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Research Article

Assessment of Medical Waste Management and Practices in Maiduguri Metropolis, Borno State, Northeast Nigeria

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ABSTRACT

Medical wastes such as sharps, infected blood, syringes, body parts and radioactive matters are waste generated during health care service deliveries in hospitals and clinics. Which often receives less attention in developing countries resulting to negative impact on human health due to improper management, and moreover data regarding medical waste management practices are limited in most part of the regions. This research therefore assesses medical waste management and practices in Maiduguri, Borno state, Nigeria. A structured questionnaire, physical observation and key informant interview were used to collect information addressing the generation, segregation, storage, treatment and disposal in 10 selected Heath care facilities across Maiduguri Metropolitan City. From the results Waste generation per bed per month ranges from 16613 kg/bed/month to 324 kg/bed/month, segregation practice was excellent as 77.5% of the respondents had adequate knowledge of waste segregation, However, few (24%) segregated wastes at the point of generation, largely using plastic bins (50%). Knowledge of color coding was satisfactory as 83.75% responded to use color code. Majority (90%) collected waste more than twice/day mainly using plastic bins (46.25%), trolleys (37.5%) and few (12.5%) use combination and plastic and wheel barrows. Personal protective equipment (PPEs) was reported to be used by 98.75% of the respondents. For disposal, medical wastes were mostly burned openly within the hospital (63.75%). In general, the state of medical waste management in Maiduguri was excellent with little challenges of facilities and equipment, the effort of NSHIP (Nigeria-State Health Investment Project) was highly commendable for bridging some gaps.

Keywords: *Medical Waste Management; Infectious diseases Maiduguri Metropolitan Council; Awareness.*

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INTRODUCTION

Medical wastes are waste generated by hospitals during health care service deliveries such as immunization and treatments, medical wastes; sharps, infected blood, syringes and radioactive materials, Placenta, body organ, etc (Patil and Pokhrel, 2004). Unless managed properly, these categories of wastes can be harmful to human health and the environment (Abah and Ohimain, 2011). However medical waste management often receives less attention particularly in developing countries (Amin et al., 2013), and data regarding waste generation and disposal practices are limited in most part of the regions. This was primarily due to lack of knowledge regarding dangers of health-related waste amongst people (Awad and Bajari 2018), hence resulting to improper handling and disposal approach, thus, creating environmental and public health issues. A number of study findings have revealed that exposure to medical waste causes HIV/AIDS, Hepatitis B virus, typhoid, cholera, hepatitis to people (PATH, 2015; Amin et al., 2013), including health workers and patients in hospitals, and as well pollution of the air, water and land resources due to indiscriminate dumping.

Internationally, waste from medicals and health facilities are recognized as hazardous and that the best management practices and disposal approach be adopted, such as segregation of waste into risk and non-risk, colour coding of waste bin for different categories of waste (Bhatia, 2005), appropriate storage facility and centralized storage system, effective treatment of waste, transportation and proper disposition, furthermore, it is recommended that deep burial should be practiced and special disposal method for radioactive waste should be carried out; and sanitary staff were to be immunized periodically against common

communicable diseases. In addition, staff training, development of Health care waste management plan, as commitment by government institutes mandate with the responsibility of funding and monitoring, are all part of healthcare waste management, in addition awareness campaign and policy formulation and legislation enforcement are also key to sustainable hospital waste management (Olukanni et al., 2014, Ola-Adisa, et al. 2015; Adewole et al; 2016).

Despite medical waste contain harmful materials, proper management still remain a critical concern in Nigeria (Abah and Ohimain, 2011), although reliable records of the quantity of the waste and management approach still remained a challenge in many developing countries, it is expected that medical waste management is very poor both by the government hospital and private hospital operating in the country, more so, agencies and organization mandated with the supervision, guidance, monitoring and law formulation and enforcement regarding medical waste are ineffective, resulting in negligence and illegal dumping of medical waste by hospitals. Thus, there is a need to assess and evaluate the management strategy towards recommending appropriate management procedures. This research work was intended for Maiduguri metropolitan, the capital city of Borno state, Northeast Nigeria, where health services are rendered by various public and private hospitals in the state.

Borno State has been facing some sort of security challenges for almost decade, this resulted in the increase in the number of in-patient per day of persons from especially various LGAs in the State, thereby exceeding the designed capacities of hospitals and clinics within the Maiduguri Metropolis the capital city, this undoubtedly will contribute greatly to the quantity of waste being generated posing a greater challenge to the health waste management system, recently, it has been reported that mortuaries are getting filled and dead bodies are being dumped openly within the hospital, thus, getting deteriorated, creating discomfort to the surrounding inhabitants which perhaps has ultimately resulted to nearby residents fleeing their home for almost a year. This finding however instigated this research to be conducted in order to ascertain in details about the waste management practice by hospitals within Maiduguri metropolis. Until this study, at present no data exist with regards the waste generated by hospitals in Maiduguri and their management approach. The aim of the study therefore is to identify the gaps in the current practices of health- related waste in Maiduguri metropolitan city of Borno and compare findings with the international standard and recommend ways of bridging this gap towards ensuring sustainable waste management considering the current economic reality and security challenges facing the state.

MATERIALS AND METHODS

Study Area: Maiduguri is the political and commercial capital center of Borno State. It has a land mass of 137.356 sq. km with a population of 1,112,449 making it the largest city in Borno state (NPC 2010), it is located between latitude 11.84620 and longitude 13.157120 it has an elevation of 325m over sea level (Google Earth, 2012, Kagu, 2013).

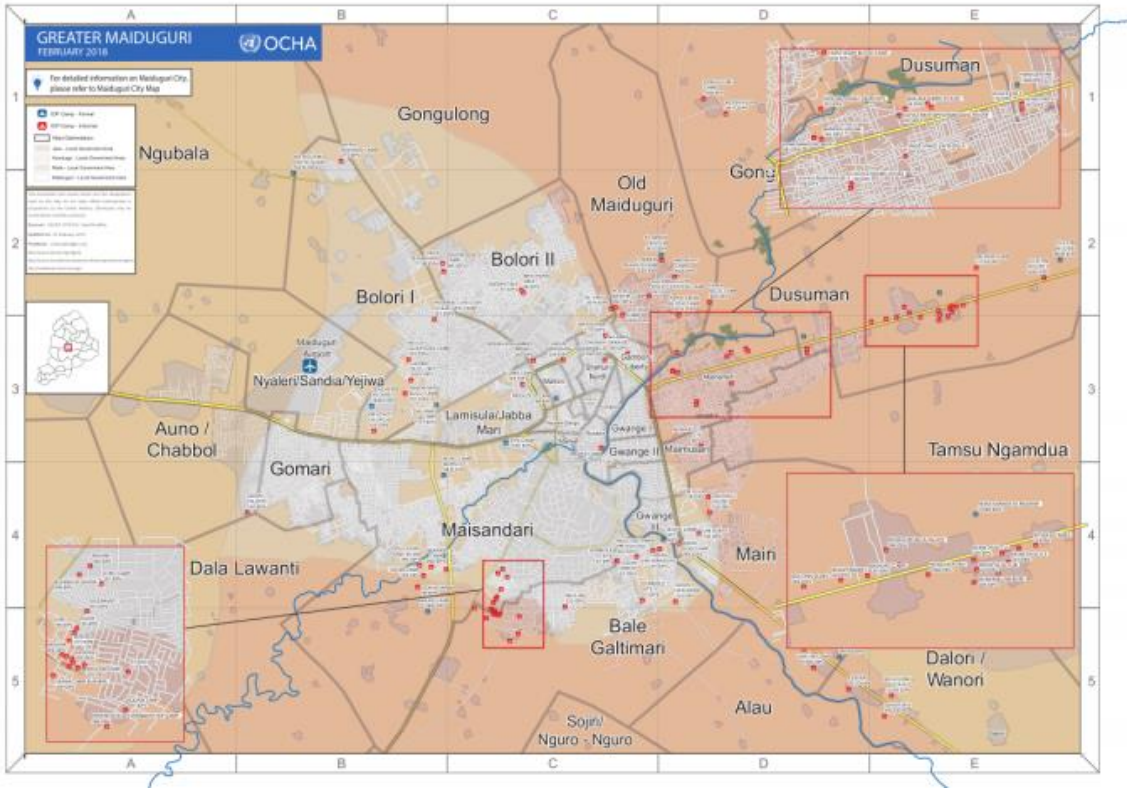

Plate 1.
Map of Maiduguri

Study design: The methodology for this research includes field observation, questionnaire survey and oral interviews. A structured questionnaire was designed to collect information addressing the generation of different medical wastes according to amount and sources from different health care establishments. A number of in-depth interviews were arranged to enhance the understanding of previous and existing management practice of medical wastes. A number of specific questions were asked of nurses, hospital managers, doctors, and cleaners to elicit their knowledge. Furthermore, specific questions were addressed to the agencies responsible for making laws regarding medical waste management (NESREA) and overall management of medical waste (BOSEPA) to evaluate their effectiveness in relation to their responsibilities and to extract their views regarding medical waste management situations in Maiduguri.

Study population: Ten (10) hospitals was selected among federal, state and private hospitals operating within the metropolis, 10 sample questionnaires were administered to each hospital making total of 100 samples. The population of the study consists of members staff of the selected hospitals in Maiduguri metropolitan council whom were selected based on their knowledge and responsibilities on the management of medical waste in the respective hospitals.

Data Collection: The data gathered were based upon questionnaire distributed to 10 hospitals. Questionnaire was used to survey the hospital wastes in terms of collection, transportation, segregation, treatment and disposal and institutional capabilities to manage the waste such as availabilities of equipments/facilities. The study covered different categories of medical waste coming from the selected hospitals which were classified with the respect to their Ownership Status as: **(1)** Two (2) Federal Hospital which belongs to the Federal Ministry of Health. **(2)** Two (2) State Hospitals belonging to the Borno State Ministry of Health. **(3)** Six (6) Private Hospitals.

Data Analysis Techniques: The questionnaire, observations and interviews were analyzed using Excel Worksheet. Data to be analyzed were entered in a format where cases (each question in the 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.

Ethical Consideration: Permission was obtained from Borno State Hospital management board, Maiduguri, Borno State and also each hospital before conducting the research.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents: Eighty (80) questionnaires were fully completed out of the 90 questionnaires distributed in the study area, giving a response rate of 88.9 %. Table 1 below shows the socio demographic characteristics of the respondents. It reveals that majority (35%) of the workers are between the ages of (31-35) years, then followed by ages (36-40) which constituting 25%, this age groups are period of carrying the burden of responsibility for men with a view to providing a decent livelihood for their families. Youth ages (20-25) constitutes only 6% of the workers, this will make it easy to train them on how to deal with medical waste. It is known that as the worker get older and exceeds the youth age, it will be more difficult to train him. Whilst 47.5% indicating there is no consideration for gender difference in the study. Regarding the working period at hospital, it is noted that (32.5%) have been working in hospital for a period 6-10 years as against 5% working for more than 20 years (i.e the percentage with the least response). On the other hand, investment in the training of these workers will be useful as it is expected that will remain in their job for reasonable period with increasing and decreasing risk of medical waste exposure.

Table 1:
Socio-Demographic Characteristics of Respondents

	Variable	No Participants/ Frequency	Percentage
Age of respondents	20-25	5	6
	26-30	10	13
	31-35	28	35
	36-40	20	25
	41-45	14	18
	Above 45	3	4
	Total	80	100
Sex of Respondents	Male	42	52.5
	Female	38	47.5
	Total	80	100
Duration of Work In The Hospital (years)	1 - 5 years	23	28.75
	6 - 10 years	26	32.5
	11 - 15 years	15	18.75
	16 - 20 years	12	15
	>20 years	4	5
	Total	80	100
Profession of Respondents	Doctor	6	7.5
	Nurse	10	12.5
	Lab. Scientist	6	7.5
	Domestic Workers	54	67.5
	Secretary	1	1.25
	Environmental Health Officer	3	3.75
	Total	80	100

General Information on Hospital Waste Management: Table 2 and figure 1 below indicates the general Information on number of beds and quantity of waste generated by the surveyed hospitals, the total number of beds in the surveyed hospitals are 1249 and an average of 122.44 kg/day and 0.842 kg/bed/day of medical waste was produced in these hospitals. Waste generation per bed per day varies from 0.89 kg/bed/day in Hospital F to 0.45kg/bed/day in Hospital J. Waste generation per bed per month ranges from 16613 kg/bed/month in Hospital H to (324 kg/bed/month) Hospital J. similar to the studies. These waste generation aspect of findings is generally similar to other studies in Nigeria (Abah and Ohimain, 201; Olagunju and Akinyemi 2015).

Table 2:
General Information on number of beds and quantity of waste generated by the surveyed hospitals

Hospital Name	No. of beds	kg/day	kg/bed/day	kg/month
A	25	18.9	0.76	567
B	2	21.87	0.84	656.1
C	148	186.96	1.26	5609.25
D	40	28.35	0.71	850.5
E	30	18.9	0.63	567
F	14	12.42	0.89	372.6
G	34	25.92	0.77	777.6
H	628	553.77	0.88	16613.1
I	280	346.5	1.24	10395
J	24	10.8	0.45	324
Total	1249	1224.4	8.42	36732.15

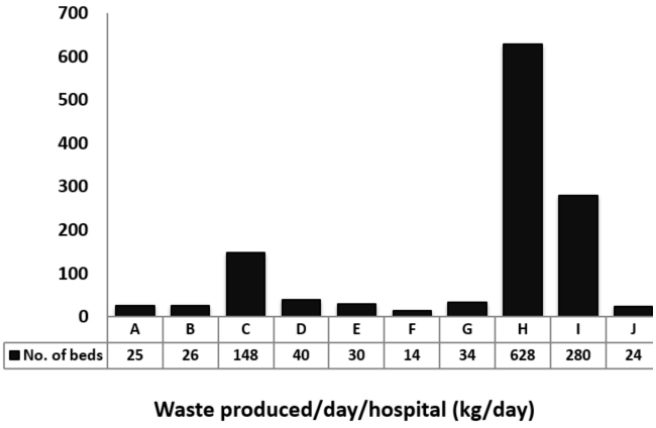

Figure 2:
Estimated quantity of waste generated by the surveyed hospitals

Segregation and color coding: Segregation is the separation of medical waste into risk and non-risk categories at source. Segregation is vital to effective medical waste management as it helps in reducing risk level as well as cost of handling and disposal (Sahiledengle, 2019). Table 3 indicates the segregation aspects of medical waste by the surveyed hospitals. The respondents in the various facilities had adequate knowledge of waste segregation as 77.5% and segregated waste to disposal, while 22.5% answered otherwise, this confirms that sometimes medical waste is not separated from ordinary waste. The existing situation should therefore be reconsidered so as to reach the full separation of medical waste from ordinary waste, hence decreasing the probability of infection and incidence of communicable diseases to the public. Comparatively there is high level of segregation practices in the surveyed hospitals as many Hospitals in Nigeria and other developing countries practice little or total absence of medical waste segregation (Chima et al. 2011; Abah and Ohimain, 2011; Olagunju and Akinyemi 2015; Ola-Adisa et al. 2015 Awodele et al 2016). However, various *locations of separation* were laboratory (29%), operation room (23%), point of generation (24%), in the emergency room (8%) and injection/dressing room (16%), according to standard practice and safety, waste segregation is done at the point of waste generation. *Types of containers* used for segregation were largely plastic bins (50%), and combination of cardboard boxes and plastic bins (37%) and few uses metal containers (5%) and safety bags (8%) respectively.

Nevertheless, there is satisfactory knowledge with regards to *color coding* of wastes which is an essential factor for proper segregation of waste (Bhatia, 2005). 83.75% of the respondents use color code for easy identification of the categories of wastes generated in their facilities. The majority of respondents also rightly identified the color codes of all the wastes generated. More than half of all the respondents 80% and 15% rightly identified red and yellow respectively as the color code for infectious waste, 66% identified red as the color code for pathological waste (figure 2), thus indicating that health workers were well trained to that respect. However, this excellent knowledge and practices of colour coding is contrary to the studies by Chima et al. 2011 and Lucy, 2017 in other studies, where majority of the health workers were less trained and lack knowledge of color coding, which may ultimately pose a great danger to the public health.

Table 3:
Segregation of Medical Waste

	Variable	No Participants/ Frequency	%
Do you segregate the medical waste?	Yes	62	77.5
	No	18	22.5
	Total	80	100
Where is the segregation taking place?	Operation Room	14	23
	Laboratory	18	29
	At point of generation	15	24
	Emergency Room	5	8
	Injection/dressing room	10	16
	Total	62	100
What type of containers are used to segregate the waste	Bags	5	8
	Cardboard boxes + plastic container	23	37
	Plastic Container	31	50
	Metal container	3	5
	Total	62	100
Do you Color-code medical waste?	Yes	67	83.75
	No	13	16.25
	Total	80	100
How do you Color-code Infectious waste?	Red	54	80
	Green	2	3
	Black	1	2
	Yellow	10	15
	Brown	-	0
	Total	67	100
How do you Color-code Pathological waste?	Valid	Frequency	Percent
	Red	44	66
	Green	9	13
	Black	5	8
	Yellow	9	13
	Brown		0
	Total	67	100

Plate 2:
Segregation of medical waste using the proper color coding.

Collection of medical waste: Table 4 below indicates the various methods utilized for collection and transportation of medical wastes from the point of generation to on-site storage by the surveyed hospitals. Majority (46.25%) indicated that plastic bins are used for the on-site transportation of waste, 37.5% and 12.5% use combination of trolleys and plastic and wheel barrows respectively similar to Lucy, (2017) assessment. While the remaining 3.75% use combination of plastic bins and wheel barrows for the on-site transportation of medical waste. However, frequency of collection was excellent across the surveyed locations as (90%) collected waste more than twice in a day. This finding is similar to the observations of Olukanni *et al* (2014) in Otta, Nigeria, where surveyed hospitals collect waste up to three times per day, in line with the standard practice (WHO 2002). For the off-site transportation of medical waste, 63.75% of the respondents indicated that the waste is been evacuated using constructed waste disposal trucks, 20% use trolleys while 16.25 use wheelbarrow are used for transportation of medical waste for final disposal. However, the use of wheel barrows for medical waste collection and transportation depicts some sort of deficits in facilities and other infrastructure for waste management in the hospitals which undoubtedly be related to lack of the funding of the hospitals towards management of medical waste for public health protection.

Storage of medical waste: As part of standard practice and efficient management, medicate waste are stored appropriately while awaiting final disposal. Table 5 below indicates the various means been utilized for the storage of medical wastes by the surveyed hospitals. 83.75% of the cleaning workers indicated that the medical waste is transferred using the waste sacks and some 16.25% reported that waste is transferred using special vessels. Moreover, the study found that that there is special place for storing the medical waste in the hospital as reported by 85% of the respondents. It is usually put in a waste storage place in the hospital which is well protected (97.5%) while awaiting final disposal. However, some (15%) reveal that it is kept at the point of generation and few (2.5%) respondents that storage places around the hospitals were unprotected. This practice is unsanitary as it may easily contaminate or infect danger to the public. Interestingly, 92.5% of the cleaning workers reported that there is special mark to identify the waste storage area, this is worthy to note as highly recommended practice for safety and safeguard reasons

Table 4:
Collection practices and facilities

	Variable	No Participants/ Frequency	%
What type of containers is used for collection & internal transport the waste	Plastic Bins	37	46.25
	Trolleys + plastic bins	30	37.5
	Wheelbarrow	10	12.5
	plastic bins + wheelbarrow	3	3.75
	Total	80	100
What is the frequency of collection of medical waste	1	3	3.75
	2	5	6.25
	3	35	43.75
	4	19	23.75
	5	18	22.5
	Total	80	100
	Valid	**Frequency**	**Percent**
How is medical waste transported?	using waste disposal vehicle	51	63.75
	Using trolleys	16	20
	Wheelbarrow	13	16.25
	Total	80	100

Table 5:
Storage of Medical Waste

Variable	No Participants/Frequency	Percentage (%)
How is the MW stored while awaiting removal from the hospital?		
Waste Sack	67	83.75
Special Vessels	13	16.25
Total	80	100
Where is the segregated waste stored while awaiting removal from the hospital for disposal		
At the beginning near the source	12	15
At the waste storage place in the hospital	68	85
Total	80	100
Is the storage area well protected?		
Yes	78	97.5
No	2	2.5
Total	80	100
Is there a special mark showing the storage area of medical waste		
Yes	74	92.5
No	6	7.5
Total	80	100

Handling of Medical Waste: Table 6 indicates the various means been utilized and specific personnel involved in handling of medical waste wastes. It is found that cleaning workers are majorly the personnel involved in segregating of waste as reported by 83.75% of the respondents, while 16.25% of the respondents indicated that medical staff together with the cleaning workers are involved on the process of separation. While commendable effort towards health care waste handling approach being observed in the survey hospitals, there is however absent of any technically trained personnel assigned specially for waste handling and segregation especially hazardous wastes in any of the hospitals. Furthermore, concerning the use of personal protective equipment (PPE), 98.75% of the respondents reported the use of PPE contrary to findings by Ola-Adisa et al. (2015) and the containers used to discard needles are not vulnerable to punching as responded by 81.25% of the workers as against 18.75%, thus reducing the workers safety risk and injury. Hazardous materials such as sharps are deposed properly into safety boxes (85%), metal and plastic containers (12.5%) and metal containers (2.5%) Which are mostly burned openly within the hospital (63.75%). Generally, for final disposal medical waste were mostly incinerated (38.75%) or taken to municipal land fill (27.5%).

Table 6:
Handling of Medical Waste

	Variable	No. of Participants /Frequency	%
Who handles (removes) the segregated waste	Cleaning workers	67	83.75
	Cleaning workers & medical staff	13	16.25
	Total	80	100
Is the waste handler using any Personal protective clothing?	Yes	79	98.75
	No	1	1.25
	Total	80	100
Is the containers used to discard needles vulnerable to punching?	**Valid**	**Frequency**	**%**
	Yes	15	18.75
	No	65	81.25
	Total	80	100
Types of containers for sharps disposal	safety box	68	85
	metal containers	2	2.5
	metal + plastic containers	10	12.5
	Total	80	100
Is waste burned in the hospital?	Yes	51	63.75
	No	29	36.25
	Total	80	100
Are there specific marks indicating waste type inside the hospital?	Yes	77	96.25
	No	3	3.75
	Total	80	100
Final disposal of medical waste	taken to municipal landfill	22	27.5
	Incinerated + buried+ burned	31	38.75
	incinerated + taken to municipal landfill	21	26.25
	Total	80	100

Medical personnel and training: Table 7 indicates the personnel involved in the management of medical waste in the surveyed hospitals. The personnel involved in handling the waste have been trained as 100% of the respondents indicated so. Most have various trainings and workshops on waste management systems (50%), health-care waste management (15%), and training on institutional training and on job training (23%) and on workshop of environmental health management (12%). The duration of training of the personnel, varies from days-months such as; for 3weeeks (46%), 2 months (27%), 2 weeks (8%) 3days (15%) 3 months (15%).

Table 7:
Personnel involved in the management of Medical Waste

	Variable	F	%
Has he/she received any training on hospital waste management	Yes	26	100
	No		0
	Total	26	100
If yes what type of training	institutional training & on job training	6	23
	Waste management systen	13	50
	Health care waste management	4	15
	workshop on environmental health management	3	12
	Total	26	100
Duration of training	2 weeks	2	8
	3 weeks	12	46
	2 months	7	27
	3 days	4	15
	3 months	1	4
	Total	26	100
Is there availability of personal protective equipment	Yes	26	100
	No	-	0
	Total	26	100
Types of PPE available	Face masks + gloves +apron	1	3
	Gloves + boots + masks	10	39
	Gloves + boots + masks+ apron	15	58
	Total	26	100
Does the management staff have job description detailing their tasks	Yes	25	96
	No	1	4
	Total	26	100
Are there instruction/training given to hired waste management staff?	Yes	26	100
	No		0
	Total	26	100

F = No. of Participants/Frequency

It is also indicated that there is availability of personal protective equipment as 100% of the respondent indicated so this findings is in disagreement with Ola-Adisa et al. (2015) and lucy, (2017) where hospitals were ill-equipped and filled with untrained personnel. Majority of the respondents (58%) indicated that the type of personal protective equipment

available are gloves, apron, boots and face mask, 39% indicated that mask, boots and gloves are available as against 3% that indicated that face mask, gloves, boots and apron are available. Also, as to whether the waste management staff has job description detailing their task, 96% indicated that the waste management staff has job description detailing their task. Moreover, the survey also indicated that instructions/training are given to newly hired waste management staff as 100% of the respondents indicate so.

Table 9:
Training and safety of personnel responsible for handling of medical waste.

Have you been trained?	Yes	52	96
	No	2	4
	Total	54	100
What was the training period?	Valid	Frequency	Percent
	1month	25	46
	3 weeks	29	54
	Total	54	100
Are new workers trained?	Valid	Frequency	Percent
	Yes	50	93
	No	4	7
	Total	54	100
Do you wear gloves?	Valid	Frequency	Percent
	Yes	53	98
	No	1	2
	Total	54	100
Are there special clothes you wear preventive so needles cannot penetrate?	Valid	Frequency	Percent
	Yes	49	91
	No	5	9
	Total	54	100
Have you been subjected to needles after wearing these clothes?	Valid	Frequency	Percent
	Yes	1	2
	No	53	98
	Total	54	100
Does your employer takes care of your health?	Valid	Frequency	Percent
	Yes	53	98
	No	1	2
	Total	54	100
Have you been given vaccination to prevent specific diseases?	Valid	Frequency	Percent
	Yes	43	80
	No	11	20
	Total	54	100
Have you been infected with a disease resulting from management of these waste?	Valid	Frequency	Percent
	Yes		0
	No	54	100

Table 9 indicates the training and safety of personnel responsible for handling of medical waste in the surveyed hospitals. It shows the response of domestic workers with regards to their training and safety. 95% of the respondents indicated that they have received training. The period of training received differs as 54% of the respondents indicated that they received training for 3weeks while 46% indicated they received training for 1 month. The study further indicates that new workers are been trained as 93% of the respondents indicated so. With regards to whether the waste handler uses gloves, 98% of the responded indicated that they use protective gloves. Furthermore, the study also indicated that the waste handlers use special clothing which prevents them from been subjected to needles as 91% of the respondents indicated so, and 98% of the respondents indicated that they not been subjected to needles after wearing such protective clothing, this indicates that the safety of the waste handler is guaranteed. As to issues regarding the health of the waste handler, 98% of the respondents indicated that their employee takes care of their health, 80% of the respondents also indicated that they are been given vaccination to prevent them from been contacting specific diseases and lastly, all the respondents included in this survey indicated that they have not been infected with any diseases resulting from management of these wastes. This is a clear indication that the waste handler is using the proper protective measures to prevent him/her from been infected from any diseases resulting from management of these waste, it also indicated that the health of the waste handler is been taken care of by their employee.

Response from Borno State Environmental Protection Agency (BOSEPA): From the questionnaire administered to the agency it indicated that they use roll on roll off dust bins stationed in some hospitals within the metropolitan for collection of medical waste generated in some of the hospitals. The methods disposal of these waste after collected from the hospital include: incineration, municipal land fill, burning and deep burial. the study also indicated that the waste is collected weekly for final disposal, the number of vehicle which are currently in operation are three (3) roll on roll off trucks. With regards to laws guiding management of medical waste, it indicated that they use Public Health Law COP 109, 1963. The study also indicated that medical waste is not managed separately from other categories of waste. It also indicated that the agency have sensitization programme, about 85% of the hospitals comply with the laws guiding medical waste management. The agency also indicated that they face challenges with regards to management of medical waste, these challenges comprises of; lack of support from apex ministry, lack of provision of adequate incinerators in some health care facilities.

Response from National Environmental Standards and Regulation Enforcement Agency (NESREA): From the questionnaire administered to the agency it indicated that there are special laws guiding the management of medical waste & the law is *"National Environment (Sanitation) and waste control Regulation 2009",* 87% of the health care facilities comply with such rules/laws**.** With regards to penalty for mismanagement of medical waste by health care facilities, it indicated that there are penalties which constitute of sanction and payment of penalty, the amount to be paid as sanctioned depends on the gravity of/magnitude of the offence. It also indicated that there are sensitization programme regarding medical waste management through radio gingles and awareness creation. The agency also faces some challenging with regards to medical waste management which are; about 70% of the health care facilities lack facilities like incinerators for managing the waste they generate.

Conclusion and Recommendations: The total number of beds in the surveyed hospital was found to be 1249. The total quantity of waste generated in kg per day and in kg per bed per day in the surveyed hospitals was 1224.41kg/day and 8.41kg/bed/day respectively. Average healthcare waste generation rates in kg per day and in kg per bed per day in all surveyed hospitals- was 122.441kg/day and 0.841kg/bed/day respectively. Despite the challenges that are associated with Medical Waste Management especially lack of awareness regarding the medical waste management practices and lack of policies and regulations as stipulated by WHO. Borno state has taken the initiatives to have a well-organized system of collecting and treating waste through the intervention of Nigeria-State Health Investment Project (NSHIP). NSHIP has also taken further steps by providing the needed items like the different colored containers, liners to the hospitals at no cost. Borno State Environmental Protection Agency (BOSEPA) has also helped in improving the medical waste management practices by frequent collection of the waste for final disposal at little cost so that the hospitals can be encouraged to segregate and collect their waste appropriately.

From the findings of this study, it suffices to conclude that there is progress in the management of medical waste in Maiduguri Metropolitan Council because of the following: The MWM practices among the various hospitals surveyed are similar except for hospital D & J respectively which still mixes its medical and general waste. The medical waste is collected and segregated using the three colors coding system by WHO, then transfer to the on-site storage and finally transported by BOSEPA to the transfer loading station where it is treated by means of incineration, burning and deep burial. This system is congruence with WHO specifications however; uniformity in MWM practices should be ensured in all hospitals as against the divergent of hospital D & J. The level of awareness and training among the workers has relatively increased due to the intervention of NSHIP. However; continuous training of the hospital staff on MWM is highly advocated. There is also a need for awareness of waste management system amongst the patient/community in order to prevent infections and environmental hazards. Policy and regulation guidelines should be provided to all the three tiers of government (federal, state and local government) so as to improve waste management practices throughout the state.

From the results of this study, the following recommendations are hereby made:

Concerned ministries should stick on the clear specification of responsibilities towards medical waste management in Maiduguri Metropolitan Council. It is suggested for the Environmental Quality Authority to maintain the laws and regulations related to medical waste management outside health care institutions; and for the Ministry of Health to put laws and regulations related to medical waste management within health care establishments; and for the Ministry of Health in coordination with the Ministry of Local Government and the Environmental Quality Authority to devise a mechanism for monitoring medical waste management outside health care establishment.

- There is need for sustained cooperation among all key actors (government, hospitals and waste managers) in implementing a safe and reliable medical waste management strategy, not only in legislation and policy formation but also particularly in its monitoring and enforcement. This can be achieved through the cooperation between the Ministry of Health, Environmental Quality Authority, Ministry of Local Government, and Non Governmental Organizations working in related fields.
- There should be an obligation for each Health care facility(HCF) to ensure a safe and hygienic system of medical waste handling, segregation, collection, storage, transportation, treatment and disposal, with minimal risk to handlers, public health and the environment through the coordination between the related persons according to their responsibilities.
- All staff and waste handlers in each hospital should be well trained at the beginning of their work at hospitals, and regularly updated with pre-employment and in-house specialized training, which provides them with a knowledge base about the process of waste management and associated health risks.
- Economically and environmentally sustainable technological options for waste treatment, which can be well operated and maintained, should be considered for medical waste management.

There should be a hazardous waste landfill specially designed for the final disposal of treated hazardous healthcare waste. Its specifications are well known in the international literature and we should benefit from that.

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