Utilization of Personal Protective Equipment Among Health Care Workers in Selected Public Hospitals of Baringo County, Kenya.

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ABSTRACT

Background: Health care workers (HCWs) are at risk of hospital acquired infections. Personal protective equipment (PPE) has been described as the last resort in protecting the HCWs from these infections when all other controls have failed. There is inadequate information available on the level of consistent PPE use in public hospitals in Kenya.Therefore, the aim of this study was to determine the utilization of PPEs among the health care workers in selected public hospitals of Baringo County, Kenya.

Methods: Analytical cross-sectional study design which incorporated both mixed quantitative and qualitative methods was used at the County referral hospital and other five sub-county hospitals. Simple random sampling was used to select proportionately respondents from six purposively selected cadre group basing on their high risk related clinical jobs. They included 6 pharmacist, 13 medical officers, 116 nurses,17 laboratory scientists,32 clinical officers and 9 public health officers. In six selected PPE items, previous usage in the past three months was self-reported through a pretested self-administered questionnaire with a test reliability of Cronbach's alpha = 0.891 and was analyzed descriptively using SPSS version 25.

Results: Of the 200 HCWs sampled, 197 responded (98.5%). Only 39.6% 'always' used. The recommended utilization of PPE as per the WHO and CDC guidelines is always use of 100%. Only 78 (39.6%) reported 'always' using the recommended PPE. The highest 'always' use PPE was for gloves (n=167, 84.8%) with masks (n=147, 74.5%) and gowns/aprons (n=108, 54.7%) less used, and the lowest use for respirators (n=15, 7.7%), goggles (n=13, 6.6%) and face shields (n=18, 9.2%). A significant percentage of respondents reported underuse of respirators (n=155, 79.0%), goggles (n=160, 83.2%) and face shields (n=138, 78.6%), lowest among medical officers and pharmacists.

Conclusion: Overall PPE use was moderate and more selective with hand and body PPEs which were prioritized over the respiratory or eye/face PPE. Consistent PPE supply, training, supervision and supportive PPE policy is advised to address these deficiencies.

Keywords: Personal Protective Equipment; Compliance; Health Care Worker; Infection Prevention And Control; Occupational Health; Baringo County; Kenya.

INTRODUCTION

Health care staff are accustomed to routine exposure to blood-borne and airborne pathogens, and occupational risks in African health facilities are still high (Mossberg *et al.,* 2019). Personal protective equipment (PPEs) - gloves, gowns and aprons, masks, respirators, goggles and face shields - creates a physical barrier between the worker and an infectious source (Livingston *et al.,* 2020). When elimination, substitution and engineering controls cannot eliminate a hazard, the Occupational Safety and Health Act 2007 advocates for PPE use as the primary safety standard for prevention and recommend its safe and effective use (GoK,2007; WHO, 2020; CDC 2020 and Adams & Walls, 2020).

Protection is not just about availability, but regular and proper use. Failure to don and doff the PPE correctly, puts workers and patients at risk (Phan *et al.,* 2019), but doing so correctly can be protective. Health workers who performed aerosol-generating procedures on a patient with unrecognized SARS-CoV-2 infection while

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using PPE adequately were not infected (Ng *et al.,* 2020). The use of PPE was reported to be sub-optimal in Ethiopia, Ghana and Malawi, where inappropriate practices were common. (Akagbo *et al.,* 2017; Haile *et al.,* 2017; Madziatera *et al.,* 2020; Sahiledengle *et al.,* 2018). Inadequate training, discomfort, work pressure and poorly resourced facilities have all been cited repeatedly to have influenced the utilization of the PPEs (Fan *et al*., 2020; Harrod *et al.,* 2020; Kang *et al.,* 2018).

In the context of public hospitals in Kenya that have had a history of PPEs supplies inadequacy (Maina *et al*., 2020) and documented cases of transmission of TB amongst HCWs (Kanyina *et al.,* 2017), such specific information as well as the extent of use of the various PPEs by the different HCW cadres is inadequate. This study, thus, set out to establish the extent of PPE use by the HCWs in selected public hospitals of Baringo County, Kenya.

METHODS

Study Design and Setting

The study design employed was analytical cross-sectional, using mixed (quantitative and qualitative) methods. This article is on the quantitative aspect of PPE use. It was carried out in Baringo County, with the County Referral Hospital and other five sub-county hospitals (Mogotio, Marigat, Eldama Ravine, Kabartonjo and Chemolingot) being the purposively sampled public hospitals.

Study Population, Sampling and Sample Size

The study population consisted of 400 HCW (as recorded in the county human resources records), working for a minimum of 12 months in the study hospitals. Purposive sampling of hospitals was done based on the fact that they have the largest number of HCW and clients. Six cadres - medical officers, pharmacists, nurses, clinical officers, laboratory scientists and public health officers, who are all exposed to a relatively higher risk of getting infected with blood borne pathogens were purposively sampled as the cadre strata. Within each stratum, respondents were selected using simple random sampling of lottery method, on proportion to the number in each cadre (see Table 1).

The sample size was estimated using the Yamane (1967) formula of 95% confidence and 5% precision:

N = N / [1 + N(e)2] n = 400 / [1 + 400(0.05)2] = 200

N = Z 2 p(1-p).

Where n is the sample size, N is the target population (400) and e is the precision (0.05).

An additional 10% was factored in for non-response, thus requiring a total of 220 respondents.

Table 1: Distribution of the study population and sample by hospital and cadre

Hospital	**Population (by cadre) A**	**B**	**C**	**D**	**E**	**F**	**Sample, proportionate (by cadre) A**	**B**	**C**	**D**	**E**	**F**
Baringo County Referral Hospital	10	3	90	25	14	3	5	2	45	12	7	2
Mogotio Sub-County Hospital	2	2	17	5	3	2	1	1	8	2	1	1
Marigat Sub-County Hospital	2	2	18	9	4	2	1	1	9	4	2	1
Eldama Ravine Sub-County Hospital	8	4	84	26	9	2	4	2	42	13	4	1
Kabartonjo Sub-County Hospital	2	2	16	8	4	1	1	1	8	4	2	1

Chemolingot Sub-County Hospital	1	1	9	7	3	1	1	1	4	4	2	1

Key: A, medical officers; B, pharmacists; C, nurses; D, clinical officers; E, laboratory scientists; F, public health officers.

Data Collection

Data were collected using a structured self-administered questionnaire on socio-demographic characteristics and PPE use. Frequency of glove, gown/apron, mask, respirator, goggle and face-shield use in the past three months was categorized as "never used", "failed to use more than ten times", "failed to use less than ten times", and "was used always". The instrument was pretested at Iten County Referral Hospital (Elgeyo Marakwet County) where the study setting was similar, and modified in areas where items were not clearly understood. Face validity was conducted and the internal consistency of the instrument was high (Cronbach's alpha = 0.891). The questionnaires were either self-administered in paper form or submitted through Google Forms (participants who had access to internet).

Data Analysis

Data were entered into Epi-Data and exported to SPSS version 25 for coding, consistency and data cleaning. Frequencies, proportions, means and standard deviations were calculated. For each PPE, categories were scored as 0 (never used), 1 (failed to use > 10x), 2 (failed to use 10x), 3 (always used) and a mean utilization index expressed as a percentage of maximum possible score (3), calculated over all the 197 respondents who responded out of the sampled 200. Underutilization was defined as never used and failed to use > 10x. Percentages in table 3 are percentages of the total valid responses for each item.

Table 1:Frequency of Utilization of PPEs

Frequency of Utilization	**Gloves**		**Gowns/ Aprons**		**Masks**		**Respirators**		**Goggles**		**Face shields**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Never used	3	1.5	20	10.4	2	1.0	133	68.2	135	68.9	118	60.2
Failed to use >10 times	8	4.1	28	14.6	11	5.6	21	10.8	28	14.3	36	18.4
Failed to use <10 times	19	9.6	39	20.3	37	18.9	26	13.3	20	10.2	24	12.2
Always	167	84.8	105	54.7	146	74.5	15	7.7	13	6.6	18	9.2
Average (%)	*92.6%*		*71.2%*		*88.5%*		*20.0%*		*18.1%*		*23.4%*	

Ethical Considerations

Approval to carry out the study was sort from the Kenyatta University Ethics Research Committee (PKU/2913/I12036), and was licensed by the National Commission for Science, Technology and Innovation (NACOSTI/P/23/31455). Authority was granted by the County, sub-county and the hospitals leadership. All respondents signed written consent forms and were assured of confidentiality and anonymity.

RESULTS AND DISCUSSION

Characteristics of Respondents

Among the 200 HCWs sampled,of which 197 responded, included pharmacists 6(3.1%), medical officers 13(6.6%), nurses 116(58.9%), laboratory scientists 17(8.6%), clinical officers 32(16.2%) and public health officers 9(4.6%). The respondents were predominantly female (59.4%), aged 40-49 years (39.1%) and had a diploma as their highest level of education (64.5%). Most (80.7%) were married. The average working day was 8.0 ± 1.1 hours (range 3–12 hours; Figure 1).

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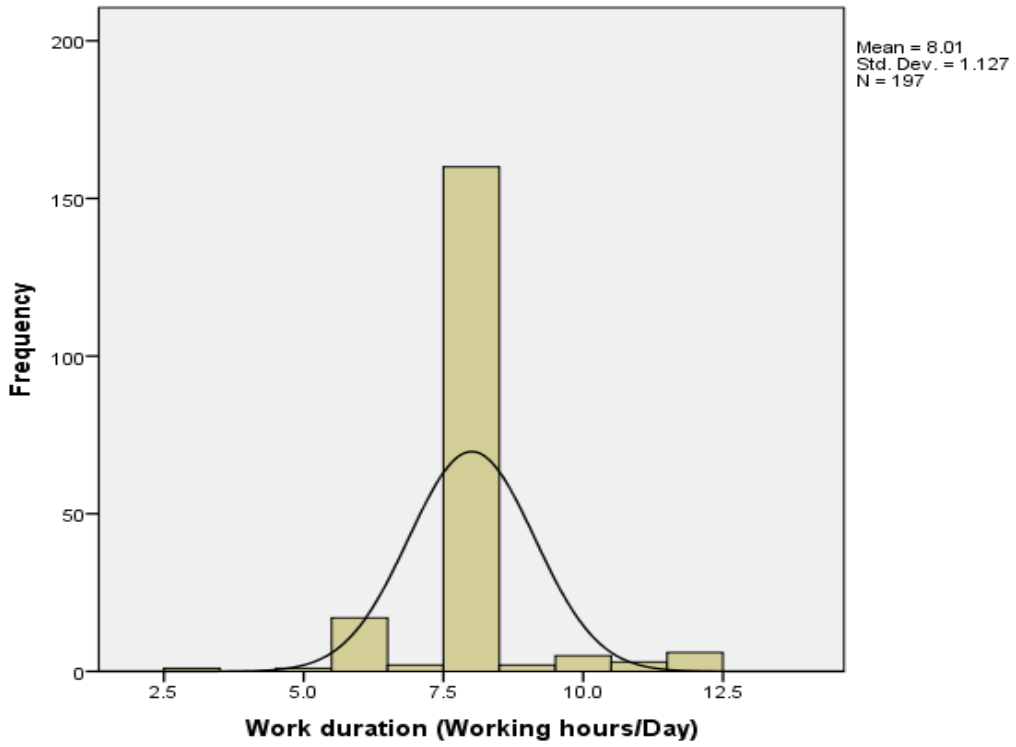


Figure 1: Number of working hours per day (mean = 8.01, SD = 1.13, n = 197)

Table 2: Socio-demographic characteristics of the respondents

Variable	Category	Frequency	Percent (n = 197)
Gender	Female	117	59.39
	Male	80	40.61
Occupation	Medical officer	13	6.60
	Pharmacist	6	3.05
	Clinical officer	32	16.24
	Nurse	116	58.88
	Public health officer	9	4.57
	Laboratory scientist	17	8.63
	Others	4	2.03
Highest level of education	Certificate	9	4.57
	Diploma	127	64.47
	Bachelor's degree	50	25.38
	Master's degree	11	5.58
Marital status	Single	32	16.24
	Married	159	80.71
	Divorced	1	0.51
	Separated	2	1.02
	Widowed	3	1.52
Age (years)	18–29	29	14.72
	30–39	56	28.43
	40–49	77	39.09
	50–59	35	17.77

Level of PPE Utilization

On average, recommended utilization of PPEs, which is 'always', over the last 3 months was at 39.6%. The recommended gloves utilization was at 84.7%, with gowns/ aprons at 54.7%, masks at 74.5%, respirators at

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7.7%, goggles at 6.6%, and face shields at 9.2%. Levels of underutilization of PPEs was reported as either 'Never used' and 'Failed to use >10(more than ten) times. Levels of underutilization of gloves was at 11(5.6%), gowns/ aprons 48(25.0%), masks 13(6.6%), respirators 154(79.0%), goggles 163(83.2%), and face shields 154(78.6%). There was reported 19(9.6%) <10 times failed use, 8(4.0%) >10 (more than ten) times failed use, and 3(1.5%) lack of use of gloves. There was reported 39(20.3%) <10 times failed use, 28(14.6%) >10 times failed use, and 20(10.4%) lack of use of gowns/ aprons. There was reported 37(18.9%) <10 times failed use, 11(5.6%) >10 times failed use, and 2(1.0%) lack of use of masks. There was reported 26(13.3%) <10 times failed use, 21(10.8%) >10 times failed use, and 133(68.2%) lack of use of respirators. There was reported 20(10.2%) <10 times failed use, 28(14.3%) >10 times failed use, and 135(68.9%) lack of use of goggles. There was reported 24(12.2%) <10 times failed use, 36(18.4%) >10 times failed use, and 118(60.2%) lack of use of face shields. This is as shown in table 3 below.

Table 3: Frequency of utilization of PPE among health care workers over the previous three months

Frequency of utilization	**Gloves (n = 197)**		**Gowns/aprons (n = 192)**		**Masks (n = 196)**		**Respirators (n = 195)**		**Goggles (n = 196)**		**Face shields (n = 196)**	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Never used	3	1.5	20	10.4	2	1.0	133	68.2	135	68.9	118	60.2
Failed to use >10 times	8	4.1	28	14.6	11	5.6	21	10.8	28	14.3	36	18.4
Failed to use <10 times	19	9.6	39	20.3	37	18.9	26	13.3	20	10.2	24	12.2
Always used	167	84.8	105	54.7	146	74.5	15	7.7	13	6.6	18	9.2
Mean utilization index (%)	**92.6**		**71.2**		**88.5**		**20.0**		**18.1**		**23.4**	

The mean utilization index is the mean score (0–3) as a percentage of the maximum score, computed over all 197 respondents. n, number of respondents.

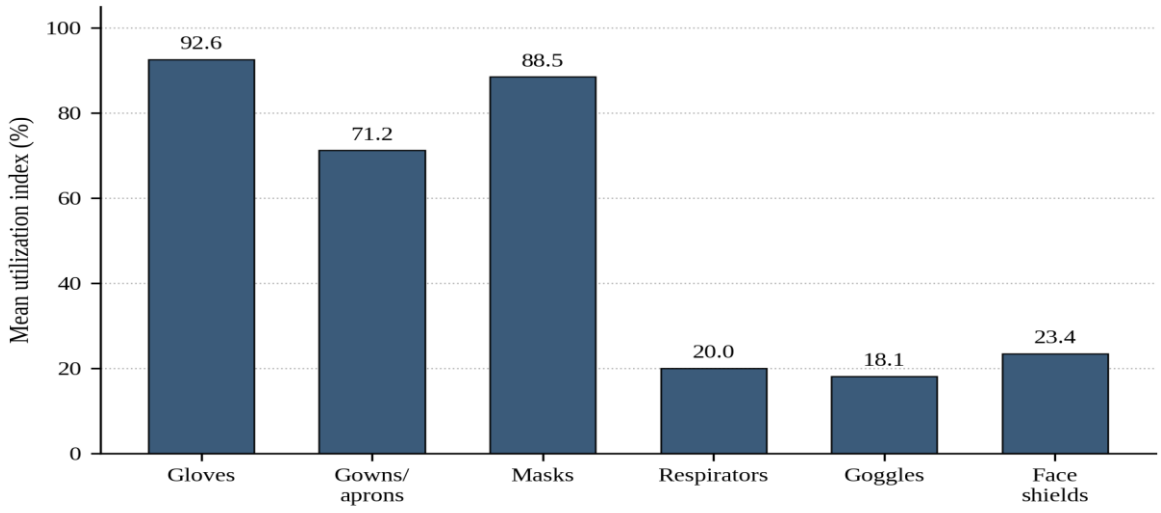


Figure 2: Mean utilization index of PPE items among health care workers

The rate of always-use of 39.6% indicates incomplete PPE use,since 100% use is provided by the WHO guidlines (WHO, 2020).These occurrences have been reported elsewhere in sub-Saharan Africa (Madziatera *et al.,* 2020). The latter study reported on how often HCW use was observed to be good, as opposed to how often it was asked

for: observation yields a somewhat different picture to self-report, and the figures are not directly comparable. Incompletely protected HCWs are at risk of becoming infected and infecting others(Phan *et al*.,2019).

The gradient in use from gloves and masks to respirators and eye and face protection suggests that PPE is used appropriately by HCWs, with eye and face protection and respirators only used when indicated, but gloves and masks more generally. Logically, the use of gloves and masks is associated with contact with blood and body fluids while eye and face protection and respirators are not. Published research literature suggests three reasons. Firstly, supply: eye protection was not available in 70.8% of wards in Malawi (Madziatera *et al.,* 2020), and public health facilities in Malawi have experienced sustained stock outs of IPC consumables (Madziatera *et al.,* 2020). Secondly, usability: there is documented low compliance with eye protection, in part due to fogging, discomfort and interference with sight (Prakash *et al.,* 2020; Ynez Bentez *et al.,* 2020), and masks may be removed to enable communication during procedures (Kwon *et al.,* 2017). Thirdly, training and organisation: inadequate training, discomfort and adverse working conditions have been associated with incomplete PPE use (Harrod *et al.,* 2020; Kang *et al.,* 2018).

PPE Utilization By Cadre

Table 4 shows the utilization index disaggregated by cadre. Because nurses accounted for 58.9% of study participants, they accounted for the most utilization index percentage points (Table 4; e.g., 56.7/92.6 total percentage points for gloves). When using the utilization index to compare the proportion of always-use with the proportion of ever-use for each type of provider, only the nurses and clinical officers use gloves as always use, 12/13 (92.3%) and 22/32 (68.8%) of clinical officers and nurses, respectively, and all clinical officers and all pharmacists report wearing gloves as always use.

The proportion of nurses who used respirator was unknown, as no nurse reported always using a respirator. However, all 13 medical officers and 6 pharmacists reported never using a respirator, whereas 11/13 (84.6%) medical officers and 77/116 (66.4%) nurses never used a res pirator.

Goggles and face shields also showed a comparable trend. The inappropriately low use of respirators in the medical officer and pharmacist cadres is particularly alarming because any of these cadres working with a patient with respiratory symptoms should be wearing the respirator.

Table 4: Utilization of PPE items by cadre (number of respondents)

PPE / frequency of use	MO	Ph	CO	N	PHO	LS	Oth	Total
Gloves								
Never used	0	2	1	0	0	0	0	3
Failed to use >10 times	0	2	1	3	0	2	0	8
Failed to use <10 times	1	1	8	7	1	0	1	19
Always used	12	1	22	106	8	15	3	167
Index contribution (%)	*6.4*	*1.2*	*14.0*	*56.7*	*4.4*	*8.0*	*1.9*	***92.6***
Gowns/aprons								
Never used	2	1	2	13	1	1	0	20
Failed to use >10 times	3	3	3	14	1	2	2	28
Failed to use <10 times	3	0	9	24	2	0	1	39
Always used	5	2	17	61	5	14	1	105
Index contribution (%)	*4.1*	*1.5*	*12.2*	*41.5*	*3.4*	*7.4*	*1.2*	***71.2***
Masks								
Never used	0	0	0	1	0	1	0	2
Failed to use >10 times	2	1	2	4	0	1	1	11
Failed to use <10 times	2	2	10	19	1	3	0	37
Always used	9	3	20	92	7	12	3	146
Index contribution (%)	*5.6*	*2.4*	*13.9*	*53.8*	*3.9*	*7.3*	*1.7*	***88.5***

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Respirators								
Never used	11	4	24	77	5	8	4	133
Failed to use >10 times	2	1	2	11	0	5	0	21
Failed to use <10 times	0	1	3	16	3	3	0	26
Always used	0	0	3	10	1	1	0	15
Index contribution (%)	*0.3*	*0.5*	*2.9*	*12.4*	*1.5*	*2.4*	*0.0*	***20.0***
Goggles								
Never used	10	5	25	80	3	10	2	135
Failed to use >10 times	2	0	3	15	2	4	2	28
Failed to use <10 times	1	1	3	11	3	1	0	20
Always used	0	0	1	9	1	2	0	13
Index contribution (%)	*0.7*	*0.3*	*2.0*	*10.8*	*1.9*	*2.0*	*0.3*	***18.1***
Face shields								
Never used	10	4	19	74	1	9	1	118
Failed to use >10 times	2	2	8	17	2	3	2	36
Failed to use <10 times	0	0	4	14	3	2	1	24
Always used	0	0	1	11	3	3	0	18
Index contribution (%)	*0.3*	*0.3*	*3.2*	*13.2*	*2.9*	*2.7*	*0.7*	***23.4***

MO, medical officers; Ph, pharmacists; CO, clinical officers; N, nurses; PHO, public health officers; LS, laboratory scientists; Oth, other cadres. Index contribution is each cadre's share of the mean utilization index (%); the total column gives the overall index (Table 3).

Strengths and Limitations

The very high response rate (98.5%) and the proportionate sampling in six cadres and six hospitals add strength. The use of self-reporting of utilisation over 3 months recall period by the respondents can possibly be inaccurate (recall bias and social desirability bias), and use of PPE (how the respondents donned and doffed PPE) was not observed. Only public hospitals in one county were included and six departments were purposively selected, so findings should be generalised with caution.

CONCLUSION AND RECOMMENDATIONS

Conclusion

PPE use among HCWs from public hospitals in Baringo County was suboptimal, with only 39.6% reporting that they always used the recommended PPE in the last three months. Use was high for gloves (84.8%) and masks (74.5%), moderate for gowns/aprons (54.7%) and very low for respirators (7.7%), goggles (6.6%) and face shields (9.2%) with up to 83% HCWs reporting they did not use these items always. The pattern was the same across the cadres and most keenly observed for protection against respiratory infections among medical officers and pharmacists. PPE use is therefore not standard, exposing HCWs and patients to undue risk of hospital associated or acquired infections.

Recommendations

Based on the findings, the study made the following recommendations;

1. Consistent supply of PPEs: Appropriate national and county health authorities should assure a timely and consistent supply of all PPE items, with special emphasis on the requirement for face-shields, face-masks and goggles, and safe facilities for donning and doffing the PPEs.

2. Training: Hospital managers should offer training materials and conducting regular and frequent in-service training on PPE donning and doffing. HCWs should be encouraged to consult credible online resources on donning and doffing of PPE.

3. Sufficient budget :National and county health authorities should increase and safeguard budget to PPEs, donning and doffing facilities, training support and refresher sessions.

4. Policy and regulation :A policy and regulation should be established and applied regarding the quality and design of PPE to ensure that PPE is accepted by HCWs and enables a positive attitude towards its use.

5. Supervision: Supervise use of PPE within departments and provide feedback to cadres with the least PPE use.

6. Patients and caregivers: Develop and implement ways to inform patients and caregivers about PPE in the health facility.

Recommendations For Further Research

Additional research should determine HCWs' willingness to self-train on the importance of and the donning and doffing of PPE, and the reasons for and against self-trainings, and should include observation of the correct donning and doffing of the PPEs.

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