



# **Assessment of Waste Management Services in Public and Private Facilities at the Three Levels of Healthcare Delivery, in Enugu State**

**A. T. Chinawa<sup>1\*</sup>, N. Onwasigwe Chikaodili<sup>2</sup>, J. M. Chinawa<sup>2,3</sup>, T. C. Asogwa<sup>1</sup>  
and K. C. Uchegbu<sup>2</sup>**

<sup>1</sup>*Enugu State University Teaching Hospital, Enugu State, Nigeria.*

<sup>2</sup>*College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria.*

<sup>3</sup>*Department of Paediatrics, Enugu State University Teaching Hospital, Enugu State, Nigeria.*

<sup>4</sup>*University of Nigeria Teaching Hospital, Ituku- Ozalla, Enugu, Nigeria.*

## **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors ATC and JMC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ATC and NOC managed the analyses of the study. Authors ATC, JMC and NOC managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Background:** Improper and uncoordinated healthcare waste management (HCWM) practice exposes the healthcare worker, patients and surrounding communities to several morbidities and mortality from nosocomial infections.

**Objectives:** This study aims at assessing waste management services in public and private healthcare facilities at the three levels of healthcare delivery in Enugu State.

**Methods:** A cross-sectional study using quantitative and qualitative data collection methods involving healthcare workers and healthcare facilities (public and private) at the three levels of care in Enugu state. The study comprised of a total of 23 health facilities and 362 health workers drawn from the three levels of healthcare for private and public facilities.

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 16.0. Chi-square test was used to compare the proportion of healthcare workers with adequate knowledge of HCWM. A significance level of  $p < 0.05$  was used for statistical calculations. Results: One hundred and eighty (47.5%) of the respondents knew the correct steps for HCWM. Most respondents 355(93.7%) admitted that there is associated risk in handling waste. About 147 (38.8%) sustained injury while they had contact with waste out of which 57(38.8%) have had this injury more than three times. The presence of written strategy was higher in public facilities compared to private facilities ( $\chi^2 = 1.446$ ;  $p = 0.485$ ), The access to it was highest in the unit ( $\chi^2 = 1.027$ ;  $p = 0.311$ ). The frequency of waste collection was highest on a daily basis in both private and public facilities. Waste measurement and segregation were also observed to be higher in public than private facilities ( $\chi^2 = 1.434$ ;  $p = 0.488$  and  $\chi^2 = 1.644$ ;  $p = 0.440$  respectively). More public facilities segregated their waste at source compared to private facilities and this was statistically significant ( $\chi^2 = 13.875$ ;  $p = 0.008$ ).

**Conclusion:** The frequency of waste collection was highest on a daily basis in both private and public facilities. However, waste measurement and segregation were observed to be higher in public than private facilities. More public facilities segregated their waste at source compared to private facilities. There seems to be a gap in communication among those involve in health management waste. The health personnel despite level of education and cadre, have poor knowledge of the risk associated with healthcare waste.

**Keywords:** *Healthcare waste management practice; healthcare worker; Enugu State; healthcare facilities.*

## ABBREVIATIONS

HCW	: Health Care Waste
HCWM	: Health Care Waste Management
WHO	: World Health Organization
HCF	: Health Care Facilities
LGAS	: Local Government Authorities
ESWAMA	: Enugu State Waste Management Agency
SPSS	: Statistical Package For Social Sciences
PPE	: Personal Protective Equipment
IDI	: In Depth Interviews

## 1. INTRODUCTION

Healthcare waste (HCW) is generated from both public and private healthcare facilities (HCFs). Healthcare waste in healthcare facilities can be classified as major or minor sources depending on the volume of healthcare waste generated. Major sources include public health facilities, while small sources come mainly from private health facilities [1].

Health service provision in Nigeria includes a wide range of providers in both the public and private sectors, such as public facilities managed by federal, state and local governments, private – for-profit providers, non-governmental organizations (NGOs), community based and faith based organizations, religious and traditional care giver [2].

The proper management of HCW depends to a large extent on strong HCF administration and

organization. Healthcare waste generation depends on other varieties of factors, such as established waste management methods; type of healthcare establishments, the proportion of patients treated on a daily basis and the level of complexity and degree of specialization of the health facility [3].

Hospital waste management is an essential part of healthcare delivery. Poorly managed hospital waste exposes healthcare workers, waste handlers and the community to infections, toxic effects and injuries and may damage the environment [4,5,6].

The knowledge of waste handler as well as their perception of risks associated with HCW in the healthcare facilities will ultimately affect practice. Healthcare facility (HCF) administration for public and private sectors will consider the importance of their worker's safety as paramount to establish

systems for the frequent training, regulation, enforcement and awareness as well as provide safety mechanisms in the work environment [7].

Studies have documented poor knowledge on waste management as well as poor personnel on waste management. For instance, a study done in the Department of Community Medicine, Army Medical College, Rawalpindi, Pakistan regarding the awareness of health hazards for sanitary workers, concluded that none of the sanitary workers ever received any training and were aware of the risks and hazards associated with handling of wastes. Another study revealed that no sanitary worker had good knowledge of healthcare waste disposal in the HCFs and 71.4% of HCF disposed of their waste in public dustbins while another study revealed low levels of training and awareness of waste legislation is prevalent among staff [8-11].

Furthermore, a study by Akinyele et al. [12], in Ibadan, noted the importance of composting, reusing and recycling hospital waste. They recommended the need to maintain a sustained cooperation among the government, hospitals and waste managers. Besides, Muluken et al. [13], in Ethiopia, noted that among 260 healthcare workers drawn from 11 healthcare facilities, majority of healthcare workers did not practice healthcare wastes management.

Awodele et al. [14] in Lagos, noted that though awareness of proper waste management amongst health workers were high, however most hospitals still mixes municipal and hazardous wastes.

This study assessed healthcare waste management practices at the facilities in the three levels of healthcare as well as detect if there are discrepancies in public and private HCFs

Importance of this study to society is that it will help to enlighten the general public on the hazards and making them more actively involved in protecting their environment from healthcare waste.

This study aims at assessing waste management services in public and private healthcare facilities at the three levels of healthcare delivery in Enugu State as well as to determine knowledge and perception of healthcare workers regarding healthcare waste.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was conducted in 5 local government areas of Enugu state. The state comprises 17 legally constituted Local Government Authorities (LGAs) and operates a district health system in an attempt to integrate all levels of service delivery.

The total number of public health facilities is 438 while that of the private health facilities is 489.

Enugu State waste management agency (ESWAMA) established through Law No. 8 of 2004 is the body responsible for the management of solid and liquid wastes in Enugu state. This it does by the collection, removal and disposal of all classes of wastes including healthcare waste.

### 2.2 Study Design

A cross-sectional study using quantitative and qualitative data collection methods was conducted involving healthcare workers and healthcare facilities (public and private) at the three levels of care in Enugu state.

### 2.3 Study Population

This comprised of the public and private healthcare facilities at the three levels of healthcare, and healthcare workers in these facilities. A total of 23 health facilities were used for the study each drawn from the three levels of healthcare for private and public facilities.

### 2.4 Sample Size Determination

Using the formula for studying proportions of more than 10,000 persons [15].

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

This minimum sample size of 362 healthcare workers was obtained with formula above.

### 2.5 Sampling Technique

For the quantitative aspect of the study, a multistage sampling technique was utilized. Five

LGAs (Awgu LGA, Enugu East LGA, Enugu South LGA, Nkanu West LGA and Nsukka LGA) were selected by simple random sampling procedure from the 17 LGAs. In each of the selected 5 LGAs, two secondary healthcare facilities (1 public and 1 private) and two primary healthcare facilities (1 public and 1 private) were selected by simple random sampling bringing it to a total of 20 HCFs. Three tertiary facilities (2 publics and 1 private) were also selected by simple random sampling procedure. The different cadres of healthcare workers (respondents) were obtained proportionately from the selected healthcare facilities by simple random sampling method to make up the minimum sample size. The cadres of healthcare staff selected were doctors, nurses, laboratory staff and waste handlers (cleaning staff).

## 2.6 Study Instruments

A pre tested semi-structured self/interviewer administered questionnaire was used. This assessed the knowledge and perception of healthcare workers with respect to healthcare wastes, HCWM and factors that influence practices. Other tools utilized were observational check list and interview guide.

## 2.7 Check List

A standardized checklist was used to assess the waste management performance of the 23 healthcare facilities and consisted of six characteristic waste management descriptors and 27 indicators of HCWM<sup>45</sup>. Research assistants were trained to observe the various activities, structure and equipment as well as cite available documents related to HCWM.

## 2.8 Interview Guide

This instrument was utilized to conduct in-depth interviews of key respondents which were drawn from top administrative and management staff in all the selected HCFs. A standard operating procedure (SOP) was developed stating clearly the preambles introductions and duration of each interview.

## 2.9 Data Analysis

Data were collated and analyzed using Statistical Package for Social Sciences (SPSS) version 16.0. Results were presented as frequency tables, texts, percentages and proportions.

Chi-square test was used to analyze both qualitative and discreet quantitative variables in the study. A significance level of  $p < 0.05$  was used for statistical calculations. Chi square test was used to compare the proportion of healthcare workers with adequate knowledge of HCWM; accessibility of HCWM documents to healthcare workers was also analyzed. Compliance by the facilities to the standard as regards conditions and steps of waste handling were compared to show sustainability of waste management system.

Qualitative data was completely captured by the note takers and tape records, transcribed in English language within 24 hours or as soon as possible. Knowledge of healthcare waste management was scored using a 21-point scale and based on this knowledge was categorized into 3: poor (<8.4 points), fair (8.4-12.6points), and good (>12.6points).

## 3. RESULTS

Waste management services in public and private health facilities at the three levels of healthcare delivery in Enugu State were assessed. A total of 379 healthcare workers responded to the questionnaires while 23 heads of health facilities were interviewed to obtain insight into their practice of healthcare waste management.

### 3.1 Section A: Findings from Questionnaire

Table 1 shows the socio demographic characteristics of the respondents. There were more female health workers 233 (61.5%) compared to the males. Majority of the respondents 169 (44.6%) were between the ages of 30 and 39 years. Most of the respondents 137(36.1%) were nurses while the least 38(10.0%) were laboratory scientists. Majority of the respondents 186 (49.1%) have been employed for less than 5 years closely followed by 81(21.4%) respondents employed for 5 to 10 years. Two hundred and thirty-five (62.0%) of the health workers had attained tertiary education with only 12(3.2%) attaining post graduate level of education

Table 2 shows the knowledge of the health workers regarding healthcare waste management. Only 194(51.2%) of the respondents have received any form of training on HCWM out of which 120(61.9%) have had

this training only once. One hundred and eighty (47.5%) of the respondents knew the correct steps for HCWM. Most respondents 355(93.7%) admitted that there is associated risk in handling waste. Majority of respondents 285(80.0%) identified HIV as risk associated with HCWM. Regarding knowledge of personal protective equipment (PPE), the most common PPE cited by respondents were gloves, face mask and boots.

Table 3 shows that all health workers studied had fair or poor knowledge of healthcare waste management where waste handlers have poor and highest score was seen amongst doctors and laboratory scientists. Table 4 shows the perception of the health worker on risks associated with healthcare waste. Most of the respondents 348 (91.8%) perceived that improper HCWM leads to infection. About 147 (38.8%) sustained injury while they had contact with waste out of which 57(38.8%) have had this injury more than three times. Nature of injury revealed needle stick to have the highest occurrence with 57(38.8%). Of the respondents who had sustained injury while handling healthcare wastes 54(47.8%) and 53(46.9%) received HBV and tetanus toxoid vaccination respectively. Only 34 respondents reported their injury to management staff, of which 12(35.3%) were given tetanus toxoid vaccination while 3(8.8%) received no form of treatment.

Regarding knowledge of personal protective equipment (PPE), the most common PPE cited by respondents were gloves, face mask and boots. Most of the respondents 288 (76%) were willing to use PPE.

Only 122 (32.2%) of respondents attested to the presence of a written strategy in their facility, out of which 65(53.3%) have it within the facility. One hundred and sixty-five (43.5%) respondents stated that their facilities collect waste daily. One hundred and forty-nine (39.3%) of respondents said wastes are segregated in their facilities of which 61(40.9%) of them reported that the segregation of waste was at the source of production.

One hundred and thirty-nine (36.7%) respondents transported waste manually to storage site, while 197(52.0%) used plastic containers for storage in their facility. One hundred and forty-two (37.5%) of the

respondents stated that the wastes are transported to their final disposal site by the Enugu State Waste Management Authority ESWAMA.

Many 127 (33.5%) of the respondents do not know the final disposal of the segregated wastes while only 53 (14.0%) said the final disposal is by burial on the hospital ground. Only 45 (11.9%) of respondents claimed to treat their waste prior to disposal of which 25 (55.6%) treated the waste by disinfection.

The quantity of waste, contents of the waste and cultural beliefs were common factors stated as affecting waste management. The cultural beliefs of re-incarnation where patients or their relatives decide to dispose of human parts so that it is not taken up in the next life was found to be least determinant for waste handling 27(20.3%). The number of patients was cited as the commonest factor affecting the quantity of waste generated.

A comparison of factors that influence practice of HCWM as reported by respondents was done between public and private facilities. The presence of written strategy was higher in public facilities compared to private facilities ( $\chi^2 = 1.446$ ;  $p = 0.485$ ), the access to it was highest in the unit ( $\chi^2 = 1.027$ ;  $p = 0.311$ ). The frequency of waste collection was highest on a daily basis in both private and public facilities. Waste measurement and segregation were also observed to be higher in public than private facilities ( $\chi^2 = 1.434$ ;  $p = 0.488$  and  $\chi^2 = 1.644$ ;  $p = 0.440$  respectively). More public facilities segregated their waste at source compared to private facilities and this was statistically significant ( $\chi^2 = 13.875$ ;  $p = 0.008$ ).

### 3.2 Section B: Findings from Checklist

Table 5 shows the healthcare waste management practices of the 23 health facilities observed with a checklist. There were no policy documents and financial statements in all facilities studied. Also no color coding was used for the segregation of wastes in all facilities. The category of staff that handled waste were called different names while 8 (44.4%) of the facilities used cleaners and in 7(38.9%) of the facilities' nurses also performed the duties of cleaners. Only one facility (4.3%) attested to the training of their cleaning staff.

**Table 1. Socio-demographic characteristics of healthcare workers**

<b>Variable</b>	<b>Frequency (n = 379)</b>	<b>Percent (%)</b>
<b>Sex:</b>		
Female	233	61.5
Male	146	38.5
<b>Marital status:</b>		
Married	233	61.5
Single	146	38.5
<b>Age:</b>		
<20	3	0.8
20 – 29	76	20.1
30 – 39	169	44.6
40 -49	99	26.1
50 -59	30	7.9
60 -69	2	0.5
	Mean = 35.96	S.D = ±8.44
<b>Cadre of health worker:</b>		
Nurse	137	36.1
Doctor	84	22.2
Waste handler	67	17.7
Others	49	12.9
Lab – scientist	38	10.0
<b>No. of years of employment:</b>		
<5	186	49.1
5 -10	81	21.4
11 -15	21	5.5
16 – 20	18	4.7
21 – 25	15	4.0
26 – 30	9	2.4
>30	11	2.9
<b>Level of education:</b>		
Primary	34	9.0
Secondary	77	20.3
Tertiary	235	62.0
Postgraduate	12	3.2

**Table 2. Knowledge of healthcare workers regarding healthcare waste management (HCWM)**

<b>Knowledge</b>	<b>Frequency (n = 379)</b>	<b>Percent (%)</b>
Received training on HCWM	194	51.2
Frequency of training (n = 194)		
Once	120	61.9
Quarterly	40	20.6
Yearly	34	17.5
Correct steps for HCWM	180	47.5
Risks associated with HCWM: (N = 355)		
HIV	285	80.0
HBV	236	66.5
Tetanus	202	56.9
Cuts/abrasions	196	55.2
HCV	157	44.2
TB	110	30.9

**Table 3. Showing the mean knowledge score across the cadre of health workers**

Cadre	Mean knowledge score (standard deviation)
Doctors	11.7 (±2.9)
Nurses	10.62 (±3.8)
Laboratory scientists	11.7 (±3.2)
Waste handlers	6.9 (±3.4)
Others	7.7 (±4.1)

**Table 4. Perception of healthcare workers on risks associated with healthcare waste**

Perception	Frequency (n = 379)	Percent
Improper HCWM leads to infection	348	91.8
Injury in contact with waste	147	38.8
Frequency of injury (n = 147):		
Once	34	23.1
Twice	29	19.7
Thrice	27	18.4
More than three times	57	38.8
Nature of injury (n = 147):		
Needle stick	57	38.8
Cut from bottle	34	23.1
Chemical burn	13	8.8
Others	2	1.4
Action taken when injured (n = 113)		
HBV vaccination	54	47.8
TT	53	46.9
Clean with disinfectant	19	16.8
Clean wound with Jik	18	15.9
None	3	2.6
Injury reporting in facility (n = 147):		
Self medication	93	63.3
Report to management	34	23.1
None	20	13.6
Action taken by management (n = 34):		
TT	12	35.3
PEP	9	26.5
Wound cleaning	6	17.6
Drugs	4	11.8
None	3	8.8

From Table 6, only 7 (30.4%) of the facilities had placental pit for disposal of placenta and amputated limbs, 2 (8.6%) of the facilities contracted the responsibility of their waste activities to waste handling companies. The final destination of wastes in most facilities 11(47.8%) is burning of the waste.

From Table 7, the cleaning personnel were usually the least cadre of staff while nurses could also take up the responsibility of cleaning in some of the facilities. There was no form of training in all public facilities whereas only one private facility ensured the regular training of their staff ( $\chi^2 = 1.817$ ;  $p = 0.611$ ). Basic PPE were provided in most facilities ( $\chi^2 = 0.000$ ;  $p =$

0.986). Types of receptacles were majorly plastic buckets in both public and private facilities which was statistically significant ( $\chi^2 = 11.806$ ;  $p = 0.019$ ).

### 3.3 Section C: Findings from in Depth Interview

#### 3.3.1 Practice in HCFS

All respondents seemed to have a vague idea about the relevance of healthcare waste management thus did not attach much importance to the proper management of wastes in their facility. An officer-in-charge (OIC) of a public primary facility commented: "I didn't know that health waste was important."

**Table 5. Practice as observed in the 23 healthcare facilities**

Practice	Frequency (n = 23)	Percent (%)
Category of staff involved in cleaning:		
Porter	3	16.7
Cleaner	8	44.4
Nurse	7	38.9
Laborers	1	4.3
PPE provided in facility:		
Gloves alone	8	34.8
Gloves and apron	1	4.3
Gloves and mask	3	13.0
Gloves, mask, boots, apron	1	4.3
Gloves, mask, uniform	1	4.3
Gloves, uniform	1	4.3
Gloves, uniform, boots	1	4.3
None	7	30.4
Collection material:		
Plastic buckets	16	69.6
Plastic booties	3	13.0
Plastic baskets	2	8.7
Polythene	2	8.7
Safety box	9	39.1
Recycling	1	4.3
Storage:		
Waste dumped outside hospital	10	43.5
Presence of storage building	7	30.4
Open waste disposal/no storage	6	26.1
Incinerator:		
Functional	6	26.1
Not functional	3	13.0
None	14	60.9

There was no waste management team in most facilities as well as waste manager. Facilities that seemed to have such a structure existed as departments, units or sections in the facility where only one is headed by an environmental health officer, the other by a company the facility contracted their wastes management to.

No color coding was practiced, only one facility admitted to recycling of injection vials used for collection of urine or stool samples, there were no written strategies or instructional posters in all facilities except one of the tertiary HCFs which the respondent said was recently placed in the facility. No treatment of wastes was practiced; segregation of waste that was common among primary facilities in particular is that of sharps into safety boxes. Apart from that all wastes were jumbled together, including human wastes

except that placenta and occasionally amputated limbs were disposed of in pits referred to as "placenta pits".

Incinerators are mostly locally constructed, poorly maintained and some are out of use leading to the open burning obtainable in those facilities.

Final disposal for most facilities is burial while others are the municipal landfill along with other wastes from non-medical sources.

Most interviewees stated that nothing in particular was done if injury was sustained during contact with wastes. Wound cleaning with disinfectant, bleach (Jik) or both were mentioned by others as the proper practice.



**Table 6. Practice (Burial, final destination and measurement)**

<b>Practice</b>	<b>Frequency (n = 23)</b>	<b>Percent</b>
<b>Burial:</b>		
None	16	69.6
Placental pit	7	30.4
Disposal contracted out	2	8.6
<b>Final destination of wastes:</b>		
Burning	11	47.8
ESWAMA dumpster	7	30.4
Municipal landfill	5	21.7
<b>Quantity of wastes generated in the ward (grams) daily:</b>		
<500	2	28.6
500 – 5000	3	42.9
>10,000	2	28.6
<b>Quantity of waste generated in the laboratory (grams):</b>		
<500	3	42.9
500 -5000	2	28.6
5000 – 10,000	1	17.3
>10,000	1	17.3
<b>Quantity of waste generated in the office (grams):</b>		
<500	4	66.7
5000 -10,000	1	16.7
>10,000	1	16.7
<b>Quantity of total waste measured (grams):</b>		
<500	2	8.6
500 -5000	14	60.9
5000 – 10,000	2	8.6
>10,000	4	17.2

**Table 7. Healthcare waste management practice observed in public and private facilities**

<b>Practice</b>	<b>Public (n = 13 ) Frequency (%)</b>	<b>Private (n = 10 ) Frequency (%)</b>	<b><math>\chi^2</math></b>	<b>p-value</b>
<b>Cleaning personnel:</b>				
Porter	2	1		
Cleaner	4	4	1.817**	0.611
Nurses	3	4		
Labourers	0	1		
<b>PPE provided:</b>				
Yes	9	7	0.000**	0.986
No	4	3		
<b>Type of receptacles:</b>				
Plastic baskets	0	2		
Plastic bucket	12	4		
Polythene	0	2	11.806**	0.019*
Plastic booter	1	2		
Safety box	8	1		
<b>Number of waste receptacles:</b>				
1 per room	10	9		
2 per room	2	0	2.433**	0.296
3 per room	1	1		

Practice	Public (n = 13 ) Frequency (%)	Private (n = 10 ) Frequency (%)	$\chi^2$	p-value
<b>Storage:</b>				
Building	6	3		
Outside	7	3		
None/open	6	2	1.167**	0.884
Incinerator	5	1		
Placental pit	6	1		
<b>Final destination:</b>				
ESWAMA dumpster	1	6		
Burning	9	2	7.970**	0.019*
Municipal landfill	3	2		

\*Statistically significant

\*\*Chi-square with correction

#### 4. DISCUSSION

Healthcare waste management is a very important part of healthcare delivery. Proper management of healthcare waste depends to a large extent on strong healthcare facility administration and organization. Poorly managed hospital waste put healthcare workers, waste handlers and the community at risk of infections and injuries as well as damage to the environment. In this study, an assessment of waste management services was conducted to determine the knowledge and perception of healthcare workers as well as examine their practice in health facilities.

There were more health workers in public facilities than in private facilities. The females were more than males in this study as well as the observation that more nurses filled the questionnaire 36.1% of total respondents while the least were the laboratory scientist 10.0%. The ratio of waste handlers to the entire health workers is 1:5.6. Majority of the health workers have been employed for less than 5 years showing inexperience. The study revealed that 62.0% of respondents had attained tertiary level of education this goes to show that despite educational status there is a dearth of information as regards healthcare waste.

The knowledge and perception of healthcare workers regarding healthcare waste management was generally poor. The findings on knowledge of medical wastes among healthcare workers are similar to those of many other researchers e.g. a study in Libya revealed that only 25% of hospital personnel had satisfactory knowledge [13,16-18]. This poor knowledge among health workers may lead to the ineffective and inefficient management of these categories of wastes. This could be

attributed to the lack of training in most facilities as revealed from the questionnaire and in-depth interviews. Only 51.2% of respondents had received training (which further probing revealed that it was coincidental i.e. while they were trained for injection safety, mention was made of waste management) this may not be in keeping with findings from checklist as only one facility admitted to training their waste handlers. The frequency of training can also be seen as inadequate as 61.9% of those trained have been trained only once. Also a study conducted in Ibadan showed that only 14.4% of waste handlers had received training on HCWM. The findings in this study is in tandem with a study in India which showed that 33.3% of health workers at the tertiary level, 29% at the secondary level of public facilities and 17.1% in private facilities had knowledge of rules and regulations on bio-medical wastes. [18-20]. Whereas 41.3% were aware of risks associated with handling waste none had received training on healthcare waste management. About 18.2% had suffered injury while in contact with waste but none reported to higher authority. Needle stick injuries were found to be prevalent amongst healthcare staff in the facilities. Low levels of training and awareness of waste policies was prevalent among staff. There was no waste segregation in most healthcare facilities that which was observed in the few was the separation of sharps in safety boxes.

Majority of health workers are aware of PPEs and expressed willingness to use them frequently. Thus the onus lies on the management to provide these materials for the workers to protect themselves.

A total of 47.8% of facilities studied provide their health workers with gloves and masks. This in contrast with other studies where only a quarter (25%) of the facilities was providing boots to

health workers handling sharps waste, while only 10% of facilities had plastic aprons [21-23]. Only heavy duty gloves were available in 40% of the low level health facilities (LLHFs). Inappropriate use of protective gears was observed in most facilities [21-23].

The healthcare waste management practice in the health facilities from questionnaire, checklist and interviews revealed unsustainable HCWM. There were no policy documents, budgetary materials, written plan, focal waste manager, color coding in all facilities. Only sharps were segregated. Most of the respondents were not aware of written strategy nor guidelines neither do they have access to policy documents. Wastes were stored in unlabeled plastic bins and manually transported outside building, often dumped outside. Only 2 of the facilities bag their wastes as directed by the state's ESWAMA, however, majority of facilities use the plastic booties, buckets and baskets which often times are overfilled and spilling over making the storage area unsightly. Also concerning the on-site transport of waste the standard is the use of trolleys (solely for that purpose to limit contact with the waste) seen in only 11.6% of facilities. This again reveals the importance attached to handling of waste by managerial staff as appropriate procedure seems to be lacking in the flow of the activities for waste handling. There is no form of waste re cycling while treatment was by burning with open fire and or burying in hospital facility. In a similar study wastes were transported manually, there was no color coding system and also the level of segregation was not satisfactory due to lack of awareness and defined policy on HCWM.

Storage of waste is necessary before further action is taken. The waste storage within a health facility should be located close to the treatment units. The storage premise is required to be large enough to handle wastes produced by the respective healthcare facility. This study has revealed only 39.1% of facilities studied had a storage building while 34.78% lack storage facilities.

Inefficiency was observed in the sharps waste segregation system in the HCFs. Sharps waste segregation is not performed comprehensively since the sharps waste are still being mixed with other waste types in waste containers, as observed in the dumping or burning sites located in HCFs. Segregation of sharps waste observed in few of HCFs was mainly during immunization

activities and this was in the public facilities mainly. It is important to note that even where sharps waste segregation is properly done, no written instructions for handling of sharps waste in the facilities were observed. On the other hand, none of the HCFs was observed to be totally adhering to sharps waste management guidelines as indicated. The comprehensive use of the puncture and leak proof containers in the healthcare facilities were mainly observed in injection and laboratory sections, while other units like minor theatre and dressing areas, such containers were not comprehensively used, instead sharps waste were mixed with other wastes and overfilled containers. The main reason for overfilling the safety boxes was lack of enough supplies for safety boxes due to affordability and lower priority for use of safety boxes. This can also be attributed to lack of knowledge among the workers in the HCFs.

In this study 38.8% of respondents have had injury more than three times when they had contact with wastes of which needle stick injury had the highest occurrence. Action taken by most was Hepatitis B Virus vaccination and only 23.1% reported to the management staff where they offered tetanus toxoid vaccine in 35.5% of cases followed by PEP in 26.5% of cases. It is well documented that a person who experiences one needle-stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% respectively to become infected with HBV, HCV and HIV. In addition, the results of a WHO assessment conducted in 22 developing countries showed that the proportion of health-care facilities that do not use proper waste disposal methods ranges from 18% to 64% [24,25].

The primary purpose of treatment and disposal of waste is to protect public health through the destruction or isolation of hazardous health care waste from people, grazing animals and disease vectors. Only very few HCFs treat their waste. This is in contrast to what was being observed in other studies which could be as a result of cost, lack of manpower or lack of knowhow of maintenance of such sophisticated treatment devices. Also, some of the sharps waste materials have carcinogenic substances, which are not environmentally friendly, indicating that disposing of sharps waste by burying continue the discharges of pollutants into the ground water and soil.

Incinerators though majorly locally constructed were seen in 39.1% of facilities studied of which only 6 were functional this is in contrast to findings in Iran and Libya where incinerators were available in 60% and 43% of health facilities respectively [31,32]. A study in Ibadan, Nigeria in 102 facilities showed 9.8% availability and in Abuja 18.3% of facilities had locally built brick incinerators [26].

Factors that affect waste management practices include the presence of clearly documented guidelines on HCWM in the HCF, training of the staff, presence or absence of a waste management team headed by a waste manager, provision of PPE as well as ensuring it's use frequently especially health workers coming in contact with waste. Also of importance are the financial obligations to proper handling of waste. Reporting of injury should be clearly communicated to all members of staff. The quantity of wastes was seen as the most important factor in the practice of waste management, while the number of patients was deemed the major determinant of the quantity of waste. The cultural belief that determined how wastes were handled majorly was ritual use. Burying was agreed upon by majority for the disposal of human parts.

There seemed to be some effect of cultural belief on waste handling as seen in the results, as human parts were disposed of majorly by giving to the patients to dispose of. The median quantity of waste generated at the facilities was 2.37 kg per day (range: 0.26 – 80 kg per day). Wastes generated at public facilities were found to be more than in private health facilities. The infectious wastes constituted more than 50% of the total waste generated in the facilities. Our finding is similar to that of a study in Abuja where the average quantity of waste generated was 2.78 kg/bed/day of solid waste [26]. The results of this study are similar to that of WHO report regarding waste generation according to source size (0.05 to 8.7 kg/bed/day) though data was sourced from high income countries [27-30]. The study showed that the management of healthcare waste at healthcare facilities was generally poor.

## 5. CONCLUSION

The frequency of waste collection was highest on a daily basis in both private and public facilities. However, waste measurement and segregation were observed to be higher in public than private

facilities. More public facilities segregated their waste at source compared to private facilities. There seems to be a gap in communication among those involve in health management waste. The health personnel despite level of education and cadre, have poor knowledge of the risk associated with healthcare waste.

## 7. RECOMMENDATIONS

It is recommended that every facility should have an infection control unit under which waste management should be strongly represented. Also staff training especially that of the waste handlers should be mandatory and this should be regular and repeated at frequent intervals. An inventory on waste activities should be recorded and audit activities employed. The HCFs should assign central segregated storage location for potentially infectious medical waste awaiting on-site or off-site treatment and disposal.

## 8. LIMITATIONS

Inability to study health facilities in all the 17 LGAs due to financial constraints this limits generalizability however this was overcome by the 5 LGAs that were selected by simple random sampling technique. The validity of the study was affected by the need to replace some facilities that were initially selected by simple random sampling but declined to participate because they felt the study was a monitoring exercise and data obtained would be used for punitive purposes. The effect of this on the validity of the study was however reduced by using a simple random sampling technique to select replacements for these facilities.

## ETHICAL APPROVAL AND CONSENT

This complies with national guidelines. [23] All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Nigeria Teaching Hospital (UNTH) Ituku – Ozalla, National Orthopedic hospital and Annunciation Specialist Hospital. Ethical approval for this study was obtained from the Health research and ethics committee of the Approval was obtained from other heads of facilities while informed consent was obtained from the healthcare workers after explaining in detail the objectives of the study as well as assuring them of the anonymity of the study. Fortis hospital gave permission to use the data. Ethical approval was obtained from the

ethic and research committee of the University of Nigeria Teaching hospital Enugu.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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## **APPENDIX 1: Self/interviewer-administered questionnaire on healthcare waste management (for healthcare workers)**

NOTE: All information given in this questionnaire by the respondents as well as the identity of your facility shall be kept strictly confidential.

### SECTION A: BIODATA

Sex:    Age:    years    Marital Status:    No. of years of employment:    Cadre of health worker:

Level of education:    Dept in the hospital:

### SECTION B: KNOWLEDGE OF HEALTHCARE WORKER ON HCWM

1.    Have you had any training for management of healthcare waste?  
      Yes                    No
2.    If yes, what is the frequency of the training?  
      Once                  Quarterly                  Yearly
3.    Is there a written strategy for you to adhere to as regards healthcare waste?  
      Yes    No    Don't know
4.    Do you have access to it?
  - a)    with you            Yes                  No
  - b)    In your unit        Yes                  No
  - c)    In your facility    Yes                  No
5.    Do you have a focal person responsible for HCWM in your unit?  
      Yes                    No
6.    Have you received any training/instruction on waste segregation?  
      Yes                    No
7.    Have you seen instructive posters on waste segregation?  
      Yes                    No
8.    Kindly outline the steps for proper waste management if you know any  
      Tick as appropriate.
  - A.    Segregate →collect →treat →store →dispose
  - B.    Collect →store →burn
  - C.    Collect →bury
  - D.    Don't know
9.    Is there any risk associated with handling healthcare waste?  
  
      Yes    No

10. Enumerate the risks you are aware of. Tick as appropriate  
a. HIV infection b. HBV infection c. HCV infection d. Tetanus e. cuts/abrasions f. TB g. don't know h. others specify
11. Which of the diseases in 10 above can be contracted by mere contact with healthcare waste? List all options
12. Improper management of HCW can lead to transmission of infection. I agree  
I disagree      I don't know

### SECTION C: HCWM PRACTICE IN HCF

13. Does your facility own a waste collection record?  
Yes              No
14. How often are the wastes collected?  
Every shift      Daily              Weekly Monthly At random
15. How often is waste collection recorded?  
Every shift      Daily      Weekly Monthly At random
16. Are the wastes measured?  
Yes              No              Don't know
17. Are the wastes segregated?  
Yes              No              Don't know
18. If yes for 17, where is the segregation done?  
At source      storagesite      treatment facility      disposal site      don't know
19. Is there a color code utilized in your facility?  
Yes              No
20. How are the waste transported from source to storage point?  
Manually      Wheelbarrow      Trolley              don't know
21. How are the wastes stored?  
Plastic containers      Building Central refuse bin      No storage facility
22. How are the wastes transported to the final disposal site?  
Hospital vans              Private haulers              ESWAMA
23. Have you received HBV vaccine?  
Yes              No
24. Is the HBV vaccine available in your facility?  
Yes              No              Don't know



25. Have you had any injury while in contact with healthcare waste?  
Yes                      No
26. If yes how many times?  
1            2            3            >3
27. If yes for question 25, describe the nature of the injury  
Needle stick                      Chemical burn                      Cut from sharp    Others specify
28. What action did you take?  
a)None                      b)Self medication                      c)Reported to management staff
29. If you ticked b) what action did you take?  
None    TT            wound cleaning with jik    wound cleaning with disinfectantdrug from chemist
30. If you ticked c) what action did they take?  
None                      PEP                      TT                      wound cleaning                      drugs
31. Enumerate the personal protective equipment required in HCWM. Tick as appropriate.  
Gloves                      Boots                      Aprons                      Cap                      Facemask                      Goggle  
Gown
32. Mention those provided for you in your facility if any
33. Kindly state your willingness and frequency to use them. Always    Occasionally  
Rarely                      Never
34. Describe briefly the final disposal of segregated waste.    Municipal landfill  
Incinerated                      Buried on hospital grounds                      Don't know
35. Do the wastes undergo any type of treatment?  
Yes                      No
36. If yes what form of treatment?

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