MPRI-JEDIR | INTERNATIONAL JOURNAL OF EARTH DESIGN & INNOVATION RES.
VOL. 1 NO. 1 JUN-2022

A CRITICAL EXAMINATION OF HOSPITAL WASTES MANAGEMENT PRACTICE IN SOME PARTS OF NIGER STATE, NIGERIA

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Abstract

The operations of hospital healthcare facilities generate large amount of wastes; a common characteristic of hospital institutions. However, improper handling of hospital wastes constitutes potential risks to the environment and public health. Unfortunately, medical waste management is not yet carried out with a satisfactory level of safety in many parts of the globe, especially in the developing countries. This study was conducted in some parts of Niger State, Nigeria. Seven public and three private hospitals were selected. The study was carried out with the aim of examine medical waste management practices among selected hospitals. A cross sectional descriptive study was carried out between November, 2018 and April, 2019. Questionnaire, and field participant observations were used for data collection. Majority of the staff of the hospitals were nurses/midwife (49.7%), paramedical with (33.8%), medical doctors (9.7%) and (6.8%) were waste handlers. Results shows that about 72.7% of respondents say only syringes and needles [redacted] wastes were segregated, 98.1% say there is not waste management manual and plan exist in the hospitals, and 98.6 had no specific training on medical wastes management. Wheel barrow was the commonest method of transporting wastes and open surface burning was the common final method of medical wastes treatment and disposal by the hospitals. This study showed that the current practices of management

KEYWORDS:
Medical waste management, Potential risk, public health, infectious and environmental pollution.

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of hospital healthcare wastes employed were not safe. There is urgent need for safer means of waste disposal among the medical facilities visited. It was, therefore, recommended among others that medical waste management plan, funds should be made available to the hospitals. This is to ensure the acquisition of all facilities needed in medical waste management and disposal. There should be training and re-training of health staff on current medical waste management to meet global best practices.

Introduction

All over the world, there is a continued growth in the number of hospitals and other health facilities in order to meet the healthcare demands of the alarming population growth (Titto *et al*., 2012). However, different healthcare activities in these health institutions has contributed to the large amount of healthcare wastes being generated (WHO, 2018). Hospitals healthcare facilities protect, restore health and save patients' lives (Annette et al., 2013). The high generation rates of wastes compounded by poor handling and disposal practices have led to increased risks in environmental pollution and diseases transmission (Hassan *et al*., 2017). Due to these facts, medical wastes (MW) are environmental as well as public health issues that attract attentions in both advanced and developing countries ((Hassan *et al*., 2017)). However, of the total amount of wastes generated by healthcare activities, about 85% is general, non-hazardous wastes. The remaining 15% is considered hazardous wastes that may be infectious, chemical and radioactive, but healthcare wastes is often not separated into non-hazardous or hazardous wastes in developing countries making the real quantity of hazardous wastes much higher (WHO, 2018)

Those wastes are both in solid and liquid form. On average, hospitals generate 750 liters of wastewater per bed per day which is loaded with pathogenic microorganisms, pharmaceutical partially metabolised materials, radioactive elements and other toxic chemical substances. This wastewater has a high potential of carrying micro-organisms that can infect individuals as well as the community exposed to it, if not properly disposed of (Babanyara *et al*., 2013). Wastes generated in the course of hospital healthcare activities entails a higher risk of injuries and infection than municipal waste. Thus, the management of hospital wastes requires special attention and needs to be assigned high priority (Sabiha *et al*., 2008). The UN Convention considers health care wastes as the second most dangerous wastes after nuclear wastes. Being hazardous and

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infectious, medical wastes also pose serious threats to public and environmental health as they may pollute air and contaminate soil and water sources. Thus, to protect human and environmental health, healthcare wastes require specific treatment and management prior to final disposal.

Health care wastes include all the wastes generated by all health care establishments, health research facilities and health-related laboratories. They also include wastes generated by home health care activities such as dialysis and insulin injections (WHO, 2018). Yearly an estimated 16 billion injections are administered worldwide, but not all of the needles and syringes are disposed of properly (WHO, 2018). In developing countries, scavenger families make a living on recycling materials from open unsanitary sites and these are at great risks especially from sharp wastes from healthcare services. Hence, the management of healthcare wastes requires special attention and needs to be assigned high priority. This has been supported by the World Health Organization estimates that unsterilized syringes alone cause between 8 to 16 million cases of hepatitis B, 2.3 to 4.7 million cases of hepatitis C and 80,000 to 160,000 cases of HIV every year (Emmanuel *et al*., 2007). Another estimate also shows that 5.2 million people in the world (including 4 million children) die each year from medical wastes related diseases (Akter, 2007).

In many developing countries, regulations governing safe disposal of healthcare wastes are either lacking or poorly enforced. In these countries, poor clinical wastes management and especially inefficient segregation, treatment and disposal methods threaten the environment, occupational and public health as the potential for the transmission of blood borne pathogens increases (Solberg, 2009; Babanyara *et al.,* 2013). An assessment done in 22 developing countries by WHO shows that the proportion of healthcare facilities (HCFs) that do not use proper waste disposal methods ranges from 18 to 64% (WHO, 2004). In addition to the fact that wastes are never segregated and poorly handled in these countries, creating additional environmental problems because healthcare wastes contains a large proportion of polyvinyl chloride (PVC) plastics. When PVC plastics are incinerated, they release dioxin into the atmosphere. Dioxin is a lipophilic and bio-accumulative toxin, which moves up the food chain easily from plants to animals and then to human beings. Dioxin is a well-known of human carcinogen, endocrine and immune disorders. It is transported by water and air (Esubalew, 2015).

Poor healthcare waste management in Taiwan in 2003 led to a severe outbreak of acute respiratory syndrome that forced the authorities to take more serious

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measures in managing healthcare wastes (TEPA, 2003). Thus several studies have indicated a clear relationship between exposure to medical wastes incinerators as well as open burning emissions. For instance, related studies conducted in Germany, Spain and Japan showed that hospital wastes incinerator or open burning workers, children and other residents living near such practices have significantly higher blood or urine levels of dioxins, furans, and hydrocarbons compared to unexposed groups. In the United States, Finland and Germany, higher prevalence of urinary mutagen and promutagen, higher levels of mercury in the hair, cadmium and lead in the blood, arsenic in urine among incinerator workers or residents living closer to the treatment sites have been reported (UNEP,2012).

Furthermore, studies conducted in the United Kingdom, France, Japan, Sweden and Italy found clusters of soft tissue sarcoma and non-Hodgkin's lymphoma, increased risks of laryngeal, lung stomach, colorectal, liver and lung cancers among populations living near incinerators. More so, in Italy, U.S. and Sweden incinerator workers have been reported to have significantly higher gastric cancer mortality; high prevalence of hypertension and related proteinuria and excessive deaths from lungs and ischemic heart disease (UNEP,2012)

According to WHO, 2019 air pollution in Nigeria is getting worse, as figures from the 2017 State Global Air database show the country leads Africa in air pollution related deaths. According to Health Effects Institute and the Institute for Health Metrics and Evaluations, more than 114,000 premature deaths in Nigeria in 2017 were attributable to air pollution. Based on State of Global Air (SOGA) report released on Wednesday 3 April 2019, Western Sub-Saharan Africa had the second highest PM2.5 exposures in the world, with Niger (94 ug/m3) ranked the highest. Cameroon was second worst with (73 ug/m3) and followed closely by Nigeria (72 ug/m3)2. In the West Africa sub region in 2017 around 264,000 deaths were attributed to air pollution. In Nigeria, pollution levels exceeded the WHO guideline for outdoor PM2.5 as much as 7 times. The WHO recommended annual guideline for PM2.5 is 10 up/m3. PM2.5 are ultra-fine particles of 2.5 micrometers or less in diameter, which are linked to heart disease, stroke and lung cancer, ug/m3= micrometers per cubic meter. Nigeria suffers from a serious lack of air pollution data, cities do not regularly monitor and report their air quality. Air pollution in Nigeria is caused mainly by exhaust from cars, wastes materials fires, industry and diesel generators. There is a significant relationship with the forgoing with the

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poor management of wastes particularly medical wastes in Africa. Since surface open burning of hospital wastes is commonest practices in the region

In developing countries such as Nigeria and Niger State in particular, medical wastes have not received sufficient attention and the priority they deserve. This is because inadequate or poor wastes management processes in which hazardous medical wastes are still handled and disposed of with non- hazardous wastes thus posing a great health risk to the healthcare workers, the public and the environment, just as observed by Shaibu (2014) in Minna reported that medical wastes management in both primary and tertiary care facilities were poorly handled in terms of segregation, treatment, collection, transportation and training of healthcare personnel. Similar results reported by Silva *et al.* (2005 and Ibijoke *et al.* (2013).

The absence of medical wastes management policies, guidelines, strategies and manuals in the study area has led to poor management of medical wastes. In addition, unavailability of adequate research data with regards to wastes generation rates, composition, hospital wastewater treatment and management practices have posed profound challenges in planning appropriate MW management methods in the state. These are the main reasons for the poor management of medical wastes and absence of suitable intervention strategies for the improvement of medical wastes management in the study area. This, in turn, makes it difficult for decision makers to adequately tackle the menace of medical wastes in the state. Therefore, this research is aimed at filling the existing information gabs by empirically examining the environmental and health implications of medical wastes management practices in selected hospitals in Niger State in order to highlight and prioritize these critical issues. It is also the objective of this study to make recommendations on the ways to improve medical wastes management strategies in the state and possibly the country in general. In addition, very little empirical studies have been reported in literature in this field in the study area. Therefore, the study is important for the assessment and improvement of wastes management systems as well as increased public awareness on the hazards of these wastes.

Sustainable Development Goals (SDGs). Specifically, SDG 3 empasizes the **e**nsurrance of healthy living and promotion of well-being for all at all ages. Strengthening primary health care and achieving health for all requires special attention on medical wastes generated, their management practices, adequately motivated professional workforce in terms of funding and other supports. Sadly,

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however, these are far from the reality in most developing countries. Thus the realization of SDG 11 goal which states that: Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable is a farfetched issue in most developing countries. More than half the world's population now lives in cities, and that figure will go to about two-thirds of humanity by the year 2050 since cities are getting bigger (UN, 2019). Consequently, these will contribute to the large amounts of healthcare wastes being generated. Therefore, a comprehensive research is required for the development of a sustainable MW management system that can minimize the health and environmental risks in a given country. Thus Niger State, if it is to be recognized in the committee of states that are ready to realize the SDG goals especially SDGs 3, 6 and 11, needs to consider management of wastes and particularly the healthcare wastes a major issue in its fiscal planning.

Study Area

The study which was conducted in Niger State, North-Central Nigeria involved selected towns (Minna, Kontangora, Bida, Suleja and Wushishi). Niger state lies between latitude 3.2° East and longitude 8° and 11.3° North with Minna as its capital. It has a land area of 76,363 square kilometres with population of 4,082,558 (National Population Commission, Census 2006). Nupe and Gbagyi are its major tribes while, Hausa, Kambari, Koro, Kamuku and Pangu constitute its minority tribes. The State has 25 Local Government Areas. It is bordered by Kogi and Kwara states in the South West. FCT and Kaduna state in the North East. The state is also bordered by Kebbi and Zanfara states in the North West. Niger State is within the semi-arid region of the savannah and Figure 1.1 shows the location of the study area.

The study covered 10 selected hospitals. The public hospitals with the respective bed capacities; IBB Specialist Hospital Minna (100), General Hospital Minna (296), Minna General Hospital New Extension (150), General Hospital Kontagora (250), General Hospital Bida (100), General Hospital Suleja (140) and General Hospital Wushishi with 87 bed capacities were selected for the study. While selected for this study as the private hospitals with their bed capacities were; Standard Hospital Minna with 50, Maharaba Hospital Bida with 20 and Al-Azeez Hospital Kontagora with 24 respectively. These are amongst the largest hospitals which generate considerable amounts of hospital solid wastes and wastewater. Since they have the average flow of inpatients and outpatients of between 50 and 200 per day.

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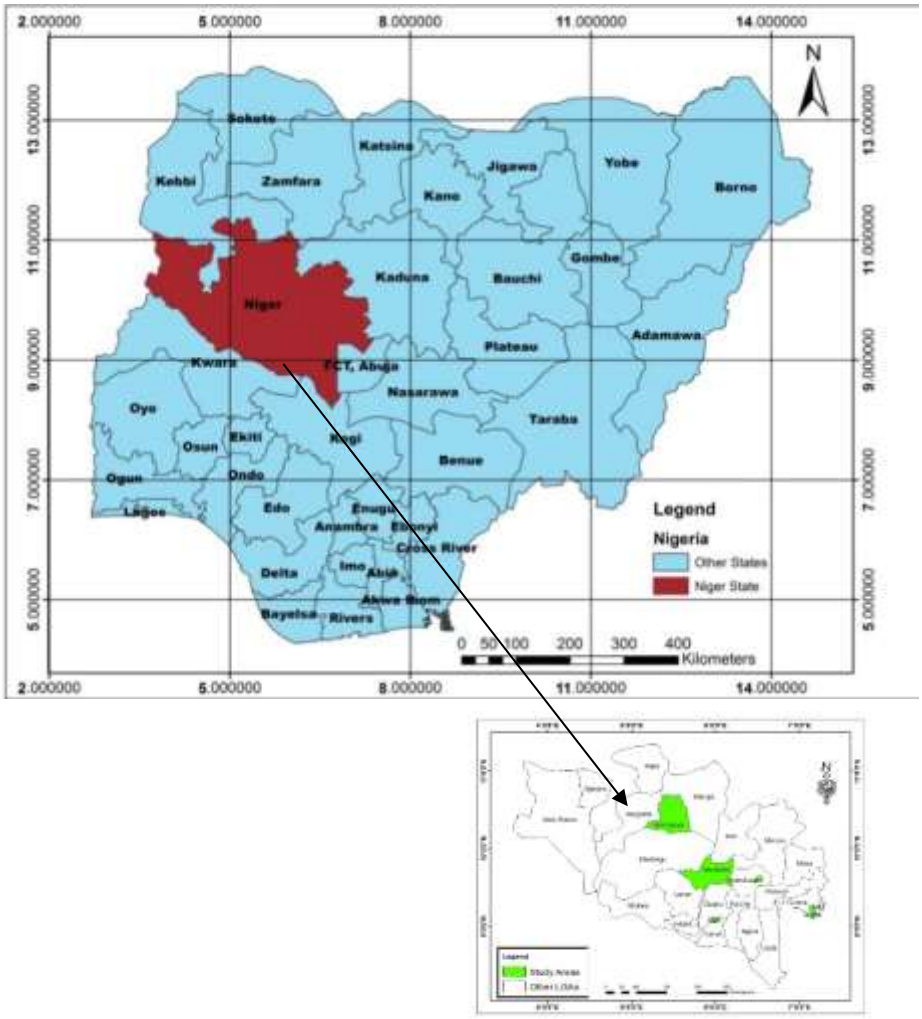


Figure 1.1: Location of Study Areas in Niger State, Nigeria.
Source: Remote Sensing and GIS Lab., FUT Minna, 2019

MATERIALS AND METHODS

The objective of this study was to examine current practices of medical waste management in parts of Niger State. To achieving this study objectives the researcher employed questionnaire and empirical approaches, visits were paid to the selected hospitals, the State Ministry of Health, State Hospital Services Management Board and Niger State Environmental Protection Agency for interaction before starting the main activities. Aimed to identify the process of

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medical waste management, related problems and strategy plans for the study were developed.

Sampling Procedures

Selection of hospitals

Purposive sampling was used in the selection of the hospitals which included seven public hospitals: General Hospital Minna, General Hospital new extension Minna, IBB Specialist Hospital Minna, General Hospital Bida, General Hospital Suleja, General Hospital Kontagora, and General Hospital Wushishi were selected while for the private ones: Maraba (Aisha Usman Hospital Bida, Standard Hospital Minna and Al-Azeez Hospital Kontagora, were considered.

Sampling frame/size

The sampling technique utilized was the non-probability sampling (census survey) procedure. According to Mohajer (2013), sometimes, the sample may be sufficiently small and the researcher has to include the entire population in the study hospitals. This type of research is called census study because data are gathered on every member of the population. This type sampling procedure was employed in this study because the target groups (medical doctors, nurses / midwifes, paramedical and wastes handlers) since are directly responsible in hospital wastes generation and handling.

Data Collection

To examine the overall practice of MW management in this study, both quantitative and qualitative methods were utilized. A semi- questionnaire, self-administered questionnaire, focus group discussions (FGD) and field observations with heads of hospitals, doctors, nurses, pharmacists, laboratory technicians, waste handlers, NISEPA and Ministry of Health and Hospital Services Management Board were engaged in the study. The main questions asked were on segregation, collection, transportation, storage, treatment, disposal, re-cycling and re-use of generated wastes, occupational health and safety, policies, plans, training, and budget for healthcare waste management. The study conducted from November 2018 to May 2019

Methods of Data Analysis

The questionnaire, focus group discussions, observations and interviews were analyzed using statistical Excel and SPSS version 22.0 (Statistical Package for the Social Sciences) software. The SPSS was used to provide statistical analysis of data. Data analyzed were entered in a format where cases (each question in the

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survey) are represented by rows and variables (the different replies to one question of a survey) are represented by columns. Then the data were manipulated and changed to percentage scale. Descriptive analysis tables, frequencies, percentages, means and charts were utilized to describe various variables encountered in this study.

Ethical approval

Ethical approval to conduct this study was obtained from Niger State Ministry of Health and Hospital Services before the beginning. The hospital and the respondents were made aware of the fact that the research is purely an academic requirement and as such, information gathered will be treated with strict confidentiality.

RESULTS AND DISCUSSION

The results and discussion from completed questionnaires, focus group discussions, key stakeholders' interviews and observations from the study. A total of 1,503 questionnaires were administered and 1,405 returned completed by the study participants.

The current practices of medical waste management

Medical waste management practice includes all activities of healthcare waste segregation and sorting, storage, collection, transportation, treatment, disposal and other safety measures in the health institutions.

Outline of surveyed groups

Figure 1.2 shows an outline of the types and distribution of the healthcare workers surveyed during the main questionnaire administration. A total of 1, 405 responses were returned by all the four (4) target groups. 137 of this number were from medical doctors, equivalent to 9.7%, 698 responses (49.7%) were received from the nursing/midwifery staff, 475 (33.8%) from paramedical while, 95 (6.8) were received from waste handlers

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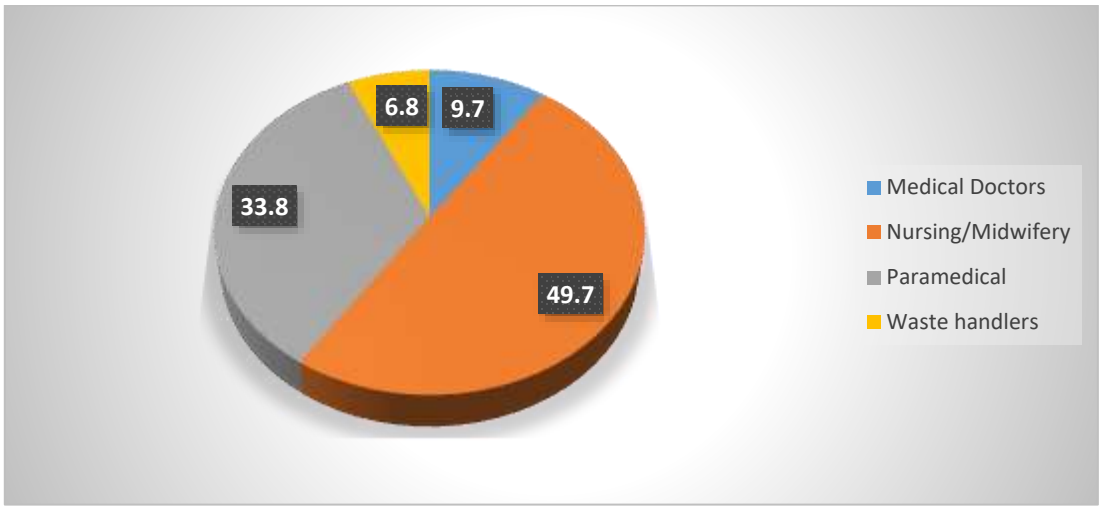
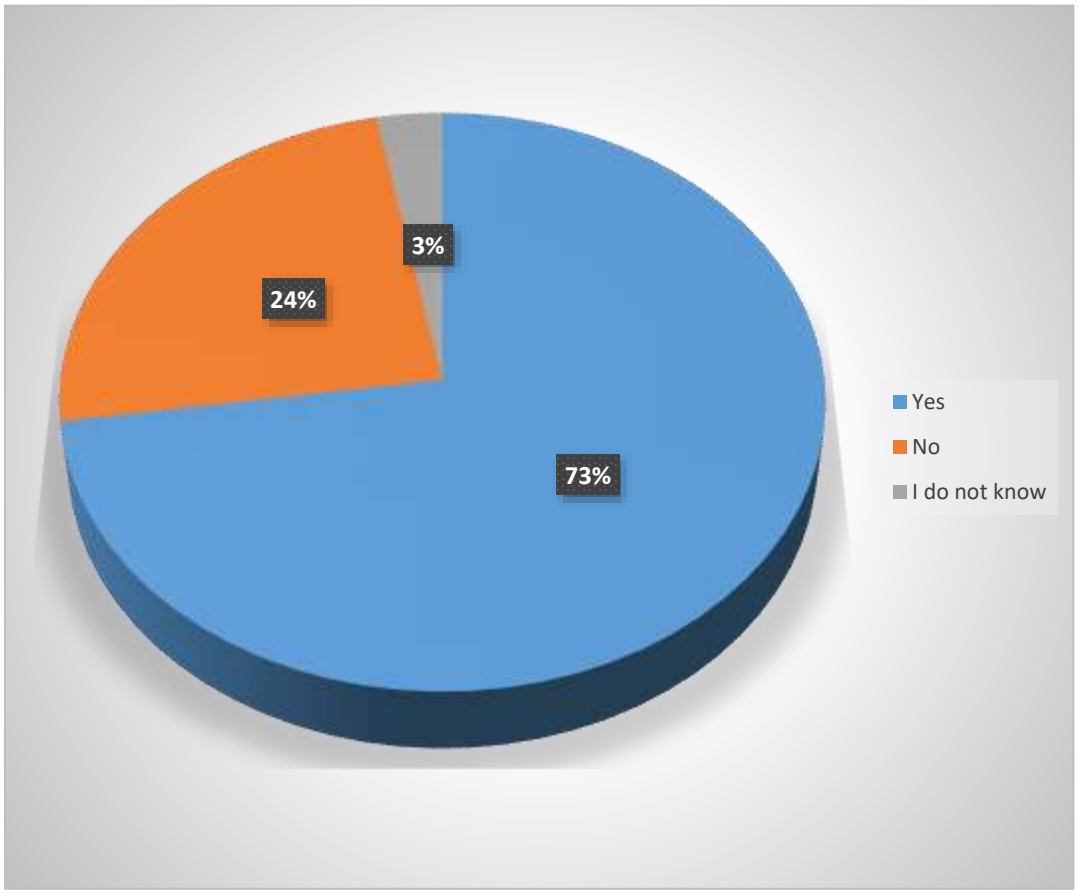


Figure 1.2: Distribution of Professional healthcare workers surveyed

Segregation

The results of respondents presented in Figure 1.3 reveals that about 1021(72.7.%) of the respondents stated that medical waste is segregated in each department, while 342 (24.3%) denied the existence of segregation methods/processes for



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medical wastes in the hospitals whereas 42(3.0%) do not know if there are segregation processes for these wastes or not.

Figure 1.3: Distribution of respondents' knowledge on the existence of medical waste segregation practices in the hospitals

The types of medical wastes segregated in the surveyed hospitals are shows in Figure 1. 4.. The most common types of medical wastes mentioned by the respondents to be segregated are; sharp objects like syringes and needles, 1296(92.2%) and pathological wastes, 109(7.8%). Only these two categories of wastes were therefore mentioned to be segregated before final disposal. In the case of segregated syringes and needles it was noticed that they were not destroyed before final disposal with other wastes as shown in Plate 1.

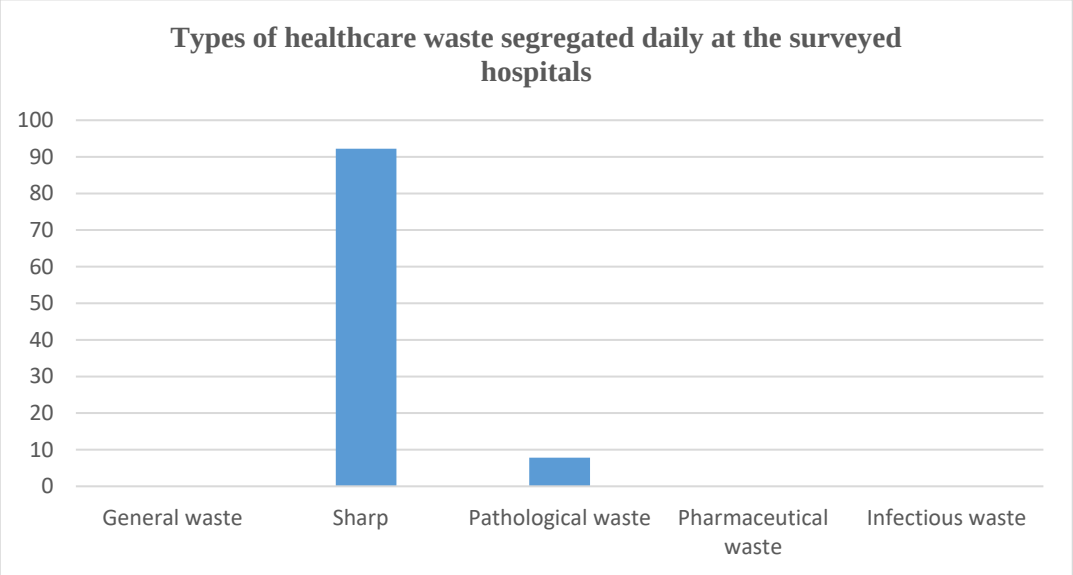


Figure 1.4: Distribution of respondents' knowledge on the type of medical wastes segregation practices in the hospitals



Plate I: Syringes and needles disposed with other wastes in a clinical waste receptacle

Source: (Author's Field Work, 2019)

Labeling and colour coding of the segregated wastes

The absence of colour- coded waste containers, polyethylene (PE) bags and safety boxes for sharp wastes make it difficult to apply the regulation of the WHO recommended system in many hospitals especially in Niger State. Labeling of hazardous and other waste types was completely absent in all the selected hospitals. As shown in Figure 1.5, about 1378(98.1 %) of respondents stated that complete absence of labeling and colour coding of waste was the usual practice in almost all the hospitals in Niger state.

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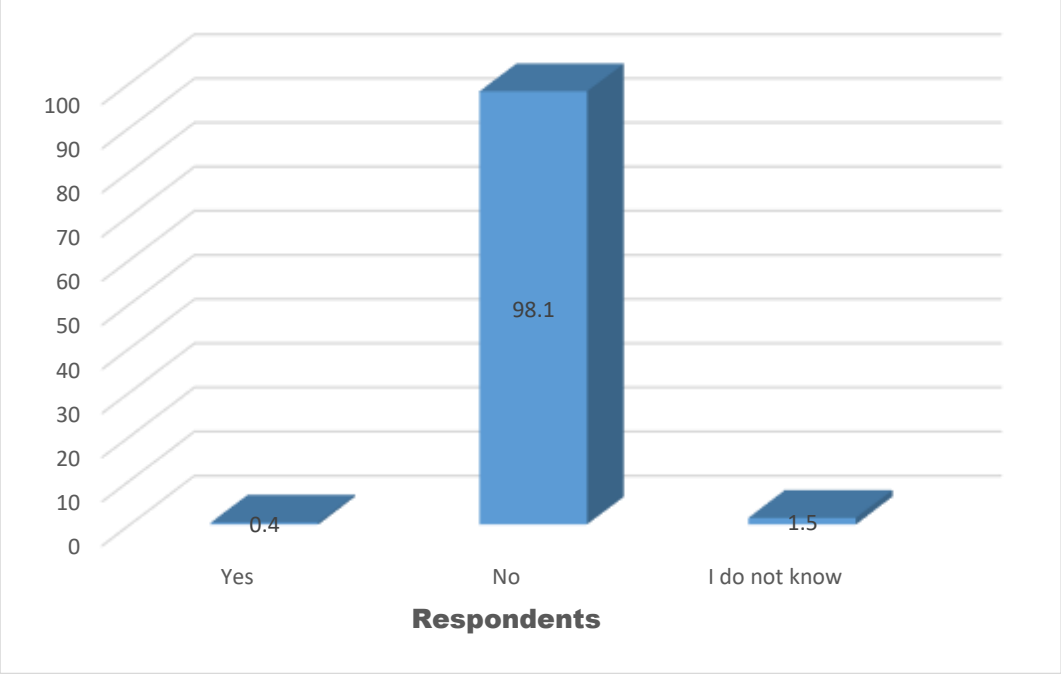


Figure 1.5: Distribution of Respondents Knowledge on practice of labeling, color coding of the Segregated Wastes

Temporally storage of healthcare wastes and on-site transportation practices

The results of this study Figure 1.6, revealed that about 1137 (80.9%) of respondents said that medical wastes are stored temporarily in the hospital while, 213 (15.2%) disagreed. 55 of respondents equivalent to 3.9% did not known or distinguish between temporally storage of medical wastes and surface dump sites located in the hospitals, since these storage sites do not bear clear marks for these purposes. However, it was noticed that the selected study hospitals visited use big metal containers, plastic bins and bare ground surfaces for the storage of the collected hospital wastes (Plate II).

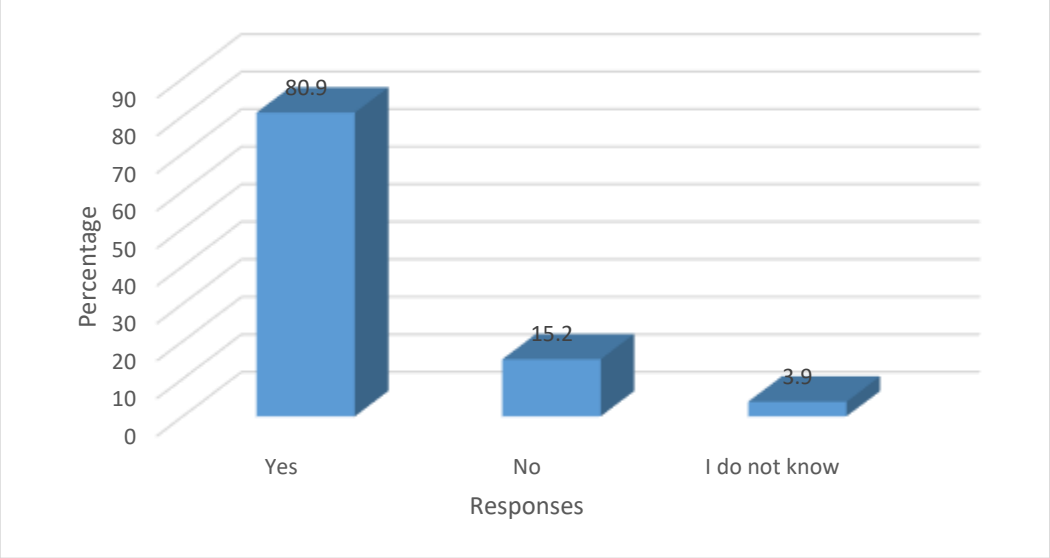


Figure 1.6: Respondents Knowledge of the Existence of Temporally Storage Practices for Medical waste Disposal









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Plate II: Temporal Storage Facilities Available in Hospitals (a) Use of polythene bags and metal drums (b) Open metal container (c) Open metal container and polythene bags under roof (d) Ground surfaces (e) Plastic and sack. Source: (Author's Field Work, 2019)

Collection of hospital healthcare waste practices and containers used

At the selected hospitals for this research, there are no defined structured collection systems for general and hazardous wastes. Wastes are collected at the points of generation (wards, operating rooms, laboratories, and offices). Results presented in Figure 1.7, show that, the most common types of containers used to collect the medical wastes mentioned by the respondents are black plastic bags; 177(12.6%), open plastic; 683 (48.1%), plastic bin and safety boxes; 188(13.4%), small plastic bins of 3-10 kg; 206 (14.7%) while 151(10.7%) represents the responses of hospitals use open plastic and metal buckets to collect medical wastes. respondents who said 50 kg plastic bins are used for this purpose. The results reveal that most

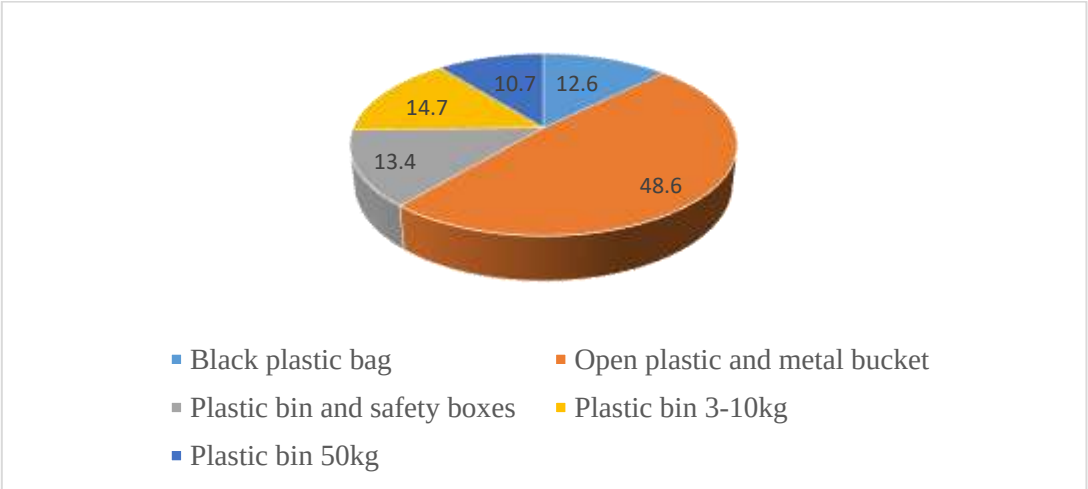


Figure 3.6: Knowledge of respondents of the type of Containers used to collect medical waste

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Plate III: Type of containers used to collect hospital waste (Source: Field work, 2018) (a) Open plastic (b) Plastic and metal buckets (c) Carton safety box (d) Close plastic bin (e) Carton safety box and open plastic bin (f) Open metal bucket (g) Open plastic bin
Source: (Author's Field Work, 2019)

Off-site transportation

The interviews conducted at the selected hospitals, revealed that heads of hospitals have a contract with Niger State Environmental Protection Agency (NISEPA) that collect their wastes once a week but the arrangements differ according to the sizes of the hospitals. Large hospitals like IBB Specialist and General Hospital New Extension Minna transport their medical wastes more than once in a week. However, the vehicles used for off-site transportation of medical wastes use similar vehicles (open Tipper) used for ordinary municipal solid wastes disposal, a practice which falls far below the WHO standard specification required for medical wastes transportation. In addition, in most cases wastes are transported without or with improper covers.

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On-site Treatment and final disposal

Treatment and disposal options in the hospitals selected in this study range from the use of open fire pits, landfills, surface burning, surface dumps and sub-standard incinerators. According to the interviews conducted, Niger State Ministry of Health and Hospital Services have four incinerators for medical wastes; only one of them is currently working and the others are out of service. The incinerator in General hospital Minna currently working is operated by three workers who operate it once in a week with 1-3 cycles per day. The capacity of the incinerator for each is 70-100 kg of medical wastes and it takes five hours per cycle. The operation temperature for this process is from 700 - 800 ℃. The new extension general hospital which is opposite the Old General Hospital equally utilizes this same incinerator. Direct observations and the results of interviews conducted on the residents within and outside the hospital indicate that the existing incinerator is considered as the main source of air pollution inside and around the hospital due to the thick smoke released by the process. This is mainly as a result of the fact that the operators are not properly trained and the operational capacity of the incinerator is not efficient.

The remaining three incinerators located at Bida, Suleja, and Kontagora General Hospitals are out of service and need maintenance. While, the rest of hospitals sampled in this study burned their medical wastes in open fire pits and surfaces at their backyards except IBB Specialist Hospital that burns its medical wastes outside the hospital premises on the surface. Most importantly, segregated syringes and needle wastes are burnt together with all other wastes at hospitals backyards, without prior pre-treatment of the wastes before burning (Plate IV).



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PLATE. IV: Treatment and final disposal practices (Source: Field work, 2018) (a) Incinerator (b, and e) Residual of Open surface burning (c) Open pit burning (d) Surface burning (f) open surface burning (g) Ash buried pit. Source: (Author's Field Work, 2019)

Off-site Treatment and final disposal

According to the interviews, Niger State Environmental Protection Agency (NISEPA), surface burning and open fire pit are the commonest treatment of medical waste treatment practices disposed together with domestic wastes, without prior pre-treatment of the wastes before burning. This practices is totally against WHO standard and this calls for urgent intervention.

Hospital waste reuse and recycling practices

The results presented in Figure 1.8 show that, reuse and recycling of hospital wastes practices in all the selected hospitals were completely absent. During the survey, it was observed that the absence of policy documents and guidelines on medical wastes reuse and recycling absolutely make the practice unknown to the health workers. From the figure, the percentage of people that said such practices are unavailable in the hospitals is 97.1 while 2.9 percent of them said that they are not aware of such practices.

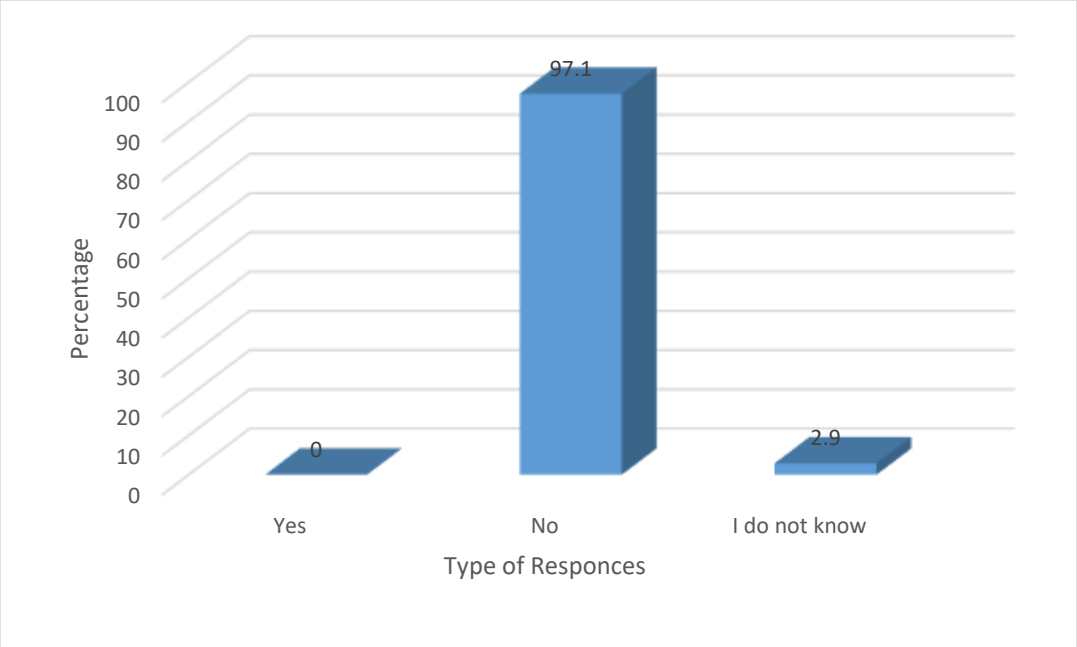


Figure 1.8: Respondents Knowledge of Presence of Reuse and Recycling of Medical Wastes Practices in the Hospitals

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Supervision and budget for healthcare waste management

In order to establish this, people were interviewed and the key officers of the Ministry of Health interviewed asserted that there is no monitory and evaluation supervision committee or body saddled with the role of supervising hospital wastes management by the Niger State Ministry of Health for both the public and private hospitals surveyed. Also, it was pointed out that no separate budget is allocated for healthcare waste management in the ministry's budget. All these are attributed to the absence of specific healthcare waste management policy document

Hospital waste management policy and guidelines

Figure 1.9 shows that about 201(14.3%) of the respondents knew that international policies and guidelines on management of medical waste do exist and that an example of such policies are those given by the World Health Organization (WHO). On the other hand, 1106(78.7%) said that they had never heard of a policy or guideline linked to the management of medical wastes. Similarly, Figure 1.10 indicates that 98.1% of respondents say that no hospital waste management manual and plan exist in the hospitals.

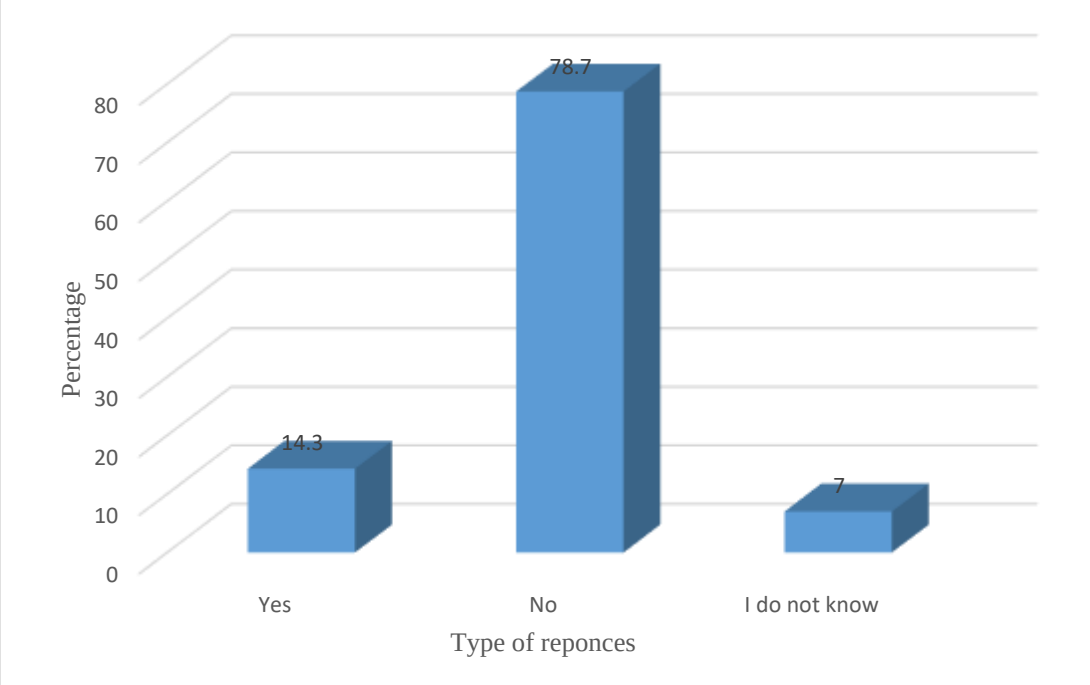


Figure 1.9: Respondents Knowledge on Presence of Hospital Waste Management Policy and Guidelines

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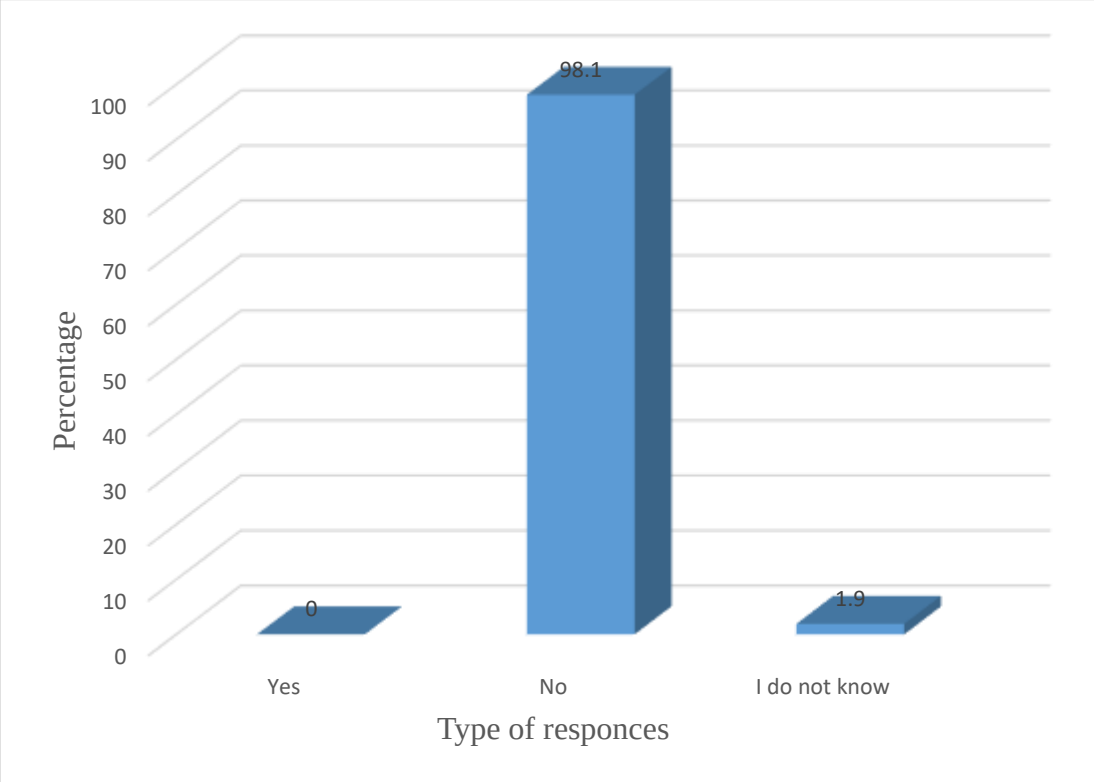


Figure 1.10: Respondents Knowledge on presences of Hospital Waste Management Manual and Plan

Training and safety device

The results of this study indicated that 98.6% of the respondents had not been trained on the field of medical waste management while, 1.4% say there received trained on the job. The interview indicated that training was not provided to doctors and nurses about medical waste management and their potential hazards .Only waste handlers who are responsible for the collection, on-site transportation, disposal and temporary storage of medical waste, are given an introductory training but this training is not enough as noticed by the researcher during the interviewed. Similarly, environmental health professionals and heads of departments in the public hospitals have not specific trained on medical waste management and have a significant lack of knowledge on how to deal with medical waste. In addition, all private hospitals surveyed had not provided any training related to healthcare waste management. Related to safety issues, waste handlers had heavy duty gloves, boots, and clothes in all public hospitals, but in private hospitals they had only heavy duty gloves and boots (plate V).

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PLATE V: Waste handler with the safety kits
Source: (Author's Field Work, 2019)

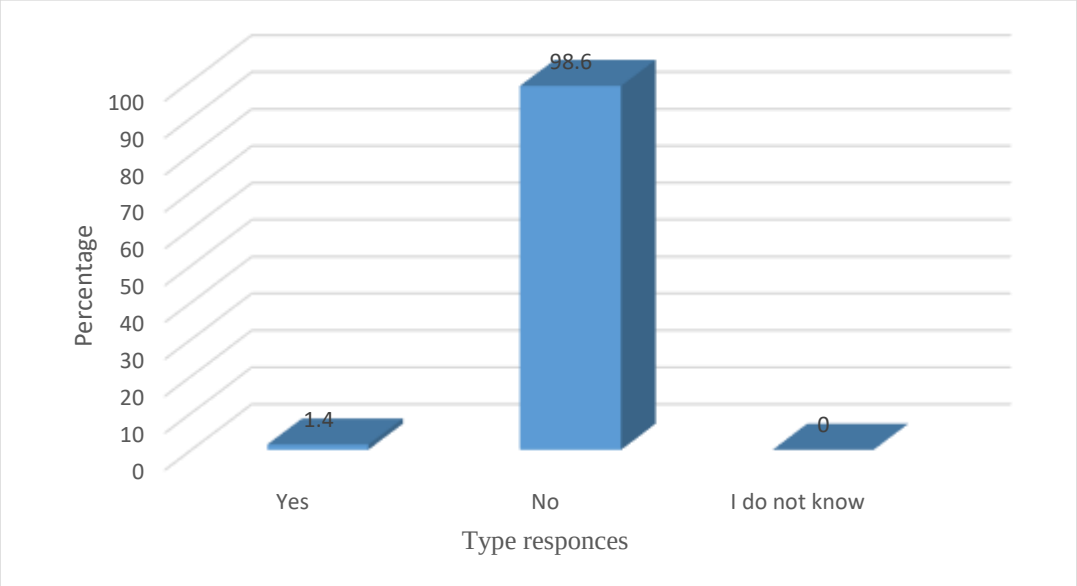


Figure 1.11: Respondents Knowledge on Presences of Staff Training on Medical Waste Management Practices

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Discussions

This study focused on the examination of current medical waste management practices, using mixed study designs. Both quantitative and qualitative data collection techniques were implemented to collect data on healthcare waste from relevant stakeholders in the selected hospitals.

The practice of current medical waste management systems

Healthcare waste management practice includes all activities of healthcare waste segregation, storage, collection, transportation, treatment, disposal and other safety measures in the health institutions. Essentially, to minimize the percentage of hazardous waste, the Ministry of Health, Hospitals and other stakeholders are supposed to develop and implement proper sustainable waste management systems in the state that will involve the use of modern management practices which is not available. The segregation of medical waste at the point of generation is the first key factor among the waste management practices system. This study reveals that there was no proper medical waste segregation practice using standard colour code containers and labels according to the international hazard symbols in all the selected hospitals. This finding is similar to the study conducted in Somaliland by Di- Bella *et al*. (2012), Kenya by Adedigba *et al.* (2010) and Ethiopia by Sisay *et al.* (2017); Ahmed (2017) noticed that there is no real application/usage of coloured bags and or containers according to the WHO standards at the two hospitals studied in Gaza Strip just as it is the case in the current study. The finding in this study is however, different from the results of the study conducted in Lagos, Nigeria by Olufunsho (2016) who found that medical wastes were segregated by the use of standard colour code containers and labels according to WHO in his studied hospitals. However, it was established in the current study that pathological wastes particularly human body parts and placentas are segregated from the point of generation and usually given to co-patients' relatives to be buried in the surveyed hospitals. However, it was noticed that the actual situation in the all the selected hospitals is that there is no real application of WHO standards in medical waste segregation practice indicating that the implementation of healthcare waste segregation is a big challenge in Niger State and even the country in general.

The absence of these key factors like the national medical waste policy, hospital waste plan management as well as poor attention to staff training and separate budget healthcare waste management policies have immensely affected

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healthcare development in Niger State in particular and Nigeria in general. The implementation of these policies have however been opined to be able to reduce the hazardous waste generation in hospitals by 17% (Esubalew, 2015).

Temporary storage exist in all the hospitals. In these hospitals, mixed medical waste (hazardous and nonhazardous) are kept in open containers and on surfaces temporarily for about 2- 4 days, without proper supervision, before final disposal. This could attract rodents, dogs, cats and insects which could potentially contaminate the environment. The mixed wastes can contain harmful agents (microbiological pathogens, hazardous chemicals, sharp and radioactive substances) that can transmit diseases and cause injury to those exposed to such sites (Singh *et al.* 2012). These containers are usually put in front of hospitals or at the back yards of the hospitals. A Private hospital (Standard Hospital, Minna) stores the wastes in an attachment to the fence of the hospital. These results are similar to the reported local study conducted in Nablus in Palestine by AL-khatib and Sato (2009) which revealed that hazardous wastes were kept in the same containers as the other categories of wastes in the hospitals. In other reported studies, similar practices of healthcare waste substandard temporary storage practices exist as reported by (Israel *et al.,* 2011) for Nigeria, Libya, and South Africa and Ethiopia by (Nemathaga *et al*., 2007). This implies that in developing countries, temporary medical waste storage practice creates environmental pollution, health risk to patients and healthcare workers as well as the general public.

On the other hand, transportation of wastes from the points of generation to the temporal storage areas are similar within the selected hospitals. In all the hospitals, the waste collector goes around with a wheel barrow and empties all the contents of the individual containers into the wheel barrow and then transports them to the temporal disposal sites. In addition, it was observed that, all the waste storage sites are substandard compared to those required by the world health organization for hospital wastes for the following reasons:

- In all the hospitals studied, hazardous HCW and non-risk HCW are mixed and stored in the same location and emptied only twice a week
- The wastes are not protected from the effects of the weather; sun, rain and animals; rats, dogs, cats, flies and birds.
- In all the hospitals, the lack of proper and purpose-built waste storage areas was apparent.

This situation is incompatible with WHO regulations which states that storage areas must be well sanitized and secured in such a way as it should be accessible

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only to authorized persons and the storage wastes inside the hospital should not exceed 72 hours in Winter, 48 hours in Summer (in cold areas) while, in the hot areas, storage should not exceed 48 h in winter and 24 h in summer (WHO, 2014). In the current study it was observed that, most common hospital wastes treatment and disposal methods practiced by all the selected hospitals are burning in open surface, open fire pit and one chamber incinerator. This observation is similar to the reported study made by Abayomi and Tolulope (2017) who identified scarce incinerator facilities at selected hospitals in Imo State, Nigeria, whereas a study by Harhay (2009) noted the absence of incineration facilities in different hospitals of Kabul. In all the selected hospitals, burning and burial sites are located inside the hospitals except IIB Specialist Hospital that burns its waste outside the hospital.

Treatment of infectious wastes before burning is not dome in all the hospitals selected in this study. A similar result was reported by Sisay *et al.* (2017) in the Hawassa University, Southern, Ethiopian hospital. On the other hand, the use of low combustion single-chamber incinerators as well as surface burning for the treatment of medical wastes is against the Stockholm Convection on persistent organic pollutant (Ngwuluka *et al*., 2009). In this study none of the hospitals burns its wastes completely thus significantly produces high smoke that releases air pollutants to the environment and this is similar to the report of Diaz *et al.* (2005). The Niger State Environmental Protection Agency (NISEPA) that has the responsibilities of wastes management equally uses surface burning for the treatment of its medical as well as domestic wastes. Such malpractices have also been reported for Jos Metropolis Hospital, Nigeria by (Longe, 2012). Also, in Bauchi and Kebbi states, 23.58% and 21.05% of the healthcare wastes are respectively burnt with some other sharp wastes without any protection as reported by (Abayomi and Tolulope, 2017). On the other hand, a different practice by the Lagos State wastes management agency, LAWMA which collect hospital wastes and uses hydroclave for their treatment as reported by (Olufunsho, 2016) is in line with WHO specifications. Therefore, the current practices of medical wastes treatment in the selected hospitals in this study could expose the whole community to high risks of chronic and acute health problems.

The specific National Healthcare Waste Management Policy and Guidelines in Nigeria which are to be given by two core Ministries; Federal Ministry of Environment and Federal Ministry of Health is still at the drafting stage. Therefore, specific national medical wastes management policy and guidelines documents

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are not yet available in the country. Also, in the selected hospitals in this study none of them has developed its own medical wastes management strategic plans and written instructions manual for the implementation of standard medical waste management practices. This observation has been corroborated by the reports of Olufunsho (2016); Babatola (2008) and Sisay *et al.* (2017). However, a different finding by Abayomi and Tolulope (2017), reported that 52.20 and 38.21% of the sampled healthcare facilities from Cross River and Bauchi states, Nigeria respectively possess guidelines for HCW management.

Medical waste management is a hazardous activity therefore, workers should be trained before handling waste and the training should be on a regular basis (Annette *et al.*, 2013). The concept of global best practices in medical wastes management requires workers who receive continuous training on the job (WHO, 2004). This study ascertained that both the public and private hospitals have not provided trainings related to specific field of medical wastes management to medical doctors, nurses, paramedical and waste handlers. Similar findings reported by Adekunle et *al.* (2018) show that most of the healthcare workers in district hospitals in KwaZulu-Natal have not received training on medical wastes management. Also, a report from Northern Jordan indicated that about 29% of the hospitals had not provided training to doctors and other personnel on medical waste management (Abdulla *et al.*, 2008). However, the report of Abayomi and Tolulope (2017) shows that trainings on management of HCW have been attended by 67.18 and 53.19% of the healthcare workers from Cross River and Imo states, respectively. Also, the reports Birpinar *et al.* (2009) and Kumara *et al*. (2013) respectively showed that in Istanbul, Turkey, 98% of healthcare personnel organize training courses on medical waste management and in every department in China hospitals. Consequently, the absence of training might be the main reason for the lack of adequate wastes management practices in the selected hospitals in the current study.

In all the surveyed hospitals in this study, mixed wastes were collected and transported in cartons or open plastic bins/metal buckets at the point of generation without labelling. The wastes are scattered on the surrounding treatment and disposal sites due to the use of sub-standard waste containers. This result is similar to the study conducted in Iran by Bazrafshan and Mostafapoor (2011) which reported malpractices in the collection and transportation of hospital wastes management. These practices could contribute to the risk of infections for healthcare providers, patients, visitors and the neighbouring community. These

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practices are different from the one reported in India by (UNEP, 2009) which states that all containers used for collection of hazardous wastes were standard with proper covers and labellings. The differences may be due to the differences in the level of awareness of the healthcare professionals and decision makers in the study area and other affected areas.

Conclusions

Medical waste management requires special attention because of the risk posed by the contents of hazardous substances in the hospital waste. From the surveyed hospitals, we confirm that, the segregation, collection, training, handling, storage, transport, disposal and treatment method of solid and liquid wastes practiced in the selected hospitals in the state were far below WHO standard. In other hand, absences of hospital wastewater treatment plants, hazardous hospital waste was mixed with the non-hazardous waste, the practices of open surface burning, open fire pit and low combustion single-chamber incinerators for the treatment of medical waste contributes the release of huge amounts of air pollutants to the environment. Therefore, all the aforementioned issues above affect the protection of environment from contamination and general public health risks. Overall, the medical waste management practices systems in the state were rate poor.

Therefore, there is urgent need for the development of rules, regulations and operational strategy plans for the management of medical waste in the state and country at large to ensure proper segregation, handling, treatment and disposal in order to protect the environment and the public.

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