

# Management of Medical Wastes: Public Awareness and Associated Health Risks

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***Abstract:** A study was carried out in 49 institutions involved in the provision of health care services in Morogoro Municipality, Tanzania. The aim was to assess the common practices with respect to the management of medical waste. Awareness of workers in the institutions on the public and environmental health risks associated with improper management of medical waste was also assessed.*

*The results showed that the most common types of wastes include sharps, waste blood and fluids, and anatomical and pathological wastes. About 91.8% of the facilities separated medical wastes depending on their types although 77.6% of the facilities did not treat the wastes before disposal. The commonest method for disposal of solid wastes was land filling (57.1%) while for liquid wastes; most facilities drained them into the municipal sewage system (85.7%). Large proportions of interviewed workers were aware of the environmental (59.2%) and public (69.4%) health risks caused by improper management of medical wastes although some of them violated the regulations related to waste management. It can be concluded from this study that although the generation of medical wastes is increasing, there is still lack of health education on proper methods for waste management among workers in health care institutions. This calls for the need of awareness programmes and enforcement of legislation on proper medical waste management in order to prevent hazards and risks to the public and environment.*

**Key words:** medical wastes, environment, public health

## INTRODUCTION

According to the USA Medical Waste Tracking Act of 1988, medical waste is defined as any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals (EPA, 1989). The Ministry of Health and Social Welfare (Tanzania) defines medical waste, also known as health care waste (HCW) as all the waste, hazardous or not, generated during medical activities, and it embraces activities of diagnosis as well as preventive, curative and palliative treatments in the field of human and veterinary medicine (MOHSW, 2007). Medical waste has also been defined as a by-product of health care that includes sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials (OTA, 1988; Lubasi-Kapijimpanga, 2008). It follows from the above definitions that medical waste includes all types of wastes generated by health

care and biomedical research organizations such as hospitals, clinics, dispensaries, medical or veterinary diagnostic and research laboratories (Baron, 1992). However, it has been argued that the definition of medical waste may vary depending on the judgement of risks associated with it from the perspective of the jurisdiction to which the definition will apply (Salkin *et al.*, 2000; OTA, 1988; 1990).

Medical waste is categorized into four major groups, which include; infectious, hazardous, radioactive and general wastes (OTA, 1988, 1990; Manyele and Anicetus, 2006; Lubasi-Kapijimpanga, 2008). Infectious waste is the waste that has the possibility of causing infections to humans and it includes human or animal tissue (blood or other body parts), blood soaked bandages, discarded surgical gloves, cultures and swabs. Hazardous waste is the waste that has the possibility of affecting humans in noninfectious ways and includes sharps, which are generally defined as objects that can puncture or lacerate the skin such as needles and syringes, discarded surgical instruments like scalpels and lancets, culture dishes and other glassware. Hazardous waste also includes chemicals, both medical and industrial. Some hazardous waste can also be considered infectious waste, depending on its usage and exposure to human or animal tissue prior to disposal (Salkin *et al.*, 2000). Radioactive waste results from nuclear medicine treatments and research, medical equipment and other by-products of health care and research that use radioactive isotopes which are dangerous to humans, animals and the environment (EPA, 2011; NRC, 2011; WNA, 2011). Pathological waste that is contaminated with radioactive material is treated as radioactive waste rather than infectious waste (WHO, 2004).

The amount of medical waste generated by health care and research facilities vary depending on the size of the facilities and nature of the activities undertaken. Although infectious waste is a relatively small portion of medical wastes, a high level of concern regarding its management exists (WHO, 2004). Based on principles of disease transmission, infectious waste is divided into five broad categories; namely (i) cultures and stocks of infections agents and associated biologicals (include specimens and cultures), (ii) sharps wastes (such as hypodermic needles, syringes, scalpel blades and Pasteur pipettes) used in human or animal care, treatment and research, (iii) waste human blood and blood components (iv) human pathological waste (tissues, organs and body parts resulting from surgery or autopsy), and (v) animal wastes which include carcasses, body parts and beddings exposed to infectious agents during research in veterinary settings (Paul and Shah, 1990; Gershon and Salini, 1992; Salkin *et al.*, 2000; Bonta, 2002).

It has been estimated that about 75-90% of the medical waste generated in health care and research institutions is general waste, while 10-25% is considered to be infectious or hazardous (Rutala *et al.*, 1989; WHO, 2004; Sharma, 2007). By 1988, hospitals in USA were generating approximately 2.1 to 4.8 million tons of medical waste per year, of which, 10-15% (about 210,000 to 720,000 tons) was considered to be infectious waste (OTA, 1988). Longe and Williams (2006) reported that the average generation rate of medical waste for hospitals in the Lagos Metropolis in Nigeria ranged from 22 kg/per day in a 40-beds hospital to 611.5 kg/day in a 1068-beds hospital, and infectious wastes accounted for 26 to 37% of this volume. Johnson (2011) reported that about 3367.3 kg to 7302.3 kg of medical waste was

generated per day in 22 hospitals in Enugu Metropolis in Nigeria. Recently, Oruonye (2012) has reported that 26.7% of the waste generated in health care institutions in Jaringo Metropolis, Nigeria are needles and other sharps and that the tertiary public health institutions use an average of 500-1000 sharps daily while the private health institutions use about 100-200 sharps daily.

Limited research has been undertaken to quantify the amount of medical waste generated by health care and research institutions in Tanzania. World Care (2010) reported that in 1995, Dar es Salaam City was producing about 25 tons/day of solid hospital wastes and the amount increased to 75 tons/day in 2000 while the production of other hazardous wastes was estimated to be 30 tons/day in 1995 and increased to 110 tons/day in 2000. Manyele (2004) reported that the average rate of generation of medical waste in Tanzania was 0.75 kg/bed, translating into about 800 kg/day country-wide. Data from the Ministry of Health and Social Welfare indicate that approximately 400 to 450 kg of syringes and needles are used and must be disposed of every day from various health care and research facilities (MOHSW, 2007). It has also been estimated that, at national level, the overall production of clinical waste is between 12 and 14 tons per day and about 50% of this, is generated in Dar es Salaam, Kagera, Iringa, Kilimanjaro, Arusha, Pwani and Mwanza regions. All these reports imply that medical waste management is an issue that deserves great attention in the country than currently is the case.

Management of medical waste is an issue of great concern for public health authorities because such waste has a great potential to cause injury and infection to humans and animals, in addition to environmental pollution (Garner and Simmons, 1983; Rutala and Mayhall, 1992; WHO, 2004; MOHSW, 2006). Infectious medical waste can cause disease in humans either through direct contact or indirectly by contamination of soil, ground or surface water and air (Lubasi-Kapijimpanga, 2008). Contamination of the environment by medical wastes renders it unaesthetic, and soils become not suitable for growing crops and other plants for human use. For instance, Ekhaise and Omavwoya (2008) reported that liquid waste discharged in the environment from hospitals in Benin City, Nigeria contained various genera of bacteria including *Klebsiella*, *Pseudomonas*, *Escherichia*, *Serratia*, *Staphylococcus*, *Streptococcus*, *Proteus* and *Bacillus*, which have significant impact on environmental pollution and predisposes workers in the waste management units, and users of wastewater to infection by these bacteria.

The goal of medical wastes management is to ensure that the wastes are disposed in such a manner that they do not pollute the environment or become a source of infections to human beings and animals. Therefore, in order to minimize hazards and risks to the environment and the public, appropriate waste management procedures must be implemented by all institutions that generate such wastes. Officers responsible for waste management in health care institutions have the overall responsibility of maintaining an efficient and safe waste management system in their respective institutions (Manyele, 2004). The managers have a particular responsibility to ensure that staff receive training on waste management and that policies, plans, guidelines and procedures for waste management are established and strictly adhered to (Curtin, 1996). All employees handling medical waste should be

adequately trained in safety procedures and in dealing with spillages or other accidents in their respective areas of work (Anon, 2004). Waste management procedures written in the language most understood by the waste handling staff and the general public should be displayed in all areas where medical waste is generated or handled. It is also recommended that labelling of medical waste containers should be multi-lingual to enable those involved in handling the wastes and members of the general public to understand the hazardous nature of the contents and take the necessary precautions (BAN and HCWH, 1999). On the other hand, it has been reported that hospitals and other employers of health care workers do not provide adequate training to workers involved in waste management, making them inadequately prepared to perform their duties efficiently and safely (OTA, 1988). Manyele and Anicetus (2006) also reported that some hospitals in Tanzania use untrained casual labourers in medical waste management and general cleanliness, and that the level of knowledge of health workers in medical waste management issues was low.

Due to the increase in human population, the number of health care and medical research institutions in Tanzania is also increasing (World Care, 2010; Manyele and Anicetus, 2006). This leads to generation of large volumes of medical waste that surpass the capacity of waste management departments to handle. The Government of Tanzania recognizes the importance of proper management of medical waste and has put in place guidelines to regulate waste management activities (MOHSW, 2006). The Tanzania National Health Care Waste Management (HCWM) plan was prepared with the objectives of developing the legal and regulatory frameworks for HCWM, standardizing waste management practices, improving management and monitoring procedures, equipping the medical institutions, and launching training and awareness measures for healthcare facilities in the country (MOHSW, 2007).

While the number of institutions that generate medical waste and the amount of waste is increasing, there is still limited information on the capacity of the Tanzanian health care and research institutions to manage the generated waste. Practices in the various institutions with respect to collection, treatment, storage and disposal of medical wastes have not been adequately documented. Quite often, medical wastes are disposed indiscriminately or the disposal facilities are not well maintained or secured. Thus, there is need for an assessment of the practices and efficiency of the medical waste management systems in health care and research institutions, which will form the basis for evidence-based recommendations to policy makers. Moreover, in view of increasing number of health care and research institutions that employ staff with diverse educational backgrounds, it is important to assess the awareness of such workers on the public and environmental health risks associated with improper management of medical waste. It is also important to assess the level of knowledge and extent of adherence of the staff to policies, plans, guidelines and procedures that govern medical waste management. The present study was intended to assess and document the practices with respect to collection, treatment, storage and disposal of medical wastes in Morogoro Municipality, Tanzania as well as the awareness of staff in health care and veterinary research institutions on the risks associated with improper management of medical wastes.

## **MATERIALS AND METHODS**

This study was carried out in Morogoro Municipality, Tanzania, which lies between latitudes 5°58' and 10° S and longitudes 35°25' to 35°30' E. A total of 49 health care and research institutions that were identified from the records available in the Municipal Health Department were involved in the study. In each institution, one staff was interviewed after a prior arrangement and consent of the institution to undertake the research had been obtained. A pre-tested semi-structured questionnaire was used for gathering information on the practices with respect to generation, collection, treatment, storage and disposal of medical waste in the various institutions. Awareness of the respondents on the environmental and public health risks associated with disposal of medical wastes as well as existing regulations, guidelines and procedures for medical waste management was also assessed. Secondary data was collected from published and unpublished reports or documents available in the institutions as well as other sources of information such as library and internet. Physical observation on the waste management practices was done by the authors in order to verify the correctness of the information collected through questionnaire. Collected data was entered in Microsoft Office Excel 2007 spreadsheet for collation and summarization.

## **RESULTS AND DISCUSSION**

### **Type of Study Facilities and Occupation of Respondents**

A total of 49 health care and research institutions located in various wards in Morogoro Municipality were visited, comprising of dispensaries (36.7%), health centres (24.5%) veterinary research laboratories (14.3%), medical laboratories (10.2%) and hospitals (8.2%). Other institutions were maternal, dental and eye clinics, whose numbers and percentages are shown in Table 1. The respondents involved in the study included nurses (30.6%), clinical officers (26.5%), medical doctors (8.2%), laboratory technologists (6.1%) and other health care workers as also shown in Table 1.

### **Medical Wastes Generated**

All the visited health care and research facilities in Morogoro Municipality generate different types of medical wastes, some of which are hazardous and others are not. While hospitals and other health care facilities are considered to be the primary generators of medical wastes by volume, the types of wastes differed from one facility to another. The wastes generated include sharps (like scalpel blades, glass slides, surgical and hypodermic needles, syringes, lancets and scissors), which were the most common types of wastes in all the facilities visited. Culture and stocks (laboratory waste, biological products and culture dishes) and waste blood were also produced in all hospitals, health centres, laboratories, clinics and dispensaries.

The production of infectious waste fluids was encountered in all hospitals, health centres, clinics, dispensaries and medical laboratories. Anatomical and pathological wastes were produced in hospitals, diagnostic laboratories, health centres, clinics and veterinary research laboratories. Other types of wastes generated in the different types of facilities are shown in Table 2.

**Table 1: Types of Health Care Institutions and Occupations of Respondents Involved in the Study**

	<b>Respondents (n=49)</b>	
<b>Type of facility</b>	<b>Number</b>	<b>Percent</b>
Dispensary	18	36.7
Health Centre	12	24.5
Veterinary Research Laboratory	7	14.3
Medical Laboratory	5	10.2
Hospital	4	8.2
Maternal Clinic	1	2.0
Dental Clinic	1	2.0
Eye Clinic	1	2.0
<b>Total</b>	<b>49</b>	<b>100</b>
<b>Occupation of respondent</b>	<b>Number</b>	<b>Percent</b>
Nurse	15	30.6
Clinical Officer	13	26.5
Medical Doctor	4	8.2
Laboratory Technologist	3	6.1
Laboratory Technician	2	4.1
Public Health Officer	2	4.1
Laboratory Assistant	2	4.1
Laboratory Attendant	1	2.1
Public Health Technician	1	2.1
Laboratory Manager	1	2.1
Assistant Medical Officer	1	2.1
Counsellor	1	2.1
Matron	1	2.1
Principal Nursing Officer	1	2.1
Hospital Administrator	1	2.1
<b>Total</b>	<b>49</b>	<b>100</b>

The types of wastes generated by health care facilities in Morogoro Municipality are similar to those generated elsewhere in the country and other parts of the world. Manyele and Mujuni (2010), observed that in lower level health facilities (LLHFs) in Tanzania, syringes and needles contributed the largest fraction of the sharps while others were blood lancets, vacutainer needles, stitching needles, surgical blades, infusion sets, scalp vein needles and cannulas. A study in Maldives revealed that 76.3% of the total solid wastes generated in a regional hospital was general wastes, 18.3% was infectious wastes, and 5.4% was sharps (Sharma, 2007). Omojasola *et al.* (2009) reported that main types of wastes generated by hospitals in Ilorin Metropolis in Nigeria were blood, faeces, urine, used syringes and needles, gauze, cotton swabs, specimen bottles, gloves and catheters. In a more recent study, Oruonye (2012) has reported that the medical wastes generated in the hospitals and clinics in the Jaringo Metropolis, Nigeria include needles and syringes, soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, medical devices and radioactive materials with 26.7% of the waste generated being needles and other

sharps. These reports reflect the similarities in types of activities undertaken in the health care facilities in different parts of the world and also the global nature of the challenges concerning medical waste management. However, the present study did quantify the different types of wastes generated in the study facilities.

**Table 2: Common Types of Medical Wastes Generated in the Health Care Facilities in the Study Area**

Types of Wastes	Facilities involved (n = 49)		
	Types	Number	Percent
Sharps	All	49	100
Waste blood	All	49	100
Infectious waste fluids	All	49	100
Containers of chemicals, reagents, sponges, plastic bags & filters	All	49	100
Stocks of infectious agents and cultures	Dispensaries (18), health centres (12), veterinary research laboratories (7), medical laboratories (5) & hospitals (4)	46	93.3
Anatomical and pathological wastes	Health centres (12), veterinary research laboratories (7), hospitals (4), medical laboratories (5) & clinics (3)	31	63.3
Radioactive wastes	Health centres (9), veterinary research laboratories (5), medical laboratories (4) and hospitals (3)	21	42.9
Mixed wastes from biosafety cabinets	Veterinary research laboratories (7) & hospitals(4)	11	22.5

### **Separation, Storage, Treatment and Disposal of Wastes**

With respect to separation of medical wastes, 91.8% of the respondents stated that they separated wastes at the point of generation while in 8.2% of the institutions, separation of the different types of wastes was not practised. The observations in this study are similar to those reported by other workers. Lubasi-Kapijimpanga (2008) reported that in 85 health care institutions that were audited in Zambia, except for sharps, other types of medical wastes were not separated. In a study involving 135 LLHFs in Ilala Municipality in Dar es Salaam City comprising 103 dispensaries, 13 clinics, 11 laboratories and 8 health centres, Manyele *et al.* (2010) observed that only 37% of the facilities segregated sharps waste from other infectious waste immediately after use. Oruonye (2012) has also reported that only 20% of the 60 health care institutions in Jaringo Metropolis in Nigeria segregate the wastes before disposal. Segregation of medical wastes helps in reducing disposal costs because

non-infectious wastes are not mixed with infectious ones, which normally demand stringent and costly disposal arrangements (Manyele, 2004). Mixing of infectious and non-infectious wastes renders all the wastes to be potentially infectious and this increases the costs of disposal (Chandra, 1999; HTMO, 2001). Therefore, there is a need of raising the awareness of staff in the facilities generating medical wastes on the importance of minimizing unnecessary costs of waste management by adhering to simple procedures like waste separation (Strain and Gröschel, 1995).

Table 3 presents the different types of waste management practices in health care facilities in the study area. With respect to the use of personal protective equipment (PPE), all the 49 respondents reported that gloves were the most common protective gear used followed by laboratory coats (95.9%), boots (71.6%) and aprons (57.1%). Other PPE used were goggles (20.4%) and gowns (20.3%). The types of gear used depended on their availability, type of activity being done and level of protection required, and hence different combinations of PPE were used. However, all respondents reported that there was shortage of PPE in their facilities, implying that the workers are exposed to occupational hazards or risks due to inadequate protection during handling hazardous wastes. These findings are similar to the observation of Lubasi-Kipijimpanga (2008) who reported that in all the audited 26 hospitals and 59 clinics in Zambia, handlers of medical wastes did not have appropriate protective clothing. Manyele *et al.* (2010) reported that most of the workers in LLHFs in Ilala Municipality lacked PPE like plastic aprons, masks and protective goggles, gloves and boots implying that they are at risk to needle-stick injuries, which may expose them to infection by blood-borne pathogens like hepatitis B virus, hepatitis C and HIV. Occupation hazards such as exposure to hepatitis B virus and HIV is an issue of major concern for handlers of infectious wastes where there is shortage of appropriate protective gears (OTA, 1988). Therefore, authorities responsible for waste management in health care institutions must ensure that staff have adequate PPE to minimize exposure to occupational hazards such as needle-stick injuries.

**Table 3: Types of Personal Protective Equipment and Storage Containers for Medical Wastes in Health Care Facilities in the Study Area**

Types of personal protective equipment used by staff	Facilities	
	Number	Percent
Gloves	49	100
Laboratory coats	47	95.9
Boots	35	71.6
Aprons	28	57.1
Goggles	10	20.4
Protective gowns	10	20.4
<b>Containers used for storage of medical wastes</b>		
Plastic buckets	47	95.9
Safety boxes	39	79.6
Plastic bags	7	14.3
Paper boxes	4	8.2



The most common containers for storage of medical waste in the institutions that were visited were plastic buckets (95.9%) and safety boxes (79.6%). Other containers were plastic bags (14.3%) and paper boxes (8.2%). These findings are in conformity with reports of other studies done elsewhere in Africa. For example, in a study by Johnson (2011) in Enugu Metropolis in Nigeria involving 12 hospitals, it was observed that sharps, regulated and infectious wastes were stored either in plastic buckets or disposable bags or waste bins or rubber buckets without a clear distinction of the types of wastes in the containers. Chemicals were either disposed through sinks or open pits that posed potential environmental risks through contamination of surface and groundwater resources. Oruonye (2012) has reported that majority of the 60 health care facilities in Jaringo Metropolis, Nigeria store different types of medical wastes in closed waste bins, plastic bags and incinerators. Manyele and Anicetus (2006) reported that hospitals in different regions of Tanzania use dust bins (71%), wheelbarrow (18%) and boxes (7%) for transport of wastes from generation points to incinerators without use of plastic bags. All these observations confirm that standard procedures for storage and handling of medical wastes in health care facilities in Tanzania, like in other African countries are not adhered to. This predisposes the staff involved in handling medical wastes, the general public as well as the environment to possible exposure to hazardous or infectious wastes.

The study also revealed that only 22.4% facilities treated the wastes before disposal while the remaining 77.6% facilities did not practice any form of waste treatment. In the veterinary research laboratories, treatment of medical waste is mandatory and no waste that was potentially infectious was disposed off without being treated. The main method of treatment of solid wastes was incineration (65.3%) as was also observed in Ilorin, Nigeria (Omojasola *et al.*, 2009). Other workers also reported that most health care facilities did not treat the wastes before disposal (Lubasi-Kajipimpanga, 2008; Manyele and Mujuni, 2010; Johnson, 2011). The fact that majority of the facilities did not treat the waste before disposal raises concern about the risk of transmission of diseases from infectious waste to the public and the environment especially where waste is disposed of in areas that are accessible to the public or scavengers. Treatment of medical wastes aims at minimizing exposure of workers to hazards and infections from the point of generation to disposal (Cheesbrough, 1981; Manyele, 2004). This observation calls for the need of raising the awareness of waste management authorities on the importance of treating infectious wastes in order to safeguard environmental and public health. It also calls for enforcement of waste management regulations, which require that infectious wastes are treated before disposal.

The methods of disposal of liquid waste in the study area were draining into the municipal sewage system as reported by 65.3% of the respondents and throwing in ground pit near the facility (16.3%). Other respondents disposed the wastes at any available space. For solid wastes, the main disposal methods were land filling (87.3%) and throwing at municipal dump site (16.3%). The latter method poses the risk of contamination of soil and ground water especially because waste treatment was not undertaken in most of the facilities. In a study of the management of medical wastes in hospitals involving 84 respondents from 8 administrative regions

of Tanzania, Manyele and Anicetus (2006) established that the main disposal methods for medical wastes in the hospitals comprised of open pit burning (48%), burying and incineration. Although it was used by a large number of the hospitals, open pit burning is not advisable as it releases toxic gases to the environment. It has been reported that indiscriminate solid waste and liquid waste disposal contributes significantly to water, air and soil pollution in Tanzania (VPO, 2005). Omojasola *et al.* (2009) reported that majority of health care facilities in Ilorin, Nigeria left untreated waste in open dump sites, burning them twice a week. This practice allowed microorganisms in the waste to discharge from waste heaps into the environment during the interval between dumping and burning, thereby contaminating it. As was the case in Ilorin, no sanitary land filling was practiced for medical wastes in Morogoro Municipality, implying that environmental contamination was a real risk. Sharma (2007) also reported that in Maldives, liquid wastes, either infectious or others, generated from health care facilities are disposed into ground without any treatment through soak pits which ultimately find their ways into the ground water aquifers. Ayers (1993) reported that leaking underground storage or disposal tanks constitute the biggest threat to underground water and efforts should be made to ensure ground pits are leakage-proof.

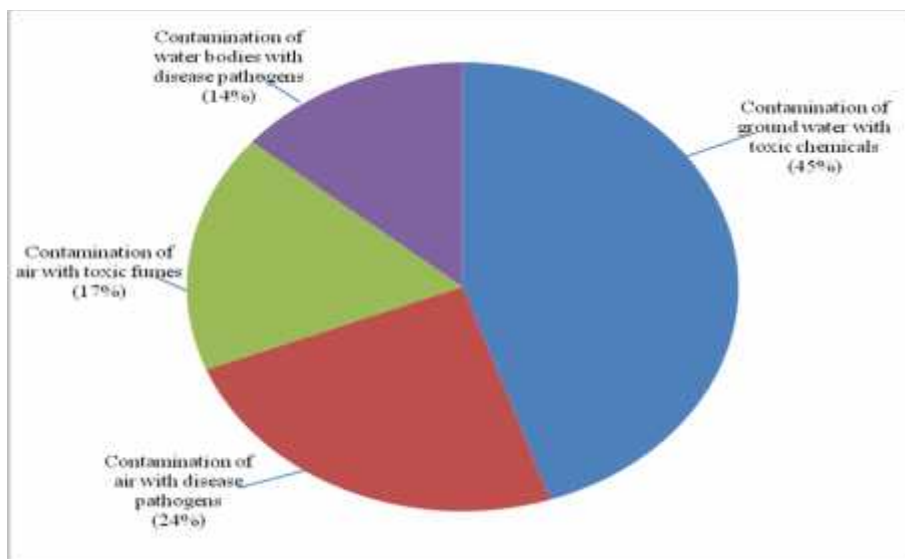
Johnson (2011) reported that chemical waste in majority of health care institutions in Enugu, Nigeria was either disposed through a sink which goes to an underground pit or disposed into an open pit, thereby becoming a potential environmental hazard through the contamination of surface and groundwater resources. Open burning of wastes results into soil and air pollution because of the release of toxic materials and gases into the air and underground. In an assessment conducted by the World Health Organization in 22 developing countries, it was revealed that the proportion of health-care facilities that did not use proper waste disposal methods ranged from 18% to 64% (WHO, 2004). It has been observed that hospitals that burn wastes or dumping bins which are transported to unsecured dumps release into the environment the wastes containing mercury and other heavy metals, chemical solvents and preservatives such as formaldehyde, which are known to be carcinogenic. Also, when plastics are combusted, they produce dioxins and other pollutants that pose serious human health risks not only to workers but to the general public (BAN and HCWH, 1999). Johnson (2011) reported that majority of the workers involved in the final disposal of wastes complained that coughing and catarrh respiratory discharges were their most common health problems.

### **Awareness on Environmental Hazards and Public Health Risks**

Respondents in the visited facilities were asked for their views about environmental hazards or risks associated with improper management of medical wastes. Twenty-nine (59.2%) of the interviewed workers reported that there were some environmental hazards or risks that can be associated with improper collection, treatment, storage and disposal of medical wastes while the remaining 41.8% respondents stated that medical wastes posed no risk to the environment. The hazards mentioned included contamination of ground water with toxic chemicals or disease pathogens (44.8%), contamination of air with disease pathogens (24.1%), contamination of air with toxic fumes or gases (17%) and contamination of water bodies with disease pathogens (14%) as shown in Figure 1. The other risk mentioned

was contamination of the food crops when people use wastewater for irrigation of crops and fishing.

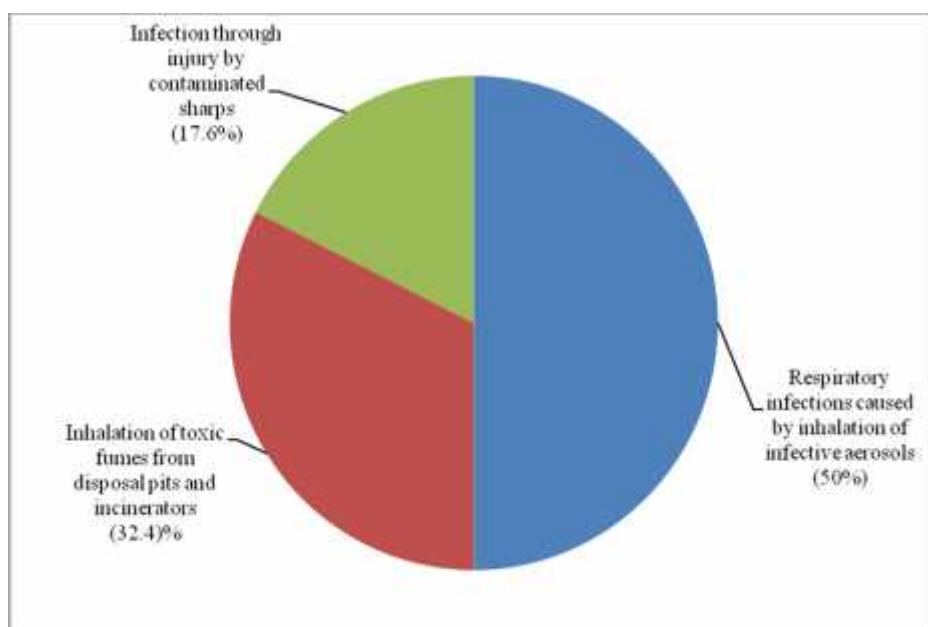
The observation that more than a half of the respondents were not aware of the environmental health risks that may be associated with improper management of medical waste implies that there is still low level of education on medical waste management among health care staff. The lack of education makes the workers prone to exposure to health hazards and risks during waste handling because such people cannot take adequate precautions to protect themselves and the general public. This problem is further compounded by the fact that workers in most facilities had not received any formal training on medical waste management. Other researchers have also reported that staff involved in management of health care waste in both developing and developed countries lack appropriate training, and consequently, are exposed to health hazards and risks as a result of improper handling of the wastes (Rutala and Mayhall, 1992; WHO, 2004 and Lubasi-Kapijimpanga, 2008; Manyele *et al.*, 2011, Oruonye, 2012). Occupational safety and health regulations require that employers must ensure that employees are protected from occupational health hazards, and this demands that workers are trained on methods of protecting themselves against the hazards (Strain and Gröschel, 1995). It is recommended that personnel charged with waste handling must participate in employee health and continuing education programmes (HTMO, 2001).



**Figure 1: Awareness of Staff in Health Care Facilities on Environmental Health Risks Associated with Improper Management of Medical Wastes**

Regarding public health risks, the study revealed that 69.4% of the respondents were aware about the existence of hazards or public health risks associated with collection, treatment, storage and disposal of medical wastes, while 30.6% of them were not aware of such risks. Some of the mentioned risks were inhalation of infective droplets or aerosols by unprotected workers leading to respiratory disease (50%) or infection that may be caused by accidental injection or injury when the

protective gear such as a glove is torn (Figure 2). Emission of toxic gases from incinerators and burnt wastes as well as fumes or air-borne pathogens from open disposal pits were considered responsible for disease in humans. Incineration of medical waste produces toxic gases such as hydrogen chloride, nitrogen oxides and sulphur dioxides while fly and bottom ash contain various toxic elements such as dioxins and furans, some of which are considered to be carcinogenic (Rutala and Mayhall, 1992; BAN and HCWH, 1999). Thus, to minimize the risks associated with incineration of medical waste, the use of alternative technologies for waste treatment is highly recommended. WHO (2004) recommended that there is a need for effective and scaled-up promotion of non-incineration technologies for the final disposal of health care waste to prevent the disease burden from unsafe health care waste management and exposure to dioxins and furans. However, until developing countries have access to alternative health care waste management options, that are safer to the environment and human health, incineration will continue to be used. Notwithstanding the above, key elements of appropriate operation of incinerators including effective waste reduction and waste segregation, placing incinerators away from populated areas, satisfactory engineered design, construction following appropriate dimensional plans, proper operation, periodic maintenance, and staff training and management must be strictly adhered to.



**Figure 2: Awareness of Staff in Health Care Facilities on Public Health Risks Associated with Improper Management of Medical Wastes**

### **Regulations and Guidelines on Waste Management**

Workers in all the study facilities reported that they were aware of the regulations governing the management of medical wastes, and had some guidelines and procedures prescribing proper handling of medical wastes. These included rules or instructions which described the steps that must be followed from the point of generation to the point of disposal of waste in order to protect workers and the

public from potential hazards or risks associated with the wastes. Although the majority of respondents (75.5%) stated that there were no problems with regard to implementation of regulations governing medical waste management, some of the respondents (24.5%) admitted that sometimes there was violation of the waste management regulations by negligent workers despite of the fact that they were aware of the regulations. For example, they stated that the lack of incinerators in most health care facilities in the municipality forced them to transport the waste to the incinerator at the Regional Hospital. When transport was not available, some of them disposed the wastes indiscriminately while being aware that regulations were being violated. Also, because of the lack of PPE, workers were forced to handle wastes with bare hands, in contravention of the safety procedures. Manyele and Mujuni (2010) observed that in cases of malfunctioning incinerators, health care workers in Ilala Municipality, Dar es Salaam City buried wastes in secured pits while 25% of the health centres reported to dump the wastes in pit latrines. Open dumping of waste was also observed in 5% of the dispensaries, while other dispensaries indicated that sharps waste was left in piles on the ground within the health facility. Because of community complaints due to nuisances emanating from the incinerators, some of the facilities, incinerated the wastes at night to hide air pollution caused by visible plumes of fumes. Lubasi-Kapijimpanga (2008) reported that some health care facilities in Zambia disposed human waste in pit latrines and septic tanks without chemical treatment to facilitate biodegradation of the waste.

The violation of the available regulations and guidelines for medical waste management as observed in the present study reflects the inadequacy in the enforcement of the regulations and lack of supervision of staff involved in the waste handling chain by managers of the waste management departments. Compliance to the medical waste management policies and regulations is the responsibility of every individual and institution that generate the waste (Anon, 2001). Since, it is always desired that systems must work for the good of the institution, proper handling, storage, treatment and transportation of wastes will not only ensure compliance to the laws governing medical waste but also enhance protection of the workers and community (McGurk *et al.*, 1994).

The present study also revealed that only 40.8% of the health care and research institutions offered some training to workers involved in waste management on procedures and precautions to be undertaken to prevent hazards to the workers, public and the environment. Further investigation revealed the training was offered mainly to clinical officers and nursing assistants, and these were expected to conduct in-house training for other staff. Lack of funds was identified to be the major factor limiting provision of training opportunities for majority of workers in all the health care and research facilities. It has also been reported that, even in developed countries like the USA, hospitals and other health care employers provide minimal training to workers involved in the waste management sections (OTA, 1988). Manyele and Anicetus (2006) reported that most health workers in Tanzania have low knowledge on medical waste management. It has also been reported that in most medical institutions in Tanzania, there are no explicit rules consigned in a single document providing adequate instructions regarding the management of the health care wastes within the establishments. Furthermore, nobody is formally nominated

to supervise the whole health care waste management system or co-ordinate the efforts between all actors within the facilities, all this leading to inefficiency and lack of harmonisation in the health care waste management procedures (MOHSW, 2007).

A study in Zambia revealed that only a few health care centres, district hospitals and general hospitals conducted training in waste management to newly hired waste management staff (Lubasi-Kapijimpanga, 2008). The remaining facilities did not provide any form of training to such workers, implying that such workers were at risk of exposure to occupational hazards associated with medical waste management. Similarly, Oruonye (2012) has reported that most of the medical waste handlers, particularly in the private hospitals/clinics in the Jaringo Metropolis, Nigeria do not have formal training in waste management techniques and hospital/clinic administrators pay very little or no attention to appropriate management and disposal of medical waste. Longe and Williams (2006) recommended that handlers of medical wastes should be trained on methods and new techniques for waste management and hazardous effects of the wastes while Manyele and Anicetus (2006) recommended that all new employees in the health sector need to acquire training on medical waste management in order to equip them with the knowledge to tackle problems associated with medical waste management in their work places. Sharma (2007) also emphasized that all persons involved in health care waste management such as doctors, nurses, paramedical staff, housekeeping supervisors, healthcare workers, waste handlers etc. shall be trained on health impacts of health care wastes and safe practices of health care waste management.

### **Opinions of Interviewed Workers on Public Awareness about Hazards and Risks**

When the respondents were asked on their opinions as to whether they considered that the general public in Morogoro Municipality was aware of the hazards that are associated with medical wastes on the environment and public health, 81.6% of the respondents were of the opinion that the general public was aware of the adverse effects of medical wastes on the environment and human health. They justified their viewpoints by the fact that, they did not see people scavenging in medical waste disposal sites, children were prevented from touching containers of medical waste and people feared to re-use syringes and needles. On the other hand, 18.4% of the respondents were of the view that the general public did not perceive medical wastes as being hazardous or risky to public health or the environment because when they visited health care facilities they did not prevent their children from touching waste containers. Also, they stated that fishing from municipal waste treatment ponds and using such wastewater for irrigating crops was an indication that people did not perceive medical wastes as hazardous to their health.

It was apparent that from the health care staff point of view that a large proportion of the general public was aware of the hazards and risks associated with medical waste to the environment and public health. This probably implies that the availability of information on health hazards in the form of posters in these institutions creates public awareness on such hazards and risks. Since there was also a proportion of

workers, albeit small, that was of the view that the general public is not aware of the hazards, the need for intensifying public awareness programmes is still eminent. Rutala and Mayhall (1992) observed that much of the public fear about medical wastes in USA in the late 1980s was a result of wide publicity by media but scientific evidence on the magnitude of risk to the public health and the environment was minimal. There have been no studies to establish the perception of the public on medical wastes in Tanzania and Africa, and most studies have focused on health care workers' perceptions. Therefore, some of the responses here may reflect the respondents' views rather than the opinion of the public. There is a need, therefore, to undertake studies for establishing the perception of the public on medical waste and compare it with those of health care workers. This is important because if the public has to participate in advocacy for good practices in medical waste management, it needs to be aware of the risks to which it is exposed. The observation by Manyele *et al.* (2011) that health care workers used to burn wastes at night to avoid public complaints imply that the public is becoming more aware of the risks associated with medical wastes and that health care institutions need to be more accountable in the way they manage the wastes.

When asked to give their views on main problems affecting proper management of medical wastes in their institutions, respondents from all health care and research institutions mentioned that lack of funds resulted into inadequate facilities such as incinerators and PPE as well as unavailability of training opportunities for proper medical waste management technologies. Inadequate funding has been identified as the major constraint for implementation of appropriate medical waste programmes in health care facilities in Tanzania and elsewhere (Manyele, 2004; WHO, 2004; MOHSW, 2007; Lubasi-Kapijimpanga, 2008; Manyele *et al.*, 2010). Longe and Williams (2006) observed that lack of comprehensive guidelines, weak enforcement of legislation and non-compliance were major problems undermining proper management of medical wastes in Nigeria.

It can be concluded from this study that, there is a great need for establishment of stringent waste management programmes in health care and research facilities in Morogoro Municipality. Such programmes have to be managed by skilled personnel who will regularly receive training on waste management technologies. It is also important that the government and other health care provisioning institutions increase the budget for waste management activities in order to ensure that the activities are conducted in an efficient manner to protect the workers and the general public from risks and hazards associated with improper management of medical wastes. Continuing public awareness programmes on hazards associated with medical wastes are required in order to mobilize the workers and general public to support the waste management policies, plans and procedures, which should also be reviewed from time to time as needs arise.

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