BIOMEDICAL HEALTHCARE WASTE MANAGEMENT IN PUBLIC HOSPITALS WITHIN NIGERIA: A SYSTEMATIC REVIEW

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ABSTRACT

Biomedical healthcare waste management has become an important aspect of medical care delivery globally. This is simply because of its hazardous and infectious components that have greater potential for adverse health and environmental impacts. As such, certain guidelines and procedures have been developed by international aid agencies and conventions to guide national governments and local administrations in formulating policies and practices for effective healthcare waste management. This study employed a system review of literatures on the topic "Biomedical healthcare waste management in public hospitals within Nigeria", we reviewed the existing literature to appraise the status of healthcare waste management practices in public hospitals within, Nigeria. This included generation, segregation, collection, storage, transportation, treatment, and disposal. The current work further reviewed the other essential elements of healthcare waste management, such as policy landscapes, training, awareness, and waste characterization, and discusses challenges and opportunities for effective healthcare waste management in Nigeria. Among the challenges are poor funding, inadequate training, ineffective legislature, and absence of data. However, there are available low-cost technologies that are suitable for the treatment of waste in a developing country like Nigeria. This technology variant offers an opportunity for a circular economy as it can simultaneously achieve energy production, waste management, and other socioeconomic advantages.

KEYWORDS: *Biomedical waste, Management, Health care workers, Infectious disease.*

1. INTRODUCTION

According to world health organization (2014), biomedical waste, also known as medical waste or healthcare waste, is defined as all forms of waste arising from activities within health care facilities, research centers, and laboratories related to medical procedures (WHO, 2014). Biomedical healthcare waste management has been challenging and critical in many developing countries, including Nigeria (Ogbonna, Chindah and Ubani, 2012). Biomedical wastes also include wastes originating from other variety of sources, such as wastes generated from healthcare undertakings at homes, self-administration of insulin, home dialysis, and recuperative care as well as rehabilitation care (WHO, 2005). WHO 2018, classified biomedical waste into hazardous and non-hazardous waste, with the former constituting 10%-25% while the latter constituting 75-90% respectively. Examples of hazardous waste categories found in healthcare facilities include sharp waste, infectious waste, pathological waste, pharmaceutical waste, cytotoxic waste, chemical waste, and radioactive waste. several studies have reported that the management of healthcare waste is still a huge burden in low- and middle-income countries because of certain concerns. These include but are not limited to poor awareness of the health hazards associated with waste, inadequate training in proper waste management techniques, inadequate or absence of state-of-the-art waste management, and disposal facilities, unavailability of economic resources, and

low-priority attention given to the issue (Chisholm, Zamani, Negm, Said, Abdeldaiem, Dibaj, and Akrami, 2021; Zafar, 2019; Awodele, Adewoye, Oparah, 2016; Ali, Wang, Chaudhry, Geng, 2017). In Nigeria, municipal solid waste management has not received satisfactory attention due to the limited economic resources, poor policy regimes, inadequate public infrastructure, and the absence of other critical capacities (Ezeudu, Agunwamba, Ugochukwu, Ezeudu, 2020). As a result of inadequate economic resources, health-related issues compete with other sectors of the economy for limited available resources (Awodele *et al*, 2016). According to study carried out by Mohammed Sarker et.al, 2014, barriers affecting biomedical healthcare waste management practice includes insufficient personal protective equipment (PPE) in the hospitals, lack of equipment for final disposal, insufficient medical waste management related staff, lack of guideline or policies, lack of incinerators were identified as the top five barriers by respondents with most respondents reporting insufficient PPEs in the hospitals as the topmost barriers amongst others

2. MATERIALS AND METHOD

This systematic review of biomedical waste management in public hospitals within Nigeria addressed the following focused questions; i) do health workers have the knowledge of biomedical waste and do they practice biomedical waste management in public hospitals within Nigeria? ii) what are the factors hindering the practice of biomedical waste management in public hospitals within Nigeria? what strategies can be used by health workers to sustain biomedical waste management in public hospitals within Nigeria?. It involved a comprehensive search of the literature which included search from databases like pubmed, google scholar and some gray literature from the net with clear inclusion and exclusion criteria for papers included in the review, addressed methodological quality of the papers, and synthesized results by themes. The key words "Biomedical waste," "Management", "Health care workers", "Infectious disease" were used as selection criteria. In addition, journal articles published between 2014 and 2024 were included in the search, which was restricted to articles published in English. The 15 articles that met the inclusion criteria were reviewed and sorted into the following themes: knowledge and attitude towards biomedical waste management in public hospitals within Nigeria, challenges and factors hindering biomedical healthcare waste management practices in public hospitals within Nigeria and strategies in engaging and sustaining a holistic biomedical waste management in public hospitals within Nigeria. When few articles met the criteria for a particular theme, references in those articles were examined. A sample size of 120 respondents was analyzed and the results were presented in the tables below;

3. RESULTS

In analyzing the demographic characteristics of the study participants (N = 120), the highest percentage in the age distribution was among those aged 26–35 years, accounting for 37.5%, while the lowest percentage was from the age group 46 years and above at 12.5%. In terms of gender, 58.3% of respondents were female the highest whereas only 1.7% identified as other, representing the lowest proportion. For marital status, married individuals made up the highest percentage at 50.0%, while the divorced/widowed group constituted the lowest at 8.3%.

Regarding educational attainment, those with a bachelor's degree were the majority at 50.0%, whereas only 20.8% had diploma qualifications, the lowest in this category. In

terms of job category, nurses were the most represented profession at 41.7%, while both cleaners/janitors and administrative staff had the lowest equal representation at 16.7% each. When it came to years of professional experience, the highest proportion had between 1–5 years of experience (45.8%), while only 12.5% had less than one year, marking the lowest.

Departmentally, the "Others" category accounted for the highest proportion of staff at 37.5%, while the laboratory department had the least representation at 16.7%. Lastly, 58.3% of participants had received prior training on biomedical waste management the highest in that variable while 41.7% had no such training, marking the lower end.

Results were presented based on findings from the keywords/themes (Table 1);

TABLE 1: Demographic Characteristics of Respondents

S/N	Variable	Category/Option	Frequency (n)	Percentage (%)
1	Age (in years)	a) 18–25	30	25.0%
		b) 26–35	45	37.5%
		c) 36–45	30	25.0%
		d) 46 and above	15	12.5%
2	Gender	a) Male	48	40.0%
		b) Female	70	58.3%
		c) Other	2	1.7%
3	Marital Status	a) Single	50	41.7%
		b) Married	60	50.0%
		c) Divorced/Widowed	10	8.3%
4	Educational Level	a) Diploma	25	20.8%
		b) Bachelor's	60	50.0%
		c) Postgraduate	35	29.2%
5	Job Category	a) Doctor	30	25.0%
		b) Nurse	50	41.7%
		c) Cleaner/Janitor	20	16.7%
		d) Admin Staff	20	16.7%
6	Years of Experience	a) Less than 1 year	15	12.5%
		b) 1–5 years	55	45.8%
		c) 6+ years	50	41.7%
7	Department/Unit	a) Emergency	30	25.0%
		b) Surgery	25	20.8%
		c) Laboratory	20	16.7%
		d) Others	45	37.5%
8	Prior Training on BMW	a) Yes	70	58.3%
		b) No	50	41.7%

Source : Fieldwork (2025

TABLE 2: Survey Questionnaire

S/N	Themes	Question	A (%)	B (%)	C (%)
1	Biomedical Waste	What is the most common type of biomedical waste in hospitals?	50.0% – Sharps	33.3% – Pharmaceutical waste	16.7% – Food and kitchen waste
2	Biomedical Waste	How is biomedical waste best segregated?	70.8% – Color-coded bins	16.7% – General trash	12.5% – Mixed with domestic
3	Management	What is the key step in biomedical waste management?	75.0% – Segregation at origin	16.7% – Incineration only	8.3% – Storage > 48 hrs
4	Management	Who is primarily responsible for waste management in hospitals?	37.5% – Hospital waste officer	50.0% – All healthcare staff	12.5% – Cleaners only
5	Health Care Workers	What is the major risk to healthcare workers from poor waste handling?	62.5% – Infection from sharps	25.0% – Muscle strain	12.5% – Eye strain
6	Health Care Workers	Which PPE is most essential when handling infectious waste?	66.7% – Gloves and mask	20.8% – Lab coat only	12.5% – Goggles only
7	Infectious Disease	Which disease is most commonly spread through improper waste disposal?	58.3% – Hepatitis B	33.3% – Malaria	8.3% – Diabetes
8	Infectious Disease	What type of waste is considered infectious?	70.8% – Blood-soaked gauze	16.7% – Paper wrappers	12.5% – Unused medications

Source : Fieldwork (2025)

Under Biomedical Waste, half of the participants (50.0%) identified *sharps (needles, blades)* as the most common type of biomedical waste in hospitals, while only 16.7% incorrectly selected *food and kitchen waste*, indicating a clear distinction between biomedical and general waste. Furthermore, 70.8% recognized the correct method of segregation as the use of *color-coded bins*, showing high compliance with standard biomedical waste handling procedures. Only a small proportion (12.5%) chose the incorrect method of mixing with domestic waste.

In the Management category, a majority (75.0%) acknowledged that *segregation at the point of origin* is the most critical step in biomedical waste management, demonstrating strong conceptual clarity. Only 8.3% incorrectly considered *storing waste for more than 48 hours* to be acceptable. When asked about responsibility, 50.0% correctly indicated that *all healthcare staff* are accountable for waste management, while just 12.5% believed it was solely the responsibility of cleaners.

Regarding Health Care Workers**,** 62.5% correctly identified *infection from sharps injuries* as the major risk arising from improper waste handling, with only 12.5% mentioning less plausible risks such as eye strain. In terms of personal protective equipment (PPE), 66.7% selected gloves and masks as the most essential when dealing with infectious waste, which aligns with safety guidelines. Lower percentages for lab coats only (20.8%) and goggles only (12.5%) highlight a good understanding that partial PPE is insufficient.

Under the Infectious Disease theme, 58.3% correctly associated Hepatitis B with improper biomedical waste disposal, reflecting a sound grasp of disease transmission risks. Only 8.3% selected diabetes, a non-communicable disease, indicating accurate perceptions of infection pathways. Similarly, 70.8% identified blood-soaked gauze as an example of infectious waste, compared to just 12.5% for unused medications, confirming clear recognition of what constitutes infectious material.

Knowledge and attitude towards biomedical waste management in hospitals within Nigeria

Results from the study by Uchechukwu et.al, (2017) on investigating Knowledge, Attitude and Health Care Waste Management by Health Workers in a Nigerian Tertiary Health Institution showed that all 115 respondents returned the completed questionnaires. Sixty (52.2%) were females and fifty five (47.8%) were males. The mean age of respondents was 31.7 ±11.8 years. Ninety three (80.9%) had heard of hospital waste management, 95 (83%) were aware that hospital waste is classified into hazardous and non-hazardous waste. Ninety nine (86.1%) were aware of waste segregation, only 25(21.7%) dispose medical waste in specified color coded container always. Majority 90 (78.3%) use latex gloves when handling waste.

Results from the study done by Musa et.al, (2023) on Knowledge and Practice of Healthcare Waste Management among Healthcare Workers at Yusuf Dantsoho Memorial Hospital (YDMH), Kaduna, Nigeria revealed a good knowledge of waste management amongst nurses (88.18%), doctors (86.68%), medical laboratory scientists and technicians (77.48%), ward attendants (19.1%), and cleaners (17.5%), respectively. In practice, all the wards and departments observed do not have (0%) colour-coded plastic bags on their waste bins, with only 70% having their waste bins covered, 30% having posters to guide waste users displayed near the waste bins, and 0% waste treatment before disposal practice. The health facility's method of final waste disposal is not in line with best practices

Also further results of the study by Musa et al, (2023) showed that the knowledge of HCWM of skilled workers was significantly higher (p=1.06E-05) than the knowledge of unskilled workers. Nurses (88.18%) had the best knowledge of HCWM while the cleaners (17.5%) had the least knowledge. The attitude of HCWM of skilled workers was significantly higher (p=8.6E-05) with medical doctors possessing the best attitude towards proper HCWM and ward attendants possessing the worst attitude. The overall comparison of knowledge and attitude was significantly better (p=2.21E-06) among skilled workers than unskilled workers.

Results from a similar study done by Ekanem et.al, (2021) on Assessment of knowledge and practices of healthcare waste management among health workers in a

general hospital in southern Nigeria showed that the majority (88.6%) of the respondents had good level of knowledge of HCW management and its effect on health. More than half (58.9%) of the respondents had good HCW management practices. Predictors of poor knowledge of HCW management were lack of training on HCW management (OR 0.24, 95%CI 0.06-0.95, P=0.04) and not seeing instructive posters on health care waste management (OR 0.16, 95%CI 0.04-0.64, P=0.01). Being a nurse (OR 0.15, 95%CI 0.04-0.59, P=0.007) and not seeing an instructive HCW management poster (OR 0.26, 95%CI 0.12-0.57, P=0.001) predicted poor practice of HCW management. All wards had sharps containers and waste bins which were not of the standard color coding. Thirty percent of the waste bins had lids.

Results from another study by Anozie et.al, (2017) on Knowledge, Attitude and Practice of Healthcare Managers to Medical Waste Management and Occupational Safety Practices; showed that two-fifth (40%) of healthcare managers had received training on medical waste management and occupational safety. Standard operating procedure of waste disposal was practiced by only one hospital (1.9%), while 98.1% (53/54) practiced indiscriminate waste disposal. Injection safety boxes were widely available in all health facilities, nevertheless, the use of incinerators and waste treatment was practiced by 1.9% (1/54) facility. However, 40.7% (22/54) and 59.3% (32/54) of respondents trained their staff and organize safety orientation courses respectively. Staff insurance cover was offered by just one hospital (1.9%), while none of the hospitals had compensation package for occupational hazard victims. Over half (55.6%; 30/54) of the respondents provided both personal protective equipment and post exposure prophylaxis for HIV.

Challenges and factors hindering biomedical healthcare waste management practices in Public hospitals within Nigeria

Results of the study by Onyekale et.al, (2017) on Healthcare waste management practices and safety indicators in Nigeria showed that 52.20% and 38.21% of the sampled healthcare facilities from Cross River and Bauchi states possessed guidelines for HCW management, respectively. Trainings on management of HCW were attended by 67.18% and 53.19% of the healthcare facilities from Cross River and Imo states, respectively. Also, 32.32% and 29.50% of healthcare facilities from rural and urban areas previously sent some of their staff members for trainings on HCW management, respectively. Sharp and non-sharp HCW were burnt in protected pits in 45.40% and 45.36% of all the sampled healthcare facilities, respectively. Incinerators were reported to be functional in only 2.06% of the total healthcare facilities. In Bauchi and Kebbi states, 23.58% and 21.05% of the healthcare facilities respectively burnt sharp HCW without any protection. Using PCA, computed risky indices for disposal of sharp HCW were highest in Bayelsa state (0.3070) and Kebbi state (0.2172), while indices of risky disposal of non-sharp HCW were highest in Bayelsa state (0.2868) and Osun state (0.2652). The OLS results showed that at 5% level of significance, possession of medical waste disposal guidelines, staff trainings on HCW management, traveling hours from the facilities to local headquarters and being located in rural areas significantly influenced indices of risky/safe medical waste disposal ($p < 0.05$).

Strategies that can be used in sustaining a holistic biomedical waste management

Results from another similar study by Failai et.al, (2023) on assessment of sustainable healthcare waste management practices among hospital workers in Owerri, Nigeria revealed that while code-colored bins are not readily available, healthcare waste (HCW) segregation was significantly related to occupation in the hospital. Regression model for predicting being trained on sustainable HCW management was statistically significant, $\chi 2\ (11) = 21.184$, $p = .032$. PCA of prevalent HCWs in the hospital point towards a two-dimension structure: low

risk waste that do not require treatment and special waste needing treatment and cautious management.

Results from another study by Idowu et.al, (2024) on assessment of medical waste management practices in selected hospital (A case study of Owo, Ondo State) showed that most of the healthcare personnel were aware of the medical waste management practices in the hospital and the practices were satisfactory. However, awareness of medical waste management practices in this institution can still be improved, especially in the segregation aspect since only 44% of the study population was aware of the correct segregation practices. Education was seen to have a significance influence on medical waste management with mean chi square results $X^2(2, N=244) = 7.4408$, $P = 0.03165(p<0.05)$. The mean chi square results $X^2(1, N=244) = 9.5386$, $P = 0.013$ indicated a significant relationship between training and awareness on correct practices as the mean $P <0.05$.

Implications of biomedical health care waste management in public hospitals within Nigeria

Results of the findings on biomedical waste management in public hospitals in Nigeria has implications which includes increased risk of infection, exposure to hazardous substances, environmental pollution and occupational hazards for health workers which can hinder effective healthcare delivery in the public hospitals in Nigeria especially when biomedical waste management is not well practiced or improperly practiced by the health workers.

4. DISCUSSION

Knowledge and attitude towards biomedical waste management in hospitals within Nigeria

A study done by Uchechukwu et.al, (2017) on investigating Knowledge, Attitude and Health Care Waste Management by Health Workers in a Nigerian Tertiary Health Institution. The purpose of the study was to ascertain the knowledge, attitude and practice of hospital waste management among health workers in Enugu. A cross sectional descriptive survey was carried out among 115 health workers at the University of Nigeria Teaching Hospital Enugu. Data were collected using self-administered questionnaire, and was analysed using SPSS version 21. Statistical significance of association between variables was assessed using Chi-square test at $p<0.05$. Ethical clearance was obtained from the Research Ethics Committee of UNTH. Findings from the study showed that most of the respondents knew what health care waste management means (HCWM), but very few practiced appropriate health care waste management. Health education and training is recommended for the health care workers periodically and regularly. Also the study revealed that that adequate knowledge can improve the attitude of the health workers which will invariably have an impact on proper biomedical waste management practices. He further stated that adequate knowledge in biomedical waste management by health workers will help in reducing the risks associated with biomedical waste management.

In another study by Musa et.al, (2023) on Knowledge and Practice of Healthcare Waste Management among Healthcare Workers at Yusuf Dantsoho Memorial Hospital (YDMH), Kaduna, Nigeria. The aim of the study was to assess the knowledge and practice of healthcare waste management (HCWM) among healthcare workers at Yusuf Dantsoho Memorial Hospital (YDMH), Kaduna, Nigeria. A cross-sectional study was conducted amongst doctors, nurses, medical laboratory scientists and technicians, ward attendants, and cleaners at YDMH. A simple random sampling technique was used to select the study unit. A total of 73 health workers consented to an interview. The data was obtained through the administration of questionnaires on the knowledge of health workers while the practice was assessed by direct observation using a checklist. Data were collected and compiled using Microsoft

Excel and analysed using IBM, SPSS version 23.0. There were 39 (53.4%) males and 34 (46.4%) females in this study. The average age of participants was 36.8 ± 8.3 years. Findings from the study highlights the discrepancy and inadequacies of knowledge and practice of proper healthcare waste management among healthcare workers. The healthcare workers with adequate knowledge were the nurses, doctors, and medical laboratory scientists and technicians while the least knowledge was found amongst ward attendants and cleaners. The practice of healthcare waste management was poor across all professions. This calls for the need to train and retrain all health workers with emphasis on the ward attendants and cleaners. Also, there is a need for the provision of colour-coded waste bin liners in all wards and departments which should be adequately budgeted for by the management.

In another similar study by Ekanem et.al, (2021) on Assessment of knowledge and practices of healthcare waste management among health workers in a general hospital in southern Nigeria. The objective of this study was to determine the level of knowledge and practices of HCW management among health workers in a general hospital in Uyo, Akwa Ibom State, Nigeria. A descriptive cross-sectional study was conducted among 158 health workers. Data was collected using a structured questionnaire, checklist for a facility walk-through assessment and a key informant interview and analyzed using STATA statistical software version10.0 Findings from the study showed that training and seeing of HCW management posters predicted knowledge and practice. Hence periodic training, supervision and display of instructive posters is vital in ensuring good knowledge and practice of safe health care waste management in health facilities to reduce the risk of infections and injuries to workers and the general public.

In another study by Anozie et.al, (2017) on Knowledge, Attitude and Practice of Healthcare Managers to Medical Waste Management and Occupational Safety Practices; Findings from Southeast Nigeria. This study was conducted to assess the attitude of healthcare managers to medical waste management and occupational safety practices. This was a cross-sectional study conducted among 54 hospital administrators in Ebonyi state. Semi-structured questionnaires were used for qualitative data collection and analyzed with SPSS statistics for windows (2011), version 20.0 statistical software (Armonk, NY: IBM Corp). Findings from the study revealed that there was high level of non-compliance to standard medical waste management procedures, and lack of training on occupational safety measures. Relevant regulating agencies should step up efforts at monitoring and regulation of healthcare activities and ensure staff training on safe handling and disposal of hospital waste.

In a similar study by Uchechukwu et.al, (2014) on Assessment of Practices and Awareness of Safety Measures of Biomedical Waste Management among Health Workers in Metropolitan Hospitals in Abuja, Nigeria. The study was aimed to evaluate the practices and the level of awareness of health workers towards biomedical waste management in selected hospitals in Abuja. Data were collected by structured questionnaire and on-the-spot observation. Three private and three public hospitals that provided health care services in Abuja were surveyed. Descriptive and inferential statistical analysis were used in the analysis of the data. Chisquare (χ 2) test was used to determine the level of significance set at $p < 0.05$. The male health workers were 200 (55.0%) and the female were 180 (45%) in the survey. The nurses were the highest number of respondents from the study with frequency percentage of 117(28.75%) followed by laboratory scientist with 96 (24%), pharmacist 71(17.4%), doctors 64(16.0%) and other healthcare workers 54 (13.5%). The practice of handling biomedical waste by health workers was a significant factor of biomedical waste management ($p< 0.05$). The awareness of

safety measures among health workers was a significant factor of biomedical waste management (P< 0.05) Improvement in the aspect of training and retraining of health workers will go a long way to fill the lapses in the biomedical waste management practices. Government should establish policies and laws to enforce strict compliance in accordance with WHO stipulations. Effective and efficient biomedical wastes management is vital in the health care delivery system, safe environment and public health could possibly be achieved through the standard practices of the biomedical waste procedures with safety measures in place.

Musa et.al, (2023) on knowledge and attitude of healthcare workers towards healthcare waste management at Yusuf Dantsoho Memorial Hospital (Ydmh) Kaduna, Nigeria The aim To assess the knowledge and attitude of healthcare workers towards healthcare waste management (HCWM) at YDMH, Kaduna, Nigeria. Materials and methods: A cross-sectional study was conducted amongst skilled workers (doctors, nurses and medical laboratory scientists/technicians) and unskilled workers (ward attendants and cleaners) of YDMH. Seventy-three (73) health workers, randomly selected, consented to an interview. 39 males (53.4%) and 34 females (46.4%) participated in this study, the mean age of participants was 36.8±8.3 years. The data was obtained through the administration of a pre-tested questionnaire on the knowledge and attitude of the health workers towards HCWM. The data were collected and collated using Microsoft Excel and analysed using IBM, SPSS version 23.0, t-test for the significance of the results. Findings from the study showed that inadequacies of knowledge and attitude toward proper healthcare waste management (HCWM) among healthcare workers were observed. The healthcare workers with the best knowledge were the doctors, nurses, and medical laboratory scientists/technicians while the ward attendants and cleaners had poor attitudes. These findings call for the need to train and retrain all health workers, with greater emphasis and attention on the ward attendants and cleaners.

Challenges and factors hindering biomedical healthcare waste management practices in Public hospitals within Nigeria

In a study done by Bako et.al, (2022) on Assessment of Compliance with Medical Waste Management Practice in Selected Hospitals in Urban Bauchi, Nigeria. This study assesses compliance with medical waste management practice in hospitals across urban Bauchi. Ten hospitals were randomly selected in each ward, representing the ten administrative wards of urban Bauchi, in which 148 set of questionnaires were administered among the waste handlers in the selected hospitals. In addition, the heads of units in each of the selected hospitals were interviewed. The results were compared with standard guidelines stipulated by the World Health Organization (WHO). It was revealed that the main treatment and disposal method in 50% of the hospitals were incineration and deep burial which were mostly in compliance with the stipulated guidelines. In the remaining 50% of the hospitals, the dominant treatment and disposal methods used were general collection of the waste, open dumping and burning. This is of significant concern because open dumping and open burning are not sustainable practices. Therefore, the study recommends that waste handling manual be developed and provided to all waste handlers to guide on handling medical waste properly.

Alade et.al, (2024). Impediments to Proper Handling of Biomedical Waste in the Tertiary Health Facilities of Ekiti State, Southwest Nigeria. This study examined owners-based exogenous factors that could hamper adequate management and treatment of Biomedical Waste (BMW) at the Federal and State governments owned tertiary health facilities located in Ekiti State, Nigeria. Failure to address these impediments has been identified of inadequate biomedical waste management (BMW), capable of escalating insurgence of epidemics. The study employed survey research design using a well-structured five-item based

questionnaire to elicit primary data from 103 purposively selected health officers from the two healthcare facilities. Evidence from relative importance index and one-way contingency chi-square tests unveil that the five factors examined possess latency to impede adequate BMW management, but more for lack of modern medical waste management equipment and less for the health workers salary and allowances while the factors are found to be statistically significant in obstructing proper management of biomedical waste. The study concludes that failure to ensure that these factors are put in place can lead to inappropriate handling of medical waste which in turn can worsen disease outbreak in the environment. Thus, as a proactive measure to curb epidemics, it is recommended that government and hospital management boards should provide adequate fund to support this course in line with global best practices.

In another similar study by Onyekale et.al, (2017) on Healthcare waste management practices and safety indicators in Nigeria. In this study, we analyzed the practices of HCW management and determinants of risky/safe indices of HCW disposal. The study used the 2013/2014 Service Delivery Indicator (SDI) data that were collected from 2480 healthcare facilities in Nigeria. Descriptive statistics, Principal Component Analysis (PCA) and Ordinary Least Square (OLS) regression were used to analyze the data. Findings from the study concluded that there was low compliance with standard HCW management. It was recommended that possession of HCW management guidelines, staff training on HCW disposal and provision of requisite equipment for proper treatment of HCW would promote environmental safety in HCW disposal.

In another study by Kaposi et.al, (2024) on Analysis of healthcare waste and factors affecting amount of hazardous healthcare wastes in a university hospital. This study aims to analyze the amount of healthcare waste (HCW) and the change in that amount over time, as well as to explore and quantify the factors that influence hazardous healthcare waste (HHCW) in a university hospital. Descriptive statistical analysis, Spearman's correlation and robust regression were performed to characterize the data. The analysis revealed that the amount of HCW has been increased annually by 2.11%, and the generation rate ranges between 2.53 and 2.68 kg/bed/day. The amount of HCW has increased by 20.19% over the 5-year period studied, with a generation rate varying between 1.13 and 1.31 kg/bed/day. It was found that surgical units, anesthesiology and intensive care, and emergency patient care have higher rates of hazardous waste production. A significant positive correlation was found between the amount of hazardous waste and the incidence of healthcare-associated infections ($r = 0.704$), and the number of diapers used by adults and children ($r = 0.555$), whose significant predictive role was also confirmed by the robust regression.

In a study by Odesanya et.al, (2018) on Biomedical waste generation and management in public sector hospital in Lagos city, Nigeria. This study examined the healthcare waste management practices of selected hospitals in Lagos, Nigeria. The study specifically compared the regulations and practices regarding healthcare waste management of public hospitals with that private hospitals in Lagos, Nigeria. Findings from the study revealed that the public hospitals have waste management policy. One of the private hospitals does not have a waste management policy. Both the public and private hospitals have waste management plan as well as a waste management team. Supervisory staff members of all the hospitals have waste management responsibilities included in their job descriptions. The findings of this study also indicated that the two public hospitals generate more wastes than the private hospitals. This is expected given that the public hospitals have more number of beds, wards and departments compared to private ones. Apart from one of the private hospitals, all the three hospitals segregate their waste into different categories. This is done by first identifying

the waste type and then separating non-infectious or general waste from infectious waste.

Strategies that can be used in sustaining a holistic biomedical waste management

In a study done by Ogbonna et.al (2014) on waste management options for Healthcare wastes in Nigeria: a case study of port Harcourt Hospitals. The study was done to identify the waste disposal options adopted by the different hospital authorities in managing wastes generated as well as determining their awareness level on hospital waste management issues. Five hospitals in Port Harcourt metropolis were randomly selected as a representative of the health care institutions in the area. Sampling was conducted for a period of 6 months to determine the effectiveness of hospital waste management practices. The hospitals were grouped into 3 categories namely large, medium and small, due cognizance of privately and publicly/government owned hospitals were noted. In this study, the University of Port Harcourt Teaching Hospital (UPTH) represents the Teaching hospitals, Braithwaite Memorial (BMH) hospital is government owned general hospital while St. Patrick Hospital represents a specialist home. Others were multinational company hospitals, such as the Shell Petroleum Development Company (SPDC), Agip and Elf oil companies, which were located variously in their areas of operation for their staff and host communities and finally Orogbun health Center in Ogbunabali, Port-Harcourt was classified for this study as representing primary health centers. The selected hospitals were carefully chosen to ensure geographical spread, and for adequate representation of large, medium, small sized hospitals in the survey. Also within the selected hospitals due cognizance of privately and public owned were noted. The scaling of hospitals to large, medium and small was based on bed space, bed occupancy rate, wards/units, staff strength and patients. Sampling was carried out for each category and vital information included nature of waste generation and disposal methods for both solid and liquid wastes. Data were obtained by administering questionnaires to hospital staff such as consultants, medical officers, paramedics (matrons, nurses, cleaners, pharmacists), and administrative personnel. The questionnaires were designed in such a way as to enable respondents indicate wastes types generated and disposal methods. The findings further show that all the hospitals fell below the recommended waste management practices as prescribed by the World Health Organization and other regulatory authorities. Wastes were not segregated into marked or color coded containers/bins for the different waste streams neither do they keep records of waste generation and disposal. Recommendations are made for training of personnel on waste handling and provision of safety gadgets and proper education on waste reduction strategies. This process will ensure a reduction in the quantity of medical waste generated which is more expensive to manage

In another similar study by Failai et.al, (2023) on assessment of sustainable healthcare waste management practices among hospital workers in Owerri, Nigeria Inadequate management and disposal of healthcare waste (HCW) in Nigeria has raised serious concerns due to its pernicious impact on human and environmental safety. The study assesses sustainable HCW management practices among hospital workers within a large hospital in Owerri, Imo State. In doing this, the study predicted the likelihood of being trained on sustainable management of HCW based on workers' occupation, years of experience and common waste disposal methods. Also, the study measured prevalent HCWs in order to ascertain their main dimensions. Data collection for the study involved cross-sectional survey of workers in the selected hospital. Logistic regression was applied in predicting the likelihood of being trained on sustainable management of HCW, based on three categorical predictors: Occupation, years of experience and common waste disposal methods. Also, principal

component analysis (PCA) was applied in ascertaining key dimensions of eight prevalent HCWs.The study recommends providing multipurpose HCW treatment systems, which can integrate recycling of general waste and incineration of special waste.

In another study by Idowu et.al, (2024) on assessment of medical waste management practices in selected hospital (A case study of Owo, Ondo State) The study examined assessment of medical waste management practices in selected hospital and adopted descriptive cross sectional design utilizing quantitative method of data collection. Simple random sampling was used to select 244 health care personnel comprising of doctors, nurses and support staff all from the casualty, orthopedic and the general surgery departments. Structured questionnaires were administered to them for quantitative data. Quantitative data were analyzed using the quantitative program for social and market research (QPSMR) and chi squares and the level of significance was set at $P \leq 0.05$. Descriptive statistics were carried out to determine relative frequencies, percentages and means of variables. It is therefore recommended that there is need to have a constant supply of the equipment and more importantly the segregation bags. Moreover, there is need to train the healthcare personnel especially the doctors as they seemed to be less aware of medical waste management.

In a study done by Isyaku et.al, (2015) on assessment of Health care waste management (HCW) management practices at Ahmadu Bello University Teaching Hospital (ABUTH) Zaria and Ahmadu Bello University Health Service (ABUHS) A.B.U. Zaria. The study utilized two sets of questionnaire to capture HCW management practices including collection, segregation, storage, disposal and treatment. One of the set of questionnaire was administered to all the waste handlers while the second set of questionnaire was administered to all the heads of waste management units in each of the hospitals. While the former was used for identifying the HCW management practices in the two hospitals, the latter was used for assessing the effectiveness of HCW management practices in the hospitals in accordance with Townend and Cheeseman (2005) guidelines. The study established the total quantities of HCW generated at ABUTH and ABUHS as 845kg and 77kg per day respectively; which translates to 1.18kg and 1.54kg per day per bed at ABUTH and ABUHS respectively. The study revealed availability of operational staff specifically responsible for medical waste management and personal protective equipment for use by medical waste handlers in both ABUTH and ABUHS. The study further revealed availability of receptacles, storage containers, dumpsites and separation of collection of sharps or infectious materials at both ABUTH and ABUHS. The study, however, also established absence of color coding, central purpose-built storage facility, recycling on healthcare waste management in both ABUTH and ABUHS. It was concluded that both the ABUTH and ABUHS are classified as Level 2 hospitals based on their operational performance in accordance with the Townend and Cheeseman (2005) guidelines, which implies that some aspects are considered sustainable while some other aspects considered unsustainable. The study recommended more sustainable practices in the management of HCW. Given the importance of effective healthcare waste management practices and the current unsustainable level of performance, the study recommended further study on the effects of the healthcare wastes from the two hospitals on the environment (soil, water and air).

5. CONCLUSION

Based on the findings from the study on knowledge, attitude and practice of health workers on biomedical waste management practice it was seen that most health workers had good knowledge, attitude and practice of biomedical waste management however some health facilities as stated in the study by

Musa et al. (2023) showed that some health workers had poor knowledge of biomedical waste management and some of the hospitals lacked adequate provision of color coded waste bins to help separate hazardous wastes from non hazardous wastes. Also findings from challenges and factors affecting biomedical waste management in hospitals showed that most health care facilities lack incinerators for treating biomedical wastes generated in the hospitals but rather burn them in pits which is a practice that is hazardous to the health of the health workers and patients. Also most of the health facilities lacked adequate trained staff on proper biomedical waste management practice as well as low compliance with biomedical waste practice.

Lastly, good medical waste management in hospitals depends on a dedicated waste management team, good administration, careful planning, sexual organization, underpinning legislation, adequate financing and full participation by trained staff. A holistic approach to healthcare waste management should include a clear delineation of responsibilities, occupational health and safety programs, waste minimization and segregation, adoption of safe and environmental sound technologies and capacity building. However, it is pertinent that before any of these options is adopted hospitals and medical facilities will need to assess the problems and put forward a management strategy that is suitable to their economic circumstances and also sustainable for use based on local technology.

6. RECOMMENDATIONS

Based on the findings from the study the following recommendations were made;

1. Health education and training should be recommended for the health care workers especially for the cleaners and ward attendants periodically and regularly.
2. Provision of color-coded waste bin liners in all wards and departments which should be adequately budgeted for by the management should be encouraged.
3. Training of health personnels on waste handling and provision of safety gadgets and proper education on waste reduction strategies should be largely encouraged.
4. Relevant regulating agencies should intensify their efforts towards monitoring and regulation of healthcare activities and ensure staff training on safe handling and disposal of hospital waste are encouraged.
5. Government should establish policies and laws that will help to enforce strict compliance with biomedical waste management practice in accordance with WHO stipulations.
6. Provision of multipurpose healthcare waste (HCW) treatment systems, which can integrate recycling of general waste and incineration of special waste should be encouraged.

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