



## ABSTRACT

Medical waste management is a complex subject that affects people all around the world. Mismanagement and ignorance of its have resulted in a variety of environmental issues in developing countries especially in many urban areas with high numbers of health centers. This study assessed the current medical waste management practices in selected

# ASSESSMENT OF MEDICAL WASTE MANAGEMENT PRACTICES IN SELECTED SECONDARY AND TERTIARY HEALTH CARE FACILITIES IN NIGER STATE, NIGERIA

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## Introduction

Waste management is a complex subject that affects people all around the world. Mismanagement and ignorance have resulted in a variety of environmental issues, particularly in densely populated countries like China, Iran, India, Pakistan, Bangladesh, and Nigeria (Bilal *et al.*, 2019, Sartaj and Aragbol, 2015, Sharma and Gupta, 2017, Kumar *et al.*, 2016, Anozie *et al.*, 2017). These are only a few of the numerous countries that have identified problems with waste management, notably trash created by healthcare facilities (HCFs). Several studies have documented the shortcomings of medical waste management (MWM) in the healthcare sector (Alukan, *et al.*, 2014, Yaro, 2018, Awodele *et al.*, 2016, Ghafuri & Nabidazeh, 2017).



*secondary and tertiary healthcare facilities in Niger State, Nigeria. A semi- questionnaire, self-administered questionnaire, focus group discussions (FGD), field observations and descriptive analysis were used. The samples for this study comprised of healthcare workers, key ministries and residents near healthcare centers. The results showed that about 1285(77.8%) of the respondents agreed that, only syringes and needles waste and human body parts and placentas wastes were segregated. 1616 respondents, equivalent to (97.7 %) agreed that there were non-availability of labelling and colour coding of hospitals wastes, neither was there segregation of hazardous waste. 100% of all the selected hospitals in this study used open surface burning and open fire pits were the major methods of treatment and disposal practices. These could contaminate the environment and affected their well-being and health. There should be proper management of medical wastes through adequate retraining of staff, provision of colour coded bins and global best waste treatment before final disposal.*

**Keywords:** Assessment, burning, disposal, treatment, environmental and public health, medical waste.

The healthcare facilities (HCFs) unavoidably generate perilous materials often refer to as medical wastes (MWs) that may be hazardous to human and the environment during healthcare service delivery (Anozie *et al.*, 2017; Awodele *et al.*, 2016). Due to a lack of consensus, several terminologies are commonly used to describe waste generated from healthcare centres, For example, some scholars use the term Healthcare waste (HCW), Medical wastes (MW), Biomedical waste (BMW), Clinical waste, Hospital wastes, Healthcare facility waste, Infectious waste, regulated or pharmaceutical waste as case may be across the different regions of the world (Oyekale, *et al.*, 2017, Kumar *et al.*, 2015, Zhang, 2013, Kumar *et al.*, 2013, Gizalew *et al.*, 2018). Though, Ciplak and Barton (2012), observed that all terms use in describing the waste mean one and the same thing and that they are used interchangeably in different parts of



the world. Thus, HCW, MW, BMW and Hospital waste are the most frequently used terms in most literature and documents produced by governmental, intergovernmental and NGOs (Non-governmental organisations). About 85% of waste generated from healthcare activity is considered 'non-hazardous waste which is similar to domestic waste and the while remaining 15% is considered hazardous material that may be infectious, toxic or radioactive World Health Organization (WHO, 2018). furthermore, Hazardous component includes Infectious waste, Pathological Cytotoxic, Chemical Pharmaceutical and Sharps Wastes While non-hazardous waste may not sound dangerous, the deficient in safely disposal of the waste can have damaging effects on the environment (WHO, 2017).

Medical waste management is a principal component of Health care services delivery. In the absence of standard prescriptive guideline for timely disposal it may posed a significant hazard by polluting the environment leading to some diseases, injuries and outbreak of epidemic in the community (Mugabi *et al.*, 2018, Atnaffu &Kumie 2017). In spite of the small proportion of hazardous MW annually generated, there are still poor practices in segregating general waste from hazardous waste streams, which consequently show that the entire waste is potentially infectious (Issam, *et al.*, n.d),

Giving that the sixth target of eleventh MDGs emphasis that countries should by 2030 reduce the adverse per capital environmental impact of cities, including paying special attention to air quality Municipal and other forms of waste management more done to ensure proper MWM. The MWM is a major problem in both rural and urban areas in Nigeria and particularly HCFs in Niger state This study therefore sought to provide a quick assessment, by combining key informants with survey questionnaires so as to gained adequate information that could be used to identify difficulties and hence begin the process of revitalizing the MWM practices in all levels HCFs in Niger state and Nigeria at large. The study will provide knowledge on MWM process that will offer opportunities for the stakeholder in the state particularly the sampled HCFs to establishment of criterion data rate of waste production at the different level of HCFs and initiate procurement specification that can be



used in planning, training, revenue allocation, waste management system improvement and assessment of environmental impacts. The need for familiarization with persons generating and Handling waste and top management staff to make good decisions on management of MW in Niger state.

## **MATERIALS AND METHOD**

### **The Study Area**

The study was carried out in Niger State, Nigeria. The state has a land area of 76,363 square kilometres with population of 4,082,558 (National Population Commission, Census 2006). It is bordered by Kwara and Kogi states in the South West. FCT and Kaduna state in the North East. The state is also bordered by Kebbi and Zangare states in the North West. Niger State is within the savannah region (Ministry of Land and Survey, 2019). Figure 1.1 shows the location of the study area

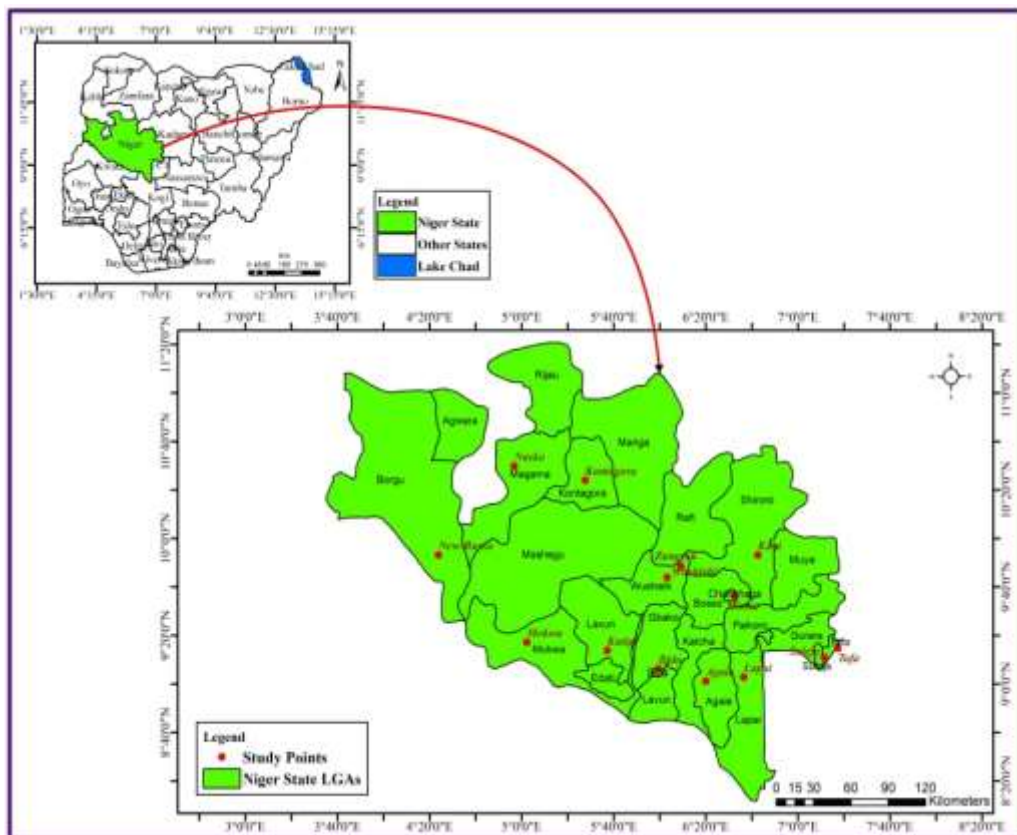


Fig. 1 Map of Nigeria and Study Area (Niger State). Fig. 1.2 Map of Study Area Niger State



**Table 1: Distribution of the Location of Selected Hospitals in the Study Areas**

S/N	Hospitals	Location	Zone
01	General Hospital	Bida	A
02	General Hospital	Lapai	A
03	General Hospital	Agaie	A
04	General Hospital	Kutigi	A
05	General Hospital	Mokwa	A
06	IBB Specialist Hospital	Minna	B
07	General Hospital Minna	Minna	B
08	General Hospital New Extension	Minna	B
09	General Hospital	Suleja	B
10	General Hospital	Tafa	B
11	General Hospital	Kuta	B
12	General Hospital	Kontagora	C
13	General Hospital	Wushishi	C
14	General Hospital	Zungeru	C
15	General Hospital	New Bossa	C
16	General Hospital	Nasco	C

### Methodology

A semi- questionnaire, self-administered questionnaire, focus group discussions (FGD) and field observations were utilized with heads of hospitals, doctors, nurses, pharmacists, laboratory technicians, waste handlers, NISEPA, Ministry of Health and Hospital Services Board. were engaged in the study. The main questions asked were on current WHO recommendation on medical waste management which involves wastes collection, segregation methods, transportation means, storage facilities, treatment methods, disposal pattern, waste minimization, recycling and re-use of generated wastes, occupational health plans and safety, policies, plans, training and budget for MW management. The data obtained were analyzed using simple descriptive statistical method such as tables, frequencies, percentages, means and charts/graphs.



## RESULTS AND DISCUSSIONS

The following stakeholders that were directly involved in the management of MW from the source of generation to final disposal point were presented in Figure 2. A total of 1651 questionnaires were returned by four (4) target groups. 160 were from medical doctors, equivalent to 9.7%, 805 were responses from nursing/midwifery staff (48.7%), 548 (33.2%) from paramedical, while 138 (8.4) were responses received from waste handlers.

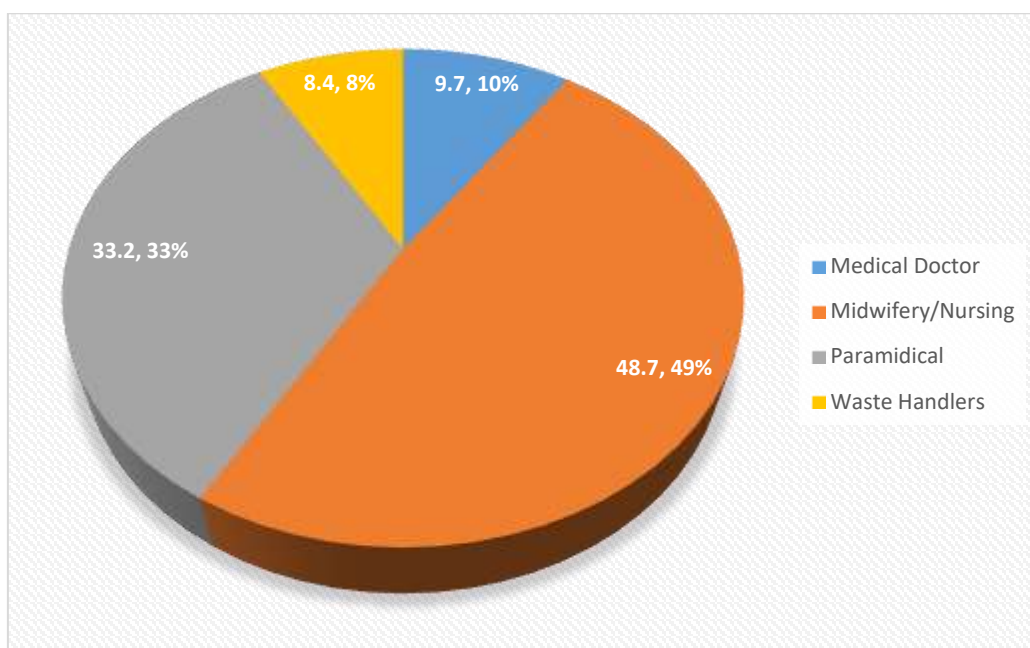


Figure 2: Distribution of stakeholders in medical waste management in the Study Area

### Segregation of medical waste

All the selected hospitals fail to maintain the segregation along the waste stream generated due to the absence of segregation of specific waste categories from the waste stream. The study revealed that, in Figure 3 about 1285(77.8%) of the respondents agreed that, only syringes and needles (sharp wastes) and human body parts and placentas (pathological wastes) generated segregated and usually given to patient relatives to be buried in the case of placentas, while 309 (18.7%) strongly disagreed (SDA) the implementation of segregation processes in the selected facilities since all wastes were disposed together, whereas



57(3.5%) disagreed of segregation (DA) processes for these wastes generated.

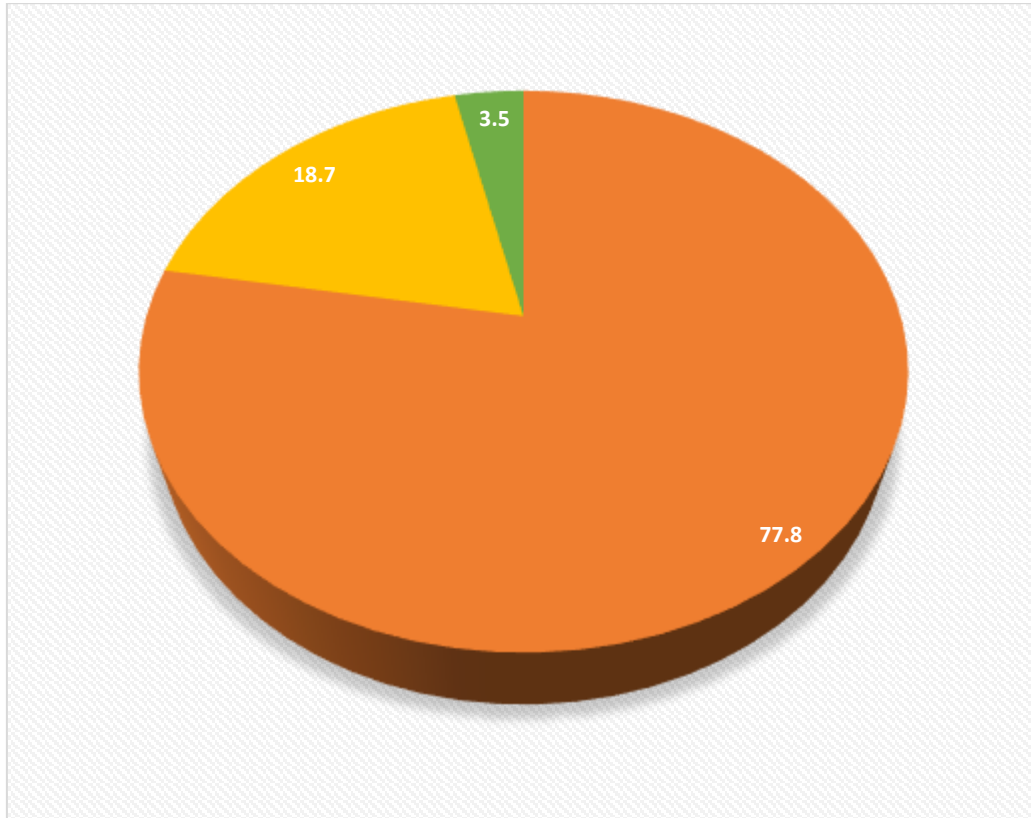


Figure 3: Awareness on the respondents' on the existence of medical waste segregation practices in the study areas

The types of MW segregated in all the studied hospitals as show in Figure 4 were; sharp objects like syringes and needles and pathological wastes (Placental and amputated body parts). The study revealed that, in Figure 4, about (94%) of syringes and needles generated were segregated from the sources while, about 2% of placental and amputated body parts wastes that form part of pathological waste were also segregated from the point of generation which are usually handover to the patient relatives for buried. Therefore, only these two categories of wastes were said to be segregated from the source of generation in this study. The segregated syringes and needles were collected daily in safety boxes, it was observed that they were not treated or destroyed before final disposal with other wastes as shown in Plate I.

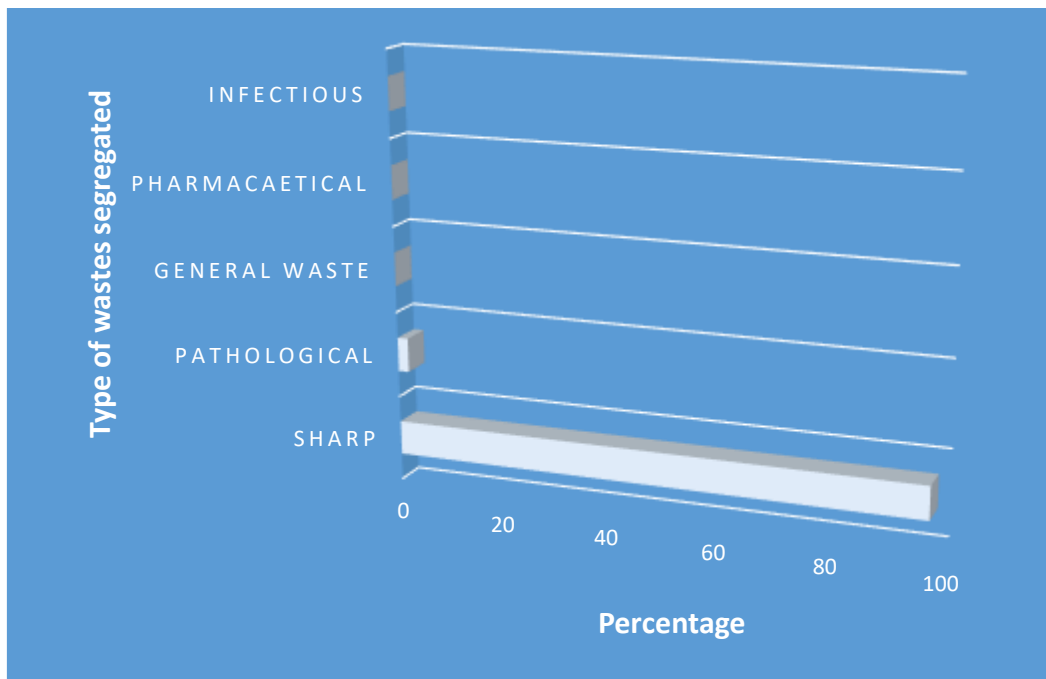


Figure 4: Distribution of respondents' knowledge on the type of medical wastes segregation practices in the hospitals



Plate I: Syringes and needles disposed with other wastes on an open surface, a practice in all the selected hospitals (Source: Field work, 2021)





On the other hand, hazardous wastes were not segregated but disposed of with the general wastes as depicted in Plate I and II which is a common practice in all the studied hospitals. These means that no implementation of WHO standards application in medical waste segregation practices in all the selected hospitals. The findings of this study similar to those submissions by Ali *et al.* (2017); Nigeria by Afon *et al.* (2017); Ankita *et al.* (2019); Karki *et al.* (2020)



Plate II: Mixed Hazardous and non-hazardous wastes disposed on an open surface in one of the hospital (Source: Field work, 2021)  
Thus, disposed of hazardous MW with the general wastes in open surface areas as being practised in all the selected hospitals in this study, which increased the quantity of hazardous waste generated can pose negative direct environmental problems due to the contamination of air, soils, surface and underground water that result from such environmentally inimical practice. Plate I and II depicts the practice that



is commonly carried out in all the selected hospitals in this study. Segregation in all hospitals is not carried out according to the international standards. These findings agreed with the studies reported by (Esubalew, 2015); (WHO, 2018a); Ahmed *et al.* (2018); Karki *et al.* (2020).

### **Hospital healthcare waste collection practices and containers used**

Wastes were collected by waste handlers at the points of generation (wards, operating rooms, laboratories, and offices) using various containers in all the selected hospitals Plate III. Figure 5, indicated that, the types of containers used to collect the medical wastes generated are open plastic and metal buckets; 851 (51.5%), plastic bin and safety boxes; 215(13.0%), black plastic bags; 257(15.6%) and small plastic bins of 3-10 kg; 328 (19.9%). The results revealed that, not standards real applications/usage of coloured bags or containers used in all the hospitals studied. This study was similar to the findings of Afon *et al.* (2017), Sisay *et al.* (2017) and Abubakar *et al.* (2019); they discovered that most hospitals in Nigeria and Ethiopia used all form of containers to collect waste without label or colour code to differentiate the categories of waste generated. Thus, segregation of waste became difficult to implement in the study areas.

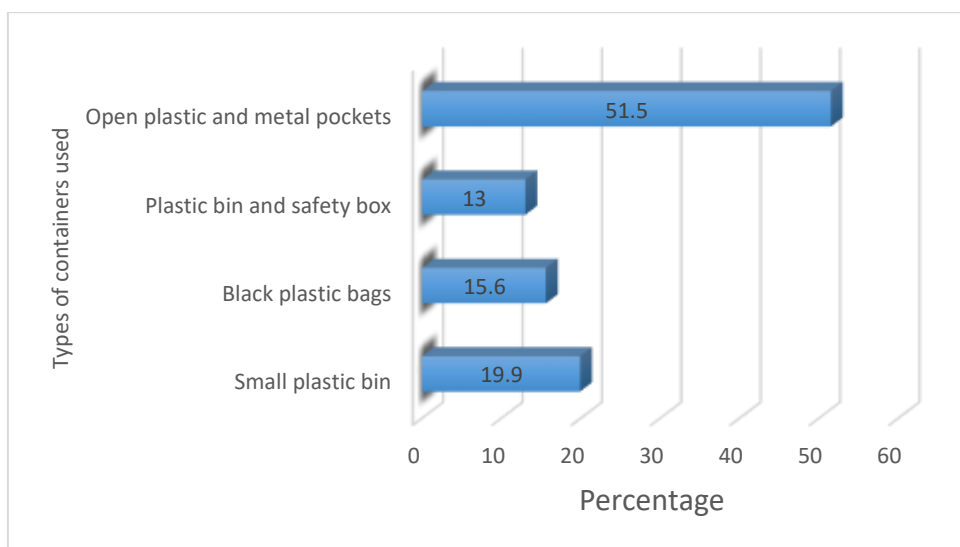


Figure 5: Knowledge of respondents of the type of containers used to collect medical wastes



a

b

c

Plate III: Type of containers used to collect hospital waste (a) Open plastic bucket (b) Plastic and metal buckets (c) Open plastic bin (Source: Field work, 2021)

### Labelling and colour coding of the segregated wastes

The Figure 6 reveals that, about 1616 respondents, equivalent to (97.9 %) strongly disagreed (SDA) that there were no practices of labelling and colour coding of hospitals wastes generated in all the hospitals selected, about 1.9% (32) of the respondents agreed that there were practices of labelling and colour coding of hospitals wastes while, 3 (0.2%) of the respondents equally disagreed (DA) the practices of labelling and colour coding of waste generated. The study reveals that, labelling of hazardous and other waste container types was completely absent in all the selected hospitals. The result in this study is however, different from the reported results by Olufunsho (2016) of the surveyed conducted in Lagos, Nigeria who found that, MW were segregated by the use of standard colour code containers and labels according to WHO.

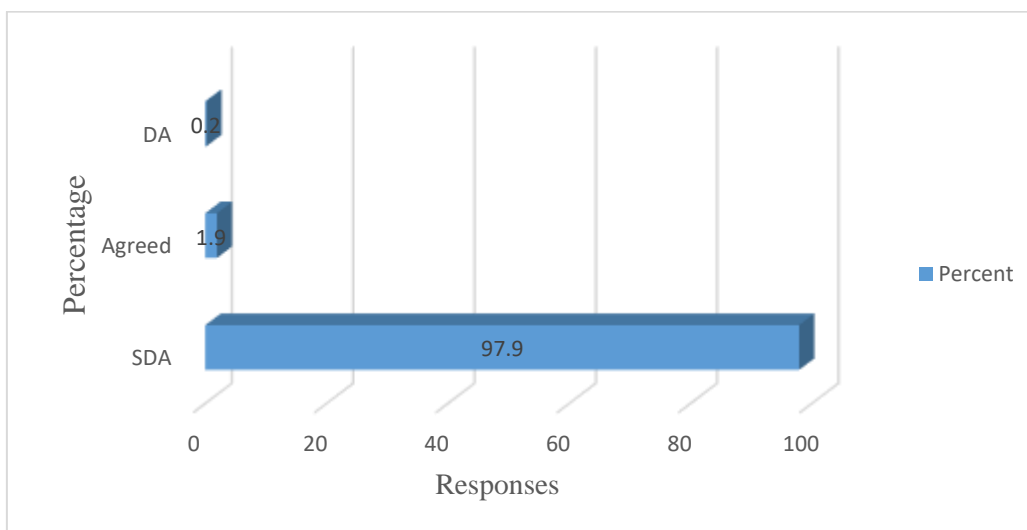




Figure 6: Knowledge of respondents' on the type of labelling, colour coding used for segregated wastes

### **Temporary storage of healthcare waste**

The results of this study, revealed that all the studied hospitals used open big metal containers, bare ground surfaces and plastic bins to store the collected hospital waste (Plate IV). The storage usually located in front of hospital or at the back yard of hospital. The Figure 7, revealed that, about 1377 (83.4%) of respondents agreed that medical wastes are stored temporarily in the hospitals while, 221 (13.4%) strongly disagreed. 53 (3.2%) of respondents disagreed because they could not distinguish between temporary storage of medical wastes and the use of surface dump sites located in the hospitals. In addition, in all the studied hospitals, hazardous HCW and general waste are stored in the same location was in an open container and on ground surface temporarily for about 2- 4 days, before final disposal (Plate IV and V). These practices could potentially contaminate the environment and transmission of different kind of diseases to the general public through free access of rodents, dogs, cats and insects. Similar results that, hazardous MW and general waste are kept in the same point could pose serious health risk and environmental contaminations Yazie *et al.*, 2019; Ghimire, 2020).

This study also, observed that, all the MW waste storage facilities are not in compliance with the WHO standard and others best practices globally, in fact wastes storage site are located inside the hospitals without any form of protection from the effects of the weather; sun, rain while animals, rats, dogs, cats, flies and birds have free access to the sites due to lack of proper and special built waste storage areas in all the studied hospitals. This could also complicate the health risks for patients, healthcare workers, visitors and the residents live close to the hospitals. Similar submissions were reported in Kano and Edo in Nigeria by Umar and Mohammed (2014) and Stephen and Elijah (2011) and in Ghana by (Áli *et al.*, 2017), respectively.

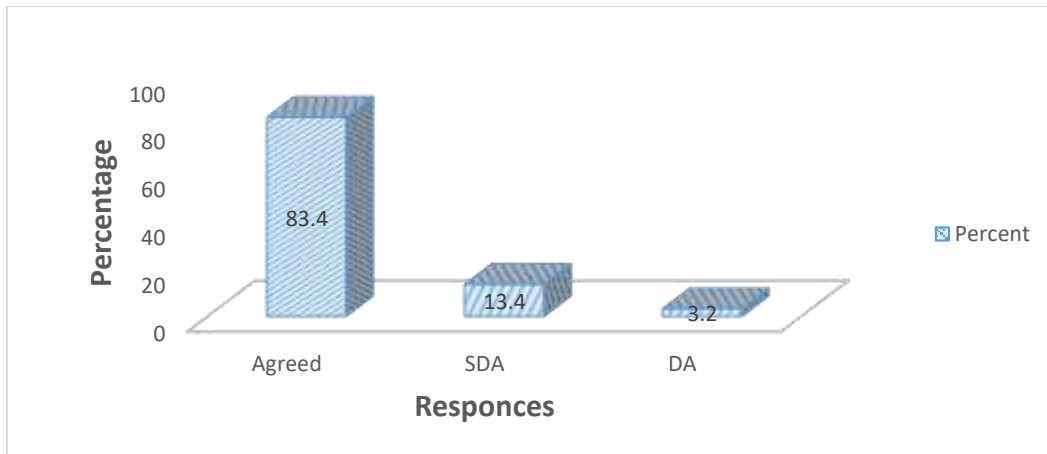


Figure 7: Respondents' knowledge of the existence of temporary storage for medical waste generated



a



b

Plate IV: Temporal Storage Facilities Available in Hospitals (a) Open surfaces (b) Bag (Source: Field work, 2021)



Plate V: Temporal Storage Facilities Available in Hospitals Open ground surfaces (Source: Field work, 2021)



### **On-site Transportation of medical waste in the study area**

The study reveals that, in all the hospitals studied transport their waste by using hand trolleys or wheel barrows. Other hospitals transport the waste container by workers hands only. Usually, transportation normally occurred two to three times daily from each point. In this study, mixed wastes were collected and transported in wheel barrow or open plastic bins/metal buckets without labelling from the generation source. The findings of this study were similar to the findings in Kano in Nigeria by Umar and Mohammed (2014). Other similar report by Ali *et al.* (2017) and by Bazrafshan and Mostafapoor (2011) which reported improper use of facilities in the collection and transportation of hospital wastes management in less developed countries. These practices could contribute to the health risk of healthcare providers, patients, visitors, residents and the general public.

### **On-site treatment and final disposal of healthcare waste generated in the study area**

To date, the treatment and disposal practices in all the selected hospitals in this study ranges from the use of open surface burning, open fire pits, sub-standard incinerator Plates VI and VII. It was observed that, open surface burning and open fire pit were most common treatment and disposal methods of hospitals waste practiced. Thus, the current treatment practices of MW in all the selected hospitals in the study area could expose the whole environment at higher risks of chronic and acute health problems. Similar practices were reported in Imo State, Nigeria by Etusim (2013), in Jos Metropolis Hospital, Nigeria by Longe (2012), in Ethiopia by (Esubalew, 2015), in South-East Asia Region by WHO (2017), (Ahmed *et al.*, 2018) and Niger State, Nigeria by Abubakar *et al.* (2019). Others similar submission in U. S and British by (Environmental Review of Incineration Technologies (ERIT), 1986), U.S. EPA (2007) discovered that substances from MW incinerators/open surface burning can influence male proliferation chemicals can straightforwardly influence the testicles, where sperm begins in which the quantity of sperm can be lessened or some sperm can be harmed or sperm may inevitably convey poisons legitimately to the egg which cause contaminations thus, given



birth to defective children as a result of exposures to toxins by men as well as prior examinations have connected chlorinated hydrocarbons to female bosom disease or cancer of breast.



b  
PLATE. VI: Treatment and final disposal practices in in the study area (a) open surface burning (b) Incinerator (Source: Field work, 2021)



PLATE. VII: Treatment and final disposal practices in in the study area open pit burning (Source: Field work, 2021).



Additionally, the bottom ash was left untreated after the burning Plate VIII. However, in this studied the leftover residual waste in the open as bottom and fly ash usually, ends up in the environment thereby contaminating the air, surface and underground water and soil as well.



PLATE. VIII: Untreated open bottom ash after burning practices in in the study (Source: Field work, 2021)

### **Reuse and recycling of medical waste practices in the study area**

The results of this study revealed that, about 96% of the respondents agreed that reuse and recycling of medical wastes generated in all the studied hospitals were 100% absent Figure 8. The absence of policy documents and guidelines on medical wastes led to unknown of health workers on reuse and recycling of MW generated while 4.1% of them disagreed saying that such practices were not available in most of the healthcare facilities studied.



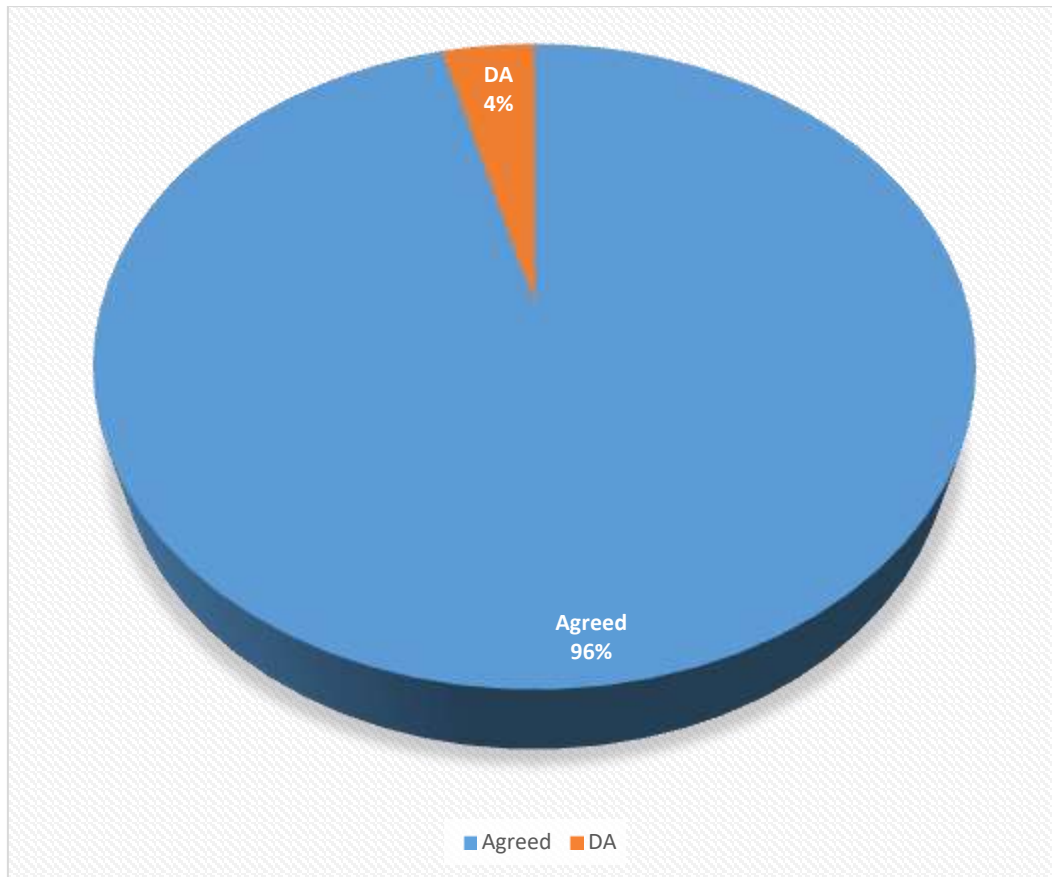


Figure 8: Respondents knowledge of presence of reuse and recycling of medical wastes practices in the hospitals

### **Supervision of medical waste management and budget allocation**

In all hospitals studied, the structure of solid waste management teams/supervision was found no available 95% of the responses revealed that, there is no monitory and evaluation supervision committee structure put in place of supervising hospital wastes management in the state. Also, no separate budget is allocated for MW management in the Ministry of Health budget.

### **Availability of medical waste management policy and guidelines in the study area**

The results indicates that, 97.2% of the respondents agreed that no hospital waste management policy and manual guidelines exist in the hospitals in the study area while, about 1.8% and 1.0% of the respondents disagreed and strongly disagreed with the statement Figure 9

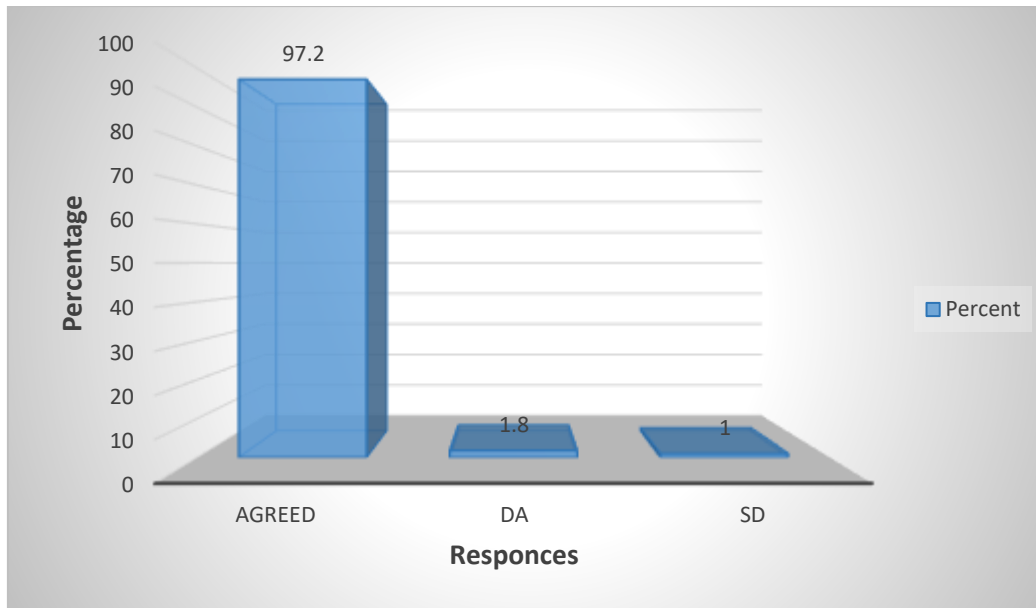


Figure 9: Knowledge of respondents on presences of hospital waste management policy, manual and plan

To date, in Nigeria the specific National Healthcare Waste Management Policies and Guidelines is still at the drafting stage. This implies that, specific national medical wastes management policies and guidelines documents are not yet available in the country. Also, Niger State Ministry of Health and all the selected hospitals in this study, none of them has developed its own medical wastes management manual guideline and strategic plans for the sustainable MW management. This implies that MW is been handle unorganized in the state. This finding has been corroborated by the reports of Olufunsho (2016), Olaniyi *et al.* (2018); Abubakar *et al.* (2019); Karki *et al.* (2020). Different submission by Abayomi and Tolulope (2017), found that, 38.21% of facilities from Bauchi states, Nigeria possesses guidelines for HCW management.

#### **Availability of staff training and safety kits in the selected hospitals**

The results of this study indicates that, scientific and systematic training programmes were completely absent in the study areas, about 97% of the respondents strongly disagreed that staff received scientific training in medical wastes management while, 2.0% said that they were no aware or disagreed of any form of training on management of MW in all the selected studied hospitals. Also, about 1.0% of the respondents agreed



that, they receive training on the job. Figure 10. In addition, the results revealed that, 95% of the respondents significant lack the knowledge on how to handle MW. The Nursing Heads and waste handlers that clean and collect the wastes from patient wards to the temporary storage containers were not aware of how the infection spreads through the waste due to absent of training. This study revealed that, all the hospitals studies have not provided specific trainings to medical doctors, nurses, paramedical and waste handlers in relation to healthcare wastes management. This might be the main factor for the failure and improper handling healthcare waste thus, exposed themselves, pollute the environment as well as the public health risk. Similarly, the provision and usage of safety kits received poor attention due to poor knowledge of healthcare workers on the risks associated with MW handling in the study areas. Similar findings reported by Adekunle *et al.* (2018) and Abubakar *et al.* (2019) shows that, most of the healthcare workers in the surveyed district hospitals in Kwazulu-Natal and Niger State, Nigeria did not receive training on medical wastes management.

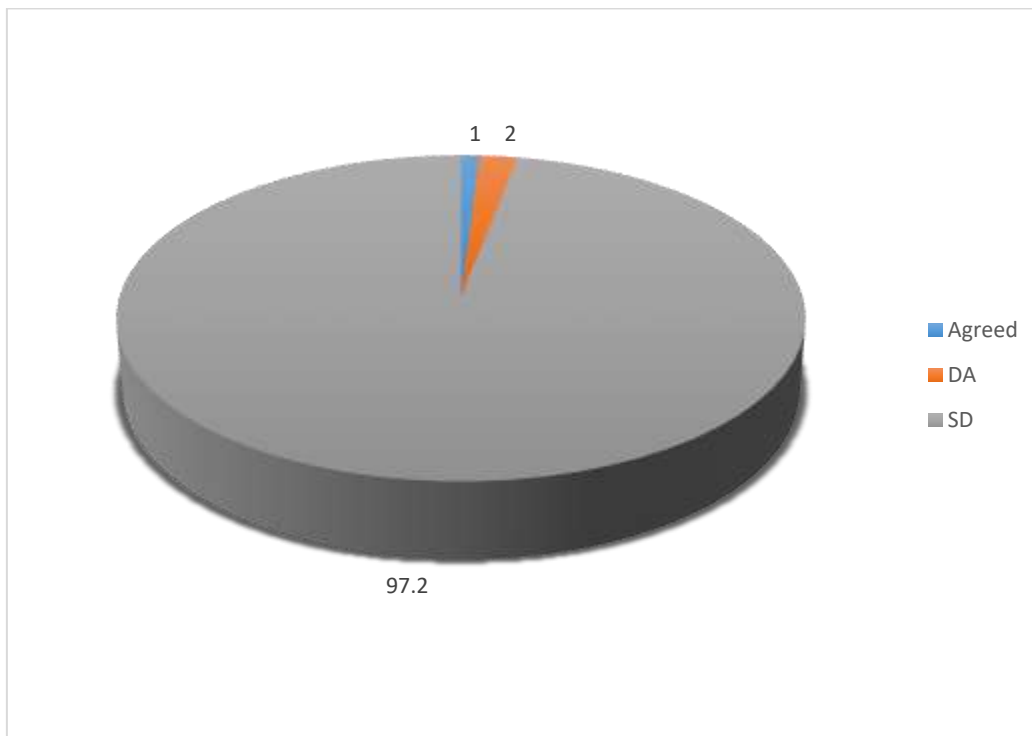


Figure 10: Respondents knowledge on staff training and safety kits for hospital waste management



### **Results from Focus Group and Interviews**

The findings obtained from Focus Group Discussion and interviews of relevant stakeholders presented.

#### **Waste collection, segregation and storage pattern practices in the study area**

The FGD revealed that, both hazardous and non-hazardous wastes generated in all the studied hospitals were collected daily by nursing heads and dumped directly into temporary storage receptacles or bins. The labelling and colour coding waste bins was no available to indicate the categories of waste to be dumped in particular waste bins. In addition, segregation of sharp waste was disposed of with others waste in the temporary storage facilities daily. The results also revealed that, the temporary storage facilities of the MW in the hospital were inappropriately located in either front or back yards inside the hospitals and open surface burning of medical wastes generated was the commonest treatment practice. Thus, this practice is quite contrary to the WHO standards required for the treatment of MW generated.

#### **Results of interviews of key stakeholders in the study area**

In the same vein, the from the interviews results conducted on the hospital administrators/managers, heads of departments indicate that, poor MW management is linked with absence of medical waste management policy, guideline manual and as a result lead to inadequate training and zero budget for MW management. Regarding the patients and residents living close to the hospitals and disposal sites interviewed across the selected hospitals, believed that the black smoke released from open surface burning of hospital wastes inside the hospitals may pose negative health implications to their health. Thus, the majority of residents said that, they have to temporarily vacate their houses during the burning processes particularly asthmatic patients and that, the case was always reported to the hospital authorities in the study area. The residents ascertained that no action was taken by the hospitals management to address the issues as at the period of this research.



### **Current stream flow of medical wastes**

The stream flow of MW generated according to the results of this research obtained from the selected hospitals shows the current practices of MW management in Niger State, where hazardous and non-hazardous MW were mixed together and disposed of in an open surface. Subsequently, treated unscientifically by open surface burning method. The practice is a linear economy waste management system (Take-Make-Use-Waste) Figure 4.11, that pose higher risks to environment and public health by ways of environmental contamination and disease transmissions. These practices are one of the largest sources of dioxin and mercury pollutants that pose higher environmental implications and health risks (USEPA, 2001).

#### **LINEAR ECONOMY**

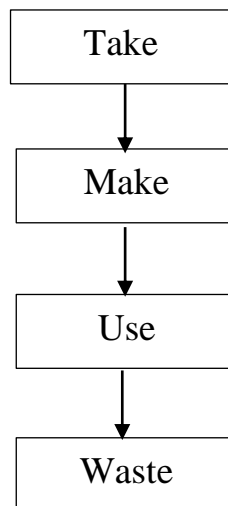


Figure 11: Current medical wastes stream flow in the study area

### **CONCLUSIONS AND RECOMMENDATIONS**

#### **Conclusions**

Hospital medical wastes management requires special attention because of the risks it poses to the environment and public health due to the presence of hazardous substances in the hospital healthcare wastes generated. From the studied hospitals, it was observed that, the segregation/sorting, storage and treatment of solid medical wastes by all the selected hospitals in the study were improper. Open surface



burning is the commonest treatment of medical waste generated thus creating contamination of environment, and public health risks. The reasons for these were not far-fetched from the total absence of medical wastes management policies and strategic especially for handling hazardous hospital wastes. The findings of this study also, revealed that people living around the health centers in the study area have negative perception about the burning method of hospital wastes and the waste disposal practices. They feel that these practices may lead to severe effects on their health

### **Recommendations**

In the light of the above observations and the obtained results in this study, the following recommendations have been made;

1. The Ministry of Health in partnership with relevant stakeholders should comprehensively develop policies, strategic plans, regulations and operational guidelines for the sustainable management of medical wastes in healthcare facilities in the state.
2. In order to meet the WHO standards and achieve sustainable development goals in medical waste management, proper training of healthcare workers is necessary.
3. Possession of healthcare waste management team: All hospitals must have sound professional, functional and accountable hospital healthcare wastes management teams that will meet on constant basis and which are assigned the responsibility of monitoring and evaluating progress in the implementation of healthcare waste management plans in their facilities.
4. This study also suggests the use of alternative technologies to incineration for medical waste treatment. The use of incinerators/open surface burning for the treatment of MW should be completely phased out to completely avoid the hazards it poses to the environment and health.

### **REFERENCES**

- Abayomi, S. O., & Tolulope, O. (2017). Healthcare waste management practices and safety indicators in Nigeria, (17): 1-12.



- Abd El-Salam, M.M. (2010). Hospital waste management in El-Beheira Governorate, Egypt. *Journal of Environmental Management* 91: 618–629.
- Abubakar, A., Emigilati, M. A., Yahya, I. T.1. & Muhammed, M. N. (2019) Critical Examine Hospital Wastes Management Practice in Some Parts of Niger State, Nigeria, *Mediterranean publications and Research International Journal – ECM* vol. 10 no.4 ISSN: 2166-3193
- Adekunle, O., Romona, D. G., & Andrew, J. R. (2018). Knowledge, attitudes and practices of healthcare workers about healthcare waste management at a district hospital in Kwazulu-Natal. *Journal of South African Family Practice*, DOI: 10.1080/20786190.2018.1432137. Retrieved 20 May, 2018 from <https://doi.org/10.1080/20786190.2018.1432137>.
- Afon, A. O., Adeniyi, S. A., Hafeez, I. A., & Akinkunle, A. A. (2017). Determinants of hospital solid waste composition of Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) Ile-Ife, Nigeria. *Journal Cogent Environmental Science*: 2331-1843. Retrieved 25 July, 2019 from <https://www.tandfonline.com/loi/oaes20>.
- Ahmed, I. A. (2017). Assessment of Medical Waste Management in El Shifa and Al Aqsa Hospitals- Gaza Strip. A thesis submitted to Research and Postgraduate Affairs Islamic University–Gaza. Retrieved 25 June, 2019 from [www.scirp.org](http://www.scirp.org) > paper information
- Ahmed, J., Kumar, R., Somrongthong, R., & Almarabheh, A. J. (2018). Correlates of Knowledge, Attitude and Practices about Health Care Waste Management among Hospital Workers of Pakistan. *Journal Liaquat University Medical Health Science*; Vol 17: No. 01.
- Ali, M., Wang, W., Chaudhr, Y. N., & Geng, Y. (2017). Hospital waste management in developing countries: (Mini Review). *Journal of Waste Management Resource* 35(6): 581-592. Retrieved 11 April, 2019 from <http://www.doi:10.1177/07342424x17691344>.
- Alukan, D. O, Azuh, D.E Toogun, T.O, Okerie U.E. (2014). Medical waste management practices among selected facilities in Nigeria: A case study science research essay academic journals Vol 19 (10).
- Ankita, S., Ajendra, S., & Neelesh, K. M. (2019). Health-Care Waste Management International Journal of Scientific Research and Review 8(2), 410-416 ISSN NO: 2279-543X [Microsoft Word Health-care waste management \(dynamicpublisher.org\)](http://www.dynamicpublisher.org).
- Anozie, O. B., Lawani, L. O., Eze, J. N., Mamah, E. J., Onoh, R. C., Ogah, E. O. & Anozie, R. O. (2017). Knowledge, Attitude and Practice of Healthcare Managers to Medical Waste Management and Occupational Safety Practices: Findings from Southeast Nigeria. *Journal of clinical and diagnostic research*, 11(3), IC01
- Atnafu, D.D., Kumie A. (2017) Health Waste Composition and Generation rate in Menelik II Referral Hospital Addis Abba, Ethiopia: Across Sectional Study *International Journal of Sustainability Management and International Technologies* 3(2) 10-19
- Awodele, O., Aishat A. A. & Oparah A. C., (2016) Assessment of Medical Waste Management in Seven Hospitals in Lagos, Nigeria *BMC Public Health* 16:269 DOI 10.1186/s12889-016-2916-1
- Bazrafshan, E. & Mostafapoor, F. K. (2011). Survey of medical waste characterization and management in Iran: a case study of Sistan and Baluchestan Province. *Waste management and research*. 29(4):442-450.
- Bilal, A. K.1., Longsheng, C.1., Aves, A. K. and Haris A. (2019). Healthcare waste management in Asian developing countries: A mini review. [sagepub.com/journals-permissions](http://sagepub.com/journals-permissions) [journals.sagepub.com/home/wmr](http://journals.sagepub.com/home/wmr) DOI: 10.1177/07342424x19857470
- Caniato, M., Tudor, T. & Vaccari, M. (2015). International governance structures for health-care waste management: A systematic review of scientific literature. *Journal of Environmental Management* 153: 93–107.
- Ciplak, N. & Barton, J.R. (2012). A system dynamics approach for HCW management: a case study in Istanbul Metropolitan city, Turkey. *Macrothink Institute* 30(6):576-586.



- Debalkie, D., Kumie, A. (2017). Healthcare waste management: the current issue in Menellik II Referral Hospital, *Ethiopia. Curr World Environ.* 12:42–52.
- Debere, M. K., Gelaye, K. A., Alamdo, A. G., & Trifa, Z. M., (2018). Assessment of the health care waste generation rates and its management system in hospitals of Addis Ababa, Ethiopia. *BMC Public Health*, 13(1), 28.
- Esubalew, T. (2015). Waste generation, composition and management in the amhara national regional state, Ethiopia A PhD Dissertation submitted to the School of Graduate Studies of Addis Ababa University. 1-128. Retrieved 15<sup>th</sup> May, 2019 from Sagepub.com>doi>abs
- Etusim, P. E., Ijere, A.O., Melariri, P. E., Ogwo, P. A., & Ikonne, A. (2013). Study on Solid Waste Generation and Characterization in some Selected Hospitals in Okigwe, Imo State-Nigeria U. *Journal of Educational and Social Research*, 3(4):337-43.
- Facts and Figures About Niger State (2017). Niger State Bureau of Statistics Health Statistics Nigeria Statistical Development Project (NSDP)
- Federal Government of Nigeria (2018), National Healthcare Waste Management Plan for Nigerian Polio Eradication Support Project Additional Financing 3 Draft Report
- Ghafuri, Y., & Nabizadeh, R., (2017). Composition and quantity of cytotoxic waste from oncology wards: A survey of environmental characterization and source management of medical cytotoxic waste. *Bioscience Biotechnology Research Communications*, 10(3), 438-444.
- Ghimire, O. P. (2020). Challenges of hospital waste management. The Rising Retrieved 15<sup>th</sup> October, 2020 FromNepal, <https://risingnepaldaily.com/opinion/challenges-of-hospital-waste-management>
- Gizalew, E., Meseret, G., Desta, H., Chuchu, C., & Zeleke, G. (2018). Health-care Waste Management and Risk Factors Among Health Professionals in Public Health Facilities of South Omo Zone, South West Ethiopia, *Journal of Healthcare Leadership* downloaded from <https://www.dovepress.com/> by 197.210.84.108
- Hassan, A. A., Tudor T., & Vaccari, M. (2018). Healthcare waste management A case study from Sudan. *Journal of Environments*. Retrieved 11 April, 2019 from <http://www.mdpi.com/journal>.
- Hayleeyesus S.F., & Cherinete, W. (2016). Healthcare waste generation and management in public healthcare facilities in Adama, *Ethiopia. J Health Pollut.* 6:64–73
- Hossain, M.S., Santhanam, A., Norulaini N.A.N., et al. (2011). Clinical solid waste management practices and its impact on human health and environment –A review. *Waste Management* 31: 754–766
- Ijah, U.J.J.& Abioye, O. P. (2003). Management of Medical Waste in Hospitals in Nigeria: A case study of Minna Nigeria *journal of environmental sciences*(7):23-24
- Issam, A. Al-Khatib, Derar E. & Joy G. (n.d) A system dynamics approach for hospital waste management in a city in a developing country: the case of Nablus, Palestine University of Worcester research publication
- Jovanović, V., Jovanović, D., Matić, B., & Đonović, N. (2016). The Influence of Healthcare factors on medical waste management in Serbian hospital facilities. *PONS-medicinski časopis*, 13(2), 57-63.
- Karki, S., Niraula, S. R., & Karki, S. (2020). Perceived risk and associated factors of healthcare waste in selected hospitals of Kathmandu, Nepal. *PLoS ONE* 15(7): e0235982. <https://doi.org/10.1371/journal.pone.0235982>
- Kumar, R., Khan, E. A., Ahmed, J., Khan, Z., & Magan, M. (2013). Healthcare management in Pakistan: current situation and training options. *Journal of Ayub Medical College Abbotabad*: 22(4):101—5.
- Kumar, R., Shaikh, B. T., Somrongthong, R., & Chapman, R. S. (2015). Practices and challenges of infectious waste management: A qualitative descriptive study from tertiary care hospitals in Pakistan. *Pakistan journal of medical sciences*, 31(4), 795.





- Longe, E. O. (2012). Healthcare waste management status in Lagos State, Nigeria: a case study from selected healthcare facilities in Ikorodu and Lagos metropolis. *Waste management and research*. 30(6):562-571.
- Mane V, Nimbannavar SM and Yuvaraj BY (2016) Knowledge, attitude and practices on biomedical waste and its management among health care workers at a tertiary care hospital in Koppal, Karnataka, India. *International Journal of Community Medicine and Public Health* 3: 953–2957.
- Manga, V. E., Forton, O. T, Mofor L. A., & Woodard, R. (2011). *Healthcare waste management in Cameroon: a case study from the south-western region*. *Resour Conserv Recycl*. 57:108–16.
- Mugabi, B. Hattingh, S. & Chima, S. C. (2018). Assessing Knowledge, Attitude and Practice of Health Care Workers regarding medical waste management at a tertiary hospital in Botswana: A cross sectional quantitative study. *Niger J Clin Practice* 21:1627-38
- Olaniyi, F. C., Ogola, J. S., & Tshitangano, T. G. (2018). Review of medical waste management in South Africa. *Journal of Environmental Science* 10: 34-45. Retrieved 11 April, 2019 from <http://www.benthamopen.com/TOENVIRJ/DOL:10.2174>.
- Oli, A. N., Ekejindu, C. C., Adje, D. U., Ezeobi, I., Ejiogor, O. S., Ibeh, C. C., & Ubajaka, C. F. (2016). Healthcare waste management in selected government and private hospitals in Southeast Nigeria. *Asian Pacific Journal of Tropical Biomedicine*, 6(1), 84-89.
- Omofunmi, O. E., Agwagu, H. C. & Atuche, A.L. (2016). Assessment of Medical Waste Management in Private Hospitals. *Journal of Engineering and Technology*, 2579-0625S.
- Olufunsho, A., Aishat, A. A. & Azuka, C. O. (2016). Assessment of medical waste management seven hospitals in Lagos, Nigeria. *BMC Public Health*.16:269.
- Omoleke, S. A., Nura, U. B., Kanmodi, K. K., & Mustapha, M. A. (2020). Medical waste Management at the Primary Healthcare Centres in a North Western Nigerian State: Findings from a Low-resource setting. *Public Health in Practice an Official Journal of Royal Society for Public Health*
- Oyekale, A. S., & Oyekale, T. O. (2017). Healthcare waste management practices and safety indicators in Nigeria. *BMC public health*, 17(1), 740.
- Patwary M., O'Hare W.T., & Sarker M.H. (2011). Assessment of occupational and environmental safety associated with medical waste disposal in developing countries:a qualitative approach. *Safety Science*;49(8/9):1200—7.
- Prüss A, Giroult E and Rushbrook P (1999) *Safe Management of Wastes from Health-Care Activities*. Geneva: World Health Organization
- Pruss-Ustun, A., et al., (Eds.), (2013). *Safe Management of Wastes from Health Care Activities*, second edition. WHO, Geneva. Available at: [http://www.healthcarewaste.org/fileadmin/user\\_upload/resources/Safe-Management-of-Wastes-from-Health-Care-Activities-2.pdf](http://www.healthcarewaste.org/fileadmin/user_upload/resources/Safe-Management-of-Wastes-from-Health-Care-Activities-2.pdf). (accessed 02.10.18.) publications/icrc-002-4032.
- Research Advisor (2006). Sample Web Calculator Sample table
- Sartaj, M.& Arabgol, R. (2015). Assessment of healthcare waste management practices and associated problems in Isfahan Province (Iran). *Journal of Material Cycles and Waste Management*, 17, 1,99-106.
- Shaibu I. S. (2014). *An Assessment of Hospital Wastes Management in Minna Towards a Waste Management Approach in a Growing Urban Area*. *Greener Journal of Medical Sciences* 5,98 Vol. 4 (1), 001-015. Retrieved 27 May, 2018 from [www.gjournals.org](http://www.gjournals.org)
- Sharma, S. K., & Gupta, S., (2017). Healthcare waste management scenario: A case of Himachal Pradesh (India). *Clinical Epidemiology and Global Health*, 5(4), 169-172.



- Sisay, A., Raju, R. P., & Gebeyew, B. (2017). Health Care Solid Waste Generation and Its Management in Hawassa Referral Hospital of Hawassa University, Southern, Ethiopia. *International Journal of innovative and development* 6(5): 26-31.
- Stephen, O. A., & Elijah, I. O. (2011). Healthcare waste management in Nigeria: A case study *Journal of Public Health and Epidemiology*, 3(3), 99-110. Retrieved 20 May, 2018 from <http://www.academicjournals.org/ijphes>.
- Tadesse, M. L. & Kumie, A., (2014). Healthcare waste generation and management practice in government health centers of Addis Ababa, Ethiopia. *BMC public health*, 14, 1, 1221.
- Tamunosiki, C.A. (2013). *Assessment of Waste Management Services in Public and Private Health Facilities at the three Levels of Healthcare Delivery* in Enugu State Submitted Dissertation the National Postgraduate Medical College of Nigeria For Award of the Final Fellowship of the Medical College in Public Health
- Tesfahun, E., Kumie, A., Legesse, W., Kloos, H., & Beyene, A. (2014). Assessment of composition and generation rate of healthcare wastes in selected public and private hospitals of Ethiopia. *Waste Management & Research*, 0734242X14521683.
- Udofia, E. A. & Nriagu, J. (2013). Health-care waste in Africa: A silent crisis, *Global Health Perspect*, 1(1), 3-10.
- Umar, A. B., & Mohammed, N. Y. (2014). Hospital Waste Management Practices: A Case Study of Primary Health Care Centers, In Fagge Local Government Area, Kano State. *Journal of Nursing and Health Science*, (3): 26-33. Retrieved 25 August, 2018 from [www.iosrjournals.org](http://www.iosrjournals.org).
- Windfeld E. S., & Brooks M. S.-L. (2015). Medical waste management–A review. *Journal of Environmental Management*, 163, 98–108. <https://doi.org/10.1016/j.jenvman.2015.08.013> PMID: 26301686
- World Health Organization (2014). Report on Health-Care Waste Management (HCWM) Status in Countries of the South-East Asia Region (No. SEA-EH-593). WHO. Regional Office for South-World Health Organization. WHO Country cooperation Strategy, Federal Republic of Nigeria, 2002-2007;2002
- World Health Organization (2017). Safe management of wastes from health-care activities: a summary (No. WHO/FWC/WSH/17.05). World Health Organization
- World Health Organization. (2018). Health-Care Waste: key facts. Available from: <https://www.who.int/news-room/fact-sheet/detail/health-care-waste> (Accessed May 10 2021)
- Yaro, A.N. (2018). *Analysis of Healthcare Waste Management Practices in Kano State* PhD Dissertation, Department of Geography Bayero University, Kano, Nigeria.
- Yazie, T. D., Mekonnen, G. T., & Kasaw, A. C. (2019). Healthcare waste management current status and potential challenges in Ethiopia: a systematic review. *Journal of Biomedical Centre Research Notes* 12:285. Retrieved on November 12, 2020 from [www.https://doi.org/10.1186/s13104-019-4316-y](https://doi.org/10.1186/s13104-019-4316-y).
- Zhang, H. J., Zhang, Y. H., Wang, Y., Yang, Y. H., Zhang, J., Wang, Y. L., & Wang, J. L. (2013). Investigation of medical waste management in Gansu Province, China. *Waste Management & Research*, 31(6),655-9