

# 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 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> categories respectively. The overall knowledge level revealed 49(15.0%) of study participants had good knowledge level and overall practice revealed 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 ( $p = 0.002$ ), training on HCWM ( $p = 0.001$ ) 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, 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 645km<sup>2</sup>, and a total population of 211,186 inhabitants for the year 2022 with 8 health areas (Zone II, Bota, Seaport, Idenau, Bojongo, Bota, Moliwe, Mabet). Data was collected for a period of 83 days, from March 10<sup>th</sup> 2023 to May 31<sup>st</sup> 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;

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

**P = (29.3%)** proportion of health professionals that safely practiced health-care waste management in a previous study carried out in Ethiopia on HCWM and risk factors amongst health professionals [11]

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

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 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> categories in the Limbe health district found across different health areas were selected by convenience. Secondly, health facilities of 6<sup>th</sup> category were selected by simple random sampling where a total of 11 health facilities of 6<sup>th</sup> category across different health areas were included. (Limbola IHC, Batoke IHC, Mokunda IHC, Bota CDC clinic, Victoria hope foundation clinic, Moliwe CDC HC, Bimbria 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 ( $\leq 50\%$ ) of the 12 practical questions correctly

**Good practice:** health facilities that answered ( $\geq 50\%$ ) 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 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> 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	
<b>Sex</b>	<b>Female</b>	<b>249</b>	<b>76.1</b>	<b>71.3</b>	<b>80.5</b>	
	Male	78	23.9	19.5	28.7	
<b>Age</b>	>50 years	20	6.1	3.9	9.1	
	<b>20-30 years</b>	<b>154</b>	<b>47.1</b>	<b>41.7</b>	<b>52.5</b>	
	31-40 years	104	32.1	26.9	37.0	
	41-50 years	48	14.7	11.2	18.8	
<b>Level of education</b>	Bachelor's degree	105	32.1	27.2	37.3	
	Bachelor's degree in medicine	10	3.1	1.6	5.4	
	Certificate	79	24.2	19.8	29.0	
	<b>Diploma</b>	<b>116</b>	<b>35.5</b>	<b>30.4</b>	<b>40.8</b>	
<b>Working unit</b>	Masters/PHD	17	5.2	3.2	8.0	
	Anesthetist	1	0.0	0.0	0.0	
	ANC	13	3.0	2.0	6.0	
	COVID-19 center	2	0.0	0.0	1.0	
	Emergency	17	5.0	3.1	7.0	
	Laboratory	43	13.0	9.0	17.0	
	Maternity	48	14.0	11.0	18.0	
	Medical	38	11.0	8.0	15.0	
	Mortuary	1	0.0	0.0	0.0	
	<b>OPD</b>	<b>69</b>	<b>21.0</b>	<b>16.0</b>	<b>25.0</b>	
	Others	58	17.0	13.0	22.0	
	Pediatrics	22	6.0	4.0	9.0	
	Surgical	14	4.0	2.0	6.0	
	X-ray	1	0.0	0.0	0.0	
	<b>Profession</b>	Anesthetist	1	0.0	0.0	0.0
		Cleaner	36	11.0	7.0	14.0
		Doctor	19	5.0	3.0	8.0
Lab scientist		1	0.0	0.0	0.0	
Lab technician		51	15.0	11.0	19.0	
Microbiologist		1	0.0	0.0	0.0	
Midwife		13	3.0	2.0	6.0	
Mortuary attendant		1	0.0	0.0	0.0	
<b>Nurse</b>		<b>157</b>	<b>48.0</b>	<b>42.0</b>	<b>53.0</b>	
Nurse's assistant		42	12.0	9.0	16.0	
Sanitary engineer		2	0.0	0.0	1.0	

	Sonographer	3	0.0	0.0	2.0
<b>Working experience (years)</b>	>12	54	16.5	12.8	20.8
	<b>0-4</b>	<b>174</b>	<b>53.2</b>	<b>47.8</b>	<b>58.6</b>
	5-8	60	18.3	14.4	22.8
	9-12	39	11.9	8.8	15.8
<b>Vaccination status</b>	Hepatitis B only	79	24.2	19.8	29.0
	Hepatitis B, Tetanus	72	22.0	17.8	26.7
	None of the above	108	33.0	28.1	38.3
	Tetanus only	68	20.8	16.7	25.4
<b>Received training on HCWM</b>	No	181	55.4	49.9	60.7
	<b>Yes</b>	<b>146</b>	<b>44.6</b>	<b>39.3</b>	<b>50.1</b>

### **Objective 1: Knowledge of 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
<b>What is HCWM?</b>	The collection, treatment, transportation and disposal of HCW	117	35.8	30.7	41.1
	<b>The generation, segregation, transport, treatment and disposal of HCW</b>	<b>164</b>	<b>50.2</b>	<b>44.8</b>	<b>55.6</b>
	The processing and recycling of HCW	29	8.9	6.1	12.3
<b>Who should be in charge of HCWM?</b>	Director of hospital	17	5.2	3.2	8.0
	Doctor	38	11.6	8.5	15.4
	Nurses	35	10.7	7.7	14.4
	IPC officer	7	2.1	1.0	4.2
	Patients	45	13.8	10.4	17.8
	Interns	165	50.5	45.1	55.9
	Cleaners	24	7.3	4.9	10.5
		26	8.0	5.4	11.3
		40	12.2	9.0	16.1
		86	26.3	21.8	31.3
<b>Does segregation reduce the cost of HCWM?</b>	Staffs	<b>64</b>	<b>19.6</b>	<b>15.6</b>	<b>24.1</b>
	<b>All of the above</b>	<b>246</b>	<b>75.2</b>	<b>70.3</b>	<b>70.7</b>
	I don't know	28	8.0	5.0	11.0
<b>When is waste discarded from the bin?</b>	No	88	26.0	22.0	12.0
	<b>Yes</b>	<b>122</b>	<b>37.0</b>	<b>32.0</b>	<b>42.0</b>
	So far as waste is in the bin	89	27.0	22.0	32.0
<b>Is the treatment of HCW necessary?</b>	When it is ½ full	15	4.6	2.7	7.3
	<b>When it is ¾ full</b>	<b>312</b>	<b>95.4</b>	<b>92.7</b>	<b>97.3</b>
	When it is completely full	242	74.0	69.1	78.5
	No	15	4.6	2.7	7.3
<b>Untreated(infectious) HCW should be stored for?</b>	yes	8	2.4	1.2	4.6
	24 hours	2	0.6	0.1	1.9
	48 hours	<b>37</b>	<b>11.3</b>	<b>8.2</b>	<b>15.3</b>
	72 hours	6	1.8	0.8	3.7
	>72 hours	17	5.2	3.2	8.0
	<b>It depends on the climate</b>	11	3.4	1.8	5.7
	It depends on the type of waste	13	10.1	7.2	13.7
<b>Can diseases (hepatitis B and C, HIV) be transmitted</b>	It should not be stored	<b>283</b>	<b>86.5</b>	<b>82.5</b>	<b>89.9</b>
	I don't know				
	No				
	Yes	6	1.8	0.8	3.7
		3	0.9	0.3	2.4

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

## 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
	Yes	2	13.3	2.9	36.3
Containers closed with a lid	No	3	20.0	6.0	44.4
	Yes	12	80.0	55.6	94.0
Waste treated before disposal	No	15	100.0		
Presence of a waste storage	No	13	86.7	63.7	97.1

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

### Objective 3: Problems Faced with The 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
Problems faced with health care waste management implementation	Non-respect of 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

**Objective 4: Factors associated to knowledge level and practice on HCWM**

**i) Factors Associated to Knowledge Level On Healthcare Waste Management**

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

**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 Chi-	P-value
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Category of health facility	3 <sup>rd</sup>	HCWM		square	
		Good	poor		
	4 <sup>th</sup>	1	0	6.23	<b>0.101</b>
	5 <sup>th</sup>	1	0		
	6 <sup>th</sup>	2	0		
		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, 12]. 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, 12]. 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 ( $p\text{-value} = 0.101 > 0.05$ ). 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, 12]. 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, 11]. 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 significant 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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