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Medical waste management practices among selected health-care facilities in Nigeria: A case study

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Inappropriate medical waste (MW) management practices have become one of the major concerns in developing countries. The objectives of this study are to appraise the procedures and techniques available in collection and segregation of MW, treatment and recycling processes, disposal practices and compliances with rules and regulations in the Health-care Facilities (HCFs) in Ota, South West Nigeria. The HCFs visited includes general hospital, private hospitals, clinics, and primary health-care centers. The survey involved the use of structured questionnaires, in-depth interviews and on-site observations. Statistical Package for Social Sciences (SPSS) software application was employed for analysis. Responses were coded using a linkert scaling procedure. Hypotheses were tested using Bivariate regression technique involving inferential statistics. In addition, the study utilized chi-square non-parametric test for normal distributional effect of the variables. Results showed that MW management practices in most facilities are not totally in line with prescribed standards as expected. It is recommended that a sustained cooperation should be developed among all key actors (government, HCF's responsible and waste managers) so as to implement a safe and reliable medical waste management strategy. This should not only be limited to legislation and policy formulation but also in its monitoring and enforcement.

Key words: Medical waste management, health-care facilities, statistical analysis, health risk, sustainability practice.

INTRODUCTION

Generation of waste is indispensible with respect to Health-care Facilities (HCFs) activities, but knowledge of its hazards and good disposable practices has been very poor. Medical waste has continued to generate increasing public interest due to the health problems associated with exposure of human beings to potentially hazardous wastes arising from health-care facilities (Tudor et al., 2005; Da Silva et al., 2005; Oke, 2008;

Coker et al., 2009; PATH, 2009; Adegbite et al., 2010). Medical wastes are from hospitals, primary health-care centers (PHCs), dispensaries, dialysis centers, first-aid posts and sick bays, medical and biomedical laboratories, biotechnology laboratories, medical research centers, mortuary and autopsy centers, blood banks and blood collecting centers, nursing homes for elderly, maternity homes, pharmaceutical, chemical and chemist stores

(WHO, 1994, 1995; Tudor et al., 2005; Mokuolu, 2009). Studies have highlighted that ineffective management of infectious hospital waste in developing countries can compromise the quality of patient care and create significant occupational public and environmental health risks (Cole, 2000; Coker et al., 2009).

Although, treatment and disposal of health-care waste aims at reducing risks, indirect health risks may occur through the release of toxic pollutants into the environment during treatment or disposal. Improper handling of medical waste can create harmful effects and reduce the overall benefits of health-care. Studies conducted in developing countries regarding Medical waste management (MWM) has described it as being poor and that the general awareness on related issues is lacking among generators and handlers (Manyele et al., 2003). Despite the fact that health-care waste is labeled as hazardous because of the serious direct threat it poses to human health (WHO, 1999), the situation of poor MWM is still common in developing countries like South Africa, Nigeria, Swaziland, Mozambique, Kenya and Tanzania (Manyele et al., 2003; Manyele, 2004). An assessment conducted in 22 developing countries in 2002 showed that 18 to 64% of HCFs do not use proper waste disposal methods (WHO, 2002). Generally, lack of awareness about health hazards, poor management practice, insufficient financial and human resources and poor control of waste disposal are the most common problems connected with MWM in developing countries like Nigeria.

No doubt some studies have been conducted on waste generation, segregation and disposal, but little attention has been given to awareness of potential risks associated with medical waste and the need of personnel protection in rural and semi-urban settings. Presently, a gap exists in knowledge and practice among health personnel which requires being bridged not only for the study area but also in the entire nation. Manyele et al. (2003) expressed that developed nations recognized poverty as a basic factor that inhibited the success of African efforts in the area of environmentally sound management of hazardous waste. In Nigeria, medical waste falls under the category of infectious waste according to Federal Environmental Protection Agency (FEPA) now National Environmental Standards and Regulations Enforcement Agency (NESREA) (FEPA, 1991). This class of waste requires a particular type of management rather than being dumped with the rest of other waste. Speculations from various bodies have pointed out that in Nigeria; medical waste disposal has received no attention in contrary to what it deserves.

Health hazards due to improper MWM affect not only HCF's occupants but also spread into the vicinity.

Medical wastes are simply mixed with municipal waste in collection bins at roadsides and disposed off while some are simply buried without any appropriate measure. Lakshmi (2003) revealed that waste generated by government hospitals is still largely being dumped in the open, waiting to be collected with general waste. Similar practice is seen where borrow-pits (pits where sand are collected during construction of express highways) are common dumpsites of general wastes including health-care wastes without being treated or having any concern for the safety of the masses. The following are environmental effects of improper waste management: Groundwater contaminations due to the leachate generated by the waste dump, surface water contamination by the run-off from the waste dump, generation of inflammable gases (e.g. methane) inside the waste dump, bad odor, pests, rodents and wind-blown litter in and around the waste dumps, acidity to the encircling soil and greenhouse gases emission. All these call for attention and standardization if good health is to be achieved and maintained at all times (IPHI, 2005).

Thus, objectives of this research are to: (a) determine the quantity of medical waste generated in kg/day; (b) examine methods of waste disposal; (c) ascertain if there is any form of training and regulations on the management of medical waste as well as level of awareness of medical waste management among health workers with a proposition of efficient methods of waste management in some selected Health-care Facilities (HCFs) in Ota, South West Nigeria.

METHODOLOGY

Study area

This study focuses on Ota metropolis, a town in the Ado-Odo local government of Ogun State, Nigeria. It has an estimated population of 526,565 residents living in and around it (NPC, 2009; Olukanni and Akinyinka, 2012). It covers an area of 885 square kilometers with an average density of 372 persons per square kilometer and lies between latitude 6° 58' N and longitude 6° 42' E. The Ado-Odo/Ota Local Government Area is one of the 20 Local Government Areas (LGAs) of Ogun State, Nigeria. Ado-Odo/Ota borders on metropolitan Lagos. The LGA is the second largest in Ogun State with Ota being it's headquarter and having about four hundred and fifty (450) towns, villages and settlements. Towns and cities include Ado-Odo, Agbara, Igbesa, Iju-Ota, Itele, Kooko-Ebiye, Ilewo-Alaga, Owode and Sango Ota, among others. The LGA has one secondary, 25 primary health-care facilities and 156 private health-care facilities. There was no data on the available number of laboratories and private diagnostic centers.

Sample and sampling technique

The study is directed on determining the understanding of health care workers on MWM and also assesses the current waste management practice of the HCFs. These facilities include general, and specialist hospitals, clinics, and health-care centers located in the North, South, East and West part of Ota. The criteria for selecting the HCFs were based on their prominence in the society and the willingness of the heads of each facility to provide information. Consents were taken from the heads and structured questionnaires on related issues were administered to the health-care workers.

The study employed parametric and non-parametric analytical

Table 1. Daily average waste generation and characterization.

Medical Waste (MW) component	Generated waste in each HCFs category (kg/day)			
	Tertiary	Secondary	Primary	Private/diagnostic
Plastics, nylon, paper	-	30.2	8.51	12.53
Sharps and needles	-	11.4	4.83	7.1
Swabs and absorbents	-	12.7	2.04	3.01
Used beddings, IV drips and pharmaceutical products	-	9.4	2.17	3.2
Infectious waste	-	3.3	0.56	0.8
Daily total generation (kg/d)	-	67	18.11	26.64
Average generation rate (kg/day)	**-**	0.45	0.31	0.39

technique in its method of data analysis. The survey involved the use of structured questionnaires administered to health-care workers, in-depth interviews and on-site observations which lasted for five months, January to May, 2013. The main items of the questionnaire were focused on medical waste segregation, collection, treatment, recycling process, waste disposal and waste management practices. The study also captures health workers understanding on the current MWM. The research instrument was divided into two parts. First part dealt with personal information of the respondent and the type of health-care facility that is currently being considered. In second part, respondents stated their experiences on the waste management practice in their various health-care facilities. Respondents were Doctors, Nurses, Pharmacists, Attendants and other medical experts. Names of health-care facilities assessed are not mentioned in this report for the purpose of confidentiality. However, consents were taken from each HCF's administrator before each survey was carried out.

Data analysis

Qualitative and quantitative data collected through questionnaire and observation were compiled and analyzed by using percentages and proportions as well as Statistical Package for Social Sciences (SPSS). Findings were then combined and presented as a whole assessment. Responses were coded using a linkert scaling procedure. Procedure combines descriptive analysis and bivariate regression estimation in arriving at the results obtained. The asymmetric distribution of the responses and the asymptotic significance of the hypotheses were verified for statistical significance and distributional effect using chi-square normal distribution test. The variables of analysis were first subjected to descriptive analysis involving frequency distribution and percentages.

The regression estimates were utilized to determine nature and direction of the relationship among the dependent and independent variables. Three hypotheses were made prior to conduct the study. The first one was that majority of the HCFs in Ota lack proper arrangement for handling and treatment of medical waste. The second was that, there is inadequate awareness of waste recycling process among medical workers in Ota and the third being that, there exist low adoption of MWM practices in most of the local health-care facilities in the study area.

RESULTS AND DISCUSSION

Classification of health-care facilities

HCFs are generally categorized based on their size,

function and type of services rendered. They are usually categorized into 4 classes: Tertiary, Secondary and Primary health care facilities—and Private/Diagnostic service laboratories. Tertiary health-care facilities are categorized based on the fact that they have modern equipments and a large number of specialists trained in handling a variety of health problems and, as a consequence, they serve as a referral hospital to many other hospitals in Nigeria. Large hospitals and clinics with capacity to handle simple to fairly complicated health problems are categorized as Secondary. Primary are relatively small in scope of healthcare delivery and usually treat only out-patients with simple ailments (Coker et al., 1999). The Private/Diagnostic service laboratories are owned by individuals to render essential health-care services and treatment to people in the community. Each other category of HCFs was visited in the course of this study except for Tertiary HCF that is not available in the study area.

Descriptive analysis

Table 1 shows the nature and average daily amount of medical waste (MW) generated for all HCFs measured. The Secondary HCF has a total generation rate of 67 kg/day. 45% of total solid medical waste material is comprised of plastics, Polyvinyl Chloride (PVC), paper, gauze pads, garments, and cellulose. Other main solid medical wastes were sharps and needles (17%), swabs and absorbents (19%), used beddings, drips and pharmaceutical products (14%). Overall, infectious wastes constituted only (5%) of total waste measured. A similar study conducted by Coker et al. (2009) in Ibadan, revealed similar values of infectious waste. The peak average rate of waste generation/facility was from secondary HCFs whose value of 67 kg/day was almost quadruple that of the primary HCFs 18.1 kg/day rate.

As shown in Table 1, Secondary HCFs have the highest average generation rate of 0.45 kg/day, followed by the private/diagnostic centers which have an average generation rate of 0.39 kg/day. The possible underlying reason for the substantial amount of medical waste

Table 2. Demographic information of Respondents-I.

Sex of respondent	Percent	Valid percent	Cumulative percent
Male	18.8	19.7	19.7
Female	76.6	80.3	100.0
Total	95.3	100.0	
Age of respondent			
19-24 years	7.8	8.1	8.1
25-30 years	21.9	22.6	30.6
31-40 years	40.6	41.9	72.6
40 years and above	26.6	27.4	100.0
Total	96.9	100.0	
Years actively engaged in the medical profession (years)			
Less than 5 years	26.6	28.3	28.3
5-10 years	28.1	30.0	58.3
11-15 years	14.1	15.0	73.3
16-20 years	7.8	8.3	81.7
20 years and above	17.2	18.3	100.0
Total	93.8	100.0	

generation in private hospitals is fundamentally linked with government expenditure reductions on health-related programs which have led to understaffing and other things in the primary HCFs. This was also supported by reports from the interviews. In the wards visited, 23% claimed that waste generated is collected 3 times daily, 13% twice, 63% at least once a day while in remaining 2%, the waste is collected from the bins as necessitated. Overall, the frequency of collection of waste from all the HCFs is in line with the WHO standard (WHO, 2002) which states that waste must not be stored for more than 24 h.

Pre-treatment and segregation of waste

In the entire survey, none of waste handlers pre-treat their medical waste prior to disposal. Lack of education or sheer ignorance of some waste handlers was exhibited because they see no need for pre-treatment. Some felt handicapped by the costs of setting up pre-treatment facilities. In the course of the study, questions were asked as regards to the segregation techniques being practiced in the HCFs. None of the HCFs currently practice any segregation techniques. All waste generated in every facility is not separated. The effect of this is an unsustainable waste management practice. Waste sorting and segregation practice has been known to aid substantial reductions in what would finally end up in the waste stream (Olukanni and Akinyinka, 2012).

Demographic information of respondents

Table 2 shows the percentage of total respondents which

indicate that majority of health care personnel were mostly females. The percentage distribution of the medical workers by age revealed that 41.9% of the sample study was between 31 to 40 years old, of which 30% carrying the highest percentage have been working in the medical area for 5 to 10 years.

The descriptive analysis of Table 3 gives an understanding that majority (68.8%) of health-care workers have been in the current employment for less than 5 years. Nurses are the preponderant profession (59.4%), followed by doctors (23.4%). Respondents were categorized according to the type of HCF where they are located, showing that the majority (60.9%) was from PHCs.

Figure 1 shows the rates at which health care workers go for training. Pharmacists and dieticians seldom go for training. On the other hand, doctors go for conference and workshops. One connecting link to doctors attending training is the fact that, points are awarded to doctors which accumulates towards their practicing license registration renewal. In this wise, every medical officer attend as many trainings and conferences as possible to meet up with the essential points.

Bivariate analysis

Table 4 shows the result of the bivariate analysis. Model I shows that there is a significant relationship between type of HCF and staff awareness regarding material recycling and waste management. It further revealed that HCFs with good waste management system would be willing to create more awareness concerning waste disposal and recycling while others with poor waste recycling could be

Table 3. Demographic information of Respondents-II.

Years of experience in current hospital			
	Percent	Valid percent	Cumulative percent
Less than 5 years	68.8	71	71
5-10 years	21.9	22.6	93.5
11-15 years	1.6	1.6	95.2
16-20 years	1.6	1.6	96.8
20 years and above	3.1	3.2	100
Total	96.9	100	
Description of job in the hospital			
Doctor	23.4	23.4	23.4
Nurse	59.4	59.4	82.8
Pharmacist	1.6	1.6	84.4
Others	15.6	15.6	100
Total	100	100	
Type of hospital respondents			
Specialist	1.6	1.6	1.6
General	34.4	35.5	37.1
Clinic/Health centre	60.9	62.9	100
Total	96.9	100	
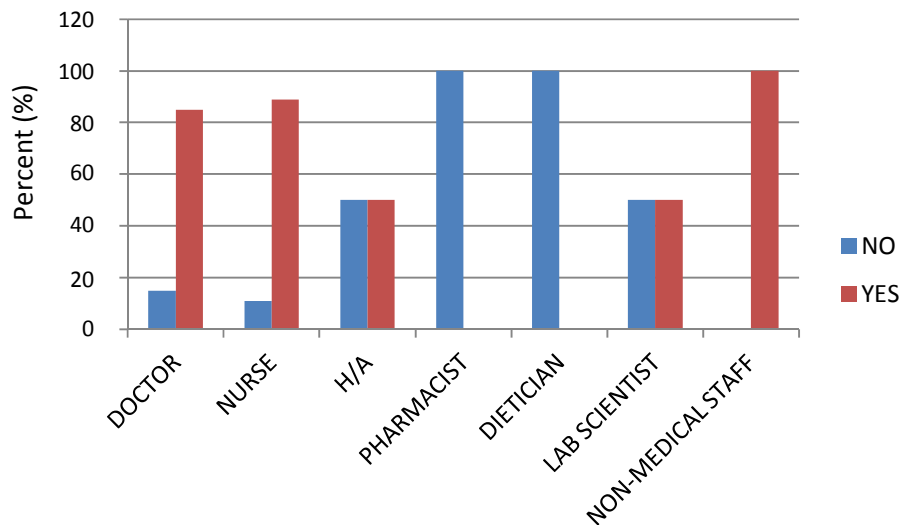
Figure 1. Distribution of training rates. H/A represents Health Attendants. The cleaners are grouped under non-medical staff.

silent about creating such awareness among their member(s) and staff. Model I also shows the relationship between types of HCFs and method adopted in providing instructive posters of waste segregation and management practice.

As depicted in the result of the surveyed HCFs, any HCF that adopts a conventional waste recycling approach would be willing to create awareness through the use of instructive posters and give directions on waste segregation, central collection point and disposal locations. This would be made available for all concerned personnel for maximum compliance and strict adherence; hence this helps to boost the image of the HCF among others as one of best practitioners in hygiene and waste management. The result also validates the fact that HCFs with low or poor waste management practice do not have instructive posters on waste segregation around their facility. In Model I, the relationship between type of HCF and frequency of medical waste collection from the wards shows a significant inverse relationship. The empirical

Table 4. Bivariate results.

Model I: Type of HCF respondents	F-value	Beta	t-value	Sig.
(Constant)			-0.477	0.635
Are you aware of any material being recycled by the HCF?	11.900	0.435	3.450	0.001
(Constant)			2.642	0.011
Are there Instructive posters on waste segregation around the HCF?	22.982	0.529	4.794	0.000
(Constant)			14.135	0.000
What is the frequency of collection of medical waste from the wards (times/day)	7.113	-0.344	-2.667	0.010
Model II: Is there any special budget in the HCF for waste management?				
(Constant)			0.644	0.523
Are you aware of any materials being recycled by the HCF?	9.444	0.409	3.073	0.004
Model III: Are there instructive posters on waste segregation around the hospital?				
(Constant)			13.947	0.000
How long have you been actively engaged in the medical Service?	3.574	-0.243	-1.890	0.064
(Constant)			3.616	0.001
Is there any waste management committee in the HCF?	17.038	0.467	4.128	0.000
Model IV: Is there a manual or document on management of Health-care waste?				
(Constant)			14.113	0.000
Who is responsible for collecting, handling, storage and disposal of the medical wastes from the wards in the HCF?	8.682	-0.468	-2.946	0.006
(Constant)			25.503	0.000
How long have you been actively engaged in the medical service?	6.752	-0.429	-2.598	0.014
Model V: Is there any waste management committee in the HCF?				
(Constant)			4.225	0.000
Is there is any special budget your facility for waste management?	45.322	0.672	6.732	0.000
(Constant)			17.598	0.000
What is the frequency of collection of medical waste from the wards (times/day)?	9.302	-0.386	-3.050	0.004

result from the analysis portrays the fact that frequency of medical waste collection is not directly related to the type of the HCF. Activities of the HWM committee in terms of supervision and monitoring should be a direct determinant factor.

Model II establishes the nature of the relationship between awareness of materials being recycled by the hospital and special budget for waste management practice. Result shows that lack of adequate knowledge on waste management practices could be responsible for poor planning and budgeting as observed in many HCFs. A critical observation reveals that a growth of 1% in special budget for waste management could increase awareness among hospital staff by over 40%, having other factors constant.

Thus, the result provides empirical evidence suggesting that increase in the budgetary allocation for waste management would facilitate publicity and awareness creation concerning recycled materials and general waste management practices.

Model III revealed that time of active engagement in health-care services does not determine level of importance attached to waste management and awareness among health-care workers. It is rather, a matter of management decision, value and orientation. Thus, a negative relationship is observed between years of active engagement in the profession and availability of instructive posters on waste segregation around the HCFs. It could be observed that from the empirical result that an active waste management committee set up by

Table 5. Distribution test.

	Type of HCF respondents	Are you aware of any materials being recycled by the HCF?	What is the frequency of collection of medical waste from the wards (times/day)?	How long have you been working in this HCF?	Is there any waste management committee in the HCF?
Chi-Square	35.065[a]	40.164[b]	71.273[d]	110.419[b]	8.397[a]
df	2	1	4	4	1
Asymp. Sig.	0.000	0.000	0.000	0.000	0.004

	Is there a manual document on management of hospital waste available in your HCF?	Who is responsible for collecting, handling, storage and disposal of the medical wastes from the wards in the HCF?	How long have you been working in this HCF?
Chi-Square	26.471[a]	109.448[b]	110.419[c]
df	1	3	4
Asymp. Sig.	0.000	0.000	0.000

the management should be a determinant factor in ensuring proper sensitization and publicity of medical waste management practice. Waste management committee has a significant role in facilitating awareness for waste recycling. Utilization of instructive posters and other informative symbols should be examples of approach and procedures to be adopted.

Model IV informs that proper assignment of roles and responsibilities for collection, handling, storage and disposal of medical waste from the wards should be well driven with utmost compliance. On average, there is assignment of responsibilities for medical waste collection, handling, storage and disposal in some HCFs, but there is no manual or guideline documented. As discussed earlier, this result also points out that the nature and activities of the MWM committee and the level of consideration given to MWM and recycling could account for the ability of HCFs to provide instructive manual or guideline document(s). It is also worth to emphasize here that, apart from the availability of MWM manual or guideline documented, there is also need for strict adherence and compliance to the speculation outlined therein for significant result to be achieved. The evidence from Model V reveals a significant positive impact of special hospital budget for waste management. Further analysis of the result indicates that 1% increase in the level of special budget and allocation for waste management in the hospital could significantly increase the existence and performance of the waste management committee by over 67% in the hospital, all things being equal.

Hence, the following hypotheses were suggested;

H$_1$: Majority of HCFs in Ota lack proper arrangement for handling and treatment of MW

Model V establishes the relationship between frequency of collection of medical waste and management committee in the hospital. The result in Table 4 suggests that the presence of hospital waste management committee (if any) do not positively influence the frequency of medical waste collection from the hospital wards per day. Although, the frequency of waste collection invariable could be directly related to the volume of waste production, active engagement by cleaners and other waste management officials, however, the MWM committee should supervise and coordinate the activities of these workers to ensure a quick response to waste disposal, collection, treatment and recycling process. Table 5 presents the distribution test employed to analyze distributional effect of the responses. The chi-square normal distribution and asymptotic significance was utilized to test the distributional effect of the responses and also determine its statistical relevance as it relates to the hypothesis of this study.

H$_2$: There is inadequate awareness of hospital waste recycling process among medical workers in Ota

The result of the analysis in Table 4 supports the evidence that the different categories of HCFs captured by the survey are well distributed and therefore highly significant. It confirms that majority of the HCFs workers are not aware of any material being recycled by the hospital. The study therefore provides support that among the various types of HCFs surveyed, there is low level of awareness on whether materials are recycled. It also establishes that medical waste from the wards are collected at time intervals per day based on the hospital waste management routine of cleaners or agents responsible for the hospital waste collection and disposal.

H$_3$: There exist low adoptions of MWM practices in most of the local medical health organizations in Ota

The empirical result emanating from Table 3 also shows

that the surveyed staffs have had some year(s) of experience in active engagement in health-care services. Responses indicating existence of waste management committee are statistically significant. It can be concluded that the responses are from experienced medical personnel and that there exists little or no waste management committee or people charged with the responsibility of handling waste products in majority of HCFs surveyed. It further reveals the probability of having an error in 4 responses out of every 1000 tables as revealed in the chi square normal distribution.

The result of the chi square test is shown in Table 5. Given the degree of freedom at 1, 3 and 4, respectively indicates no associated probability for the occurrence of Type 1 error in 1000 tests. This result shows that on average, there could be negligible Nigerian HCFs with effective manual or document on MWM available in their facility. The result provided significant evidence of people responsible for collecting, handling and disposal of the medical wastes from the wards in the HCFs which consists mostly of the health attendants. Some well experienced medical workers within the various HCFs also confirmed the result of the responses from the administered questionnaire.

CONCLUSION AND RECOMMENDATIONS

The determination of the quantity of medical waste generated in kg/day has been realized and various methods of waste disposal examined. This study has also situated the various levels of training and regulations on the management of medical waste, as well as levels of awareness of medical waste management among health-care workers in selected HCFs in Ota, South West Nigeria.

The HCFs in Ota metropolis, in comparison to the developed nations have minimal appropriate practices when it comes to handling and disposal of these wastes, starting from the personnel responsible for collection and storage through to the final disposal of the wastes. Though regulation exists, but there is no implementation and enforcement. This has made many health-care facility operators to relax. The study has demonstrated that medical waste management in Ota faces many challenges because there had been lack of data on the quantities and nature of the waste generated in previous times which this study has been able to come up with a significant information that could serve as baseline data for other researchers. Such important data are of utmost importance for meaningful planning of waste management procedures. Also, there is no formal policy or directive put in place by stakeholders or government. Currently, the management of infectious waste is normally governed by activities of largely untrained and uneducated waste handlers from poor backgrounds. Collectively, this study indicates important implications for the health of handlers, other health care staff, patients,

their families and indeed entire residents of the community. To this end, the recommendations to improving the management of medical waste in Ota are listed below:

1. A sustained cooperation must be formed among all key actors (government and waste managers) with the purpose of implementing a safe and reliable medical waste management strategy, not only in legislation and policy formation but also in its monitoring and enforcement;
2. All staff and waste handlers in each HCF should be regularly updated with specialized training, which provides updated knowledge about the process of waste management and associated health risks;
3. The mass media should also sensitize the general public and raise their awareness level on environmental risks associated with improper management of medical waste;
4. There is a need for further studies to be conducted on other aspects of medical waste, not covered by this study, so as to generate a comprehensive pool of much-needed baseline data in other local government and Nigeria.

Conflict of interests

The authors have not declared any conflict of interests.

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