ASSESSMENT OF HEALTHCARE WASTE MANAGEMENT ACROSS DIFFERENT CATEGORIES OF HEALTH FACILITIES IN THE LIMBE HEALTH DISTRICT.

ABSTRACT

Context/Justification: In Cameroon, healthcare waste management (HCWM) is ineffective as waste is seldom segregated, serving as a threat to human health, the public and the environment. An assessment carried out by WHO/UNICEF in 2015 revealed that 58% of health facilities sampled in 24 different countries had adequate waste management system.

Objective: To evaluate healthcare waste management in fifteen selected health facilities of 4 different categories in the Limbe health district.

Methodology: We carried out a health facility based cross sectional study with descriptive and analytic components in 15 health facilities in the Limbe health district from November 2022 to July 2023. Data was collected for a period of 83 days, from March to May 2023 from all healthcare workers; whose work led to the generation of healthcare waste, who were involved in HCWM and who accepted to participate in our study. The data was collected using a questionnaire, a health facility based observational checklist and also through interviews.

Results: Out of the 341 healthcare workers who participated in our study, 327 were retained giving a response rate of 95.9%, Of which; 129(39.4%), 79(24.2%), 38(11.6%), 81(24.8%) were from 3rd, 4th, 5th and 6th categories respectively. The overall knowledge level revealed; 49(15.0%) of study participants had good knowledge level and 7(46.7%) health facilities practiced safe HCWM. The most reported problems faced with HCWM implementation was non-respect of HCWM guidelines 136(41.6%). Statistical significant associations were shown between education level (0.002), training on HCWM (0.001) and knowledge on HCWM. Marginal statistical significant associations were found between health facility category and HCWM practice.

Conclusion: From the gaps observed in our study, we noticed that an appreciable percentage (50.2%) of healthcare workers knew what healthcare waste management was but didn't practice appropriate HCWM which could have been because of; Ignorance due to their level of education, Lack/inadequate training on HCWM, Non-respect of HCWM guidelines. We can therefore conclude that healthcare waste management practice did not meet norms and does not depend on the health facility category.

Keywords: healthcare waste, healthcare waste management, healthcare workers, Cameroon.

Introduction

Healthcare waste management is a growing concern worldwide, particularly in developing countries as revealed by studies carried out in; Bangladesh, Ethiopia, Addis Ababa; Ethiopia, and in North West Ethiopia respectively[1–4]. However, in the process of performing healthcare activities, health facilities generate hazardous and non-hazardous waste that could be potentially harmful to healthcare workers, the public and the environment [5]. According to the World Health Organization, of the total amount of waste generated by healthcare activities, about 85% is general, non-hazardous waste. The remaining 15% is considered hazardous material that may be infectious, toxic or radioactive. If both these types are mixed together then the entire quantity becomes contaminated and harmful [6]. Many findings in developing countries on healthcare wastes management revealed that segregation, collection, and storage of waste in isolated area were not satisfactory. Furthermore, healthcare wastes originating from healthcare facility are dumped either into their backyard, in a simple pit or put in open garbage bins on the roads [7] [8].

In developed countries, there is legislation and good practice guidelines that define healthcare wastes and state the various possible ways for collection, transport, storage and disposal of such wastes unlike in Africa whereby healthcare waste management is still at its infancy; characterized by the lack of awareness on the impacts of healthcare waste, the total absence of healthcare waste regulations and a high incidence of non-compliance in cases where they exist [6].

In Cameroon, a study conducted on Health Impact Assessment and Evaluation of a Clinical Waste Management Policy for Cameroon stated that healthcare waste management is ineffective, due to the absence of an elaborate waste management policy and also due to the knowledge, attitude and practice of the people involved in the sector [9]. Also, current approaches adopted in the handling and management of health care wastes in Cameroon is not well documented, though this is the basis for formulating appropriate and sustainable waste and resource management strategies as stated in a study conducted in the Southwest region of Cameroon [10]. We therefore thought of evaluating healthcare waste management in fifteen selected health facilities of 4 different categories in the Limbe health district by:

1- Determining the knowledge level of healthcare workers on HCWM in the Limbe health district
2- Evaluating HCWM practice in health facilities in the limbe health district
3- Determining problems faced with implementation of HCWM in the Limbe health district
4- Determining factors associated to knowledge level and practice on HCWM

Methods and Materials

Study Setting, and Period: The Limbe health district is found in the Fako division of the South-west region which is one of the 10 administrative regions of Cameroon. It has a surface area of 645km², and a total population of 211,186 inhabitants for the year 2022 with 8 health areas (Zone II, Bota, Seaport, Idenau, Bojongo, Bota, Moliwe, Mabeta). Data was collected for a period of 83 days, from March 10th 2023 to May 31st 2023.

Study Design: We carried out a health facility based cross-sectional study with descriptive and analytic components

Research Population

Target Population: Healthcare workers of health facilities in the Limbe health district.

Source Population: Our source population were healthcare workers in selected health facilities in the Limbe health district.

Study population: Healthcare workers whose job led to the generation of healthcare wastes in the process of administering care and also those involved in the handling and subsequent management of potential hazardous waste in the selected health facilities.

Eligibility criteria

Inclusion criteria: All healthcare workers whose work led to the generation of healthcare waste irrespective of their working experience and level of education, healthcare workers directly involved in the management of healthcare waste, all healthcare workers whose work led to the generation of healthcare wastes who accepted to participate in the study.

Exclusion criteria: Healthcare workers who did not give their consent**,** all healthcare workers absent during the period of data collection.

Non-inclusion criteria: All healthcare workers whose work did not generate healthcare wastes.

Sample Size Determination

Using the Cochran equation which follows;

$$\mathbf{n} = \frac{Z^2 \alpha P\ (1-P)}{d^2}.$$

$$\mathbf{n} = \frac{1{,}96^2 * 0{,}293(1-0{,}293)}{0{,}05^2} = 318$$

After calculations, **334** was the final sample size considering a non-respondent rate of 5%.

The study participants (healthcare workers) were gotten through exhaustive sampling method.

Sampling Technique

Firstly, Health facilities of 3rd, 4th, 5th and 6th categories in the Limbe health district found across different health areas were selected by convenience. Secondly, health facilities of 6th category were selected by simple random sampling where a total of 11 health facilities of 6th category across different health areas were included. (Limbola IHC, Batoke IHC, Mokunda IHC, Bota CDC clinic, Victoria hope foundation clinic, Moliwe CDC HC, Bimbia IHC, Divine grace HC, Holy Mary HC foundation, Debuncha CDC clinic, Zion HC).

Data Collection Tools and procedure

Data was collected with the help of a semi structured paper questionnaire, an observational checklist and also through interviews.

Data Quality Management and Data Analysis

Data collected were checked for completeness, accuracy and clarity by the principal investigator before entering the data in an online questionnaire hosted on KoBo Toolbox®.

The data entered into KoBo Toolbox® was exported to Microsoft excel version 2016 and analysed using SPSS statistical software, version 21.

Ethical Consideration

We began collecting data only after obtaining an ethical clearance delivered by the faculty of health sciences institutional review board, Buea (FHSIRB), as well as all other administrative authorizations necessary for its implementation.

Operational Definitions

Poor Knowledge: knowledge was considered poor when the score of the knowledge questions were less than 6 of the 11 item scale knowledge questions.

Good knowledge: knowledge was considered good when the score of the knowledge questions were > 6 of the total knowledge questions.

Poor practice: health facilities that answered (≤50%). of the 12 practical questions correctly

Good practice: health facilities that answered (≥50%) of the 12 practical questions correctly.

Results

Socio-Demographic Characteristics of Respondents

Out of the 341 healthcare workers who participated in our study, 327 were retained giving a response rate of 95.9%. Of which; 129(39.4%), 79(24.2%), 38(11.6%), 81(24.8%) were from 3rd, 4th, 5th and 6th categories respectively. Of this healthcare workers that participated in our study, 78(23.9%) were males and 249(76.1%) were females. A majority were in the age group 20-30 years old 154(47.1%). From an educational perspective, 116(35.5%) were diploma holders. Concerning profession, they were; 19(5.8%) doctors, 157(48.0%) nurses, 51(15.0%) lab technicians, 2 sanitary engineers, and 36(11.0%) cleaners. The most represented working unit was the OPD 69(21.0%), next, the maternity 48(14.0%) and the laboratory 43(13.0%). Regarding work experience, 174(53.2%) of the respondents had between 0-4 years of experience. Concerning vaccination, 79(24.2%) of participants had been vaccinated against hepatitis B virus only, 68(20.8%) against tetanus bacteria only, 72(22.0%) against hepatitis B and tetanus virus. As concerned with training on HCWM, less than a majority, 146 (44.6%) of the study participants had undergone training.

Table 1: Socio-demographic characteristics of participants.

Variable	Modality	Frequency(n)	Percent(%)	95% LCI	95%UCI
Sex	**Female**	**249**	**76.1**	**71.3**	**80.5**
	Male	78	23.9	19.5	28.7
Age	>50 years	20	6.1	3.9	9.1
	20-30 years	**154**	**47.1**	**41.7**	**52.5**
	31-40 years	104	32.1	26.9	37.0
	41-50 years	48	14.7	11.2	18.8
Level of education	Bachelor's	105	32.1	27.2	37.3
	degree	10	3.1	1.6	5.4
	Bachelor's				
	degree in	79	24.2	19.8	29.0
	medicine	**116**	**35.5**	**30.4**	**40.8**
	Certificate	17	5.2	3.2	8.0
Working unit	**Diploma**	1	0.0	0.0	0.0
	Masters/PHD	13	3.0	2.0	6.0
	Anesthetist	2	0.0	0.0	1.0
	ANC	17	5.0	3.1	7.0
	COVID-19	43	13.0	9.0	17.0
	center	48	14.0	11.0	18.0
	Emergency	38	11.0	8.0	15.0
	Laboratory	1	0.0	0.0	0.0
	Maternity	**69**	**21.0**	**16.0**	**25.0**
	Medical	58	17.0	13.0	22.0
	Mortuary	22	6.0	4.0	9.0
	OPD	14	4.0	2.0	6.0
	Others	1	0.0	0.0	0.0
Profession	Pediatrics	1	0.0	0.0	0.0
	Surgical	36	11.0	7.0	14.0
	X-ray	19	5.0	3.0	8.0
	Anesthetist	1	0.0	0.0	0.0
	Cleaner	51	15.0	11.0	19.0
	Doctor	1	0.0	0.0	0.0
	Lab scientist	13	3.0	2.0	6.0
	Lab technician	1	0.0	0.0	0.0
	Microbiologist				
	Midwife	**157**	**48.0**	**42.0**	**53.0**
	Mortuary	42	12.0	9.0	16.0
	attendant	2	0.0	0.0	1.0
	Nurse	3	0.0	0.0	2.0
Working experience	Nurse's	54	16.5	12.8	20.8
(years)	assistant	**174**	**53.2**	**47.8**	**58.6**
	Sanitary	60	18.3	14.4	22.8

	engineer	39	11.9	8.8	15.8
	Sonographer	79	24.2	19.8	29.0
Vaccination status	>12	72	22.0	17.8	26.7
	0-4				
	5-8	108	33.0	28.1	38.3
	9-12	68	20.8	16.7	25.4
	Hepatitis B	181	55.4	49.9	60.7
Received training on HCWM	Hepatitis B, Tetanus	**146**	**44.6**	**39.3**	**50.1**
	None of the above				
	Tetanus				
	No				
	yes				

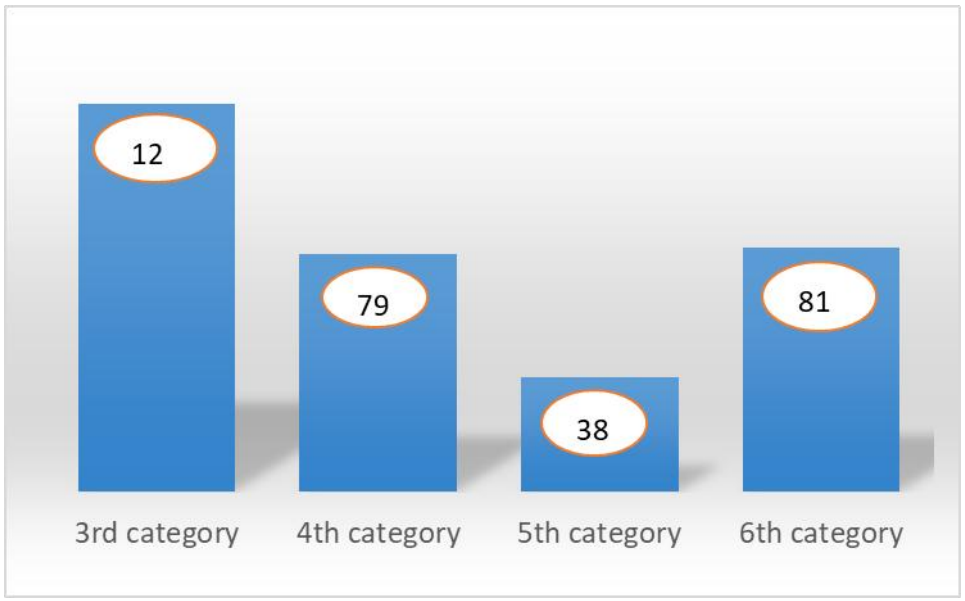

Figure 1: Number of respondents per health facility category

Objective 1: Knowledge of Healthcare Healthcare workers on HCWM.

The overall knowledge level of health professionals on HCWM was; 42(12.8%) for poor knowledge, 89(27.2%) for average knowledge, 147(45.0%) for fairly good knowledge and 49(15.0%) for good knowledge. Amongst the total number of respondents, 164(50.2%) knew

what healthcare waste management was and only 64(19.6%) of respondents knew who should be in charge of managing healthcare waste. It was encouraging finding out that a good number of participants 283(86.5%) were aware that diseases can be transmitted through healthcare waste. Almost all participants 318(97.2%) knew that the wearing of PPE reduces the risk of infection. Over 236(72.2%) of respondents were aware of an existing HCWM guideline/policy.

Table 2: Knowledge on healthcare waste management

Variable	Modality	Frequency(n)	Percent(%)	95% LCI	95% UCI
What is HCWM?	The collection, treatment, transportation and disposal of HCW	117	35.8	30.7	41.1
	The generation, segregation, transport, treatment and disposal of HCW	**164**	**50.2**	**44.8**	**55.6**
	The processing and recycling of HCW	29	8.9	6.1	12.3
	The segregation and disposal of HCW	17	5.2	3.2	8.0
Who should be in charge of HCWM?	The government	38	11.6	8.5	15.4
	Director of hospital	35	10.7	7.7	14.4
	Doctor	7	2.1	1.0	4.2
	Nurses	45	13.8	10.4	17.8
	IPC officer	165	50.5	45.1	55.9
	Patients	24	7.3	4.9	10.5
	Interns	26	8.0	5.4	11.3
	Cleaners	40	12.2	9.0	16.1
	Staffs	86	26.3	21.8	31.3
	All of the above	**64**	**19.6**	**15.6**	**24.1**
Does segregation reduce the cost of HCWM?	I don't know	17	5.2	3.2	8.0
	No	64	19.6	15.6	24.1
	Yes	**246**	**75.2**	**70.3**	**70.7**
When is waste discarded from the bin?	So far as waste is in the bin	28	8.0	5.0	11.0
	When it is ½ full	88	26.0	22.0	12.0
	When it is ¾ full	**122**	**37.0**	**32.0**	**42.0**
	When it is completely full	89	27.0	22.0	32.0
Is the treatment of HCW necessary?	No	15	4.6	2.7	7.3
	yes	**312**	**95.4**	**92.7**	**97.3**
Untreated(infectious) HCW should be stored for?	24 hours	242	74.0	69.1	78.5
	48 hours	15	4.6	2.7	7.3
	72 hours	8	2.4	1.2	4.6
	>72 hours	2	0.6	0.1	1.9
	It depends on the climate	**37**	**11.3**	**8.2**	**15.3**
	It depends on the type of waste	6	1.8	0.8	3.7
	It should not be stored	17	5.2	3.2	8.0
Can diseases (hepatitis B and C, HIV) be transmitted	I don't know	11	3.4	1.8	5.7
	No	13	10.1	7.2	13.7
	Yes	**283**	**86.5**	**82.5**	**89.9**

through HCW?					
	I don't know	6	1.8	0.8	3.7
Does the wearing	No	3	0.9	0.3	2.4
of PPE reduce the	**Yes**	**318**	**97.2**	**95.0**	**98.6**
risk of infection?	I don't know	73	22.3	18.1	27.1
Is there an existing	No	18	5.5	3.4	8.4
national guideline	**Yes**	**236**	**72.2**	**67.1**	**76.8**
for HCWM?	I don't know	84	25.7	21.2	30.6
Is there any	No	38	11.6	8.5	15.4
specific guideline	**Yes**	**205**	**62.7**	**57.4**	**67.8**
for HCWM in this HF?					
Is there a	I don't know	89	27.2	22.6	32.2
record/register for	No	132	40.4	35.2	45.8
HCWM in this	**Yes**	**106**	**32.4**	**27.5**	**37.6**
unit/HF?					
KNOWLEDGE	**Poor**	42	12.8	9.5	16.8
LEVEL	**Average**	89	27.2	22.6	33.2
	Fairly good	147	45.0	39.6	50.4
	Good	49	15.0	11.4	19.2

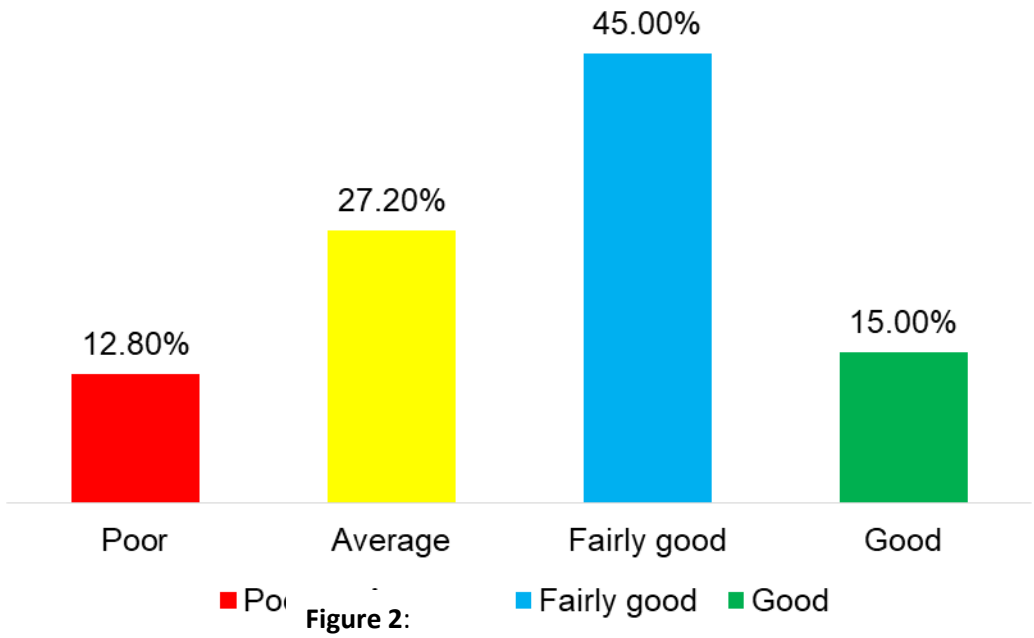

Figure 2: Overall knowledge on HCWM

Objective 2: Evaluation of Healthcare Waste Management Practice

Waste collection and segregation: From the 15 health facilities surveyed, 14(93.3%) had wastes collecting bins amongst which only 10(66.7%) lined them with garbage bags. Only 2(13.3%) of health facilities were noticed of displaying biohazard symbol on some of their waste collecting bins. It was observed that, all of these health facilities 15(100%) do not segregate waste according to the color coding system.

Waste transportation: 6(40%) of these HF's transported infectious and non-infectious waste separately as recommended by norms and only 2(13.3%) used a will barrow as their transportation medium which was quite appropriate. It was observed that the use of PPE was applied in 9(60.0%) of the 15 HFs in this study.

Waste storage: 2(13.3%) facilities had a temporal waste storage site/room.

Treatment and disposal: All 15(100%) of these health facilities don't treat/disinfect infectious waste before disposal. 8(53.3%) of the surveyed health facilities had an incinerating unit, 12(80%) had a landfill site and 10(66.7%) had a placenta burry pit. Provision of waste bins by the council for waste disposal was done only in 1 (6.7%) health facility.

Overall, 53.30% health facilities practiced poor healthcare waste management while 46.7% practiced good healthcare waste management. This can be seen in table 3 below.

Table 3: Evaluation of healthcare waste management practice

Variable	Modality	Frequency(n)	Percent(%)	95% LCI	95% UCI
A container or bin for collecting waste	No	1	6.7	0.7	27.2
	Yes	**14**	**93.3**	**72.8**	**99.3**
Containers lined with garbage bag	No	5	33.3	14.0	58.4
	Yes	**10**	**66.7**	**41.6**	**86.0**
Waste segregation performed	No	11	73.3	48.3	90.3
	Yes	**4**	**26.7**	**9.7**	**51.7**
Waste segregation performed according to color coding	No	15	100.0		
Biohazard symbol displayed on the container	No	13	86.7	56.3	94.0
Containers closed with a lid	**Yes**	**2**	**13.3**	**2.9**	**36.3**
	No	3	20.0	6.0	44.4
Waste treated before disposal	**Yes**	**12**	**80.0**	**55.6**	**94.0**
Presence of a waste storage unit	No	15	100.0		
	No	13	86.7	63.7	97.1
Presence of an incinerating unit	**Yes**	**2**	**13.3**	**2.9**	**36.3**
	No	7	46.7	23.9	70.6

Presence of a landfill site	**Yes**	**8**	**53.3**	**29.4**	**76.1**
	No	3	20.0	6.0	44.4
Presence of a burry pit	**Yes**	**12**	**80.0**	**5.6**	**94.0**
	No	5	33.3	14.0	58.4
Council provide waste bin for the disposal of general waste	**Yes**	**10**	**66.7**	**41.6**	**86.0**
	No	14	93.3	72.8	99.3
Use of PPE	**Yes**	**1**	**6.7**	**0.7**	**27.2**
	No	6	40.0	18.8	64.7
Waste transportation	**Yes**	**9**	**60.0**	**35.3**	**81.2**
	Joined	9	60.0	35.3	81.2
Responsible for transporting waste	**Separately**	**6**	**40.0**	**18.8**	**64.7**
	Cleaners	**11**	**73.3**	**48.3**	**90.3**
	Nurse	3	20.0	6.0	44.4
Means of waste transportation within the health facility	Staff	1	6.7	0.7	27.2
	Manually	13	86.7	63.7	97.1
PRACTICE	**will barrow**	**2**	**13.3**	**2.9**	**36.3**
	Good	7	46.7	23.9	70.6
	Poor	8	53.3	29.4	76.1

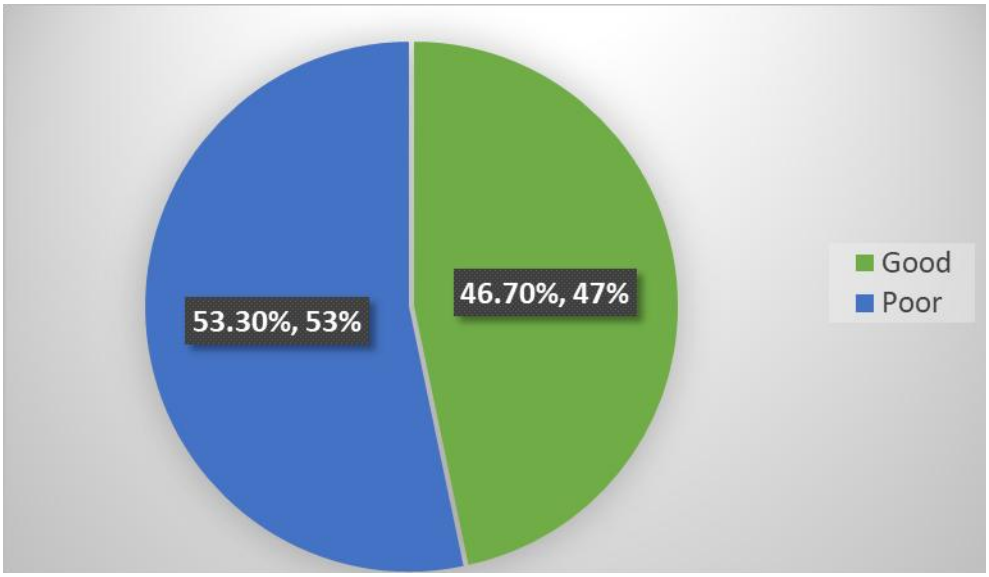

Figure 3: Overall practice on HCWM

Objective 3: Probl Implementation of Healthcare Waste Management

The table below shows the problems faced by healthcare workers of the surveyed health facilities in implementing appropriate healthcare waste management. The non-respect of HCWM guideline 136(41.6%), lack of manpower 134(41.0%) were the main bottlenecks

followed by lack of equipment 88(26.9%), lack of a waste treatment facility 83(25.4%), budget constraints 76(23.2%) and lack of supervision 72(22.0%).

Table 4: Problems faced with implementation of HCWM

Variable	Modality	Frequency(n)	Percentage(%)	95% LCI	95% UCI
	Non-respect of	**210**	**64.2**	**58.9**	**69.3**
Problems faced with health care waste management implementation	HCWM guideline	136	41.6	36.3	47.0
	Lack of manpower	134	41.0	35.7	46.4
	Lack of storage facility	67	20.5	16.4	25.1
	Lack/poor compliance of waste treatment facility	83	25.4	20.9	30.3
	Budget constraints	76	23.2	18.9	28.0
	Lack of equipment	88	26.9	22.3	31.9
	Lack of supervision	72	22.0	17.8	26.7

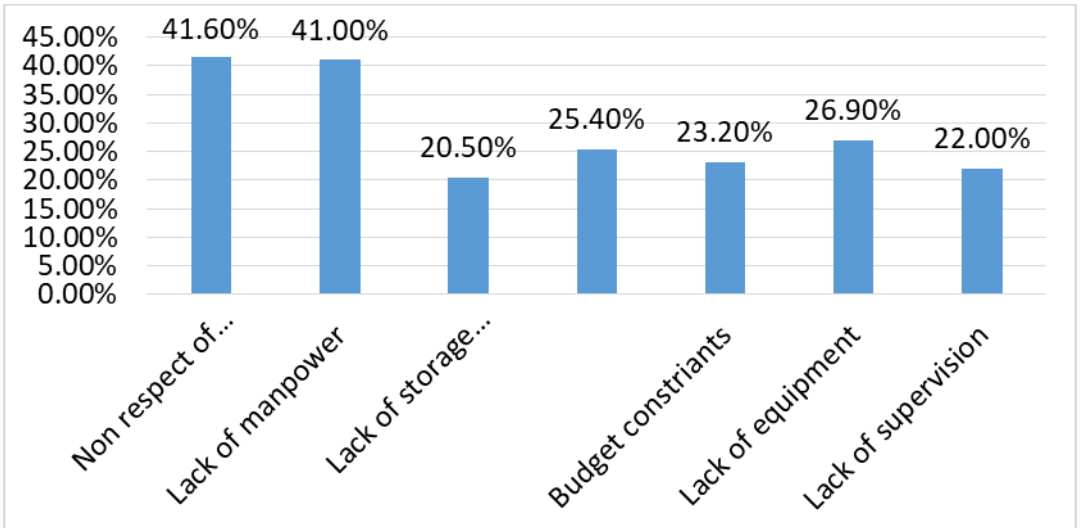

Figure 4: problems faced with the implementation of HCWM

Objective 4: Factors associ evel and practice on HCWM

i) Factors Associated t On Healthcare Waste Management

After carrying out statistica he dependent variable (knowledge) and the independent variables (sociodemographic characteristics), we found out Statistical significant

associations between knowledge and level of education ($p = 0.002 < 0.05$), knowledge and training on healthcare waste management ($p = 0.001 < 0.05$).

Table 5: Sociodemographic factors associated to knowledge on HCWM

Variable	modality	Knowledge		Chi-2	p-value
		Poor	good		
Sex	Female	28	221		
	Male	14	64	2.38	0.123
Age	>50 years	2	18		
	20-30years	18	136	0.653	0.884
	31-40years	15	90		
	41-50years	7	41		
Level of education	Bachelor's	15	88		
	degree	1	11		
	Bachelor's				
	degree in	17	62	11.72	**0.002**
	medicine	8	108		
	Certificate	1	16		
Working experience	Diploma	3	51		
	Masters/PhD	28	146		
	>12years	8	52	5.14	0.162
	0-4years	3	36		
Health facility	5-8years	10	97		
Category	9-12years	10	64	2.01	0.572
	3rd	9	56		
	4th	13	68		
Received training	5th	33	148		
On HCWM	6th	9	137	10.51	**0.001**
	No				
	yes				

ii) Association Between Healthcare Waste Management Practice and Health Facility Category

The cross tabulations carried out between the dependent variable, practice and the independent variable, health facility category revealed marginal statistical significant association as ($p = 0.101 > 0.05$). Hence, HCWM does not depend on HF category.

Table 6: Association between category of health facility and knowledge on HCWM

Variable	Modality	Practice on HCWM		Chi-square	P-value
		Good	poor		
Category of health facility	3rd	1	0		

	4th	1	0	6.23	**0.101**
	5th	2	0		
	6th	3	8		

Discussion

Since healthcare workers play an important role in regulating healthcare waste disposal, it is important to have a high level of awareness. This emphasizes the importance of evaluating the knowledge and practice of healthcare workers with respect to HCWM and the factors that influence them, as well as the problems faced in implementing proper HCWM.

Characteristics of Respondents

The most represented sex were females (76.1%) which was also the case (54.1%) and (53.1%) in a study conducted by Letho et al (2021) and Assemu et al (2020) [7, 11]. Concerning the level of education, a majority (35.5%) of participants had diploma which was consistent to (32.9%) obtained in a study conducted by Letho et al (2021), lesser than 97.3% and 67.3% in a study conducted by Omoleke in Nigeria (2021), and Gizawel et al (2021) [11–13]. The gaps observed can be explained by the similarities and the differences in the target populations and sample size used in these studies. The low training level (44.6%) was in line with (43.2%) obtained by Letho et al (2021) and Assemu et al (2020) [7, 11]. It was also lower than (84.5%, 54.87% and 54.4%) respectively, obtained by Abalkhail et al (2021), Lohani et Dixit (2021) Alemayehu et al (2016) [14–16]. The gaps could be due to the difference in availability and utilization of HCWM guidelines across the different categories of facilities as said by Deress et al (2018) [4].

Knowledge on HCWM

Knowledge is an essential resource in health science, and inadequate knowledge may lead to improper application that may be detrimental to any healthcare organization [17]. The results obtained revealed that (15.0%) of participants had good knowledge on HCWM which was lesser than; (56.6%) obtained by Deress et al (2018), (26.3%) obtained by Abalkhail et al (2021) and (72.2%) obtained by Assemu et al (2020) These gap observed could be due to inadequate training on HCWM [4, 7, 14].

Factors associated to knowledge on HCWM

Concerning factors associated to knowledge in the chi-squared statistical analysis; sex, age, work experience, category of health facility and vaccination status were marginal as their ($p > 0.005$). Similar results obtained were obtained by Thirunavukkarasu et al (2022) [17]. Education level ($p = 0.002 < 0,005$) and training ($p = 0.001 < 0,005$) showed statistical significant associations with knowledge. similar to a survey conducted by Deress et al (2018) [4]. This therefore implies that training is a key factor to having good knowledge on healthcare waste management.

HCWM Practice

Practice was evaluated with the help of an observational checklist and by carrying out transect walks within the health facility premises. It was noticed that Overall 7(46.7%) of the surveyed health facilities practiced good HCWM. This could be due to lack of training, non-respect of the National (Cameroon) and/or International IPC guideline. Similar findings were not really found on HCWM practice based on health facility in correspondence.

Factors associated to HCWM practice

Marginal statistical significant association was found between practice and the different categories of health facilities as (p-value = 0.101 > 0.05). This implies HCWM practice does not depend on the category of HF and thus, health care waste management should be practiced appropriately irrespective of the category of HF. Similar findings were not found between HCWM practice and the category of HF.

a) Waste collection and segregation: 14(93.3%) of the health facilities had appropriate waste bins for collecting waste that were placed in strategic positions amongst which 10(66.7%) lined their bins with garbage bags which was contradictory to a study conducted by Lanyuy et al (2017) in Cameroon and Letho (2021) [8, 11]. Although waste segregation is the most critical step in HCWM, the waste segregation rate in our survey was poor as only 4(26.7%) of the sampled health facilities practiced proper segregation of infectious and non-infectious waste at the point of waste generation and disposal. This was in line to results obtained 2(20%) by Meleko et al (2018) and lower than (64.5%) in a study conducted by Gizalew et al [5, 12]. It was worth noting that all the HF's practiced proper segregation of sharp waste to an extent as syringes were disposed in a safety box.

Also, neither of the health facilities performed waste segregation according to color coding. A majority of participants did not understand what color coding is all about. this was in line with results obtained by Meleko et al (2018), where only 1(10.0%) of the sampled health facilities had coded or marked bins. This finding agreed with similar finding carried out by Omoleke (2021) It was also reported in a study conducted by Lanyuy et al (2017) where neither of the bins were lined with garbage bag nor were they color coded [5, 8, 13]. This is a clear indication of training deficit, non-availability/insufficiency of the different color coded bins in local markets and lack of funds, as confirmed by a sanitary engineer from one of the surveyed HFs.

b) Waste transportation: Transportation of healthcare waste from point of generation to final waste disposal site was mostly done manually (86.7%) by cleaners/sanitary engineer/nurse. will barrows be seldom and this was observed to be used in two health facilities 2(13.3%) only. This result was almost similar to that obtained by Lanyuy et al (2017) in the Kumbo health districts of Cameroon where (96.7%) of HFs transported waste by hand lifting, also only 3.3% of facilities used a trolley. Tsamo et al (2017) also made mention of this aspect in his study [6, 8].

c) Waste treatment and disposal;

i) Incineration: Disposal of sharp waste and highly infectious waste and at times expired drugs was done using an incinerator of which 8(53.3%) out of 15 surveyed HFs had a local incinerator. 1 amongst the 8 HFs had a modern incinerator that was environmentally friendly. Results obtained was compared to results obtained in Ghana by Adu et al (2020) [18] where 4

out of 5 of the HFs surveyed had an incinerator installed for burning infectious waste. Only modern incinerators operating at 850-1100 °C and fitted with special gas-cleaning equipment are able to comply with the international emission standards for dioxins and furans WHO [19]. The modern incinerator was not used most often because of insufficient financial resources to maintain its functioning. Incinerators in our study site were locally constructed with brick and did not meet the guidelines and contributed to air pollution endangering the lives of the nearby population. Ash from these incinerators were disposed in pits and could leach into the ground polluting underground water this was similar to a study Conducted by Lanyuy et al (2017) in Kumbo and by Veronica et al(2011) in the South west region of Cameroon .[8, 10]**.**

ii) Landfill sites and open dumbs: Most disposed non segregated wastes in landfill sites 12(80%) and open community dumps. This could be due to the fact that incinerators were not enough to accommodate all the infectious wastes generated. Some of the HFs that didn't have a landfill site, used community open dumps, by the road side to dispose their non-segregated waste. This act is contagious and exposes nearby inhabitants and scavengers at high risk of infection. This similar aspect was also observed in a survey by street et al (2022) on Diagnostic waste. [20]. Open dumping has long been recognized as a potential source of public health and environmental problems, because of its inherent problems such as leakage of toxic substances into the environment; easily accessed by insects, rodents and other small animals, most of which are disease vectors. Tsamo et al (2017) and Veronica et al(2011) [6, 10].

Problems Faced

The main problems reported with HCWM implementation were; non-respect of HCWM guidelines (41.6%), and lack of manpower (41.0%). Lack of equipment (26.9%), lack of waste treatment facility (25.4%), budget constraints (23.2%) and lack of supervision, (22.0%) were the least reported problems faced with HCWM implementation. This result is contradictory to the previous finding in a study conducted by Dixit et al (2021) *[21]* as the least reported problems in their study happens to be the most reported problems cited in our study. This might be due to absence of sensitization of health professionals on HCWM. Similar findings on problems faced with healthcare waste management implementation were limited.

Overall, results obtained from our study were similar to results obtained by Veronica E.Manga et al (2011) [10] in a study conducted on HCWM in the SWR of Cameroon and in line with results obtained from several studies in Africa revealing that HCWM is ineffective.

Conclusion

The overall findings of this study revealed that,

- (12.8%) of surveyed healthcare workers had poor level knowledge; (27.2%) average level knowledge, (45.0%) had fairly good level knowledge and (15.0%) had good level knowledge on HCWM.

- HCWM Practice was poor as only (46.70%) practiced good healthcare waste management methods.
- The 2 main Problems faced with HCWM implementation were; non-respect of HCWM guidelines (41.6%) and lack of manpower (41.0%).
- Statistically signification associations (p-value < 0.005) were found between level of education (0.020) and training (0.001) with knowledge on HCWM.
- Marginal significant associations were found between health facility category and healthcare waste management practice.

From the gaps observed in our study, we noticed that an appreciable percentage of healthcare workers (50.2%) knew what HCWM was but did not practice appropriate healthcare waste management which could have been because of; ignorance due to their level of education, lack/inadequate training on HCWM, and problems faced such as non-respect of HCWM guidelines. We can therefore conclude that, HCWM practice did not meet norms and does not depend on the health facility category.

Recommendations

Given the public health and environmental implications of sub-optimal HCWM in health facilities in the Limbe health district, we recommend;

- **the study participants:** To respect HCWM guidelines, to practice appropriate HCWM methods in health facilities
- **the Infection prevention controller:** To sensitize healthcare workers on the importance of HCWM and the effects of its poor implementation to human health and the environment, to train healthcare workers on HCWM**,** to carry out proper supervision of HCWM
- **the health facility heads (director/COCs):** To prioritize HCWM and allocate budget for healthcare waste management in the health facility, to employ more staffs (cleaners)
- **public health officials:** To reinforce HCWM guidelines**,** to pay more attention and prioritize HCWM, to include HCWM as a course of training curriculum in the medical field**.**

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