

# A Comparison of Medical Waste Generated in Selected Private and Public Hospitals in Abeokuta Metropolis, Nigeria.

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**Keywords:** Abeokuta, Disease, Hospital, Infection, Management, Medical Waste, Public

## ABSTRACT

Medical waste management (MWM) has received very little attention in waste management process in Nigeria. Neither the government nor hospital authorities pay proper attention to its management. Hospital workers and patients are at risk of acquiring infection from sharps and contamination of environment with multiple drug resistant microorganisms if wastes are not properly managed. A survey of medical waste management (MWM) practices and their implications to health and environment was carried out in Abeokuta Metropolis, Nigeria. This study assessed management practices in two (private and public) hospitals. Empirical data was obtained on medical waste generation, segregation, storage, collection, transportation and disposal. The observed MWM practices in all hospitals indicate absence of full compliance with the protocol for handling medical waste as stipulated in the relevant sections of the guidelines and standards for environmental pollution control in Nigeria. The private hospital demonstrated high priority for segregation of infectious medical waste. The average solid waste generated rate per bed/day was found to be 0.232kg of solid waste of which 15.6% was hazardous in nature. Infectious wastes account for about 13.6% of the total waste. Only the private hospital investigated carry out treatment of her infectious and sharp waste types by incineration before final disposal. Waste management officers do not have formal training in waste management and techniques and hospital administration pay very little attention to appropriate management of medical waste. The study proffers recommendation to include: (1) Formulation of a medical waste management policy separately from a hospital waste management policy. This can be done by a multidisciplinary team including Environmental Health experts and waste management experts. (2) All staff and personnel handling medical waste in each hospital should be trained on methods and new techniques of medical waste.

## 1.0 Introduction

The management of medical waste is of great importance due to its potential environmental hazards and public health risk [1]. The field of medical waste disposal is changing rapidly. Over the past decade, there has been increasing public health concern over the health care's infectious wastes [2]. Though medical waste constitutes a small fraction of the municipal solid waste (MSW), the potential environmental and health hazards could be deleterious if not properly handled, the worst scenario being in developing countries [3]. In Nigeria, a typical developing African nation, not many people are aware that medical waste contributes sizeable to environmental pollution [4]. Patronage of hospital and other health care facilities in Nigeria is on the increase. The rapidly increasing population coupled with the deteriorating environment is some of the factors responsible for this trend. The situation cuts across rural and urban settlements [5].

According to WHO [6], almost 80% of medical waste is comparable to domestic waste while the remaining approximate of 20% is considered hazardous as it may be infectious, toxic

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and/or radioactive. Infectious wastes together represent the majority of the hazardous waste (up to 15%) from health care activities. Sharp objects, genotoxic waste, heavy metals (1% each), chemical and pharmaceuticals (3%) constitute the rest of the hazardous waste. The composition of hospital wastes may also typically include waste chemicals, pathological wastes, anatomical waste, mercury and other heavy materials [7]. It is a known fact that hospitals are the major producers of medical waste. In hospitals, different kinds of therapeutics procedures (i.e cobalt therapy, chemotherapy, autopsy, biopsy, Para clinical test, injections etc.) are carried out and result in the production of infectious wastes, sharp objects, radioactive wastes and chemical material [8]. Health care Waste (HCW) has come to be defined as the total waste stream from a healthcare establishment, research facilities, laboratories and emergency relief donations. In Nigeria, health care waste falls under the category of infectious waste [9]. Within this category are cultured and stock of infectious agents, sharps (hypodermic needles, syringes, and scalpel blades), waste from human blood and products of blood and laboratory waste. Early discharge will mean that larger volumes will arise

from care given inside hospital premises and special arrangements have to be made for uplift of the waste [10]. It is very sad however, to note that the procedure for management of Health Care Waste in Nigeria today is nothing to write home about. A close look at top hospitals either owned by the Federal, State or Local Government or even by the private sector reveals a serious dereliction of duty by the authority of such facilities. There can be difficulties in reconciling the current legislation and guidance with a practical solution to the problems of medical waste arising in a community setting [11],[12].

Medical waste arising from the hospital environment is a serious problem in its ability to cause injuries, environmental pollution and various diseases sometimes life-threatening. Public concern is based largely on a fear that the human immunodeficiency virus (HIV) can be contacted through accidental exposure of infectious waste. Fear also emanates from potential exposure to the hepatitis B Virus. Waste generators, waste haulers and landfill personnel are more susceptible to suffer from these diseases and hence precautions should be taken to ensure safe handling [4]. In developed countries like the United States of America, England, France, Australia and Japan, a medical waste management strategy is well established. While health care facilities and home-care settings in these developed countries conform to certain safety standards laid out by regulatory bodies on disposing medical waste, the same is not often true in developing countries for where the level of awareness about the health threat that improper disposal of medical waste pose is lower. The observed medical waste management practices in all hospitals indicate absence of full compliance with the protocol for handling medical waste as stipulated in the relevant sections of the guidelines and standards for environmental pollution control in Nigeria [13].

Medical waste is collected, handled through the municipal collection system, and is mostly disposed off in open dumps thus creating a serious health risk to municipal workers, the

public and the environment: There are no landfills specifically designed to receive infectious wastes either in the country or in Abeokuta, Ogun State, There is no current formal policy to regulate the generation and management of medical waste in Nigeria [4], hence the urgent need to pay serious attention to hospital generated medical wastes and its associated problems by all stakeholders.

### 1.1 Problem Statement

As the rapid development going on in health care institution plays a significant role in raising human life expectancy with the rising number of health care institutions, the amount of medical waste generated will increase at the same time. Improper management of medical waste may expose health and safety hazards to health workers, public and also environment. Medical waste is the inevitable part of today's ever developing and expanding health care industry. Medical waste is considered to be the most harmful of every type of hazardous wastes because of its infectious characteristics. It is necessary to search for ways to improve the medical waste management system in order to minimize or eliminate the harm done to the environment.

### 1.2 Justification of the Study

Researchers have decried poor medical waste disposal service in Nigerian hospitals. They posited that the general awareness on issues related to medical waste management was generally lacking among generators and handlers. Medical waste disposal in Nigeria is usually neglected, and oftentimes compromises the health of members of the community.

Improper collection, storage, treatment and disposal can lead to serious environmental damages of various kinds. Some of the health problems associated with improper collection, treatment and disposal of healthcare waste includes typhoid fever, cholera, skin disease, malaria, intestinal parasitosis hepatitis B and C and liver cancer [14]. Hence, the disposal of items used at health institution must be handled with utmost care to ensure that health care workers, patients and members of the community are

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protected from the dangers of secondary transmission of diseases and cause of injuries.

Burning and incineration of medical and municipal waste have been linked to severe public health threat and pollution resulting in the release of toxic dioxin as well as mercury and other toxic substance [15]. Putrefaction occurs in portions of refuse which have not been fully burnt and add to air pollution through foul smells. Sanitary landfill can lead to pollution of ground water if not properly managed.

### 1.3 Objectives of the Study

The objectives of this study are:

- i. To assess the extent of medical waste generated in selected public and private hospitals in Abeokuta, Ogun State.
- ii. To investigate the current status of waste management practices in selected public and private hospitals.
- iii. To evaluate the problems associated with disposal method and management practices adopted in selected public and private hospitals.
- iv. To proffer feasible solutions to the militating problems of medical wastes.

## 2 Materials and Methods

### 2.0 Study Area

This study was conducted in a private and public health care institution strategically chosen based on size, level of patronage, and service utilization in Abeokuta metropolis, Ogun State. Abeokuta is a city in Ogun State in South West Nigeria and is situated at 7°9'39"N 3°20'54"E on the Ogun River; 64 miles north of Lagos by railway or 81 miles by water. As of 2005, Abeokuta and the surrounding area had a population of 593, 140. Palm-oil, timber, rubber, yams and shea-butter are the chief articles of trade.

### 2.1 Data Collection

Three instruments namely: questionnaire administration, in-depth interview and participant observation strategy/discussion were adopted in this study. The questionnaires were administered to the hospital administrator. The existing waste

management policy with respect to collection, storage, transportation and final disposal were evaluated. Information regarding staff strength, services available, wards, units, number of beds, average bed occupancy rate, and profile of waste handlers were collected through administered questionnaires; others are quantities and waste type produced. The discussion was organized to obtain additional information from respondents and heads of units and wards as well as use the responses to validate some of the results from the questionnaire and in-depth interview.

### 2.2 Waste Sampling and Analysis

The solid medical waste generated in each ward or unit of the hospitals selected for the study were collected in labeled polythene leak proof bags inserted into existing dustbins or waste receptacle of each point of medical waste generation. Twenty-four (24) hours solid waste was collected in labeled polythene bags. Waste samples were sorted into five main categories (sharps, small glass bottles, plastic syringes, infectious and general wastes) and measured for 7 days. On the seventh day, an average of the week's data was recorded. Due to the tasking nature of the research work, trained field assistants were employed in the study to facilitate questionnaire administration, waste collection and sampling. Field work materials include a top loading digital beam balance of 6kg capacity, spring balance (used to measure solid waste mass that may exceed the capacity of the beam balance), sorting plate, labeled polythene bags, measuring tape and protective materials (thick boots, gloves, nose cover, face-mask and aprons).

Towards the latter part of the investigation, visits were made to landfill sites (at Ojere and Quarry) to determine the management practices in operations.

### 2.3 Data Analysis

The quantities of hospital waste were presented in terms of Kg/day and Kg/bed/day for total amount of waste generation and generation rate respectively. The data gathered from the

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questionnaire were compiled with computer and analyzed using statistical excel and SPSS software.

### 3. Results and Discussion

#### 3.0 Results

**Table 1: MEDICAL WASTE MANAGEMENT CONSIDERATION**

	Hospital type	
	Private	Public
Tracking programme	Absent	Absent
Monitoring and testing	Absent	Absent
Treatment facility	Incinerator	None
MWMP	Present	Absent.

MWMP: Medical Waste Management Plan.

**Table 2: AMOUNT OF WASTES WITH TYPE GENERATED (Kg/day) IN**

SURVEYED WASTE CATEGORY	HOSPITALS		
	Private	Public	Average
General Waste	1,106.7 (70.5)	729.2 (70.1)	1836.2 (70.3)
Infectious waste	222.3 (14.1)	132.0 (12.7)	354.3 (13.6)
Sharps	4.0 (0.3)	6.1 (0.6)	10.1 (0.4)
Plastic and syringes	8.2 (0.5)	32.7 (3.1)	40.9 (1.6)
Small bottles	229.6 (14.6)	140.5 (13.5)	370.1 (14.1)
Total	1,570.8	1,040.8	2,611.6

\*Figure in the parenthesis indicates the percentage of each waste category.

**Table 3: MEDICAL WASTE GENERATION IN SURVEY HOSPITALS.**

	Hospital type	
	Public	Private
Number of beds	250	350
Total waste generated (Kg/day)	1,040.8	1,570.8
Generation rate (Kg/bed/day)	0.240	0.224
Average (Kg/bed/day)	0.232	

Table 1 presents the management consideration used to assess the medical waste management practices.

Results obtained from investigation on generation rate Kg/day are presented in Table 2.

It is apparent that the surveyed hospital generated 2,611.6 Kg/day of wastes of which 1836.2 Kg/day (70.3%) are general wastes; 405.3 Kg/day (15.6%) are hazardous wastes and 370.1 Kg/day (14.1%) small glass bottles. Domestic wastes and other non-hazardous wastes are found to be the highest component in the selected public and private hospitals in Abeokuta metropolis and the quantity covers more than three-quarters of the generated wastes, followed by small broken bottles (14.1%), infectious waste (13.6%), plastic and syringes (1.6%) and sharp items (0.4%) as indicated in Figure 4.1.

Figures showing the volume of waste generated from each health care institution from the selected public and private hospitals in the Abeokuta metropolis, Ogun State are presented in Table 3. The average waste generation rate per bed per day is 0.232 Kg/bed/day while 0.240 Kg/bed/day and 0.224 Kg/bed/day were generated for public and private hospitals respectively.

#### 3.1 Discussion

Medical waste management has received very little attention in waste management process in Nigeria. Neither the government nor hospital authorities pay proper attention to its management. Unwholesome waste disposal by many hospitals, clinics and health centers in Abeokuta pose serious health hazards to the city

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dwellers in general and people living within the vicinity of the health care institution in particular. Almost all the health care institutions surveyed dispose every kind of waste generated into municipal dumpsites without pre-treatment leading to an unhealthy and hazardous environment around the health institutions, affecting patients and staff. Scavengers who collect waste from dustbins and temporary dumpsite within the hospital premises are at risk of injury from sharp instruments and direct contact with infectious materials. Liquid medical wastes are disposed directly into the municipal sewer system by the institutions surveyed. Direct disposal of feces and urine of infectious patients in municipal sewer system may cause outbreak of epidemic disease [15],[16]. The scavengers that engage in recycling operation are unaware of the harmful consequences of exposure to contaminate and hazardous waste [17].

### 3.1 Waste Management Practices

The adequacy or otherwise of the waste management practices of surveyed hospitals were measured based on three principal criteria as stipulated in the National Guidelines for the management of medical waste. These include the presence or absence of the Tracking programme, monitoring and testing and the existence or otherwise of any Medical Waste Management Plan (MWMP) in place. Results of investigation revealed a complete absence of medical waste tracking, monitoring and testing programme. Equally noted was the absence of an institutionalized medical waste management plan and treatment facility in the public hospital. This is grossly due to poor funding from the government. Functional treatment facility in form of incineration was present in the private hospital. Furthermore, results from survey revealed non compliance of any of the health care facility investigated with the existing national regulatory requirements. A similar study conducted by Longe and Williams [13] show a similar trend. Though the requirements are necessary management consideration, there has not been any known

serious compliance by the hospitals in general or enforcement by the relevant regulatory bodies in particular.

### 3.2 Waste Segregation

Segregation of waste i.e. sorting into waste categories is an important step in reducing the quantities of hazardous waste as it offers the ability to make more accurate assessment about its composition with the use of labeled bags to distinguish infectious waste from domestic waste effectively. Segregation of hazardous/infectious waste types is a key to achieving effective waste management [13]. Therefore it should be done according to specific treatment and disposal requirements. Results from investigation revealed that the selected private hospital gave high priority to segregation from source of infections, sharps, plastic and syringes and small glass bottle wastes by use of colour coding system. Coloured buckets are used; white for sharps, red for small glass bottles, green for syringes and plastics and blue for infections. There is complete absence of waste segregation practices in the public hospital as both hazardous waste and general waste are mixed together by collectors either at the point of collection or at the dumpsite. This procedure not being practiced by the selected public hospital may be due to lack of waste managers in the healthcare studied. The whole mixed volume therefore could be considered as being infectious which portends a serious risk to the general public [18]. By the WHO report, it was estimated that in 2000, worldwide, injections undertaken with contaminated syringes caused about 23 million infections of Hepatitis B and Hepatitis C and HIV [18].

### 3.3 Waste Generation and Characterization

The composition of medical waste varies from one hospital to another with no distinction between private and public hospitals as presented in Table 3. It could be observed that the general waste made up of "domestic waste" constitutes the larger percentage of the waste stream in all the hospitals. This is perhaps due to the habit and culture of people who take the home-cooked food

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for the patients and while serving to the patients, they also join them to eat the food. This cultural factor contributes to the additional waste generation. This practice is unhygienic and one way of reducing the waste generated is to discourage the relatives of the patients from eating in the hospital premises. Domestic wastes are often mixed with other hospital waste either due to ignorance or convenience of the patients or their relatives [5]. The mean percentage compositions are presented in Figure 4.1. General waste constitutes 70.3%, infectious waste 13.6%, small glass bottle 14.1%, plastic and syringes 1.6% and lowest sharps with 0.4%.

Table 3 presents medical waste generation in surveyed hospitals in Kg/bed/day and the total waste generated in Kg/day. It was discovered that most hospitals had no record of the volume of waste being generated by them. The amount of waste generated is easily expressed in volume as most storage facilities are in litres aside those at depot centers. However all data were evaluated and presented on a weight basis. Medical waste generation rates of 0.240 Kg/bed/day and 0.224 Kg/bed/day was obtained for public and privates hospitals respectively. Average generation rate of 0.232 Kg/bed/day was recorded. This could not be taken as an absolute value for the entire metropolis due to existence of multiplicity of hospitals within the city.

The result however, serves as a reference point in our initial understanding of medical waste management situation in the city. The current results are comparable and consistent with the results obtained by Longe and Williams [13]. The total volume of medical waste generated in all the hospitals was 2,611.6 kg/day. This translates to 130.58kg/bed/month and a calculated total waste volume of 78,348.00kg/month by the selected hospitals. Out of this infectious was 10,629.00 kg/month, sharps, 303.00kg/month and plastic and syringes 1,227.00kg/month. General domestic waste constitutes 70% of the total medical waste stream. Another noticeable inference is that the proportion of medical waste from the private

hospital was more than 60% of the total volume of waste stream. The percentage of weight of infectious waste generated by this hospital is also of higher magnitude compared with public hospital. The only explanation for this has to do with the number of available medical services and facilities in the private hospital. A similar study reported by Coker et al. [4] in Ibadan recorded 3.7% infectious waste. Characterization revealed that 13.6 percent of the total waste generated from the selected public and private health institutions were hazardous and therefore require special attention for their disposal. Rahman (1999) reported comparable values for Netherlands (5.0%), Dhaka city (15.5%) and Germany (14.0%). However in Denmark and New York City much higher values viz: 25.0% and 28.0% respectively were reported. This variation may be due to differing living habits and standards, availability of different treatment facilities, geographical location and perhaps the way in which solid wastes are segregated and categorized in the different countries.

### 3.4 Waste Collection and Storage Time Duration

Collection of medical waste from the wards to the temporary dumpsite located within the hospital premises is effected twice daily in the selected private health institution. The wastes were collected at the end of each shift at 8.00 am and 4.00 p.m. This is not so in the public health institution as medical wastes were transported once daily at 6.00am by tricycle. Cleaners and nursing assistants are responsible for the collection of medical waste from wards to temporary storage sites.

Resource recovery exists in an informal level and affects mostly small glass bottles, plastics, unused beverages and empty paper cartons. The personnel mostly involved are cleaners. Typically, storage media used by the hospitals are metal drum, drums, plastic bin with cover and plastic storage bin with wheels. Plastic or paper boxes are used for the storage of sharps. The frequency of collection from

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temporary storage site by external waste collectors in the public hospital is grossly irregular; collection could be once or twice every two weeks. The survey revealed poor handling by this set of workers who are therefore exposed to high occupational and health hazards.

### 3.5 Waste Treatment and Disposal

Generally, treatment options employed by the surveyed hospitals fell short of the World Health Organization standard, WHO [16]. A common practice by the public hospital is the disposal of infectious and general domestic waste type on fallow land within hospital premises. This study also revealed that none of the selected hospitals surveyed treated its wastes before disposing into the municipal dumpsites. Waste segregation was not practiced in the public hospital. As earlier on indicated, a private hospital is equipped with functional incinerator of 400kg capacity and 46 kg/hr throughput. However, the location of the incinerator within the hospital premises is poor. The attendant air pollution arising from its operation is another cause for concern.

The study by Coker et al. [19] reported that the environmental pollution being caused by the malfunctioning incinerator at the University College Hospital (UCH), Ibadan stemmed principally from its being overcharged with wastes and incomplete combustion of the waste constituents. Some incinerating facilities are obsolete or operate at low efficiencies (Coker et al., 2009). Infectious medical waste and sharps are incinerated in-house by the hospital's engineering department. To its credit, it is the only hospital that engages the services of an environmental officer to oversee the treatment and eventual disposal of its medical waste.

Open dumping either within the hospital premises or at government recognized dumpsites and non-treatment of infectious waste before final disposal are the two notable challenges to the environment. Open dumps are known to have no control over access of unauthorized persons or

environmental pollution, hence, the potential health risk, [16]. Visits to waste disposal sites at Ojere and Quarry within the vicinity of the metropolis revealed unregulated, disapproved and open dumping of waste at sites that are supposed sanitary landfills. The various dumpsites within the vicinity of the metropolis do not meet necessary design criteria to operate as landfills for hazardous waste. Moreover, technical and hygienic considerations are absent. For instance, several heedless scavengers were observed waste picking, so as to resell materials considered recyclable or reuse, [4]. Another issue, beyond the scope of this study is that the lactates from beneath the disposal sites base may contain heavy metals and other organic pollutants that could lead to gross contamination of surface and groundwater resources, [20],[21].

### 4.0 Conclusion and Recommendations

The results of the investigation on the two selected hospitals gave a global view of Medical Waste Management in public and private hospitals in Abeokuta metropolis in particular and indeed in Nigeria. The management of medical wastes has received little attention despite their potential environmental hazards and public health risks. There had been a paucity of data on the quantities and nature of the waste generated in the metropolis. Such baseline data are of extreme importance for meaningful planning of waste management procedures [4]. The metropolis is surrounded by many challenges because there had been lack of awareness, appropriate policy and laws and apathy are responsible for improper management of medical waste in Abeokuta city.

Medical waste even though, attracted a high level of segregation in the selected private hospital; it is generally co-disposed with the municipal solid waste stream by waste handlers. The process of collection, segregation and disposal of medical waste is not performed according to recommended standards by the selected public hospital and concerned people are exposed to the danger of such wastes. Medical waste were often

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mixed with general (domestic) wastes and disposed of in municipal solid waste landfill, therefore posed serious health and environmental hazards as most landfills are open dumps without adequate design consideration to guaranty protection of the environment from the disposal of such hazardous wastes. Hence, improving medical waste handling and disposal methods is a necessity.

#### 4.1 Recommendations

The following recommendations are hereby made:

1. There is need for the public hospital to have a Waste Management Department saddled with the responsibility of strict monitoring of the amount and the type/nature of medical wastes resulting from daily operations. This is to adequately plan for the waste management either by on-site disposal facility or establishing collaboration with private hospital for the purpose of disposal.
2. Waste sorting at source coupled with pre-treatment before disposal should be enforced by the management of the public hospitals so as to prevent health risks to the waste handlers and the public at large.
3. A medical waste management policy should be formulated separately from a hospital waste management policy. This can be done by a multidisciplinary team including Environmental Health experts and waste management experts.
4. All staff and personnel handling medical waste in each hospital should be trained on methods and new techniques of medical waste management.
5. There is need to carry out studies on other hospitals located within the metropolis so as to generate a comprehensive pool of much-needed baseline data in Abeokuta.

#### References

- [1] Dehghani, M., Azam, K., Changani, F. and Fard, D., "Assessment of Medical Waste

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- Management in Educational Hospitals of Tehran University Medical Sciences. Iran." *J. Environ. Health. Sci. Eng.*, vol. 5 (2), pp. 131-136, 2008.
- [2] Zazoni, P., "Going green by reducing red. New alternative waste treatment technologies". *Mich Health Hosp.* vol. 34, pp. 38-39, 1998.
- [3] WHO, "Safe Management of wastes from Health care Activities", WHO, Geneva, 1999.
- [4] Coker, A., Sangodoyin, A., Sridhar; M., Olomolaiya, P., and Hammond, F., "Medical Waste Management in Ibadan, Nigeria: Obstacles and prospects", *Waste Management*, vol. 29, pp. 804-811, 2009.
- [5] Coker, A.O., "Engineering Applications in the Management of Wastes from General and Specialist hospitals in Ibadan, Nigeria", Ph.D. Thesis, Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan, Nigeria, 2002.
- [6] WHO, "Wastes from health-care activities, WHO information, Fact sheet", pp. 253, 2002.
- [7] Coker, A.O. Sangodoyin, A.Y. and Ogunlowo, O.O., "Managing hospital wastes in Nigeria", *Proc. of the 24th WEDC Conf. Islamabad, Pakistan*, pp. 70 - 72, 1998.
- [8] Pruss, A., Giroult, E. and Rushbrook, P., "Safe Management of Wastes from Health care Activities", *World Health Organization, Geneva*, 1999.
- [9] Federal Environmental Protection Agency (FEPA), "Guidelines for the management of Solid and Hazardous wastes in Nigeria", 1991.  
[http://www.dailytrust.com/index2.Php?option=com\\_content&do\\_pdf=1&Tid=1680](http://www.dailytrust.com/index2.Php?option=com_content&do_pdf=1&Tid=1680).
- [10] Martell, R., "Clinical waste campaign stepped up after landmark court ruling", *Nurs Times*, vol. 93, pp.5, 1997.



- [11] Carlise, D., Waste away. *Nurs Times* vol. 92, pp. 16-17, 1996.
- [12] Simpson, R.A., "Appropriate disposal of wound dressings", *Journal of Hospital Infections*, vol. 13, pp. 92 – 94, 1989.
- [13] Longe, E.O and Williams, A., "A preliminary Study of Medical Waste Management in Lagos Metropolis, Nigeria", *Iran. J. Environ. Health Sci. Eng.*, vol. 3 (2), pp. 133-139, 2006.
- [14] Patil, G.V and Pokhrel, K., "Biomedical Solid Waste Management in an Indian Hospital: a case study", *Waste Management*, vol. 25, pp. 592-599, 2005.
- [15] Chintis, V., Chintis, S. Vaidya, K, Ravikant, S. Patil, S. and Chintis, D. S., "Bacterial Population Changes in hospital effluent treatment plant in central India", *Water Research Journal*, vol. 38(2): pp. 441-447, 2004.
- [16] WHO, "Survey of hospital waste management in Southeast Asia Region", New Delhi, 1997.
- [17] Rahman, H. M., "Hospital sanitation in Bangladesh", *Proc. of 12th Int. Conf. on solid waste management. U.S.A.*, pp. 1-4, 1999.
- [18] WHO, "Management of solid waste Health-care Waste at Primary Health-Care Centres", *WHO, Geneva*, [http://www.who.int/water\\_sanitation\\_health/medicalwaste/decisionsmguiderev221105.pdf](http://www.who.int/water_sanitation_health/medicalwaste/decisionsmguiderev221105.pdf), 2005.
- [19] Coker, A.O. , B.O. Olugasa and A.O. Adeyemi, "Abattoir Wastewater Quality in South Western Nigeria", *Proceedings of the 27th WEDC Conference, Lusaka, Zambia*. Pickford J. ed. *Water, Engineering and Development Centre, Loughborough University, UK* pp. 329-331, 2000.
- [20] Sangodoyin, A.Y., "Conciderations on contamination of ground water by waste disposal systems in Nigeria", *Environmental Technology*, vol. 14 (10): 957 – 964, 1993.
- [21] Longe, E.O, and Kehinde, M.O., "Investigation of potential ground water impacts at an unlined waste disposal site in Agege, Lagos", *Nigeria Proc. 3rd Faculty of Engineering International conference, University of Lagos, Lagos, Nigeria*, 2005.

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