

Full Length Research Paper

Healthcare waste management in Nigeria: A case study

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Healthcare Waste (HCW) constitutes a special category of waste because they contain potentially harmful materials. The problem of how to manage HCW has become one of critical concerns in developing countries. A cross sectional descriptive study was carried out between June and September 2008 at a tertiary health facility (Teaching Hospital) in Nigeria with the aim of assessing the current practices and commitment to sustainable HCW management in a tertiary healthcare facility. The study approach involved the estimation of the quantity of HCW generated, evaluation of the waste segregation practices and determination of the knowledge of healthcare workers regarding HCW management. Daily waste inventory of each ward was carried out. A total of 52 health workers, including doctors and nurses were interviewed to determine their knowledge and practice with regards to HCW. An evaluation of the status of the waste management practice in the health facility was carried out using the following criteria: waste management (responsibility, segregation, storage and packaging); waste transport; waste recycling and reuse; waste treatment and final disposal. Results show that the average amount of HCW was 0.62 kg/person/day at the out-patient units and 0.81 kg/bed/day in the in-patient wards. The proportion of respondents who had received specific training in the management of HCW was 11.5% (6/52). The number who understood the importance of HCW management in the provision of safety to the public was 46% (24/52). The level of healthcare waste management practice was found to be 0 (that is, unsustainable). This paper has highlighted the pitfalls of HCW management in Nigeria, a developing country where resources are limited. The paper concluded by recommending measures to improve the HCW management practices in the country.

Key words: Healthcare waste, microbial infections, public health, waste segregation, sustainability.

INTRODUCTION

The sustainable management of Healthcare Waste (HCW) has continued to generate increasing public interest due to the health problems associated with exposure of human beings to potentially hazardous wastes arising from healthcare (Tudor et al., 2005; Ferreira, 2003; Da Silver et al., 2005). Presently considerable gap exist with regard to the assessment of healthcare waste management practices particularly in Nigeria and in several other countries in sub – Saharan Africa. The nature and quantity of healthcare waste generated as well as institutional practices with regards to sustainable methods of healthcare waste management,

including waste segregation and waste recycling are often poorly examined and documented in several countries of the world despite the health risks posed by the improper handling of HCW (Farzadika et al., 2009; Oke, 2005). It is also of serious concern that the level of awareness, particularly of health workers regarding healthcare waste has not been adequately documented.

HCW are a special category of waste because they often contain materials that may be harmful and can cause ill health to those exposed to it. A number of studies have indicated that the inappropriate handling and disposal of healthcare waste poses health risks to health workers who may be directly exposed and to people near health facilities, particularly children and scavengers who may become exposed to infectious wastes and a higher risk of diseases like hepatitis and

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HIV/AIDS (Adegbita et al., 2010; Coker et al., 2009, PATH, 2009; Oke, 2008; WHO, 2002, 1999). The World Health Organization estimates that each year there are about 8 to 16 million new cases of Hepatitis B virus (HBV), 2.3 to 4.7 million cases of Hepatitis C virus (HCV) and 80,000 to 160,000 cases of human immune deficiency virus (HIV) due to unsafe injections and mostly due to very poor waste management systems (WHO, 1999; Townend and Cheeseman, 2005). In developing countries like Nigeria, where many health concerns are competing for limited resources, it is not surprising that the management of healthcare wastes has received less attention and the priority it deserves. Unfortunately, practical information on this important aspect of healthcare management is inadequate and research on the public health implications of inadequate management of healthcare wastes are few and limited in scope.

Although reliable records of the quantity and nature of healthcare wastes and the management techniques to adequately dispose of these wastes has remained a challenge in many developing countries of the world, it is believed that several hundreds of tones of healthcare waste are deposited openly in waste dumps and surrounding environments, often alongside with non-hazardous solid waste (Alagoz and Kocasay, 2007; Abah and Ohimain, 2010). A near total absence of institutional arrangements for HCW in Nigeria has been reported by others (Coker et al., 1998).

Various methodologies have been used all over the world to assess and quantify HCW. They include the use of physical observation, questionnaire administration and quantification (Adegbita et al., 2010; Olubukola, 2009; Phengxay et al., 2005), as well as checklists (Townend and Cheeseman, 2005) and private and public records (Coker et al., 2009). Recent studies in Nigeria has estimated waste generation of between 0.562 to 0.670 kg/bed/day (Longe and Williams, 2006) and as high as 1.68 kg/bed/day (Olubunmi, 2009). As reported in the literature, there may not be much of a difference in the way and manner wastes generated in various health care institutions are managed in Nigeria. A good example is given by the findings of the study in Lagos by Olubukola which reported the similarity in waste data and HCW management practices in two General hospitals, characterized by a lack of waste minimization or waste reduction strategies, poor waste segregation practices, lack of instructive posters on waste segregation and disposal of HCW with general waste (Olubukola, 2009).

The mismanagement of healthcare waste poses health risks to people and the environment by contaminating the air, soil and water resources. Hospitals and healthcare units are supposed to safeguard the health of the community. However, healthcare wastes if not properly managed can pose an even greater threat than the original diseases themselves (PATH, 2009). There are a reasonable range of treatment technologies available for healthcare wastes that may be appropriate for third

world countries, however, it is pertinent that before any of these options are adopted, hospitals and medical facilities will need to assess the problem and put forward a management strategy that is suitable to their economic circumstances and that can be sustained based on local technology.

The aim of this research therefore is to identify the gaps in current practices of healthcare waste in Nigeria compared with international best practice and recommend ways of bridging this gap considering the current economic and technological realities in the country. Using a tertiary health institution (Teaching Hospital) in Southern Nigerian state of Edo as a case study, this paper therefore sets out to:

1. Assess the current waste management practices in terms of type of wastes and quantities of waste generated in the various units of a tertiary level healthcare facility and the waste handling and disposal practices.
2. Assess the level of awareness of health workers regarding HCW management.
3. Assess the level of compliance with recommended best practices for the sustainable management of healthcare wastes based on the United Nations Environmental Programme/World Health Organization (UNEP/WHO, 2005) and the Townend and Cheeseman (2005) guidelines.

MATERIALS AND METHODS

This study was carried out between June and September 2008 as a cross sectional descriptive study at a tertiary healthcare facility (Teaching Hospital) in Nigeria based on the modified methods of Townend and Cheeseman (2005) and UNEP/WHO (2005). The health facility selected is a major hospital with over 350 bed capacity and providing emergency, surgical and maternal and child health services. An inventory of the waste generated in each of the following sections of the hospital: Operation theatres, Pharmacy, Laboratories, In-patient wards, Out-patient units, Radiology unit and the Mortuary were obtained over a period of seven days using an inventory form (UNEP/WHO 2005). The different types of waste generated in the out-patient and in-patient were collected separately and weighed daily for a period of one week. Since the waste were not segregated, at each of the aforementioned unit, the entire quantity of waste generated was weighed together each day (using a weighing balance) prior to disposal and recorded in the inventory form. The quantity of the different categories of waste was deduced by estimation while the type of waste was identified through direct observation. In addition, the pharmacists and nurses were interviewed with a view to obtaining an accurate estimation of the number of sharps items used every day. Calculations of average quantity of waste per bed per day were then carried out by dividing the quantity of waste by the number of beds in the unit (UNEP/WHO, 2005; WHO, 2002). The wastes were classified according to the scheme presented in Figure 1.

Using a list obtained from the personnel department of the hospital, a total of 52 healthcare staff including doctors and nurses were randomly selected for questionnaire administration, comprising of 1 administrator, 18 doctors, 26 nurses and 7 ward attendants. The questionnaires were administered by medical

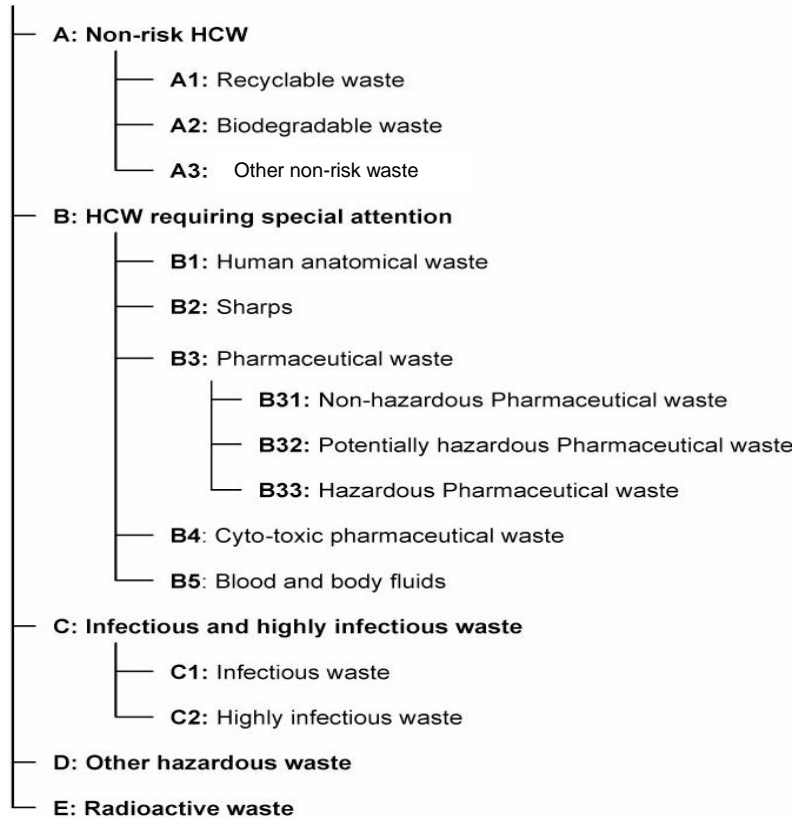


Figure 1. Classification of HCW (UNEP/WHO, 2005).

students in their 5th year of training and consist of questions on their knowledge and practice of HCW; knowledge of existing HCW management practices; knowledge and practice of waste handling, segregation and treatment and injuries related to HCW (Phengxay et al., 2005; WHO, 1999). To understand the overall healthcare waste management of the hospital, the principal researchers also interviewed the head of the hospital's administration face to face (key informant interview). The main questions asked were:

- (a) Hospital waste management policy.
- (b) Special budget for waste management.
- (c) Training of waste handling staff.

Data for the analysis were then extracted from the inventory form and personal interviews conducted by the researchers. The waste management performance of the hospital was assessed using a checklist consisting of six characteristic waste management descriptors and 27 indicators of healthcare waste management, presented in Table 1, namely:

- (i) General management strategy.
- (ii) Waste collection.
- (iii) Waste segregation.
- (iv) Waste recycling.
- (v) Waste storage.
- (vi) Offsite disposal.

An overall performance rating was then assigned using the approach outlined in the guidelines suggested by Townend and Cheeseman (2005). This guideline uses a simple table format that links performance with a set of criteria to assess the level of sustainable development associated with the healthcare facility.

Based on this guideline, healthcare facilities can be grouped into 4 different levels of sustainable practice based on the characteristics described in Table 2.

RESULTS

The results of the HCW quantification and current management practices are presented in Tables 3 and 4 respectively. The average amount of HCW was 0.62 kg/person/day at the outpatient units and 0.81 kg/bed/day in the in-patient wards. The labour ward had the highest diversity of wastes, most of which are classified as either infectious (C series) or HCW requiring special attention (B series). The key findings on the current situation of HCW management practice are summarized in Table 4 and presented under the following sub-headings.

Overall responsibility for managing waste

Through face to face interview (key informant interview) of the hospital head of administration it was revealed that there was no focal person or waste manager responsible for HCW management, rather sanitation in the hospital is overseen by a committee. The hospital had thus retained the services of 2 environmental officers directly responsible for maintaining sanitation in the hospital. There were

Table 1. HCW management description and the indicators used in the assessment of waste management performance at the healthcare facility.

HCW management criteria	Indicators
1.General management strategy	Hospital waste management policy or strategy Special budget for waste management Operative staff for management of waste Training on waste management Personal Protective Equipment worn by operative staff
2.Waste collection and Segregation	Type of receptacles/storage containers (uniform or specific, varying types, sizes etc) Color coding of receptacles Number/adequacy of waste receptacles Are sharps or infectious materials collected separately Is segregation regulated or controlled
3.Waste recycling	Is there any form of recycling? What is recycled? Are syringes reused? What else is re-used?
4.Waste storage	Presence or absence of purpose built waste handling facility Waste dumped outside the hospital building? Open waste disposal?
5.Waste treatment	None Autoclaving of lab wastes Crude incineration outside Encapsulation e.g. of sharps Waste burial within healthcare facility Chemical disinfection of body fluids Other advanced technology
6. Offsite disposal	Waste disposal contracted out? How are wastes transported (open vehicle or Enclosed compaction vehicle?) What is the final destination of the waste (open dump, level 1 landfill, hazardous waste engineered landfill, shredded + some other technology?)

also a number of cleaners assigned to each ward and unit who are responsible for the day to day cleaning of the wards and emptying of waste bins. The overall responsibility for HCW management is not clearly defined.

HCW management manual and instructive posters

Interviews of key informants and observations by the researcher reveal that the hospital does not have a HCW management manual. It was also observed that instructive posters on waste segregation were not on display anywhere in the health facility.

Waste collection, segregation and storage

Direct observation revealed that waste was collected in different types of receptacles. Out of 63 bins inspected, 41 (76.2%) did not have a lid. There was no form of color coding to indicate the type of waste to be deposited in a

particular waste bin. There was no provision of weighing scales for measuring the weight of wastes generated at any of the wards or locations that waste were collected. As a result it is impossible to determine precisely the quantity of waste generated in the health facility. Sharp waste segregation was done in the wards. No other form of waste segregation occurs at any level and no strategy is in place for waste minimization. Temporal storage of waste occurs in the receiving receptacles or waste bins which are emptied daily or more frequently depending on the filling rate. Waste is collected daily by ward attendants and cleaners for dumping directly from storage receptacles or bins.

Waste re-cycling and re-use

Direct observations and face to face interviews of key informants revealed that no form of waste re-cycling or re-use exist or is planned for the near future at the health facility.

Table 2. Guidelines for the assessment of level of sustainable waste management practice.

Sustainable level of practice	Operating performance	Characteristic
Level 0	Operating in a totally unsustainable manner with reluctance to change	No waste management strategy, only limited segregation of wastes, storage containers are unspecific with no color coding and waste likely to be dumped outside the hospital building. In addition waste is transported in open trucks, limited re-use of materials and no recycling at the facility; waste treatment is limited to the simplest technologies such as crude incineration while if off-site disposal exists it will be mainly to a dumpsite or level 1 landfill with the attendant environmental hazards.
Level 1	Generally operating in an unsustainable manner, although there is some evidence of awareness and willingness to change.	Although having no specific waste management strategy, will have separate collection of segregated wastes in enclosed vehicles, autoclave of infectious waste and use single cell incineration plant.
Level 2	Operating in a manner with some aspects that are considered sustainable and others that are considered unsustainable	Waste management policy in place, segregation of wastes and color coding, specified waste storage containers, waste transported with enclosed compaction vehicles and separate vehicles for hazardous waste, some recycling at facility (paper, cardboard etc), use of multi chamber incinerator plants and alternative modern technologies (such as microwave) to treat waste and disposal in level 2 landfill.
Level 3	Generally operating in accordance with sustainable development, but some aspects not ideal	Local waste management policy and strategy in place, full color coding, dangerous goods are stored in UN approved containers and packaging all waste in containers of approved standard and a dedicated waste handling facility. Re-use and re-cycling of materials (example, print cartridges, oil), incineration of hazardous materials to EU Directive emission standards plus use of alternative technology and offsite disposal at a level 3 engineered landfill site
Level 4	Operating in a way that displays all the characteristics normally associated with sustainable development	Waste management policy, full time waste manager, full segregation of materials, full color coding, contracts with secondary raw materials industry, storage in UN approved containers, all wastes in containers or sacks to approved standard and a dedicated well secured waste facility. Waste is transported in enclosed compaction vehicles, Basel convention applied to waste transport. Recycling of paper, glass, plastic, metal, construction waste, food waste, textiles etc. incineration of hazardous materials to EU Directive emission standards plus use of alternative technology, hazardous waste to strictly controlled landfill sites and offsite disposal to level 4 engineered sanitary landfill.

Source: Modified from Townend and Cheeseman (2005).

Waste treatment and disposal

Waste is collected at a central open dumpsite and burnt periodically. Occasionally, the wastes are buried by covering with a layer of earth. No prior treatment takes place. Human body parts such as placenta and amputated limbs are either disposed with the general waste or returned to the patient for disposal. Used swabs and dressings as well as pharmaceutical wastes are disposed with general

waste. Sharps are collected separately in sharp proof containers and disposed by burying.

Training, knowledge and practice of doctors and nurses

The proportion of respondents who had received specific training in management of HCW was 11.5% (6/52). The number who understood the importance of HCW management in the provision

of safety to the public was 46% (24/52). Only 8% (4/52) responded that they had seen instructive posters on waste segregation. None of the respondents knew the focal person responsible for HCW management in their unit and the hospital strategy for managing HCW. About 69% (36/52) of the respondents reported that the waste generated in their unit of the hospital was disposed of by open burning or burying on facility site (Figure 2).

Table 3. Type and average quantity of HCW generated.

Hospital unit	Type of waste	Waste classification codes	Average quantity
Out patient Ward	Waste paper,	A1	0.62 (\pm 0.16) kg/ patient/ day
	Hand gloves	C1	
	Swabs	C1	
	needle and syringes	B2	
Labour Ward	Used hand gloves	C1	0.84 (\pm 0.21) kg/ bed/ day
	used i.v. fluid giving sets	C1	
	Swabs	C1	
	needle and syringes	B2	
	Placenta	B1/B5	
	soiled clothes and materials	C1	
	Papers	A1	
	empty medicine bottles and packaging	B31	
	Empty drip containers	B31	
	Other Wards	Needle and syringes	
used I.V fluid giving sets		C1	
Used dressing materials		C2	
hand gloves		C1	
Swabs		C1	
soiled clothing		C1	
used infusion and blood giving sets		C1	
soiled beddings		C1	
Used dressing materials		C2	
hand gloves		C1	
Accident and Emergency unit	Swabs	C1	0.63(\pm 0.23)kg/ patient/day
	needle and syringes	B2	
	soiled clothing	C1	
	used infusion and blood giving sets	C1	

Rating of HCW management practice

The HCW management practices adopted at the study site was rated using the guidelines proposed by Townend and Cheeseman (2005). Results of the ratings are presented in Table 5, which show that the level of waste management is 0 for all the criteria considered; indicating that the waste management practices at the studied health facility is unsustainable.

DISCUSSION

Management and commitment

This study has revealed significant problems with HCW management at the tertiary facility studied. These include lack of management commitment, poor waste handling practices, inadequate training on HCW, nonexistent segregation of HCW and risky disposal practices. Although some form of segregation of sharps (needle and syringes) takes place at the facility, which has reduced the incidence of needle prick injuries, the overall practice

of HCW management is still problematic. HCW management is a management and technical issue (WHO, 1999) requiring urgent attention. Sustainable HCW management practice depends on the commitment of all healthcare facility staff, particularly commitment from the hospital leadership. The current management approach to HCW found in this study mirrors waste management at the national level in a number of ways. For instance, national legislation and policy specific to HCW management is yet to be implemented at any level despite the existence of Draft Nigeria National HCW (2007) and the fact that Nigeria is a signatory to several multilateral environmental agreements including the Basel convention; municipal waste management is ongoing problem in many states and the absence of functional landfills in the country has further compounded the problem. Other factors contributing to poor health care waste management in the country include the general situation of infrastructure such as poor roads, intermittent electricity, lack of health vehicles (thus making transportation of waste unsafe) and the absence of effective municipal waste disposal system. These

Table 4. Characteristic of HCW management at the study site.

HCW management criteria	Description of existing practice
General management strategy	
Hospital waste management policy or strategy	No existing HCW management policy
Special budget for waste management	No special budget
Operative staff for management of waste	No dedicated HCW manager
Training on waste management	No records of special training for handlers of healthcare waste
Personal Protective Equipment worn by operative staff	Personal Protective Equipment is limited to uniforms
Waste collection and segregation	
Type of receptacles/storage containers (uniform or specific, varying types, sizes etc)	Varying types and sizes of non specific waste containers.
Color coding of receptacles	No color coding
Number/adequacy of waste receptacles	Waste receptacles are small in size and require physical contact to open lid
Are sharps or infectious materials collected separately	Yes, sharps are collected in puncture proof containers
Is segregation regulated or controlled	Only sharps are segregated
Waste recycling	
Is there any form of recycling?	No form of recycling
What is recycled?	Nothing
Are syringes reused?	No
What else is re-used?	Bed linings
Waste storage	
Is there a purpose built waste treatment facility?	No
Are waste dumped outside the hospital building?	Yes
Open waste disposal?	Yes. Waste is dumped in a large pit outside the hospital building
Waste treatment	
Autoclaving of lab wastes	Autoclaving of theatre materials
Crude incineration outside	No
Encapsulation example, of sharps	No
Waste burial within healthcare facility	Yes
Chemical disinfection of body fluids	No
Other advanced technology	Nil
Offsite disposal	
Waste disposal contracted out?	No
How waste is transported (open vehicle? Enclosed compaction vehicle?)	Open bins and vehicles, carried manually to waste dumps
What is the final destination of the waste (open dump, level 1 landfill, hazardous waste engineered landfill, shredded + some other technology?)	Open waste dump. Waste is burned in open fire or buried by covering with earth at healthcare facility.

constraints notwithstanding it is possible to demonstrate management commitment in a number of other simple but effective ways such as training and creating awareness of the health risks from the inadequate management of medical waste, provision of simple institutional guidelines, provision of adequate personal protective equipment for waste workers and a focus on implementation of solutions that are currently affordable and available. The findings from this study has shown

clearly the critical need for management to provide institutional support and guidance aimed at ensuring that health workers follow a standard procedure in the management of HCW waste at the institutional level. Without a clear policy from management there is likely to be very little attempt at waste segregation, waste minimization and adequate treatment and disposal. Another major issue confronting the management of healthcare waste is perhaps the fact that it is generally

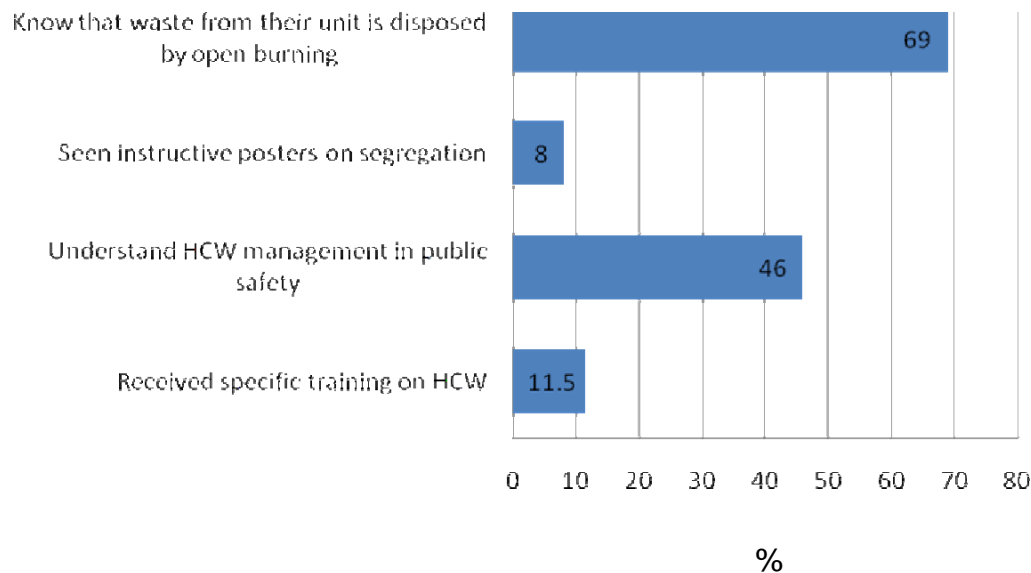


Figure 2. Training, knowledge and practice regarding HCW.

viewed mainly from an environmental and less from a public health perspective. As a result gaps exist in visions and understanding, particularly as it relates to the much desired robust integration of the Environment ministry and the Health ministry at both the state and National levels of Governance. In Nigeria, liability for any pollution occurring as a result of unauthorized waste management activities rests with the waste generator in accordance with Article 20(1) of Decree No. 58/88. The Public Health Act 1958 and various state edicts on environmental sanitation also provide regulations on the management of solid waste, particularly non hazardous, general (municipal) waste. These laws however do not adequately address the important aspects of healthcare waste. A mechanism to regulate and enforce sustainable management of wastes generated from health cares as an integral part of the existing environmental protection framework should be considered.

The 1992 Earth Summit in Rio de Janeiro called for action to establish national policy, national guidelines and a training program for HCW management in all countries in the world (UNCED, 1992). In Nigeria, the Government response to the conference has yet to result in a national policy on HCW management. The current national action plans for waste management (as published in Daily Trust Newspapers of 17 September, 2008) does not include participation from the health sector. It is thus not surprising that healthcare waste management centers are generally lacking at any level of health care.

The establishment of specific policies and strategic plans on HCW at the national level, particularly given the limited budget available to the health sector is a crucial initial step towards the achievement of a minimum level of HCW management practice in a developing economy like Nigeria.

Waste generation, segregation, treatment and disposal

Our study has shown that generally the quantity of waste generated in the out-patient units is less than that in the in-patient units. This may be because a large proportion of the wastes generated by patients in the in-patient wards are similar to general waste such as packaging and food waste, and thus there may be no real difference in the actual quantity of general waste. In-patients on the other hand are more likely to generate infectious wastes, pharmaceutical wastes and pathological wastes. Good segregation practice will ensure a reduction in the quantity of medical waste which is more expensive to manage.

The absence of waste segregation at the health facility imply that the estimates of the various categories of waste may not be precise, nonetheless it provides a useful guide for the assessment of the different waste streams generated many of which are hazardous in nature requiring special handling to avoid health consequences. The World Health Organization recommends the segregation of HCW waste preferably at the source of production and provides guidelines for the safe and sound management of medical waste in developing countries (WHO, 1994, 1995). From this study, it is obvious that the WHO guidelines have not been followed in the HCW management of the hospital. The WHO recommends the following color coding of waste receptacles to facilitate the segregation of HCW at the source of generation (and to keep them separated from each other):

Red for highly infectious waste, yellow for other infectious waste, yellow marked "SHARPS" for sharp waste, brown

Table 5. Summary result of the application of the Townend and Cheeseman guidelines for the sustainable management of HCW at the studied healthcare facilities.

Waste management criteria	Description of existing practice	Townend and Cheeseman criteria	Corresponding sustainable level of HCW management at study site*
Waste management			
Responsibility, Segregation, Storage and Packaging	No focal waste manager, No written waste management plan, only sharps are segregated, waste stored in unlabelled plastic bins, no color coding and 76% of bins have no lids; waste dumped outside building	No waste management strategy; Limited segregation (sharps only); storage containers not specific (no color coding); Waste dumped outside building	0
Waste transport	Waste collected in bins and manually transported to dumpsite outside the building.	Municipal solid waste (MSW) collection and transport with open topped vehicles used for all wastes	0
Waste recycling and reuse	No form of waste recycling. Limited re-use of some theatre materials and beddings.	Some re-use of materials. No recycling at the HC facility	0
Waste treatment	Burning with open fire and burying at healthcare facility	Crude incineration on site of hazardous wastes. Environmental pollution and dangers to public health from crude incinerators. Some waste burying at HC facility in remote areas.	0
		Scavenging by animals and insects.	
	No offsite disposal Causing environmental pollution 0 Dangers to public health.		
		No site security	

* 0 = unsustainable level of HCW management.

for pharmaceutical waste, lead box labeled with radioactive symbol for radioactive waste and black for general or non-infectious waste (Pruss et al., 1999).

It must be emphasized that in addition to the color, special sharp proof containers are required for sharps waste. Segregation of HCW serves many important public health functions: segregation reduces medical waste and thus reducing the health impacts on the general public (after dumping); reduction of medical waste impacts positively on the budget required for HCW disposal. Phengxay et al. (2005) have reported a reduction in cost of up to US\$2938/year in the Vientiane municipality if perfect segregation practices are applied. The use of instructive posters and color coded bins are

important to achieve effective segregation of waste. Hagen et al. (2001) in their study of infectious wastes in a Saudi Arabian hospital have also reported the importance of providing instructive posters as tool to promote effective segregation of HCW. In this study, the lack of HCW management manual and hospital policy on HCW management are likely to be responsible for the low awareness of health workers on HCW management. This finding is consistent with the outcome from other studies (Askarian et al., 2004). A lack of sufficient health budget means that waste management is probably not a priority issue amongst competing needs in the health facility and may be a factor in the non provision of standard waste bins of desired size and make, such as bins with foot operated lid. To overcome these limitations the health

facility should consider the use of inexpensive locally available containers which can be modified to make them suitable and then inserting colored labels. This can be used as a short term measure. A medium to long term measure will be the proper allocation of financial resources for the provision of appropriate storage bags and containers, construction of temporal storage facility, training of operational staff and other health workers and the investment in appropriate technology for waste treatment and disposal. The provision of instructive posters is also not expensive and can be achieved in the short term within available resources.

The current disposal method adopted by the health facility, which is dumping and open burning at the facility premises poses health risks to patients and people residing close to healthcare facilities (Kuroiwa et al., 2004). The HCW may also contain a large proportion of plastics. When burnt, dioxin is a major air pollutant of concern from chlorinated polymer as reported by the World Health Organization (WHO, 2004). Hazardous healthcare Waste poses potential risk of injury or infection to all those exposed to it, including;

- (i) Medical staff: doctors, nurses, sanitary staff and hospital maintenance personnel.
- (ii) In- and out-patients receiving treatment in health-care facilities as well as their visitors.
- (iii) Workers in support services linked to health-care facilities such as laundries, waste handling and transportation services.
- (iv) Workers in waste disposal facilities, including scavengers.
- (v) The general public and especially the children, who play with items scavenged from open waste dumps.

The WHO (2002) estimates that over 20 million infections of Hepatitis B, C and HIV occur yearly due to unsafe injection practices (reuse of syringes and needles in the absence of sterilization). Improperly disposed hazardous HCW also poses indirect risks to humans through direct environmental effects by contaminating soils and ground water. During open burning or incineration, air pollutants are released into the atmosphere causing respiratory illnesses to nearby populations. Immediate improvements in the waste disposal system can be achieved through a combination of waste segregation and a simple high temperature system. It is generally acknowledged that the items of waste corresponding to the category of "non risk or general waste" constitute about 80 to 85% of HCW (WHO, 1999; Adegbita et al., 2010) which can be disposed through the regular municipal waste disposal system. The hazardous component can be disinfected or autoclaved. Although incineration has the advantage of being able to handle most types of medical waste and of achieving volume reduction, it has a number of significant disadvantages. It is a relatively costly technology requiring frequent maintenance, and limited life span. In

addition environmental concerns arising from emissions of green house gases and dioxins to the atmosphere and the impacts of the residual ash make incineration a less acceptable technology. Advanced pollution control mechanisms for dioxin emission now exist in many developed countries and involve the injection of activated carbon and calcium hydroxide into the flue gases emerging from the furnace and collecting the resultant particulate in a fabric filter. It is however doubtful if many hospitals in developing countries can afford this expensive air pollution control equipment (APC). Unfortunately it is not enough to have incinerators fitted with APC, it is also critically important to have professionally trained personnel to operate it (Connett, 1997). The present study is of the view that incineration will not solve the problem of medical waste in developing countries. Other simple technologies worth considering are autoclaving, shredding followed by chemical disinfection or microwaving, inertization and encapsulation.

Improving current HCW management practices

Significant improvements in the current practice of HCW management can be achieved through a number of simple steps. A clear policy on medical waste management must be put in place both at the institutional and national levels. Health workers must then be trained to follow a simple but systematic procedure that is based on the policy. To achieve this, healthcare institutions must utilize the most practical options to achieve acceptable standards and practices for HCW management using available technologies. New technologies used in advanced economies, although desirable may not be appropriate on account of cost, power requirements, maintenance capabilities and availability. The choice of waste treatment technology should be tailored to urban or rural health facility as well as the availability and affordability of the technology in the context of long term sustainability. Waste segregation is a critical beginning step to achieve waste minimization, cost reduction and sustainable waste management practice. It offers the health facility the ability to make more accurate assessment of their waste composition and also positions the facility for practical HCW management strategies (Shaner 1993; Going, 2001).

Improving the standard of healthcare waste management in Nigeria will serve several useful public health purposes:

- (i) Protecting the health and safety of healthcare workers, patients and visitors at healthcare facilities.
- (ii) Improving occupational health and safety conditions of those responsible for handling healthcare waste.
- (iii) Improving environmental protection.
- (iv) Saving costs through segregation, salvaging and re-use.

(v) Improving the service delivery of the healthcare sector, particularly in terms of compliance with the 'duty of care' principle (which requires that any person who generates, transports, treats or disposes of waste must ensure that there is no unauthorised transfer or escape of waste from her/his control. Such a person must retain documentation describing both the waste and any related transaction. In this way, he retains responsibility for the waste generated or handled).

(vi) Boosting the morale of healthcare workers.

CONCLUSION AND RECOMMENDATIONS

The current management practices for healthcare wastes generated at the health facility studied is unsustainable and cannot be relied upon to protect human health and environmental integrity. There is no existing policy or plan and no systems in place for sustainable management of HCW. There is thus urgent need to take practical steps aimed at ensuring the 'duty of care' and safeguarding the environment for current and future generations. Although, the findings of the present study is important for the management of HCW in Nigeria and other developing countries, the widespread application of these findings may be limited because of the small sample size, the narrow scope of study and the short duration of the study. It will be useful to consider the waste management practices at lower levels of health care practice, such as Primary Health Care Centres, in future research.

The authors recommend the following directions as a way forward towards attaining sustainable HCW management:

1. Management commitment to the sustainable management of HCW through:

- (i) Formulation of hospital waste operational procedure (HCW Management plan).
- (ii) Allocation of appropriate resources.
- (iii) Adequate staff training and capacity building.
- (iv) Technology transfer.
- (v) Information and awareness of HCW management plan to all hospital staff and their patients.

2. Formulation of appropriate institutional and national policies on HCW and initiating monitoring activities relating to HCW in Nigeria.

Tertiary health institutions should apply the principle of "waste to wealth". Over 75% of HCW is general non hazardous waste. Materials such as paper, glass and plastics can be safely and easily re-cycled. Not only is the market readily available, the process can also be used as a powerful economic tool to improve the financial resources available to the hospital, given the current poor funding of health care in Nigeria.

3. The current levels of HCW management in tertiary health facilities need to be given more attention through

improved funding and research to protect the health of the public and the environment.

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