Knowledge and Practice of Medical Waste Management in Small, Medium and Large Hospitals in Bayelsa State

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ABSTRACT: *The consciousness and practical in-depth knowledge of the nature of medical waste, its public and environmental implications serves as a veritable tool in the effective and efficient management of medical waste in any healthcare institution. Thus, this study considered the knowledge and practice of medical waste in small, medium and large hospital in Bayelsa State, South-south Nigeria. It is aimed at assessing waste management practices with respect to colour coding at the various healthcare institutions within the study area. A descriptive study design was considered and a sample size of 300 obtained using Cochran's formula. A well-structured questionnaire was used to elicit information from the respondents. Data were analyzed using simple percentage and frequency including graphs and bar chart. Result indicated that the rate of awareness and utilization of colour code for medical waste segregation in the various hospitals was poor except the large hospital (63%). The poor awareness level observed in the Medium and small hospitals in this study could be attributed to paucity of waste management infrastructure in addition to medical waste management deficiency and policy implementation practices. Furthermore, it was discovered that the use of sharp receptacle was high in small hospital (56%) and large hospital (75%) as compared to Medium hospital (43%). Also, knowledge, awareness and practice of medical waste management across the various healthcare institutions revealed that the small hospital (79%), medium hospital 71% and the large hospital 75% are well abreast and thus have good understanding of medical waste management, albeit, proper medical waste management is in a state of limbo at the hospitals at the time of this study. Government at all levels should ensure adequate funding and encourage professional to handle medical waste management whereas staff of the various hospitals should be properly trained on significance of the utilization of colour coding.*

KEY WORD: Hazardous medical waste, non-hazardous medical waste, incineration, medical waste management, waste receptacles.

INTRODUCTION

The hospital environment is one of the complex institutions that deal with different walks of life. Either the sick, well or sound, religion or none, political or apolitical etc., are often found in this environment. It accommodates people beyond patients and staff. Hospital environment is also

called healthcare facility or medical facility. However, the by-product (waste) from these various hospitals if not properly management could pose danger to public health. Healthcare waste therefore is any solid or liquid waste generated from healthcare facilities [1]. It is composed of wide range of materials like needle and syringes, blood samples, cotton swabs, blood containers, radioactive materials, tissue and body parts, razors and scalpels, chemical solutions, histopathology collections, fecal samples etc. These wastes could be hazardous (i.e., toxic, infectious, reactive, radioactive etc.) or it could be nonhazardous [2] [3]. The common sources of these wastes are the material used for the examination and evaluation of patients; treatments, immunization and animals etc., and it could be gotten from various units in the hospital setting such as emergency, laboratory, theater, maternity, wards, labour room, etc. According to world health organization [4], about 85% of the healthcare waste is nonhazardous while 15% is hazardous.

Improperly managed healthcare waste is a threat to the ecosystem because it may have the potency to infect or release toxic substances which may be genotoxic and radioactive [5]. It because of these associated potential health risks that healthcare waste is receiving more attention in the twenty first century. Healthcare waste also encompasses waste arising from healthcare facilities, research centers as well as laboratories associated with medical procedures [6].

The management of healthcare waste commenced at the source of generation. It has been averred by several authors that waste management involves generation, sorting (segregation), collection, transportation, storage, treatment and final disposal including financing, administration and management [7] [8] [9]. According to [10], healthcare facilities must retain it sanitary and hygiene status at all levels operation. To achieving this underscore the utilization of colour coding [11]. Effective and sustained colour coding practices encourages sound health and good environmental serenity while contrary to this could promote and ensures public health risk. However, healthcare waste management (i.e., disposal) in 21st century has gone beyond encapsulation, burial and sanitary landfill. Modern waste management scholars are suggesting space disposal in a bid to reduce and or eliminate the associate risk therewith in the biosphere. Therefore, this study is aimed at assessing waste management practices with respect to colour coding at the various healthcare institutions in Bayelsa State.

MAERIAL AND METHOD

Study Design
This study undertakes a descriptive research design. The approach involves the gathering of relevant information with respect to each healthcare facility as it affects colour coding [12] [3].

Study Area
Geographically, the state is located between latitude $4^0 15^{'}$ and $5^0 23^{'}$ N, and longitude $5^0 15^{'}$ and $6^0 45^{'}$ E with a total land mass size of 9,415.8sq.km. The State has eight Local Government Areas, namely: Brass, Kokokuma/Okpokuma, Ekeremor, Nembe, Ogbia, Sagbama, Southern Ijaw and Yenegoa as its capital territory. The percentage distribution of the population among the five LGA

ranges from 23.8% in Southern Ijaw, 14.2% in Ogbia, 11.1% in Ekeremor, 9.3% in Yenagoa and 6.0% in Kolokuma/Opukuma. Brass, Nembe and Sagbama has the rest 35.6%. The state has a riverine and estuarine like-setting and 78% of the communities are completely surrounded by water and creeks [14]. The total population of Bayelsa state was 1,704,515 (874,083 for male and 830,432 for female) according to [15]. It has limited dry land for settlements and agricultural purposes but it is characterized with extensive mangrove swamps, excessive rainfall, prolonged and disastrous flooding as well as coastal erosion [16].The state is almost entirely below sea level with a network of meandering creeks and mangrove swamps. The creeks and rivers connected in the South Pole drains into the Atlantic Ocean via the major rivers[17]. The population are thinly scattered among floating settlements called villages and towns; and concentrated majorly among five Local Government Areas. The state experiences equatorial type of climate in the southern most part and tropical rain towards the northern parts. The mean annual rainfall is estimated to be approximately 4900 mm and temperature variation from 20°C to 31° C. The hottest months are December to April.
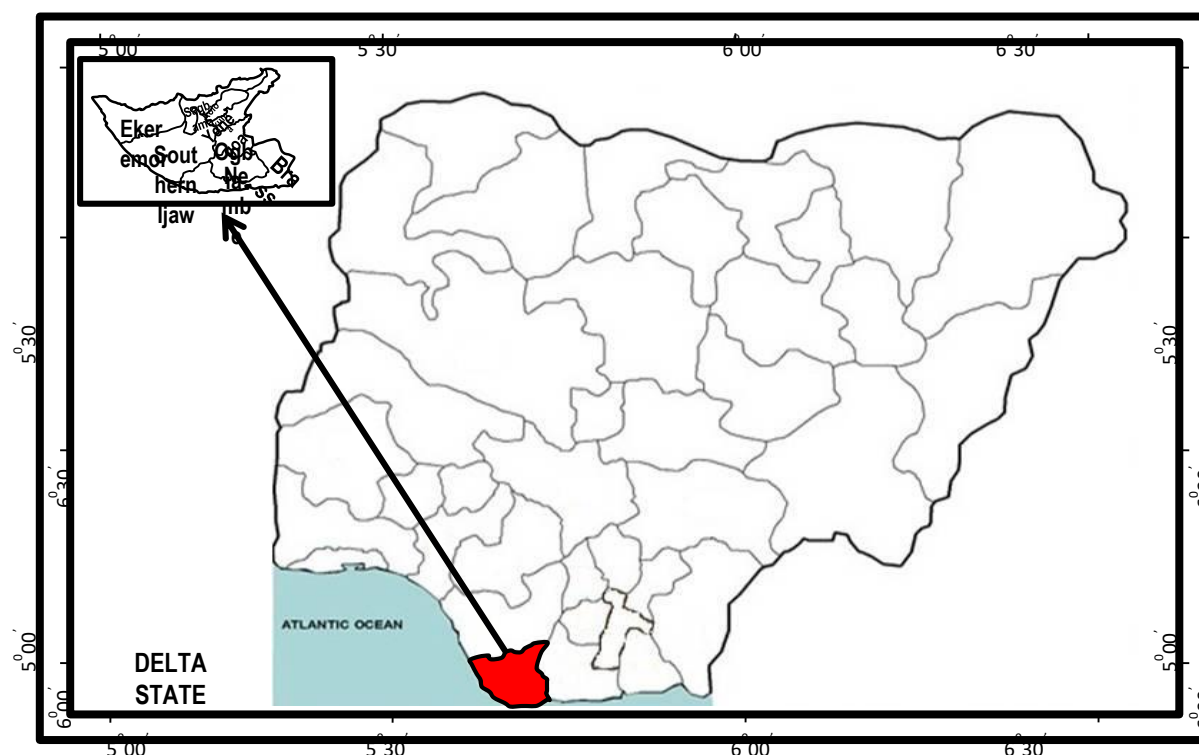

Figure 1: Map of Nigeria showing Bayelsa State

Source: Bayelsa State Ministry of Land, Urban Development and Housing, (2018)

Data Collection
Data were collected with the aid of a well-structured questionnaire, field measurement and field observation. The questionnaire was segmented into two parts. Part A deals with bio-data of the respondents while part B strictly emphasizes on the aim of the study. The field observations were made at each location, using WHO and ICRC checklist that focused on the collection, storage,

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transportation, treatment and disposal of hospital waste in consistent with WHO and ICRC standards.

Data Analysis

The quantities of hospital wastes collected from field measurements were presented in terms of kg/day for total amount of waste generated and percent (%) for the composition of wastes. Statistical excels and SPSS version 21 software, Analysis of Variance (ANOVA), Bivariate Analysis and Factor Analysis (FA) were used for the organization of data.

RESULT

Demographic Characteristic of Respondents

The results of the demographic characteristics of the respondents are presented in Table 1 with data on sex, age, marital status and level of education of the respondents that participated in the Primary Healthcare facilities, Secondary Healthcare Facilities and Tertiary Healthcare facilities. However, these healthcare facilities were classified as thus, Primary Healthcare facilities as Small Hospital, Secondary Healthcare facilities as Medium Hospital and Tertiary Healthcare facility was classified as Large Hospital respectively6t. Gender composition of the facility's respondents sampled revealed that male 17(40%), 67(37%) and 103(41%) represents small, medium and large hospitals while the female 26(60%), 116(63%) and 150(59%) also represents small, medium and large hospitals respectively. This implies that across the three categories of healthcare facilities studied, the female gender were more than their male counterparts. The corresponding Age class of the respondents between 18-30years and 31-40years for small, medium and large hospitals were 8(17%) and 19(40%), 44(23%) and 19(40%), 85(44%) and 134(50%). More so, 41-50years and 51-60years had 12(26%) and 8(7%) for small, 54(28%) and 9(5%) for medium and 62(23%) and 12(4%) for large hospitals respectively. Furthermore, the marital status of the correspondents across the small, medium and large hospitals revealed that single had 10(22%), 54(28%) and 75(30%); married had 33(73%), 133(69%) and 168(66%) while Divorce had 1(2%), 1(1%) and 6(2%), and Widow had 1(2%), 3(2) and 4(2%) respectively. Finally, the opinion of respondents concerning their level of education attainment shows that SSCE, ND and Midwifery had 1(%), 6(18%) and 7(21%) for small hospitals; 23(15%), 16(10%) and 15(10%) for medium hospitals; 9(4%), 15(7%) and 17(8%) for large hospitals while HND/B.Sc. and Postgraduate had 17(54%) and 2(6%) for small hospital, 78(51%) and 21(14%) for medium hospital, 129(59%) and 47(22%) for large hospital correspondingly (Table 1).

Table 1: Bio-demographic Data of the Respondents

Parameter	Category	Proportion of Respondents (%)	Parameter	Category
		Small	Medium	Large
Sex	Male	17(40)	67(37)	103(41)
	Female	26(60)	116(63)	150(59)
Age class	18-30	8(17)	44(23)	61(23)
	31-40	19(40)	85(44)	134(50)
	41-50	12(26)	54(28)	62(23)
	51-60	8(17)	9(5)	12(4)
Mar. St.	Single	10(22)	54(28)	75(30)
	Married	33(73)	133(69)	168(66)
	Divorce	1(2)	1(1)	6(2)
	Widow	1(2)	3(2)	4(2)
Education	SSCE	1(3)	23(15)	9(4)
	ND	6(18)	16(10)	15(7)
	Midwifery	7(21)	15(10)	17(8)
	HND/BSC	17(52)	78(51)	129(59)
	Postgraduate	2(6)	21(14)	47(22)

Mar. St. =Marital Status.

Source: Author's Field Survey, 2021.

Healthcare Facilities in the Bayelsa

There were variations in the number of health facilities in Bayelsa State. Small Hospital (Primary Healthcare Centres) was 172; Medium Hospitals (Secondary Health Facilities) had 58 while Large Hospital (Tertiary Healthcare Facilities) had 3. There were 22 private Medium Hospitals and none for Small and Large Hospitals respectively. These hospitals spread across the eight local government areas of the state (Table 2).

Table 2: Bayelsa State Healthcare Facilities

LGA	Small Hospital		Medium Hospital		Large Hospital		Total
	Public	Private	Public	Private	Public	Private	
Brass	11	0	4	0	0	0	**15**
Ekeremor	17	0	5	0	0	0	**22**
Kolokuma/Opokuma	7	0	5	0	0	0	**12**
Nembe	19	0	3	0	0	0	**22**
Ogbia	24	0	4	0	1	0	**29**
Sagbama	24	0	3	0	0	0	**27**
Southern Ijaw	37	0	6	0	1	0	**44**
Yenogoa	32	0	6	22	1	0	**61**
	171	0	36	22	3	0	**232**
Total	**172**		**58**		**3**		

Source: Bayelsa State Ministry of Health, 2020

Awareness on Medical Waste Management Strategies in the Health Facilities

Several waste management strategy exists. One of such strategy is by assessing the awareness of workers on colour coding. In Table 3, the percentage respondents on awareness of colour code for the segregation of medical waste across the Small, Medium and Large Hospital revealed that 16%, 21% and 63% correspondingly are aware and practiced colour code while 64%, 60% and 18%

respectively are not aware and thus do not practice colour coding whereas 20%, 19% and 63% respectively shared no knowledge whatsoever about colour coding.

On the awareness and utilization of safety box for sharps (receptacles) in the Small, Medium and Large Hospitals, 56%, 43% and 75% correspondingly maintained to be aware; 35%, 41% and 8% congruently maintained no awareness of colour coding while 9%, 16%, and17% respectively maintained no knowledge whatsoever they had on colour coding. Similarly, on the awareness of the Technical Guide on hazardous medical waste management for the Small, Medium and Large Hospitals, 16%, 34% and 63% respectively maintained that they are aware; 60%, 36% and 12% congruently maintained not been aware while 23%, 30% and 25% asserted that they do not have no knowledge whatsoever on the "Technical Guide" (Table 3).

Finally, on the awareness and utilization of the European Waste Catalogue (EWC) coding for medical waste management across the Small, Medium and Large Hospitals, 0%, 11% and 17% respectively asserted that they are aware and thus make use of EWC code whereas 58%, 52% and 25% correspondingly maintained that they are not aware and thus do not utilize EWC code while 42%, 38% and 58% respectively asserted that they do not have any knowledge whatsoever on the EWC code for the management of medical waste in their various health facilities. Albeit, on the issue of waste sacks (receptacles) being subjected to tear in the Small, Medium and Large Hospitals, 36%, 57% and 47% congruently revealed that they are well aware and thus utilizes it; 43%, 28% and 30% respectively maintained that they are not aware while 21%, 15% and 22% correspondingly maintained that they do not have any knowledge whatsoever on waste sacks being subjected to tear (Table 3).

Table 3: Respondents' Awareness of Application of Colour Coding, Technical Guidance and International Codes in Waste Management

Respondents' Awareness	Options	Percentage of Respondents		
		Small	Medium	Large
Awareness on the use of colour code for waste segregation	Yes	16%	21%	63%
	No	64%	60%	18%
	No knowledge	20%	19%	19%
Awareness on the use of sharps receptacles	Yes	56%	43%	75%
	No	35%	41%	8%
	No knowledge	9%	16%	17%
Awareness on hazardous waste technical guidance WM2?	Yes	16%	34%	63%
	No	60%	36%	12%
	No knowledge	23%	30%	25%
Awareness and use of the European waste catalogue (EWC) codes	Yes	0%	11%	17%
	No	58%	52%	25%

	No knowledge	42%	38%	58%
		36%	57%	47%
	Yes			
Awareness of waste sacks being subjected to tear	No	43%	28%	30%
	No knowledge	21%	15%	22%

Utilization of Incinerator in various Health Facilities

At the primary healthcare facility (Small Hospital), the percentage rate of the respondents towards the awareness and utilization of incinerator in across the health facility shown 0.0% which depict that none of the respondents agreed to have been aware and utilizes incinerator in the health facility; 76.8% of the respondent maintained not to have seen or utilize incinerator in the health facility while 7.3% of the respondents asserted that to some extend they are aware and have used incinerator, and 15.9% maintained that incinerator is not applicable as a waste management method in the health facility (Figure 2).

At the secondary health facility (Medium Hospital), 12.2% of the respondents maintained that they have knowledge on incinerator and have also used it, 64.9% of the respondents maintained the they do not have knowledge nor aware of incinerator and thus had never used it while 9.6% of the respondents undoubtedly said to some extend the y are aware of incinerator and 13.3% of the respondents maintained the applicability of incineration void in their health facility (Figure 2).

Again, at the Tertiary healthcare facility (Large Hospital), it was observed that 44.9% of the respondents maintained been aware and thus make do with incinerator in their health facility while 14.7% of the respondent also asserted in strong terms that they are not aware of incinerator and had not used it. Finally, 32.5% of the respondents posited that to some they have been aware of incinerator(s) or may have used it and 7.9% emphatically asserted that the utilization of incinerator in their healthcare facility is not applicable (Figure 2).
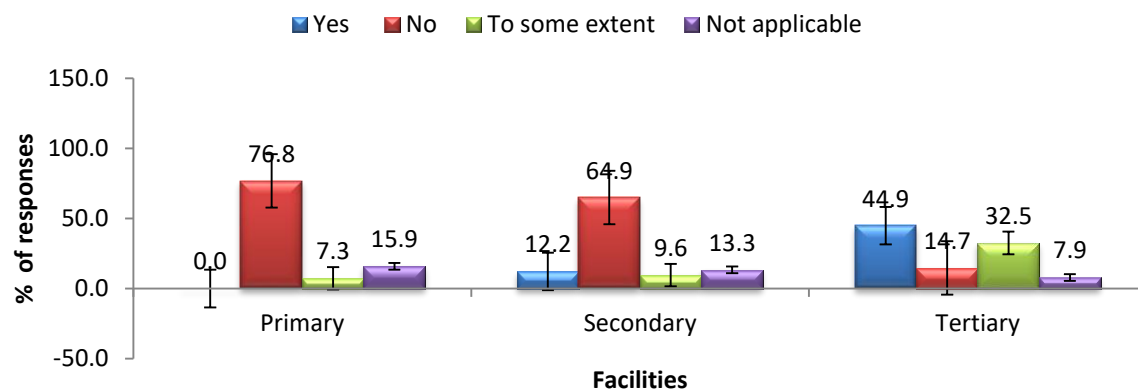

Figure 2: Awareness and utilization of Incinerators in Health Facilities

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Comparison in Medical Waste Management Practices among Different Hospitals
There were lots of variations and similarities of waste management practice across the different hospitals. In Table 4, several options about what waste management practice is all about was showcased across the health facilities. The Small Hospital (79%), Medium Hospital (71%) and Large Hospital (75%) indicated a very high similarity percentage ratio (i.e., 79%:71%:75%) on the understanding and practiced of an ideal and effective medical waste management practice (i.e., generation, segregation, collection, storage, treatment, transportation and disposal). Subsequently, there were very low similarities percentage ratios of 17%:21%:16% for generation, collection and disposal option, 5%:3%:4% respectively for collection, storage, treatment and transportation options, and finally 0%:4%:5% respectively define generation, segregation, collection, storage and treatment (Table 4).

On policy development in accordance with current best practice(s), Figure 4.20 revealed that there were lots of percentage variations across the various hospitals. In Small Hospital, the percentage respondents revealed that 7% depicts favourable application of current best practice (CBP) while 34% define un-favourable application of current best practice, and 59% declined no knowledge. At the Medium and Large Hospital, their corresponding values are 24%, 21%, 91% and 40%, 11%, 49%. The highest dissimilarity occurred in Large Hospital in all the health facility [i.e., 59% (Small Hospital), 91% (Medium Hospital) and 49% (Large Hospital respectively) accounting for declined of any knowledge.

Finally, the comparison on the level of policy stability, utilization and its effectiveness in medical waste management process by the different Hospitals as showed in Table 4.8 had 10%, 12% and 8% of the respondents which account for extremely unreliable policy correspond with Small, Medium and Large Hospitals while 33%, 53% and 25% of the respondent that accounted for not good and need lots of updating correspond with Small, Medium and Large Hospital respectively, and 43%, 30% and 39% of the respondent which justify the option of very good but need some updating correlated with the Small, Medium and Large Hospital congruently whereas 13%, 2% and 10% of the respondent defining optimal, updated and in line with the best available practice corresponded with the Small, Medium and Large Hospital respectively (Table 4).

Table 4: Comparison in medical waste management by different Hospital

Description of medical waste management	% of respondents		
	Small Hospital	**Medium Hospital**	**Large Hospital**
Its generation, segregation, collection, storage, treatment transportation and disposal of healthcare waste.	79%	71%	75%
It's the generation, collection and disposal of healthcare waste	17%	21%	16%
It's the collection, storage, treatment and transportation of healthcare waste	5%	3%	4%
It's the generation, segregation, collection, storage, treatment of healthcare waste	0%	4%	5%

DISCUSSION

The demographic variables revealed that the female workers [Small Hospital 26(60%), Medium Hospital 116(63%) and Large Hospital 159(59%)] more when compared to their male [Small Hospital 17(40), Medium Hospital 67(27) and Large Hospital 103(41)] counterpart across the various hospitals. The significance of this is that, women could be more exposed to any likely dangers resulting from poor management of medical waste in the facilities and therefore should be protected. Most of the respondents have post-secondary school educational qualification which qualifies the authenticity of the responses to be highly valid. Again, there were 44 private sector hospitals (Medium Hospital) cutting across two major senatorial district (Southern-Ijaw and Yenegoa) which underscore the integration of all major players in the medical management process that ensured and maintained an effective study.

However, colour coding in waste management has been viewed as a significant instrument that promotes volume reduction, safe handling, transportation and treatment processes etc., [2] [18] [19] [20] [3]. In the current study, the rate of awareness and utilization of colour code for medical waste segregation in the various hospitals was poor except the large hospital (63%). The poor awareness level observed in the Medium and small hospitals in this study could be attributed to paucity of waste management infrastructure in addition to medical waste management deficiency and policy implementation practices. This corroborate with [3] and [21] who maintained that lack of waste management infrastructure influences some stakeholders awareness and participation level in the waste management process. Furthermore, the study revealed that the use of sharp receptacle was high in small hospital (56%) and large hospital (75%) as compared to Medium hospital (43%) respectively. The technical composition of the large hospital may have contributed to the highest rate of utilization of sharp receptacles while at the small hospital, co-infection like Tuberculosis and HIV/AIDS during antenatal and other routine medical services may have

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possibly enhance the utilization of sharp receptacles. This is in agreement with [2] but contrast the view of [21]. The study however revealed that only the large hospital (63%) has knowledge on the hazardous waste technical guidance WM2, albeit, they do not have knowledge on the European Waste Catalogue Code (EWCC) for managing hazardous waste in the hospitals. The knowledge and awareness on waste sack bag being subject to tear was observed to be poor across the various hospitals (40% 28% 30%) for small, medium and large hospital respectively. This indicate that active waste collection practice is needed in the various hospitals to curb littering and scavengers activities since the respondents awareness rate on waste sack-bag subject to tear is poor [10].

Incineration is the process of utilizing thermal means of treating waste before safe disposal is carried out. It encourages the total destruction of microorganisms and the volume reduction of total waste that goes into the disposal stream [22] [23] [24] [25]. On the utilization of incinerators at a means of waste management process at the various hospital in this study indicates that at the large (Tertiary) hospital, 44.9% of the respondents make do with incinerators while at the medium (secondary) hospital only 12.2% practiced incineration, and no practiced was observed at the small (primary) hospital. Incinerators are capital intensive and demand effective maintenance for maximum productivity. This could be responsible for the non-availability of incinerator at the small hospital while at the medium and large hospitals, the utilization was poor. The poor utilization experienced in this study could not be far from poor maintenance culture and low political will of the administrator(s) in-charged.

Medical waste management is the composition of several waste management processes and procedures that ensure safety of man and his environment [26] [23] [27] [38] [29]. It involves generation, segregation, collection, storage, treatment transportation and disposal of healthcare waste [30] [31] [32]. Finally, on the knowledge, awareness and practice of medical waste management across the various healthcare institutions revealed that the small hospital (79%), medium hospital 71% and the large hospital 75% are well abreast and thus have good understanding of medical waste management. Consequently, it is expected that sound medical waste management practice be carried in the various health institutions but this is on the contrary in most of the health institutions surveyed. Poor funding, paucity of waste management infrastructure, training and retraining, lack of professional waste managers, very low political will on the part of the government etc., may have contributed to this observed differences.

SUMMARY OF FINDINGS

1. The rate of awareness and utilization of colour code for medical waste segregation in the various hospitals was poor except the large hospital (63%).
2. The poor awareness level observed in the Medium and small hospitals in this study could be attributed to paucity of waste management infrastructure in addition to medical waste management deficiency and policy implementation practices.
3. Furthermore, the study revealed that the use of sharp receptacle was high in small hospital (56%) and large hospital (75%) as compared to Medium hospital (43%) respectively.

4. The technical composition of the large hospital may have contributed to the highest rate of utilization of sharp receptacles while at the small hospital, co-infection like Tuberculosis and HI/AIDS during antenatal and other routine medical services may have possibly enhance the utilization of sharp receptacles.

5. The large (Tertiary) hospital 44.9% utilizes incinerators while at the medium (secondary) hospital only 12.2% practiced incineration, and no practiced was observed at the small (primary) hospital.

6. Consequently, it is expected that sound medical waste management practice be carried in the various health institutions but this is on the contrary in most of the health institutions surveyed.

7. Finally, on the knowledge, awareness and practice of medical waste management across the various healthcare institutions revealed that the small hospital (79%), medium hospital 71% and the large hospital 75% are well abreast and thus have good understanding of medical waste management. Yet, proper medical waste management is in a state of limbo at the hospitals at the time of this study.

CONCLUSION

Medical waste management constitutes several key components that must not be ignored at all level of operation. It takes into account a systematic way of waste generation, segregation, collection, storage, treatment transportation and disposal of healthcare waste in such a way and manner that the end result of the process does not constitute a nuisance to man nor the environment either at the short term or long term instances. To achieving this underscore the utilization of colour code and the application of incinerators. Thus, the knowledge, awareness and practice of medical waste management as a fundamental component is an essential commodity that should be encouraged even though incinerators are capital intensive and demand effective maintenance for maximum productivity.

RECOMMENDATION

1. Government at levels should ensure adequate funding and encourage professional to handle medical waste management.
2. Staff of the various hospitals should be properly trained on significance of the utilization of colour coding.
3. There should be provision of all medical waste management infrastructures to cushion the likely impact of these wastes on the environment.
4. Waste handlers should be incorporated in the training and re-training of staff to enhance proficiency in the entire waste management stream of the various health institutions.

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COMPETING INTEREST
Authors averred that there was no competing interest.

REFERENCE

1. JeyaSundar, P.G.S.A. and Zhang, Z. (2020). Waste treatment approach for environmental sustainability, https://www.sciencedirect.com
2. USAID, UNICEF, AIDSTAR-one; WHO, FMH etc., (2017). Healthcare waste management for injection control. Federal Ministry of Health, Abuja.
3. Bibiye, A.A.S., Ogbonna, D.N. & Ayotamuno, A. (2021). Impact of waste management deficiencies on soil, groundwater: its knowledge, attitude and perception and public health implications. *Journal of Applied Science and Management*, 5(2), 213-229.
4. World Health Organization (WHO) (2018). Healthcare waste. https://www.who.int/news-room/fact-   sheets/details/healthcare-waste
5. Jang, Y.C. (2011). Encyclopedia of environmental health, Second edition, vol. 3.
6. World Health Organization (WHO) (2019a). Health-care waste components and facilities. Report 2019.
7. Kofoworola, O.F. (2007). Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria. *Waste Manag*.
8. Ogbonna, D. N.; Amangabara, G.T. & Ekere, T. O. (2007). Urban solid waste generation in Port Harcourt Metropolis and its implications for waste Management, *Inter. J. Environ. Qual. Manag.,* 18(1), 71-88.
9. Bibiye, A.A.S. (2020). Environmental impact of waste management deficiency and its implication   on public health in Port Harcourt and its environs. A Ph.D. Dissertation Seminar presented   at the Institute of Geo-sciences, Environmental Management and Control, Rivers State University, Nigeria. Dated 17th November 2020.
10. WHO/UNICEF (2015). Water, sanitation and hygiene in health care facilities: status in low-and   middle-income countries. World Health Organization, Geneva
11. AIDSTAR-one, FEFPER/USAID, MMIS, WHO, UNICEF and FMH (2007). Injection safety and healthcare waste management in Nigeria. *Federal Ministry of Health* (P), 1, 79-105, 119-124.
12. Suwannnee, A. (2022). Study on waste from hospital and clinics in Phitsanulok, online *Journal of Health and Allied Sciences*, 3(3), 1-15.
13. Ogbuagu, D.K. & Njoku-Tony, R. F. (2010). Keys to research report writing by students, Desired Pbublishers, ISBN 978-34740-4-9, 27-38,

14. Ayanlade, A. & Proske, U. (2015). Assessing wet land degradation and loss of ecosystem services in Niger Delta, Nigeria, *Marine and Freshwater Research,* 3(2), 1-8.

15. NBS, (2011). "Nigerian Population Census Results. National Bureau of Statistics, Annual Abstract of Statistics". Federal Republic of Nigeria. 2011, pp. 33

16. Eludoyin, O.S., Obafemi, A.A. and Hardy, T. (2017). Effects of Urbanization Changes on Landuse in Yenagoa Metropolis, Bayelsa State, Nigeria (1986-2013). *International Journal of Development and Sustainability*, 6(8):728-745.

17. Ohimain, E.I. and Akinnibosun, H.A. (2007). Assessment of Wetland Hydrology, Hydrophytic Vegetation and Hydric Soil as Indicators for Wetland Determination. *Tropical Journal of Environmental Science and Health*, 10(1): 1-11.

18. Mugabi, B.; Hattingh, S. and Chima, S.C. (2018). Assessing knowledge, attitude and practices of   healthcare workers regarding medical waste management at a tertiary hospital in   Boswana: A cross-sectional quantitative study. *Niger Journal of Clinical Practices*,   21(21), 16+27-1638.

19. World Health organization (WHO) (2018). Healthcare waste: key facts. https://www.who.int/news-roo/fact-sheet/detail/health-care-waste

20. Chamberlain, M. (2018). Healthcare waste segregation. https://www.danielhealth.com/knowledge-center/healthcare-waste-segregation

21. Nazli, S.N.; Karuppannam, S.A.L. and Omar, D. (2014). Knowledge and awareness of clinical waste management among medics practioners in hospital Batu Pahat, Johor. *International   Journal of Innovation, Management and Technology,* 5(2), 139-142.

22. Kiely, G. (1988). *Environmental Engineering.* International Edition. Irwin/McGraw-Hill, p. 106, 427, 493-552, 623-652, 787-94, 815.

23. Bhatia, S. C. (2009). Environmental Pollution and Control in Chemical Processing Industries. Second Edition. Khanna Pub. New Delhi, India. 2(d)

24. Horsfall, M. (Jnr.) & Spiff, A.I. (2013). Principles of environmental pollution, toxicology & waste management. Onyoma Research Publication, 341-345. www.onoyomaresearch.com

25. Andales, J. (2022). Hospital waste management: Free Template and PDF Reports. *SafeyCulture https://safetyculture.com/checklist/hospital-waste-management#.*

26. Santra, S.C. (2012). *Healthcare waste management.* Environmental Science, *New Central Book   Agency (P),* Second Edition, 508-514.

27. Bibiye, A.A.S. (2013). *Environmental pollution and control*, Nybraide Enterprises with Pearl Publisher, ISBN: 978-978-49132-9-4.

28. Ogbonna, D. N., (2011).Characteristics and Waste Management Practices of Medical Wastes in Healthcare Institutions in Port Harcourt, Nigeria. *J. Soil Sci. Environ. Manage*. 2(5):132-141.

29. Pensiri, A.; Husna, R. and Mongkolchai, A. (2020). Assessment of knowledge, attitude and   practice in respect of medical waste management among healthcare workers in clinics, *Journal of Environmental and Public Health.* https://www.hindawi.com/journals/jeph/2020/8745472/

30. Izugbara, C.O & and Umoh, J.O. (2004). Indigenous waste management practice among the Ngwa of South-east Nigeria. *The Environmentalist,* 24, 62-64.
31. GASTEM (2014). Waste Management Methods. www.gastem.ca/wasdte-management-methods/s
32. Nasir, Kofi Essuman (2017). Knowledge Attitude and Practice of Coastal Communities on Waste Management in Ghana, *Novia University of Applied Sciences (NOVIA)*, 5.