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

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ABSTRACT

Health facilities can be 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 endeavored to assess the range and quality standards of PPEs available, adherence to PPE safety guidelines, and the rates of occupational exposures HIV, HBV, and HCV occupational exposure amongst HCP in these facilities. The research adopted a Descriptive Cross-sectional design by utilizing structured questionnaires and lab assays as data collection tools. A simple random sampling approach was used in selection of the subjects. The subjects included Clinical Officers, Lab Technicians, Nursing, Medical assistants, and Housekeepers. Laboratory assays were conducted to determine the quality standards of the PPE sampled from the facilities against KEBS standards. The findings were analyzed with the Statistical Package for the Social Sciences (SPSS), version 23.0 and presented using pie charts, contingency tables, and bar charts. This study ascertained 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 (DF= 1, N= 149) = 0.017, p= 0.05]. Quality standard analysis results established that the gloves met the accepted quality levels. 69%were exposed to blood and OPIM, Sharp related injuries were the highest reported mode of exposure at 44.7%, 70.4% of the exposed had access to hands protection [X^2 (DF= 1, N= 103) = 0.548, p= 0.05]. PPE are not effective as apparatus but are effective when implemented as a policy whereby adequate supply, quality standards, adherence to usage and guidelines are critical to the success of the program.

Introduction

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 number and quality of health facilities in a country or region is one common measure of that area's prosperity and quality of life. 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: Level 1- Community centres, Level 2- Dispensaries, Level 3- Health centres, Level 4- Sub-County referral hospitals, Level 5- County referral hospitals, and Level 6- National referral 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.

The healthcare 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 of1:18678. 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. 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 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).

Mombasa County is located in Southeastern part of Kenya and consists of four Sub-Counties (Figure VI). 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. The research was conducted within a period of six months. 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 Kenyan Occupational Health and Safety Act, 2007 (OSHA, 2007). Engineering controls and work practices are the principal methods used to prevent blood-borne infections in healthcare setting. PPE are also vital because most of the times exposure to these pathogens remain a threat even after applying these controls (Oregon OSHA, 2014). 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).

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). 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 advocating for appropriate choice, fitting, usage, removal, disposal and review of PPE (OSH-MOH, 2014). 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).

Gloves protect users against contact with hazardous materials and they are vital in healthcare environment for health and safety of HCWs (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. 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 *eta al*, 2012). According to Gerberding *et al* study, (1993), observed that during simulated needlestick injury, glove material reduced the transferred blood volume by 46%-86% and further concluded that gloves may exert some protective effect and should be worn whenever needles are handled. However, it is important to remember that the use of gloves is not a substitute for effective hand washing.

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. 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. However, scrub outfits made of natural or manmade fabrics are equivalent to usual clothes and can't be considered protective laboratory apparel (OSHA-USA, 2012).

Face masks 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, 2102). Facemasks serve as barriers during invasive procedures to protect the mucous membranes of the nose and mouth from splash. Protective eyewear includes clear plastic goggles, safety goggles, and face-shields. 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).

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). 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, slip-on shoes, poly-vinyl chloride (PVC) safety boots, etc.

Methodology

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).

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.

Sampling Frame

The study was conducted amongst HCWs working in the 33 primary healthcare facilities in the 6 sub-counties within Mombasa County (Kisauni, Nyali, Changamwe, Jomvu Mvita, and Likoni). The sample size consisted of Clinical Officers, Lab Technicians/Technologists, Nursing workforce (Registered Nurses and Nurses), and Housekeepers (Cleaners and Waste handlers).

Subjects will be arrived at by use of Atchleys formula (Saunders and Thornhill 2009).

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

$\boldsymbol{n}$= desired sample size

$\boldsymbol{p}$= proportion in target group or prevalence estimated to have the measured character.

$\boldsymbol{Z}$= reliability co-efficient or standard normal deviation at the required confidence level

$\boldsymbol{d}$= the level of statistical significance or degree of freedom, so if

$\boldsymbol{z}$= reliability co-efficient ($\mathbf{1.96}$)

$\boldsymbol{p}$= prevalence ($\mathbf{50\%}$)

$\boldsymbol{d}$= degree of freedom ($\mathbf{0.05}$)

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

The required sample will be

$$n = 384$$

But since target population is way below 10,000 the final sample estimate ($\boldsymbol{n_f}$) will be calculated using

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

Where $\boldsymbol{N}$ is the estimated study population and $\boldsymbol{n}$ is the required sample size.

Estimated study population, $\boldsymbol{N}$= 297

Therefore, the final sample size estimate, $\boldsymbol{n_f}$;

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

Sample and Sampling Technique

A multi-stage simple random sampling approach was used in selection of the subjects by first sampling the health facilities using the simple random method. Next, the sampling of HCP was conducted within the subject facilities. Medical gloves samples were also obtained randomly from each of the sampled health facilities. This study design applied the principle of picking the subjects randomly hence reducing the selection bias.

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. 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.

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.

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 (I).

Table (I). KEBS Acceptance Quality Limits - Source: KEBS.

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

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.

Dimensions

The gloves were measured to conform to the dimensions for palm width and length shown in Table V. 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 22Kpa ±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 (II).

Table (II). Dimensions -Source: KEBS.

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	Textured area 2.03	Textured area 2.03
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		

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 VI (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 70^0C ±2 for 168h±2h and then cut from the gloves (Table (III)).

Table (III). Tensile strengths -Source: KEBS.

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

Water tightness

To test for water tightness apparatus were set to accommodate 1000ml of water and held on a holding device in a vertical position. The procedure involved attaching the glove to a 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.

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).

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.

Results and Findings

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, 2010).

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 (Figure II). 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). Table (IV) provides a summary of the traits under social and other demographics of the study population.

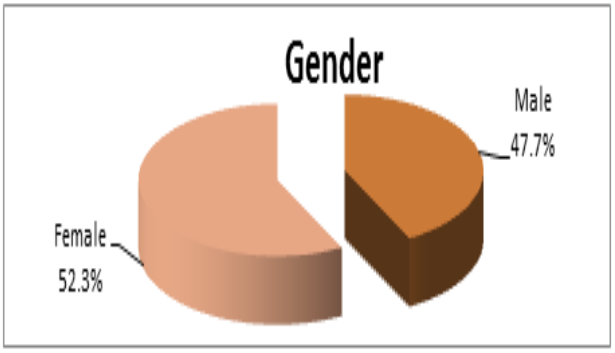

Figure (I). Gender distribution.

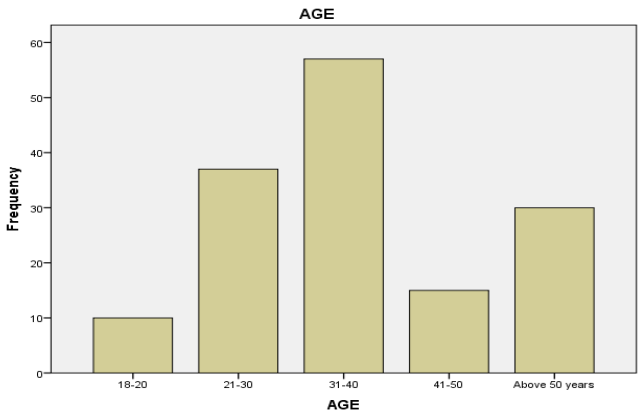

Figure (II). Age distribution.

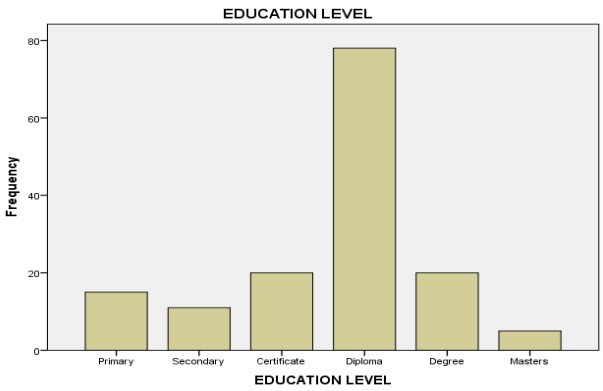

Figure (III) Education level.

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). As per 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 from the job cadre waste handlers/housekeepers 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 [Table (V)] summarizes these statistics.

Table (IV). Social and other 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

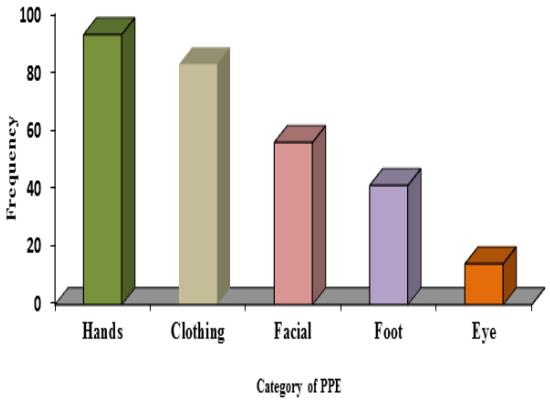

Figure (IV). Categories of Ppe Available

Table (V). 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

Adherence to Work Safety Provisions

Job description

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.

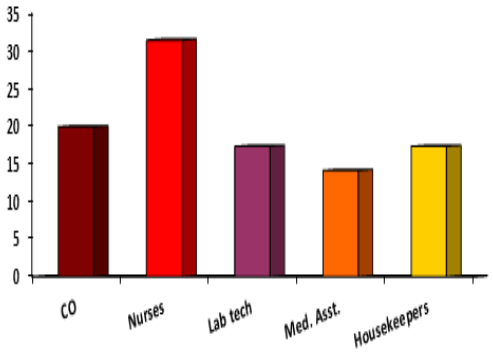

Figure (V). Job cadre distribution.

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%) [Table (VI)].

Table (VI). 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

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 [Table (VII)]

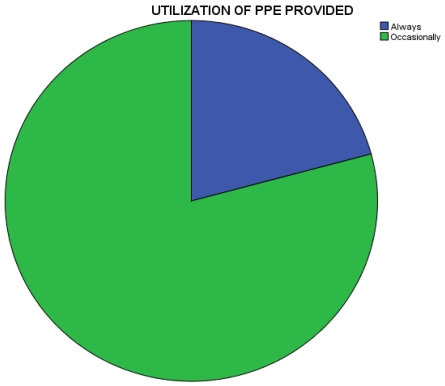

Figure (VI). Utilization of PPE provided.

Table (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

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.

Table (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

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 [Table (IX)].

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 [Table (X)].

Table (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

Table (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

Table (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

Table (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

Table (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

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. Table (XI) gives a summary of the results on general performance of the PPE. Table (XII) to (XV) sums up the results of quality standards of the sampled gloves.

Table (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

Exposure to potentially infectious material

Table (XVI) 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.

Table (XVI). Exposure incidences.

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 accidents	Reported	77	74.8
	Did not report	26	25.2
Post exposure prophylaxis	Accessed	69	89.6
	Did not access	8	10.4

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.

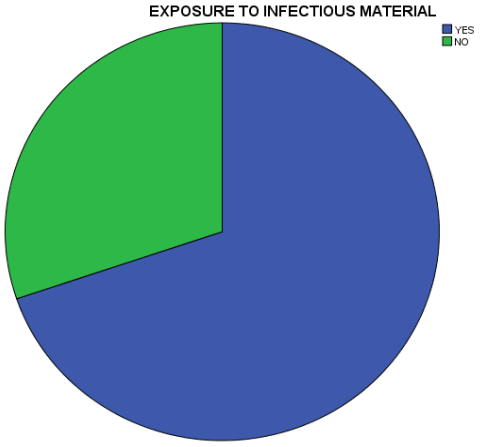

Figure (VII). Exposure to infectious material.

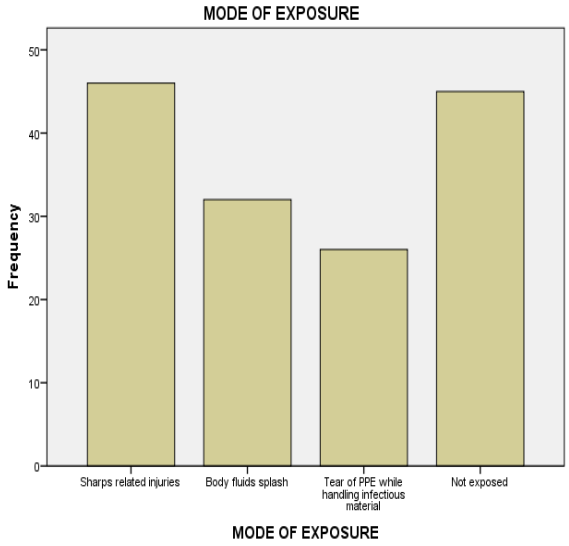

Figure (VIII). Mode of Exposure.

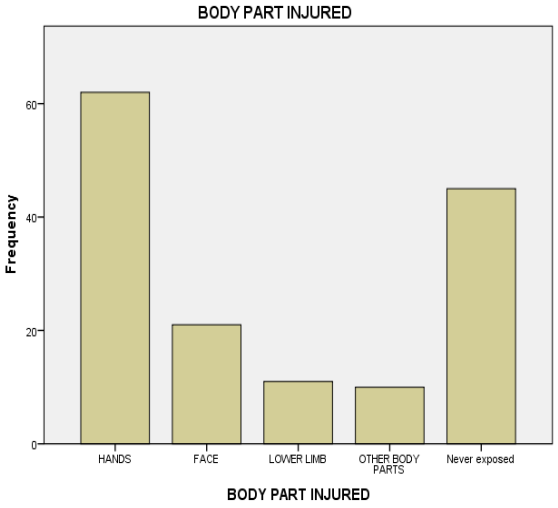

Figure (IX). Body part injured during exposure.

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) to evaluate the various parameters, namely: range of PPE available, adherence to PPE and related work safety guidelines, and performance of the available PPEs.

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 consumption 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 resistance gloves.

As per 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 accord 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% [X^2(DF=4, N=149) =0.601 (p=0.05)]. 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.

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). This study found out that there is significant association between range of PPE and utilization of available protective gear [X^2 (DF= 1, N= 149) = 0.017, p= 0.05]. 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 utilization 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) = 0.16, p= 0.05]. 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= 3, N= 149) = 0.265, p= 0.05]. The study established that a majority 73.9% with pre-job training on safety reported exposure to blood and other potentially infectious material [X^2 (DF= 3, N= 149) = 0.26, p= 0.05]. 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) = 0.008, p= 0.05]. 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= 25) = 0.331, p= 0.05]. 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= 108) = 0.796, p= 0.05]. 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) = 0.352, p= 0.05].

There was a significant association between adequate provision of PPE and utilization of available PPE. Where there was adequate supply of PPE, 60% of the participants reported to always use them [X^2 (DF= 1, N= 149) = 0.017, p= 0.05]. USAID, (2012), study showed that inadequate supplies and

lack of appropriate protective gear exposed medical waste handlers to infectious pathogens.

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= 0.05].

The study found out that 82.1% of those who reported to have been provided with fitting gloves also indicated that they had incidences of glove tearing either when donning, removal or using them [X^2 (DF= 1, N= 149) = 0.642, p= 0.05]. In addition, the study found out that there was an association between the HCP who are allergic to latex rubber and those provided with alternatives. Approximately half of those who reported latex allergy were provided with alternative gloves [X^2 (DF= 1, N= 149) = 0.001, p= 0.05].

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).

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 [X^2 (DF= 1, N= 146) = 0.326, p= 0.05]. 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= 3, N= 103) = 0.001, p= 0.05]. 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) = 0.548, p= 0.05]. 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 percutaneous 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 [X^2 (DF= 4, N= 103) = 0.001, p= 0.05]. 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, 2010).

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 blood and OPIM 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.

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.

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 guarantee 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.

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