

# SOLID WASTE CHARACTERIZATION IN PRIVATE HEALTH INSTITUTIONS: EMPIRICAL EVIDENCE FROM IBADAN METROPOLIS

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## Abstract

The study investigated the solid waste characterization in private health institutions in Ibadan metropolis, Nigeria. Primary data were obtained through the measurement of solid waste generated in the selected private health institutions segregated into sharps, plastic and nylon, paper, food waste, pharmaceutical, pathological components. PHI in each LGAs of Ibadan metropolis were stratified according to the services they render. Simple random sampling technique was used to select one PHI from each stratum for data collection. Waste components categorized as 'others' was the highest waste generated (10.68kg). This accounted for 23.6% of the total waste generated and a daily average of 0.51kg. The per capita waste generation was 0.01kg/head/day. The lowest waste component (0.38kg) generated was pharmaceutical waste and it represented 0.84% of the total waste generated. The daily average for this waste component was 0.02kg. The per capita generation of sharp waste components was 0.01kg/head/day. Food waste represented 19.2% of the total waste generated while nylon/plastic represented 18.4%. The study concluded that a better understanding of the composition of medical solid waste is fundamental in order to choose the best management approach sequel to generation. This study has shown that very little has been done on medical waste management in the study area. Thus, this study recommends that; the stakeholders (the state ministries of Environment and Health and the Oyo State Waste Management Agency) should pursue strict enforcement of legislation that will have a significant impact on the sorting, segregation and storage of medical solid waste in the study area.

**Keywords:** solid waste, health

## 1. INTRODUCTION

Healthcare institutions (private and public) are service-oriented establishments that provide medical care comprising observational, diagnostic, research and therapeutic and rehabilitative services. The processes involved in rendering these services often result in unwanted substances referred to as waste. Apart from waste being an unwanted substance that is discarded, the amount of it and the impact it makes on the environment also become important considerations in defining waste. Events of the late 20th and early 21st centuries indicate that waste, in whatever form or classification: solid, liquid, or toxic, has become a major consequence of modernization and economic development. Notably, the

solid form of waste, is fast becoming a menace in both developed and developing nations (Tsiboe, and Marbell 2004; Contreras et al., 2009; Musadamba et al., 2011 and Samuel, 2015).

One of the important streams of solid waste generated in any advanced community is the waste emanating from in medical and health centers such as: hospitals, clinics, and diagnostic medical laboratories. These facilities have been noted to be among the significant outlets where huge amount of solid waste are generated on a per capita basis (Coker et al., 1998).

Waste generated by health care activities includes a broad range of materials from used needles and syringes to soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, medical devices and radioactive materials. Of the total amount of waste generated by health-care activities, about 80% is general waste. The remaining 20% is considered hazardous material that may be infectious, toxic or radioactive (WHO, 2011). Medical waste is infectious and hazardous; posing serious threats to environmental health and requires specific treatment and management prior to its final disposal (Manyele and Lyasenga, 2010). Until recently, the management of waste generated in health institutions has received little attention despite their potential environmental hazards and public health risks. Although medical waste constitutes a small fraction of the municipal solid waste, the potential environmental and health hazards could be dangerous if not properly handled, the worst scenario being in developing countries (WHO, 1999).

Health care waste management is a process aiming at ensuring proper storage, as well as the collection and disposal of all unwanted substances emanating from hospital and health-care facilities, hygiene and safety of health care workers and communities in dealing with such unwanted substances. Furthermore, this includes; planning and procurement, construction, staff training and behavior, proper use of equipment, treatment and constant evaluation of these processes (WHO, 2004).

Sophisticated instruments have come into existence in various operations for disease treatment. Such improvements and advances in scientific knowledge have resulted in per capital patient generation of wastes in health-care units. In Nigeria, as close to the end of the third millennium, it was observed that there were weak policies on hospital waste management in Nigeria, and that is why it is not uncommon to find various components of hospital waste like used syringes, discarded blood vials, needles, empty description bottles among others, improperly disposed and left untreated (Coker et al., 1998).

However, the waste produced by health institutions if not characterized properly, managing such can pose an even greater threat than the original diseases treated in such institutions (Rao et al., 2004). This has led to the review of some previous studies on solid waste management, with a view to identify

notable gaps in knowledge and established the pivotal need of this study. In many developing countries, the availability and inadequacy of data about the quantity and composition of healthcare waste is one of the major reasons for inadequate and improper healthcare waste management (WHO, 2004). Notably, past attention on solid waste management practices focused on markets, schools, and domestic solid waste among others (Scheinberg et al 2006; Afon 2007a; Rathana 2009). For instance, Afon (2007a) examined the resident's willingness and affordability to pay for privatized solid waste management services. On the other hand, Rathana (2009), discussed the feasibility of integrating the informal scavenging into the formal management of solid waste. Scheinberg et al. (2006) revealed that waste pickers were ignorant of the kind of job they do and operated such business because of the need to survive poverty. These studies however did not examine solid waste characterization in health institutions.

Medical waste is considered an important issue, because it represents a relatively significant portion of the total waste generated in a community (Cheng et al., 2008). Thus, a few empirical studies have attempted to examine the waste management practices in a number of health institutions (Hamoda et al. 2005; Alhumoud and Alhumoud 2007; Marinkovic et al. 2008; Cheng et al. 2008; Towend et al. 2009; Bassey et al. 2006 and Longe and Williams 2006; Idowu et al 2013) but the focus of these studies was mainly on tertiary health care institutions. The above studies did not determine the rate of solid waste generation, characterization and segregation of various components of the solid waste emanating from private health institutions.

Therefore, much remains to be done to quantify and characterize the solid waste generated by various health institutions facilities (especially private health institutions) in Nigeria. Based on the above established gaps, the study will attempt at providing answers to the following questions: What is the quantity and composition of waste generated in private health institutions? What is the per capita daily generation of waste among private health institutions? Thus, this study intends to identify and locate private health institutions facilities in Ibadan metropolis, determine the quantities and characteristics of the solid waste they generate.

## 2. STUDY AREA, MATERIALS AND METHODS

Ibadan, the capital of Oyo State is located in the southwestern part of Nigeria. It is situated approximately on latitude 7° 22' and 7° 40' North of the Equator and 3° 53' and 4° 10' East of the Greenwich Meridian. The city is elevated at about 234 meters above sea level and it is situated on gently rolling hills running in a northwest/southeast direction (Agboola and Olurin 2000). Ibadan

witnessed a rapid growth when it became the Western Province headquarters in 1939. The built up area of Ibadan was 38.85sq/km in 1935, 46.40sq/km in 1955, 77.70sq/km in 1965 and extended to 152.80sq/km in 1977, 214sq/km in 1988 (Fadare,1997). By the year 2000, it is estimated that Ibadan covered 400sq/km (Onibokun and Faniran, 1995). The population growth rose from 1,141,677 in 1973, 1,829,300 in 1991 and 2, 550,593million in 2006 (National population commission 2006). Presented in Figures 1 is the location of Ibadan the map of Nigeria.

According to Agboola and Olurin (2000), Ibadan comprises of eleven local government areas, five of the local government areas are urban which encompass Ibadan North, Ibadan North East, Ibadan North West, Ibadan South East and Ibadan South West with respective headquarters at Agodi-Gate, Iwo Road, Onireke, Mapo and Oluyole. The remaining six local government areas are rural local government areas covered by Akinyele, Egbeda, Ido, Lagelu, Oluyole and Ona-Ara. Spatially, Ibadan sprawls over a radius of 12-15 km. At a crow fly, Ibadan is 128km north east of Lagos and 345km southwest of Abuja. According to Hospital Management Board, Oyo State Ministry of Health, there are 680 registered health institutions of which 26 were public, 654 were private and the university college hospital in Ibadan. There were 443 private health institutions in Ibadan metropolis established between 1973 and 2012. Preliminary study showed that there were 163, 66, 37, 53 and 119 private health institutions in Ibadan North, Ibadan North-West, Ibadan South-East, and Ibadan South-West respectively.

Investigations showed that the services provided by these health institutions differed from one another. The hospital and maternity provides a broad range of services from diagnosis to treatment while some of the health institutions specializes on one particular area of health services provision. The eye clinic specializes in diagnosis, management and treatment of patient with eye problems. The dental clinics provides services diagnostic, treatment of dental problems like, bad breath, cavities, dry mouth, gum diseases among others. The laboratory does not provide treatment to patients but provide diagnostics services to patient through medical test. The physiotherapy clinic offer treatment solutions in a variety of areas including massage, psychology and speech pathology, body therapy, rehabilitation of musculoskeletal injuries and disabilities, electrotherapy, orthotics. Conditions they treat include, low back pain, osteoarthritis, sports injuries, neurological pains and neck pains. The orthopedic clinic renders services like treatment of the disorder of the musculoskeletal system, joint replacement, fractures and complex trauma. Further investigation showed that most of these health institutions are small scale establishment and has only one doctor (who is the medical director and the owner of the health institution) and one to two nurses.

Primary data were obtained through questionnaire administration and direct observation. The questionnaire was designed to obtain information from the cleaners in private health institutions. Information regarding the measurement of solid waste generated in the selected private health institutions were segregated into sharps, plastic and nylon, paper, food waste, pharmaceutical, pathological and others components. The measurement took place in the month of July, August and September. Each week's measurement lasted seven days of the week.

The sample frame for this study was all private health institutions in the five Local Government Areas (LGAs) of Ibadan metropolis. These LGAs are: Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East and Ibadan South-West. The Study adopted a multi-stage sampling technique. Thus, private health institutions in each LGA of Ibadan metropolis were stratified into six. These are: hospital and maternity clinic, eye clinics, dental clinics and laboratories. Others are physiotherapy and orthopedic clinics. The classification was based on the services they provide as recognized by Hospital Management Board, Oyo State Ministry of Health. There were 443 private health institutions in the study area. There were 335 hospitals and maternity, 14 eye clinics, 13 dental clinics and 73 laboratories. Others were 4 physiotherapy clinics and 4 orthopedic clinics.

Simple random sampling technique was used to select six private health institutions in the LGAs from each stratum for data collection. The method adopted by Afon (2007b) and Bernache-Perez, et al., (2001) were used for the measuring the quantity of solid waste

### 3. RESEARCH FINDINGS

#### ***3.1. Comparative Analysis of Daily and Total Quantity of Waste Generation in the Selected Health Institutions Disaggregated According to Material Composition***

The solid waste generation in the selected health institutions for July, August and September is summarized in the Tables 1, 2 and 3 below as disaggregated according to days, month, materials and health institutions. The daily waste generation for the three months was calculated by summing up each day generation of the three months. The daily average was arrived at by dividing the total quantity of waste generated by the number of days which waste quantities were recorded.

### ***3.2. Aggregate Quantity and Average Daily Waste Generated on Different Days of the Week during the Survey period***

The total quantity of waste generated in the selected health institutions in three months was 45.26kg. The total waste generated in each month was 14.26kg, 15.92kg and 15.14kg respectively. It was however revealed through ANOVA test that there was no significant variation between the quantity of solid waste generated in the three months ( $F_{2, 15} = 0.064$  and  $p > 0.05$ ). Hospital and maternity generated a total quantity of waste of 8.39kg with a daily average of 0.40kg. The highest quantity of waste (2.33kg) was recorded on Monday while the least (0.58kg) was recorded on Saturday in hospital. The total quantity of waste generated in the eye clinic was 5.29kg and a daily average of 0.30kg. The highest quantity was recorded on Monday. The day's generation was 0.98kg. The lowest quantity of waste generated was recorded on Friday and it accounted for 0.74kg. The dental clinic generated a total waste of 6.08kg with a daily average of 0.33kg. The highest quantity of waste generated in the dental clinic was 1.23kg and it was constantly recorded on Monday and Saturday. The lowest quantity of waste (0.78kg) was recorded on Thursday.

The laboratory generated a total quantity of 6.16kg and a daily average of 0.34kg of waste. The highest waste was 1.32kg and this was recorded on Monday. The lowest waste quantity (0.86kg) was recorded on Friday.

A total of 4.46kg quantity of waste was generated in physiotherapy clinic and a daily average of 0.24kg. The highest quantity of waste (1.12kg) was recorded on Saturday because more people visited the clinic for massage and body therapy. The lowest quantity (0.57kg) was recorded on Tuesday; this was because few people visited the clinic. Most of the patients that visited the clinic on week days were given treatment including rehabilitation of musculoskeletal injuries, speech pathology among others.

The orthopedic clinic generated a total waste quantity of 14.88kg and average daily waste of 0.70kg. The highest quantity (2.99kg) of waste was recorded on Monday while the lowest (1.43kg) was recorded on Saturday. It can be deduced from the table that waste generation was at peak on Monday in the private health institutions in Ibadan metropolis except for physiotherapy clinic where it was Saturday. The highest waste generated (9.5kg) was recorded on Monday, while the least (2.47kg) was recorded on Sunday. This was because most of the health institutions did not operate on Sundays. The health institution that generated the highest waste quantity (14.9kg) was orthopedic center while the least quantity was generated in the physiotherapy clinic. A daily average of 0.71kg was generated in the orthopedic clinic, while 0.25kg was generated in the physiotherapy clinic. The study established that

more waste was generated in the hospital and orthopedic clinic than the other health institutions. Therefore, it can be concluded from the study that waste generation is dependent on type of establishment and specialization. These findings validate the postulation of Marinkovic et al. (2008) that argued thus; quantity of clinical waste generation depends on the size and type of health care institutions.

The study also revealed that waste generation was at peak on Monday in all the health institutions except for the physiotherapy clinic where the highest quantity of waste was generated on Saturday. The least quantity of solid waste was generated on Friday and Saturday in all the private health institutions except for physiotherapy clinic where the lowest quantity of waste was generated on Tuesday. This least quantity of waste being generated can be attributed to the number of patients attended to on these days which ranked the least when compared to all other days of the week. This validates the finding of Komilis and Katsafaros (2009), who in their study of hazardous medical waste management in Icaria, Greece, also established that generation rates of waste on Saturdays and Sundays were statistically lower compared to the amounts generated on weekdays.

### ***3.3. The Aggregate Quantity and Per Capita Waste Components Generated on Different Days of the Week, during the Period the Survey Lasted***

The total quantity, daily average and daily per capita waste generation during the period the survey lasted. Waste components categories as 'others' was the highest waste generated (10.68kg). This accounted for 23.6% of the total waste generated and a daily average of 0.51kg. The 'others' include components like; used hand gloves, cotton wools, bandages, soiled cloths, foams, cans, plasters, sanitary pads and diapers. The per capita waste generation was 0.01kg/head/day. The lowest waste component (0.38kg) generated was pharmaceutical waste and it represented 0.84% of the total waste generated. The daily average for this waste component was 0.02kg. Sharps as waste components ranked second and it represented 22.9%. Averagely, a total of 0.50kg of sharps waste components was generated daily and 3.47kg was generated monthly by the private health institutions in Ibadan metropolis while 0.08kg was generated daily per health institution. The per capita generation of sharp waste components was 0.01kg/head/day.

Food waste represented 19.2% of the total waste generated. Generation of nylon/plastic represented 18.4%. Furthermore, as presented on the Tables 1; more waste were generated during the week days than the weekend and this could be attributed to the presence of more patients visit and admission into the clinic during the week than weekend.

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TABLE 1 - AGGREGATED QUANTITY AND PER CAPITA WASTE COMPONENTS GENERATED ON DIFFERENT DAYS OF THE WEEK IN THREE MONTHS

Waste component	Sun	Mon	Tue	Wed	Thu	Fri.	Sat.	TQWG	%	DA	MA	DAPHI	Per capita
Sharps	0.71	3.16	0.52	0.59	0.25	0.29	0.88	10.4	22.9	0.50	3.47	0.08	0.0113
Nylon/Plastic	0.32	1.29	0.11	0.34	0.38	0.55	0.32	8.31	18.4	0.40	2.77	0.07	0.0090
Paper	0.28	0.88	0.73	0.12	0.66	0.57	0.69	4.93	10.9	0.23	1.64	0.04	0.0053
Food waste	0.39	1.66	1.46	1.43	1.18	1.23	1.35	8.7	19.2	0.41	2.90	0.07	0.0094
Pharmaceutical	0	0.2	0.13	0	0.05	0	0	0.38	0.84	0.02	0.13	0.00	0.0004
Pathological	0.23	0.41	0.3	0.21	0.3	0.24	0.17	1.86	4.11	0.09	0.62	0.01	0.0020
Others	0.54	1.9	1.85	1.73	1.37	1.55	1.74	10.68	23.6	0.51	3.56	0.08	0.0116
Total	2.47	9.5	7.1	7.42	6.19	6.43	6.15	45.26	100				0.0491
Daily %	5.46	20.9	15.7	16.39	13.7	14.2	13.6	100					
Number of generators	46	173	141	134	136	130	162	922					
Generators/21	2	8	7	6	7	6	8	44					
Daily per capita	0.05	0.05	0.05	0.06	0.05	0.05	0.04	0.05					

**NB:** TQWG = Total quantity of waste generated, DA = Daily average, MA = Monthly Average, DAPHI = Daily Average/private health institution

TABLE 2 - ANOVA FOR THE AGGREGATED QUANTITY OF SOLID WASTE GENERATION IN THREE MONTH

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.230	2	.115	.064	.983
Within Groups	26.756	15	1.784		
Total	26.986	17			

AGGREGATED QUANTITY OF WASTE GENERATED ON DIFFERENT DAYS OF THE WEEK IN THREE MONTHS

Private Health Institutions	Sun	Mon	Tue	Wed	Thu	Fri.	Sat.	Total quantity generated over 21days	%/ private health institutions	Daily average (Total /21days)	Weekly average (Total/3 months)
Hospital & maternity	0.93	2.33	1.32	1.42	0.85	0.96	0.58	8.39	18.5	0.40	2.79
Eye	0	0.98	0.95	0.84	0.88	0.74	0.9	5.29	11.7	0.30	1.76
Dental	0	1.23	1.03	0.94	0.87	0.78	1.23	6.08	13.4	0.33	2.03
Laboratory	0	1.32	1.18	0.94	0.97	0.86	0.89	6.16	13.6	0.34	2.05
Physiotherapy	0	0.68	0.57	0.59	0.58	0.92	1.12	4.46	9.85	0.24	
Orthopedic	1.54	2.99	2.02	2.69	2.04	2.17	1.43	14.9	32.9	0.70	
Total	2.47	9.53	7.07	7.42	6.19	6.43	6.15	45.26	100		
%/day	5.46	21.1	15.6	16.4	13.7	14.2	13.6	100			

#### 4. CONCLUSIONS AND RECOMMENDATIONS

A better understanding of the composition of medical solid waste is fundamental in order to choose the best management approach sequel to generation. The findings of this study indicated that sharps represented 22.9%, food waste represented 19.2% and nylon/plastic represented 18.4% of the medical

solid waste generation. On the average, a total of 0.50kg of sharps waste components was generated daily and 3.47kg was generated monthly by the private health institutions in Ibadan metropolis while 0.08kg was generated daily per health institution. The per capita generation of sharp waste components was 0.01kg/head/day.

The health institution that generated the highest waste quantity (14.9kg) was orthopedic center while the least quantity was generated in the physiotherapy clinic. A daily average of 0.71kg was generated in the orthopedic clinic, while 0.25kg was generated in the physiotherapy clinic. The study established that more waste was generated in the hospital and orthopedic clinic than the other health institutions. Therefore, it can be deduced from the study that waste generation is dependent on type of establishment and specialization. On the basis of these results, the following can be suggested about medical solid waste management in Ibadan metropolis.

This study has shown that very little has been done on medical waste management in the study area. Thus, this study recommends that; the stakeholders (the state ministries of Environment and Health and the Oyo State Waste Management Agency) should pursue strict enforcement of legislation that will have a significant impact on the sorting, segregation and storage of medical solid waste in the study area. This factor is closely linked to attitudes and awareness, and also to the willingness to pay for waste collection services. To be effective, legislation needs to have the general support of the owners/managers of Private health institutions, being regarded as necessary and appropriate. Furthermore, the legislation that will regulate medical waste generation and management must adopt a multidisciplinary approach to medical waste management in Nigeria.

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