



## Assessment of Healthcare Waste Management Practices Compliance among Health Workers in Enugu State University Teaching Hospital, Enugu

Elizabeth Uju Okonkwo<sup>1</sup>, Justin Agorye Ingwu<sup>2</sup>, Chukwudi Joseph Okonkwo<sup>3</sup>

<sup>1</sup>Department of Maternal and Child Health, David Umahi Federal University of Health Sciences, Uburu, Ebonyi State Nigeria.

<sup>2</sup>Department of Nursing Sciences, University of Nigeria, Enugu Campus, Enugu, Nigeria

<sup>3</sup>Department of Entrepreneurship Studies, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, Nigeria.

### Abstract

**Objectives:** This study aims to examine Healthcare Waste Management (HCWM) compliance as it concerns healthcare workers in Enugu State University Teaching Hospital, Enugu.

**Methods:** Yamane's sampling formula was used to determine a sample size of 270 from a population of 834, and a descriptive survey research design was judged appropriate and employed. To ensure that respondents were represented proportionately, a stratified random sampling technique was used. A well-structured questionnaire was used to gather the data, and descriptive statistics such as frequency distribution, percentages, and chi-square tests were used for analysis.

**Results:** The study achieved a 78% response rate, with most respondents being female (78.6%) and aged 30–39 years (40%). Chemical disinfection of body fluids (21.0%) was the most common waste treatment method, while waste burial (8.2%) was the least practiced. Further findings revealed that compliance varied across various healthcare worker categories, with nurses showing higher adherence to segregation and disposal practices, while doctors and scientists exhibited lower compliance rates. Hypothesis testing confirmed significant differences in compliance levels.

**Conclusion:** The study concludes that healthcare workers' adherence to best practices for healthcare waste management varied; while outsourcing and non-dumping waste disposal were positively correlated, there were notable gaps in the availability of recycling and treatment facilities, and different professional categories had varying levels of compliance that needed to be addressed. For better adherence and a safer hospital environment, the study suggests bolstering HCWM training, making investments in waste treatment infrastructure, enforcing stringent monitoring, and improving waste segregation, especially through better color-coded disposal systems.

**Keywords:** Healthcare, Waste Management Practices, Workers, Compliance, Enugu State.

### Introduction

Healthcare waste management (HCWM) is an important aspect of hospital administration and public health, ensuring that medical waste is handled, treated, and disposed of safely to prevent environmental

#### Corresponding Author:

**Chukwudi Joseph Okonkwo**

Department of Entrepreneurship Studies, Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State, Nigeria.

[jochy2kng@yahoo.com](mailto:jochy2kng@yahoo.com)

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contamination and health hazards. Proper waste management practices are essential for minimizing the risks associated with hazardous waste, these may include infections and injuries among healthcare workers, patients, and the general public. The World Health Organization (WHO)<sup>1</sup> defines healthcare waste as all waste produced from medical activities. According to WHO, there is a chance of infection for

anyone who comes into contact with hazardous medical waste. Medical professionals like physicians, nurses, hygienic staff, and hospital maintenance workers are among those at risk. Outpatients and inpatients, as well as their guests, might also be impacted. Also, support service workers, waste disposal facility employees, scavengers, and the general public are vulnerable to the impacts of healthcare waste<sup>2</sup>.

About 15% of the waste produced in healthcare facilities is hazardous, according to recent academic studies, with the remaining 85% being non-hazardous or general waste<sup>3</sup>. According to WHO estimates, each year between 8 and 16 million new cases of Hepatitis B (HBV), 2.3 to 4.7 million cases of Hepatitis C (HCV), and 80,000 to 160,000 cases of HIV are caused by unsafe injection disposal and inadequate waste management systems. All waste produced by healthcare facilities, including hospitals, research institutes, and labs, is referred to as healthcare waste (HCW), or medical waste (MW)<sup>3</sup>. This waste follows a structured path from its point of origin to its final disposal. Also, apart from certain liquid waste components, including sewage, blood, and bodily fluids, the majority of healthcare waste falls under the category of solid waste<sup>4</sup>.

Healthcare waste management frequently receives less attention than it needs in developing nations due to competing demands on scarce resources. Therefore, a major obstacle is the lack of institutional frameworks for managing healthcare waste. The strength of healthcare facility (HCF) administration and organization has a significant impact on the management and disposal of clinical waste<sup>5</sup>. Poor collection, storage, and final disposal procedures, as well as insufficient waste segregation at the point of use, result from the neglect of healthcare waste management or the total lack of a structured plan. Ineffective waste management puts patients, healthcare staff, and the environment at major risk for health problems<sup>5</sup>. Key issues include the absence of color-coded waste bags for proper segregation and the lack of clear guidelines on waste disposal, contributing to poor healthcare waste management in hospitals.

Despite established guidelines and regulatory frameworks, compliance with healthcare waste management practices varies across healthcare institutions<sup>4</sup>. Several factors, such as inadequate training, lack of infrastructure, and limited

awareness, contribute to non-compliance. Issues such as the absence of color-coded waste segregation, inadequate waste disposal facilities, and limited awareness of proper waste management protocols contribute to poor healthcare waste management<sup>5</sup>. These gaps not only endanger healthcare workers but also pose environmental hazards due to improper disposal methods. The Enugu State University Teaching Hospital (ESUTH) in Enugu serves as a major healthcare facility, making it imperative to assess how well healthcare workers adhere to best practices in HCWM. Therefore, it is against this mentioned issue that this study was conceived.

This study aims to evaluate the level of compliance with healthcare waste management practices among health workers in ESUTH, Enugu. By identifying gaps and areas requiring improvement, the findings will contribute to the development of more effective waste management policies and interventions, ultimately ensuring a safer healthcare environment.

## Materials and Methods

This study is a descriptive survey research design. This design is most appropriate to elicit proper expression and responses from the respondents on waste management practices. The study was carried out at Enugu State University Teaching Hospital (ESUTH), Enugu State. It is located along Parklane Avenue, G.R.A. in Enugu North Local Government Area, Enugu State. It is a tertiary institution that provides a variety of health care services.

The population of the study comprises of all the healthcare workers in the hospital's wards. That -is, doctors, nurses, scientist, and sanitary staff. The population at the time of study was 834.

Table 1 Population of Health Workers in ESUT Teaching Hospital Parklane Enugu.

| Health Workers | Number     | Sample Size Distribution |
|----------------|------------|--------------------------|
| Nurses         | 394        | 127                      |
| Doctors        | 346        | 112                      |
| Scientists     | 64         | 21                       |
| Sanitary staff | 30         | 10                       |
| <b>Total</b>   | <b>834</b> | <b>270</b>               |

Source: Planning Research and Statistics of ESUT Teaching Hospital, Parklane Enugu.

## Sample Size

Due to the large size of the population, the Taro Yamane formula was used to determine the sample size. The formula is:

$$n = N / 1 + N(e)^2,$$

Where:

n = Sample size

N = Number of population, which 834

e = Level of significance or limit of tolerable error, which is 0.05

1 = Unit or a constant

n = 270.34 approximately, n = 270

### Sampling Technique

To ensure proportional distribution of the sample size across all strata of health workers, a stratified random sampling technique in the selection of the exact number of health workers was adopted.

### Method of Data Analysis

The collected data was analysed using descriptive statistics; specifically, Frequencies and proportions were calculated for qualitative variables, while the means and standard deviations were calculated for quantitative variables.

For analysis of the study, percentages, simple frequency distribution, means, standard deviations and chi-square were used. 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.

Data were collated and analyzed using Statistical Package for Social Sciences (SPSS) version 23.0. Results are presented as frequency tables, texts, percentages and proportions.

### Ethical Consideration

Before the collection of data, a protocol/summary of the research was forwarded to Enugu State Ministry of Health, the Hospital ethical committee of ESUTH, Enugu and a copy of the instrument was submitted. After review, an ethical approval was given to the researcher. The consent of the facility managers whose units were used for the study was sought before administering the questionnaire. Strict confidentiality of the respondents and their responses was ensured and participants were nurses, doctors, laboratory scientist and sanitary staff who were willing to be part of the research.

### Results

The study targeted a sample size of 270 respondents from which 210 filled in and returned the

questionnaires making a response rate of 78%. This response rate was satisfactory to make conclusions for the study, that is, a response rate of between 30 to 80% of the total sample size can be used to represent the opinion of the entire population<sup>6</sup>.

Table 2: Demographic Characteristics of Health Workers n=210

| Variable                               | Frequency (n=210) | Percentage (%) |
|----------------------------------------|-------------------|----------------|
| <b>Age:</b>                            |                   |                |
| <20                                    | 15                | 7.1            |
| 20 – 29                                | 36                | 17.1           |
| 30 – 39                                | 84                | 40.0           |
| 40 – 49                                | 75                | 35.7           |
| <b>Gender:</b>                         |                   |                |
| Male                                   | 45                | 21.4           |
| Female                                 | 165               | 78.6           |
| <b>Category of Healthcare Workers:</b> |                   |                |
| Nurse                                  | 123               | 58.6           |
| Doctor                                 | 66                | 31.4           |
| Scientist                              | 15                | 7.1            |
| Sanitary Staff                         | 6                 | 2.9            |
| <b>Length of Stay in the Facility:</b> |                   |                |
| <5years                                | 156               | 74.3           |
| 5 – 10                                 | 45                | 21.4           |
| 11 – 15                                | 6                 | 2.9            |
| 16 – 20                                | 3                 | 1.4            |

Source: Field survey 2021

Table 2 shows the demographic characteristics of the respondents. From the table, it was seen that respondents less than 20 years formed the lowest population 15(7.1%), while majority 84(40%) of the respondents was between 30 and 39 years. It is observed that majority 165(78.6%) were female. Concerning the category of healthcare workers that made up the respondents, it was observed that majority were Nurses 123(58.6%), with Sanitary Staff being the least 6(2.9%).

It was observed concerning the Length of stay of the respondents that those who have stayed less than 5 years were 156(74.3), making them the highest of the population while those that have stayed between 16 and 20 years were the lowest among the respondents. 3(1.4%)

Table 3: Waste Management Practices in terms of Type

| Variable                                          | Frequency (n=210) | Percentage (%) |
|---------------------------------------------------|-------------------|----------------|
| Types of wastes being generated in various units: |                   |                |
| General wastes (GW)                               | 192               | 21.5           |
| Pathological wastes (PW)                          | 126               | 14.1           |
| Chemical wastes (CW)                              | 78                | 8.8            |
| Infectious wastes (IW)                            | 171               | 19.2           |
| Sharp wastes (SW)                                 | 195               | 21.2           |
| Pharmaceutical wastes (PW)                        | 129               | 14.5           |

Source: Field survey 2021

From Table 3, the respondents had sharp wastes as the highest waste generated in their units 195(21.2%), followed by general wastes 192(21.5%), pathological wastes generated 126 (14.1%), 171(19.2%) of respondents had infectious wastes generated while 129(14.5%) of respondents had pharmaceutical wastes generated in their units and Chemical wastes being the lowest generated waste in the units 78(8.8%).

Table 4: Waste Management Practices in terms of Frequency of Waste Generation

|                                                            | R  | S  | O   | N  | M+SD       |
|------------------------------------------------------------|----|----|-----|----|------------|
| How often does your unit generate General Waste (GW)?      | 12 | 30 | 162 | 6  | 2.77+0.591 |
| How often does your unit generate Pathological Waste (PW)? | 42 | 66 | 66  | 36 | 2.46+0.998 |
| How often does your unit generate Chemical Waste (CW)?     | 60 | 75 | 18  | 57 | 2.34+1.160 |
| How often does your unit generate Infectious Waste (IW)?   | 24 | 12 | 162 | 12 | 2.77+0.722 |
| How often does your unit generate Sharp Waste (SW)?        | 12 | 18 | 171 | 9  | 2.84+0.578 |
| How often does your unit generate Pharmaceutical Waste?    | 39 | 81 | 75  | 15 | 2.31+0.856 |

Note: R=Rarely, S=Sometimes, O=Often, N=Never

Source: Field survey 2021

Table 4, also shows that in terms of frequency of waste generation, sharp waste was the highest 2.84+0.578 generated waste in the study area, while chemical waste was the least generated 2.34+ 1.160. It was observed that General waste 2.77+0.591 and infectious waste 2.77+ 0.591 was equally generated in the study area.

### Research Question: What is the level of compliance with HCW management standard practices?

Table 5 above shows the respondents' level of compliance with best practices as concerning waste management. 90(42.9%) of respondents do not colour code their healthcare waste for disposal while 120(57.1%) colour code their healthcare waste for disposal. 123(58.6%) of respondents says there is no form of waste recycling in their facility while 87(41.4%) says there is a form of waste recycling. 63(30%) of respondents says there is a form of purpose built waste treatment in their facility while 147(70%) says there is no form of purpose built waste treatment. Concerning if dumping wastes are done outside the hospital building, Majority 156(74.3%) of respondents says waste are not dumped outside hospital building., while concerning if waste disposal are contracted out or not, 132(62.9%) says it is contracted out. Concerning treatment of wastes; 105(17.9%) of respondents had performed autoclaving of lab wastes in their units, while 123 respondents representing 21.0% had chemical disinfection of body fluids.

### Hypothesis 1

1.  $H_0$ : There is no significant difference in compliance with healthcare waste management standard practices among health workers in the study area.

Table 6: Comparing the compliance of healthcare waste management standard practices among health workers in the study area

| Best Practices                           | Category of Healthcare Workers |             |                |                    | $\chi^2$ | p-value |
|------------------------------------------|--------------------------------|-------------|----------------|--------------------|----------|---------|
|                                          | Nurses (%)                     | Doctors (%) | Scientists (%) | Sanitary Staff (%) |          |         |
| Color coding of HCW for disposal         | 68.3                           | 45.5        | 20.0           | 50.0               | 18.501   | 0.000*  |
| Availability of forms of waste recycling | 43.9                           | 31.8        | 40.0           | 100                | 11.318   | 0.010*  |
| Purpose built waste treatment facility   | 75.6                           | 54.5        | 80.0           | 100                | 12.635   | 0.005*  |
| Dumping of waste outside hospital        | 29.3                           | 27.3        | 0.0            | 0.0                | 8.166    | 0.043*  |
| Disposal contracting                     | 61.0                           | 72.7        | 20.0           | 100.0              | 18.287   | 0.000*  |
| Autoclaving of lab wastes                | 46.3                           | 54.5        | 40.0           | 100.0              | 7.804    | 0.050*  |
| Crude incineration outside               | 61.0                           | 36.4        | 20.0           | 100.0              | 22.083   | 0.000*  |
| Encapsulation e.g. Sharps                | 39.0                           | 50.0        | 20.0           | 100.0              | 13.313   | 0.004*  |
| Waste burial within healthcare facility  | 24.4                           | 18.2        | 20.0           | 50.0               | 3.559    | 0.313   |
| Chemical disinfection of body fluids     | 48.8                           | 77.3        | 60.0           | 50.0               | 14.566   | 0.002*  |
| Other advanced technology                | 58.5                           | 45.5        | 40.0           | 50.0               | 4.58     | 0.255   |

\*Statistically significant

Table 5: Level of compliance with recommended best practices

| Variable                                           | Yes         | No         | Total (n=210)  |
|----------------------------------------------------|-------------|------------|----------------|
| Do you colour code your HCW for disposal?          | 120 (42.9%) | 90(42.9%)  | 210            |
| Is there any form of waste recycling?              | 87(41.4%)   | 123(58.6%) | 210            |
| Is there a purpose-built waste treatment facility? | 63(30%)     | 147(70%)   | 210            |
| Are waste dumped outside the hospital building?    | 54(25.7%)   | 156(74.3%) | 210            |
| Is your waste disposal contracted out?             | 132(62.9%)  | 78(37.1%)  | 210            |
| Treatment of wastes in various units?              |             | Frequency  | Percentage (%) |
| Form of treatment (n = 45)                         |             |            |                |
| Autoclaving of lab wastes                          |             | 105        | 17.9           |
| Crude incineration outside                         |             | 108        | 18.5           |
| Encapsulation e.g. Sharps                          |             | 90         | 15.4           |
| Waste burial within healthcare facility            |             | 48         | 8.2            |
| Chemical disinfection of body fluids               |             | 123        | 21.0           |
| Other advanced technology                          |             | 111        | 19.0           |

Source: Field survey 2021

From table 6, the compliance to best practices concerning Color coding of HCW for disposal, Availability of forms of waste recycling, Purpose built waste treatment facility, Dumping of waste outside hospital, Disposal contracting, Autoclaving of lab wastes, Crude incineration outside, Encapsulation e.g. Sharps and Chemical disinfection of body fluids had significant chi-square values ( $\chi^2 = 18.501$ ,  $p = 0.000$ ;  $\chi^2 = 11.318$ ,  $p = 0.010$ ;  $\chi^2 = 12.635$ ,  $p = 0.005$ ;  $\chi^2 = 8.166$ ,  $p = 0.043$ ;  $\chi^2 = 18.287$ ,  $p = 0.000$ ;  $\chi^2 = 7.804$ ,  $p = 0.050$ ;  $\chi^2 = 22.083$ ,  $p = 0.000$ ;  $\chi^2 = 13.313$ ,  $p = 0.004$ ;  $\chi^2 = 3.559$ ,  $p = 0.313$ ;  $\chi^2 = 14.566$ ,  $p = 0.002$ ;  $\chi^2 = 4.58$ ,  $p = 0.255$ ).



= 8.166,  $p = 0.043$ ;  $X^2 = 18.287$ ,  $p = 0.000$ ;  $X^2 = 7.804$ ,  $p = 0.050$ ;  $X^2 = 22.083$ ,  $p = 0.000$ ;  $X^2 = 13.313$ ,  $p = 0.004$  and  $X^2 = 14.566$ ,  $p = 0.002$  respectively) with a  $p$ -values of less than 0.05.

Therefore, we reject the null hypothesis that there is no significant difference in compliance with Health care waste management standard practices among health workers in the study area while accepting the alternate hypothesis that there is significant difference in compliance with Health care waste management standard practices among health workers in the study area.

## Discussions

The study achieved a response rate of 78%, which is considered satisfactory for drawing valid conclusions<sup>6</sup>. The demographic analysis revealed that the majority of respondents (40%) were aged between 30 and 39 years, with females (78.6%) constituting the larger portion of the sample, which reflects the gender distribution in the study facility at the time of data collection not due to refusal to respond by males. This is also consistent with prior research<sup>3,18,19</sup> indicating that there are more female health care workers in ESUTH medical facility. Nurses represented the highest proportion of healthcare workers (58.6%), while the sanitary staff made up the lowest percentage (2.9%), which is in line with some studies<sup>20</sup>. The majority (74.3%) had been in the facility for less than five years, indicating a relatively high turnover rate or recent recruitments. Regarding the level of compliance with healthcare waste management (HCW) standard practices, findings revealed that 57.1% of respondents practiced color coding for waste disposal, whereas 42.9% did not, being consistent with submissions from these studies<sup>18,21</sup>. Waste recycling was found to be lacking in most facilities, with 58.6% reporting no form of recycling, this finding was supported by some scholarly submissions<sup>22</sup>. The presence of a purpose-built waste treatment facility was also limited, with only 30% of respondents confirming its availability, which is concerning, this is consistent with<sup>23,24</sup> while the study<sup>25</sup>, show that few healthcare facilities in Nigeria maintain purpose-built storage facilities for healthcare waste. The majority (74.3%) reported that waste was not dumped outside the hospital building, indicating some level of compliance with proper disposal practices, which was commendable. Also, 62.9% of respondents

indicated that waste disposal was outsourced, reflecting a reliance on external waste management services. These issues are widely corroborated by other studies<sup>7,18,20</sup>, which highlighted inadequate segregation, poor infrastructure, and absence of appropriate treatment technologies in Sudan, while others<sup>8</sup> similarly identified a need for better management practices in Bangladesh. Also, studies<sup>9</sup> further supported these findings within Nigeria, reporting low compliance with guidelines and a scarcity of functional incinerators (only 2.06%).

Further analysis on waste treatment methods indicated that the most common practice was chemical disinfection of body fluids (21.0%), followed by crude incineration (18.5%) and the use of advanced technology (19.0%). The least practiced methods included waste burial within healthcare facilities (8.2%). In affirmation,<sup>8</sup> Suggested 45.4% of incineration use as a suitable method, while scholars<sup>9</sup> noted the frequent burning of sharp and non-sharp HCWs in protected pits in Nigeria was about 45.36% in their respective studies, reinforcing the continued use of less advanced or "crude" methods. The limited use of "advanced technology" (19.0%) and "waste burial" (8.2%) further points to systemic infrastructure deficits<sup>8,9</sup>, which should require some attention.

The hypothesis testing revealed significant differences in compliance with HCW management standard practices among various healthcare worker categories. Nurses exhibited higher compliance with color coding and disposal contracting, which is consistent with<sup>10,3</sup> study, who found nurses had higher knowledge scores compared to other healthcare professionals in South Africa. Similarly, sanitary staff showed 100% compliance in some aspects, such as encapsulation of sharps and autoclaving of lab waste<sup>23,25</sup>, suggesting specialized training or role-specific adherence, contrasting with the lower compliance rates observed among doctors and scientists<sup>18,20</sup> in various practices. This aligns with other studies<sup>8</sup>, which found that a significant portion of healthcare workers (56%) had not received training on hazardous waste handling, and other studies<sup>9</sup> highlighting varying training attendance rates across states in Nigeria. Also,<sup>11,12,13,14,15</sup> underscored the positive influence of prior training and recognition of HCW importance on satisfactory management, reinforcing the need for targeted training programs across all professional groups to

bridge these identified compliance gaps<sup>16,17</sup>. Doctors and scientists had relatively lower compliance rates in various practices. Therefore, the null hypothesis is rejected, confirming that compliance with HCW management standards significantly varies among healthcare workers.

### Conclusion

This study found varied compliance with healthcare waste management best practices among healthcare workers, with positive adherence in waste disposal outsourcing and preventing external dumping, yet critical gaps in waste recycling and the availability of dedicated treatment facilities. Furthermore, compliance levels significantly differed by healthcare worker category, with nurses and sanitary staff generally showing higher adherence than doctors and scientists, underscoring the need for targeted interventions.

### Recommendations

From the findings of the study, the following recommendations are made;

1. The hospital management should consider regular training programs for all healthcare workers, emphasizing the importance of HCW management best practices, including color coding, recycling, and safe disposal methods.
2. The hospital management should invest in purpose-built waste treatment facilities to enhance proper waste management and reduce reliance on external disposal services.
3. The hospital management should implement strict policies ensuring adherence to HCW management guidelines, with periodic monitoring and evaluation.
4. There should be intense efforts made to introduce recycling initiatives within healthcare facilities to reduce waste generation and promote sustainable waste management practices.
5. The government and regulatory bodies should enforce compliance through periodic audits and provide financial or technical support to improve HCW management practices in healthcare facilities.

### Declarations

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**Authors' contributions:** The study was conceived by EUO. The drafting, writing, design, coordination, reading and approval of final manuscript was done by EUO, JAI, and CJO.

**Ethics considerations:** Institutional Ethical Approval was obtained. Confidentiality was ensured by not writing the names of workers responding to the study questionnaires and interview questions. A copy of the written Approval is available for review by the Editor-in-Chief of this journal

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