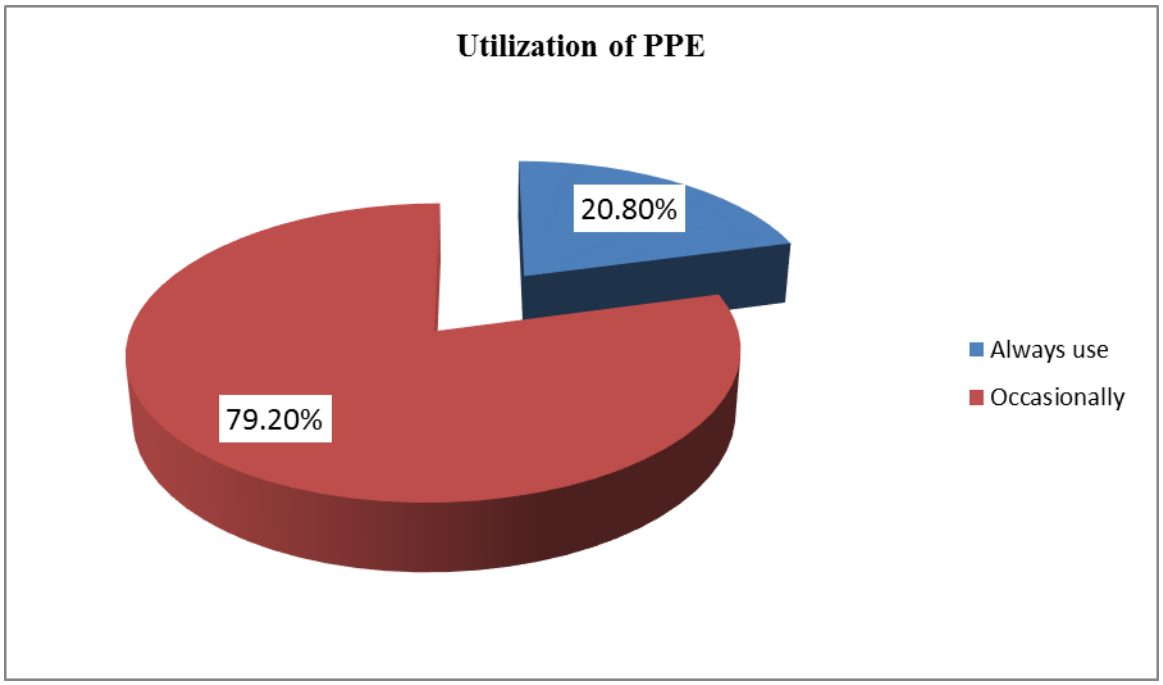

Figure 4.6: Utilization of PPE provided

4.1.3.2 Overview of infection prevention measures provided

Findings from the study showed that 96.6% (144 out of 149) respondents pointed out that there is proper management of sharps at the facilities. Fifty one percent (76/149) indicated that Hepatitis B vaccines were not available at the facilities while 89.9% (134) reported that they had access to the post exposure management services. About 52.3% (78) pointed out that training on health and safety is availed at their respective facilities. Most of the participants (72.5%) approved of the provision of safety guidelines but 73.2% (109) indicated that there was no formation of safety committees at their health facilities.

4.1.3.3 PPE policy implementation gaps

The study also revealed that a majority 96.6% (144) reported that they required a sustainable PPE supply program and about 91.9% (137) wanted a regular training on health and safety. To compliment PPE program, 38.9% (58) require improvement of the facilities infrastructure and use of modern technologies to make infection prevention and control more effective. 75.8% of the respondents indicated that there was room for improvement for waste management and vaccination services which was under the public health docket. Most of the participants (58.4%) reported that they were understaffed and required human resource improvement.

4.1.3.4 Observation guide results

Besides the questionnaire, the observations made revealed that 72.7% of HCP (N=11), excluding the housekeepers, donned hand gloves before undertaking procedures that involved blood and OPIM. In addition, 55.5% were observed to remove the gloves correctly after the procedure while only 45.5% disposed the gloves correctly. Moreover, 63.6% of the observed HCP performed hand hygiene after the removal of gloves. There was only 36.4% who put on facial protection for procedures that involved the risk of splashing whereas 45.5% donned protective gowns. Further observations revealed that 55.5% of the housekeeping HCW (N=11) donned, removed, and disposed the gloves correctly. 27.3% of the observed waste handlers had their protective gowns while performing their duties. 72.7% were observed not to wear their foot wear whereas 81-8% did not have facial protection. Observations made are summarized in Appendix XVIII.

4.1.4 Performance and Quality Standards of PPE

One hundred and twenty four participants (83.2%) reported that they are provided with fitting gloves but 95.3% pointing out to have encountered incidences of glove tearing

during donning and/or removal of gloves. Most of the respondents (93.3%) reported not to be allergic to latex rubber. However, only 40% of those allergic to latex rubber were provided with alternative makes. Fifty five percent of the respondents indicated not to have been provided with fitting facial PPE while 81.9% of those who participated in the research pointed out that replacement of worn out foot PPE is delayed. Majority of the respondents (82.6%) reported that they self-source the protective clothes whereas only 26 out of the 149 respondents indicated that they were provided with protective gowns. Appendix XVI provides a summary of the results tabled from Appendix XII to Appendix XV showing that the sampled gloves passed the accepted quality levels.

4.1.5 Exposure to potentially infectious material

Appendix XVII gives a summary of the findings on exposure incidences amongst the HCP in the primary health facilities. A majority 98% (146/149) reported to have been always in contact with potentially infectious persons or material. Moreover, 69.1% admitted to have been exposed to blood and other potentially infectious material. Sixty six percent (68/103) of this number indicated to have been exposed at least once. 77% of them reported the cases while about 69% were provided with post exposure management services.

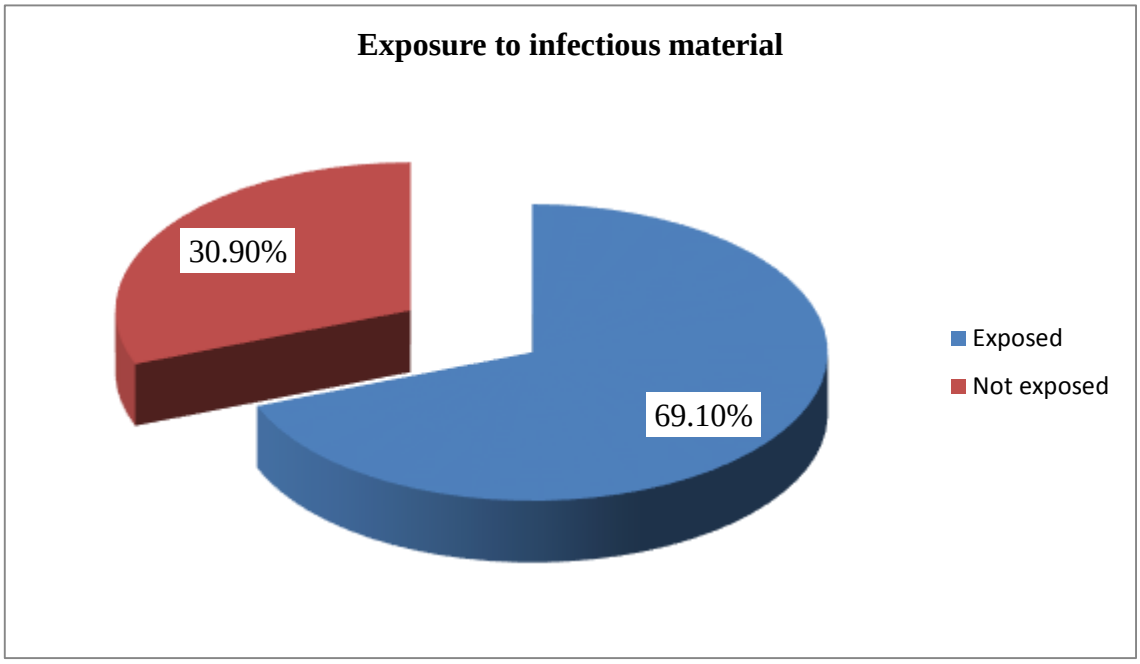

Figure 4.7: Exposure to infectious material

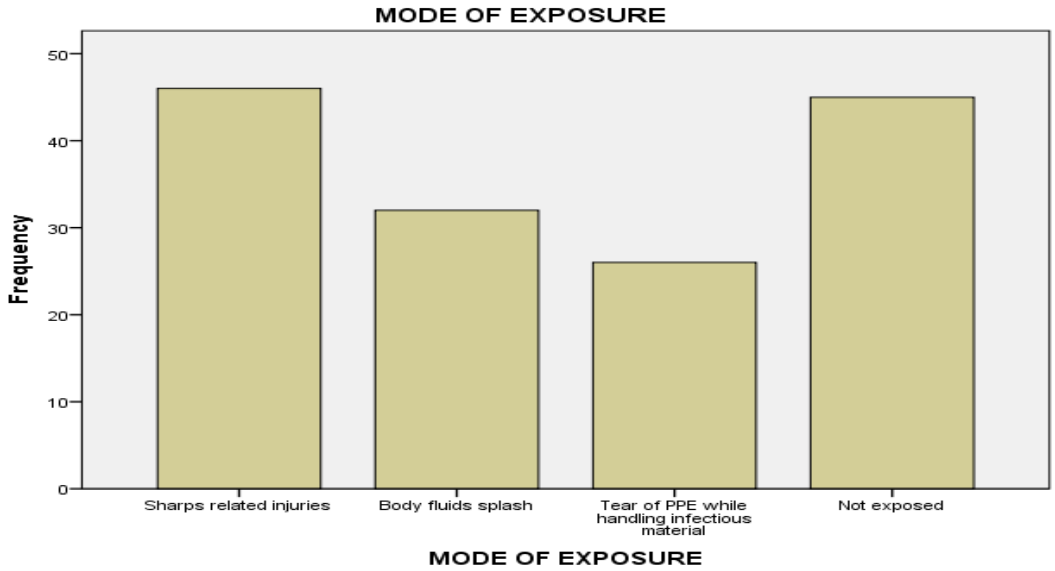

Figure 4.8: Mode of exposure

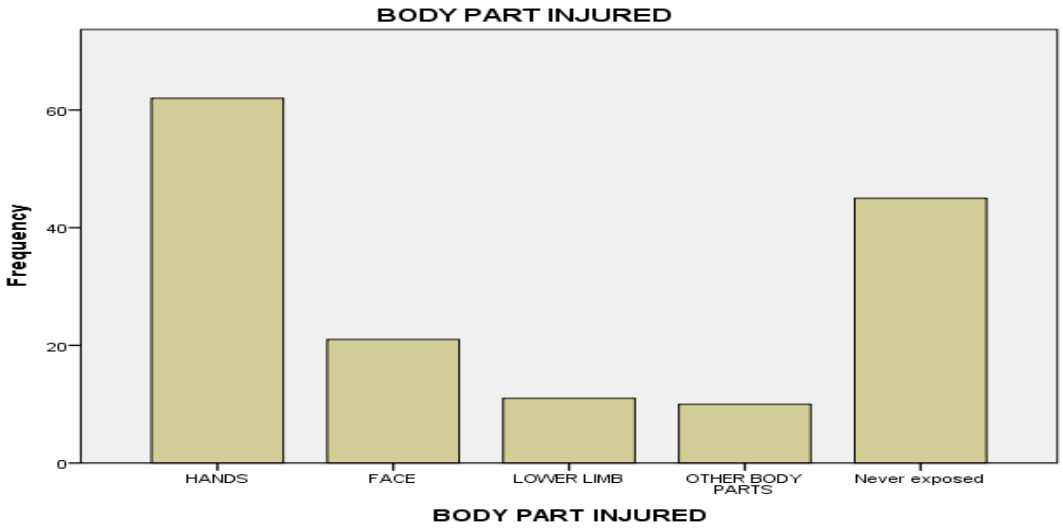

Figure 4.9: Parts of the body injured

4.3 Discussion

This study brought out the status and level of PPE implementation policy at primary healthcare facilities in Mombasa County in comparison to the provided national and international principles. This was revealed by using Chi Square (X^2) at significant level of 0.5 to evaluate the various parameters, namely: range of PPE available, adherence to PPE and related work safety guidelines, and performance of the available PPEs.

4.2.1 Range of PPE in protection against exposure to blood-borne pathogens

The study found out that the most common PPE available were gloves and specifically so, medical examination gloves. This is in agreement with previous related studies affirming that gloves are mostly available in any health facility (CDC, 2010). The uptake and compliance to gloves usage was ascertained to be the highest (93.3%) amongst the HCP especially where blood and other potentially infectious material were present or anticipated. The healthcare workers who participated in this study, majority, reported that they required hands protection at their workstations all the time. Ngesa, (2008) in a study to evaluate management of blood and body fluids in a Kenyan hospital reported a compliance rate of about 93%. Re-usable gloves were least available (10%) partly because of their limited use since they are almost exclusively used by the waste handlers (housekeeping department).

It was established that most of the housekeeping personnel were using disposable examination gloves as a substitute to the re-usable rubber gloves. The latex rubber medical examination gloves are however not suitable for the physical and vigorous nature of the activities associated with housekeeping and waste management hence exposing them to the risk of sharps related injuries. According to Ansell UK (2011) activities such as medical waste handling involve scrubbing of surfaces and handling of abrasive materials which require puncture, tear, and blade cut resistant gloves.

According to the respondents, protective gowns were the second most common category of PPE at 82.6% (123). The availability of protective gowns was least reported amongst clinical officers and housekeeping personnel but compliance rate was quite high amongst the nurses and lab technicians. This can possibly be explained by the fact that, as established by this study, over 86% of the HCP self-source their protective clothing. Majority of the nurses were observed to be donning branded gowns and aprons donated to them by NGOs and pharmaceutical companies. Very few HCWs (14%) reported to have been provided with protective clothing by the management of the primary healthcare facilities contrary to the findings that 100% of the HCP indicted that they require protective gowns at their workstations.

Surgical face masks accounted for only 17.3% which can be explained by the minimal surgical procedures performed at primary healthcare facilities. When prompted, participants from one facility reported to have been referring almost all surgical procedures including the minor ones. They indicated to hardly receive any supplies of surgical masks and therefore avoid invasive procedures that would expose them to splashing of body fluids. However, dust masks were more regularly available (43%) in most of the facilities and they were used as a substitute for surgical masks with less protection and higher exposure risks. Eye protection was least available in terms of facial protection with 85.2% indicating not to have access to while a majority 71.8 % reported to require this form of protection against body fluid splashes. This is in agreement with Sadoh *et al* (2006) and Ngesa (2008) who established that eye protection is not habitually utilized. Foot protection despite being critical in compromising sterile environments and conditions during surgical procedures was only reported to be available by 41.2% of the respondents. This is despite the fact that most of the primary facilities had functioning minor theatres and more so maternity facilities. Due to the high risk nature of their work, medical waste handlers were obliged to access appropriate protective gear but only an average of 20% were furnished with foot wear and clothing, while facial protection (mostly dust masks) was at 40%. This is in consistent with

USAID, 2012, study on healthcare waste management which pointed out that waste handlers are mainly underequipped across all levels of healthcare facilities in Kenya. The USAID study established that waste handlers lacked respirators and gloves in 71% and 58% of the facilities across Kenya respectively as quite alarming. Their personal safety was further compromised by non-working incinerators which are an additional occupational hazard.

4.2.2 Adherence to PPE work safety guidelines in preventing exposure to HIV, HBV, and HCV

Critical in adherence to PPE safety guideline is access to a wide and the entire range of protective gear- hands, gowns, facial, foot wear and eye protection (USAID, 2012). Gender had no effect on pattern of utilizing PPE [X^2 (df = 1, n=149) =0.009, $p \geq 0.5$ (0.94)]. This study found out that there is significant association between provision of PPE and utilization of available protective gear [X^2 (df =1, n=149) = 5.69, $p \leq 0.5$ (0.17)]. USAID (2012), study showed that inadequate supplies and lack of appropriate protective gear exposed medical waste handlers to infectious pathogens. However, most of the primary healthcare facilities in this study fell short of the accepted standards in terms of availability of a wide range PPE.

This study found out that pre-job training had little impact on PPE use with 26.1% of those who underwent the training at college level reporting to always utilize PPE and 73.9% indicating to use PPE occasionally [X^2 (df=1, n=149)= 1.974, $p \leq 0.5$ (0.16)]. This could have been influenced by other factors such as availability and frequency of on-job safety training. Wafula (2010), in a study on occupational risk factors amongst health workers, reported that continuous training on infection prevention and control has a positive impact on the reduction of sharp injuries. This study's findings were in harmony with Wafula, (2010), in that 87.5% of those who underwent a refresher training only once a year reported to occasionally utilize PPE and none of those who never got on-job

training reported to be using the PPE always [X^2 (df =1, n=149) = 3.963, $p \leq 0.5$ (0.265)]. The study established that pre-job training had little effect on prevention of occupational exposure with a majority 73.9% with pre-job training on safety reported exposure to blood and other potentially infectious material [X^2 (df =1, n=149) = 1.271, $p \leq 0.5$ (0.260)]. However, lack of formal professional training which was demonstrated by majority of the housekeeping personnel, had a negative effect on exposure. Only 20% of the housekeeping workers had pre-job training [X^2 (df =4, n=149) = 0.796, $p \leq 0.5$ (0.008)]. This had a connection with 60% of the same workers reporting to have been involved in exposure in one way or another [X^2 (df =4, n=149) = 3.61, $p \leq 0.5$ (0.331)]. Correspondingly, Janjua *et al.* (2010) concluded in a study that an advanced knowledge of the risks of exposure to medical sharps was associated with fewer injuries, whereas a lack of professional qualification was linked to more sharps related injuries.

Adherence to provided sharps disposal guidelines had a positive impact on prevention of exposure to blood-borne pathogens and OPIM. Only 24.1% of those provided with sharps disposal guidelines were involved in sharps related injuries [X^2 (df =3, n=149) =0.796, $p \leq 0.5$ (0.216)]. In addition, proper disposal of used sharps had a constructive effect on preventing sharps related injuries with a minority 10.3% of those provided with safety boxes and other improvised puncture resistant containers reporting incidences of sharps related injuries [X^2 (df =1, n=149) = 2.8, $p \leq 0.5$ (0.352)]. Lab technicians were reported to be the keenest in utilizing PPE [X^2 (df =4, n=149) = 5.097, $p \leq 0.5$ (0.277)]. This could be explained by their job description which involves frequent exposure to biohazards hence rendering them more cautious than any other job cadre.

4.2.4 Performance and quality standards of PPE

This study demonstrated that there was a significant difference between PPE available at the primary healthcare facilities in Mombasa County and those required by the HCP at their respective work stations. For instance, only 15% of those who require eye

protection had access to eye protection gear [X^2 (df = 1, n=149) =0.78, $p \leq 0.5$ (0.166)]. The study found out that provision of fitting gloves to HCP does not prevent tearing with 82.1% of those who reported to have been provided with fitting gloves indicating that they had incidences of glove tearing either when donning, removal or using them [X^2 (df = 1, n=149) =0.216, $p \geq 0.5$ (0.642)].

The few waste handlers (81.9%) that had access to foot protection equipment reported that the replacement of worn out foot wear is delayed and therefore go for a long time without any foot wear. This puts them at a higher risk of exposure to sharp injuries and incidences of splash with potentially infectious body fluids. In addition, a minority 45% reported to be provided with fitting face masks indicating that there's 55% of the HCP who have access to face masks but still face the risk of exposure to potentially infectious material. This is in agreement with the USAID study on the situation in most Kenyan health facilities (USAID, 2012).

4.2.5 Prevalence of exposures to blood-borne pathogens amongst HCP

Majority of the participants (98%) reported that they are always in contact with potentially infectious persons and/or material but only 49% had been vaccinated against the highly infectious Hepatitis B virus. Out of the 149 respondents 103 (69%) admitted to have been exposed to blood and other potentially infectious body fluids and materials. Sharp related injuries were the highest reported mode of exposure (44.7%, 46/103) followed by blood and other body fluids splash at 30.1%. PPE tear accounted for 26 out of the 103 reported incidences of exposures [X^2 (df = 1, n=103) =0.78, $p \leq 0.5$ (0.001)]. Most of the respondents pointed out to have been handling metal and glass sharps (52.3%) and about 46 (30.9%) to have been handling bones, metal, and glass sharps. Wafula, (2010), in a study at Kenyatta Hospital, Nairobi, Kenya found out that the HCP faced the risk of exposure to blood and OPIM mainly via needle pricks, cuts, glove tear, bloods splash, abrasion, bruise, urine splash and occupational infections. Additionally,

the results in this study that most participants experienced sharps injuries compared well with a study at a Karachi Hospital (Ahmad *et al.*, 2008) which found that needle stick injuries was the commonest (78%) type of exposure to blood and fluids in contrast to other forms of exposure such as injury by other sharps.

The point of exposure or body part injured was mostly the hands (60.2%) followed by facial area at 20.4%. The lower limbs accounted for about 9.7% same as the other parts of the body. However, in this study, 70.4% of the respondents who reported to have been exposed, also indicated to have been provided with hands protection [X^2 (df = 1, n=103) =0.361, $p \geq 0.5$ (0.548)]. Moreover, 33.3% of those who had access to hands protection gear suffered sharps related injuries. This concurs with a study by Tidley *et al.* (2013) on needle stick fluid transmission through surgical gloves of the same thickness. They concluded that body fluids from an infected patient can transmit infection to healthcare personnel via per-cutaneous injury even with gloves protection.

Sixty six percent of those exposed reported to have been exposed once while 29.1% indicated that they had been exposed twice in the course of their employment at their respective facilities. Seventy seven out of the one hundred and three exposed respondents (74.8%) reported the incidences out of which 69 (89.6%) accessed post exposure prophylaxis services. These findings compares favorably with other studies reported from Kenyan health facilities elsewhere (Ngesa, 2008; Wafula, 2012)

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a summary and makes conclusion of the findings discussed in this thesis report. Further, it wraps up with recommendations to address the gaps realized in this study.

5.2 Conclusion

The primary healthcare facilities (PHFs) in Mombasa County are insufficiently and inconsistently supplied with personal protective equipment. Personal protective equipments are not effective as gears or apparatus but are effective when implemented as a policy whereby adequate supply, quality standards, adherence to usage and other related guidelines are critical to the success of the program.

Adequate supplies of a wide range of PPE in terms of category of protection (e.g. hands, foot, and facial protection, etc), task specific (e.g. sterile versus examination gloves, dust masks versus surgical masks, etc), and size variety, reduces exposure to biohazards if used correctly.

Hand protective gears, and specifically so medical gloves, are the most commonly available category of PPE in PHFs. The gloves at these health facilities meet the acceptable quality level standards as per the Kenyan Bureau of Standards which employs The International Organization for Standardization (ISO) requirements. However, quality of gloves does not prevent tearing when donning, using, or removing them.

There is a gap in adherence to infection control and prevention measures at the PHFs by both the management of these facilities and the healthcare personnel. Management fall short of ensuring adequate supplies of PPE, proper management of used sharps and other medical wastes, provision of regular training programs on occupational health and safety, formation of health and safety committees, and provision of Hepatitis B vaccines. Nevertheless, the management has succeeded in ensuring access to post exposure prophylaxis services for the healthcare personnel. Healthcare workers on their part do not fully adhere to safety guidelines provided during their professional as well as refresher trainings, and proper utilization of PPE at their disposal. They fall short also on their reporting when involved in occupational incidences and accidents.

There is a high incidence rate of exposure amongst the healthcare workers in primary healthcare facilities. Sharp related injuries followed by body fluid splashes are the most common mode of exposure to blood-borne pathogens. The prevalence of exposure to blood and other potentially infectious body fluids and materials at PHFs was found to be at 69%. Sharp related injuries have the highest prevalence of 44.7% whereas blood and other body fluids splash at 30.1%, while PPE tear accounts for 25.2%. The point of exposure or body part injured is mostly the hands (60.2%) followed by facial area at 20.4%. However, in this study, 70.4% of the respondents who reported to have been exposed also indicated to have been provided with hands protection. Moreover, 33.3% of those who had access to hands protection gear suffered sharps related injuries and therefore gloves can be said only to partially protect against sharp injuries.

5.3 Recommendations

To ensure adequate and sustainable supply of PPE at primary healthcare facilities, the Mombasa County should review the procurement processes and empower the individual facilities with resources and the mandate to procure these protective gears independently.

To promote adherence to safe work practices, it is recommended that the management should improve on provision of regular and continuous training on health and safety. The frequency of training programs should be made at least once every month. This should go hand in hand with formation of well structured health and safety committees and provision of suitably displayed safety guidelines for the health care workers. The heads of the said health and safety committees should encourage and enforce reporting of occupational incidences and accidents by the workers.

The management should also ensure all healthcare personnel are fully vaccinated against the highly infectious Hepatitis B virus which will compliment the effectiveness of PPE program. It should be made a job induction pre-requisite to guarantee all health workers are not at risk of infection from the onset of employment. The management should continue providing and more so improve on post exposure management services to reduce chances of healthcare personnel becoming infected with the potential blood-borne pathogens.

The management should advocate for the use and internalization of the infection prevention and control guidelines provided by the MoH and WHO which would complement the PPE utilization guidelines. In order to check the compliance to the PPE policy, internal and external audits should be conducted regularly at the health facilities.

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APPENDICES

Appendix i: Questionnaire

Questionnaire for appropriateness of personal protective equipment against bio-hazards exposure in public primary healthcare facilities in Mombasa County, Kenya.

SECTION A: DEMOGRAPHICS

Please indicate your answer with a tick (√).

1. Sex
   a. Male [ ]
   b. Female [ ]

2. Age
   a. 18-20 [ ]
   b. 21-30 [ ]
   c. 31-40 [ ]
   d. 41-50 [ ]
   e. Above 50 years. [ ]

3. What is your marital status?
   a. Single [ ]
   b. Married [ ]
   c. Separated [ ]
   d. Divorced [ ]

4. What is your highest education level?
   a. Primary [ ]
   b. Secondary [ ]

c. Certificate [ ]
d. Diploma [ ]
e. Degree [ ]
f. Masters [ ]

SECTION B: RANGE OF PERSONAL PROTECTIVE EQUIPMENT

5. What categories of PPE have you been provided with in your workstation?
   a. Hands protection [ ]
   b. Protective clothing e.g. lab coats [ ]
   c. Facial protection [ ]
   d. Foot wear [ ]
   e. Eye wear [ ]

What varieties of task specific PPE have you been using regularly?

6. **Gloves**
   a. Examination [ ]
   b. Surgical [ ]
   c. Re-usable [ ]
   d. Sterile [ ]
7. **Facial PPE**
   a. Dust Masks [ ]
   b. Surgical face masks [ ]
   c. Goggles [ ]
   d. Face Shields [ ]
8. **Protective clothing**
   a. Lab coats [ ]
   b. Gowns [ ]
   c. Disposable gowns [ ]
   d. Aprons [ ]
   e. Coveralls [ ]
   f. Disposable coveralls [ ]

9. **Footwear**
    a. Medical rubber shoes [ ]
    b. Safety slip-ons [ ]
    c. PVC safety boots [ ]
    d. Steel-toe safety boots [ ]

10. What different makes of gloves are you provided with regularly?
    a. Latex rubber [ ]
    b. Latex powdered [ ]
    c. Natural rubber [ ]
    d. Nitrile [ ]
    e. Poly Vinyl Chloride (PVC) [ ]
    f. Neoprene [ ]

SECTION C: ADHERENCE TO WORK SAFETY GUIDELINES

11. What is your job cadre?
    a. Clinical Officer [ ]
    b. Nursing [ ]
    c. Laboratory Technicians [ ]
    d. Medical Assistant (e.g. phlebotomists and dressers) [ ]
    e. House Keeping [ ]

12. How long have you worked in the above job cadre at the hospital?
    a. ‹1 Year [ ]
    b. 1-10 Years [ ]
    c. 11-20 Years [ ]
    d. 21-30 Years [ ]
    e. >30 Years [ ]

13. How long do you work (on a daily basis) at the health facility?
    a. < 1 Hour [ ]
    b. 1-4Hour [ ]

c. 5-8 Hours [ ]
d. >8 Hour [ ]

14. Indicate your working area
    a. Examination department [ ]
    b. Treatment room [ ]
    c. Laboratory [ ]
    d. Housekeeping/ Waste management [ ]

15. Were you trained on infection control during your professional training?
    a. Yes [ ]
    b. No [ ]

16. How regular do you get training on personal protective equipment?
    a. Monthly [ ]
    b. Every three months [ ]
    c. Twice a year [ ]
    d. Once a year [ ]
    e. Not at all [ ]

17. What types of sharps do you handle in the course of your job?
    a. Metal [ ]
    b. Glass [ ]
    c. Bones [ ]

18. Are there standard guidelines for handling used disposable healthcare sharps?
    a. Yes [ ]
    b. No [ ]

19. Where do you dispose used healthcare sharps after procedures?
    a. Safety boxes [ ]
    b. Plastic bags [ ]
    c. Left on the floor [ ]
    d. Plastic containers (specify)…… [ ]

e. Mixed with other wastes [ ]

20. What categories of PPE do you need in your workstation to protect you against blood and other body fluids pathogens?
    a. Hands protection [ ]
    b. Protective clothing e.g. lab coats [ ]
    c. Facial protection [ ]
    d. Foot wear [ ]
    e. Eye wear [ ]

21. Are the personal protective equipments provided adequate for use all the time?
    a. Yes [ ]
    b. No [ ]

22. How often do you use the personal protective equipments/ materials available?
    a. Always [ ]
    b. Occasionally [ ]
    c. Rarely [ ]
    d. Not at all [ ]

23. How often do you have contacts with patients infected with HIV, HBV, and HCV?
    a. Always [ ]
    b. Occasionally [ ]
    c. Rarely [ ]
    d. Not at all [ ]

24. Have you been vaccinated against Hepatitis B?
    a. Yes [ ]
    b. No [ ]

SECTION D: PERFORMANCE OF GLOVES

25. Are you provided with fitting gloves?
    a. Yes [ ]
    b. No [ ]
26. Have you ever had an experience of gloves tearing while donning or on minimal strain and pressure?
    a. Yes [ ]
    b. No [ ]
27. Are you allergic to latex rubber?
    a. Yes [ ]
    b. No [ ]
28. If the answer to Question 27 above is yes, are you provided with alternative make of gloves?
    a. Yes [ ]
    b. No [ ]

29. Are you provided with fitting facial protective equipment?

    a. Yes [ ]
    b. No [ ]

30. Are you promptly provided with a replacement of worn out foot ware?

    a. Yes [ ]
    b. No [ ]

31. Where do you source your protective gowns from?

a. Provided with [ ]
b. Self-source [ ]

SECTION E: INCIDENCES AND ROUTES OF EXPOSURE

32. Have you been involved in any accident/risk related to handling healthcare sharps?
    c. Yes [ ]
    d. No [ ]

33. Which of the following modes of exposure describes the incidents/accidents mentioned in question 32 above?
    a. Sharps related [ ]
    b. Body fluids splash [ ]
    c. Glove tear while potentially infectious material [ ]

34. What procedure or activity were you carrying out when the incident /accident mentioned in question 32 above occurred?
    a. Surgical procedures [ ]
    b. Disposal [ ]
    c. Handling of used sharps [ ]

35. Which part of your body was affected by the incident/accident mentioned in question 32 above?
    a. Hand [ ]
    b. Foot [ ]
    c. Face [ ]
    d. Other parts of the body (specify) …… [ ]

36. How many times in the course of your practice at the facility have you experienced the accidents/risks mentioned in question 32 above?
    a. Once [ ]
    b. Twice [ ]
    c. Thrice [ ]

d. More than thrice [ ]

37. Did you report the incident /Accident that occurred?
    a. Yes [ ]
    b. No [ ]

38. Did you seek for Post Exposure Prophylaxis (PEP)?
    a. Yes [ ]
    b. No [ ]

39. What measures has the health facility management put in place to control occupational related infections caused by HBV, HCV and HIV?
    a. Proper medical sharps management [ ]
    b. Provision of vaccines [ ]
    c. Providing post-exposure testing [ ]
    d. Providing post-exposure prophylaxis services [ ]
    e. Adequate supply of personal protective equipment [ ]
    f. Training on health and safety [ ]
    g. Availing of health and safety guidelines [ ]
    h. Establishing of safety and health committee [ ]

40. What measures would you suggest the hospital management to put in place to improve on PPE implementation policy?
    .....

Appendix I: Consent From

INFORMED CONSENT

Title of study: Effectiveness of Personal Protective Equipment against Blood-Borne Pathogens Exposure in Mombasa's Public Primary Healthcare Facilities.

Study population: Healthcare personnel primary healthcare facilities (dispensaries and healthcentres), Mombasa, Kenya.

Principal investigator : Benson Kaguthi Macharia,

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Supervisors: Professor Robert Kinyua and Mr. Andrew Mwenga

Study population : Healthcare personnel (Clinical Officers, Lab technicians/technologists, Nursing, Medical assistants and Housekeepers) working at primary healthcare facilities (dispensaries and healthcentres).

Aim and Objectives of the Study

The main aim of this study is to determine the efficacy of Personal Protective Equipment as a safeguard against Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and Human Immunodeficiency Virus (HIV) exposure amongst Health Care Personnel at Public Primary Health facilities in Mombasa County.

1. To assess the range of Personal Protective Equipment available at the primary health facilities for protection against exposure to HIV, HBV, and HCV.
2. To determine the adherence of healthcare personnel to Personal Protective Equipment guiding principles at primary healthcare facilities in Mombasa County.
3. To assess the quality of medical gloves available at the primary health facilities against the Kenya Bureau of Standards specifications.
4. To establish the incidence rates of exposure to HIV, HBV, and HCV amongst healthcare workers at primary healthcare facilities in Mombasa county.

Procedure

1. About 167 participants will take part in this research.
2. You will be asked a few questions pertaining the personal protective equipments and clothing at your workplace. The questions may take about 10 minutes. Please provide correct information to assist us in drawing meaningful conclusions.
3. The findings of this study will be anonymously analyzed using an assigned code and not your name to understand how effective the personal protective equipments are in blood-borne infection prevention and control.
4. The results will then be submitted to the relevant authorities to assist in policy making with regards to implementation of personal protective equipment.

Participation information

We would like you to take part in the described research study. It is very important that you understand the following general principles, which apply to all participants in our studies

1) Participation is entirely voluntary.
2) Persons may withdraw from participation in this study or any part of the study at any time. Refusal to participate will not affect your treatment.
3) After you read the explanation, please feel free to ask any question that will allow you to understand clearly the nature of the study.
4) Strict confidentiality relating to your information shall be observed. The information shall be maintained by means of codes to protect the identities of the participants. Unauthorized personnel shall not have access to the data.
5) There are minimal risks involved by participating in the study. For instance, questions pertaining to your exposure to blood borne infections e.g. HIV may cause anxiety and tension. There are no direct benefits to you from your taking part in this research. Possible indirect benefits include the invaluable information obtained in this study that shall be used by policy makers to formulate better policies and infection prevention guidelines amongst healthcare workers.

Signature

Your signature below indicates your permission to take part in this research:

Code of participant

Signature of participant Date

Signature of person obtaining consent Date

Appendix iii: Observation Guide

HCP handling patients:

OBSERVATION	**YES**	**NO**
1. Dons gloves before undertaking procedure that involve blood and OPIM		
2. Removes gloves correctly after procedure		
3. Disposes the gloves correctly after removal		
4. Performs hand hygiene after removing the gloves		
5. Wears eye protection before procedures that involve splashing of blood and OPIM		
6. Wears facial protection before procedures that involve the risk of splashing		
7. Wears protective gowns when performing procedures that involve blood and OPIM splashing		

Housekeepers and waste managers when cleaning and handling medical wastes:

OBSERVATION	**YES**	**NO**
1. Dons, removes, and disposes gloves correctly		
2. Wears protective clothing/gowns		
3. Wears protective footwear		
4. Wears facial protection		

Appendix iv: ASTM Standards

ASTM Standard	**Standard Application**
D 3577-00	Standard Specification for Rubber Surgical Gloves
D 3578-00	Standard Specification for Rubber Examination Gloves
D 5250-00	Standard Specification for Poly(vinyl chloride) Gloves for Medical Application
D 6319-00	Standard Specification for Nitrile Examination Gloves for Medical Application
D 5151-99	Standard Test Method for Detection of Holes in Medical Gloves
D 6355-98	Standard Test Method for Human Repeat Insult Patch Testing of Medical Gloves
D 6124-00	Standard Test Method for Residual Powder on Medical Gloves
D 6499-00	Standard Test Methods for the Immunological Measurement of Antigenic Protein in Natural Rubber and its Products

Appendix v: Social Demographics

Variable	Trait	Frequency (N)	Percentage (%)
Gender	Male	71	47.7
	Female	78	52.3
	Total	**149**	**100**
Age (years)	18-20	11	7.4
	21-30	38	23.5
	31-40	58	38.9
	41-50	29	19.5
	Above 50	16	10.7
	Total	**149**	**100**
Marital Status	Single	63	42.3
	Married	60	40.3
	Separated	15	10.1
	Divorced	11	7.4
	Total	**149**	**100**
Educational Level	Primary	15	10.1
	Secondary	10	6.7
	Certificate	20	13.4
	Diploma	78	52.3
	Bachelor's degree	21	14.1
	Master's degree	5	3.4
	Total	**149**	**100**
Job Cadre	Clinical officers	31	20.8
	Nursing	48	32.2
	Lab technicians	25	16.8
	Medical assistants	20	13.4
	Housekeepers	25	16.5
	Total	**149**	**100**

Appendix IIi: Range of Personal Protective Equipment

Variable	Response	Frequency (N)	Percentage (%)
Hands protection	Yes	139	93.3
	No	10	6.7
Protective clothing	Yes	123	82.6
	No	26	17.4
Facial protection	Yes	84	56.4
	No	65	43.6
Foot wear	Yes	62	41.6
	No	87	58.4
Eye protection	Yes	22	14.8
	No	127	85.2
Types of gloves	Examination	25	16.8
	Examination/Sterile	99	66.4
	Re-usable	10	6.7
	Examination/Re-usable	15	10.1
Range of facial PPE	Dust masks	36	24.2
	Surgical face masks	25	16.8
	Dust/Surgical masks	28	18.8
	Goggles/ Surgical	10	6.7
	Dust/Surgical/Goggles	5	3.4
	Not available	45	30.2
Protective clothing	Lab coats	56	37.6
	Aprons	45	30.2
	Lab coats/Aprons	16	10.7
	Aprons/Disposable gowns	11	7.4
	Not available	21	14.1
Types of foot wear	Medical rubber shoes	21	14.1
	Gum boots	20	13.4
	Slip-ons/Gum boots	16	10.7
	Not available	92	61.7
Makes of gloves	Latex powdered/Non-powdered	126	84.6
	Latex powdered/Non-powdered/Rubber	15	10.1
	Not available	8	5.3

Appendix vii: Job Description

Variable	Response	Frequency (N)	Percentage (%)
Job Cadre	Clinical officers	31	20.8
	Nursing	48	32.2
	Lab technicians	25	16.8
	Medical assistants	20	13.4
	Housekeepers	25	16.5
Work experience	< 1 year	21	14.1
	1-10years	82	55.0
	11-20 years	30	20.1
	21-30 years	16	10.7
Daily man hours	5-8 hours	129	86.6
	>8 hours	20	13.4
Workstation	Examination, treatment rooms	99	66.4
	Laboratory	20	13.4
	Exam, Treatment, Lab, Waste management	30	20.2

Appendix viii: Adherence to Work Safety Guidelines

Variable	Response	Frequency (N)	Percentage (%)
Pre-job training on infection prevention and control	Yes	119	79.9
	No	30	20.1
PPE usage training	Every three months	30	20.1
	Once a year	42	28.2
	Twice a year	52	34.9
	Not at all	25	16.8
Sharps handled	Metal	20	13.4
	Glass	5	3.4
	Metal and glass	78	52.3
	Metal, glass, bones	46	30.9
Disposal of sharps	Safety boxes	108	79.5
	Safety boxes, improvised plastic containers	32	20.5
Sharps disposal guidelines	Yes	108	72.5
	No	41	27.5
Hands PPE required	Yes	149	100
Protective clothing	Yes	149	100
Facial PPE	Yes	149	100
Eye protection	Yes	102	71.8
	No	47	28.2
Foot wear	Yes	67	45
	No	82	55
Provision of adequate PPE	Yes	26	18.6
	No	123	81.4
Utilization of PPE available	Always	31	20.8
	Occasionally	118	79.2

Appendix ix: Provision of Infection Preventive Measures

Variable	Response	Frequency (N)	Percentage (%)
Proper management of sharps	Yes	144	96.6
	No	5	3.4
Provision of Hepatitis B vaccines	Yes	73	49.0
	No	76	51.0
Post exposure management	Yes	134	89.9
	No	15	10.1
Training on health and safety	Yes	78	52.3
	No	71	47.7
Provision of health and safety guidelines	Yes	108	72.5
	No	41	27.5
Formation of health and safety committee	Yes	40	26.8
	No	109	73.2

Appendix x: Ppe Policy Implementation Gaps

Variable	Response	Frequency (N)	Percentage (%)
Sustainable PPE supply	Yes	144	96.6
	No	5	3.4
Improvement of technology and infrastructure	Yes	58	38.9
	No	91	61.1
Regular training and safety guidelines provision	Yes	137	91.9
	No	12	8.1
Improved waste management and vaccine services	Yes	113	75.8
	No	36	24.2
Adequate human resource	Yes	87	58.4
	NO	62	41.6

Appendix xi: Performance of PPE

Variable	Response	Frequency (N)	Percentage (%)
Provision of fitting gloves	Yes	124	83.2
	No	25	16.8
Incidence of glove tearing	Yes	142	95.3
	No	7	4.7
Allergy to latex rubber	Allergic	10	6.7
	Not allergic	139	93.3
Provision for latex alternative	Provided	4	2.7
	Not provided	6	4.0
	Not allergic	139	93.3
Provision of fitting facial PPE	Provided	67	45.0
	Not provided	82	55.0
Replacement of worn-out foot wear	Prompt	27	18.1
	Delayed	122	81.9
Source of protective clothing	Provided with	26	17.4
	Self-sourced	123	82.6

Appendix xii: Provision of Packaging Information Results

Type Of Glove	Size		Size Label	Manufacturer	Quality Mark	Usage	Risk Protection Level	Latex Allergy Alert
		N	PASSED (%)	PASSED (%)	PASSED (%)	PASSED (%)	PASSED (%)	PASSED (%)
Examination	Small (6.5)	10	100	100	100	100	100	100
	Medium(7.5)	10	100	100	100	100	100	100
	Large (8.5)	10	100	100	100	100	100	100
Sterile	Small (6.5)	10	100	100	100	100	100	100
	Medium(7.5)	10	100	100	100	100	100	100
	Large (8.5)	10	100	100	100	100	100	100

Appendix xiii: Dimensions of Gloves Results

Type of Glove	Size	N	Width (Mm)		Length (Mm)		Minimum Thickness (Mm)		Maximum Thickness (Mm)	
			STD	PASSED (%)	STD	PASSED (%)	STD	PASSED (%)	STD	PASSED (%)
Examination	Small (6.5)	34	**75-85**	98.8	**220**	99.6	**Smooth (0.08)**	96.5	**Smooth (2.00)**	98.8
							Textured (0.11)	96.8	**Textured (2.03)**	97.5
	Medium (7.5)	34	**90-100**	99.3	**230**	98.7	**Smooth (0.08)**	97.1	**Smooth (2.00)**	97.7
							Textured (0.11)	97.8	**Textured (2.03)**	98.1
	Large (8.5)	34	**105-115**	98.4	**230**	98.6	**Smooth (0.08)**	97.4	**Smooth (2.00)**	95.9
							Textured (0.11)	97.2	**Textured (2.03)**	92.4
Sterile	Small (6.5)	6	**75-85**	99.9	**220**	99.3	**Smooth (0.08)**	98.5	**Smooth (2.00)**	97.6
							Textured (0.11)	98.2	**Textured (2.03)**	96.8
	Medium (7.5)	6	**90-100**	99.1	**230**	99.1	**Smooth (0.08)**	99.1	**Smooth (2.00)**	97.4
							Textured (0.11)	97.8	**Textured (2.03)**	98.9
	Large(8.5)	6	**105-115**	98.8	**230**	99.5	**Smooth (0.08)**	96.7	**Smooth (2.00)**	96.7
							Textured (0.11)	98.3	**Textured (2.03)**	98.4

Appendix xiv: Tensile Strength Results

Type of Glove	Size	Minimum Force at Break				Minimum Elongation at Break				
			BAA (N)		AAA (N)		BAA (%)		AAA (%)	
		N	STD	PASSED (%)	STD	PASSED (%)	STD	PASSED (%)	STD	PASSED (%)
Examination	Small (6.5)	34	7	96.7	6	97.9	650	97.8	500	96.5
	Medium (7.5)	34	7	97.8	6	96.9	650	97.4	500	96.8
	Large (8.5)	34	7	96.7	6	98.1	650	97.2	500	97.1
Sterile	Small (6.5)	4	7	96.4	6	98.3	650	98.5	500	97.8
	Medium (7.5)	4	7	98.2	6	97.7	650	98.2	500	97.4
	Large (8.5)	4	7	98.4	6	94.9	650	99.1	500	97.2

Key: BAA- Before Accelerated Ageing, **AAA**- After Accelerated Ageing, **STD**-Standards

Appendix xv: Kebs Water Tightness Results

Type of Glove	Size	N	Passed (%)
Examination	Small(6.5)	23	98.9
	Medium(7.5)	23	97.6
	Large(8.5)	23	97.7
Sterile	Small(6.5)	4	99.8
	Medium(7.5)	4	99.8
	Large(8.5)	4	99.7

Appendix xvi Kebs Acceptance Quality Limits

Properties	Inspection level	Acceptance quality limits
Physical dimensions (width, length, thickness)	S-2	4.0
Water tightness	G-1	2.5
Force and elongation at break	S-2	4.0

Appendix xvii: Incidence of Exposure

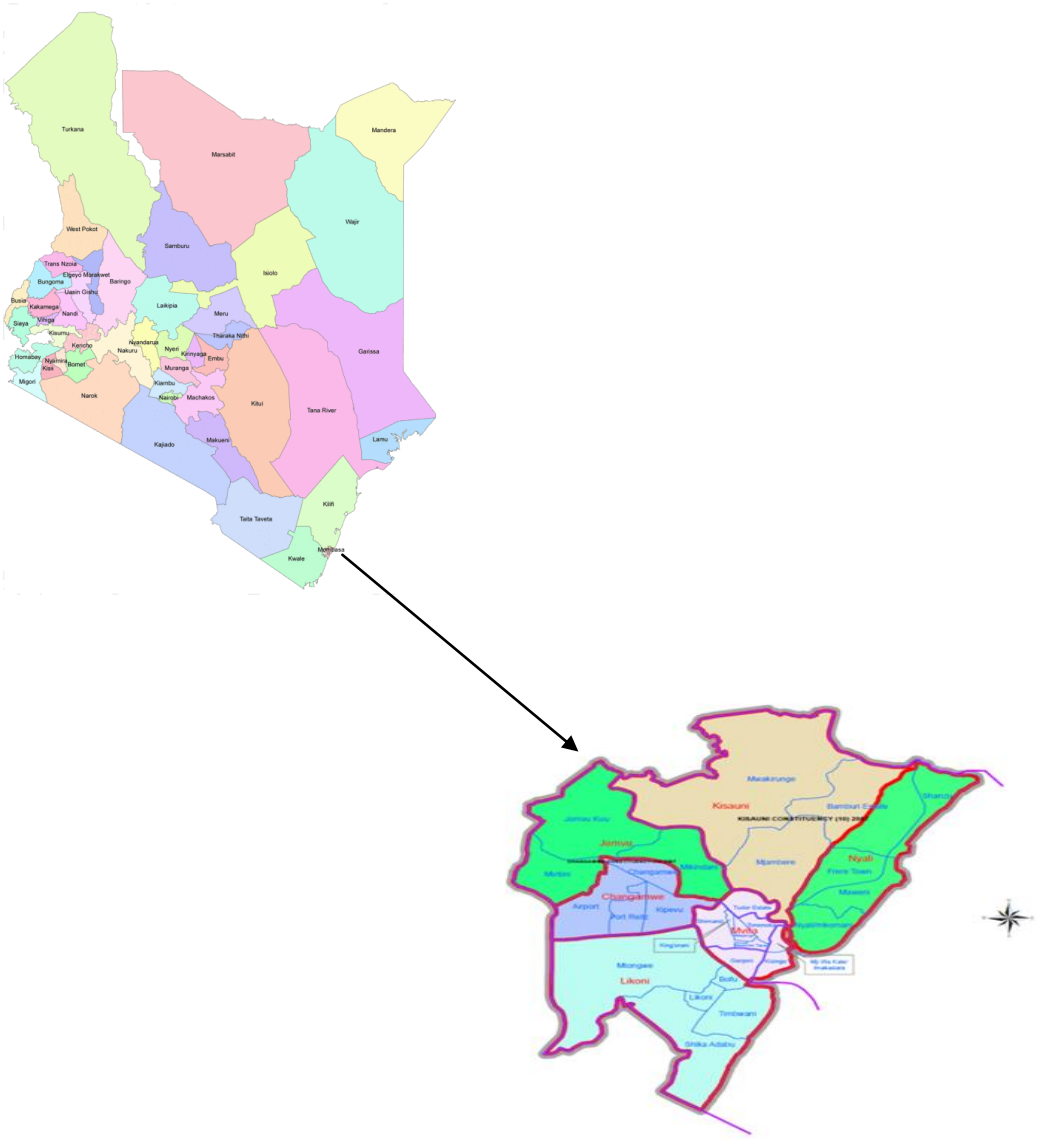
Variable	Response	Frequency (N)	Percentage (%)
Contact with potentially infectious material	Always	146	98.0
	Occasionally	3	2.0
Hepatitis B Vaccine	Vaccinated	73	49.0
	Not Vaccinated	76	51.0
Exposure to infectious material	Exposed	103	69.1
	Never exposed	46	30.9
Mode of exposure	Sharps related injuries	46	44.7
	Body fluids splash	31	30.1
	PPE tear	26	25.3
Body part injured	Hands	62	60.2
	Face	21	20.4
	Lower limb	10	9.7
	Other body parts	10	9.7
Frequency of exposure	Once	68	66.0
	Twice	30	29.1
	Thrice and above	5	4.8
Reporting of exposure incidences or	Reported	77	74.8

accidents			
	Did not report	26	25.2
Post exposure prophylaxis	Accessed	69	89.6
	Did not access	8	10.4

Appendix xviii: Observation Guide Results

Observation for clinical officers, nurses, lab technicians and medical assistants.	**YES** **%**	**NO** **%**
Dons gloves before undertaking procedure that involve blood and OPIM	72.7	27.3
Removes gloves correctly after procedure	55.5	45.5
Correct disposal of the gloves after removal	45.5	55.5
Performs hand hygiene after removing the gloves	63.6	36.4
Wears eye protection before procedures that involve splashing of blood and OPIM	18.2	81.8
Wears facial protection before procedures that involve the risk of splashing	36.4	63.6
Wears protective gowns when performing procedures that involve blood and OPIM splashing	45.5	55.5
Results for observed housekeepers and waste handlers		
Dons, removes, and disposes gloves correctly	55.5	45.5
Wears protective clothing/gowns	27.3	63.6
Wears protective footwear	27.3	72.7
Wears facial protection	18.2	81.8

Appendix xix: Location of Study- Mombasa County



Source: Google maps

Appendix xx: Gloves

LATEX GLOVES

NITRILE GLOVES

NEOPRENE GLOVES

PVC GLOVES

LEATHER GLOVES

Appendix xxi: Disposable Lab Coats

LAB COATS

GOWN

Appendix xxi: Disposable Lab Apron

LAB APRON

Appendix xxiii Coveralls and Surgical Mask

Appendix xxiv: Faceshield and Safety Goggles

Appendix xxv: Steel-Toe Safety Boots and Slip-On Safety Shoes

Appendix xxvi: Ethical Review Approval