Critical Success Factors of Medical Waste Management Implementation in Healthcare Facilities in Nigeria: A Case Study

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Medical waste management (MWM) in developing countries such as Nigeria continue to lag in the development and implementation of successful MWM programs. The concentration of research on management practices, waste generation and characterization, disposal practices implies very little attention has been given to understanding the factors that are critical to implementing successful MWM programs. The aim of this study is therefore to identify critical factors of MWM success in developing countries, and assess the recognition and implementation of these factors toward achieving MWM goals in healthcare facilities (HCFs) in Benue State, Nigeria. This study adopted a case study approach. Factors critical to MWM success were identified from literature and validated through key informant interviews conducted across four (4) case study HCFs. The study found that, training, sensitization and awareness was considered the most critical factor, followed by environmental legislation in compliance with international environmental rules/regulations; and specific and elaborate regulations with regard to medical waste. The third most critical factors were financing and investment; infrastructure; and adequate and efficient workforce. It was found that implementation of the critical factors at the HCFs was poor. Issues contributing to poor implementation include lack of awareness on existing medical waste management guidelines; lack of enforceable national policy or regulation on medical waste management; inadequate finance among others. This stresses the need for increased participation at both internal (HCF), and external (ministry) levels in creating awareness on the risk potential of medical wastes and existing guidelines to encourage acceptable practices, and enactment of specific legislation dealing with MWM.

Keywords: Medical waste management, healthcare facilities, critical factors, developing countries, Nigeria

1. INTRODUCTION

Planning a hospital waste management system is a very complex and difficult task since wastes from healthcare is unique and heterogeneous. Medical wastes over the years have increased due, in part, to the number and size of healthcare facilities, increase in population, industrial and economic advancements, urban growth, medical services, use of medical disposable products, etc. (Askarian, Vakili, and Kabir, 2004; Mohee, 2005). While most of these wastes are domestic- or municipal-type wastes, a small portion has pathogenic properties that are both a risk to human health and the environment. Managing this composition of waste stream, especiallyin developing nations, remains a big problem.If handled improperly, the small portion of medical waste, amounting to only about 25% (Chartier, Emmanuel, Pieper, Prüss, Rushbrook, Stringer,…Zghondi, 2014) could contaminate the whole waste stream. This continue to be the situation with many developing countries as inefficient practices elevate the potential of the whole medical waste stream becoming infectious/hazardous, posing high health and environmental risks (Abor & Bouwer, 2008;Coker, Sangodoyin, Sridhar, Booth, Olomolaiye, & Hammond, 2009), and resulting in high disposal costs (Nichols, Grose, & Mukonoweshuro, 2016; Zhang, Williams, Kemp, & Smith, 2011). Although improvements are being reported (WHO, 2007), several challenges still remain. Issues such as lack or poorly formulated medical waste management-specific regulations and policies; poor risk awareness and training; inadequate financing; cultural norms and social status; nature, size, and type of healthcare facilities; improper implementation of policies and best practices; inadequate infrastructure and slow technological advancement (Abah & Ohimain, 2011; Abor &

Bouwer, 2008; Chartier et al., 2014; Coker et al., 2009) have been identified as being responsible for failed medical waste management programs. Among many developing nations, medical waste management is still only toward achieving safe management objectives, and existing research in developing nations' context has focused mostly on management practices (Abah & Ohimain, 2011; Abor & Bouwer, 2008; Akter & Tankler, 2003; Coker et al., 2009; Mbongwe, Mmereki, & Magashula, 2008), and waste generation and characterization (Askarian, Vakili, & Kabir, 2004; Cheng, Sung, Yang, Lo, Chung & Li, 2009; Mohee, 2005). To succeed with any program at all, certain critical factors have to be considered and implemented. It is to this note that, this study is formulated. This study therefore is set to (1) identify factors critical to the success of medical waste management programs (MWM) in developing countries, and, (2) determine how well these factors have been implemented toward achieving MWM goals in selected healthcare facilities (HCFs) in Benue State, Nigeria.

2. LITERATURE REVIEW

2.1 Medical Waste Definition And Classification

The World Health Organization (WHO) defines medicalwaste as "all waste generated by health-care establishments, research facilities and laboratories including the waste originating from 'minor' or 'scattered' sources—such as that produced in the course of healthcare undertaken in the home (such as dialysis and insulin injections, etc.)" (Chartier et al., 2014). However, while some researchers have adopted this definition (Kumari, Srivastava, Wakhlu, & Singh, 2013; Patil &Pokhrel, 2005; Prem Ananth, Prashanthini, & Visvanathan, 2010; Chartier et al., 2014; Sawalem, Selic, & Herbell, 2009; Tsakona, Anagnostopoulou, & Gidarakos, 2007; Tudor, Noonan, & Jenkin, 2005) others see medical waste as only wastes generated from actual clinical activities (Bdour, Altrabsheh, Hadadin, and Al-Shareif, 2007; Jang, Lee, Yoon, & Kim, 2006; Bdour, Altrabsheh, Hadadin, and Al-Shareif, 2007; Verma, Mani, Sinha, & Rana, 2008; Wahab, 2011). While the Chapter 18 of the European Waste Catalogue and Hazardous List does not establish what 'immediate healthcare' means, it defines medical waste to include wastes from human and animal healthcare and related research activities, but excluding of wastes from kitchen and restaurants which do not arise from 'immediate healthcare'.

Existing literature shows varying classifications of wastes from HCFs. This could be seen in one part as a result of the non-uniformity of medical waste definition and on the other part, the heterogeneity of waste from healthcare activities. The World Health Organization categorizes medical wastes into two broad categories: hazardous healthcare waste and non-hazardous healthcare waste with hazardous healthcare waste further classified into six sub-categories (see Table 1). Some or all of the following criteria exist for classifying medical waste: composition (e.g., chemical and biological properties, etc.) (Chartier et al., 2014); degree of risk (e.g., hazardous or non-hazardous etc.) (Da Silva, Hoppe, Ravanello, & Mello, 2005; Patwary, O'Hare, Karker, 2011); type of waste (e.g., clinical or general/domestic-type medical waste, etc.) (Oke, 2008).

Table 1: Categories of healthcare waste

Waste Category	Description and examples
Hazardous healthcare waste	
Infectious waste	Waste suspected to contain pathogens and that poses a risk of disease transmission (see section 2.1.2) (e.g. waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards)
Pathological waste	Human tissues, organs or fluids; body parts; fetuses; unused blood products
Sharps	Used or unused sharps (e.g. hypodermic, intravenous or other needles; auto-disable syringes; syringes with attached needles; infusion sets; scalpels; pipettes; knives; blades; broken glass)
Pharmaceutical	Pharmaceuticals that are expired or no longer needed; items contaminated by or

waste, cytotoxic waste	containing pharmaceuticals Cytotoxic waste containing substances with genotoxic properties (e.g. waste containing cytostatic drugs – often used in cancer therapy; genotoxic chemicals)
Chemical waste	Waste containing chemical substances (e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents; waste with high content of heavy metals, e.g. batteries; broken thermometers and blood-pressure gauges)
Radioactive waste	Waste containing radioactive substances (e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources)
Non-hazardous or general healthcare waste	Waste that does not pose any particular biological, chemical, radioactive or physical hazard

Source: Chartier, et al. (2014)

The Technical Guidelines on Environmentally Sound Management of Biomedical and Health-Care Waste provided by the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal provides a comprehensive categorization of wastes from healthcare facilities (see Figure 1). The repealed Decree No. 58 of 1988 in Nigeria describes medical waste in 13 categories and mentioned it as constituting the nature of waste to be tracked under the *Harmful/dangerous/hazardous/toxic wastes Tracking Programme* (Federal Republic of Nigeria, 1988).

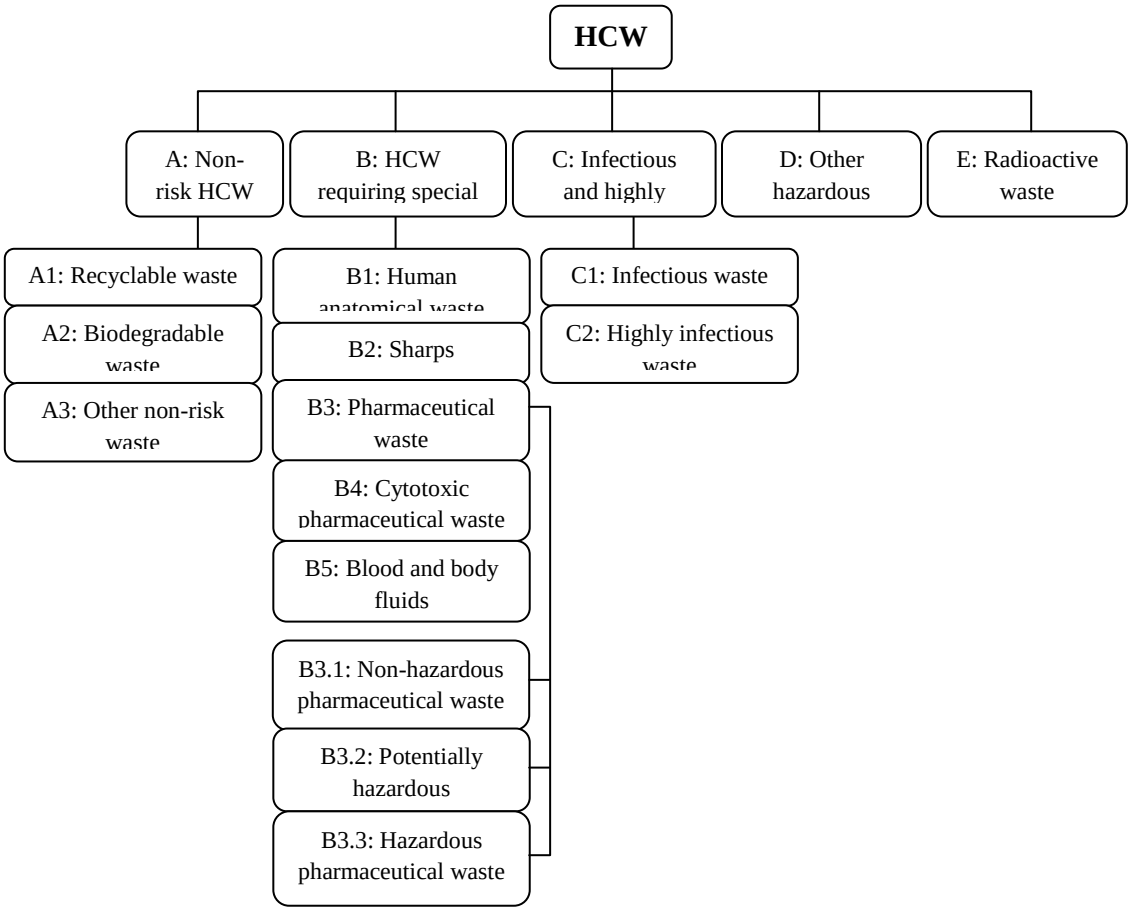


Figure 1: Categories of healthcare waste
Source: Slovak Environmental Agency (1998).

Classification of medical wastes has to be appropriate and exhaustive to ensure proper understanding of the waste stream. Diaz, Eggerth, Enkhtsetseg, & Savage (2008) note that, this is invaluable to the development and implementation of a realistic waste management plan. The existing literature points to lack of a general consensus on the definition and classification of medical waste. In this study, medical waste definition and classification derives from the perspective adopted by WHO and refers to all waste produced as a result of healthcare provision, including waste generated from such activities as healthcare provided at home.

2.2 Categories of HCFs

Healthcare facilities are the main generators of medical waste. They are institutions providing health or medical care for humans and animals, and include facilities such as hospitals, clinics, specialized care centers such as birthing centers and psychiatric care centers, etc. A healthcare facility could either be a small quantity generator (SQG), i.e., generating below 200lbs of waste per month or a large quantity (LQG), i.e., generating in excess of 200lbs of waste per month (State of California, 1990). There is no common criterion for classifying healthcare facilities. Categorizing healthcare facilities, however, is vital to a medical waste management program. Komilis, Fouki, & Papadopoulos (2012) categorized healthcare facilities in two broad types based on ownership: public and private healthcare facilities. In Taiwan, the Department of Health has classified healthcare facilities into four levels based on socio-economic status, and nature of care services provided: these include, medical centers, local (community) hospitals, regional hospitals, and independent clinics and others (psychiatric treatment facilities, institutions for training and special functions, postnatal care centers, and care centers for the elderly) (Cheng et al., 2009). Coker et al. (2009) categorized healthcare facilities into four groups based on size and function: primary, secondary, tertiary, and diagnostic healthcare facilities. The nature, type, size, etc., are significant determinants of the amount of waste they could generate (Cheng et al., 2009; Abor & Bouwer, 2008).

2.3 Medical waste management situation in developing countries

Medical waste management in many developing countries still strive to tackle 'safe' waste management. Nowadays, a successful medical waste management system is one that achieves reasonable to total levels of safe, efficient and sustainable objectives (see Figure 3).

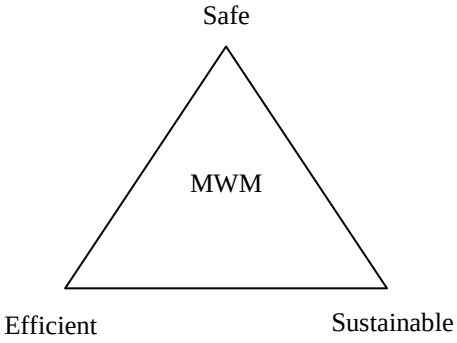


Figure 2: Holistic medical waste management

Medical waste management entails all the activities and processess involved in developing and implementing an effective waste management program. It begins with establishmnet of policies, guidelines and legislation at national level to waste management operational activities at hospital level. Establishing a medical waste management program begins with institutional frameworks such as policies, regulations, guidelines, etc. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal of 1989, set out to reduce or prevent the adverse effect of hazardous waste on human health as well as the environment, remains the earliest

regulation regarding hazardous waste management issues across international borders.

Several developing countries now have policies/legislations regarding medical waste management. For example, in Cameroon, the 1964 Law on the Conservation of Public Health and 1996 Framework health Law; Laws of the Ministry of Environmental Affairs and Ministry of health & Populations in Egypt; the 2002 Removal & Disposal of Hazardous Wastes and the 2003 Improvement of healthcare waste management in Mongolia (Manga, Forton, Mofor, & Woodard, 2011); the Public Health Act 1925 and the 2001 Standards for Hazardous Waste Regulations in Mauritius (Mohee, 2005); the (ANISA 2004) and the National Environmental Council of Brazil (CONAMA 2005) in Brazil (Da Silva et al., 2005; Moreira& Gunther, 2013); Bio-medical Waste Management and Handling Rules of 1998 in India (Goddu, 2007), etc. In Nigeria, the Draft National Policy on Healthcare Waste, 2007 remains the closest to providing a national legislation and policy on medical waste management(Abah &Ohimain, 2011). While these regulatory frameworks represent an improvement in addressing waste management issues in developing nations, challenges such as inadequate funding and resource commitment remains major militating factors to proper medical waste management (WHO, 2007).

2.3.1 Medical waste management practices

(a) Generation: While offering healthcare services, healthcare facilities generate a lot of waste. Table 2 shows medical waste generation rates in some developing countries measured in kg/bed/day. There is, however, no standardized waste measurement unit. Tudor (2007) noted that, for instance, kg/bed/day were prone to fluctuations, failed to take into account proper measurement of waste generated from non-patient activities and could provide false data as beds could be either unoccupied or over-occupied. Factors responsible for waste generation rates include type of healthcare services provided by a hospital, the number of beds, insurance reimbursement, economic, social and cultural status of the patients and the general condition of the area the hospital is located (Abor & Bouwer, 2008; Cheng et al., 2009).

Table 2: Medical waste generation rates in some developing countries

Country	Generation rate (kg/bed/day)	GNP per capita (US$)
Tanzania	0.84	320
India	1.60	620
Iran	1.25	2320
Thailand	1.75	2490

Source: Chaerul, Tanaka, and Shekdar (2008).

(b) Segregation: Medical waste segregation means separating different types of waste streams according to their classifications. Waste segregation is the most essential part of the medical waste management process. The fundamental aim is to separate infectious/hazardous waste from non-infectious/non-hazardous waste and prevent contamination. This would also reduce the quantity of infectious/hazardous waste. Segregation goes beyond just separating clinical waste from general medical waste as this determines the adoption of suitable treatment and disposal options. For instance, Abor & Bouwer (2008), in a study in South Africa observed that though clinical waste was satisfactorily separated from general medical waste, the practice of further separating clinical waste into categories was not practiced. Segregation must be done at source as the starting point, i.e. at the point of waste generation. Highly infectious waste such as pathological and anatomical waste must be separated from pharmaceutical waste; same must be done with sharps and radioactive waste, etc. Elsewhere in Bangladesh, a study by Akter & Tankler (2003) showed that apart from segregating syringes/needles, hospitals did not practice waste segregation. The study showed that only about 8% of doctors and 3% of nurses employed proper practices in dealing with medical waste; about 30% of doctors and 37% of nurses employed improper practices; and about 60% of doctors and 60% of nurses

were uncertain about what they did. Segregation should be done by the use of color-coding and labeling. At the point of waste generation, segregation is the sole responsibility of hospital staff. Chartier et al. (2014) suggests that all waste generation points at the HCFs should have appropriate containers and bags matching the category of waste generated placed at each point of waste generation. Table 3 provides a general recommendation for color-coding of medical waste bags and containers as provided by the World Health Organization.

Table 3: Color-coding recommendations for medical waste (Chartier, et al., 2014)

Type of waste	**Color of container and markings**	**Type of container**
Highly infectious waste	Yellow, marked "HIGHLY INFECTIOUS", with biohazard symbol	Strong, leak-proof, plastic bag, or container capable of being autoclaved
Other infectious waste, pathological and anatomical waste	Yellow with biohazard symbol	Leak-proof plastic bag or container
Sharps	Yellow, marked "SHARPS", with biohazard symbol	Puncture-proof container
Chemical and pharmaceutical waste	Brown	Plastic bag or rigid container
Radioactive waste[1]	Labeled with the radioactive symbol	Lead box
General healthcare waste	Black	Plastic bag

[1]Not generated in all hospitals

(c) Handling, on-site transportation and storage: This involves moving collected wastes to a temporary storage point for either treatment or in the case of general medical waste, off-site transportation to either landfills or incinerators. Handling and transportation personnel have to be well equipped with Personnel Protection Equipment (PPE) such as masks, protective clothing, general purpose gloves, puncture- and water-proof boots, protective eyewear (Abor & Bouwer, 2008; Vieira et al., 2009; Razali & Ishak, 2010). Storage areas must be well designated. Where infectious wastes are to be stored for more than a week, they must be kept cool or refrigerated at temperatures not higher than 3^0C to 8^0C. Where that is not provided, temporary storage of infectious wastes, in a temperate climate, should not exceed 72 hours and 48 hours in temporary storage during winter and summer respectively; in warm climates, 48 hours and 24 hours during the cool and hot seasons respectively; cytotoxic should be stored in separate secure locations; and radioactive stored behind lead shielding in dispersion-proof containers (Chartier, et al., 2014). Temporary storage areas should also be inaccessible to unauthorized personnel and animals such as rodents, dogs, cats, etc.

(d) Treatment, off-site transportation and disposal: Incineration has been reported as the most common treatment technology available for medical waste (Caniato, Tudor, & Vaccari, 2015). However, incinerators are increasingly becoming an unpopular option for both treatment and disposal of wastes due to environmental concerns (Wilburn, 2012). Diaz et al., (2005), observed that combustion of medical waste generates chemical compounds and particulate matter that can potentially have health effects on humans and the environment as, especially, in developing countries, makeshift combustion devices and systems are prevalent. While developed countries can afford both the technology and capacity to operate incinerators with air pollution control (APC), developing nations usually lack that capacity (Abah &Ohimain, 2011). Table 4 shows some alternate treatment and disposal options for various categories of medical waste.

Off-site transportation of waste from healthcare facilities in some developing countries is usually outsourced and is the responsibility of either concessionaires or municipal authorities in the case of general healthcare waste (Abor & Bouwer, 2008; Diaz et al., 2005; Razali & Ishak, 2010). This does not, however, completely eliminate improper handling and transportation practices. Indiscriminate disposal practices have been reported with practices such as open burning and dumping around hospital premises (Akter & Tankler, 2003; Coker et al., 2009). Before hazardous medical waste is transported, it must be packaged and should follow WHO Guidelines for the Safe Transport of Infectious Substances and Diagnostic Specimens (Chartier et al., 2014).

Disposal of any category of medical waste is supposed to be final. Akter & Tankler (2003) reported that hospitals in Bangladesh used municipal bins and dumping grounds for medical waste disposal. Waste could be found in canals and rivers around large hospitals. The following medical waste disposal methods exist: landfill; burial; incineration. Advanced treatment technologies such as microwaving, encapsulation and autoclaving etc., mentioned earlier can also serve as disposal mechanisms. While landfills should be a method of disposing off of general medical waste, it is not uncommon to find clinical waste at landfills in developing countries (Coker et al., 2009; Oke, 2008). Burial of medical waste such as anatomical parts is also a common practice in developing countries. Akter & Tankler (2003) reported that disposal practices in Bangladesh included burial of wastes suchplacenta/fetuses around or within the medical facilities. The study also showed that, about 21% of doctors and 18% of nurses were disposed to open burning as a medical waste disposal option. However, financial and social factors might affect certain disposal practices. For instance, Chartier et al. (2014) observed that in certain countries, religious and cultural practices might make it unacceptable to collect anatomical waste in yellow bags and dispose of it as per the MWM policy; such should therefore be disposed of safely in accordance with local customs.

Table 4: Treatment and disposal options for hazardous medical waste*

Technology	Method	Waste Handled
Thermal	- Autoclave - Hybrid autoclave - Continuous steam - Microwave technologies - Frictional heat treatment - Dry heat - Incinerators	- Autoclaves: cultures, stocks, sharps, material contaminated with blood and body fluids, isolation and surgery waste, laboratory waste excluding chemical waste, soft waste from patient care etc. - Microwave: same as for auto-claves plus pathological waste, bottles containing fluids. - Frictional heat: cellulosic material, glass, plastics, metals, liquids and pathological waste. - Dry heat: sharps and small amounts of infectious waste. - Incinerators: same as for auto-clave plus large beddings, cadavers, large anatomical remains, cytotoxic waste.
Chemical	- Chlorine - Glutaraldehyde - Lime slurry - Calcium oxide - Alkaline hydrolysis	- Chlorine based: liquid waste, infectious waste, microbiological cultures, sharps. - Alkaline hydrolysis: pathological waste, organs, tissues, cadavers, anatomical parts, stocks and cultures, chemotherapeutic agents.
Irradiative	- Electron beam - UV-C (germicidal UV)	- Radioactive waste

	-	Irradiation		
Biological	-	Enzyme treatment	-	Biological waste
	-	Composting		
	-	Vermiculture		

Source: UNEP (2013).

*General medical or domestic-type waste not reflected. Chartier et al. (2014) suggested general medical waste should be taken care of by municipal disposal options.

(e) Recycling: Because of the high risk of health infections and hazards associated with a percentage of medical waste, little attention is paid to its recycling potential. However, the percentage of infectious/hazardous wastes constitutes only a fraction of the total waste generated from healthcare facilities. Most of it, 75% to 90% is non-risk and similar to domestic- or office-type wastes with high recycling potential. In a study by Hossain, Santhanam, Nik Norulaini, & Omar (2011) involving 14 mostly developing countries only 3 out of the 14 countries recycled parts of the waste generated from healthcare facilites. Lack of recycling initiatives, low technological advancement, etc. could be seen as factors militating against medical waste recycling. Furthermore the scenario created by the fact that non-risk wastes from healthcare facilities could easily get contaminated through improper handling could be the reason toward the limited enthusiasm regarding medical waste recycling, especially in developing countries.

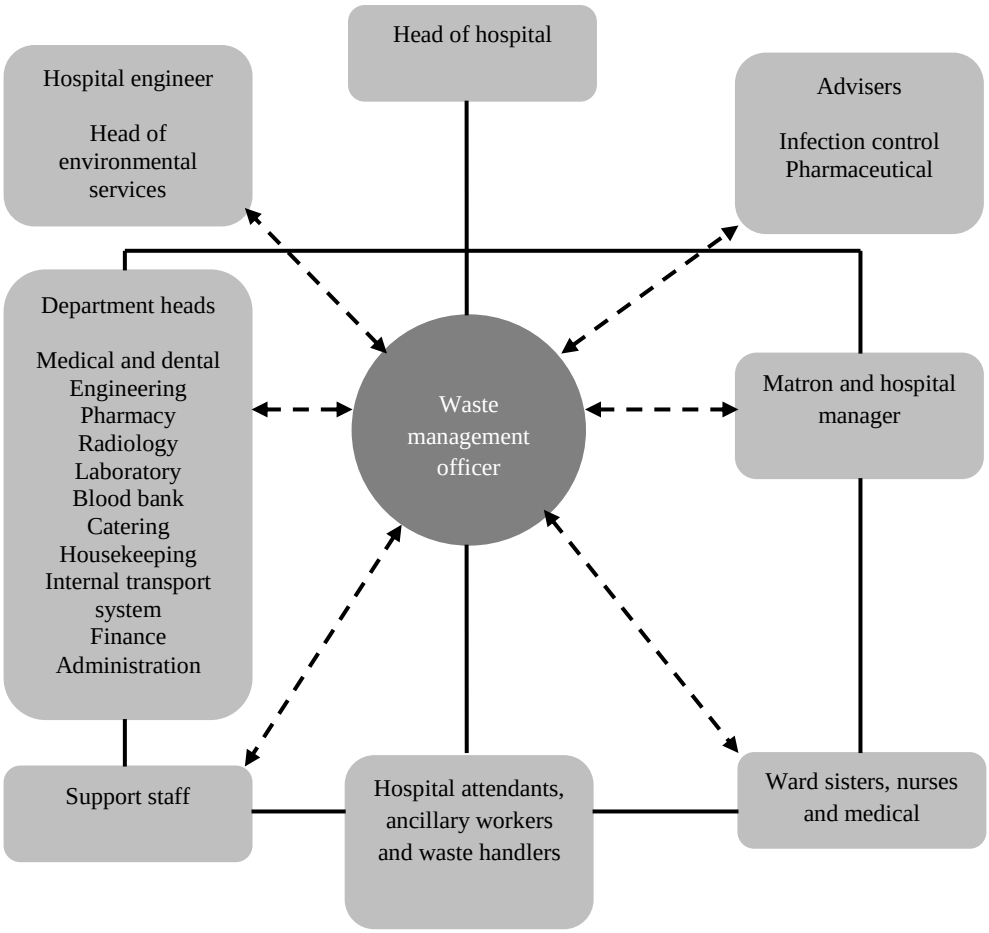
2.4 Critical success factors of medical waste management

Nowadays, the ultimate goal for any medical waste management program should be to achieve safe, efficient and sustainable objectives. These three general objectives form the basis upon which, any medical waste management program should be formulated. Exploring the critical factors of medical waste management is informed by the concept of critical success factors (CSFs). According to Baharum &Pitt (2010), the CSFs concept has been utilized as a management measure for decades in information systems (Bullen and Rockart, 1981); financial services (Boynton and Zmud, 1984); waste water management (Keremane and McKay, 2009); and manufacturing industry (Mohr and Spekman, 1994)to evaluate performance. Also studies regarding critical success factors in waste management have covered areas such as retail shopping center waste recycling (Baharum, 2011); municipal solid waste management (Ezeah & Roberts, 2012); and waste management in higher educational institutions (Jibril, Sipan, Sapri, Shika, Aliyu, Isa, & Abdullah, 2012). Critical success factors are, "the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. Critical success factors are the few key areas where 'things must go right' for the business to flourish and for the manager's goals to be attained" (Bullen & Rockart, 1981, p. 7 in Grunert, & Ellegaard, 1992).

Regarding the problems with medical waste management especially in developing countries, key factors vital to success have to be understood. The concentration of research on management practices, waste generation and characterization, disposal practices implies very little attention has been given to understanding the factors that are critical to implementing successful MWM programs. In a study to develop the Angola National Healthcare Waste Management Plan, several critical factors essential to medical waste management implementation were identified. The document noted that, these factors are decisive for a medical waste management plan to be successful. These critical factors include (Engineer Adérito de Castro Vide, 2009): adequate management at all levels, including integrated management plans; adequate and efficient workforce; environmental legislation in compliance with international environmental rules/regulations;environmental policies that include medical waste management subject; specific and elaborate regulations with regard to medical waste; training, sensitization and awareness; financing and investment questions; and infrastructure.

a) Adequate management at all levels, including integrated management plans: Commited management such as strategic MWM at

national, provincial and healthcare facilities levels; coordination and management of the whole MWM chain; organization and management of incinerators and landfills; synergies between healthcare facilities and entities managing incinerators and landfills (Engineer Adérito de Castro Vide, 2009). Figure 3 shows a typical hospital waste management structure.



Note: Liaison paths represented by dotted lines. Line-management represented by solid lines
Figure 3: Hospital waste management structure
Source: Chartier, et al. (2014)

b) *Adequate and efficient workforce*: The need for adequate, efficient and motivated workforce cannot be overemphasized. Without efficient, competent and adequate workforce, conformity to standards and guidelines toward MWM becomes a problem. Longe (2012) noted the lack of professionally competent waste managers among healthcare providers as a key contributor to improper medical waste management in surveyed HCFs in Lagos, Nigeria. The amount of medical waste management personnel and staffing should reflect the size and level of activity of healthcare facilities. In large HCFs where large quantities of wastes are produced, a separate management group or committee is deemed necessary (Chartier, et al., 2014). Such committee should include the head of hospital (as chairperson), heads of hospital departments, infection-control officer, chief pharmacist, radiation officer, matron (or senior nursing officer), hospital manager, hospital engineer, financial controller, waste-management officer (if one is designated).

c) *Environmental legislation in compliance with international environmental rules/regulations*: Global guidelines such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal of 1989 was formulated in response to indiscriminate toxic wastes disposal across borders (UNEP, 2011). Formulating policies that reflect this scenario is a vital factor toward medical waste management as the consequences of improper waste management activities are not just national health and environmental concerns but global.

d) *Environmental policies that include medical waste management subject*: Medical waste is a contributing factor to environmental degradation and significantly poses health risks that are a threat to peoples' quality of life. Starting point is environmental legislation that includes the subject of medical waste. Defining where medical waste belongs as a contributor of environmental and health risks is vital. Legislation, according to the Angola National Healthcare Waste Management Plan of 2009, establishes legal controls and licenses, etc., so that the responsible entities can effect required implementation (Engineer Adérito de Castro Vide, 2009). Such policies could include also enforceable provisions that, for instance, ban certain wastes from landfills (Aziz, Rao, & Salleh, 2013).

e) *Specific and elaborate regulations with regard to medical waste*: For successful management to be achieved, medical waste requires policies and regulations that are tailored specifically toward its peculiarity. The World Health Organization encourages every regional and national governments to establish legislations, policies and guidelines tackling medical waste management both at national (external) and healthcare facility (internal) levels (Chartier et al., 2014). Mohee (2005) noted that, the problem with many developing countries waste management programs success is that, specific policies regarding medical waste management activities are either non-existent or poorly formulated.

f) *Training, sensitization and awareness*: Need for sensitization both on healthcare waste and hygiene topicsis vital. For optimum results, implementation of this factor is not limited to waste handling personnel and must be targeted at all the stakeholders involved in the medical waste management system (Caniato, Tudor, & Vaccari, 2015). Such stakeholders include but are not limited to government, healthcare products manufacturers, hospital management, patients, general public, etc. (Engineer Adérito de Castro Vide, 2009; Prem, Ananth, el al., 2010).

g) *Financing and investment questions*: Healthcare facilities must have sufficient budgets to ensure implementation of MWM activities and provide infrastructure. In some countries, there are no specific budgets allocated to medical waste management activities, where there is, it is insufficient (Longe, 2012). For instance, Abah &Ohimain (2011) noted that, budget allocation to the healthcare sector in Nigeria is highly inadequate, noting the healthcare sector as one of the least funded sectors in the economy. There also, appear to be no desire to invest in medical waste management initiatives such as pursuing treatment and recycling options on a commercial scale.

h) *Infrastructure*: The need for medical waste treatment and disposal infrastructures and equipment for waste management activities at healthcare facility and municipal levels is a pressing one. In a study in Nigeria, Longe (2012) found that most surveyed HCFs lacked treatment facilities. The major form of medical waste disposal in many developing countries remains incineration. However, some of the incinerators are make shift, and the practice of open burning is prevalent (Akter & Tankler, 2003; Baaki, 2014). On the other hand, landfills are not well developed and unsanitary. As much as this appear to be a question of finance, it seems also a question of lack of institutional and management commitment to provision of waste management infrastructure.

3. MATERIALS AND METHODS

This study adopted a case study approach and triangulation technique was utilized. A case study approach was deemed appropriate for this study since it involved an exploration and further evaluation (Yin, 2012) of the level of importance and performance of critical success factors of

medical waste management in a certain scenario. Certain factors critical to the success of a medical waste management, especially in developing countries, were identified through literature review that covered medical waste aspects from context to actual management. Eight (8) critical factors were identified. To validate the factors identified from the literature review, 4 key informant semi-structured interviews were conducted across four (4) HCFs in Benue State, Nigeria within a two-month period. The 4 interviewees represented the best source of information on the basis of expert knowledge regarding the medical waste management situation in their respective HCFs. Two of the interviewees were maintenance officers, while the other two were environmental health officer and sanitation officer respectively. The four (4) interviewees were the heads of the units responsible for waste management activities in their respective HCFs. The four HCFswere chosen for the study because they represented about the largest and most sophisticated healthcare facilities in Benue State. Benue State is one of the 36 states in Nigeria. It is ranked as the 11th largest state in size with an area of 32,818.43km^2 (12,671.27mi^2) (Tser, 2013), and the 7th most populated state with 4,123,641 people (National Population Commission, 2014). The state lies along latitudes 6.41^0 and 8.2^0 North and longitudes 7.5^0 and 9.5^0 East. Healthcare facilities in Benue State include a medical center, teaching hospital, general hospitals, specialist hospitals, numerous private and primary healthcare clinics. Following a classification of HCFs by Coker et al. (2009) the selected HCFs were either secondary or tertiary HCFs. The entire medical waste management situation at the selected hospitals formed the scope for the study with specific focus on the factors critical to successful implementation of medical waste management programs at these healthcare facilities.

The semi-structured interview questions were administered to three (3) of the four (4) selected HCFs through an e-mail format while the other interview session was conducted over the phone and the interview session audio-recorded. The audio-recorded interview was transcribed together with the e-mail format interviews and these were essentially descriptively analyzed. Six (6) of the critical factors were validated by the key informant interview. Subsequently, to determine their performance level—the extent to which the identified factors have been taken into account in the case study healthcare facilities—a structured question comprising all the identified factors was provided to the interviewees. They were asked to rank the identified factors according to importance on a Likert Scale of 1 – 5 (1 - less important; 5 - extremely important), and express the level to which these factors have been implemented within their individual HCFs (1- not implemented; 5 - efficiently implemented). Mean scores were computed to determine the level of importance of factors and level of implementation (performance) of the factors at each. The factors were then ranked according to their mean and standard deviation values. Where the mean values of two variables happened to be the same, the variable with the lower standard deviation was ranked higher. By expressing how far a value deviates from the mean, the standard deviation has been utilized in a case of similar mean scores to differentiate ranks (Lu & Yuan, 2010).

4. RESULTS AND DISCUSSION

4.1 Profile of healthcare facilities

Table 5 shows the type of healthcare facilities, their bed capacity as well as number of in- and out-patients per day. While HCF A has the biggest bed capacity, record regarding in- and out-patients statistics were not present. HCF B did not have record of its bed capacity.

Table 5: Profile of HCFs

HCF	Type	Number of beds	Number of in-patients/day	Number of out-patients/day
A*	Teaching Hospital	300	x	x
B*	Medical Center	x	122	339
C*	Specialist	144	10	20
D*	General Hospital	130	35	45

x = no record

*healthcare facilities renamed for confidentiality

4.2 Critical factors identified from interview

The interviewees were asked to indentify factors that, in their opinion, were critical to medical waste management success. Six factors out of the nine factors identified from literature review were validated by the interviewees. The results are presented and discussed below.

All the four interviewees agreed that **environmental policies and legislations** are critical to the success of any waste management program. *"Without specific polices, guidelines and legislations no one would know what to do and how to do it,"* said one of the interviewees. *"Policies are very important,"*said another. *"There must be a way that shows you how to do something, and because there is high risks associated with medical waste, there must be guidelines that should tell how to deal with such wastes."***Specific policies and regulations on medical waste** was also identified as a critical factor to any waste management program as revealed by one of the interviewees, *"…we need environmental policies and regulation, yes. But we also need policies and regulations that specifically address the issues of medical waste because medical waste is a tricky and very high risk type of waste if handled improperly…."* This strengthens the findings of Coker et al. (2009) and Abah & Ohimain (2011), who found that there was no specific policy or regulation governing medical waste management in Nigeria, and supports the positions of Mbongwe et al. (2008) and Mohee (2005), that even where policies and regulations exist in some countries, they are not well formulated. National policies and regulations provide the overarching intitutional frameworks for formulating medical waste management strategies and action plans. Following the replacement of Decree No. 58 in Nigeira with the enactment of the National Environmental Standards and Regulations Enforcement Agency Act, 2007, the subject of medical waste became completely non-existent in the new Act as incorporated in the repealed Decree 58 (Baaki, 2014). The Draft National Policy on Healthcare Waste, 2007 remains the closest to providing a national legislation and policy on medical waste management practices in Nigeria (Abah, 2011). WHO recomends and states that, it is the responsibility of regional and national governments to provide frameworks such as policies, regulations and national action plans for medical waste management activities (Chartier et al., 2014).

Financing and investment was another factor all the interviewees identified as a critical factor to a waste management program, noting that insufficient finance would pose problems to implementation of medical waste management objectives by healthcare facilities. One of the interviewees noted that, the inadequacy of waste management equipment and tools at their healthcare facilities was a question of finance and investment. It was revealed that at some of the HCFs, there were no specific budgets or financial allocations to cater for waste management within their healthcare facilities and therefore no specific consideration to medical waste management issues. This reflects other findings on the aspect of financing and investment in medical waste management. In many developing countries, inadequate funding and resource commitment is a fundamental militating factor to proper medical waste management (Abah &Ohimain, 2011; WHO, 2007). Where segregated appropriately, up to 90% of wastes generated by healthcare facilities are non-risk and similar to domestc- or municipal-type wastes. These waste have tremendous potential for recycling and safe reuse. With adequate financing and investment, a waste-to-wealth scenario can also be achieved with the management of medical waste.

All the interviewees identified **training and awareness campaigns** as another critical factor. It was revealed that formal training was carried out occasionally at some of the healthcare facilities but hardly any form of mass awareness creation and sensitization was carried out. According to one of the interviewees, lack of good educational background among some of the waste handlers ensured a management commitment to training is informed by the health risks associated medical waste, noting, *"…the management has identified the health risks associated with medical waste. And since some of the waste handlers are not well educated, health education and training is normally carried out to educate them on dangers of medical waste and implications. Training and retraining is carried out routinely."* This finding, in part, strengthens the findings of Botelho (2012) who found inadequate education and training as a major contribution to lack of compliance with relevant legislation on medical waste management. Risk

awareness is important, and can be achieved only through regular awareness campaigns such as signage posting and instructive posters, and trainings engagements that do not only expose medical waste management personnel to risks of medical waste but also expose and inform them of relevant legislation and best practice guidelines.On the other hand, inadequate training and awareness elevates the potential of risk and the vulnerability of waste handling personnel to risk of infection. By not understanding the full spectrum of the risk potential of medical wastes, there can be a tendency of casualness from both waste generating sourcesand waste management personnel resulting in an improper medical waste management situaiton which can be detrimental to health and the environment.

Infrastructure and equipment was also identified by all the interviewees. To be able to execute a waste management program, there must be adequate infrastructure and equipment to support the activities. At one of the healthcare facilities, an incineration facility is provided on-site for infectious/hazardous waste treatment and disposal but equipment and tools still are inadequate. The other HCFs exhibited a much more desperate need, while acknowledging the significance of this factor as indicated by one interviewee, *"We do not have waste management infrastructure. It is now that an incinerator is being built, and we also lack tools and equipment for medical waste handling and this has greatly affected how well we could execute our waste management activities."* This supports the view of Abor & Bouwer (2008) that the capacity to handle and dispose of medical wastes is one lacking in many developing countries. This inadequacy has been identified as one of the major obstacles to medical waste management success in especially parts of West Africa (UN-Habitat, 2005). Providing medical waste handling equipment and appropriate disposal mechanism is key to limiting infection risks and adverse environmental impacts of improper medical waste disposal.

Another factor that was identified by all the interviewees was **adequate and efficient workforce**. All the interviewees revealed that the amount and quality of workforce contributed to their current situation with medical waste management. One of the interviewee mentioned, *"We are a big hospital. This is the biggest federal medical center in the state and a lot of people come here and that means we generate a lot of waste. The current pool of personnel is highly inadequate to handle these wastes."* Adequate and efficient workforce is necessary for effective implementation of medical waste management programs. This supports the contention by Coker et al. (2009) that inadequate staffing and non-educated personnel on the waste management team contribute to challenges facing medical waste management implementation in developing countries.

4.3 Determining the level of importance and implementation of criticalsuccess factors at the HCFs

To correspond with the performance level and importance of factors being observed across the four cases, means were calculated to determine the dominant factors as well as performance outcomes. Table 6 and Figure 4 show the mean ranking of importance levels and performance levels of the identified critical factors. Most of the factors were considered very critical to the success of any medical waste management program by the respondents. Training, sensitization and awareness was considered the most critical factor with a mean score of 4.75, followed by environmental legislation in compliance with international environmental rules/regulations and specific and elaborate regulations with regard to medical waste with a mean of 4.25 each. The third most critical factors were financing and investment, infrastructure, and adequate and efficient workforce with a mean score of 4. The least critical factors were environmental policies that include medical waste management subject; and adequate management at all levels, including integrated management plans with a mean score of 3.75 each. The result stresses the need for adequate training and awareness on the health and environmental risks of medical waste; policies, legislations and regulations; financing, infrastructure, and adequate efficient workforce provision.

Table 6: Mean score of factors critical to the success of a medical waste management program ranked in order of importance and performance level by HCFs

Factors	Code	Mean	Std. Dev.	Rank	Mean	Std. Dev.	Rank

		Importance			Performance		
Training, sensitization and awareness †	ST	4.75	0.4330	1	2.5	0.866	2
Environmental legislation in compliance with international environmental rules/regulations†	EL	4.25	0.4330	2	2	1.2247	7
Specific and elaborate regulations with regard to medical waste †	SMW	4.25	0.4330	2	2	1	4
Financing and investment†	FI	4	0	4	2.75	0.8292	1
Adequate and efficient workforce†	AW	4	0	4	2.25	0.8292	3
Infrastructure†	I	4	0.7071	6	2	1.2247	7
Adequate management at all levels, including integrated management plans	AM	3.75	0.4330	7	2	1	4
Environmental policies that include medical waste management subject	EP	3.75	0.8291	8	2	1	4

† Factor validated by interview

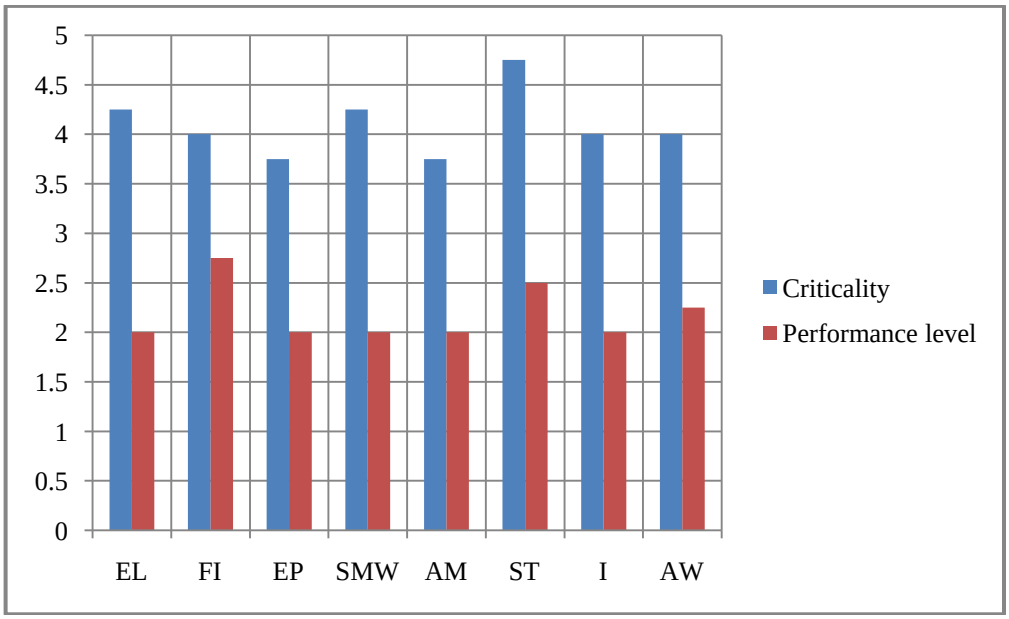


Figure 4: Mean scores of importance and performance levels of medical waste management critical factors

With regards to implementation of these factors at the case study healthcare facilities, Table 6 and Figure 4 show that none of the nine factors were well implemented at any of the HCFs. The most implemented factor among the HCFs was financing and investment with a mean score of 2.75, followed by training, sensitization and awareness of healthcare personnel on medical waste management with a mean score of 2.5. The third most implemented factor was adequate and efficient workforce with a mean score of 2.25. The least implemented factors were environmental legislation in compliance with international environmental rules/regulations; environmental policies that include medical waste management subject; specific and elaborate regulations with regard to medical waste; infrastructure; and adequate management at all levels, including integrated management plans with a mean score of 2 each. The mean scores of performance, i.e., implementation of the critical factors by HCFs show a wide gap. Issues observed include lack of awareness on existing medical waste management guidelines; lack of enforceable national policy or regulation on medical waste management; lack of medical waste management; lack of waste management equipment and frequent breakdown of facilities; inadequate finance; inadequate staffing and tendency of waste handlers to disregard risk potential of medical waste.

5. CONCLUSION

This study has identified critical factors of medical waste management success in developing countries. Poor implementation of these critical factors as identified from the selected healthcare facilities can be seen as a major reason for failing attempts to achieve medical waste management best practice. Some of the most dominant critical factors identified relate to commitment in developing institutional frameworks such as policies, regulation, guidelines, etc., and providing training and raising mass awareness regarding the potential of health and environmental risks associated with improper medical waste management. The issues and challenges to implementation of these factors require the combined efforts of both the government and the management of healthcare facilities. Issues such as lack of awareness on existing medical waste management guidelines, lack of enforceable national policy or regulation on medical waste management, and inadequate finance stresses the need for the input of the government to establish enforceable and specific legislation on MWM and increased participation at both internal (HCF), and external (ministry) levels in creating awareness on the risk potential of medical wastes and existing guidelines to encourage acceptable practices. This study considered only a small number of healthcare facilities, and recommends further studies with a wider sample for further understanding of the success factors of medical waste management, especially with regards to the peculiar challenges of developing countries.

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